Transport Canada 2nd Class M.E. E.K. General – Questions and Answers

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This document contains various questions, which a person might encounter during a Transport Canada, Second Class Marine Engineering written exam, for the subject of Engineering Knowledge – General.

The answers provided herewith will hopefully assist you in studying for the exam. They are just one possibility of an answer. Nor is this a definitive list of questions and answers. You are therefore encouraged to keep an objectionable view.

I am fully aware, as are most of your peers, how antiquated some of the questions are, as they pertain to equipment and procedures aboard modern ships. Bear in mind that these questions remain in the "question bank" judging from feedback I get.

These questions were submitted to www.dieselduck.net, in May 2010. There has been some minor editing, and lots of formatting on my part.

Feel free to submit other work, corrections, and observations, that you feel might benefit the community, by sending me an email.

Martin Leduc
Martin's Marine Engineering Page
www.dieselduck.net
martin@dieselduck.net

8.7 Sketch and describe a purifier showing the construction and operation. Explain the startup procedure, the purpose of the gravity disc and what happens when the gravity disc is change?

picture

An oil purifier is an essential part of any system of forced lubrication. Its purpose, as the name suggest is to purify the oil by the removal of impurities and so maintain the oil conditions that it can be used over and over again with perfect safety. Water, dust, sand, and metallic dust are the most common impurities and of them water forms the larger proportion. Also water and oil when together tend to emulsify, water finds its way into storage tanks through leakage from sea, condensation. Dirt, sand and metallic dust are picked up from the engine parts and pipe connections through which it circulates, and rust from the tanks in which it is stored. The purifier, which is also a separator, depends for its action on centrifugal force.

The bowl in which the separation takes place carries a number of coned shaped metal discs, the disc having holes through which the oil can pass in an upward direction. The bowl is mounted on a spindle in the lower end of which can be seen the worm gear through which it is driven. A motor providing the power.

The action of the purifier is a follows; the oil to be purified enters at the top and flows downwards to the lower part of the bowl. Due to the speed at which the bowl is made to revolve, about 7000 rpm, the centrifugal force imparted to the oil causes it to ascend through the holes in the disc. In the process any solid material is thrown outward to the periphery of the bowl, where it is retained in sediment. Water being heavier than the oil passes outward and upward along the outer edges of the disc and from there to the water discharge outlet. The oil having a lesser specific gravity than the water, passes upward between the disc and then to the oil discharge outlet. The construction of the purifier is such that that it will adjust itself automatically to varying proportion of oil and water, so that when no water is in the oil there is no discharge from the water outlet and vice versa. The same type of purifier can be used in the purification of fuel oils, but it may be necessary to change the discharge discs used in the bowl to suit the specific gravity of the oil. The discs are stamped with the range of specific gravities.

Some types of purifiers are self cleaning. Manual cleaning may be preferred so that the solids can be examined and also because use may be intermittent and the extra expense not justified. While the oil is passing through the purifier the sliding bowl bottom is held up in position by the operating water beneath it. The sliding bottom seals the bowl by being pressed against the sealing ring in the rim of the cover. Solid from the oil are thrown outwards by centrifugal force and collect against the bowl periphery. At intervals dictated by either time or choice the oil feed is turned off and the bowl opened to discharge the solids. There are a number of discharge ports around the bowl. At the end of the discharge the bowl is closed and after the liquid seal has been established the oil feed is continued. During normal running the pressure exerted by the water under the sliding bottom is sufficient to keep it closed against the pressure from the liquid in the bowl. The operating water tank maintains a constant head of water to the passing through the operating valves. The paring discs, which acts like a pump opposing this head provided that the radius of the liquid remains constant. If the evaporating or leakage causes a slight water loss the reverse pumping effect of the paring disc is reduced and water from the operating tank and the quantity of water in the passing chamber back to the correct radius. The operating slide prevents loss of water from beneath the sliding bowl by closing the drain holes.

8.1 How is water detected in fuel oil? In lube oil? How it affected? What effect would water in fuel have on engines?

If a sample of oil in a test tube is heated any water drops in the sample will cause a crackling noise, and can cause the formation of steam bubbles. A simple settling would be sufficient to detect large quantities of water in the oil. Also a water detection paste can be used changing color when there is no water present and changing color when there is water present. Some fuel reject water easily, others retain it, and have a cloudy appearance for an extended period after being mixed with water. Some fuels contain as little as .01 percent of water will appear cloudy. When lube oil is contaminated by water it turns cloudy or a milky color. This cuts down considerably on the efficiency of the lubricating oil. It also causes parts of the engine to rust and moving parts to stick. Water is an undesirably contaminant because apart from the fact that it is not a good lubricant it may combine with oil in tank to form of an emulsion which by adhering to cooling surfaces may reduce their efficiency. The effect of water on a diesel engine are uneven engine operations. When water gets into the fuel lines it cause the engine to shut down. Another problem with water in fuel is it could cause pumps and injectors to stick. Water in fuel causes filter stoppage. Needed for bacteria to grow.

8.4 Sketch and describe the pneumatic guage. State its use and how it operates. Does the specific gravity of a liquid in the tanks have any effect on this guage?

picture

The pneumercator guage is a simple and reliable apparatus used to measure the quantity of liquid in a tank. It consist of these main parts, a balance chamber fixed to the bottom of the tank, a hand operated air pump placed near the tank, and a graduated mercury guage column. A light copper tube connects the chamber to the pump and gauge. The balance chamber is a cast iron bell shaped chamber having an orifice out on its side, near the bottom as possible. The top is attached a copper tube to the pump with a branch leading off to the mercury gauge.

The pump increases air through its tube to the balance chamber. The air pressure displaces the liquid from the chamber until the level is steady to the level of the orifice. When the level is steady the air can escape passing upward through the liquid to the atmosphere via the vent pipe. The air pressure necessary to displace the liquid from the balance chamber is a measure of the weight of depth of the liquid in the tank.

When the pump has displaced the liquid in its chamber the cock is switched over to admit the air pressure to the mercury guage and the height of the mercury is read off the graduated scale. The scale is graduated for sole average specific gravity and a correction has to be made for oils of different specific gravity and a chart is provided to ascertain the tanks depths.

8.5 What is meant by flashpoint of oil? What is meant by fire and ignition point? What is meant by viscosity and by cetane number? Describe briefly the apparatus used to determine the closed flashpoint of a fuel and how it is used?

Flashpoint: is the temperature at which the oil gives off a flammable vapour when heated. When a naked light is applied the vapour flashes into a flame but does not burn. This only occurs when there is air to mix with the vapour to form an explosive mixture.

Firing or ignition point: is generally about 40 degree to 50 degree above flashpoint. This is the temp at which the vapours given off from the heated sample are ignited by flame application and will burn continuously.

Viscosity: is a measured on a time basis. It is expressed as the number of seconds for the outflow of a fluid quantity of a fluid through a specially calibrated instrument of a specified temperature British praticier uses the Redwood viscometer. This redwood #1 is the flow time of 50ml of fluid up to 2000 seconds. Is an oils resistance to flow?

Cetane number: is an indication of the ignition quality of a fuel. Speed and cetane number can be connected. The bridge speed engines, above 13.3 rev/sec a cetane number of 48 usually are regarded as a minimum while for very slow running engines below 1.7 rev/sec a cetane number of 15 is min.

Picture

To determine the closed flashpoint of oil, an apparatus known as the Pensky Martin Test can be used.

- A fresh sample must be used for every test and can be taken from tank but caution must be taken that no trace of cleaning solvents is present in the oil cup.
- When the operating handle is depressed the shutter uncovers the ports. The flame element is depressed through one port above the oil surface. Starting out at a temperature 17 C below the judge flashpoint the flame is depressed raise again in a period of under two seconds at 1 C temperature intervals.
- Just below the flashpoint is reached a blue halo occurs around the flame. The flash is observed just after through the observation ports stirring being discontinued during flame depression.
- Oils with flashpoint below 22C are classified as dangerous (highly flammable such as gasoline)
- Flash points in the range 22-66C would relate to kerosene and vapouring oils
- above 66 safe and include diesel and fuel oils

8.6 Describe, with the aid of a sketch, a carburetor for gas engine.

Picture

In the carburetor system shown above a main air fuel mixture of approximately constant ratio is obtained by mounting a petrol spraying orifice in a venture or choke tube. The spraying orifice is supplied with petrol from a chamber in which a float needle valve maintains a constant petrol level. This level is maintained very slightly below the mouth of the sprayer orifice, and petrol flows from the chamber to the orifice through a jet or restriction, which controls the rate of flow. The air flow is controlled by a butterfly valve.

When the fuel moves into the intake manifold under partial vacuum the boiling point of the gasoline is lower. This causes many of the atomized particles of fuel to flash into vapor. As the partially vaporized fuel moves through the manifold it is warmed by the heat of the many...... This causes further vaporization. When the mixture enters the combustion chamber, both the swirling motion and the sudden increase in temp due to the compression stroke causes ignition of the fuel.

8.9 a. Sketch some type of shell and tube type of lubricating oil cooler indicating the direction of flow oil and coolant.

b. name the materials used for the components

c. what major faults are likely to arise with this equipment

d. how are faults inhibited?

Picture

Tube coolers for engine jacket water and lubricating oil cooling are usually circulated with sea water. The sea water is in contact with the inside of the tubes and the water boxes at the cooler ends. The oil or water being cooled is in contact with the outside of the tubes and the shell of the cooler. Baffles direct the liquid across the tubes as it flows through the cooler. The baffles also support the tubes.

The shells of the cooler are made of cast or fabricated metal. The material is not critical provided it is not reactive with chemicals, because it is not in contact with sea water. The tubes are made of stress relieved aluminum brass tubes expanded into Naval brass tube plates. The coolers are made up to have a fixed plate at one end and a tube plate at the other end which is free to move with expansion of the tubes. "Other materials found in service are gunmetal aluminum bronze and sometimes special alloys.

The tube stack is fitted with disc and ring baffles. The fitted end, gaskets are fitted between either side of the tube plate and the shell and end cover. At the other end, the tube plate is free to move with seals fitted either side of a safety expansion ring. Should either liquid leak past the seal it will pass out of the cooler and be visible. If the joints leak at the other end the special "tell tale" ring will allow the liquids to escape without mixing. The joint rings are of synthetic rubber. Water boxes and covers are commonly made of cast iron or fabricated from mild steel coated with rubber or a bitumastic type coating which protects the iron or steel but provides protection for the tubes and tube plates. Water boxes of gunmetal and other material are used but these like the coated these metals give no protection soft iron or mild steel, anodes can be fitted in the water boxes provided they cause no turbulence will help to give cathodic protecting and a protective film.

Manufacturer recommends that coolers are arranged vertical. If horizontal installation is necessary the sea water should enter at the bottom and leave at the top. This system will ensure less corrosion, and air lock will reduce the cooling area and cause overheating. Therefore vent cocks should be fitted, for purging air. Clearance is required at the cooler fixed end for removal of the tube nest. Before cleaning coolers are isolated from the system by valves and blanks or by removing pipe and blanking the cooler flanges. Flushing is necessary after the cleaning agent has been drained from the cooler.

picture

1.15 Describe the open hearth process of steel manufacture. What is meant by acid steel and basic steel?

In the open hearth process a broad shallow furnace is used to support the charge of pig iron and scrap steel. Pig iron content of the charge may constitute 25% to 75%of the total, which may vary in size depending upon furnace capacity, between 10 to 50 tonnes. Scrap steel is added to reduce melting time if starting from cold. Fuel employed in this process may be enriched blast furnace gas (blast furnace gas may contain 30% CO after cleaning) which melts the charge by burning across its surface. Reduction of carbon content is achieved by oxidation; this may be assisted by adding pure iron oxide to the charge. Other impurities are reduced either by oxidation or absorption in the slag. At frequent intervals samples of the charge are taken for analysis and when the derived result is obtained the furnace is tapped.

When pig iron is refined by oxidation a slag is produced. Depending upon the nature of the slag one of two types of processes is employed. If the slag is siliceous it is the acid process. If it is high in lime content the basic process is used. Hence the furnace lining which is in contact with the slag is made of siliceous material or basic material according to the nature of the slag. Thus avoiding the reaction acid plus base =salt plus water. Both acid and basic process can be operated in the open hearth, Bessemer, LD and electric are furnace.

1.6 Name materials used to make the following: cylinder line, connecting rods, and fuel lines. State the properties of each.

Cylinder liner:
Cylinder liners must not only withstand serve stresses due to differences in temp and pressure but must resist the abrasive action of the piston rings. The composition on the material of cylinder liners is so as follows, but it must be remembered that the foundly methods employed the pouring temperature and time taken to cool out after casting are also important.

Graphite cast iron

Composition:

- combine carbon 0.8 to 0.9 %
- free carbon 2.2 to 2.4%
- silicon 0.8 to 1.0%
- manganese 1.0 to 1.7%
- phosphorus 0.2 to 0.3%
- sulphur 0.08 to 0.1%

Mechanical properties:
Tensile strength- not less than 14 tons/in2
Transverse strength- not less than 2500 lbs/in
Brinell hardness figure- over 200

Connecting rod:
For connecting rods the scemins- martin open hearth or ingot mild annealed steel is used.
Ultimate tensile strength: 28 to 32 tons/ sq. in.
Elongation 25 to 29%
Low medium carbon steel with 3 to 3.5%nickel content.

Fuel lines:
These lines must be of a strong solid drawn ....high pressure steel tubing. It must have a high tensile strength. The thickness of these lines can and set for the individual installation taking the working pressure into account.

1.7 Describe fully how case hardening is carried out. What are the properties of metal that may be case hardened? What part of a ship machinery can be case hardened?

Case hardening is also sometimes referred to as "pack carbonizing". The steel component to be case harden is packed in a box, which may be made of fire clay cast iron or a heat resisting nickel, usually alloy carbon rich material such as charred leather, charcoal, crushed bone and horn or other material containing carbon is the packing medium which upon encompass the component. The box is then placed in a furnace and raised in temp to above 900 C. The surface of the component will then absorb carbon forming an extremely hard case.

Depth of case hardening depends upon two main factors, the length of time and the carbon rich material used. Actual case depth with this process may vary between 0.8 mm to 3mm requiring between two to twelve hours achieving these limits. Case hardening of steel is required in certain places depending on the type of work the steel will be doing. Low carbon steels (0.08 to

0.34 carbon do not harden to any extent even when combines with other alloying elements. Therefore when a soft tough core and extremely hard outside surface are needed the steel should be case hardened. Gudgeon pins and other bearing pins are examples of components which may be case hardened. They would possess a hard outer case with good wearing resistance and a relative soft inner core which ductility and toughness necessary for such components.

1.8 Describe the construction of a tail shaft. What metals are used? What test is carried out and what readings would you expect to find.

The propeller or tail end shaft is the aftermost length of shaft from good quality mild steel of 28 tons tensile strengths. It requires having toughness and being resistant to fatigue. In the past propeller shaft were commonly made of wrought Iron. The tail end shaft is 10% greater in strength than the tunnel shafting by reason of the varied stresses to which it is subjected, also to the liable to corrosion by its contact with sea water.

The shaft is machined over with a taper at the end for taking the propeller. The propeller boss is of the order of (0.75 inch per feet 1mm per 10mm length) length and has a length of approx. 3 times the shaft dia. The keyway is milled out and has semicircular ends to avoid stress concentration. To protect the shaft from corrosion and from wear it has a sleeve or lines of gunmetal shrunk on. This liner may be in one or more lengths and is machined to have the dia of forward length slightly greater than the after length. The difference in diameter is an aid for fitting shaft into the stern tube. The working stress induced in a propeller shaft is torsion, going ahead and astern and which will vary in intensity on the power developed by the engine.

COMPRESSION: while going ahead
TENSION: while going astern
BENDING AND SHEERING: due to the weight of the propeller and its overhang.

1.2 describe as many as you can of the physical test supplied to metals in construction of boilers.

The metal used for most of the main parts of a marine boiler, both multi-tubular and water tube is mild steel but of varying quality.
The tests carried out in the metal used for various parts are:

- tensile tests for shell plates, drums, header, tubes, and stays
- bend test for end plates corrugated furnaces, rivets
- flattening test for rivets heads and boiler tubes
- hydraulic test for tubes, smoke tubes, and water tubes

For welded parts of pressure vessels the following added tests are required
1. Radiographic examination for the detection of faults in the metal
2. Micro examination for picturing the structure of the .....

TENSILE TEST:
This test is carried out to ascertain the strength and ductility of a material. To carry out this test

a specific testing machine is necessary. The specimen to be tested is held in self-aligning gripe and is subjected to a gradually increasing tensile load. The beam must be maintained in a floating condition by movement of the jockey weight as the oil pressure to the straining cylinder is increased. An enteriameter fitted across the specimen gives extension readings as the load is applied with respect to extension, the normal stress shear diagram is plotted for comparison purpose on the same diagram.

The difference is due to the fact that the value of stress in the minimal diagram is calculated using the rise sectional area of the specimen. The actual fact the cross sectional area if the specimen is reducing as the specimen is extended. Specimens may round or rectangular in cross section, the gauge length being found by reducing the cross section of the certain portion of the specimen. This reduction must be gradually, rapid change of section can affect the results. In the tensile test the specimen is broken. After breakage the broken ends are fitted together and the distance between reference marks and the smallest diameter is measured. Maximum load and load at yield are also determined. The tensile stress can be calculated by.

$$\text{ULTIMATE TENSILE STRESS} = \frac{\text{MAXIMUN LOAD}}{\text{ORIGINAL CROSS SECTIONAL AREA}}$$

BENDING TEST:
This is a test which is carried out on boiler plate materials and consists of bending a straight specimen of plate through 180 degrees around a former. For the test to be satisfactory, no cracks should occur at the outer surface of the plate.

FLATTENING TEST:
This test is used for testing rivets. The head of the rivet is hammered while hot until it is 2 1/2 times the diameter of the shank. The ends are then inspected for defects. The shank of the rivet is bent cold and then hammered until the end meet. The curved part is then inspected for defect.

To test the welds on a pressure vessel the following tests are carried out.

CADIOGRAPHY:
This can be used for the examination of welds, forgings and casting, that is x-rays, which penetrate up to 180mm of steel pass through the metal and impinge up a photographic plate or paper to give a negative. Due to the variation in density of the metal the absorption the rays is non-uniform, hence giving a shadow picture of the material. It is like shining light through a semitransparent material, x-rays produce in a Coolidge to give quick clear results and a clear negative.

ULTRASONICS:
With ultrasonic we do have the limitations of metal thickness to consider so we have radio sonic testing. High frequency sound waves reflect from internal interfaces of good metal and defects. These reflected sound waves are then displayed onto a screen of cathode-ray oscilloscope. Size and position of a defect can be ascertained. It can also be used for checking material thickness that is a probe could be passed down a heat exchanger tube. a portable battery operated, hand held cylindrical detector with cable to a set of headphones can be used to detect leakage in vacuum, air lines, superheated steam, air conditioning etc. a recent application of ultrasonic is

testing concept. A generator placed inside the condenser floods it with ultrasound. By using a head set and probe, tube leakage can be found. Where a pin holes exist, sound leaks through and noise a tube is thinned vibrates like a diaphragm transmitting the sound through the tube wall.

METHODS OF DETECTING SURFACE DEFECTS

1. A visual examination, including the use of a microscope or hand lens.

2. PENETRANT TESTING:
Penetrating liquids must have a low viscosity in order to find there way into fine cracks.

a. Oil and white wash. This is one of the oldest and simplest of the penetrate tests. The oil is first applied to the metal then the surface is wipes clean. Whitewash or chalk is then painted or dusted over the metal and oil remains in the cracks will discolor then whitewash or chalk. Paraffin oil is often used because of its low viscosity and the component may be alternately stressed and unload to assist in bringing oil to the surface.

b. Fluorescent penetrate wiped or sprayed over the metal surface which is then washed, dried and inspected under near ultra-violet light. A developer may be used act as a blotter, to cause the penetrate to re-emerge at the surface.

c. Red Dye Penetrate: This is probably the most popular of the penetrate methods because of its convenience. The aerosol cans are supplied, red dye penetrate, cleaner, and developer. Components must be thoroughly cleaned and degreased, and then the red dye is applied by spraying on. Excess dye is removed by hosing with a jet of water or cleaner is sprayed on and then wiped off with a dry cloth. Finally a thin developer is applied and when it is dry the component is examined for defects. The red dye stains the developer almost immediately, but further indication of defects can develop after 30min or more. Precautions that must be observed are 1) use protective clothing 2) use aerosols well ventilated placed 3) no naked light, the developer is inflammable.

MAGNETIC CRACK DETECTION
A magnetic field is applied to the component under tests... and where ever there is a surface or subsurface defect flux leakage will occur. Metallic powder applied to the surface of the component will accumulate at the defect to try and established continuity of the magnetic field. This will also occur if there is a non-metallic in the metal or at just below the surface.

1.4 with reference to the heat treatment of steel describes process of hardening, temping and annealing. What parts of an engine would require any of those treatment.

HARDENING:
This is the process of heating steel to above its, critical temperature, in an ordinary fire about 1253 C and then cooling the steel in an air or water. During the heating operations, care should be taken to cool the steel when this temp is reached. The hardening temperature depends upon the carbon content of the steel, temp increasing as percentage of carbon decreases. The process of hardening produces internal stresses and also makes the material brittle.

When steel is melted to is critical temperature there are changes in internal structure of the iron which affect also the carbon which is present in the form of carbide. At the upper critical temp range 720-900C in the solid state the iron structure formed has the ability to dissolve the iron carbide into solution forming a new structure. If at this stage the steel is suddenly quenched in water the iron carbide will remain in solution in the iron, but the iron will have reverted to its original form.

TEMPERING:
To relieve these stresses from hardening material is tempered.
This process consist of heating the material to about 250C retaining this temperature for a duration of time (depending upon the mass and degrees of toughness required) and then quenching or cooling in air. The process relieves stress and restores ductility without loss of hardness or toughness.

Such as drills, chisels, ouches, saws, reamers

ANNEALING
This process consists of heating the material to a predetermined temperature, possibly allowing it to soak at this temperature till cooling it in the furnace at a controlled rate. Annealing is used on a material to achieve the grain, induce ductility, relieve stress, or a combination of these. For full annealing the temp for carbon steals is usually 30 to 40C above the critical temperature. Casting, forgings, sheets, wires and welds materials can be subjected to the annealing process.

With reference to an engine. Gudgeon pins, and other bearing pins are examples of components which may be case hardened. They would possess a hard outer case with good wearing resistance and a relative soft inner core which retains the ductility and toughness necessary for such components.

Tempering would be present also in the gudgeon pins, and other bearing pins as well as piston rings.

Example of annealing for an engine would be of casting such as cylinder heads and liners, forgings, sheet wire and welded material.

1.3 Describe how electric welding is carried out. Where can electric welding be done on a boiler? What metals can be welded?

In electric welding an electric arc is struck between the electrode, which serves as a filler metal, and the metal to be welded. The heat which is generated causes the electrode to melt and the molten metal is transferred from the electrode to the plate. AC or DC current can be used for welding. When welding a generator is used, two leads are attached to the generator, one is the electric current and on the other lead a holder is attached which is clamped or grounded to the material to be welded.

The arc is formed by touching the material with the point of the electrode. The current continue to pass when the work and the electrode are separated. The heat of the arc melts the metal on the electrode so that the two fuse together. The melting metal of the electrode for the filler metal. The electrode rod are usually flux coated. This coating melts at a higher temperature then the electrode metal, and therefore the coating protrudes beyond the case during welding. This gives better stability, contact, and concentration of the arc. The coating shields the arc from the atmosphere by means of inert gases given off. Silicates from the coating forms a slag on the surface of the hot metal which protects it from the atmosphere as it cools. Also due to the larger concentration of the slag than the metal as cooling is taking place, the slag is easily removed.

AC welding is more popular than DC welding because

1) More compact plant.
2) Less plant maintenance
3) Higher efficiency than DC
4) Initial cost is less for similar capacity plants

Disadvantage

1. Higher voltage is used therefore high stock risk
2. More difficult to weld cast iron and non-ferrous metals

Circuit is about 15-45 volts and about 80-360 amps. Metals that can be welded, are steel and ferrous metal, aluminum, and magnesium, copper, and ferrous metals such as stainless steel without a flux, oxygen arc welding or tag welding.

Electric welding can be done on boiler parts, but it must be carried out by a qualified welder and under strict codes pertaining to welding of pressure vessel. The welding must also be subjected to various tests.

1.13 In reference to metals what is meant by: a) compressibility b) elasticity c) tenacity d) ductility e) malleability and f) brittleness

a) Compressibility: is the property the body may possess of changing its bulk so as to be of less capacity without changing its form. For example a gas may be compressed to have a volume, but a solid is not so compressible but while a liquid is often said to be incompressible.

b) **ELASTICITY**
The ability to return to the original shape or size after having been deformed or loaded,
Is the property that a body may possess of changing its bulk so as to be of greater capacity without changing its form. The law that governs compressibility should apply to elasticity; gases expand easily, solids to a limit extent, and liquid not at all. The term compressed and elasticity in metals are used to denote that properties of changing he original form or bulk when under load and returning to these original form or bulk when the load has been removed.

c) Tenacity
Is a property a body may possess being drawn out so that its particles are stretched permanently. This is the main single criterion with reference to metals. It is a sure of the material's ability to withstand the loads upon it in service.

d) Ductility

Is that property of a material which enables it to be draw easily into wire form. The percentage of elongation and contraction of area, as determined from a tensile test are a good measure of ductility.

e) Malleability
Is a property similar to ductility. If a material can be easily beaten or rolled into plate form, it is said to be malleable.

F) Brittleness
Where a body is neither plastic nor elastic it is said to be brittle. For example, cast iron when under tension breaks off short, under compression it crumbles therefore shows that it possesses no elasticity or plasticity, and is therefore said to be brittle.

1.12 What is monel metal? How is it made and for what application is it used? What engine parts may be made of monel?

Monel metal is a natural alloy containing approx. 2/3 nickel, 1/3 copper, a small percentage or iron and anganese. It is found in its natural state and in the production commercial metal eliminating the impurities is accomplished without separation of its contengent metal. Monel metal being composed largely of nickel has none of the characteristics of nickel.

It has great physical strength when subjected to high temperature and a high resistance to corrosion and erosion. It has a large co-efficient of expansion and high fatigue value and is rust proof and highly resistant to corrosion from acids such as ammonia. It has a glass like polish and is highly resistant to wear and abrasion.

It can be worked by all conventional methods, as easy as steel is. It can be rolled into sheets or sheer, drawn into wire, forged or cast. It has a tensile strength ranging between 30 and 50 tons a square inch, depending on the treatments to which it has been subjected. For instant when rolled cold it has a tensile strength of 45 tons per sq inch and a percentage of elongation of approx 15%, but has an effect of lowing tensile strength to about 30 tons per sq inch but bringing elongation percentage to near the same value. When cast the tensile strength is about 21 tons per sq inch and elongation about 12%. it has a specific density of 8.6 and a melting point of 1350C.

Monel metal is used for turbine blades when high heat and pressure are encountered. Other uses are: condenser tubes, pump rods, impellers, scavenge valves, and super heat steam valves.

1.5 What is stress when referring to engineering materials? Name the types of stress set-up in the following

- **a) cylinder cover studs**
- **b) crank web**
- **c) connecting rod**
- **d) the shaft forward of the thrust collar when the piston is on the down stroke**
- **f) the propeller shaft aft of the stern tube**

Stress is the state the particles of a body are present in when a load is applied to the body. When we use the term "stress" we mean, the average load per unit area expressed as tons per square inch or pressure per sq inch. The nature of stress depends on how the load is applied to the body. Stress may be compressive, tensile, bending, shearing or torsional.

$$\text{STRESS} = \frac{\text{OTAL LOAD}}{\text{AREA OF SECTION}}$$

CYLINDER COVER STUD
The pressure set up by combustion in the cylinder causes the piston to move downward and puts an upward force on the cylinder cover. This upward force causes a tensile stress in the cylinder cover stud.

CRANK WEB
The stress cause on the crank web would be a bending stress which would be a combination of tensile stress on the upper side of the web, and a compressive stress in the lower side of the web, a shearing stress would be also created.

CONNECTING ROD
On the downward stroke of the piston a compressive stress would be set up in the connecting rod, also a bending stress (combination of tensile and compressive stress) might be present due to the piston forcing straight down on the connecting rod, and the crank web forcing up on the connecting rod at a certain angle. This bending stress would be very small.

SHAFT FORWARD OF THRUST COLLAR
The stress set up in this shaft would be a torsional stress due to the twisting moment caused by the downward force of the connecting rod acting on the length of crank web.

1.9 What stresses are found in anchor chains. Describe the constituents.

The stress in anchor chains are tensile and compressive stresses, shear (erosion and corrosion, forging and casting defects.

Tests carried out by classification society on cables 12.5 mm and above, one length of cable being one shackle (90 ft) thus links are taken from each length and tested to a tensile breaking stress. If proven satisfactory the length of cable is then subjected to a tensile proof test, then inspected for flaws, weakness and material deformation. Certain grades of steel are subject to tensile stress, elongation and impact loads. Shackles and accessories are subjected to same.

The chain cables is also awarded a test certification which contains such information as type and grade of chain, diameter total length, total weight, dimension of links and the loads used in test. Serial number, name and mark of testing establishment and certifying authority. When possible anchors should be used alternatively. Cable in a locked idle for a long time becomes brittle
1) transposing of shackles to take place every so often
2) the first two or three lengths should be placed at inboard end, which require remarking.
3) inspection should now be carried out with a 10% wear down in bar diameter being

acceptable.

At a survey, joining shackles will be opened and all parts examined closely, cleaned and well lube before assembly. Warm tallow used for bolts and white lead for split pins. Hammer test on every link. When links are replaced or repaired, test to be carried out again.

1.1 Describe the manufacture of cast iron. What is its approximate density, tensile and compression strength? What parts of an engine are made of cast iron.

Cast iron is made from iron ore, which has been smelted in a blast furnace. The ore is put into a blast furnace along with coke and coal and heated to a very high temperature which caused the iron to become molten and owing to its density it falls to the bottom of the furnace while the slag or waste floats on the surface. The furnace is tapped at the bottom and the molten metal which is filtered down through the charge to the bottom of the furnace is drawn off through suitable passages and run into molding machines which forms what is known as pig iron. The percentage of carbon may range from 2 to 5 % the fracture of cast iron is a good index of its quality. It should show a close crystallinin fracture.

Cast iron has an approx. density of 7194 KG/m3. it has a tensile strength of 125 MPA, and a compressive strength of 700MPA.

The pig iron produced is of various qualities depending on the nature and quality of the ore, and is classified as being of a white, grey and mottled variety. White cast iron is clear and crystalline in structure and is of high quality. It is used for the manufacture of steels. Gray cast iron is more open or granular in structure and of a cloudy appearance. It is soft and crumbles. Mottle cast ion is the intermediate variety. Cast iron is used for nearly all casting in board ship, being easily shaped into complex forms by the method of making wooden patterns and recasting the pig iron after reheating in a smaller furnace called a cupola. Parts of engine where cast iron is employed are cylinders, valve casing and covers; the following parts are made of cast steel:

- hull
- propeller bracket
- stern frame
- rudder post
- bollard or bits
- handsaw pipe, etc

ENGINE: with superheated steam

- hp turbine casing
- main stop valve chest
- turbine nozzle box
- safety valve chest

engine: part lined with white metal

- eccentric straps
- top and bottom end bearing
- main bearing
- reversing shaft levers

in boiler work cast steel is seldom used unless for mounting included above.

1.10 Describe how you would re-metal a bottom end bearing machine it and fit it to the engine. What clearance is necessary for a 300 mm shaft?

Many engines still in service are fitted with split sleeve Babbitt lined bearings. When a lined bearing becomes overheated and the trouble is not notice in time, the soft metal of the bearing lining which may have a t.... or lead base will melt and run out.

To reline the bearing the following method is used.

1) First the upper and lower halves of the bearing are removed.

2) Next the old Babbitt is melted out of the shells by heating the bearing with a blowtorch or acetylene torch to a temp about 20 F above the melting point of the bearing metal. Before this is done however care must be taken that all recesses if the bearings are free of moisture in order to avoid explosion.

3) After the bearing metal has been melted out remove all traces of oil, dust, rust, or old lining by sandblasting, burning or pickling in hydrochloric acid. Steel and iron shells should have anchors holes or grooves. On bronze shells complete tinning is adequate in most cases.

4) All oil and drain holes are plugged, with plugs long enough to project through the white metal lining. The bearing shells are then reassembled so as to form a bearing box, with a suitable number of shims between the joints, to serve as parting piece for separating the halves of the bearing. The halves then clamped together.

5) The assembled bearing is placed on its end on a flat-finished clay surface. An oiler or mandrel from 1/8" to 1/4" smaller in diameter than the crank is placed in the center of the box with an evenly divided space all around the outside. The mandrel itself is lined with white lead and the parting piece should bear against the mandrel. In this way there will be only a thin strip of Babbitt lines to connect the halves of the lining, which facilitates the breaking apart of the lining after it is cast. Mandrels may consist of machined pieces of pipe having an outside diameter slightly less than the shaft diameter.

6) Enough Babbitt must be melted in the ladle or in a pot lined with black lead to re-babbit the whole bearing in one pouring. Melt the metal close to the mold to prevent cooling between the pot and the mold. The Babbitt should be heated to a temperature of about 700 F (330C approx.) using a pyrometer if possible. For a rough test insert a pine stick in the metal. If the temp is right the stick will char, but not burn. Keep the molten metal thoroughly mixed before pouring.

7) Be sure the mold is clean and dry. Then preheat the shell and mandrel to 250 For (120 C approx.) before pouring the Babbitt, as this will reduce the difference between the amounts the Babbitt and the box will contrast while cooling and will aid in the free flow of the molten steel. Pour the molten metal slowly to allow air to escape from the mold, thus preventing air holes. If the ladle does not pour from the bottom, skim drops from the surface before pouring t...

8) Metal is poured around the mandrel, and as the metal shrinks upon cooling, the clamps are removed and the two halves are separated.

9) The joints are dressed so that the metal is flush with the parting edges of the shell and the plugs are removed from the oil and drain hole. After clamping the halves together the bearing is bored in a machine shop to a small fraction of an inch smaller than the shaft so as to allow a perfect fit to be made by scraping the bearing by hand.

The Babbitt melted from the bearings can be reused in the future. However do not mix or use re-melts of an unknown or inferior quality. Small amounts of tin in a lead base Babbitt represent contamination while as little as 3 % of lead in a tin based Babbitt reduce its physical properties. Lead softens an alloy while antimony hardens it. Copper is used in some of the better grades of Babbitt**.** High antimony babbits are used in large bearing operating under high pressure. Babbitt metals low in antimony are used in bearings of high speed engines. A very high grade of bearing metal may be made by melting 7 percent of copper at as low a heat as possible and adding 25 parts of antimony and 200 parts of tin. The metal is cast in ingot molds and re-melted, then 8 lbs of tin is added to each 5lbs of the batch. The final mixture can then be cast until needed.

As a general rule the clearance for a 12" shaft is from 8-9 thousandths of an inch. Therefore for a 300mm shaft (12") the clearance is from 8-9 thousands of an inch. This will vary with the type of engine. Approximate clearance used is one thousand per inch up to 4"and1/2 thousandth per inch after that.

600mm=0.004
calculations

SAFETY:

CO2 TOTAL FLOODING SYSTEM FORMACHINESPACES:

PICTURE

For machinery space containing diesel propelling machinery, or auxiliary machinery whose total power 746 kw or more a fixed fighting installation has to be provided. One such system is the CO2 total flooding system which must give a 40% saturation of the compartment of which at least 85% must be discharge into the compartment in about two minutes CO2 flooding is often used for tanker engine rooms and pump rooms even if the machinery used in steam turbine.

First ensure that the compartment is evacuated of personal and sealed off. This necessitates closing all doors to the engine room, shutting down skylights, closing dampers on vents and stopping ventilation fans. Pumps should also be stopped and collapsible bridge valves closed. In a modern vessel the sealing off can be done by remote control from the fire control station generally using compressed air or hydraulic system. The door of the steel control box situated at the fire centre station would then be opened; this operates a switch which may have a dual

purpose. One is to operate audile and visual alarms in the engine room spaces, the other may be to shut off ventilation fans. The CO2 direction valve handle would then be pulled and that would be followed by gas released. Ensure that all moving parts are kept clean free and will lubricated. Wires must be checked for tightness, toggles and pulleys must grease. With the use of compressed air the co2 distribution pipes could be blown through periodically. CO2 bottles must be weighted regularly to check contents (an ultrasonic or radio active iso tape unit detector could be used to check liquid level. The CO2 storage bottles have seals which also act as bursting disc. Should there be a CO2 leakage from one or more of the starting bottles this cannot result in CO2 discharge into the engine room from the battery because of the cables operated safety valves. When leakage occurs either in the starting section of main battery a pressure switch in the lines will cause alarm to be sounded vents to the atmosphere can then be operated.
The CO2 system is used if a fire is severe enough to force evacuation of the engine room. An alarm is sounded by an alarm button as the co2 cabinet is opened and in some ships there is also a stop for the engine room fans incorporated.

Before releasing the CO2 personal must be counted and the engine room must be in a shut down condition with all openings and vent flaps closed. It is a requirement the 85% percent of the required quantity of gas is released into the space within two minutes of operating the actuating handle. In the system the actuating handle opens the operating bottle of CO2 and the gas from this pushes down the piston to release the other bottles. To avoid sticking, all the handles must be in good alignment. The bottles valves may be of quick release type where the combined seal/bursting disc is pierced be a cutter. The latter is a hallow passage of liquid co2 to the discharge pipe. CO2 bottle pressure is normally about 52 bars but this varies with temperature. Bottle should not be stored where the temperature is likely to exceed 55C. The seal bursting disc are designed to rupture spontaneously at a pressure of 177 bar produced by temp of about 63 C. The master valve prevents CO2 released in this way from reaching the engine room and it is despised safety a relief on the manifold.

Rapid injection of CO2 is necessary to combat an engine room fire, which has attained such magnitude that the space has to be evacuated. This is the reason for the rule that 85% of the gas must be released within two minutes.

The quantity of gas carried

a) must be sufficient to give a free gas volume equal to 40 percent of the volume of the space except where the horizontal casing area is less than 40 percent of the general area of the space or
b)must give a free gas volume equal to 35 percent of the entire space which ever is greater.

The free air volume of air receiver may have to be taken into consideration. The closing all engine room openings and vent flaps will prevent entry of air to the space. All fans and pumps for fuel can be shut down remotely, as can valves on fuel pipes from fuel service and storage tanks.

CO bottles made of solid drawn steel, hydraulically tested to 228. The contents are checked by weighing or by means of radioactive level indicator. Recharging is necessary if there is a 10 percent weight loss. Pipe work is of solid drawn mild steel, galvanized for protection against corrosion. The syphen tube in the bottle ensures that liquid if discharged from the bottle, without the syphen tube CO2 would evaporate.

CO2 FLOODING SYSTEM FOR HOLDS

This system of smoke detection, alarm and CO2 flooding is frequently used for hold spaces and in some installations may be found as additional firefighting equipment for engine rooms. For the detection of smoke 20 mm diameter sampling pipes are led from the various hold compartments in the vessel to a cabinet on the bridge. Air is drawn continuously through these pipes to the cabinet by suction fans which delivers the air through a diverting valve into the wheelhouse.

When a fire burst out in a compartment smoke issues from the diverting valve into the wheelhouse, warning bridge personal of the outbreak. Simultaneously, an electronic smoke detector in the cabinet sets off audible alarms, hence if the bridge is unoccupied (e.g. in port) the notice of outbreak fire is still obtained. Within the cabinet is a dark chamber where in the sampling pipes goes into labeled chimneys. Diffused light illuminates strongly as smoke issuing from chimney, hence the compartment which is affected by fire can easily be identified. Before the dark chamber in the cabinet is well lighted compartment fitted with a glass window and hinged for cover.

Inside this compartment, 13mm dia glass tubes are fitted which are the ends of the sampling pipes, these glass tubes protrude into the metal chimneys in the dark chamber above. Small nylon propellers are visible inside the glass tubes in the lighted portion of the cabinet and when the fans all in operation these propellers we be seen to be continuously whisler if the sampling tube is not blocked. Change over valves are generally situated inside the lower portion of the cabinet one fore each of the sampling pipes. To flood an affected compartment with CO2 gas, the operator would first operate the appropriate change over valve and secondly release the requiste number of CO2 cylinders for the compartment. CO2 gas would then pass through the sampling pipe to the space in which the fire exists.

When a smoke detection system is to be used for the hold compartments of a refrigerated cargo vessel the lines to the refrigerated holds will be blanked off in the detector cabinet. These blanks can be removed once per watch as a test (for a few days after loading cargo) and removed altogether when the hold is open and debusted. When an outbreak of fire in a compartment is detected the fire may be of small proportions and be capable of being extinguished by means other than flooding with the CO2 equipment provided. In this event it would be necessary for personal to enter the compartment in order to extinguish the fire.

However after inspection the may be such that CO2 flooding is necessary. Before this is done, an audible alarm should first be operated warning personal that CO2 flooding of the compartment is about to be used. After the fire has been extinguished the compartment must be well ventilated before entry for damage inspection, as CO2 gas is heavier than air and does not support human life.

6.6 Describe a sprinkler system and explain how it operates. Describe the control valve and explain how it is reset after use or testing of system.

picture

The sprinkler system is an automatic fire detecting alarm and extinguishing system that is constantly "on guard" to deal quickly and effectively with any outbreak of fire that may occur in accommodations or other spaces. The system is composed of a pressurized water tank with water pipes leading to various compartments. In these compartments the water pipes have sprinklers heads fitted which come into operation when there is an outbreak of fire. The pressure tank is half fitted with fresh water, through the fresh water supply line. Compressed air is delivered from the electrically driven air compressor raises the pressure in the tank to a predetermined level, this should be such that the pressure at the highest sprinkler head in the system is not less than 4.8 bars. Sprinkler heads are grouped into sections with not more than 150 heads per section and each section has an alarm system. Each sprinkler head is made up of a steel cage fitted with a water deflector.

A quardtroid by which contains a highly expansible liquid is retained by the cage. The upper end of the bulb presses against a valve assembly which incorporates a soft metal seal. When the quartizoid bulbs are manufactured a small gas space if left inside the bulb, as the bulb is subjected to heat the liquid expands and the gas diminishes. This will generate pressure inside the bulb and the bulb will shatter once a predetermined temperature (and hence pressure) is reached. Generally the operating temp range permitted for these is 68C to 93C, but the upper limit of temp can be increased this would be depending upon the position where the sprinkler head or heads is the rated. Quartriod bulbs are manufactured in different color the colors indicate the temp rating for the bulb.

rating
68C = red
80C = yellow
93C = green

Once the bulb is shattered the valve assembly falls, permitting water to be discharged from the head, which strokes of the deflector plate and sprays over a considerate area. When a head comes into operation the non-return alarm for the section opens and water flows to the sprinkler head. This non-return valve also uncovers the small bore alarm pipe to a rubber diaphragm and then operates a switch which causes a break continuously live circuit. Alarms both visible and audible fitted in the engine room, bridge, and crew spaces are then automatically operated. Stop valves, A and B are locked open and if either of these valves are inadvertently closed a switch will be operated that brings the alarms into operation. The alarm system can be tested by opening valve C, which allows a delivery of water similar to that of one sprinkler head to flow to drain.

An electrically operated pump with a direct suction to the sea comes into operation when the fresh water charge in the pressure tank has been used up. This arranged to operate automatically through the pressure relay. A hose connection is also provided so that water can be supplied to the system from shore when the vessel is in dry dock. This connection must be an international shore hose connection. Any part of the system which might be subjected to freezing must be protected.

Some sections may be of the dry pipe type, where considered necessary. The dry pipe extends upward from the section valve which also acts as the link between the sprinkler system water pressure and the dry pipe pressurized with air. Water pressure is contained by the water clapper which is held on its seat by the centre valve. The space above the centre valve is fitted to the level with water and the pipe above that is filled with air under pressure. The center valve is made watertight by a joint and intermediate sprinkler is dry. When operation of a sprinkler a sprinkler head releases the pressure in the dry pipe, the centre valve is pushed by the force of water under the clapper. The clappers lifts and rotates on the yoke being swing to one side by the effect on the water flow on the skirt. The water floods up through the dry pipe causing the centre valve to lock open, and in filling the intermediate chamber pressurizes and operates the alarm.

Pressure gauges for air and water are required. The section valve opens when air pressure drops to 1/16th that of water pressure. The cover has to be removed to reset the valve. The clapper valve alarm is tested by opening a testing valve on the dry side of the suction valve alarm allowing water to flow through the valve as though the sprinkler had been operated. After resetting the clapper the water is admitted on top of the centre valve through a water connection for that purpose and water brought to the correct level. The water is necessary for maintaining a good seal on the clapper.

picture

DRY PIPE SECTION ALARM FOR SPRINKLER SYSTEM

6.3
A) Foam

A 9 liter portable foam fire extinguisher of the inverting type. The inner and outer container are made of iron or zinc coated steel, the outer being of riveted construction. Cap and nozzle are made of brass and a loosely fitted lead valve may be situated at the top of the inner container to provide a seal. The brass cap has a series of small radial holes drilled through it which communicate the inside of the extinguisher with the atmosphere when the cap is being unscrewed; hence these holes serve as a vent if the nozzle is blocked.

Contents:
The inner container is filled with aluminum sulphate and the annular space formed by the inner and outer container is filled up to the level indicator with a solution of sodium bicarbonate and foam stabilizer. 1:3 inner and outer containers respectively.

Operation:
By inverting the extinguisher the lead seal will fall, clearing the ports in the inner container and the two solutions will mix. As the solutions mix they react, generating foam under pressure which is discharged through the nozzle.

Performance:

72 liter of foam
Working pressure 7 bar
Testing pressure 25 bar
Length of jet 7.5 to 9 m
Duration of discharge 1.5 min

6.3
B) soda-acid portable fire extinguisher

picture

The body of a soda-acid portable fire extinguisher is made of riveted mild steel, lead coated internally and externally. A screwed brass neck ring is riveted to the top dome of the mild steel body and the brass head assembly which incorporates plunger and acid bottle carrying cage is screwed into it. The head assembly joint is either acid resisting rubber or greased leather. The nozzle is made of brass and delivery tube with lose gauze filter, generally copper. To ensure that the solution does not leak out of the nozzle due to increase of air pressure in the enclosed space above the solution; (due to increase of temp) a non-return vent valve is usually incorporated in the head assembly. A 9 liter sodium bicarbonate solution fills the body to the limit of the level indicator and the glass bottle in the carrying cage contains sulphuric acid.

Operation:
When the plunger is depressed the seal bottle is shattered and the acid is released. The acid will then react with the surface of the sodium bicarbonate solution and the result of this chemical reaction is CO_2. The CO_2 builds up in pressure and the solution is then driven out of the extinguisher through the dip tube and nozzle.

Performance:

Length of jet is approx 9m
Working pressure is 2.7 bars to 3bar.
Time of discharge is approx. 1.5 min.
The body is tested hydraulically to a pressure (approx) of 25 bar (2.5 MN/m^2)

Soda acid fire extinguisher should always be stored at temperature above 0C to keep the water from freezing. They should be recharged annually and immediately after each use. During annual recharging all parts must be carefully inspected and washed with fresh water. the hose and nozzle should be checked for deterioration and clogging. The proper chemicals must be used for recharging. The sodium bicarbonate solution should be prepared outside the extinguisher preferable with Luke warm water. The recharge data and the signature of the person who serviced the extinguisher must be placed on the tag attached to the extinguisher. Several times a year the extinguisher should be checked for damage and to ensure that it is fully charge and the nozzle is not clogged. this extinguisher is only used on class A fires.

C) DRY POWDER FIRE EXTINGUISHER

PICTURE

The body of a dry powder fire extinguisher is constructed of riveted or welded steel with a brass neck ring. The neck ring incorporates the CO2 injection tube. Screwed over the neck ring is the head assembly which is fitted with a spring loaded plunger, and has screwed into it a replaceable CO 2 bottle. Connected to the outlet end of the discharge tube is a reinforced hose which leads to a brass nozzle that is fitted with a lever operated control valve the body of the extinguisher contains approx. 4.5 kg of dry powder. The powder charge is principally sodium bicarbonate with some magnesium stearate added to prevent the powder from caking. The CO2 bottle contains about **60 mg of** CO2.

To operate the extinguisher remove the safety cap and depress the plunger. When the plunger is depressed it pierces the CO2 bottle seal. The CO2 then blows out the powder charge. the charge is aimed towards the fire and the discharge is controlled by the valve .... and hose. the range of the extinguisher is about 3 to 4 meter. The duration of the discharge is about 15 sec. the body of the extinguisher is tested to about 35 bar (3.5 MN/m2) Dry powder acts to smoother a fire in a similar way to a blanket, owing to the great shielding properties of the powder cloud, the operator can approach quite close to the fire.

The sodium bicarbonate powder will, due to the heat from the fire, produce a CO2 which should further assist in smothering the fire. Dry powder extinguishers have at least a B and C rating and the multipurpose type is also availed.

Some extinguishers are stored pressure dry powder extinguisher which have the propellant gas mixed in with the dry powder. This extinguisher is controlled with a squeeze-grip trigger on top of the container. A pressure gauge indicates the condition of the charge. Dry powder and their propellants are unaffected by extreme temp and may be stored anywhere about the ship. They do not deteriorate or evaporate so periodic recharging is not necessary. However the cartridges should be inspected and weighted every six months. Cartridges that are punctured should be replaced. At the same time the hose and nozzle should be checked to ensure they are not clogged. With stored pressure extinguishers the gauge should be checked at regular intervals to ensure that the pressure remains at the required level.

CO2 FIRE EXTINGUISHER

picture

The body of a CO2 portable fire extinguisher is made of solid drawn steel which is hydraulic tested to 227bar (22.7 MN/2) and it is coated internally and externally with zinc, the external surface being finally painted. A solid brass pressing forms the head assembly and this is screwed into the neck of the steel bottle. The head assembly incorporates a lever operated valve, copper dip tube, bursting disc and a discharge horn, made of non-conducting (electrically) material that can be swiveled in one plane only into the desire position. The body is charged with 4.5 kg of liquid CO2 and a fire extinguisher a safety pin would first be removed and then the valve operated lever would be depressed. The liquid CO2 would pass into the discharge horn and emerge as a cloud of CO2.

The range of the fire extinguisher is about 3 to 4 m in still air, duration of discharge about 20 sec, with about 2.5 m3 of gas produced. CO2 extinguishes a fire by cooling and smothering, the gas has the advantage that it can get into inaccessible places. CO2 extinguishers need not be protected for freezing. However they should be stored at temps below 54C to keep their internal pressure at a safe level. At 57C bursting disc erupts at 2700 psi to release excess pressure. Several times a year, CO2 extinguisher should be examined for damage and to ensure they are not empty. An extinguisher that has lost more than 10% OF ITS CO2 weight should be recharged.

CO 2 AND WATER PORTABLE FIRE EXTINGUISHER

PICTURE

The body of the extinguisher is off welded steel zinc coated, with the external surface painted. a brass ring is silver soldered to the top of the steel body and a brass head assembly, which incorporates plunger, handle, and swivel safety guard, is screwed into it and seals on a thick rubber washer. Small radial vent holes are drilled in the head assembly which serves to relieve internal pressure when the head is being unscrewed in the event of the nozzle being blocked. A brass double purpose nozzle is fitted to the delivery end of the reinforced rubber hose and the nozzle can be operated to give water jet or spray.

The body of the extinguisher contains 9 liters of fresh water, usually a wetting agent is added to the able the water to spread more readily. The inner container is welded steel, zinc coated, and charged with 74 mg of CO2 at a pressure of approx 36 bar (3.6 MN/m2). When operating the fire extinguisher the hose is first uncoiled from the body and the swivel guard is swing to uncover the plunger. The plunger is then depressed; this releases the co2 which then drives the water out of the extinguisher by way of the dip tube and hose.

Length of jet is approx. 10.6 m, spray 6.06m with about 36 sq ft of cover. Duration of discharge approx 60 seconds. Body tested hydraulically to 25 bar (2.5 MN/m2) the pressure cartridge should be inspected and weighed annually. It should be replaced if it is punctured or if it weight is 14 grams less than the indicated weight. Nozzle and hose should be inspected for blockages. The extinguishes should be stored in place above freezing point.

Another type of fire extinguisher is the stored pressure fire extinguisher. With this type the extinguisher is fitted with water or an anti-freezing solution to within 15 cm of the top. The screw on cap holds a lever operated discharge valve, a pressure gauge and an automobile tire-type valve. The extinguisher is pressurized through the air valve with normal charging pressure is about 100 psi the gauge allows the pressure in the extinguisher to check at any time, with most gauges being color coded to indicate a normal or abnormal charge.

To operate, the pin is removed and the trigger depressed (discharge lever). The steam should be directed at the seat of the fire, and moved back and forth to ensure complete coverage of the burning material. Short burst can be used to conserve the limited supply of water. This extinguisher should be stored above freezing point. The condition of the extinguisher should be checked regularly, such as checking for leaks or blocked hose. The pressure gauge should also be checked regular. This type of extinguisher should only be used on class A type fire only.

SAND

Sand is also an extinguishing agent that can be used on ships to fight fires. Sand is required as an extinguishing agent in the amount of 10 cubic feet for spaces containing oil fired boilers. However sand is not very efficient when compared with modern extinguishing agents and thus can be replaced by an extra class B fire extinguisher.

The function of the sand is to smoother the oil fire by covering its surface. But if the oil is more than an inch or so in depth the sand will just sink below the surface. Then unless a sufficient amount of sand is available to cover the oil, it is rendered ineffective. However, when properly used, sand can be used to dam fire with a scoop or shovel. Its minimal effectiveness may be further reduced by an unskilled user.

After the fire, there is a clean up problem. In addition to these difficulties sand is abrasive, and has a way of getting into machine and other equipment. It is difficult to smoother combustible metal fires with sand because the extremely hot temp of the fire extract oxygen from the sand. Any water in the sand will increase the intensity of the fire or cause such reactions as steam explosions; it would be very unusually to find completely dry sand aboard ship. Sand may be used to dam off running molten metal but an approved dry powder should be used to extinguish the fire.

6.9 DESCRIBE SOME TYPE OF EMERGENCY BILGE PUMP AND HOW IT IS CONSTRUCTED

Picture

This pumps function is to drain compartments adjacent to damaged compartments. The pump is capable of working when fully submerged. The pump is a standard centrifugal pump with twin reciprocating air pumps or rotary air pumps the motor is enclosed in air bell as that even with the compartment full of water the compressed air in the bell will prevent water coming into contact with the motor. The air bell is tested to withstand a water pressure equivalent to 70 feet head. The motor is usually DC operated by a remote controlled electric circuit which is part of the vessels emergency power.

The pump is designed to operate for long periods without attention and is also suitable for an emergency fire pump. This design is particular suited for use in large passenger vessels giving outputs of 60 kg/sec. In the ordinary centrifugal pump priming usually required to facilitate good pumping. In the emergency bilge, pump this process is taken care of by properly designed reciprocating twin air pumps geared to the pump motor and sucking the air from the pump chamber. The air when mixed with water rises to the top of the suction chamber where it is withdrawn by the twin air pumps through a float operated valve. When the air is extracted from the suction chamber the chamber becomes full of water causing the bell float to rise and close the valve between the suction chamber and the air pumps. This permits the pump a continuous flow of suction and discharge.

The pump consists of:

PUMP CASING:
Unless otherwise stated the pump casing is made of cast iron, with renewable impeller clearance rings made of brass. The casing is of the divided type with suction and discharge branches arranged in the back portion so that the front part can be removed and the impeller and spindle can be taken out without breaking any pipe joints. An extension is provided for taking the driving motor. This pump casing is provided with a hand hole giving access to the impeller eye.

IMPELLER:
The impeller is made of bronze, so arranged as to pass any solid material which can come through the suction strainers and mud boxes. The impeller is of the sided type so designed that the upward thrust tends to balance the weight of the rotating parts of the pump and motor but in addition a double thrust bearing is provided in the motor, capable of taking charge of any unbalance thrust and weight of those rotating parts.

SPINDLE:
This is usually a very large diameter, fitted with an impeller of special hard bronze finished by grinding. An external bearing is provided of suitable dimensions and of the divided type for case of overhauling. A grease lubricator is fitted to this bearing.

STUFFING BOX:
This is fitted with special metallic packing rings, and is pressure sealed from the pump through a central cock. Where specified a filter may be fitted

AIR PUMP:
The air pump has a cast iron crank case with detachable top arrangement for bolting to facing on the pump casing to cylinders, valve plates and piston are of highest quality gunmetal alloy, the latter being fitted with special piston rings and stainless steel gudgeon pins. Reversible monel metal discharge valves with phosphor bronze spindle and cast iron valves covers are incorporated, so design as to give ready access to the valves for cleaning and overhauling.

The air pump pistons are driven from a high tensile steel crankshaft carried in two split gunmetal main bearing. The crankshaft is driven through worm reduction gearing (case hardened steel worm and phosphate bronze worm wheel) by the main pump spindle. The air pump has no suction valves, the pistons uncovering the inlet ports during their travel. The air pump has been found in service to give satisfactory results over long periods without wear or adjustment. The air pump can be removed from the main unit for overhaul by the removal of four nuts and is divided in place to ensure correct alignment of gearing. Lubricating of air pump bearings is by a mechanical pump feeding the drips in proportion to the speed of the pump, from a box of ample capacity.

AIR BELL:
The air bell is of the best quality welded steel painted with betumactic solution, and is water tested to a pressure equivalent of 70 ft head. A hand hole with an air tight joint is fitted near the top of the air bell so that the commutators and bushing of the motor can receive attention, without the unseal of the air bell. Suitable handles are fitted for convenience of removing or turning the air bell.

ELECTRIC MOTOR

The electric motor is of the vertical spindle mica insulated, shunt wound type fitted with series stability windings. All windings are thoroughly impregnated to withstand dampness. The thrust bearing are of the roller type and the double thrust bearing of the heavily rated ball type. When the motor is running non-submerged fresh air is drawn in around the motor and discharged again by an air fan mounted on the armature shaft of the motor. When the motor is submerged, this fan causes the entrapped air to imping on the sides of the air bell which is kept cool by the surrounding water. The rating of the motor is such that it can be run continuously of the water rises sufficiently high to seal the bottom of the bell but not submerge it. To facilitate rapid charging a non-return valve is fitted on the delivery side of the pump.

6.8 GAUZE WIRE IS SOMETIMES USED OVER VENTILATION PIPES ... HOW IS THE GUAZE FITTED IN PLACE AND WHY? WHAT PLACES IN PATICULAR SHOULD HAVE THEM?

picture:

Gauze wire screens are fitted over ventilation pipes various ways. In some instances a single screen is used while in other instances a double screen is used. A flange is welded to the vent pipe and several holes are drilled into the flange. The gauze wire is fitted to the over the flange and a second flange is bolted to the first holding the gauze wire between the two flanges. In a double screen installation the procedure is the same except a second wire screen and a third flange is fitted.

The gauze wire is fit over the vent pipe ends to protect potable water tanks from dirt and insects. In tanks containing flammable liquid the gauze protects it from dirt and sparks. Sludge and slop tanks are required to have these gauze screen fitted to them as flame protection. in open flame enters the vent pipe the gauze wire would help dissipate the flame. the screen should be bronze, brass, or nickel copper alloy and should be installed so that cannot easily be removed.

6.2 Describe an engine suitable for a lifeboat. Describe the cycle of operation. How is it reversed and what fuel does it use?

1. it should be a compression ignition engine
2. should be provided with enough fuel to run for 24 hrs
3. be capable of starting readily and reliably in cold weather and bad weather conditions
4. run properly under conditions of 10 degree trim and 10 degree list
5. it shall have self-priming circulating water pumps if engine is water cooled
6. If air cooled it should have the proper amount of air supplied to the position where it is most needed.
7. Adequate protection of engine and fuel tanks and accessories from bad weather
8. the engine casing should be of fire proof material
9. The engine should be able to be started remotely?
10. The engine should be using light weight materials
11. efficient ventilation of the engine
12. Fuel tank must be capable of withstanding 15 foot head water. It should have intake fitting and relief arrangement and if steel constructed it should be galvanized externally.

Before starting the engine the oil level in the base should be checked. Fuel oil level should be check. Then, levels should be maintained at all times. Turn-on the fuel and prime the fuel filter with the fuel left on and lift the decompression lever to facilitate the turning of the engine. Turn the engine with the starting handle and move the decompression lever back to the run position and as the engine picks up speed, as the engine fires remove the turning handle. When the engine starts. Slowly turns the control level back to run position and the engine is running. Some lifeboat engines may be started by means of a 12 volt battery and starting motor system or a hydraulic cranking system.

The engine is reversed with a gearbox which incorporates a cone type ahead clutch and a reverse gear. It is not necessary to fit a thrust block. The gear box is capable of absorbing the end thrust. The engine should always at idle when changing gears.

picture

1) engine shaft running in one direction only
2) bevel wheel solid on engine shaft
3) propeller shaft
4) loose bevel wheel on propeller shaft
5) feather on propeller shaft (keyway)
6) clutch

7) free bevel wheel fixed to floor

In the ahead position the clutch dog (6) locks into the solid wheel (2) of the engine drive shaft (1) and by means of the feather (5) both shafts (1) and (3) turns in the same direction while wheels (4) and (7) running idle. in the astern position the clutch (6) is moved by means of the lever of the reversing gear by a yoke the clutch dog (6) now locks in the loose bevel wheel (4) and the drive is moved from the freewheel with ( ) propeller shaft (3) and revolves in the reverse position direction of the engine shaft, the feather (5) again acts as the drive.

Another method of reversing is the reversible propeller blades of which can be rotated to any angle by movement of suitable gear contained in the hollow boss and actuated by a lever and rod, the rod passing through the hallow tail shaft.

6.1 **describe the firefighting equipment which would be used on oil fired ships. Describe the procedure you would follow if you discovered a fire on the tank tops.**

Cleanliness, vigilance and common sense are the principal weapon with which to prevent fires. Tank tops should be kept clean and well lighted. It is recommended that tanks tops to be painted white so that any oil leaks from drip trays, pipes, joints, filters, and valves may be easily spotted and the leakages dealt with promptly before any dangerous accumulation of oil arises. Bilges must be kept clean and the pumps and strainers for the bilges maintained in good working order. All firefighting application must be kept in good working order and tested regularly.

Emergency pump and fan stops, collapsible bridge oil valves, water tight doors etc. should be in good working order. All fire detection devices should be tested regularly and all faults rectified. All engine room personal should be fully conversant with the recognized procedure for dealing with a fire aboard ship and should know its where about and methods of operating all firefighting equipment.

Non return valves and safety relief valves are fitted throughout the engine room. There are relief valves on cylinders, boilers, and crankcases. There should be non-return valves in fuel oil lines. Oil mist detectors are fitted to IC engines. All these devices should be kept in good working order. There are relief valves on air receivers and relief disc on crankcases.
In every ship class I (i.e. a passenger ship engaged on voyages and of which are long international voyages) there shall be provided;

1) Fixed fire extinguishing installation operated from outside of the space and capable of giving a depth of foam of at least 150mm in not more than four minute over the largest single area over which oil fuel liable to spread. Such installation shall include mobile sprayers ready for immediate use in the firing area of the boiler and in the vicinity of the oil fuel unit. A pressure water spray system of fire smothering gas installation can be used as an alternative.

2) A 136 liter foam fire extinguisher (or 45kg CO2) capable of delivering foam to any part of the compartment.

3) Two portable fire extinguishers suitable for extinguishing oil fires

4) A receptacle container at least 0.3 m3 of sand and a scoop

5) Two fire hydrants one port and one stbd with hose and nozzles (spray nozzles must also be provided)

6) There should be an international shore connection provided to enable water to be supplied from another ship or from shore to the fire main and fixed provision shall be made to enable such a connection to be used on the port and starboard side of the ship

7) Every ship of class I of 4000 tonnes or over shall be provided with at least three fire pumps. The arrangement of sea connections, pumps, and the source of power of operating them shall be such as will ensure that a fire in any compartment will not put all the fire pumps out of action

8) Every class I ship shall be provided with are least two firemen's outfits each consisting of: a safety lamp, a fireman axe, breathing apparatus or smoke helmet or smoke mask. The outfit shall be kept in widely separated places.

9) Emergency controls for shutting off fans, oil fuel pump, purifiers and for closing suction from oil tanks. Also there should be emergency shut off valves for generator and boilers. These should be arranged so that they can be operated from a readily accessible position, which is not likely to be cut off by fire in the engine room or boiler room.

10) Wire gauze must be also fitted to vents of all oil fuel tanks.

11) Every ship of class I shall be provided with water pipes and hydrants. The diameter of the water pipes shall be sufficient to enable an adequate supply of water to be provided for the simultaneous supply of at least two fire hoses and for the projection thereby of two powerful jets of water. The number and position of the hydrants shall be such that at least two such jets may be directed into any part of the ship by means of two fire hoses each not exceeding 18 m in length, each jet being supplied from separate hydrant.

12) Portable fire extinguishers shall have a capacity of not more than 13.5 liters and not less the 9 liters. CO2 extinguishers shall have a capacity of not less than3.2 kg. Dry powder extinguisher shall have a capacity of not less than 4.6 kg.

BOILERS

2.1 Describe the following terms:

- **a)specific heat**
- **b) latent heat**
- **c)calorific value**
- **d)temperature**
- **e) spontaneous combustion**
- **f) enthalpy of evaporation of steam**
- **g) British thermal unit (BTU)**

A) SPECIFIC HEAT:
The specific heat of a substance is the quality of heat required to raise the temp of a unit mass of a substance by one degree. Water is used as the standard substance because it has a greater capacity for heat than any other known liquid, as well as most solids. Gases have two different specific heats according to whether heat is applied at constant volume or constant pressure. Specific heat is measured in British Thermal Unit or BTU.

B) LATENT HEAT
Latent heat is the heat which supplies the energy necessary to overcome the bending forces of attraction between the molecules of a substance, and is responsible for it changing its physical state from a solid into a liquid or from a liquid into a vapor the change taking place without any change in temperature.

C) CALORIFIC VALUE:
The heat energy given off during complete combustion of unit mass of fuel in the cylinders of an internal combustion engine is termed the calorific value and may be expressed of kilojoules of heat energy given during the burning of one kilogram of fuel.

D) TEMPERATURE:
Temperature is the degree of hotness or coldness of a body relative to some zero value. Is a measure of intensity of heat? The fact that one body has a higher temp than the other does not mean that the hotter body necessarily contains more heat. Heat will always flow from a hotter body to a colder body in contact with it, however this does not mean that a rise in temperature of the colder body will equal to the fall in the temp of the hotter body even through the mass in each case is equal and the transfer takes place without loss.

E) SPONTANEOUS COMBUSTION:
Spontaneous combustion refers to a material bursting into flame without being ignited by an outside source (sparks or flame). Ignition often occurs through the chemical interaction of two or more substances, one of which is often air or water. Sodium and potassium react with water. Magnesium, titanium, calcium, and zirconium oxide rapidly in the presence of air. Careful storage of materials is an ever present fact in the prevention of fire by spontaneous combustion.

F) ENTHALPY OF EVAPORATION OF STEAM:
Enthalpy of evaporation of steam is equal to the latent heat of evaporation. the process of changing the physical state of a substance from a liquid into a vapor is called boiling or evaporation, and the quantity of heat to bring about change at a constant temp to unit mass is the latent heat of evaporation.

G) BRITISH THERMAL UNIT:
British thermal unit refers to the quantity of heat in one degree, the temperature of the water being that of maximum density namely 39.2 F

Describe an experiment to find the specific heat of a solid such as copper.

In order to determine the specific heat of a solid such as a piece of copper: take 10lbs of water at 60F and place 1 lb of copper into it, noting the temperature of the copper before mixing. Say it was 200F; now note the resultant temperature after mixing. Say it should be 61.6 F, now make an equation where (x) is the specific heat of copper.

BTU before mixing= BTU after mixing

Heat in water + heat in copper= heat in water + heat in copper

(10lbx60Fx1)+(1lbx200F+x) = (10lbs x 61.6F x1) + (1lbx61.6Fx (x))

600 + 200 x = 616 + 61.6 x

200 x - 61.6 x = 616 - 600

138.4 x = 16

X = 16/138.4

X = 0.115 BTU

2.10 With reference to heat give definition of the following:

a) radiation
b) conduction
c) convention
d) latent heat
e) sensible heat

Explain the terms Joules mechanical equivalent of heat. What is the numerical valve? Describe the apparatus used by Doctor Joule to find this value. Where would there be found in reference to a boiler.

a) RADIATION:
Radiation is the transfer of heat energy from one body to another through space by rays of electro-magnetic waves. The rays of heat travel in straight lines in all directions at approx. the same velocity as light.

Example: in a boiler the heat from the burning fuel passes off in rays in all directions striking the furnace walls, tubes, and other heating surfaces raising their temps. The heat will pass through the metal parts named by conduction, and into the water in contact with the furnaces and heating surface. Loss of heat through radiation is prevented by the use of water walls and the lagging of all exposed parts such as shell, end plates, steam and water drums, steam pipe, and stop valve.

B) CONDUCTION:
Conduction is the flow of heat energy through a body or from one body to another in contact with each other, due to difference in temp. The natural flow of heat takes place from a region of high temp to a region of lower temperature.

Example: in boilers heat is conducted through the heating surface to the water. Heat is also conducted through the shell end plates and steam drums. In diesel engines, conduction of heat takes place through the metal of all parts in contact with the burning fuel, this heat being carried away by the cooling medium used for the purpose.

C) CONVENTION:
Convention is the method of transferring heat through a fluid by the movement of heated particles of the fluid.

picture

This fig shows a vessel containing water with an inclined tube connected at the bottom. When heat is applied to the tube, the heated particles of water become less dense and rise. Denser particles move to take their place and thus convection current is set moving resulting in all the vessels water becoming uniformly heated due to continuous circulation of the water.

Example: In the water tube boiler the tubes are arranged to assist the convection current and the boiler designed to take full advantage of the law of heat transmission.

D) LATENT HEAT:
Latent heat is the heat which supplies the energy necessary to overcome some of the binding forces of attraction between the molecules of a substance and is responsible for it changing its physical state from a solid into liquid or from liquid into a vapor, the change taking place without any change in temp.

E) SENSIBLE HEAT
Sensible heat is the name given to heat when its transferred to or from a substance with changes in temp only, and no physical change of state.

Joule:
A joule is the basic unit of all energy including heat

MECHANICAL EQUIVALENT OF HEAT:
Is the relationship between mechanical energy and heat energy? This was determined by doctor joule using an apparatus which generated heat by the expenditure of mechanical work. In Imperial units the accepted figure was 778 ft of work = 1 BTU of heat. In the S.I. system, the joule is the unit of all forms of energy. One joule the work done when a force of one Newton moves through a distance of one meter in the direction in which the force is applied. Thus the work done is one Newton-meter and this is equal to one joule. Hence the mechanical equivalent of heat is 1Nm/J which is unity.

2.2 What is the average density of sea water? List the scale forming salts usually present in
a) fresh water
b) salt water
At approx. what temp does calcium carbonate and calcium sulphate deposit? Under what circumstanced is thus deposit of sodium chloride (common salt)? How would you find the density of boiler water?

The average density of sea water is 1.025 tons/m3

The scale forming salts in fresh water are

- calcium carbonate 200 ppm(carbonate of lime)
- calcium sulphate 90 ppm (carbonate of lime)
- sodium chloride 50ppm
- sodium nitrate 35ppm
- sodium sulphate 30 ppm

TOTAL 400ppm approx

Scale forming salts in salt water are:

- sodium chloride 25000 ppm (79% common salt)
- magnesium chloride 3300 ppm (10%)
- magnesium sulphate 2000 ppm (6% Epsom salts)
- calcium sulphate 1200 ppm
- calcium bicarbonate 200 ppm

TOTAL 32000PPM APPROX

Calcium carbonate deposits at a temp of 212F at atmospheric pressure in a high pressure boiler and evaporator calcium sulphate deposits at a temp of 280 F, 34.5 psi pressure in a high pressure boiler and at a density of 5/32 NDS in an evaporator. Magnesium sulphate is too soluble to deposit under normal boiler operating temp but if too high a density is carried it may deposit.

Magnesium chloride breaks up at a temperature of 360 F 140 psi pressures into magnesia and chlorine the chlorine combining with the hydrogen and oxygen of the steam to form hydrochloric acid, which will cause corrosion. In addition magnesium hydroxide which may form a hard scale will be produced. In a evaporator the magnesium chloride will decompose at a density of 5/32 nds.

Sodium chloride (salts) deposits at 7/32 nds in either a high pressure boiler or evaporator. The saturated point is 7/32 with the exception of the salt, the solid matter in solutions in sea water will deposit or break up with temp or --- which ever is encountered first.
To find the density of boiler water a sample is drawn through the test cock into the salinometer pot. The salinometer is placed on the pot where it floats upright in the sample of water. The salinometer sinks according with the density of the water and the density measured off the scale on stem at the water level.

2.3 Sketch and describe a salinometer. How is it graduated? What results would you expect from a test? Why is it graduated for specific temperature? How would you test the water density of a multi-tubular boiler?

picture

A salinometer is an instrument used for measuring the density of water. It is made of glass or silverized brass. It consist of a stem with a hallow bulb 1/3 of its length from the lower weighted end in the instrument to float upright with varying portions of the copper graduated stem submerged depending on the density of the sample measured. The graduations on the upper stem are in 1/32 nds. The average density of sea water is 5 ozs per gallon, and as one gallon of distilled water weights 10 lbs or 160 ozs, then 5 ozs of dissolved solids per gallon of distilled water = 5/160=1/32nd density.

The density of the sample is read off the surface of the water and must be taken at the temperature specified on the instrument. thus a reading of 1/32 density indicates for every 32 pounds of water. The water density of a multi-tubular boiler can be measured by a salinometer. A sample of boiler water is drawn off to fill a salinometer pot. A salinometer is inserted and a reading taken when the temperature is right. The range of scale is normally from 0 to 4/32 and while the salinometer is floating in pure water at 93C which has a relative density at that temperature of unity, the salinometer reading is zero. When the salinometer reading is 1/32 (approx. 32000ppm) when the relative density of solution is 1.025 or 1/32 on the scale, and sea water is used for makeup feed it is recommended that the boiler density should maintain as close as possible to 4/32 (125000ppm).

This would be attained by resorting to blow down. The use of sea water as make up for boiler should be avoided as far as possible but if it has to be used a certain amount of protection for the boiler can be provided by using soda ash.

Describe how you would carry out any these of the following tests in a sample of boiler water.
1. hardness
2. alkalinity
3. chlorides
4. excess phosphate
5. excess sulphites
6. pH
7. dissolved oxygen

HARDNESS TEST:

- Take 100ml of boiler water sample
- add 2ml at a time of standard soap solution
- shake vigorously after each addition of soap until lather persists for at least five minutes
- calculation____-ml of soap solution used x 10= ppm CaCO3 equivalent

A waters ability to form a lather with soap depends upon the hardness salts which are present, hence the quantity of soaps solution used is a direct measure of the hardness salts in the sample

ALKALINITY:

ALKALINITY TO PHENOLPHTHALEN

- Take 100ml sample of boiler water
- added N/50 sulphuric acid to clear the sample
- calculation__ml of N/50 acid used x 10= ppm CaCO phenolphthalum is less alkaline than hydroxides or carbonate, and when it is added to a sample containing hydroxides and or carbonate it will turn pink in color. The acid used after this coloration will first the hydroxides forming salts. It will then react with the carbonate present forming bicarbonate molecule. Bicarbonate molecules are less alkaline then phenolphthalum, hence the pink coloration will disappear once all the hydroxides and carbonate have been dealt with by the acid. Once bicarbonate molecules is formed the quantity of acid used is a measure of the alkalinity due to the hydroxids (caustic)present and half the carbonates

TOTAL ALKALINITY

- Take alkalinity to phenolphthalum sample
- add 10 drops of methyl-orange resulting in yellow coloration
- add n/50 sulphuric acid until pink
- calculation _____ml of N/50 acid used for both test x 10= ppm CaCO3

Methyl-orange indicator is less alkaline than phenolphthalum and bicarbonates. It can be used initially in place of phenolphthaling or as is more normal as a continuation after the alkalinity to phenyolphthalum test. If no yellow coloration result when methyl-orange is added to the alkalinity phenolphthalum sample no bicarbonate are present hence no carbonates are present. Therefore the alkalinity as determined in the alkinility to phenolphthalin test, been due to hydroxides above. Note: hydroxided and carbonates can co-exist together in a solution, but hydroxide and bi-carbonates cannot.

CAUSTIC ALKALINITY

- Take 100 ml sample of boiler water
- add 10ml of barium chloride
- add 10 drops of phenolphthalic, resulting in pink coloration
- add N/50 sulphuric acid to clear sample
- calculation______ml of N/50 acid used x 10 = ppm CaC...

In this test burium chloride is first added to the ....carbonate which are present. The test is then carried out as for the alkalinity to phenolphthalum test but in this case only the hydroxide (caustic) will be measured.

3) CHLORIDE TEST:

- Take alkalinity to phenolphthalin sample
- add 2 ml of sulphric acid
- add 20 drops of potassium chromate indicator
- add N/35.5 silver nitrate solution until a brown coloration results
- calculation_____ml of N/35.5 solution used x10= ppm CaCO3

Chlorides may be present in the boiler water sample and it is essential that they be measured as they would be an indication of salt water leakage into the feed system, either a leaky condenser or a primed evaporator. The alkalinity to phenolphthalum sample taken has hydroxides and carbonate dealt with and they will play further part in test no conducted for chloride the sample is made definitely acidic by the addition. A further small quality of acid, this is to speed up the chemical reaction which next takes place. Silver nitrate has an affinity for potassium chromate and chloride, its principal preference however is for the chlorides. When it has neutralized the chlorides present in the sample, it is then free to react with the potassium chromate, in doing so it produces a reddish brown coloration. It is therefore apparent that the amount of silver nitrate solution used is a direct measure of the content of the boiler water sample reddish brown local coloration results which quickly disappears if chlorides are present. This should be ignored.

4. PHOSPHATE TEST

- take 25 ml of filtered boiler water sample
- add 25 ml vanodomolybdate reagent
- fill comparator tube with this solution and place in right hand compartment of comparator
- in left had compartment place a blank prepared by mixing equal volumes of vanodomolybdate reagent and demonized water.
- allow color to develop for at least 3 mins and then compare with disc.
- calculation: phosphate reserve in ppm from the disc reading

5. EXCESS SULPHITES:

- Take 100ml of boiler water sample, add 2ml of sulphric acid
- add 1ml of starch solution
- add potassium iodide - iodate solution until sample is blue in color
- calculation: ml of iodide - iodate solution used x 120?= RPM Na2SO3 (sodium sulphate)

The boiler water sample is made slightly acidic to speed up the chemical reactions which are to take place. Potassium iodide - iodate produces a blue coloration through reaction with starch, but it has a preferential chemical reaction with sulphate it is present in the sample. Hence when the potassium sulphate present it is then free to react with the starch present in the sample, producing a blue coloration. It is therefore apparent that the amount of potassium iodide-iodate solution used is a direct measure of the sulphite content on the boiler water sample. As far as is possible, the atmosphere should be excluded in this test otherwise an incorrect result may occur. If the test indicates that an adequate reserve of sodium sulphite is present in the boiler water there in no need to conduct a test for dissolve oxygen

6. PH VALVE

A boiler water pH valve can be obtained by three basic methods:

1 litmus paper
2 colourimeterically
3 electrolytically

LITMUS PAPER

These are used to ascertain the degree of acidity of alkalinity of the boiler water. A litmus paper when inserted into a sample of boiler water makes changes in color, turning blue if the water is alkaline or red if the water is acidic. The degree of coloration is very rough indication of the PH valve of the boiler water.

COLOURIMETRIC METHOD
Take a sample of boiler water. Place one thymol blue tablet in a 50 ml cylinder. Add 50 ml of boiler water sample to dissolve cylinder and ensure tablet is dissolved into the other cylinder. Place first sample in right hand compartment of nessleriser. Place second sample in left hand compartment of nesslerier. Place approximate disc in nessleriser and match the colors then read the PH valve from the right hand window.

ELECTROLYTIC METHOD
An electric cell, using the boiler water as an electrolyte and two special electrodes, both made of glass are used. The potential difference between the electrodes id directly dependent upon the hydrogen control of the electrolyte (boiler water). The potential difference is measured by a sensitive voltmeter connected into the external circuit of the cell and calibrated to read pH valves.

7. DISSOLVED OXYGEN
Take 500ml of boiler water sample, add 0.3ml of manganese chloride, add 0.3 ml of potassium hydroxide, add 1 ml of hydro-chloride acid, and add 2 ml ortho tolidine. In this test it is essential the atmosphere be excluded from the sample being tested. To arrange for this a special designed sampler flask is used. After the addition of various chemicals to the boiler sampler, the resulting solution is compared colour metrically with a color chart or a series of indicator solutions whose dissolved oxygen content is known. Where colors of sample and indicator coincide, the dissolved oxygen content of the boiler water sample is used from the indicator.

2.5 What could be the cause of a gradual increase in boiler water density? How is the boiler water tested for density, alkalinity and acidity? What is the maximum density you would oplaite the following boiler at and why?

a) scotch marine boiler
b) water tube boiler

Feed water employed for boilers is usually, un-evaporator fresh water or evaporated salt water. The first and third of these are normally employed as feed for low pressure boilers such as the scotch boiler. Evaporated fresh water and evaporated salt water is employed with water tube boilers. All of this water can contain salts which could be harmful to the boiler from the point of view of scale forming and corrosion. However, feed systems can become contaminated with salt water, leaky condenser or an evaporator priming could be the cause.

Testing for density, acidity and alkalinity

Density-use the salinometer

Acidity and alkalinity- litmus paper can be used turning blue for alkalinity and red for acidity. However methyl-orange or phenolphthalum are more reliable and sensitive as testing agents. One or two drops of methyl-orange, will turn yellowish to indicate alkalinity and pink to indicate acidity. In the phenolphthalum test the sample will turn purplish for alkalinity and cloudy white for acidity.

Scotch boilers
Maximum density would be 2.5/32 - 3/32 but if the feed consist entirely of sea water then a convenient density would be 4/32.

Water tube boilers
Only distilled water should be used, but 3/32 would be the maximum scale on tubes causing overheating and failure.

2.5 Describe how you would proceed to clean the lubricating oil of a turbine. What principle is involved in this process?

The oil use in connection with the turbine is a special grade of pure mineral oil. Even a small quantity of another oil might ruin the whole charge of oil in the system. In all modern installations an oil separated of the centrifugal type is provided and full advantage can be taken of this unit to maintain the oil in a proper condition.

Despite all precautions a certain amount of moisture will find its way into the system. There is usually a certain amount of solid material present in a very finely divided state, and there may be a certain amount of sludge formation. The use of the separator will remove these impurities so that it should be in use 3 or 4 hrs each day and periodically when the opportunity occurs, when the vessel is in port a few days, the whole oil in the system should be centrifuged. If the centrifuging is not carried out in proper manner the desired results may not be obtained. Care should be taken to follow the instructions issue by the manufacture of the particular machine concern.

Any time when the vessel is in port and the oil allowed settling, advantage should be taken of this fact that most of the impurities in the oil such as water, sludge and particles of metal having a higher specific gravity than the oil will settle to the bottom of the containing vessel. If these impurities are drawn off from the bottom of the drain tank by means of a hand pump better results will be obtained with the separator. The efficiency of the clarification will be increased if the oil being passed through the separator.

In addition, about 2 % by volume of hot distilled water should be added the oil at the separator. This helps to dissolve out the acids of a corrosive nature which are sometimes formed and also sea water which may have found its way into the oil. The salts tend to promote the formation of these acids and must therefore be eliminated. Care should be taken that the gravity disc used in the separator includes within the range of the specific gravity of the oil being treated. It is also essential that the separator must be run above its specific capacity in order to get the work done more quickly.

Picture

2.9 Trace the path of fuel from the settling tank to the burners. List the temp and pressure at intervals.

Picture

1. Double bottom fuel oil tank
2. main engine
3. F/O transfer pump
4. filter
5. settling tank
6. overflow to DB tank
7. heater
8. centrifugal oil purifier
9. main service tank
10. gauge glass
11. float control cock
12. engine service tank has overflow to DB tank, also low level alarm
13. quick shut off valve controlled from deck
14. change cock
15. filter in duplicate
16. M/E fuel pump
17. settling tank vent
18. main service tank vents
19. engine service tank vents
20. overflow to double bottom tank
21. fuel for boiler
22. fuel for aux. engines

The fuel oil transfer pump 3) draws oil from the double bottom tanks and delivers it to one of the settling tanks. One tank is in use while the oil in the other is being heated by means of steam coils in the tanks or by other means. The temp of the oil in these tanks should never exceed 150F. The heating of the oil allow some of the water which may be mixed with oil to settle to the bottom. A drain connection, fitted very bottom of the tanks, allows the water to be drained to the dirty oil tank. The oil may be transferred to the main service tanks (9) direct or may be passed through a second heating system (7) and from there to any of the centrifugal separator and then to the main service tanks. The transfer valves in the settling tanks are at higher level than the drain valves. below the tanks (5)(9)(12) trays are fitted. The drains from the trays are led to the dirty oil tank. air pipes (17)(18)(19) of at least 2 in dia are fitted in the highest part of the tank and the open ends, with a gauze diaphragm over the outlets, are let to some place where there is no danger of vapor from oil being ignited.

Flat type gauge glass, not tubular, or a pneumercator may be used to ascertain the depth of oil in the tank type of sounding apparatus may be used. If gauge glasses are used then they must have self closing cocks or valves.

From the main service tanks (9) the purified oil is led to the engine or boiler service tanks. The oil for the main engine or boiler enters the tank (12) through a float control cock. The oil leaving this tank passes through a quick shut off valve (13) and then one of two filters (15). This are duplex filters, one can be cleaned while one is use. The oil now goes to the fuel pumps on the engine or boiler from while it delivers at high pressure also metered as to the quantity to the fuel valves. The outlet pipes from all of theses tanks can be shut remotely in case of fire.

MOTOR

10.13 Sketch and describe a flexible coupling with which you are familiar with?

picture

The flexible rubber coupling are used between engine and gearbox to damper the torque fluctuations, reduce the effect of shock loading on gears and engine. They also cater for misalignment, minimize vibration and reduce noise levels. Since oil will attach natural to rubber these coupling are usually made with reinforced synthetic rubber which is oil resistant.

Before these coupling are installed all parts must be cleaned and free from grease and oil. The coupling disc is held in position by nut and bolts. A steel ring is fitted on the side opposite the contact side, when in position will ensure even torque on the coupling disc. Marks on the coupling will change form, if the coupling starts to wear and loose its strength. Another indication of wear maybe rubber in the form of dust particles around the coupling area. These couplings, may be used for different machinery so the size and shape may vary for each unit.

10.7 Brake horsepower is a measurement of actual usable power delivered to the crankshaft of the engine. Brake power= indicated power-friction power. A dynamometer can be used to find the brake horsepower of an engine.

The engine under test drives the shaft to which the rotor is directly coupled. The shaft bearings are inside the casing containing the stator, which is free to serve... trunion supports. Each face of the rotor has pockets or cells of semi-elliptical or oval cross section divided from one another by oblique 45 vanes. The stator inlet channel, entering between 45 vanes and passes into a rotating rotor. The water constantly circulated around the cells in as torque is transmitted from rotor to stator via the water. This torque tends to turn the stator, this action being resisted by a load measuring device so that the resisting torque will equal the applied torque and thus being a measured.

Shaft power equals torque applied by weights time 2pie N. For testing in both directions of rotation two rotor are provided, one used astern, the other ahead. In modern practices the load measure devices are much simplified by use of levers. In some designs resistance to motion is caused by a measure of field coil resistance which causes variation of eddy current resistance to rotor rotation, in place of the hydraulic resistance.

$$\textbf{Brake horse power} = \frac{\textbf{2pie N}}{\textbf{60}} \times \textbf{torque}$$

10.4 Describe the method in which the following types of machinery are reversed.
a. steam reciprocating engines

b. steam turbine
c. direct drive diesel engine
d. geared diesel engine
e. steam turbine

a. STEAM RECIPROCATING ENGINE

The valve gear on a steam reciprocating engine is generally of the Stephenson's Link Motion type. There are two eccentrics rods, the top end of the eccentric rod being connected one at each end two parallel quadrant bars by means of pins and brass bearing bushes. Movement of the reversing lever brings to quadrant bars over from the ahead position to astern so that the astern eccentric radius now in line with the valve spindle. The ahead eccentric rod will now be idling and the valve will receive its motion form the astern eccentric rod. Since the astern eccentric is set for astern running the engine will now be reversed. When running deal slow the reversing gear may be thrown right over. At other speeds the engine stop valve is closed before the gear is reversed and then gradually opened.

b. STEAM TURBINE
Steam turbines have a reversing turbine and when the reversing is required the ahead stop valve is closed, and the astern stop valve is opened which admits steam to the astern turbine. The astern power, which is required mainly to brake the head way of the ship, is usually about 70% of the ahead power. A deflector plate.......

c. DIRECT DRIVE DIESEL ENGINE
A direct drive diesel engine is reversed by changing the position of the cams

d. GEARED DIESEL ENGINE
Reversing is done through transmission gears, which is usually done by hydraulic pressure operated clutch. The pressure pump is operated by the main shaft which turns the main gear wheel. When the fluid is allowed flow the pressure engaged the clutch and disc together, thus causing friction on their surface and thus causing the shaft to turn. Reversing is done in the same manner except that when the reverse is done the astern clutch is engaged by pressure and causes the shaft to turn the idlers gear and the reverse gear the same time. The fluid is pumped from the pump and returned again.

e. STEAM STEERING
Steering engine slide valves are of piston type and have no lap or lead. This means that steam is carried full stroke and the engine can start from any position of the crank. The piston valves are hollow and carry steam over ends or in the centre according to the position of the control valve. With the control vale in one position exhaust will take place at say the bottom of the cylinder and steam will be admitted to the top. With the control valve in the other position exhaust will take place from the top of the cylinder and steam will be admitted at the bottom, the piston will move in the opposite direction.

10.2 With reference to heat give definition of the following
a. radiation
b. conduction
c. convention

d. latent heat
e. sensible heat.
Explain where they are found in an engine room.

A) RADITION:
Radiation is the transfer of heat energy from one body to another through space by rays of electro-magnetic waves. the rays of heat travel in straight lines in all directions at approx. the same velocity as light.

Example: in a boiler the heat from the burning fuel passes off in rays in all directions striking the furnace walls, tubes, and other heating surfaces raising their temps. The heat will pass through the metal parts named by conduction, and into the water in contact with the furnaces and heating surface. Loss of heat through radiation is prevented by the use of water walls and the lagging of all exposed parts such as shell, end plates, steam and water drums, steam pipe, and stop valve.

B) CONDUCTION:
Conduction is the flow of heat energy through a body or from one body to another in contact with each other, due to difference in temp. The natural flow of heat takes place from a region of high temp to a region of lower temperature.
Example: in boilers heat is conducted through the heating surface to the water rise in temp latter and generating steam. Heat is also conducted through the shell end plates and steam drums. In diesel engines, conduction of heat takes place through the metal of all parts in contact with the burning fuel, this heat being carried away by the cooling medium used for the purpose.

C) CONVENTION:
Convention is the method of transferring heat through a fluid by the movement of heated particles of the fluid.

picture

This fig shows a vessel containing water with n inclined tube connected at the bottom. When heat is applied to the tube, the heated particles of water become less dense and rise. Denser particles move to take their place and thus convection current is set moving resulting in all the vessels water becoming uniformly heated due to continuous circulation of the water.
Example: In the water tube boiler the tubes are arranged to assist the convection current and the boiler designed to take full advantage of the law of heat transmission.

"Convention is the transmitting of heat through a substance by actual mixing of the particles as a result of circulation. Convention therefore is the principal means by which temperature is equalized in liquids and gases. It cannot occur in solids as the parts of such substances are fixed relatively to one another.

D) LATENT HEAT:
Latent heat is the heat which supplies the energy necessary to overcome some of the binding forces of attraction between the molecules of a substance and is responsible for it changing its physical state from a solid into liquid or from liquid into a vapor, the change taking place

without any change in temp.
In the engine room we a certain temp is reached the cooling water will begin to evaporate forming steam. Although this temp may remain constant the latent heat absorbed by the water will gradually change it to steam.

E) SENSIBLE HEAT
Sensible heat is the name given to heat when its transferred to or from a substance with changes in temp only, and no physical change of state. in an engine the heat given to the cooling water before the boiling temp is reached is called sensible heat.

In the case of internal combustion engine cylinder heat in the burning and expanding gases is transferred to the engine walls mainly by radiation and conventions. The heat when received by the cylinder walls passes through them by conduction and is carried away in the cooling water by convection.

10.1 Sketch and describe a bridge gauge. How is it used? What other instrument could be used in it place of the bridge gauge?

picture

The bridge gauge is also called the Lloyds gauge is reliable method in checking the wear down of main bearing. The bridge gauge is of steel construction with machined faces which will rest on the machined faces of the bedplate.

The bridge gauge is especially designed for the engine in question and cannot be interchanged between engines. To check for the wear down using these method top halves of the bearing can be removed and the halves of each journal relative to the machine uppermost face of the bedplate is measured. This is done by placing the bridge gauge across the crank journal in the place of the top half of the bearing. If the bearing has worn of the crank sagged, there will be a clearance between the bridge gauge and the top journal. This clearance is then measured using feeler gauges. The value is compared with the value stamped on the bridge gauge for that journal, which are the manufacturer's specifications.

Any number readings should be recorded and attached to the engine, as a permanent record. If the original gauge reading is subtracted from the new reading the result is the combined wear down of the bearing and journal. However as the wear down on the journal usually very small, the bridge gauge reading are usually accepted as the bearing wear down.

In some cases where to shaft has not sagged, but the bearing are suspected of wearing a hydraulic jack is used to jack the crackdown on to the bearing. The bridge gauge is then fitted in place and he clearance recorded, thus giving the bearing wear down.

There are several sources of error involved with using a bridge gauge. The feet of the bridge gauge may have been placed on dirt, or there may be small burrs on or under the feet. These faults will result in high readings. To reduce the chances of error, the surface below the bridge gauge feet and the feet themselves as well as the journal should be thoroughly cleaned. In some engines a specific location is scraped up for taking the readings so that the reading is the same throughout the engine when it is new. If the bridge gauge is moved from this especially scraped area, errors in readings will result. Instead of using the bridge gauge to measure wear down a dial gauge, deflection gauge or a clock gauge can be used. A clock gauge is used in the same manner as a bridge gauge, expect the clock gauge records the readings instead of having to use feeler gauges.

There are several factors which contribute to bearing wear down such as:
1. Unequal power distribution in the cylinders
2. impurities in the oil such as debris
3. interruption in the flow of lube oil, which would cause overheating and possible melting of the bearing metal
4. If different bearing are lined with different anti-friction material, then different rates of wear would occur

10.5 Describe a bedplate for a large reciprocating engine. How is the ships hull strengthened around the bedplate? Show by a sketch, how the holding down bolts are fitted to the double bottom tanks.

picture

The bedplate is one of the most important parts of a marine engine. The present practice is to construct bedplates of welded mild steel in order to prevent financial lose in the event of cast bedplate turning out to be deflective. The two main types of bedplates are 1. Trestle Type and 2. Box type.

The box type enables the engine to be bolted directly to the double bottom tank tops, thus eliminating the necessity to build an elevated sealing, as with the trestle type bedplate, which must be very soundly constructed and very robust to obtain the desire degree of rigidity.

With the trestle type bedplate stool are provided, being constructed of iron or steel casting or one built of plates and angles riveted by stepping up the double bottom tank top to accommodate the trestle type bedplate and thus gives a more solid foundation for the bedplate.

Trouble with engine alignment is becoming more and more obsolete with the introduction of the box type bedplates provided however that the design allows access to the holding down bolts. Pending weathering conditions at sea, holding down bolts may become strained and should be tested by the engineers using the hammer test. The engineer should also examine the underside of the lubricating oil sump for leakage. These tests should be carried out as the engine operates as any weakness in the foundations will be more easily detected.

The bearing halves are semi-circular this allows for removal of the bottom bearing half by rolling it around the crankshaft. The bearing halves or bushings are made of cast iron or cast steel, lined with white metal. The bedplate is constructed of vertical sections at each section throughout the length of the crankshaft, spaces being cut through this section to allow for oil flow.

Inspection doors are placed on each side of the bedplate these doors being located between each section of the bedplate and held by bolts screwed into the bedplate. The transverse vertical girders have their connector section which contains the main bearing saddle and tie bolt connection formed by a steel casting which is welded in. these transverse girders with main bearing saddlers are fitted between each throw of the crankshaft, as close as design allows and are secured by substantial butt welds to complete the rigid structure of the bedplate.

All welding in bedplates must meet a high standard and be carefully controlled. It must be stress relieved, shot blasted and tested. Plate edges must be correctly prepared and double butt welds used where possible. Plates of diameter and thickness should not be butt welded together. Bed plate flanged is machined for landing on support chocks and for assembly of other parts. Regular inspection of internal parts should be made, partially of the girders for fatigue and cracks.

The ships hull is strengthened by placing a doubling plate on the tank top before securing the bedplate to the tank top with holding down bolts. During construction the ships structure is stiffened to rigidly support engine weight, stiffening extending outside the engine area to allow distribution of stress over a wider area of the ships structure.

Direct drive engines are jacked up using jacking bolts to accurately align the main bearing centering with the propeller shafting. Holding down bolts are then drilled and tapped in the tank top. Cast iron or steel chocks are then carefully machined and fitted between the tank tops and bedplate. Chocks must be located at each bolt and their total area must be sufficient top support the engine and chocks must be tight when the bolts are hardened down.

An alternative to chocks would be a non-shrink epoxy resin chocking material cast into the space between the engine and tank top. This may not be as strong as cast iron, but by filling a larger area and by the intimate matching of surfaces left by casting it will give excellent load bearing and avoid the possibility of fritting which can occur with metal chocks.

Mild steel bolts are then screwed into the tank top until the conical -face at the lower end on the plain part of the bolt seats on the tank top and forms a watertight joint. A grommet and nut are placed on the bolt under the tank top.... recommended torque, and then the upper nut is tightened. This procedure ensures a seal between the conical face of the steel and the tank top, thus preventing any liquid spillage into the double bottom tank which usually contained fuel or oil. Nuts must be hydraulically tested and chocks hammer tested at regular intervals and additionally tested after heavy weather or damage.

Side and end thrust (transverse and longitudinal) is transmitted through brackets welded o the tank tops at the sides and ends of the bedplates. Vertical chocks or packing pieces are fitted and locked between each bracket and the engine. Side brackets are situated at the ends of each transverse member, and end thrust is taken in a similar manner. Although the main forces are transmitted at the bedplate further transverse struts to secure large engines to the ships structure are fitted at upper platform levels.

Picture of holding down bolt

10.6 Describe a governor other than the ordinary flyweight type. How is it driven and how does it control engine spend?

picture

The electric governor, which is operated without a flyweight has proportional and reset action with the added advantage of load sensing. With the governor small permanent magnet alternator is used to obtain a speed signal from the engine.

The advantage of using permanent magnet is that there will be slip rings or bushing to wear. The alternator generates voltage which determine the speed signal. This signals converted into DC voltage by a rectifier. This DC voltage is proportional to engine speed. The DC voltage is then sent to the amplifier and controller which also require a reference DC voltage of opposite polarity from the speed setting unit. (This voltage is represented of the diesel operating speed desired) These two voltages are connected to the input of an electric amplifier. If the voltages are different, the amplifier is equal and opposite, they cancel and there is no change in amplifier voltage output.

If the voltage is different, the amplifier sends a signal through the controller to the electro-hydraulic converter which via a servo -motor will change the fuel rack to lower or increase speed as required. In order that the system is isochronous the amplifier controller has internal feedback. The load sensing unit is included in the governor to correct the fuel supply to the prime mover before a speed change occurs. The speed of response of the load sensing element must be better than that of the speed sensing element which would be used to correct small errors of fuel rack position.

The example of the electric governor the electric output of the main generator would be tapped and it any load alternation took place on the main generator this would be synchronized and a signal fed into the controller to order the electro-hydraulic converter (via the servo motor) to increase or decrease engine speed by adjusting the fuel rack.

SHAFTING AND PROPELLER

4.7 Describe a single collar thrust block. How would it be fastened to the ship hull? How would it compare with a multicollar thrust block? What care and attention does it require and how is clearance measure?

picture

The thrust shaft is connected to the main engine crank shaft. In the case of a direct drive reciprocating engine, to the main gear wheel shaft. In geared installation; it functions as well as transmitting the engine torque also to the next shaft, is to transfer the thrust of the propeller, to the thrust block, which being securely fitted to the hull of the ship. The shaft is comparatively short with a coupling at each end a thrust collar in the middle of its length and a ? at each side of the thrust collar.

The journals run in bearings housed in the thrust block which is secured. Each side of the collar bears upon a number of kidney shaped white metal faced pads supported in the thrust block those on the forward face of the collar being to take the astern thrust. The back of each kidney piece has a hump or step to allow the pads to pivot and the slightly so that the lubricating oil, picked up by the collar from the bottom of the block can squeeze its way as a wedge shape film between the pad and collar surface and be dragged over the whole surface. Thus there is always a film of oil maintained between the faces and there is consequently no metallic contact.

Thrust pressures in the region of 24 bar can therefore be carried without danger of overheating due to friction. Particular attention is giving to the strengthening of the structure of the double bottom heavy loads be supported and vibration minimized, but the thrust from the thrust block is to be transmitted to ship's hull.

All structure below the boiler and engine rooms is increased in thickness, additional longitudinal girders are incorporated so that they are pitched closer together, all girders have double angles and all parts are bearing fit. A tank top plate of extra thickness (40mm or more) runs continuously from under the engine bedplate to under the thrust block seating, the forward edge of the thrust block base either contacts the engine bedplate or chocks are fitted to have the same effect of spreading thrust load over a greater area of the ship's hull.

Chocks are also fitted at the after edge of the thrust block. Most medium diesels have the thrust block as an appendix to or integral with the engine. When the engines are going ahead the thrust force is taken up by the surface of collars. This reduces the length of the block and it will be obvious that this is not a drawback as the engines only need to run astern for short period.

The thrust block is secured to the hull of the ship by means of a pedestal made up of plates and angle iron, the hull being strengthened at this part so to transfer the thrust and distribute it over the hull. The shoes are usually held in position by large adjusting screws each shoe having separate jam nuts to permit the load to be distributed evenly over the various collars. The faces of the shoes are usually filled with white metal which permits about 70lbs per sq in of effective surface when the engine are running at full speed ahead.

On many ships the shoes are water cooled while on others they are contained in an oil bath. the modern Mitchell thrust block only one collar, the collar having kidney pieces or rolling fitted, and the pressure that can be carried may be as high as 500psi this style of thrust is fitted in all modern ships having either turbine, reciprocating or diesel machinery, as the friction is greatly reduced and the size and weight of the thrust block is greatly reduced.

Base and covers are made of cast iron, while the bearing at each end are made of gunmetal. Lubrication carried out by means of an oil scraper, fitted in the collar which intercepts the oil brought up by the rotating collar from the oil bath below, so forming a cascade of oil over the thrust pads. The end bearings are self lubricated and oil deflecting rings are fitted at each end to prevent oil escaping.

4.1 Describe in detail, how you would fit a new propeller to a tail shaft already in place. State size of shaft and size of key used. How would you ascertain that the propeller is in right place?

When fitting a new propeller to a tail shaft already in place, the tall shaft should be checked for signs of wear and corrosion. The key should be removed from the shaft and the bottom of the keyway carefully examined. The key is then tested in the keyway of the new propeller. It must be good fit on the sides to prevent movement left or right when reversing the propeller.

The screw of the shaft is examined for corrosion. The taper on the shaft is examined for corrosion or any signs of movement of the old propeller. Also the shaft at the end of the liner is examined for corrosion. If the old propeller was moving the cone will not be true and a new propeller will not fit as it should. The propeller is fitted by smearing the taper with mechanical blue. The propeller is then slipped on over the taper and any high spots will be noted by the taper being scraped clear and the mechanical blue showing up on the propeller boss. The high spots are scraped down again and the propeller is placed on the shaft taper. The process is continued until about 80% or more of the propeller has turned blue.

When the taper is fitted perfectly the nut and bossier marked, when the boss is hold up on the taper. The nut is then slacked back and the propeller is dropped back against the nut. A ball of soft lead wire is laid on the top of the shaft close to the lines and the propeller is then hammered up until two marks on the boss and nut coincide. The nut is slackened back again and the propeller is also dropped back against the nut.

Wire will now be rectangular and will indicate the size of the rubber ring needed. The rubber ring is sandwiched between the propeller and the end of the brass lined to ensure that no part of the steel shaft is in contact with the sea water. the nut is removed and the propeller is forced is taken right back in order to insert the key in the keyway. The propeller is forced upon the taper again until the marks coincide, the nut is removed again and feeler is inserted on the top of the keyway its whole length. Top of the key must not touch the boss. When this is checked the rubber ring is put in place, up against the lines.

The propeller is put on the taper again and the nut hammered up with a ring spanner until the marks on the nut goes beyond the mark on the boss slightly. This is to ensure the propeller is hard in its place. A stopper plate is next bolted to a recess in the propeller nut. A pintle on the plate passes through the hole drilled into the propeller nut. This is a locking device to prevent the nut from backing off.

The size of the key is governed by the size of the shaft. If the size of the shaft is say 300mm dia, the key width size is equal to 1/5 dia shaft. the key depth is equal to 1/2 breath of keyway. The propeller nut and the end of the tail shaft should be protected in some way against the corrosion action of the seawater. The practice is to ... a hollow cone-shaped casting (filled with grease) over the nut and bolt and bolt it to the propeller boss. Therefore no part of the steel tail-shaft will be in contact with the sea water if the various parts have been properly fitted. If no cone is fitted over the propeller nut it should be cemented over.

4.2 Describe a modern method of aligning shafting on a ship. What method is used for boring out to fit a stern tube?

The first important step to the fitting of the length of shafting from the propeller to engine in correct alignment is the installation of the stern tube to carry the propeller shaft, at its designated height from the keel and in the, directional line, so that the remaining shafting can be lined up with it.

The stern frame and after peak bulkhead have initial rough holes, smaller in size and approximately positioned to the final requirements. This arrangement also applies to other water tight bulkhead up to the forward end of the engine room. A plate is fixed in the hole of the stern frame and a small hole of about 2mm dia drilled through it at the exact height above the keel as required according to the plans of the ship and carefully athwarthip. At the height and athward centre line of the engine shaft, a similar hole is drilled a plate in the engine room forward bulkhead, and a strong tight is placed on the forward side of the hole.

Therefore by sighting from the after wall of the small hole drilled in the stern frame plate, the tiny beam of light can be seen through the hole in the engine room forward bulkhead and any other water tight bulkheads through which the shafting is to pass. Beginning at the after peak bulkhead and later taking the others in turn, a sighting plate with a horizontal straight edge is moved vertically upwards over the hole from below the centre until the beam of light is just cut off from sight, and a horizontal reference line is drawn alone this straight edge on the bulkhead to each side of the hole.

This plate is above the centre until the light is again just cut off and another horizontal reference line is drawn. These two horizontal and parallel lines will be fairly close together depending upon the "thickness" of the beam of light as righted. Bisecting the two lines gives the exact horizontal center line of the shafting. A similar operation is now performed by horizontal movement of a plate with a straight vertical edge to obtain the exact vertical center line of the shafting. A bridge plate is now fixed into the rough hole and the shafting center scrub on it by intersecting the vertical and horizontal centerlines, and a small sighting hole drilled through this centre.

When this is done to all intermediate water tight bulkheads, the beam of light should be seen right through the entire centre sighting holes from stern frame to engine room. With the sighting holes as centers, references circles of the correct diameter are scribe with dividers on the stern frame and bulkheads. Then the bridge plates are removed, the boring gear set up and the holes bored to the required size. A further check may be made before the final cut of boring out by means of an optical telescope with vertical and horizontal micrometer adjustment.

The stern tube is inserted, drawn into place by plates and draw bars, stern tube nut (if fitted) screwed up tightly and locked. The propeller shaft is then inserted and propeller fitted. The intermediate shafts are usually placed in position when the ship is afloat at the fitting out berth.

Each shaft form aft to forward is line up by the use of feeler gauges between the coupling faces, chocking the tunnel bearings on their pedestals as required. A final check for alignment is made with all shafts in position by the optical telescope which is placed at one end and a target at the other end. Both telescope and target are setup at the same height above the shaft journals, and sighting takes place on a graduated seal mounted on each shaft journal in turn. Final adjustments are made to the bearing chock bearing firmly bolted down on their pedestals and coupling bolts fitted.

4.5 Describe the construction of a tail shaft. What metals are used? What test would the tailed shaft be subjected to and what would the results be?

The propeller or tail shaft end shaft is the aftermost length of shafting, and has the propeller attached to its end. It is forged from good quality mild steel of 28 tons tensile strength. It requires toughness and resistant to fatigue. For the latter property, shafts were made of wrought iron in the past. It is some 10% greater in strength than the tunnel shafting by reason of the varied stresses to which it is subjected also to its liability to corrosion by its contact with sea water. The shaft is machined all over.

The taper at the end for taking the propeller or propeller boss in (of the order of .75inch per foot) length of shafting and has a length of approx. three times the shaft diameter. The keyway is milled out and has semicircular end to avoid stress concentration. To protect the shaft from corrosion and from wear it has a sleeve or liner of gunmetal shrunk on. The liner may be in one or more length and is machined to have the diameter of the forward length slightly greater than after length. The difference in diameter is an aid in fitting shaft into the stern tube.

The following are working stresses induced in a propeller shaft.

TORSION: Going ahead and astern and which will vary in intensity on the power developed by the engine.

COMPRESSION: While going ahead

BENDING AND SHEARING: Due to the weight of the propeller and its overhang from the end of the ship.

TENSION AT TAPER: Due to the tightening of the tail end nut.

FATIGUE: This results from the variation and combination of all other stress.

It should be noted that when bending occurs the upper layers of metal are put into tension, and the bottom layers in compression. It therefore follows that with overhang of the propeller these varying stresses are created in the tail shaft as the propeller revolves in the water. For this reason the propeller shaft is the greatest in dia of all the shafting.

7.3 Sketch and describe an electric hydraulic steering gear with which you are familiar. What provisioned for wear down. What happens when heavy sea strikes the rudder? Sketch charging lines.

Picture

The electric hydraulic steering gear uses an electric motor to drive a hydraulic pump for piping and discharging hydraulic oil from one cylinder to the other depending upon the direction required. Movement of the rudder stock is achieved by the force of the hydraulic oil being exerted. These rams are of steel construction while the cylinders usually gunmetal. The hydraulic pipes in the system are heavy gauge copper, and the hydraulic fluid is a mineral oil. The hydraulic power is supplied by constant running rotary pumps. The delivery of the pumps to the rams is achieved by translating the rotary movement of the steering wheel into the "stroke" movements of the pumps by the inclusion of the telemotor system.

The electric-hydraulic steering gear consist of a hydraulic rams situated on the port side of the tiller and another on the starboard side, linked at their outer ends to the tiller and by a crosshead and swivel block, the other ends of the rams working inside their own hydraulic cylinder, pipes connect these cylinders to a hydraulic pump. The function of the pump is to draw oil from one cylinder and pump it (at high pressure) into the other, thus causing one ram to move out and push the tiller over while the other moves back into its cylinder.

The hydraulic pump is of the rotary displacement types driven by an electric motor. The pup is of special construction and may be a Hele-shaw or Williams-Janney design. It runs continuously in the same direction and the position of a moveable plate inside the pump controls the suction and discharge of the oil. When the plate is moved in one direction from mid position no oil is drawn in or discharged. When the plate is moved in one direction from the mid position oil is drawn from one cylinder and discharged into the other. When the plate is moved in the opposite direction the suction and discharge of the oil is reversed in direction. The plate is actuated by a control rod which is attached at its outer end to the hunting gear.

If a heavy sea strikes the rudder the shock is transmitter through the tiller to one of the cylinder and double spring loaded relief valves allow the tiller to give way slightly (80-190 bar) by bypassing a little of the oil into the other cylinder resulting displacement of the rudder, tiller and ram crosshead moves the pump control rod through the hunting gear and the tiller is automatically brought back to proper position. The following sketch shows simply to operation of the hunting gear.

picture

The telemotor moves the end of the floating rod A to A1 and the pump control is moved, therefore from B to B1. Pumping of the hydraulic oil causes movement of the rams and the end of rod C moves to C1, thus causing a pump control to be pulled back to the neutral position B. An emergency tiller is attached directly to the rudder stock for emergency steering, if the hydraulic system fails. Due to normal operation this hand wheel is designed by removing connecting pin which is attaches it to the control rod.

The steering gear itself must be completely filler with oil and all air must be excluded. Thus the air release valves are opened on hydraulic cylinders and pumps also stop valves pump can be used to pump the oil around the system (while keeping the replenishing tank topped up) It can be put on stroke by the hand wheel and turned by a bar. The rams may be filled through the filling holes until all air has been displaced, before starting to pump the system through. When all the air has been purged from the system and the level in the relishing tank ceases to fall, the air released valves are closed. Finally the by-pass and stop valves are set for normal operation and the pump started. Using the hand control, the gear is then run from hard over to hard over slowly and the air release valves are open again to check. To allow for wear down in the crosshead arrangement a wear down rudder allowance of 19mm is provided so as not to induce bending stresses on the ram.

7.4 sketch and describe a rudder quadrant and tiller. How are they fastened to the rudder post? What provisions are made to take up the shock from heavy seas? What is the sealing arrangement for passing the rudder stock through the ship's hull?

picture

The steering engine or electric motor transmits its movement to the tiller, firmly keyed to the rudder stock by means of a worm on the engine crankshaft which engages with a worm wheel. The shaft of this worm wheel carries a pinion which meshes with a large quadrant, the centre of which sets loosely over the head of the rudder stock above the tiller. Two heavy shock absorbing helical buffer springs connect the two side of the fixed tiller to the loose quadrant. When the quadrant is moved it pulls the tiller with it through one of the springs which takes the load in compression so if one of the springs break it will not pull the tiller to one side and impure steering. The function of the springs is to absorb the shock of heavy seas sticking the rudder and so prevent damage to the steering gear and the teeth on the driving pinion and quadrant.

An emergency hand steering gear may be fitted to drive a pinion engaging with a tooth quadrant extension secured to an arm on the tiller, the drive being from a hand wheel carries on a pedestal above the steering gear, through a worm gearing, friction clutch and vertical shaft down to the quadrant driving pinion. The shackle shown on the line of each wing of the loose quadrant is for coupling block and tackle gear to operate the rudder (and also the emergency hand wheel fitted). The block and tackle arrangement is worked through wire rope, guided by puller and led to the after winch. A screw-operated brake is fitted to enable the rudder stock to be locked while changing over from engine to emergency steering, or while repairs are being carried out and the steering engine and driving pinion can be slid out of gear after the emergency gear has been coupled up. If one of the helical springs breaks a key can be placed in the key way of the quadrant for direct steering, through the quadrant, to the rudder stock.

7.6 Sketch and describe a variable delivery pump as used for a steering gear. What provisions are made for the pump heating up. Why is this type of pump used?

picture

The constant speed Hele-shaw pump has its output controlled by a simple push/pull rod attached to guide rings in the pump. Without stopping or starting the pump, the output can be varied from zero to full in either direction. The pump consists of a bronze cylinder body with seven or nine radial cylinders which is rotated at constant speed in one direction. The radial cylinder block rotates on a fixed steel constructed piece having two ports opposite to one another and in line with the bottom of the rotating cylinders. In each cylinder there is oil hardened steel piston having a gudgeon pin with bronze slippers on the ends. The slippers revolve with the cylinder block in grooves machined in a pair of floating rings. These are the rings which are moved horizontally by the control rod. Movement of the floating rings from the mid position displaces the circular path of rotation of the piston from that of the cylinder block and produces a pumping action. When the rod is in mid position and the centers of rotation of piston and block coincide here is no pumping action

A) When the circular floating ring is concentric with the central valve arrangement the pistons have no relative reciprocating motion in their cylinders. As an result no oil is pumped and the pump although rotating is not delivering any oil

B) If however the ring is pulled to the right then a reciprocating motion of the piston in their cylinder does occur. The lower piston moves inward, it discharges fluid out through the lower port in the central v/v arrangement. As it continues to pass the horizontal position the piston moves out drawing in the fluid from the upper port.

C) Once past the horizontal position on the other side it begins to discharge fluid. If the floating ring was pushed to the left the suction and discharge ports would be reversed.

BILGE AND BALLAST

5.6 Describe a centrifugal type of salt water circulating pump and illustrate answer with sketch. Under what conditions would the pump fail to function?

picture

This is a rotary pump which works on the principal of centrifugal force, that is, that outward radial force set up by a mass rotated in a circular path due to its natural tendency to fly off at a tangent to the circular path and travel in a straight line.

The pump consist of a rotating impeller within a stationary casing. The impeller is like a hollow disc wheel with internal curved vanes, mounted on a shaft which is driven by an electric motor, steam engine or turbine, or other prime mover. Openings in the sides of the impeller smear the shaft communicate with the suction branch, water or oil enters the rotating impeller through these ports, and due to the circular motion given to the water it is thrown by centrifugal force to the open periphery of the impeller and the casing and directed to the outlet branch.

The centrifugal pump does not have a positive suction action and must be primed by flooding before it will draw water from a lower level. Therefore it is employed mainly where the suction is submerged of the lift is very small. Centrifugal pumps will only pump in one direction of rotation. The drive for these pumps is most often directly from an electric motor but can be from an auxiliary turbine. In the latter case the prefix turbo is adopted for exam; " turbo feed pump"

"***Fluid enters the impeller axially through the eye, then by centrifugal force/action continues radically and discharges around the entire circumference. The fluid in passing through the impeller receives energy from the vanes giving an increase in pressure and velocity. The kinetic energy (velocity) of the discharging fluid is partly converted to pressure energy by the design of the vanes and casing. In some types a diffuser is used, which consist of a ring of stationary guides' vanes surrounding the impeller, the passage through the diffuser is designed to change more kinetic energy to pressure energy. The sealing arrangement may be a packing gland of a mechanical seal depending on the type of service the pump is used for.*** "

material
casing: gunmetal (sw)/cast iron
impeller: aluminum bronze
shaft: stainless steel
brg seals: leaded bronze

5.2 Describe and sketch a fitting which would be used on tanks which could carry fuel or ballast to avoid mixing of the two.

picture

This water-oil ballast chest is a standard fitting on many cargo vessels, on the double piping systems. Normally all chest are open to oil fired (bend) and blanked to water ballast. For ballast or ballast prior cleaning, the bend and blanks are as shown in the sketch. This means that an error in opening the wrong valve would not in itself allow crossing of circulation.

As an alternative to this fitting hollow one way discharge plug cocks or a system of interlocking valves would be acceptable. Any system employed must prevent easy joins of oil and water circuits by accident. Great care is necessary to avoid any mistakes being made, and a ridged routine is advised. Clear explanatory notices are to be provided and all valves should be in good order and easily accessible. This chest is interchangeable in that in its present state if it opens to ballast but blanked from oil fuel, but this can be reversed simply by interchanging the dome and the blank. Care should be taken when this is done to ensure.....

5.4 What type of valves are fitted to double bottom or water ballast tanks and why? How would you proceed to pump out a double bottom tank? Why vents fitted? Why are sounding pipes fitted and where?

Double bottom and water ballast tanks are fitted with screw lift valves. In these cases screw lift valves are used in order to pump in and out thus the same valve. Once opened they stay opened until closed manually. To empty a tank, the appropriate valve for the tank on the distribution chest in the engine room is opened, next the tank suction valve to pump distribution chest is opened. The discharge overboard valve on the discharge chest and ships side is opened and the pump started up. All other valves should be shut. To fill a tank, open appropriate tank valve in distribution chest in engine room. Open sea suction valve and close overboard discharge. Open discharge valve to main tank line on discharge chest and start the pump. Air pipes (vents) are fitted at the forward end of each tank. This end is the highest point of the tank while under normal trim, therefore all air will be expelled, otherwise air pockets might be formed which would result in damage being done to the tank by movement of water, also the ship is inclined to list more readily. Sounding pipes are fitted at the aft end of each tank, usually port and starboard this end being the lower end under normal trim. Sounding pipes are fitted so the level of the liquid in the tanks can be ensured. These pipes may also serve as vent pipes when filling tanks, but it should be noted that it is still essential to also have vent pipes.

5.1 Describe with a simple line sketch a bilge system a ballast system for a 7000 ton cargo ship. What is bilge injection valve? What is the main difference between bilge and ballast?

picture

The line diagram consist of a typical bilge suction arrangement where the bilge pump, ballast pump, general service pump, or the OWS can be used for pumping out any bilge. The distribution valve chest is situated in the engine room to enable any bilge to be pumped out by the watch keeping engineer. All bilge suction valves are of the screw down non return type to prevent water flowing back and flooding the bilges. The operated hand wheels are labeled by engraved brass plates as to which bilge the pipe runs into. A mud box is fitted on the bilge suction of each pump and open end of every bilge pipe in the bilges is enclosed a strainer box.

1) a bilge pump has suctions from all bilge main and engine room bilge, with discharge to fire main, oily water separator and overboard.

2) a ballast pump has suctions from sea, ballast main, engine room bilge direct and bilge main with discharge to overboard, the ballast main, the oily water separator and possibly the main sea water circulating system.

A general service pump has suction from sea, ballast main, bilge main and engine room bilges, which discharges to the fire main, the ballast main, the ows, and overboard. In this way three pumps provide effective alternatives for all essential services in the event of breakdown of one or even two. The mains must be at least 65mm and the branches 30mm.

The pumps should be of the self priming type unless efficient priming devices are provided. The capacity of the pumps should give water speeding the main line of not less than 2m/s and the capacity should be about 65% of the displacement of the ship. Vessels should have at least four independent power pumps connected to the main line pump should have a direct suction to the space in which it is situated, such suction to be at least the same bore as the bilge line. Not more than two such suctions are required and in the machinery space such suctions should be arranged, one each side.

Emergency bilge pumps are also used on ships in the case of emergency such as a compartment flooding due to, most likely, hull damage. It is a self-contained unit consisting of a centrifugal pump to deal with the water, reciprocating, rotary air pumps to rid the water suction of air to help priming of the centrifugal pump, and an electric motor to drive the pump. The drive shaft is vertical and the electric motor is above the pumps, the motor being enclosed in an air bell to protect it from being flooded when the compartment is full of water, thus the system continues to work when the unit is completely submerged. The electric supply is taken from the ships emergency electrical circuit and the unit can be operated by remote control.

The bilge injection valve is one of the most important fitting in the machinery space. It is provided for use in the event of serious flooding in the machinery space. By closing in the main injection valve and opening up the bilge injection valve the largest pump (or pump) in the engine room are drawing directly from the lowest point in the space; this suction can remove large quality of water. The diameter of the BILGE INJECTION VALVE IS AT LEAST 2/3 OF THE DIAMETER OF THE MAIN SEA INLET. Valve spindle should be clear above the engine room deck plating so that examination and greasing, with cleaning of strum or strainer.

Picture of injection valve

- Bilge pipes should not be led through oil tanks or double bottom tanks.
- Joints should be flanged, pipes well secured and protected against damage.
- The pipes should be independent to the bilge system only.
- Collusion bulkhead should not be pierced below the margin line more than one pipe, such pipe to be fitted with a screw down valve operated from above the bulkhead deck.
- valve chest being secured to the forward side of the collusion bulkhead (divide peaks may have two pipes)
- Valve and cocks not forming part of a pipe system are not to be secured to watertight bulkhead.
- Pipes, cables, etc passing through such bulkhead are to be provided with watertight fillings to retain the integrity of the bulkhead.

5.12
A) Make a line diagram of a bilge pumping system for a container ship.
B) Indicate the position and type of valve fitted to ensure satisfactory operations of the system.
C) What arrangement are provided to ensure integrity of the system should collision damage occur.

The arrangement of the bilge and ballast pumping system shall be such to prevent the possibility of water passing from sea and from water ballast spaces into the cargo and machinery spaces, or from one compartment to another. Special provisions shall be made to prevent and deep tank having bilge and ballast connections being inadvertently run from the sea when containing cargo, or pumped out through a bilges pipe when containing water ballast. Provisions shall be made to prevent the compartment served by any bilge suction pipe being flooded in the event of the pipe being severed or otherwise damaged by collision or grounding in any other compartment. For this purpose where the pipe is at any part situated nearer the side of the ship than one fifth the breath of the ship a non-return valve shall be fitted to the pipe in the compartment containing the open end. All the distribution boxes, cocks and valves in connection with the bilge pumping arrangements shall be position which is accessible at all times under ordinary circumstances. They shall be so arranged that in the event of flooding one of the bilge pumps may be operative on any compartment.

9.2 Describe a reducing valve. Where this would be used? What else would be fitted and why?

picture

A reducing valve is used to reduce the supply pressure of steam or air to a suitable working level for the operation of auxiliary equipment. The valve shown consists of a valve body, valve, valve seat, valve spindle, adjusting nut, spring and diaphragm. The reducing valve steam or air on the inlet side of the valve to the lower side pressure on the outlet side of the valve. The adjusting nut is used to regulate spring compression and determine the pressure of the outlet side. The adjusting nut also acts against the spring diaphragm to lift the valve from its seat slightly and allowing a reduced amount of air and therefore lower air pressure to the outlet side of the valve. If the air pressure should increase on the lower side, air will act downward against the diaphragm and causer the valve to close slightly thus keeping the air pressure on the low side at it's working level.

A gauge is fitted on the lower side of the reducing valve to monitor the pressure and will also aid in the adjusting the spring tension to attain the correct pressure setting. The gauge will help in determining that the valve is working properly. A relief valve is also placed on the low pressure side to relieve and high pressure should the valve malfunction thus preventing any damage to the auxiliary equipment. The valve body is usually of cast iron or steel. Valve, valve seat and valve spindle are steel or bronze. All materials will depend on the operating condition of the valve.

Since the valve must be in equilibrium under the action of the forces which act upon it
downward force=upward force

p1xA = (p1-p2)xa+F

if p1, A and a are constant we have:
p2 varies directly as F

Hence if the supply pressure is kept constant the discharge pressure can be reduced or increased at will by rotating the adjustment screw.

9.3 Sketch and describe the construction and operation of a windlass. What provision is made for a power failure?

picture

A windlass is used to lift anchors or assist in way of the ship, and therefore its size and power depend upon the masses of the anchors and cable and full hauls which is governed by the size of the ship. It may be powered by a steam engine, hydraulic or electric motor.

The basic design is that of a double purchase lifting machine consisting of a primary shaft, intermediate shaft and main half-shaft, with corresponding pinions and gear wheels as shown in the diagram. In the electrically driven windlass, the primary is driven by a worm a worm wheel through a worm shaft from the electric motor. The primary shaft carries a pinion which meshes with an intermediate shaft mesh with two main gearwheels one on each main half. Each main half shaft carries a cable lifter which has snug around its circumference of the size and pitch to suit the links of the cable.

The cable lifters are not fixed on the shaft but are mounted freely to allow them to rotate independent of the shafts. A screw operated steel hand brake is fitted around a brake drum on the outer edge of the rim of the cable-lifter controlling the speed of the cable when paying out and for locking it stationary when required.

The power for hoisting is transmitted through a clutch formed by jaws on the side of the main gear wheel may be fit a corresponding set of jaws on the side of the cable lifter. The main gear wheel may be a sliding fit and keyed to its half shaft allows it to be moved actually into and out of gear alternatively. The gear wheel may be fixed on the shaft and the cable lifter moved laterally to engage gear, a screw control rod attached to a cod piece riding in a groove in the boss of either the main gear wheel or the cable lifter operated the clutch.

Thus the two cable lifter is entirely independent the anchor may be fitted both at once and separately or one may be fitted while the other is being lift. Each end of the intermediate shaft is extended through a dog clutch to carry a warping drum. In the event of a power failure, the windlass can be operated by hand gear consisting of a lever and pawl to act as a ratchet on the teeth of the intermediate gear wheel. In windlass cable lifter brakes must be able to control the running anchor and cable when the cable lifter is disconnected form the gearing during "letting go".

Average cable speed varied between 5 to7 meters per minute during operation. The windlass must be able to have a certain weight of cable at a specified speed. this full load duty of the windlass varies but is common between 4 and 6 times the weight of one anchor, the speed of haul being at least 9 meters per min up to 15 meter per min. the braking effort obtained at the cable lifter must be at least equal to 40 % of the breaking strength of the cable.

9.4 Describe how the engine room of a motor ship is ventilated. Give reasons for the ventilation of diesel engine rooms. What provision is made to prevent moisture from entering through the ventilation system and what would be the effects of too much moisture getting carried in the machinery spaces?

Ventilation can be defined as the movement of air from outside the ship to inside of the ship, or from the inside of the ship to the outside of the ship. Ventilation systems can be broken down into two parts air supply and exhaust.

The air supply system consist of weather intake, centrifugal fans, and duct work through the engine room so positioned that the entire engine room is supplied with fresh air. The exhaust system consists of a hood or canopy and exhaust or extraction fans, ductwork, and a weather opening. In the case of exhaust air they can be extracted from the engine room by pressure difference. They will rise through the engine room and escape through the funnel.

In the supply air system air is drawn in through the air inlet vent by the centrifugal fans and pushed through the duct work to the engine room spaced. The supply fans are usually two speeds because less air flow may be required in the heating season. Each of the duct holds may be fitted with cut off shutters to cut air flow to any space it is not required. The ventilation air intake parts are fitted with fire dampers to cut off are supply in case of fire and fans have remote shut offs outside the engine room for use in case of fires.

With the increase in generator capacity on board ships the fans are able to produce higher pressure of ventilation in the engine room of a ship is to supply the air necessary for the operation of the engines and possible boiler, also to remove contaminants and heat generated by the running machinery. The air supply is used for cooling the spaces and machinery in the space and make the spaces somewhat comfortable for working.

With the introduction of heating and air conditioning the engine room can be very live able in hot and cold weather. To reduce a large flow of moisture through the ventilation system, provisioned must be made. Most ships have filters installed in the system to absorb the moisture. The ductwork may be provided with drains and if a build up of moisture is large enough it can be drained. In more modern ships an air dryer will be fitted in the system. the end of the ductwork opening are designed to not blow on electric motors or electric equipment. If there was too much moisture in the machinery space its biggest effect would-be on the electrical equipment. Moisture is a very good conductor of electricity, therefore an electric equipment exposed to moisture will most likely overheat causing a breakdown in insulation on the wiring forming a short of ground. This may cause fuses to blow or the electrical equipment to burn out. Engine should also be vented because of gases escaping from the engines. These gases can be very harmful to humans.

9.1 Sketch and describe a mercurial barometer. How is it graduated? What is the average reading expressed in KPA? What is sometimes used in place of a mercurial barometer and how is it graduated?

picture

The mercury barometer is comprised basically of a glass capillary tube, sealed at one end, and approx 400mm long, filled with mercury and inserted into a container of mercury open to atmosphere pressure. The space above the mercury in the capillary tube is now under vacuum condition (a Torricelli vacuum where any pressure present is due to the vapor pressure of the liquid) and a column of mercury rises up the tube, balanced by the atmospheric pressure acting on the mercury. The level adjusting screw raises the level of mercury in the leather cup by pushing up on the bottom of the cup. The barometers also equipped with an adjustable vernier scale.

Sometimes an aneroid barometers is used instead of a mercurial barometer. This barometer consists of a thin cylinder with the surface corrugated. The space inside the cylinder being evacuated so that the pressure of the atmosphere tends to collapse it as atmospheric pressure increases the centre of the corrugated area moves down taking the tensioning spring with it, and thus moving the pointer. A drop in atmospheric pressure allows the tensioning spring to lift the diaphragm center re=adjusting the bell crank so that it moves the pointer spindle against the return spring. The diaphragm may be of phosphos bronze or cupro-nickel the remainder of the components being of brass or steel. The scale on this barometer is graduated to measure in kilo-Pascal.

9.7 Explain fully the procedure taken before dry-docking a vessel and the precautions taken before undocking.

In many companies it is the responsibility of the marine engineers to inspect the hull of the ship on entering the graving dock. It is essential on such occasion to make a thorough examination to ensure that all necessary work is carried out. The shell plating should be hosed with fresh water and brushed down immediately to remove the salt before the sea water dries. The plating must be carefully checked for distortion, birching, roughness, corrosion and slack rivets.

In the case of welded ships the buts and seams should be inspected for cracks. The side shell maybe slightly damaged due to rubbing against stays. After inspection and repairs the plating should be wired brush and painted. Any sacrificial anodes must be checked and replaced if necessary, taking care not to paint over the surface.

The ship side valve and cocks are examined, glands repacked and greased. All external grids are examined for corrosion and freed from any blockage. If service wastage has occurred the grid maybe built up with welding. The shell boxes are wire brushed and painted with an anti-fouling composition. If the double bottom tanks are to be cleaned, the tanks are drained by unscrewing the plugs fitted at the after end of the tank. This allows for complete drainage since the ship lies at a slight trim by the stern. It is essential that these plugs should be replaced before undocking new gunmetal always is fitted.

The after end must be examined with particular care. The propeller shaft is measured by inserting a wedge between the shaft and the packing. If this wear down exceeds about 8mm the bearing material should be renewed, 10mm being regarded as an absolute maximum. There should be little or no wear down on an oil lubrication stern tube. The wear down in this type is usually measured by means of a special gauge as the sealing ring is not allowing the insertion of a wear down wedge. The efficiency and safety of the ship depends to a great extent on the case taken in carrying out such an inspection. The anchor chain should be flashed out on the dock floor and inspected. The chain should then be sand blasted and the ends changed over before being pick up.

DRYDOCKING OF A VESSEL

REASONS:
1) periodical docking for CSI and classification survey to assess and ascertain the extent of wear and type of the underwater parts of the hull-shell, plating, welded seams, rudder, rudder pintle clearances, propeller, tail shaft wear down, sacrificial anodes, sea chest, sea suction and overboard discharge valves, sanitary discharges, storm valves and anchor chains.

2) occasional docking when it is not possible to inspect or repair a suspected damage to any underwater part with the vessel afloat.

PREPARATIONS:
1) A detailed repair specification covering docking survey or inspections and accepted repair pertaining to these items.

2) A repair and survey specification covering overhaul of deck, engine, electrical, navigation, communications and accommodation equipment, repairs to hull plating hatch covers, cargo gear, cleaning and painting approved alternations or additions to vessels equipment etc. This specification is for items that would-be dealt with concurrently with docking surveys and repairs.

3) all repair items to be marked out physically and spares stores required to be arranged for.

4) Ballast condition to comply with the dockyard.

5)cleaning and gas freeing of tanks for possible manning

PRECAUTIONS:
1) Fire lines tested before docking and line pressure ensured during the entire docking period

2) Potable fire extinguisher checked and ready at the area of any hot work. To confirm with the yard that they would be providing fire watch and extinguishers for any hot work undertaken by then.

3) Tanks and enclosed spaces to be checked for gas free certificate obtained for man entry and hot work from approved government chemist.

DOCKING:
1) The yard prepares the block for the vessel to rest on, from the docking plans of the ship. The docking plan shows strengthened areas on hull for supporting the vessel in dock with minimum stress, location of sea openings and double bottom tank plugs. Arrangement is made to ensure none of the blocks would cover sea openings, bottom plugs, etc.

2) Vessel enters dock with draft and trims conditions acceptable to the yard under the pilot age of a dock master.

3) The dock gates are closed and water is pumped out. The ship hull aft first touches the blocks,

the keel forward following. Trim is therefore an important factor as the pumping of the water must be rapid to allow minimum time between the stern resting and the keel.......

4) When water level in the dock lowers to sea suction draft, the ships power is switched off and ensuring air bottles are pressed up, and shore power and fire lines are connected promptly.

5) All sea water lines are allowed to drain into the dock to prevent ingress of water while removing any connection.

6) Cooling water connection for domestic fridge and air conditioning plants cooling are connected

7) Sewage plant to be in operation where applicable or facilities made available ashore and toilets locked out.

DOCKING INSPECTION WITH CSI AND CLASSIFICATION SURVEYORS:
1. Ship’s hull to be inspected for any damage like indentations in way of strakes and frames

2. Inspect ship hull for corrosion and wastage. An ultrasonic gauging of the hull may be necessary depending on the extent of corrosion and/or age of vessel. Specification for gauging would be as CSI classification unless generally in way of wind and weather strakes-two below about a quarter from either end of vessel.

3. Inspect welded seams for corrosion

4. Inspect sacrificial anodes for wastage

5 Rudder should be drained and air pressure tested for leaks

6. Rudder pintle bush clearances taken, recorded and compared with last readings for extent and rate of wear

7. Inspect propeller blades for physical damage and cavitation corrosion

8. Propeller wear down should be recorded and compared with previous readings

9. inspect sea chest grating and chambers for any damage and wastage of anodes of fitted

10. Check sea suction/discharge and storm/sanitary valves for wear and tear.

SAFETY PRECAUTIONS:
1. Fire main pressure and fire watches maintained at all times

2. Supervision to ensure personal and fire safety practices adhered to

3. Warning to be posted on electrical starter or breakers for equipment under repair, tank valve locked up and notices displayed as necessary. proper lock out procedures followed, checklist

4. make sure lifting gear like wire slings, chain blocks have proper certification before being taken into service.

5. A check list should be made and verified before flooding the dock for undocking the vessel. list to include fit of bottom plugs, sea gratings, propeller ropes guard, rudder, anodes, sea suction and discharges

6. Tank conditions checked and stability worked out for undocking draft and trim, and to verify conditioned with dock master, the same condition as the vessel went up on dock

7. After flooding dock to sea chest level, open and check sea suction valves for any abnormality like leaky joints or packing

8. Main engine crankshaft deflections are taken before and after docking to check out any deviations from standard readings.

9.5 What is meant by thermo dynamic, volumetric efficiency, mechanical efficiency, and thermal efficiency?

THERMO DYNAMIC:
Physics, including the relationship of heat with mechanical forms of energy

VOLUMETRIC EFFICENCY
The ratio between the volume drawn into the cylinder during the suction stroke and the full stroke volume swept out by piston is the volumetric efficiency of compression

MECHINICAL EFFICIENCY
The mechanical efficiency id the ratio of the brake power to the indicated power

THERMAL EFFICIENCY
The thermal efficiency of an engine is the relationship between the quantity of heat energy converted into work and the quantity of heat energy supplied.