Nov 2020

1. With reference to a pressure compensated variable displacement, swash plate pump, explain FOUR different possible causes of reduction in performance.

   Note: The filter has been cleaned, the system is in good condition and there are no visual signs. (10)

Question 1. Although the question clearly states that the system is in good condition, many give low / high viscosity, air etc. Many give worn pistons but no explanation as to why the performance is affected – unless they explain I can't award marks. Few appear to understand what a pressure compensated pump is or how it maintains a constant pressure output hence no faults regarding this are given, whereas many appear to believe that the swash angle is externally set.

Nov 2020

2. Describe, with the aid of a sketch, a hydraulic rack and pinion starting system, labelling the MAIN components. (10)

Question 2. Some sketch a standard hydraulic system for e.g. a steering gear. Some give no description. Some show a hydraulic motor.

Nov 2020

3. (a) On the Worksheet, sketch how an a.c. motor would be connected in EACH of the following:

   (i) star; (3)

   (ii) delta. (3)

   (b) Explain why an a.c. motor may need a star-delta starter. (4)

Question 3. Although all can show a triangle and star shape many are unable to transfer this to a terminal box layout. Few consider the effect on the distribution system od a large motor starting.

Nov 2020

4. With reference to the Electrical Circuit Diagram:

   (a) state the purpose of this circuit; (2)

   (b) describe the functions the areas marked within the dotted lines numbered 1, 2, 3 and 4. (8)

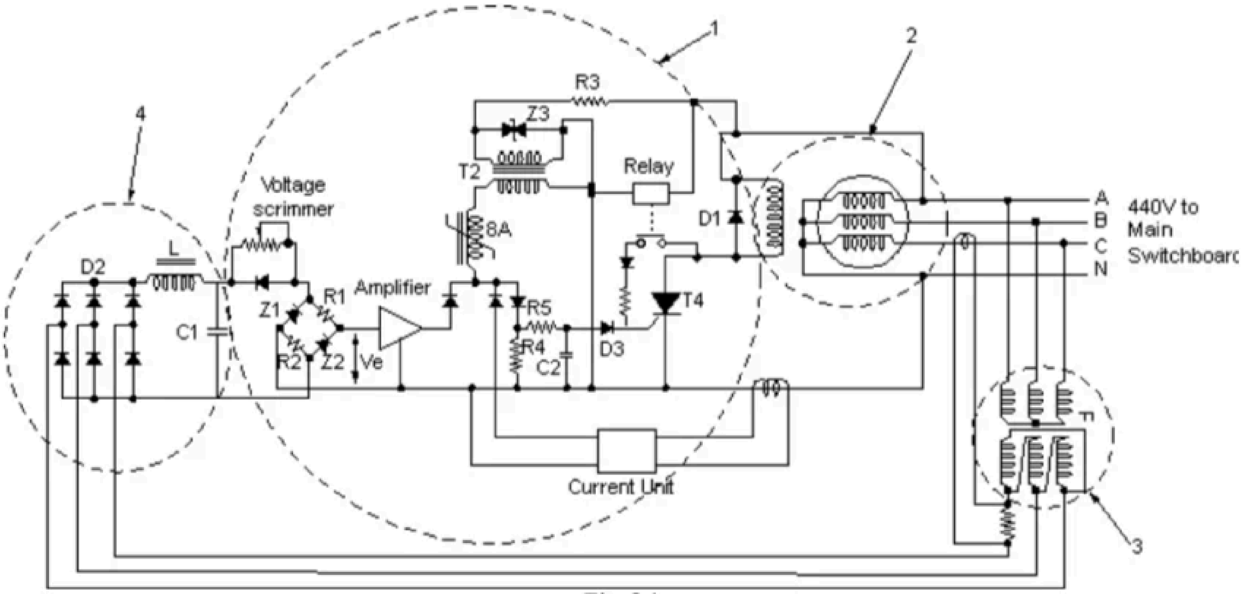

Fig Q4

Question 4. Most recognise the circuit but many fail to identify the component sections and explain their purpose.

Nov 2020

5. With reference to refrigeration systems:

   (a) state the THREE basic laws of refrigeration; (6)

   (b) state the location and method of re-setting of EACH of the following:

      (i) the High Pressure cut out; (2)

      (ii) the Low Pressure cut out. (2)

Question 5. Well answered by most.

Nov 2020

6. With reference to refrigeration systems, explain EACH of the following:

   (a) why air is undesirable; (3)

   (b) how air may enter; (3)

   (c) how air may be removed. (4)

Question 6. Many fail to understand that a refrigeration system is positively pressurised throughout and give leaks as a cause of ingress of air with no explanation of how a negative pressure can occur. Many state that air can be bled and some mention pumping down but do not explain what this means or the procedure for removing air.

Nov 2020

7. (a) Describe TWO possible sources of contamination of compressed air used for breathing. (4)

   (b) State THREE contaminants that may be found in compressed air, outlining the effect of the contaminant on the user when the compressed air is used for diving (SCUBA) purposes. (6)

Question 7. Many simply state the possible contaminants, the question asks for sources. Several concentrate on the effects of contaminants on the system rather than the user.

Nov 2020

8. The lifting arrangement shown in the figure, has two slings, A, with a SWL of 5 tonnes, four slings, B, with a SWL of 2.5 tonnes with a ring and beam each of which have a SWL of 12 tonnes .
Explain the suitability or otherwise of this arrangement for lifting a generator engine, including flywheel, weighing 8.5 tonnes that has certified lifting points, 2 at each end of the entablature, 6 m apart. (10)

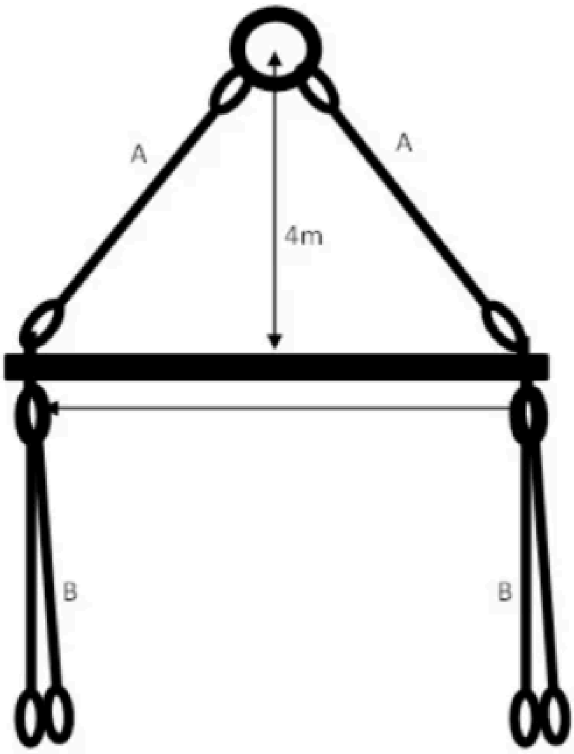

Fig Q8

Question 8. Well answered by those who have an understanding of basic triangle of forces. Many ignore the effect of the flywheel on load distribution.

Nov 2020

9. Describe, with reasons, the features of watertight doors fitted to the weather deck. (10)

Question 9. Mainly well answered

Nov 2020

10. (a) Explain what is meant by the term *pounding* as applied to a vessel being driven hard in a seaway. (3)

(b) Explain how *panting* may often occur at the same time as pounding in heavy seas. (3)

(c) Describe how the hull is strengthened to resist *panting* and *pounding*. (4)

Question 10. Candidates lose marks by not stating specific hull areas for strengthening to resist panting and pounding. Most think that pounding resistance is simply by increasing scantling size.

Nov 2020

1. With reference to a pressure compensated variable displacement, swash plate pump, explain FOUR different possible causes of reduction in performance.

Note: The filter has been cleaned, the system is in good condition and there are no visual signs. (10)

Question 1. Although the question clearly states that the system is in good condition, many give low / high viscosity, air etc. Many give worn pistons but no explanation as to why the performance is affected – unless they explain I can't award marks. Few appear to understand what a pressure compensated pump is or how it maintains a constant pressure output hence no faults regarding this are given, whereas many appear to believe that the swash angle is externally set.

Here are four possible causes of a reduction in performance in a pressure-compensated variable displacement, swash plate pump, assuming a clean filter and a system in good condition with no visual signs of damage:

1. **Internal Leakage:**
- Worn components within the pump can lead to internal leakage.
- This leakage allows fluid to bypass the intended flow path, reducing the pump's ability to generate pressure and flow.
- Worn components may include:
    - **Piston rings or valve plates:** Worn or damaged rings or plates can allow leakage between the high-pressure and low-pressure sides of the pump.
    - **Swash plate bearing:** Excessive wear in the swash plate bearing can cause internal leakage around the swash plate.
    - **Control valve components:** Wear in the control valve spool or sleeve can lead to leakage within the pressure compensation mechanism.

2. **Internal Friction:**
- Increased friction within the pump can cause a performance reduction.
- This can be caused by:
    - **Sticking components:** Sealing surfaces or valve components that stick due to wear, debris, or varnish buildup can increase friction and reduce pump efficiency.
    - **Tight clearances:** Manufacturing tolerances or wear may cause tighter clearances between moving parts, leading to increased friction.
    - **Improper lubrication:** Insufficient or incorrect viscosity of the hydraulic fluid can lead to increased friction within the pump.

3. **Swash Plate Control Issues:**
- Problems with the swash plate control mechanism can affect pump performance.
- Potential causes include:
    - **Sticking or malfunctioning control valve:** A faulty control valve may not respond properly to pressure changes, leading to an inability to maintain the desired swash plate angle and flow output.
    - **Worn or damaged linkage:** Wear in the linkage between the control valve and the swash plate can lead to imprecise control of the swash plate angle and reduced pump efficiency.
    - **Pressure relief valve malfunction:** A malfunctioning pressure relief valve may not properly regulate system pressure, leading to excessive internal pressure and reduced pump performance.

4. **Air Entrapment:**

- Air trapped within the pump can cause performance issues like erratic operation, reduced flow, and spongy control response.
- Air can enter the system through:
  - **Suction line leaks:** Leaks in the suction line can allow air to be drawn into the pump.
  - **Low fluid level in the reservoir:** Insufficient fluid level in the reservoir can lead to air being drawn into the pump inlet.
  - **Improper bleeding procedures:** Incomplete air bleeding during system maintenance can leave air pockets trapped within the pump.

Diagnosing the cause of the performance reduction requires further investigation. This may involve:

- **Monitoring system pressure and flow:** Analyzing pressure and flow readings can help identify if the issue is related to pressure generation, flow delivery, or internal leakage.
- **Checking for abnormal noises:** Unusual noises can indicate internal wear, sticking components, or air entrainment.
- **Reviewing system operating conditions:** Verifying proper system temperature, fluid level, and cleanliness can help rule out external factors.

By systematically examining these potential causes, technicians can identify the root cause of the performance reduction and implement appropriate corrective actions.

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Nov 2020

2. Describe, with the aid of a sketch, a hydraulic rack and pinion starting system, labelling the MAIN components. (10)

Question 2. Some sketch a standard hydraulic system for e.g. a steering gear. Some give no description. Some show a hydraulic motor.

A hydraulic rack and pinion starting system utilizes pressurized hydraulic fluid to crank a vehicle's engine instead of a traditional electric starter motor. Here's a breakdown of the main components:

1. Hydraulic Pump:

- This positive displacement pump is driven by the vehicle's engine (usually via belt or shaft from the crankshaft) and generates pressurized hydraulic fluid.

2. Hydraulic Reservoir:

- This tank stores the hydraulic fluid and maintains its level. It may incorporate a filter and breather to prevent contamination.

3. Pressure Relief Valve:

- This safety valve protects the system from excessive pressure build-up. It bypasses excess fluid back to the reservoir if the pressure exceeds a set limit.

4. Solenoid-Operated Directional Control Valve:

- This valve controls the flow and direction of pressurized fluid based on electrical signals from the driver's ignition switch. It typically has two main positions:
    - **Neutral:** Blocks fluid flow to the starting motor, keeping the engine stopped.
    - **Start:** Directs pressurized fluid to the hydraulic starting motor.

5. Hydraulic Starting Motor (Rack and Pinion Design):

- This is the core component that replaces the traditional electric starter motor. It consists of a housing containing a hydraulic cylinder with a piston connected to a rack. The rack meshes with a pinion gear that engages with the engine's flywheel (ring gear).
    - When the directional control valve sends pressurized fluid to the cylinder, the piston extends, pushing the rack and pinion gear. This pinion gear rotates the engine's flywheel, cranking the engine for starting.
    - Once the engine starts and reaches a certain speed, an overrunning clutch mechanism within the starting motor disengages the pinion gear from the flywheel to prevent over-cranking.

6. Check Valve (Optional):

- This one-way valve can be used in some systems to prevent fluid backflow when the engine starts and the hydraulic starting motor disengages.

Benefits of Hydraulic Rack and Pinion Starting System:

- **Higher Torque:** Compared to electric starters, hydraulic systems can generate significantly higher torque, making them suitable for starting large diesel engines used in heavy-duty vehicles or machinery.
- **Reduced Strain:** The hydraulic system takes the load off the electrical system, which can be beneficial in applications where electrical power is limited.
- **Durability:** Hydraulic components are often known for their durability in harsh operating environments.

Drawbacks:

- **Complexity:** Compared to electric starters, hydraulic systems are more complex and require additional maintenance.
- **Size and Weight:** Hydraulic components can be larger and heavier than electric starters, adding weight to the vehicle.
- **Cold Weather Performance:** Hydraulic fluid viscosity can increase in cold weather, potentially affecting starting performance.

Nov 2020

3. (a) On the Worksheet, sketch how an a.c. motor would be connected in EACH of the following:

(i) star; (3)

(ii) delta. (3)

(b) Explain why an a.c. motor may need a star-delta starter. (4)

Question 3. Although all can show a triangle and star shape many are unable to transfer this to a terminal box layout. Few consider the effect on the distribution system od a large motor starting.

AC Motor Connections and Star-Delta Starters

Here's a breakdown of AC motor connections for star and delta configurations, along with the reason why a motor might need a star-delta starter:

(a) AC Motor Connections:

(i) Star Connection:

1. **Terminals:** Most three-phase motors with star-delta capability have six terminals, likely designated U1, U2, V1, V2, W1, and W2 (one set for each winding).
2. **Connection:** Connect the three ends of the motor windings together at a single point. This creates a "star" shape. You can imagine the three windings coming together like the spokes of a wheel at a central hub.
3. **Line Connections:** Connect the remaining terminal of each winding (U1, V1, W1) to the three individual lines (L1, L2, L3) from the power supply. These remaining terminals are like the individual wires coming out from the rim of the wheel to connect to the power supply.

(ii) Delta Connection:

1. **Terminals:** Use the same six terminals (U1, U2, V1, V2, W1, W2).
2. **Connection:** Connect the end of one winding (e.g., U1) to the **beginning** of another winding (e.g., V2). Do this for all three windings, creating a closed triangular loop (delta) with the windings. Imagine connecting the ends of the three spokes of the wheel together, forming a triangle.
3. **Line Connections:** Connect each corner point of the delta formed by the windings (U1-V2, V1-W2, W1-U2) to the three individual lines (L1, L2, L3) from the power supply. These connection points are like the corners of the triangle connecting to the power supply.

Important Note: Always refer to the motor's manufacturer's manual or data plate for specific connection instructions. Modifying motor connections without proper knowledge can damage the motor or pose safety risks.

(b) Why Star-Delta Starter?

AC motors, particularly larger ones, can draw a very high surge of current when they first start up. This high starting current can overload the electrical supply and cause voltage dips, potentially affecting other equipment. Additionally, the motor itself may not be designed to handle such a high current for an extended period.

A star-delta starter addresses these issues by providing a reduced voltage startup for the motor:

1. **Star Connection at Startup:** During startup, the star-delta starter connects the motor windings in a star configuration. This reduces the voltage applied to each winding by a factor of 1/√3 (approximately 58%). Consequently, the starting current is also significantly reduced, protecting the power supply and the motor windings.
2. **Transition to Delta:** After a short delay (set by a timer), the starter reconfigures the motor windings to a delta connection. This applies the full line voltage to each winding, allowing the motor to operate at its designed efficiency and full torque capability.

In essence, a star-delta starter offers a compromise:

- **Reduced Stress During Startup:** Limits the initial current surge, protecting the electrical supply and the motor.
- **Full Power Operation:** Allows the motor to run at its full capacity after overcoming the initial load.

This is particularly beneficial for applications where the motor doesn't require high starting torque but can benefit from reduced strain during startup.

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Nov 2020

4. With reference to the Electrical Circuit Diagram:

(a) state the purpose of this circuit; (2)

(b) describe the functions the areas marked within the dotted lines numbered 1, 2, 3 and 4. (8)

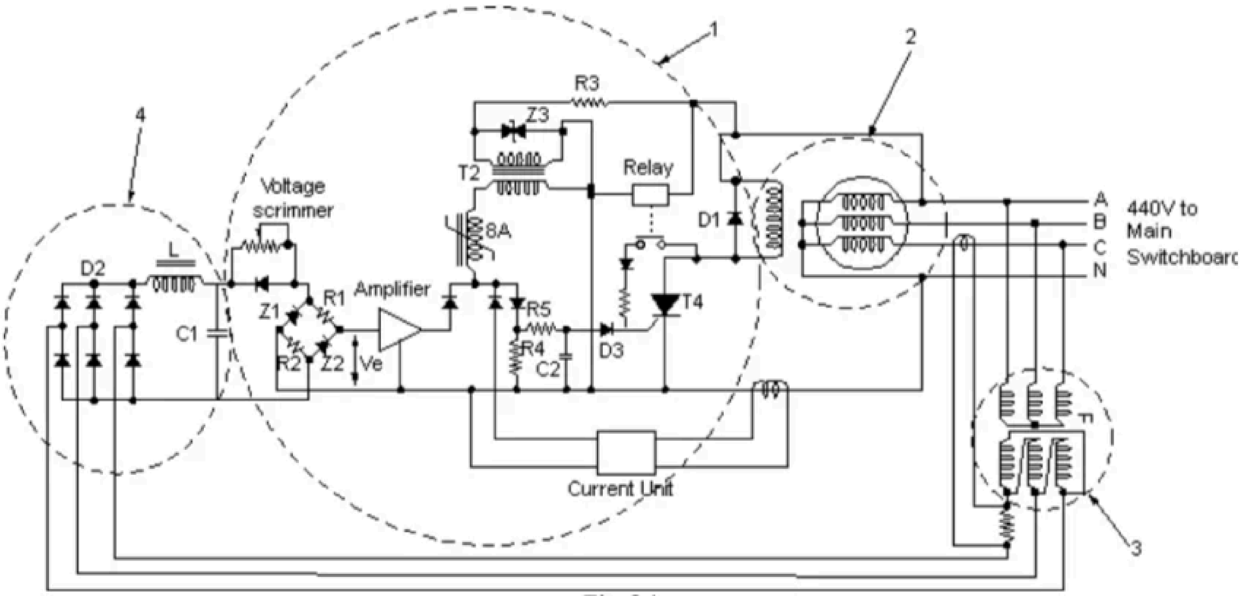

Fig Q4

Question 4. Most recognise the circuit but many fail to identify the component sections and explain their purpose.

Based on the circuit diagram labeled "Fig Q3" it appears to be a voltage divider circuit with an amplifier circuit.

(a) The purpose of a voltage divider circuit is to distribute a voltage source across two or more resistors. The output voltage can be calculated based on the ratio of the two resistors. In this specific circuit, the voltage divider seems to be formed by resistors R1 and R2. The purpose of the amplifier circuit appears to be to amplify the signal from the voltage divider circuit.

(b) Here's a description of the functions of the areas marked by dotted lines:

Area 1: This area contains the voltage source (440V) and the voltage divider circuit (R1, R2).

Area 2: This area contains capacitors C1 and C2. Capacitors are used to store electrical energy and block DC current while allowing AC current to pass. In this circuit, they likely function as filters.

Area 3: This area contains resistors R3, Z3, transistor T2, and relay. Transistors are used to amplify or switch electronic signals. Here, T2 appears to act as a switch controlled by the voltage divider circuit. The relay likely functions as a switch that controls a separate circuit.

Area 4: This area contains resistor R4, diode D3 and the current unit. Diodes allow electric current to flow in one direction only. It's likely D3 prevents current from flowing back into the circuit from the current unit. The current unit likely measures the amount of current flowing in the circuit.

Nov 2020

5. With reference to refrigeration systems:

(a) state the THREE basic laws of refrigeration; (6)

(b) state the location and method of re-setting of EACH of the following:

(i) the High Pressure cut out; (2)

(ii) the Low Pressure cut out. (2)

Question 5. Well answered by most.

Refrigeration System Basics: Laws and Safety Cut-Outs

(a) Three Basic Laws of Refrigeration:

1. **First Law of Thermodynamics (Law of Conservation of Energy):** Energy can neither be created nor destroyed, only transformed. In a refrigeration system, the total amount of heat removed from the cooled space (cold reservoir) plus the heat rejected to the surrounding environment (hot reservoir) equals the work done by the compressor (energy input).
2. **Second Law of Thermodynamics (Law of Entropy Increase):** In a natural process, entropy (measure of disorder) always increases over time. In a refrigeration system, this translates to the need for work input (compressor) to move heat from a colder area (low entropy) to a hotter area (high entropy).
3. **Boyle's Law:** For a fixed amount of gas at a constant temperature, the pressure and volume are inversely proportional. This principle applies to the compression process in the

refrigeration cycle. As the compressor reduces the volume of the refrigerant vapor, its pressure increases.

(b) Location and Resetting of Safety Cut-Outs:

These safety cut-out switches prevent damage to the refrigeration system by automatically stopping the compressor if pressure levels go beyond safe operating ranges.

(i) High-Pressure Cut-Out (HPC):

- **Location:** The high-pressure cut-out is typically located on the **discharge line** of the compressor, where the refrigerant pressure is highest.
- **Resetting: Do not reset the high-pressure cut-out** without identifying and fixing the underlying cause of the high pressure. High pressure can be caused by a dirty condenser coil, a blocked capillary tube (in some systems), or a faulty pressure relief valve. Resetting without addressing the cause can lead to compressor failure.

(ii) Low-Pressure Cut-Out (LPC):

- **Location:** The low-pressure cut-out is typically located on the **suction line** of the compressor, where the refrigerant pressure is lowest.
- **Resetting: Consult the equipment manual** before resetting the low-pressure cut-out. Possible causes for low pressure include a refrigerant leak, a clogged suction line, or a malfunctioning expansion valve. Once the cause is identified and repaired, the low-pressure cut-out may have a manual reset button that can be pressed to restart the compressor.

Important Note: Refrigeration systems can contain harmful refrigerants. Always consult a qualified technician for troubleshooting and repairs involving safety cut-outs to ensure proper safety procedures are followed.

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Nov 2020

6. With reference to refrigeration systems, explain EACH of the following:

(a) why air is undesirable; (3)

(b) how air may enter; (3)

(c) how air may be removed. (4)

Question 6. Many fail to understand that a refrigeration system is positively pressurised throughout and give leaks as a cause of ingress of air with no explanation of how a negative pressure can occur. Many state that air can be bled and some mention pumping down but do not explain what this means or the procedure for removing air.

Air in Refrigeration Systems: Why it's Bad and How to Deal With It

(a) Why Air is Undesirable in Refrigeration Systems:

Air is highly undesirable in refrigeration systems for several reasons:

- **Reduced Efficiency:** Air acts as a non-condensable gas. It occupies space within the system that should be filled with refrigerant. This reduces the amount of refrigerant available for absorbing heat, leading to a decrease in the system's cooling capacity and efficiency.
- **Increased Pressure:** Air can increase the pressure on the high-pressure side of the system, putting extra strain on the compressor and potentially leading to overheating or component failure.
- **Oil Circulation Issues:** Air can interfere with the proper circulation of oil within the system. Oil is essential for lubricating moving parts in the compressor. Disrupted oil flow can increase friction, wear, and tear on components.
- **System Acidification:** Under certain conditions, air can react with compressor oil to create acidic byproducts. These acids can corrode internal components and degrade system performance.
- **Capacity Control Issues:** In systems with capacity control mechanisms like pressure regulators, the presence of air can lead to inaccurate readings and erratic system operation.

(b) How Air May Enter a Refrigeration System:

Air can enter a refrigeration system through various leaks or during maintenance procedures:

- **Leaks:** Leaks in suction lines, compressor seals, valve stems, or brazed/welded connections can allow air to infiltrate the system.
- **Improper Charging:** Poor charging practices, like failing to purge air from charging lines before connecting them to the system, can introduce air.
- **Component Replacement:** When replacing system components, air can be introduced if proper evacuation procedures are not followed before reassembly.

(c) How Air May Be Removed from a Refrigeration Systems:

There are two main methods for removing air from a refrigeration system:

- **Mechanical Vacuum Pumping:** This method involves using a vacuum pump connected to the system to evacuate air and non-condensable gases. The pump creates a low-pressure environment that draws out air from the system. This method is typically used during system installation, major repairs, or when a significant air leak is suspected.
- **Purge Method (limited application):** In some cases, a purging method might be used for small systems. This involves introducing a small amount of refrigerant vapor into the system while simultaneously allowing some non-condensable gases to escape through an open service port. However, this method requires careful monitoring and is not as effective as vacuum pumping, especially for larger systems.

Prevention is Key:

The best way to deal with air in refrigeration systems is to prevent it from entering in the first place. Here are some preventive measures:

- **Leak Detection and Repair:** Regularly inspect the system for leaks and promptly repair any identified leaks.
- **Proper Charging Procedures:** Follow proper procedures for charging the system, ensuring proper purging of air from charging lines before connecting them.

- **Evacuation During Service:** Always evacuate the system using a vacuum pump before performing major repairs or whenever a component is opened to the atmosphere.
- **Technician Training:** Ensure technicians servicing the system are properly trained on proper leak detection, evacuation, and charging procedures.

By minimizing air presence in a refrigeration system, you can ensure optimal performance, efficiency, and extend the lifespan of the system's components.

Nov 2020

7. (a) Describe TWO possible sources of contamination of compressed air used for breathing. (4)

(b) State THREE contaminants that may be found in compressed air, outlining the effect of the contaminant on the user when the compressed air is used for diving (SCUBA) purposes. (6)

Question 7. Many simply state the possible contaminants, the question asks for sources. Several concentrate on the effects of contaminants on the system rather than the user.

Compressed Breathing Air Contamination in SCUBA Diving

(a) Two Possible Sources of Contamination of Compressed Air Used for Breathing:

1. **Intake Air Contamination:**
   - The air used to fill the breathing cylinders comes from the surrounding environment. If the air intake is located in an area with high levels of pollutants like:
     - Carbon monoxide (CO) from vehicle exhaust fumes
     - Industrial emissions containing harmful chemicals
     - Dust or other particulates

These contaminants can enter the compressed air system and pose a health risk to divers.

2. **System Contamination:**
   - Contamination can also occur within the air compression and storage system itself. Sources include:
     - **Oil leaks:** From compressor lubricants entering the air stream.
     - **Rust or corrosion:** Degradation of system components releasing particles into the air.
     - **Improper maintenance:** Failure to properly clean and maintain filters and separators within the compressed air system.

(b) Three Contaminants and their Effects on SCUBA Divers:

1. **Carbon Monoxide (CO):**
   - **Effect:** CO binds to hemoglobin in the blood more readily than oxygen, reducing the blood's ability to carry oxygen to vital organs.
   - **Symptoms:** Headache, dizziness, nausea, fatigue, confusion, and in severe cases, unconsciousness and death. Even low levels of CO can impair judgement and coordination, increasing the risk of diving accidents.
2. **Hydrocarbons (Oil Vapors):**

- **Effect:** Oil vapors can irritate the respiratory system, causing coughing, wheezing, and shortness of breath. In severe cases, they can lead to fluid buildup in the lungs (pulmonary edema).
- **Symptoms:** May not be immediately noticeable during the dive, but symptoms can develop after surfacing.

3. **Nitrogen Dioxide (NO2):**
   - **Effect:** NO2 irritates the respiratory tract, causing coughing, chest tightness, and shortness of breath. High exposure can lead to fluid buildup in the lungs (pulmonary edema).
   - **Symptoms:** Similar to hydrocarbon exposure, symptoms may develop after surfacing.

Additional Points:

- Regular testing of compressed breathing air is crucial to ensure it meets safety standards and is free from harmful contaminants.
- Divers should use reputable dive centers that maintain their equipment properly and use high-quality breathing air.

Remember, breathing contaminated air underwater can be life-threatening. Divers should be aware of the risks and take steps to minimize them.

Nov 2020

8. The lifting arrangement shown in the figure, has two slings, A, with a SWL of 5 tonnes, four slings, B, with a SWL of 2.5 tonnes with a ring and beam each of which have a SWL of 12 tonnes .
Explain the suitability or otherwise of this arrangement for lifting a generator engine, including flywheel, weighing 8.5 tonnes that has certified lifting points, 2 at each end of the entablature, 6 m apart. (10)

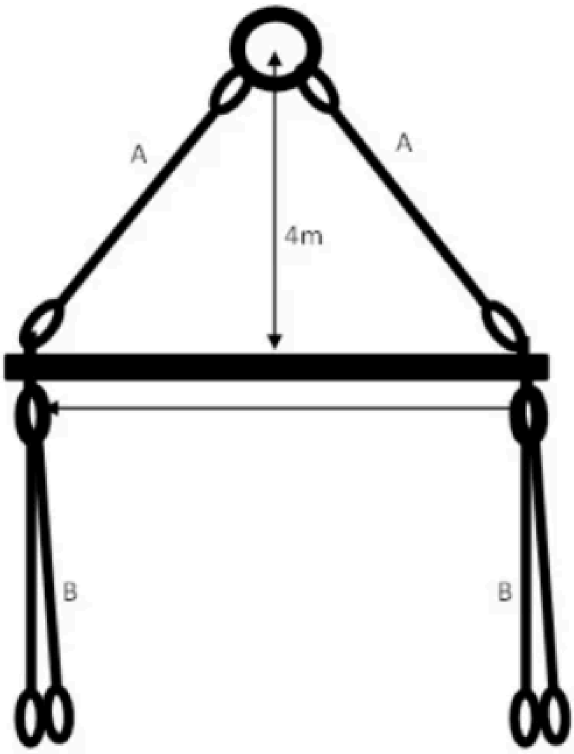

Fig Q8

Question 8. Well answered by those who have an understanding of basic triangle of forces. Many ignore the effect of the flywheel on load distribution.

Nov 2018Sept 2021May 2021Based on the information provided and the image of the lifting arrangement, the lifting arrangement **might be suitable** for lifting the 8.5-tonne generator engine, but a more detailed analysis is needed to confirm. Here's a breakdown of the factors to consider:

Available Lifting Capacity:

- Total capacity of slings A: 2 slings * 5 tonnes/sling = 10 tonnes
- Total capacity of slings B: 4 slings * 2.5 tonnes/sling = 10 tonnes
- Minimum capacity of ring and beam (whichever is lower): 12 tonnes

At first glance, it appears there's sufficient capacity:

- Minimum sling capacity (A or B) + ring/beam capacity = 10 tonnes + 12 tonnes = 22 tonnes
- This is greater than the weight of the engine (8.5 tonnes).

However, we need to consider additional factors:

- **Derating factor (if applicable):** Some slings might have a derating factor applied depending on the lifting angle. This reduces their safe working load (SWL) at angles other than vertical. Check the sling specifications for any derating factors.
- **Weight distribution:** Since there are slings at both ends (6 meters apart) with a spreader beam, the weight distribution might not be perfectly equal. This can affect the loading on each sling. A proper sling angle calculator should be used to determine the exact load on each sling considering the spreader beam configuration and lifting angle.
- **Lifting point limitations:** The certified lifting points on the engine might have a lower capacity than the slings or ring/beam. Verify the lifting capacity specified by the engine manufacturer for the designated lifting points.

Based on these considerations:

- If there's no derating factor for the slings at the intended lift angle,
- The weight is evenly distributed between the slings due to the spreader beam, and
- The engine's lifting points can handle the load,

then the lifting arrangement appears suitable.

Recommendations:

- Consult a qualified lifting professional to assess the specific lifting arrangement and ensure it complies with relevant regulations.
- Use a sling angle calculator to determine the exact load on each sling based on the spreader beam configuration and lifting angle. Refer to the image you sent for the spreader beam configuration details.
- Verify the lifting capacity of the engine's certified lifting points as specified by the manufacturer.
- Never exceed the SWL of any lifting component in the arrangement.

Additional Considerations:

- **Spreader Beam:** Ensure the spreader beam used has a sufficient capacity and is suitable for the lifting points on the engine. The spreader beam in the image appears to be a double beam spreader beam, which can help with equal distribution of the load between the slings.
- **Rigging:** Double-check all rigging components (shackles, hooks, etc.) for compatibility and adequate capacity.
- **Inspection:** Before lifting, ensure all slings, spreader beam, and other lifting equipment are thoroughly inspected for any signs of damage or wear and tear.

By carefully considering these factors and consulting with a lifting professional, you can ensure the safe and successful lifting of the generator engine.

Nov 2020

9. Describe, with reasons, the features of watertight doors fitted to the weather deck. (10)

Question 9. Mainly well answered

Features:

1. **Construction:**
- **Strong and Corrosion-resistant Material:** Watertight doors are typically made of high-grade steel or other suitable materials with excellent strength and corrosion resistance to withstand harsh weather and seawater exposure.
- **Double Skin Construction (Optional):** Some doors may have a double-skinned design with a cavity filled with a buoyant material for added strength, insulation, and improved fire resistance.
2. **Sealing Mechanism:**
- **Watertight Gasket:** A robust, watertight gasket is installed around the door frame to create a seal against the surrounding bulkhead opening. This gasket is typically made of elastomeric material like rubber or synthetic polymers for flexibility and compression.
- **Closing Mechanism:** The door utilizes a secure closing mechanism, usually a combination of:
    - **Hinges:** The door hinges are robust and designed to withstand slamming forces from waves or wind gusts.
    - **Clamps or Cleats:** Several strategically placed clamps or cleats are used to compress the gasket against the bulkhead opening, ensuring a watertight seal. These may be operated manually with levers or wheels, or hydraulically for larger doors.
    - **Weathertight Dogging:** In some cases, additional weathertight dogging mechanisms may be used for extra security, especially when the door is not in use for extended periods.
3. **Operational Features:**
- **Quick-acting Opening and Closing:** Watertight doors on the weather deck need to be opened and closed quickly and efficiently in emergency situations. This may involve:
    - **Lever or wheel operation:** Simple levers or wheels allow for manual operation by crew members, even under challenging conditions.
    - **Hydraulic operation:** Large or heavily trafficked doors may use hydraulic closing mechanisms for faster and more effortless operation.
    - **Emergency release mechanisms:** The door may have an emergency release mechanism to allow for quick opening from the inside in case of flooding or fire on the other side.
4. **Location and Accessibility:**
- **Strategic Placement:** Watertight doors on the weather deck are strategically positioned to isolate compartments and prevent water ingress from specific areas in case of breaches or heavy seas.

- **Clear Signage and Lighting:** The doors are clearly marked with appropriate signage to indicate their purpose and operation. They may also have emergency lighting to ensure visibility during low-light conditions.

Reasons for these Features:

- **Strength and Corrosion Resistance:** To withstand the harsh environment on the weather deck, exposed to seawater, wind, and potential impacts.
- **Watertight Seal:** To prevent water ingress into the vessel's interior in case of heavy seas, wave breaking over the deck, or accidental openings.
- **Quick Operation:** To allow for rapid closure during emergencies or to isolate compartments to minimize flooding.
- **Ease of Use:** To ensure crew members can operate the doors efficiently, even under pressure or challenging conditions.
- **Accessibility and Visibility:** To be easily located and operated during emergencies, regardless of lighting conditions.

By incorporating these features, watertight doors on the weather deck become a crucial line of defense for maintaining a ship's watertight integrity and crew safety during adverse weather and potential flooding scenarios.

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10. (a) Explain what is meant by the term *pounding* as applied to a vessel being driven hard in a seaway. (3)

(b) Explain how *panting* may often occur at the same time as pounding in heavy seas. (3)

(c) Describe how the hull is strengthened to resist *panting* and *pounding*. (4)

Question 10. Candidates lose marks by not stating specific hull areas for strengthening to resist panting and pounding. Most think that pounding resistance is simply by increasing scantling size.

Pounding and Panting in Ships: Causes and Mitigation Strategies

(a) Pounding:

Pounding refers to the violent impact of the vessel's forward sections (bow) against the water surface when driven hard in a head sea (waves directly ahead). This typically occurs in rough seas with large waves and high vessel speeds.

- **Mechanism:** As the vessel encounters a wave crest, the bow rises and may emerge partially out of the water. When the bow descends rapidly towards the next wave trough, it can slam against the water surface with significant force. This impact can cause localized damage to the bow plating and can also transmit shockwaves through the hull structure, potentially affecting other areas of the vessel.

(b) Panting:

Panting refers to the rapid inward and outward flexing of the forward hull plating, particularly at the bow and forepeak (compartment at the extreme forward end). This bellows-like effect is often synchronized with the wave encounter frequency.

- **Mechanism:** As the vessel rides waves, the varying water pressure distribution along the length of the hull creates a pressure differential. The bow section experiences alternating high and low pressures as it encounters wave crests and troughs. This pressure difference causes the relatively flexible plating at the bow to flex inwards (when encountering a wave trough) and outwards (when encountering a wave crest).

(c) Hull Strengthening for Pounding and Panting:

- **Forepeak Bulkhead:** A strong and well-reinforced forepeak bulkhead located at the extreme forward end of the cargo hold helps distribute impact loads from pounding more evenly throughout the hull structure.
- **Double Bottom:** A double bottom provides additional structural stiffness and strength in the bow area, helping to resist the inward flexing during panting.
- **Longitudinal Stiffeners:** Additional longitudinal stiffeners (vertical beams) running along the length of the forepeak can help to resist the inward and outward flexing of the plating during panting.
- **Increased Plate Thickness:** The bow plating itself may be increased in thickness compared to other areas of the hull to withstand the higher local stresses from pounding and wave impacts.
- **Sloped Forefoot:** A carefully designed bow shape with a sloped forefoot can help to deflect wave forces more gently and reduce slamming impacts.

Overall Design: The ship's overall design plays a crucial role in mitigating pounding and panting. Factors like hull form, deadrise angle (angle of the bottom plating with the vertical), and longitudinal strength are considered during the design phase to optimize the vessel's ability to handle rough seas while minimizing the risks of pounding and panting.