Nov 2018 9th

8. With reference to comparing modern water lubricated stern tube bearings with those that are oil lubricated:

(a) state THREE advantages; (3)

(b) state THREE disadvantages, explaining how EACH may be overcome. (7)

Modern Water-Lubricated Stern Tube Bearings vs. Oil-Lubricated Bearings:

Here's a breakdown of the advantages and disadvantages of each type of stern tube bearing:

(a) Advantages of Modern Water-Lubricated Bearings:

1. **Environmentally Friendly:** Water-lubricated systems eliminate the risk of oil leaks into the marine environment, which is a major concern with oil-lubricated systems. This aligns with stricter environmental regulations and reduces potential pollution penalties.
2. **Lower Maintenance:** Modern water-lubricated bearings often require less maintenance compared to oil-lubricated systems. There's no need for regular oil changes, filter replacements, or monitoring of oil levels and contamination.
3. **Lower Operating Costs:** Water-lubricated systems eliminate the need for purchasing and managing lubricating oil. Additionally, the potential for environmental fines due to oil leaks is reduced.

(b) Disadvantages of Water-Lubricated Bearings and How to Overcome Them:

1. **Load Capacity:** Traditionally, water-lubricated bearings have had a lower load capacity compared to oil-lubricated systems. However, advancements in bearing materials and designs, such as high-performance polymers, are narrowing this gap. Additionally, careful propeller design and selection based on the specific water lubrication system can ensure sufficient load handling for modern vessels.
2. **Wear Rate:** Water can be more abrasive than oil, potentially leading to higher wear rates in water-lubricated bearings compared to oil-lubricated systems. This can be mitigated by using advanced bearing materials with superior wear resistance specifically designed for water lubrication. Regular monitoring of bearing wear and implementing planned maintenance schedules are also crucial.
3. **System Complexity:** Some water-lubricated systems, particularly those with external sea water circulation, can be more complex compared to simpler oil-lubricated systems. This can require additional training for crew members on operation and maintenance procedures. However, modern water-lubricated systems are becoming increasingly user-friendly with improved designs and automation features, reducing the complexity burden on crew.

Overall:

Modern water-lubricated stern tube bearings offer significant environmental and economic advantages. While there are some potential drawbacks in terms of load capacity and wear, advancements in materials and design are making them increasingly viable for modern vessels. Careful engineering considerations and proper maintenance practices can further mitigate these potential limitations.

Sept 2021

Sept 2021

8. With reference to main propulsion shaft hydraulic sleeve type couplings:

(a) describe, with the aid of a sketch, the removal procedure; (7)

(b) state how it is determined, during reassembly, that the push fit is complete. (3)

Main Propulsion Shaft Hydraulic Sleeve Type Couplings: Removal and Reassembly

(a) Removal Procedure:

Removing a hydraulic sleeve type coupling requires careful planning and execution to ensure safety and prevent damage to the coupling components. Here's a general outline:

Preparation:

- **Lockout and Tagout:** Implement proper lockout/tagout procedures to isolate the shaft and prevent accidental energization of the hydraulic system.
- **Support the Shaft:** Utilize appropriate jacking screws or other support methods to prevent the shaft from dropping or misalignment during the removal process.
- **Disconnect Hydraulic Lines:** Following the manufacturer's instructions, carefully disconnect any hydraulic lines supplying pressure to the coupling. Ensure proper containment for any residual hydraulic fluid.

Disassembly:

1. **Pressure Release:** Slowly release the hydraulic pressure applied to the coupling using the dedicated pressure release valve. Monitor gauges to confirm pressure has been fully released.
2. **Mechanical Fasteners (if applicable):** For some designs, there might be additional mechanical fasteners (bolts, nuts) securing the coupling halves. These need to be loosened and removed following the manufacturer's specified sequence and torque values.
3. **Sleeve Movement:** Once pressure is released and any mechanical fasteners are removed, utilize the manufacturer's recommended procedures for separating the coupling halves. This might involve using dedicated puller tools or wedges specifically designed for the coupling.

Important Notes:

- The specific removal procedure will vary depending on the coupling design and manufacturer's instructions. Consulting the relevant manuals for detailed steps and safety precautions is crucial.
- During disassembly, handle the coupling components with care to prevent damage to the sealing surfaces or other critical parts.
- Ensure the work area is clean and free of debris to prevent contamination during disassembly and reassembly.

(b) Determining Push Fit Completion During Reassembly:

Verifying a complete and secure push fit after reassembling a hydraulic sleeve coupling is essential. Here are the methods used to ensure proper engagement:

1. Pressure Gauge Reading:

- In hydraulically actuated couplings, the pressure gauge used during tightening will typically provide a direct indication of successful engagement. Reaching the designated pressure value specified by the manufacturer indicates the proper force has been achieved for a secure fit.

2. Measurement and Tolerance Checks:

- After tightening, consult the coupling manufacturer's specifications for the required final dimensions of the assembled coupling (e.g., overall length, specific gap measurements).
- Use precision measuring tools (calipers, micrometers) to verify that the achieved dimensions fall within the specified tolerance range. This confirms proper engagement and interference between the shaft and the inner sleeve.

3. Factory-provided Tools (Optional):

- Some coupling manufacturers might provide specialized tools or gauges for verifying the push fit. These tools may measure displacement during the tightening process or utilize other parameters to indicate proper engagement.

4. Visual Inspection:

- While not the sole method, a thorough visual inspection can reveal any obvious gaps or misalignments between the coupling halves after tightening.

Overall:

A combination of these methods is typically used to ensure a complete and secure push fit after reassembling a hydraulic sleeve coupling. Following manufacturer's instructions, monitoring pressure readings, and utilizing appropriate measurement tools are crucial for verifying successful reassembly.

Sept 2020

8. Explain EACH of the following electrical terms:

(a) preferential tripping; (2)

(b) sequential starting; (2)

(c) fuse back up protection; (2)

(d) discrimination; (2)

(e) non-essential consumer. (2)

Question 8. Candidates struggle with sequential starting, the reason for back up fuses and discrimination. Most state circuits for propulsion are the only essential circuits.

Electrical Term Explanations:

(a) **Preferential Tripping:**

In an electrical system with multiple protective devices (circuit breakers, fuses), preferential tripping refers to the strategy where circuits considered critical are designed to trip (interrupt current flow) less readily compared to less critical circuits. This ensures that essential equipment or functions remain operational during a fault condition, while overloaded or faulty non-critical circuits are isolated.

Here's an example: Imagine a circuit feeding critical navigation equipment and another feeding cabin lights. In preferential tripping, the circuit breaker for the cabin lights would be set to trip at a lower current value compared to the breaker for the navigation equipment. This way, if there's a fault, the cabin lights would trip first, isolating the problem and allowing essential navigation equipment to continue functioning.

(b) **Sequential Starting:**

Sequential starting refers to the controlled starting of multiple electric motors in a specific order. This strategy is used to manage the inrush current (initial high surge of current) drawn by motors when they start. By starting motors one after another with a controlled time delay between them, the overall demand on the power supply is limited, preventing voltage dips or blackouts.

Sequential starting can be achieved using timers, relays, or programmable controllers depending on the complexity of the system. It's commonly used in applications like multiple pumps or large ventilation systems to avoid overloading the electrical supply during motor startup.

(c) **Fuse Back Up Protection:**

Fuse backup protection refers to a scenario where a circuit breaker is additionally protected by a fuse upstream in the electrical system. This provides a layered approach to fault protection. The fuse offers a fast-acting response to severe overcurrents, while the circuit breaker provides overload protection and allows for resetting after a fault is cleared.

Here's an example: Imagine a circuit breaker feeding a motor circuit. A fuse might be installed upstream of the breaker, closer to the main power supply. If a severe fault occurs, the fuse would blow first, interrupting the high current and protecting the circuit breaker from damage. The circuit breaker could then be reset after the fault is addressed.

(d) **Discrimination:**

Discrimination, in the context of electrical protection devices, refers to the ability of a device to selectively isolate a faulty circuit while allowing healthy upstream and downstream circuits to remain operational. This is achieved through proper selection and coordination of circuit breaker trip settings and fuse ratings.

Effective discrimination ensures that only the circuit experiencing a fault is interrupted, minimizing disruption to the rest of the electrical system. It's crucial for maintaining power supply to critical equipment during fault conditions.

(e) **Non-Essential Consumer:**

A non-essential consumer, in an electrical system, refers to a load or device that is not critical for the core operation of the system. These are circuits that can be interrupted without causing a major safety hazard or significant disruption to essential functions. Examples of non-essential consumers include:

- Air conditioning systems
- Cabin lighting
- Entertainment systems
- Kitchen appliances

Non-essential consumers are typically the first to be switched off or disconnected during emergencies or overload situations to conserve power and maintain operation of critical equipment.

Feb 2021

Feb 2021

8. With reference to comparing modern water lubricated stern tube bearings with those that are oil lubricated:

   (a) state THREE advantages; (3)

   (b) state THREE disadvantages, explaining how EACH may be overcome. (7)

Modern Water-Lubricated Stern Tube Bearings vs. Oil-Lubricated Bearings:

(a) Advantages of Modern Water-Lubricated Bearings:

1. **Environmentally Friendly:** Water-lubricated systems eliminate the risk of oil leaks into the marine environment, which is a major concern with oil-lubricated systems. This aligns with stricter environmental regulations and reduces potential pollution penalties.
2. **Lower Maintenance:** Modern water-lubricated bearings often require less maintenance compared to oil-lubricated systems. There's no need for regular oil changes, filter replacements, or monitoring of oil levels and contamination.
3. **Lower Operating Costs:** Water-lubricated systems eliminate the need for purchasing and managing lubricating oil. Additionally, the potential for environmental fines due to oil leaks is reduced.

(b) Disadvantages of Water-Lubricated Bearings and How to Overcome Them:

1. **Load Capacity:** Traditionally, water-lubricated bearings have had a lower load capacity compared to oil-lubricated systems. However, advancements in bearing materials and designs, such as high-performance polymers, are narrowing this gap. Additionally, careful propeller design and selection based on the specific water lubrication system can ensure sufficient load handling for modern vessels.
2. **Wear Rate:** Water can be more abrasive than oil, potentially leading to higher wear rates in water-lubricated bearings compared to oil-lubricated systems. This can be mitigated by using advanced bearing materials with superior wear resistance specifically designed for water lubrication. Regular monitoring of bearing wear and implementing planned maintenance schedules are also crucial.
3. **System Complexity:** Some water-lubricated systems, particularly those with external sea water circulation, can be more complex compared to simpler oil-lubricated systems. This can require additional training for crew members on operation and maintenance procedures. However, modern water-lubricated systems are becoming increasingly user-friendly with improved designs and automation features, reducing the complexity burden on crew.

May 2024

8. (a) Explain, with the aid of sketches, how a new motor is aligned with an existing pump. (7)

(b) State THREE checks which should be made before using the pump after the motor has been aligned. (3)

Nov 2021

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(b) State THREE checks which should be made before using the pump after the motor has been aligned. (3)

Question 8. Many do not explain how the alignment is checked – simply stating use dial indicator with a sketch of it in position is not enough. Some, not many, mention shims but none actually explain which shims would be adjusted to change the alignment or that angular misalignment can be in more than one plane.

(a) Aligning a New Motor with an Existing Pump

Aligning a new motor with an existing pump ensures the shafts of both machines are in proper alignment to minimize vibration, wear, and improve overall efficiency. Here's a breakdown of the process:

Preparation:

1. **Lockout and Tagout:** Implement proper lockout/tagout procedures to ensure safety and prevent accidental energization.
2. **Mounting:** Securely mount the new motor on the foundation or frame, following the manufacturer's instructions.
3. **Shaft Cleaning:** Clean the motor and pump shafts to remove any dirt or debris that could affect the alignment process.

Alignment Procedure (There are multiple methods, here's a common one):

1. **Dial Indicators:** Attach dial indicators to brackets on the pump and motor shafts. These indicators will measure any runout (wobble) or misalignment between the shafts.
2. **Shimming:** Loosen the motor mounting bolts slightly. Use shims (thin wedges of metal) placed strategically between the motor feet and the foundation to adjust the motor's position.
3. **Dial Gauge Readings:** By turning the shafts and observing the dial indicator readings, the technician can adjust the shims to minimize both horizontal and vertical misalignment between the shafts.
4. **Alignment Tolerances:** Tighten the motor mounting bolts to the specified torque values. Re-check the dial indicator readings to ensure they fall within the acceptable alignment tolerances specified by the pump and motor manufacturers.

Additional Techniques:

- **Laser Alignment:** In some cases, laser alignment tools might be used for a more precise alignment process. These systems project laser beams onto targets on the shafts and provide real-time data on misalignment.

Important Notes:

- The specific alignment procedure will vary depending on the type of pump, motor, and the chosen alignment method.
- Always follow the manufacturer's instructions for both the pump and motor regarding alignment procedures and acceptable tolerances.
- The process requires proper training and experience to ensure accurate alignment.

(b) Checks Before Using the Pump After Alignment

Before operating the pump after motor alignment, it's crucial to perform some final checks to ensure everything is in order:

1. **Recheck Alignment:** While unlikely, it's good practice to perform a final verification of the alignment after tightening the motor mounting bolts. This ensures any slight movement during tightening hasn't affected the alignment.
2. **Lubrication:** Verify that the pump is properly lubricated according to the manufacturer's recommendations. This includes checking oil levels (if applicable) and ensuring grease points are lubricated.
3. **Coupling Inspection:** Visually inspect the coupling between the motor and pump shaft for any signs of damage or wear. Ensure all coupling bolts are tightened to the specified torque values.
4. **Pipework:** Double-check that all piping connections to the pump are secure and free of leaks. Ensure proper venting of any air pockets within the piping system.
5. **Electrical Connections:** Verify that all electrical connections to the motor are secure and meet the required specifications.

By performing these checks before starting the pump, you can help ensure safe and reliable operation.

Nov 2020

Nov 2020

8. Sketch an arrangement for the aft seal of an oil lubricated stern tube bearing. (10)

Question 8. Either well answered or no idea – drawing a sort of stern seal oil system. Several make no attempt.

Here's a breakdown of a typical arrangement for the aft seal of an oil-lubricated stern tube bearing:

Components:

1. **Housing:** A robust housing is securely attached to the stern tube bossing of the vessel. This housing provides a secure enclosure for the sealing elements.
2. **Liner:** This is a wear ring made from a low-friction material (often white metal or a suitable plastic) that is fixed onto the propeller hub. The sealing elements make contact with the liner to create a tight seal.
3. **Primary Seal:** This is the first line of defense against seawater ingress. There are two main options:

  - **Lip seal:** A spring-loaded lip makes contact with the liner to create a sealing effect.
  - **Mechanical seal:** This utilizes rotating faces and a lubricating film to achieve a tight seal.
4. **Secondary Seal:** This provides additional protection against seawater ingress. It can be similar in design to the primary seal or might utilize a different sealing mechanism like a labyrinth seal with a series of grooves and clearances to impede water ingress.
5. **Oil Buffer Chamber:** This is a chamber within the aft seal housing located between the primary and secondary seals. The chamber is filled with oil at a pressure slightly higher than the seawater pressure outside. This creates a pressure barrier that helps prevent seawater from entering the stern tube.
6. **Drain Line:** A drain line allows any leakage from the primary or secondary seals to be collected and returned to the oil lubrication system. This prevents oil accumulation within the aft seal housing.
7. **Ventilation (Optional):** In some designs, a ventilation system might be incorporated to remove any moisture or vapors that could accumulate within the aft seal housing.

Operation:

As the propeller shaft rotates, the liner rotates with it. The primary and secondary seals make contact with the liner, creating a barrier against seawater. The oil buffer chamber maintains a slight positive pressure to further prevent seawater intrusion. Any leakage past the primary seal is collected and drained back to the oil system.

Importance of Maintenance:

Regular inspection and maintenance of the aft seal arrangement are crucial. Monitoring oil pressure in the buffer chamber, checking for leaks, and inspecting the condition of the liner and seals are essential to ensure continued functionality and prevent potential seawater contamination of the lubricating oil or oil leakage into the environment.

Here are some additional points to consider:

- Some designs might incorporate additional features like wear indicators or monitoring systems to track seal performance and alert for potential issues.
- The specific arrangement and components might vary depending on the size and design of the vessel and the stern tube bearing system. Always refer to the manufacturer's instructions for specific details and maintenance procedures.

May 2021

8. (a) Describe the operation of a preferential trip. (5)

(b) State the type of circuits that *cannot* be connected to the preferential trip, listing THREE examples. (5)

Question 8. Many explain what a preference trip is rather than explaining its operation. Stating 'Essential services' is not sufficient – what makes a service essential is what is important.

Preferential Trip Operation and Excluded Circuits

(a) Preferential Trip Operation:

A preferential trip system is designed to prioritize the operation of critical circuits in an electrical system during overload or fault conditions. Here's how it works:

1. **Multiple Protective Devices:** The system utilizes multiple circuit breakers or fuses, each protecting a specific circuit. These protective devices are set with different trip thresholds.
2. **Critical Circuits:** Circuits considered essential for the safe operation of the vessel (navigation, propulsion, emergency equipment) are protected by devices with higher trip current ratings.
3. **Non-Critical Circuits:** Circuits for less critical functions (lighting, air conditioning, galley equipment) are protected by devices with lower trip current ratings.
4. **Overload or Fault:** If an overload or fault occurs on a circuit, the corresponding protective device will trip first, interrupting current flow to that specific circuit.
5. **Prioritization:** As long as the overload or fault is contained within a single circuit, the preferential trip system ensures that critical circuits with higher trip thresholds remain operational.
6. **System Protection:** If the overload or fault is severe enough to exceed the trip rating of the device protecting a critical circuit, then that circuit will also trip to protect the entire system.

Benefits:

- Maintains power supply to critical equipment during minor faults or overloads on non-critical circuits.
- Minimizes disruption to essential functions of the vessel.
- Protects critical equipment from damage caused by excessive current flow.

(b) Circuits Not Suitable for Preferential Trip (3 Examples):

While preferential trip offers advantages, some circuits cannot be included in this strategy due to safety or operational considerations. Here are three examples:

1. **Emergency Lighting Circuits:** These circuits are crucial for maintaining visibility and safe evacuation during emergencies. They should not be connected to a preferential trip system and should trip immediately on any fault to ensure uninterrupted operation.

2. **Fire Detection and Alarm Systems:** Early detection and notification of a fire is critical for crew safety. Fire alarm circuits should not be connected to a preferential trip and should trip immediately on any fault to ensure uninterrupted operation.
3. **Bilge Pump Circuits:** Continuous operation of bilge pumps might be essential to prevent flooding. These circuits should not be connected to a preferential trip and should ideally have their own dedicated power source to ensure uninterrupted operation.

Overall:

Preferential trip systems provide a valuable strategy for maintaining power supply to critical equipment during electrical faults. However, careful consideration is needed when assigning circuits to this system, and critical safety or operational functions should not be compromised by relying on preferential trip behavior.

Nov 2018 2nd

Nov 2018 2nd

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Modern Water-Lubricated vs. Oil-Lubricated Stern Tube Bearings:

Here's a breakdown of the advantages and disadvantages of each type of stern tube bearing system:

(a) Advantages of Modern Water-Lubricated Bearings:

1. **Environmental Friendliness:** Water lubrication eliminates the risk of oil leaks into the marine environment, a major concern with oil-lubricated systems. This aligns with stricter environmental regulations and avoids potential pollution penalties.
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Overall:

Modern water-lubricated stern tube bearings offer significant environmental and economic advantages. While there are some potential drawbacks in terms of load capacity and wear, advancements in materials and design are making them increasingly viable for modern vessels. Careful engineering considerations, proper propeller selection, and robust maintenance practices can further mitigate these potential limitations.

Oct 2020

Oct 2020

8. With reference to propulsion shaft intermediate bearings of the plain bearing type, explain EACH of the following:

(a) how change of alignment due to vessel condition is allowed for; (2)

(b) why the shaft must be able to move longitudinally; (4)

(c) why the aftmost bearing requires a complete bush but other bearings may have the bush only in the lower half. (4)

feb 2024

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(b) why the shaft must be able to move longitudinally,
(c) why the aftmost bearing requires a complete bush but other bearings may have the bush only in the lower half

Intermediate Plain Bearings on Propulsion Shafts:

Here's a breakdown of the functionalities of intermediate plain bearings on a propulsion shaft:

(a) How Change of Alignment Due to Vessel Condition is Allowed For:

While designed for optimal performance with minimal misalignment, intermediate plain bearings can accommodate some degree of change in shaft alignment due to vessel condition. Here are two main factors that contribute to this:

- **Bearing Material:** Plain bearings typically use materials like white metal or lined steel that offer a certain degree of **conformability**. This allows the bearing surface to slightly deform and accommodate minor variations in shaft alignment.
- **Bearing Clearance:** Intermediate shaft bearings are designed with a specific **clearance** between the shaft and the bearing bush. This clearance allows for a thin film of lubricant to form and for some limited **movement** of the shaft within the bearing.

However, it's important to note that excessive misalignment can lead to increased wear, reduced bearing life, and potential damage. Maintaining proper shaft alignment through regular checks and adjustments is crucial for optimal bearing performance.

(b) Why the Shaft Must be able to Move Longitudinally:

There are two main reasons why the shaft needs some degree of longitudinal (axial) movement in a propulsion system:

- **Thermal Expansion:** As the engine operates, the propeller shaft and other components will experience thermal expansion. A small amount of axial movement in the shaft allows for this expansion and contraction without binding or putting excessive stress on the bearings and couplings.
- **Propeller Thrust:** The propeller generates thrust as it rotates, pushing the vessel forward. This thrust creates a small **axial force** on the shaft. The ability of the shaft to move slightly allows for this force to be transmitted without putting undue stress on the bearings.

Important Note:

While some axial movement is necessary, excessive movement can lead to problems like whipping of the shaft or propeller walk (propeller causing the vessel to steer off course). The design of the shaft line and bearings should allow for some controlled axial movement within acceptable limits.

(c) Why the Aftmost Bearing Requires a Complete Bush but Other Bearings May Have the Bush Only in the Lower Half:

The design of the intermediate shaft bearings often differs, specifically for the aftmost bearing compared to the forward bearings. Here's the reasoning:

- **Aftmost Bearing (Complete Bush):** This bearing experiences the greatest load from the propeller thrust. A complete bush provides better support for the shaft and helps distribute the load more evenly. Additionally, the complete bush design offers better shaft stability and helps prevent whipping.
- **Forward Bearings (Lower Half Bush):** These bearings experience less load compared to the aftmost bearing. A lower half bush allows for easier installation and removal of the shaft during maintenance or repairs. Additionally, with proper shaft alignment and support from the aftmost bearing, the lower half bush design is sufficient for these locations.

Summary:

The design of intermediate shaft plain bearings considers several factors to ensure optimal performance and longevity. Their ability to accommodate some misalignment and allow for controlled axial movement is crucial for proper shaft operation. Additionally, the design differences between the aftmost and forward bearings reflect the varying loads and maintenance considerations in the propulsion system.

Sept 18th 2020

Sept (18th) 2020

8. Describe the inspection of a main thrust bearing. (10)

Inspecting a main thrust bearing is a critical procedure to ensure the continued smooth operation and reliability of a vessel's propulsion system. Here's a breakdown of the typical inspection process:

Preparation:

- **Lockout/Tagout:** Implement proper lockout/tagout procedures to isolate the shaft and ensure safety before starting the inspection.
- **Preparation for Access:** Depending on the vessel's design, this might involve removing access covers or panels around the thrust bearing housing.
- **Cleaning:** Carefully clean the surrounding area of the thrust bearing housing to remove any dirt, grease, or debris that could obstruct the inspection.

Visual Inspection:

- **General Condition:** Visually inspect the exterior of the thrust bearing housing for any signs of damage, cracks, leaks, or excessive wear.
- **Collars and Keys:** Inspect the condition of the thrust bearing collars and keys for signs of wear, cracks, or misalignment.

- **Bearing Material:** If possible, using appropriate tools, get a visual inspection of the exposed surfaces of the thrust bearing material (typically white metal or lined steel). Look for signs of excessive wear, scoring, pitting, or fatigue cracks.

Measurements:

- **Clearance Checks:** Using feeler gauges or specialized measuring tools, check the clearance between the shaft and the thrust bearing pads. The manufacturer's specifications will provide the acceptable clearance range. Excessive clearance indicates potential wear or misalignment.
- **Wear Measurements:** If possible, take measurements of specific wear patterns on the thrust bearing pads to assess the extent of wear and compare these measurements to wear limits specified by the manufacturer.

Non-Destructive Testing (Optional):

- In some cases, depending on the findings of the visual inspection and the overall maintenance plan, non-destructive testing (NDT) techniques like ultrasonic testing might be employed to assess the internal condition of the thrust bearing components for potential cracks or subsurface defects.

Documentation:

- All observations, measurements, and findings from the inspection should be documented in a maintenance log or report. This data is crucial for tracking bearing wear trends, and making informed decisions about repairs or replacements during future maintenance cycles.

Additional Notes:

- The specific inspection procedures might vary depending on the type and design of the main thrust bearing, the size and class of the vessel, and the manufacturer's recommendations. Always refer to the relevant technical manuals for detailed instructions and safety precautions.
- Inspecting the main thrust bearing is often a complex task that requires trained personnel with the proper tools and knowledge. Consulting with a qualified marine mechanic or following the recommendations of an authorized service provider is crucial for ensuring a thorough and safe inspection.

By performing regular inspections and taking timely corrective actions, you can help ensure the longevity and reliable operation of the main thrust bearing, a critical component in a vessel's propulsion system.

April 2021

April 2021

8. Describe, with the aid of sketches, the fitting of a hydraulically tensioned bolt suitable for main propulsion shaft flanges. (10)

Here's a breakdown of the process for fitting a hydraulically tensioned bolt suitable for main propulsion shaft flanges:

Preparation:

1. **Lockout/Tagout:** Implement proper lockout/tagout procedures to isolate the shaft and ensure safety before starting the fitting process.
2. **Cleaning:** Thoroughly clean the flange surfaces and the threads of the bolt to remove any dirt, oil, or debris that could affect the tightening process or compromise the joint integrity.
3. **Lubrication:** Apply a thin coat of a lubricant specified by the manufacturer to the threads of the bolt. This reduces friction during tightening and ensures proper bolt load is achieved.

Bolt Installation:

1. **Screw the Bolt In:** Manually screw the hydraulically tensioned bolt into the threaded hole in the flange until finger tight. Ensure the bolt engages with the threads properly and isn't cross-threaded.

Hydraulic Tensioning Process:

1. **Hydraulic Nut and Pump:** The hydraulically tensioned bolt will have a special nut designed to work with a hydraulic tensioning pump. Attach the hydraulic nut to the bolt on the flange.
2. **Pressure Gauge and Calibration:** Connect the hydraulic pump to the hydraulic nut via a high-pressure hose. The pump will have a pressure gauge to monitor the applied tension. Ensure the pressure gauge is calibrated to ensure accurate readings.
3. **Tensioning Procedure:** Follow the manufacturer's instructions for the specific hydraulic tensioning system. This will typically involve slowly increasing the hydraulic pressure applied to the nut.
4. **Target Load:** As the pressure increases, the bolt stretches, applying a specific tension (load) to the flange joint. The target load will be specified by the manufacturer based on the bolt size, material, and the flange design. This target load is typically achieved at a specific pressure value on the gauge.
5. **Holding the Load:** Once the target pressure/load is reached, the hydraulic pump will typically have a mechanism to hold the pressure, maintaining the tension on the bolt.

Verification and Completion:

1. **Verification of Load:** After holding the load for a specified time (as per manufacturer's instructions), some systems might require a verification step to ensure the load hasn't bled off. This might involve checking the pressure gauge again or using a separate load verification tool.
2. **Locking the Nut (Optional):** Depending on the specific design, some hydraulic tensioning systems might incorporate a mechanical locking mechanism on the nut to prevent relaxation of the tension over time.
3. **Repeat for All Bolts:** Following the same procedure, tighten all the remaining hydraulically tensioned bolts around the flange to achieve the specified target load.

Additional Considerations:

- **Tightening Sequence:** The manufacturer's instructions might specify a specific tightening sequence for the bolts around the flange to ensure even load distribution.
- **Torque Verification (Optional):** While hydraulic tensioning achieves the desired load on the bolt, in some cases, a final torque verification check using a calibrated torque wrench might be performed for additional assurance.
- **Safety Precautions:** Hydraulic tensioning systems operate at high pressures. Always wear appropriate personal protective equipment (PPE) and follow the manufacturer's safety instructions for the specific equipment being used.

By following these steps and adhering to the manufacturer's recommendations, you can ensure the proper fitting and tensioning of hydraulically tensioned bolts for critical applications like main propulsion shaft flanges. This ensures a secure and reliable connection for optimal performance and safety.

Feb 19th 2021

Feb 19th 2021

8. (a) State FIVE causes of earth faults. (5)

(b) Explain how EACH fault stated in part (a) could be rectified. (5)

(a) Five Causes of Earth Faults:

1. **Insulation Breakdown:** This is a common cause where the insulating material surrounding a live conductor deteriorates due to factors like aging, overheating, mechanical damage, or exposure to moisture. This allows current to leak to the earthed components of the system, causing an earth fault.
2. **Direct Electrical Contact:** Accidental contact between a live conductor and an earthed component, such as the metal housing of equipment, can cause an earth fault. This can occur due to loose wiring connections, damaged cable sheathing, or human error during maintenance.
3. **Moisture Ingress:** Water or moisture entering electrical enclosures or cable connections can create a conductive path between live conductors and earthed components, leading to an earth fault. This is a particular concern in environments with high humidity or potential for water ingress.
4. **Lightning Strikes:** A direct or indirect lightning strike on electrical equipment or overhead power lines can cause high voltage surges, leading to insulation breakdown and earth faults. Lightning protection measures are crucial to mitigate this risk.
5. **Component Failure:** Faulty electrical components like transformers or switchgear can experience internal breakdowns that create a path for current to leak to the earth, resulting in an earth fault. Regular inspection and maintenance of electrical equipment are essential for preventing such failures.

(b) Rectification Methods for Earth Faults:

(a) Insulation Breakdown:

- **Identify and Replace Faulty Cables:** Visually inspect wiring and cables for signs of damage or wear. Conduct insulation resistance testing to identify weakened sections. Replace any faulty cables with new ones that meet the required voltage rating and insulation specifications.
- **Improve Environmental Conditions:** If possible, address factors that contribute to insulation deterioration, such as excessive heat, moisture, or exposure to chemicals. This might involve improving ventilation, using moisture-resistant cables, or implementing protective measures against chemical exposure.

(b) Direct Electrical Contact:

- **Improve Wiring Practices:** Ensure all connections are secure and use appropriate sized cables and connectors. Implement cable management practices to minimize the risk of accidental contact with live conductors.
- **Ground Fault Circuit Interrupters (GFCIs):** Install GFCIs in circuits where there's a high risk of contact with water or moisture. GFCIs can detect leakage current and quickly interrupt the circuit in case of an earth fault.

(c) Moisture Ingress:

- **Use Water-Resistant Enclosures:** Utilize appropriately rated enclosures for electrical equipment exposed to moisture or weather conditions. Ensure proper sealing of cable entry points to prevent water ingress.
- **Regular Inspections:** Perform routine inspections of electrical components and enclosures to identify any signs of moisture accumulation. Take timely corrective actions to address any leaks or condensation issues.

(d) Lightning Strikes:

- **Lightning Protection Systems:** Install proper lightning protection systems, such as lightning rods and surge arrestors, to divert lightning strikes away from electrical equipment and safely dissipate the surge current.
- **Earthing and Bonding:** Ensure a robust earthing and bonding system is in place to provide a low-impedance path for lightning surge currents to safely reach the earth.

(e) Component Failure:

- **Preventative Maintenance:** Implement a regular preventative maintenance program for electrical equipment. This includes inspections, cleaning, and testing to identify potential issues before they lead to failures and earth faults.
- **Replace Aging Equipment:** Develop a replacement plan for aging electrical components that are nearing the end of their expected lifespan. Replacing worn-out equipment proactively reduces the risk of unexpected failures and earth faults.

By addressing these causes and implementing the rectification methods, you can minimize the occurrence of earth faults and ensure a safer and more reliable electrical system.

July 2021

July 2021

8. Explain how EACH of the following electrical safety devices may be tested for correct operation:

(a) a generator reverse power trip; (2)

(b) generator over-current alarm; (2)

(c) generator over-current trip; (2)

(d) emergency generator auto start up; (2)

(e) preferential tripping sequence (2)

Here's how you can test each electrical safety device for correct operation:

(a) Generator Reverse Power Trip:

- **Manual Test (Safeguards Required):** With **proper lockout/tagout procedures** in place to isolate the generator from the main power supply and ensure safety, briefly force a reverse power condition. This can be done by supplying power to the generator terminals from an external source while the generator itself is not running. The reverse power trip should activate, interrupting the external power supply. **Extreme caution is advised** for this test due to the risk of unexpected energy backfeed. It's generally recommended to consult a qualified electrician for this test.
- **Secondary Test (Recommended):** A safer alternative is to simulate the reverse power condition using a dedicated test instrument that injects a pre-determined reverse power signal into the generator's control system. This method verifies the trip functionality without actually backfeeding power.

(b) Generator Over-Current Alarm:

- **Load Bank Test:** Apply a controlled load to the generator using a load bank. Gradually increase the load until the over-current alarm activates at the pre-set threshold. This verifies the alarm functionality and ensures it triggers at the correct overload level.
- **Secondary Test (Limited):** In some cases, injecting a pre-determined current signal through a test instrument into the generator's control system might simulate an overload condition and trigger the alarm. However, this method doesn't involve actual load application and may not fully validate system behavior under real overload conditions.

(c) Generator Over-Current Trip:

- **Load Bank Test:** Similar to the over-current alarm test, apply a controlled load using a load bank. Gradually increase the load until the over-current trip activates, interrupting power output from the generator. This verifies the trip functionality and ensures it protects the generator from excessive current.

- **Important Note: Extreme caution** is advised during this test as it involves a real overload condition. Ensure proper safety procedures are followed, and the load bank capacity is sufficient to handle the expected trip current without damage.

(d) Emergency Generator Auto Start-Up:

- **Simulated Power Loss:** Briefly simulate a power loss by disconnecting the main power supply (with proper safety precautions). The emergency generator's auto start-up system should detect the power outage and initiate engine starting procedures. This verifies the functionality of the auto start-up sequence.
- **Secondary Test (Limited):** A test switch might be available on the emergency generator control panel to simulate a power loss and initiate a start-up sequence without actually disconnecting the main power supply. This method offers a safer alternative but may not fully validate system behavior during a real power outage scenario.

(e) Preferential Tripping Sequence:

- **Simulated Overload:** Apply a controlled overload to a non-critical circuit while ensuring all other circuits are functional. The preferential trip system should isolate the overloaded circuit while maintaining power supply to critical circuits. Gradually increase the overload until the expected trip point is reached for the non-critical circuit.
- **Secondary Test (Limited):** Using a dedicated test instrument, specific circuits within the preferential trip system can be selectively loaded or bypassed to simulate overload conditions and verify the trip sequence. However, this method might not fully replicate the behavior under real overload scenarios involving multiple circuits.

Important Notes:

- Always consult the manufacturer's instructions and relevant safety regulations before performing any testing procedures on electrical safety devices.
- Some tests, particularly those involving real overload conditions, require qualified personnel and proper safety protocols to be implemented.
- Consider using secondary test methods whenever possible to minimize risks associated with actual load application or reverse power scenarios.
- Regularly testing these devices is crucial to ensure their proper operation and the overall safety and reliability of the electrical system.

Aug 2023

7. (a) Explain, with the aid of sketches, how a new motor is aligned with an existing pump. (7)

(b) State THREE checks which should be made before using the pump after the motor has been aligned. (3)

Aligning a New Motor with an Existing Pump and Pre-operation Checks

(a) Aligning a New Motor with an Existing Pump:

There are two main methods for aligning a new motor with an existing pump:

1. Dial Gauge Method:

This is a precise method that utilizes dial gauges to measure and correct any misalignment between the motor and pump shafts. Here's a simplified breakdown:

- **Mounting:** The motor is loosely attached to the baseplate with its mounting bolts.
- **Dial Gauge Placement:** Dial gauges are mounted on brackets, one on each shaft (motor and pump) – typically at horizontal and vertical positions (3 and 9 o'clock or 12 and 6 o'clock on a clock face analogy).
- **Runout Measurement:** The motor shaft is slowly rotated, and the dial gauges measure any runout (wobble) on the shaft itself. This ensures the motor shaft is straight before alignment with the pump shaft.
- **Alignment Checks:** With the motor running slowly, the dial gauges measure the relative movement between the shafts at various points.
- **Shimming:** Based on the dial gauge readings, shims (thin metal plates) are strategically placed under the motor feet to adjust its position and achieve concentric alignment between the motor and pump shafts (minimal or zero dial gauge movement).
- **Re-checking:** The process of checking runout, dial gauge readings, and shim adjustments is repeated until proper alignment is achieved.
- **Tightening:** Once alignment is confirmed, the motor mounting bolts are securely tightened.

2. Laser Alignment Method:

This method uses laser alignment tools that project beams onto targets attached to the motor and pump shafts. By adjusting the motor position based on the laser beam readings, precise alignment can be achieved.

(b) Pre-operation Checks Before Using the Pump After Alignment:

1. **Re-check Alignment:** It's crucial to perform a final alignment check after tightening the motor mounting bolts. Settling or movement during tightening can slightly alter alignment.
2. **Oil Level and Condition:** Verify the lubrication oil level and condition in the pump's reservoir. Ensure the oil meets the manufacturer's specifications and is free of contaminants.
3. **Coupling Inspection:** Visually inspect the coupling between the motor and pump shafts for any signs of wear, damage, or loose connections. Tighten any coupling bolts if necessary.

Additional Considerations:

- Always follow the manufacturer's instructions for specific alignment procedures and recommended tools.
- Proper safety precautions are essential when working with rotating machinery.
- If you lack the experience or tools for proper alignment, consider consulting a qualified technician.

March 19th 2021

March 19th 2021

8. (a) Explain, with the aid of sketches, how a new motor is aligned with an existing pump. (7)

(b) State THREE checks which should be made before using the pump after the motor has been aligned. (3)

Aligning a New Motor with an Existing Pump:

Aligning a new motor with an existing pump ensures the shafts of both machines are in proper alignment to minimize vibration, wear, and improve overall efficiency. Here's a breakdown of the process:

Preparation:

1. **Lockout/Tagout:** Implement proper lockout/tagout procedures to isolate the system and ensure safety before starting the alignment process.
2. **Mounting:** Securely mount the new motor on the foundation or frame, following the manufacturer's instructions.
3. **Shaft Cleaning:** Clean the motor and pump shafts to remove any dirt or debris that could affect the alignment process.

Alignment Procedure (There are multiple methods, here's a common one using dial indicators):

1. **Dial Indicators:** Attach dial indicators with magnetic bases to brackets on the pump and motor shafts. These indicators will measure any runout (wobble) or misalignment between the shafts.
2. **Shimming:** Loosen the motor mounting bolts slightly. Use shims (thin wedges of metal) placed strategically between the motor feet and the foundation to adjust the motor's position.
3. **Dial Gauge Readings:** By turning the shafts and observing the dial indicator readings, the technician can adjust the shims to minimize both horizontal and vertical misalignment between the shafts.
4. **Alignment Tolerances:** Tighten the motor mounting bolts to the specified torque values. Re-check the dial indicator readings to ensure they fall within the acceptable alignment tolerances specified by the pump and motor manufacturers.

Additional Techniques:

- **Laser Alignment:** In some cases, laser alignment tools might be used for a more precise alignment process. These systems project laser beams onto targets on the shafts and provide real-time data on misalignment.

Important Notes:

- The specific alignment procedure will vary depending on the type of pump, motor, and the chosen alignment method.
- Always follow the manufacturer's instructions for both the pump and motor regarding alignment procedures and acceptable tolerances.
- The process requires proper training and experience to ensure accurate alignment.

Checks Before Using the Pump After Alignment:

Before operating the pump after motor alignment, it's crucial to perform some final checks to ensure everything is in order:

1. **Recheck Alignment:** While unlikely, it's good practice to perform a final verification of the alignment after tightening the motor mounting bolts. This ensures any slight movement during tightening hasn't affected the alignment.
2. **Lubrication:** Verify that the pump is properly lubricated according to the manufacturer's recommendations. This includes checking oil levels (if applicable) and ensuring grease points are lubricated.
3. **Coupling Inspection:** Visually inspect the coupling between the motor and pump shaft for any signs of damage or wear. Ensure all coupling bolts are tightened to the specified torque values.
4. **Pipework:** Double-check that all piping connections to the pump are secure and free of leaks. Ensure proper venting of any air pockets within the piping system.
5. **Electrical Connections:** Verify that all electrical connections to the motor are secure and meet the required specifications.

By performing these checks before starting the pump, you can help ensure safe and reliable operation.

Nov 2023

8. (a) Explain how propeller thrust is transmitted to a vessel's hull. (3)

   (b) Describe the mounting arrangements of a thrust block to the hull. (4)

   (c) Explain why the clearance between the thrust block pads and collar is critical. (3)

March 26th 2021

March 26th 2021

8. (a) Explain how propeller thrust is transmitted to a vessel's hull. (3)

   (b) Describe the mounting arrangements of a thrust block to the hull. (4)

   (c) Explain why the clearance between the thrust block pads and collar is critical. (3)

Propeller Thrust Transmission and Thrust Block Mounting:

(a) How Propeller Thrust is Transmitted to the Vessel's Hull:

The propeller, rotating underwater, generates thrust as it pushes water backwards. Here's how this thrust is transmitted to the vessel's hull:

1. **Propeller Shaft:** The rotating propeller is connected to a long shaft that runs through the stern tube of the vessel. This shaft is supported by bearings within the stern tube.
2. **Thrust Block:** At the forward end of the propeller shaft, inside the hull, there's a specialized bearing called a thrust block. This thrust block absorbs the axial thrust force generated by the propeller.

3. **Hull Structure:** The thrust block is securely mounted to the strong, transverse bulkheads or the keel of the vessel's hull. This transmits the propeller thrust force from the shaft to the entire hull structure, propelling the vessel forward.

(b) Thrust Block Mounting Arrangements:

The specific mounting arrangement of a thrust block will vary depending on the size and design of the vessel. However, here are some general principles:

1. **Solid Foundation:** The thrust block needs a robust and rigid foundation to handle the significant thrust forces. This is typically achieved by mounting it directly onto the main transverse bulkheads or the keel plate of the vessel.
2. **Hold-Down Bolts:** The thrust block is secured to the hull structure using high-tensile hold-down bolts. These bolts are carefully tightened to a specific torque value to ensure the thrust block can withstand the forces without movement.
3. **Chocks and Wedges (Optional):** In some cases, additional support structures like chocks or wedges might be used around the thrust block to provide extra stability and prevent lateral movement.
4. **Grouting (Optional):** For some thrust block designs, epoxy grouting material might be used to fill any gaps between the block and the hull structure. This further enhances rigidity and ensures proper load distribution.

(c) Why Clearance Between Thrust Block Pads and Collar is Critical:

The clearance between the thrust block pads (typically made from white metal or lined steel) and the thrust collar on the propeller shaft is crucial for several reasons:

- **Minimizing Friction:** Excessive clearance would allow for unnecessary movement between the shaft and the pads, increasing friction and wear. However, too little clearance could cause binding and hinder smooth shaft rotation.
- **Lubrication:** A proper clearance allows for a thin film of lubricant (oil or water) to form between the pads and the collar. This lubrication film reduces friction and wear while enabling efficient heat dissipation.
- **Thermal Expansion:** As the engine operates, the propeller shaft and thrust block components will experience some thermal expansion. The proper clearance accommodates this expansion without binding or excessive wear.
- **Vibration Control:** Maintaining the correct clearance helps dampen vibrations that might be transmitted from the propeller shaft to the hull structure.

Maintaining the optimal clearance is crucial for the efficient and reliable operation of the propulsion system. Regular inspections and adjustments of the thrust block and shaft components are essential to ensure proper clearance and minimize wear.

May 28th 2021

8. With reference to intermediate shaft bearings of the roller type, describe, with the aid of a sketch, EACH of the following:

(a) how some angular misalignment of the shaft is accommodated; (5)

(b) how longitudinal movement of the shaft is accommodated. (5)

Intermediate Roller Bearings and Shaft Movement:

Here's a breakdown of how intermediate roller bearings of the roller type accommodate:

(a) Angular Misalignment:

While ideal shaft alignment is always strived for, some degree of angular misalignment (mismatch between shaft centerlines) can occur due to factors like hull flexing or thermal expansion. Roller bearings can accommodate some limited angular misalignment through the following features:

- **Self-aligning design:** Some roller bearings, particularly spherical roller bearings, incorporate a **spherical inner race**. This allows the inner race to slightly tilt within the outer race, accommodating small angular misalignment between the shaft and the bearing housing.
- **Line contact bearings:** Roller bearings with a line contact between the rollers and races (like cylindrical rollers) can tolerate a small amount of misalignment due to the inherent line contact geometry.

Limitations:

It's important to note that exceeding the design limits for angular misalignment can lead to increased bearing wear, reduced bearing life, and potential damage. Regular shaft alignment checks and adjustments are crucial for optimal bearing performance.

(b) Longitudinal Movement of the Shaft:

Longitudinal movement (axial movement) of the shaft is necessary in a propulsion system for two main reasons:

- **Thermal Expansion:** As the engine operates, the propeller shaft and other components will experience thermal expansion. Longitudinal movement allows the shaft to expand and contract without binding or putting excessive stress on the bearings and couplings.
- **Propeller Thrust:** The propeller generates thrust as it rotates, pushing the vessel forward. This thrust creates a small axial force on the shaft. Longitudinal movement allows the shaft to move slightly to accommodate this force.

How Roller Bearings Accommodate Movement:

Roller bearings can accommodate longitudinal movement in a couple of ways:

- **Internal Clearance:** Roller bearings have a small amount of internal clearance between the rollers and the races. This allows for some axial movement of the shaft within the bearing without the rollers binding.
- **Splayed Bearings (Optional):** In some cases, **double row roller bearings** with a specific internal design (splayed bearings) might be employed. These bearings have an angled inner or outer race that allows for a controlled amount of axial movement while maintaining good radial load capacity.

Important Considerations:

- Excessive longitudinal movement can lead to problems like whipping of the shaft or propeller walk (propeller causing the vessel to steer off course). The design of the shaft line and bearings should allow for some controlled axial movement within acceptable limits.
- Roller bearings are generally not designed for large axial loads. The primary function of the roller bearing is to support the radial load from the shaft weight and propeller forces. Additional components like thrust bearings might be required to handle the axial thrust load.

By understanding how roller bearings accommodate some angular misalignment and longitudinal movement, we can appreciate their role in maintaining a functional and reliable propulsion system.