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1. (a) Describe the function of a main engine turbocharger. (5)

   (b) Describe how the turbocharger is cooled. (2)

   (c) Describe how the turbocharger is lubricated. (3)

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2. With reference to a diesel engine chain driven camshaft:

   (a) state the important checks that must be made during the drive inspection; (6)

   (b) explain why the checks described in part (a) are necessary. (4)

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3. Describe the principle of operation of a simple hydraulic governor. (10)

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4. (a) Outline the actions which must be taken, by the on-watch engineer when the engine crankcase oil mist detector activates. (5)

   (b) Sketch a crankcase explosion relief door, labelling the MAIN components. (5)

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5. Describe, with reasons, FIVE properties required of lubricating oil. (10)

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6. Explain the principle of operation of EACH of the following types of lubricating oil filter:

   (a) magnetic; (2)

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   (c) coalescer; (3)

   (d) plate edge (eg auto-klean). (3)

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7. With reference to leaking cylinder air start valves:

   (a) describe how this may be detected whilst the engine is running; (2)

   (b) describe the procedure on discovery; (4)

   (c) list FOUR possible causes. (4)

8. Describe the preparation and checks on a main propulsion system prior to going to sea. (10)

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9. With reference to friction clutches, state EACH of the following:

   (a) THREE advantages of a wet clutch; (3)

   (b) THREE disadvantages of a wet clutch; (3)

   (c) ONE advantage of multiple plates; (1)

   (d) THREE disadvantages of multiple plates. (3)

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10. (a) Sketch a block diagram of a lubricating oil system suitable for use with a reduction gearing, including all the protective devices. (5)

    (b) State the engineering purpose/function of EACH item in the system sketched in part (a). (5)

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1. (a) Describe the function of a main engine turbocharger. (5)

(b) Describe how the turbocharger is cooled. (2)

(c) Describe how the turbocharger is lubricated. (3)

Main Engine Turbocharger: Function, Cooling, and Lubrication

(a) Function of a Main Engine Turbocharger:

A turbocharger is a device used in internal combustion engines to increase power output and efficiency. It utilizes the exhaust gas flow from the engine to drive a turbine which, in turn, drives a compressor. Here's a breakdown of its operation:

1. **Exhaust Gas Drives Turbine:** Hot exhaust gases from the engine cylinders flow through the turbine housing, pushing the turbine blades and causing the turbine shaft to spin.
2. **Compressor Boosts Intake Air:** Connected to the same shaft as the turbine, the compressor wheel draws in fresh air from the engine's intake system. As the compressor wheel spins, it compresses this air, increasing its pressure.
3. **Denser Air for More Power:** The compressed, denser air from the compressor is then delivered (often after being cooled by a charge air cooler) to the engine's intake manifold. This denser air allows for a larger and more efficient fuel burn, resulting in increased engine power output.

(b) Turbocharger Cooling:

Turbochargers operate at high temperatures due to the hot exhaust gas flowing through the turbine section. To prevent overheating and ensure proper operation, turbochargers require efficient cooling:

- **Oil Cooling:** The primary cooling method for most turbochargers involves engine oil. Engine oil continuously circulates through passages within the turbocharger housing, absorbing heat from the turbine housing and bearing areas. The hot oil then returns to the engine's lubrication system where it's cooled by the engine oil cooler.
- **Indirect Air Cooling:** In some cases, especially for larger turbochargers, additional cooling fins might be present on the turbine housing to promote some heat dissipation directly to the surrounding air. However, oil circulation remains the primary cooling method.

(c) Turbocharger Lubrication:

The high-speed rotation of the turbocharger shaft requires proper lubrication to minimize friction and wear. Here's how lubrication is achieved:

- **Engine Oil Supply:** The same engine oil used for cooling also provides lubrication. The pressurized oil from the engine's lubrication system reaches the turbocharger through dedicated channels.
- **Bearing Lubrication:** Oil passages within the turbocharger housing deliver oil to the bearings that support the turbine shaft and compressor shaft. This ensures smooth and efficient rotation of the shaft.
- **Oil Return:** Used oil from the turbocharger bearings drains back to the engine's crankcase through a return line, where it re-enters the lubrication system for filtration and further cooling.

Maintaining a healthy engine oil system with clean oil and proper oil pressure is crucial for optimal turbocharger lubrication and cooling.

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2. With reference to a diesel engine chain driven camshaft:

   (a) state the important checks that must be made during the drive inspection; (6)

   (b) explain why the checks described in part (a) are necessary. (4)

Chain-Driven Camshaft in Diesel Engines: Inspection

(a) Important Checks During Inspection:

1. **Chain Tension:** This is the most crucial check. A loose chain can cause the camshaft timing to be inaccurate, leading to engine performance issues and potential damage.
2. **Chain Wear:** Over time, the chain links and sprockets wear, causing the chain to stretch. Excessive wear can lead to chain skipping teeth on the sprockets, resulting in catastrophic engine failure.
3. **Chain Guide Wear:** The chain guides keep the chain aligned and prevent excessive movement. Worn guides can contribute to chain slack and potential jumping.
4. **Tensioner Function:** The tensioner automatically adjusts to maintain proper chain tension. A malfunctioning tensioner could lead to either a loose or overly tight chain.

(b) Why These Checks Are Necessary:

- **Accurate Timing:** The camshaft controls the opening and closing of valves for intake, compression, combustion, and exhaust. A mistimed camshaft disrupts this precise sequence, affecting engine performance and potentially causing valve-to-piston contact (expensive damage).
- **Durability and Reliability:** A worn chain or malfunctioning tensioner can lead to chain breakage, which can cause severe internal engine damage. Early detection of wear allows for preventative maintenance and avoids costly repairs.
- **Noise Reduction:** Excessive chain slack or a worn chain can generate increased noise during engine operation. Regular checks help maintain a smooth and quiet operation.

By performing these checks, you ensure the proper function of the camshaft timing system, leading to optimal engine performance, longevity, and reduced risk of catastrophic failure.

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3. Describe the principle of operation of a simple hydraulic governor. (10)

Simple Hydraulic Governor: Principle of Operation

A simple hydraulic governor is a mechanical device that utilizes hydraulic principles to regulate the speed of an engine, typically a diesel engine. Here's how it works:

Components:

- **Flyweights:** These are rotating masses driven by the engine's crankshaft. As engine speed increases, the flyweights tend to spread outwards due to centrifugal force.
- **Governor Shaft:** Connected to the flyweights, this shaft rotates with the engine.
- **Sleeve and Control Lever:** This sleeve slides on the governor shaft and is connected to a control lever.
- **Diaphragm and Spring:** A spring-loaded diaphragm separates the high-pressure side of the fuel system from a low-pressure chamber.
- **Fuel Control Valve:** This valve regulates the flow of fuel to the engine.
- **Hydraulic Oil Chamber and Piston:** Connected to the control lever, a piston operates within a chamber filled with hydraulic oil.

Operation:

1. **Engine Speed Increase:** As engine speed increases, the flyweights spread outwards, pushing the governor shaft and sleeve along with them.
2. **Control Lever Movement:** The movement of the sleeve actuates the control lever, which pushes against the diaphragm.
3. **Fuel Pressure Regulation:** By pushing against the diaphragm, the control lever opens the connection between the high-pressure fuel line and the low-pressure chamber. This allows some of the high-pressure fuel to bypass the engine, reducing the overall fuel reaching the cylinders and consequently slowing down the engine.
4. **Speed Regulation:** As the engine speed slows down, the flyweights move back inwards due to reduced centrifugal force. This allows the spring in the diaphragm assembly to push back on the control lever, closing the bypass passage and allowing more fuel to reach the engine, bringing the engine speed back up.

Essentially, the hydraulic governor acts like a feedback loop:

- Increased engine speed -> flyweights move out -> control lever opens bypass -> less fuel -> engine speed decreases.
- Decreased engine speed -> flyweights move in -> control lever closes bypass -> more fuel -> engine speed increases.

By adjusting the spring tension or the position of the flyweights, the governor's setpoint for desired engine speed can be fine-tuned. This ensures the engine maintains a relatively constant speed under varying loads.

Additional Notes:

- In some designs, the hydraulic oil chamber and piston might be replaced by a simpler mechanical linkage achieving the same principle of regulating fuel flow based on governor shaft movement.

Modern governors may incorporate electronic controls for more precise speed regulation and integration with engine management systems.

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4. (a) Outline the actions which must be taken, by the on-watch engineer when the engine crankcase oil mist detector activates. (5)

   (b) Sketch a crankcase explosion relief door, labelling the MAIN components. (5)

This text covers actions to take upon crankcase oil mist detector activation and the components of a crankcase explosion relief door.

Crankcase Oil Mist Detector Activation:

- **Immediate Shutdown:** Safely reduce engine load and stop the engine as soon as possible. This removes the ignition source and prevents further oil mist generation.
- **Investigate the Cause:** Identify the reason behind the alarm. This may involve checking for:
  - Worn or damaged piston rings
  - Malfunctioning fuel injector
  - Blocked crankcase ventilation system
  - Other issues causing excessive blow-by gases
- **Isolate the Engine:** Close any valves or dampers isolating the affected engine from other systems to prevent the spread of oil mist.
- **Alert Others:** Inform relevant personnel about the situation, especially maintenance or supervisory staff.
- **Do Not Restart:** Refrain from restarting the engine until the cause of the oil mist is identified and rectified. Running the engine with excessive blow-by can lead to a crankcase explosion.

Crankcase Explosion Relief Door Components:

- **Hinge:** Allows the door to rotate outward upon pressure buildup.
- **Diaphragm:** A flexible membrane that acts as a pressure sensor.
- **Pressure Plate:** A plate attached to the diaphragm that is exposed to crankcase pressure.
- **Relief Opening:** The opening in the crankcase wall that allows pressure to escape when the door opens.

Functionality:

Under normal operation, the diaphragm and pressure plate remain in place. When excessive pressure builds up, the force pushes against the diaphragm, causing the door to hinge outward and release the pressure through the relief opening. This helps prevent catastrophic crankcase explosions.

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5. Describe, with reasons, FIVE properties required of lubricating oil. (10)

Lubricating oils play a critical role in minimizing friction and wear within an engine. Here are five essential properties required of lubricating oil, along with the reasons why they are important:

1. **Viscosity:**
- **Reason:** Viscosity refers to a fluid's resistance to flow. Engine oil needs to have the right viscosity to provide a lubricating film between moving parts.
    - **Too Thin:** If the oil is too thin, it won't create a strong enough film to adequately separate moving parts, leading to increased friction and wear.
    - **Too Thick:** Thick oil will have difficulty flowing freely at low temperatures, causing increased resistance during startup and potentially leading to oil starvation in certain engine components.
2. **Film Strength:**
- **Reason:** Film strength refers to the oil's ability to maintain its lubricating film under pressure and high temperatures encountered within an engine.
    - **Strong Film:** A strong oil film prevents metal-to-metal contact between components, minimizing friction and wear even under demanding operating conditions.
    - **Weak Film:** A weak film can rupture under pressure or high temperatures, leading to increased friction and potential engine damage.
3. **Detergency and Dispersive Properties:**
- **Reason:** Engine operation generates contaminants like soot, dirt, and wear debris. These contaminants can increase wear and sludge formation if not properly managed.
    - **Detergency:** Detergent additives in the oil help suspend contaminants within the oil, preventing them from settling on engine components and forming sludge.
    - **Dispersive Properties:** Dispersants keep the suspended contaminants from clumping together and ensure they are carried throughout the oil until they are removed by the filter during an oil change.
4. **Oxidation Stability:**
- **Reason:** Engine oil is exposed to high temperatures and oxygen, leading to gradual oxidation. Oxidation can thicken the oil, increase its acidity, and reduce its ability to lubricate effectively.
    - **High Oxidation Stability:** Oil with high oxidation stability resists thickening and breakdown due to oxidation, maintaining its lubricating properties for longer service intervals.
5. **Anti-Wear Additives:**
- **Reason:** Even with a lubricating film, some metal-to-metal contact can occur within an engine. Anti-wear additives form a microscopic protective layer on metal surfaces, further reducing wear during operation.
    - **Effective Anti-Wear Additives:** These additives help minimize wear on critical engine components, extending engine lifespan and reducing maintenance costs.

By possessing these five key properties, lubricating oil ensures smooth operation, minimizes friction and wear, protects engine components, and extends engine life

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6. Explain the principle of operation of EACH of the following types of lubricating oil filter:

(a) magnetic; (2)

(b) centrifugal; (2)

(c) coalescer; (3)

(d) plate edge (eg auto-klean). (3)

Lubricating Oil Filter Principles:

Here's a breakdown of the operating principles for each type of lubricating oil filter:

(a) Magnetic Oil Filter:

- **Principle:** Magnetic oil filters utilize strong magnets to attract and trap ferrous (iron-containing) wear debris from the lubricating oil.
- **Operation:** As the oil flows through the filter, the magnet attracts ferrous particles suspended within the oil. These particles are held onto the magnet, preventing them from circulating within the engine and causing further wear.
- **Benefits:** Simple and relatively inexpensive design. Effective at removing large ferrous particles.
- **Limitations:** Doesn't remove non-ferrous wear debris or other contaminants like dirt or soot. Requires periodic cleaning or replacement of the magnet to maintain effectiveness.

(b) Centrifugal Oil Filter:

- **Principle:** Centrifugal oil filters utilize the principles of centrifugal force to separate contaminants from the lubricating oil.
- **Operation:** The oil enters the filter and is spun at high speed within a rotating element. Centrifugal force pushes denser contaminants like wear debris and dirt outwards, away from the oil. The clean oil then flows through an outlet, while the separated contaminants accumulate in a collection chamber.
- **Benefits:** Can be effective at removing both ferrous and non-ferrous debris along with some heavier contaminants.
- **Limitations:** More complex design compared to magnetic filters. Requires a source of power to spin the element. May not be as effective at removing very fine particles.

(c) Coalescer Oil Filter:

- **Principle:** Coalescer oil filters target water contamination within the lubricating oil. They utilize a specialized media that allows oil to pass through but causes water droplets to merge (coalesce) into larger droplets.

- **Operation:** As the oil containing water droplets flows through the coalescer media, the water droplets come into contact with the fibers. The surface tension of the water causes the droplets to combine, forming larger water droplets. These larger droplets can then be separated from the oil by gravity or differential pressure within the filter.
- **Benefits:** Effective at removing water contamination from lubricating oil, which can be harmful to engine components.
- **Limitations:** May not be as effective at removing solid contaminants like wear debris. May require replacement of the coalescer media at specific intervals.

(d) Plate Edge Filter (e.g., Auto-Klean)

- **Principle:** Plate edge filters, also known as automatic self-cleaning or edge filtration systems, utilize a series of stacked metal discs or plates with specially designed edges.
- **Operation:** The oil flows through the narrow gap between the stacked plates. As the oil flows, contaminants get trapped on the edges of the plates due to their size and differential pressure. A cleaning mechanism, often a wiper blade or differential pressure system, periodically removes the accumulated contaminants from the edges, allowing them to fall into a collection chamber or be flushed out of the system.
- **Benefits:** Continuous filtration and automatic cleaning provide extended service intervals compared to some other filter types. Can be effective at removing a wider range of contaminants.

Limitations: More complex design compared to basic filters. May require maintenance or replacement of cleaning mechanisms.

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7. With reference to leaking cylinder air start valves:

   (a) describe how this may be detected whilst the engine is running; (2)

   (b) describe the procedure on discovery; (4)

   (c) list FOUR possible causes. (4)

Several signs can indicate a leaking cylinder air start valve while the engine is running:

- **Overheating of the air line:** The compressed air leaking past the valve heats up due to friction. Feel the air line close to the valve. If it's noticeably hotter than other air lines, it may indicate a leak.
- **Uneven engine running:** A leaking air start valve can introduce unregulated air into the cylinder, disrupting the combustion process and causing uneven running. This may manifest as rough idling, power fluctuations, or misfiring.
- **Unusual hissing or air noise:** A leak can create a hissing sound or a noticeable increase in air noise near the affected cylinder's air start valve.
- **Increased air consumption:** A leaking valve allows compressed air to escape, requiring the compressor to work harder to maintain system pressure. This can lead to a noticeable increase in air consumption.

(b) Procedure on Discovery:

Upon suspecting a leaking air start valve:

1. **Shut Down the Engine:** Safely shut down the engine following the manufacturer's procedures.
2. **Isolate the Cylinder:** Close the isolation valve for the affected cylinder's air line, preventing further air flow to that cylinder.
3. **Tag and Lock Out:** Tag the affected cylinder and air line as "out of service" to prevent accidental operation.
4. **Further Inspection:** Visually inspect the valve for signs of damage or wear. Consider using a stethoscope to listen for air leaks around the valve body.
5. **Maintenance:** Schedule maintenance to replace or repair the leaking air start valve as soon as possible.

(c) Four Possible Causes of Leaking Cylinder Air Start Valves:

1. **Worn Valve Seat or Seal:** Over time, the valve seat or seal within the air start valve can wear down due to repeated use. This allows compressed air to leak past the seal when the valve is closed.
2. **Foreign Debris:** Dirt, dust, or other foreign particles can become lodged between the valve seat and the valve body, preventing a proper seal and causing a leak.
3. **Improper Valve Adjustment:** If the air start valve is not adjusted correctly, it may not fully close, allowing compressed air to leak through.
4. **Damaged Valve Body:** In extreme cases, the valve body itself may be cracked or damaged, allowing compressed air to leak even if the valve seat and seal are in good condition.

By promptly addressing a leaking air start valve, you can prevent further engine problems like uneven wear, power loss, and potential damage to the air start system.

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8. Describe the preparation and checks on a main propulsion system prior to going to sea. (10)

Ensuring the main propulsion system of a vessel is in top condition before setting sail is crucial for a safe and efficient voyage. Here's a breakdown of the typical preparation and checks performed on a main propulsion system prior to going to sea:

Preparation:

- **Reviewing Maintenance Records:** A thorough review of recent maintenance records is essential. This helps identify any outstanding repairs or potential issues that need attention before departure.
- **Obtaining Updated Charts and Publications:** Having the latest navigational charts, publications, and operational manuals onboard is crucial for safe navigation and proper system operation.
- **Fuel Oil Management:**
  - **Fuel Quality:** Testing fuel quality is vital to ensure it meets the engine manufacturer's specifications and avoid potential problems like increased emissions or engine damage.
  - **Bunkering:** If bunkering (fueling) is planned, ensure proper procedures are followed to prevent contamination and maintain fuel system cleanliness.

- **Tank Switching and Settling:** Tanks should be switched and allowed sufficient settling time to allow any water or contaminants to settle at the bottom before starting the engine.

Checks:

Engine Checks:

- **Visual Inspection:** A thorough visual inspection of the engine for leaks, loose connections, or any signs of damage is essential. This includes checking for leaks around seals, hoses, and piping in the fuel, lubrication, and cooling systems.
- **Lubrication System:**
  - **Oil Level and Quality:** Oil level should be checked and topped up if necessary, ensuring the oil meets the manufacturer's recommendations. Oil samples might be taken for analysis to identify any signs of wear or contamination.
  - **Oil Filters:** Replacing oil filters as per maintenance schedules or based on oil analysis results helps maintain proper lubrication and prevent wear on engine components.
- **Cooling System:**
  - **Coolant Level and Quality:** Coolant level should be checked and topped up if necessary, using the correct coolant type recommended by the manufacturer. Coolant properties might also be tested to ensure proper corrosion protection and heat transfer efficiency.
  - **Seawater System:** Inspecting seawater inlets for blockages and proper operation of pumps and valves that circulate cooling water through the engine.
- **Fuel System:**
  - **Fuel Filters:** Replacing fuel filters as per maintenance schedules helps prevent contamination from reaching the injectors and protecting the engine.
  - **Fuel Injection System:** Checking for proper fuel delivery pressure and injector operation ensures efficient fuel delivery and combustion.
  - **Fuel Lines and Tanks:** Inspecting fuel lines for leaks and damage, and verifying proper fuel levels and tank switching procedures.
- **Starting System:**
  - **Batteries:** Battery voltage and condition should be checked to ensure sufficient cranking power for starting the engine.
  - **Starting System Components:** Testing the starter motor, solenoid, and associated electrical connections verifies their functionality for reliable engine starting.

Auxiliary Systems Checks:

- **Air Intake System:** Inspecting air filters for cleanliness and ensuring proper operation of the air intake system to provide clean air for efficient combustion.
- **Exhaust System:** Checking for leaks, blockages, and proper operation of turbochargers (if applicable) in the exhaust system.
- **Alarm Systems:** Testing engine alarms and safety systems like low oil pressure, high temperature, and overspeed alarms ensures they function properly to alert crew of potential issues.

Operational Checks:

- **Engine Starting and Running:** Following proper starting procedures and running the engine at various loads to verify smooth operation, responsiveness, and absence of abnormal noises or vibrations.
- **Control Systems:** Testing engine control systems, including remote controls and bridge controls, ensures proper communication and functionality.
- **Maneuvering Tests:** Performing maneuvering tests at low speeds, such as ahead/astern and turning circles, verifies the engine's responsiveness and proper operation of the steering gear and propulsion system.

Documentation:

- **Pre-Departure Checklist:** Completing a comprehensive pre-departure checklist that documents all the checks performed and their results ensures a record is kept for future reference.

By following these preparation and check procedures, crew members can ensure their main propulsion system is in optimal condition for a safe and efficient voyage. It's important to note that specific procedures and checks might vary depending on the vessel type, engine model, and company regulations. Always refer to the manufacturer's operation manuals and company specific procedures for detailed instructions.

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9. With reference to friction clutches, state EACH of the following:

   (a) THREE advantages of a wet clutch; (3)

   (b) THREE disadvantages of a wet clutch; (3)

   (c) ONE advantage of multiple plates; (1)

   (d) THREE disadvantages of multiple plates. (3)

Friction Clutch: Wet vs. Multiple Plates

Here's a breakdown of the advantages and disadvantages of wet clutches and multiple plates in friction clutches:

(a) Advantages of a Wet Clutch (3):

1. **Improved Cooling:** Wet clutches are submerged in engine oil, which acts as a coolant. This helps dissipate heat generated by friction during clutch operation, particularly beneficial for high-performance applications or frequent clutch use (e.g., stop-and-go traffic).
2. **Smoother Engagement:** The oil provides a dampening effect, reducing the harshness of clutch engagement. This translates to smoother starts and gear changes.
3. **Reduced Wear:** The oil acts as a lubricant, minimizing wear and tear on the friction surfaces of the clutch plates, extending their lifespan.

(b) Disadvantages of a Wet Clutch (3):

1. **Power Loss:** Due to the oil's resistance, there's a slight decrease in power transmission from the engine to the wheels compared to a dry clutch. This is a trade-off for the benefits of cooling and smoother operation.
2. **Maintenance:** Wet clutches require periodic oil changes to maintain their lubrication properties and prevent clutch slippage due to contaminated oil.
3. **Messy Service:** Disassembling a wet clutch can be messier because of the engine oil involved compared to a dry clutch.

(c) Advantage of Multiple Plates (1):

1. **Increased Torque Capacity:** By using multiple clutch plates, the total friction surface area is significantly increased. This allows the clutch to handle higher engine torque without slipping, making it suitable for powerful engines.

(d) Disadvantages of Multiple Plates (3):

1. **Increased Weight and Bulk:** More plates add weight and complexity to the clutch assembly compared to a single-plate design. This can impact overall vehicle weight and space requirements.
2. **Gradual Engagement:** Engaging a clutch with multiple plates might feel slightly less direct compared to a single-plate clutch. This is because there's more friction to overcome as the plates press together. However, some riders might prefer the smoother engagement feel.

Complexity of Adjustment: Depending on the design, adjusting the engagement point or clutch play might involve manipulating multiple components compared to a simpler single-plate setup. This can require more specialized tools or knowledge.

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10. (a) Sketch a block diagram of a lubricating oil system suitable for use with a reduction gearing, including all the protective devices. (5)

(b) State the engineering purpose/function of EACH item in the system sketched in part (a). (5)

Lubricating Oil System for Reduction Gearing: Block Diagram and Component Functions

(a) Lubricating Oil System Block Diagram:

Here's a block diagram of a lubricating oil system suitable for a reduction gearing system:

```
+---------------------+
 |   Reservoir (Oil Tank)  |
 +---------------------+
          |
          v
```

```
+--------------------+
|        Filter        |
+--------------------+
        |
        v
+--------------------+
|        Pump        |
+--------------------+
        |
        v  (Pressure Relief Valve)
+--------------------+
| Pressure Regulation  |
|     Valve          |
+--------------------+
        |
        v
+--------------------+
|          Cooler       |  (Optional)
+--------------------+
        |
        v  (Flow Control Valve)
        |
+--------------------+
|  Reduction Gearing   |
+--------------------+
        |
        v
+--------------------+
|      Oil Return       |
+--------------------+
        |
        v
+--------------------+
|     Filter Bypass     |  (Optional)
+--------------------+
        |
        v
+--------------------+
|   Reservoir (Oil Tank)  |
+--------------------+
```

(b) Engineering Purpose/Function of Each Item:

1. **Reservoir (Oil Tank):** This tank stores the lubricating oil for the reduction gearing system. It provides a reserve of oil and allows for thermal expansion of the oil.
2. **Filter:** The filter removes contaminants like dirt, metal particles, and wear debris from the lubricating oil. This helps to protect the gears and bearings from wear and tear.

3. **Pump:** The pump draws oil from the reservoir and pressurizes it to circulate it throughout the system. Proper oil pressure is crucial for lubrication and heat transfer.
4. **Pressure Relief Valve:** This valve protects the system from excessive pressure build-up. If the pressure exceeds a pre-set limit, the valve opens, bypassing the oil back to the reservoir.
5. **Pressure Regulation Valve:** This valve regulates the oil pressure in the system, ensuring it stays within the desired range for optimal lubrication. 6. **Cooler (Optional):** In high-power or high-ambient temperature applications, an oil cooler may be used to remove heat from the oil before it is circulated back to the gears. This helps to maintain proper oil viscosity and prevent overheating.
6. **Flow Control Valve (Optional):** This valve can be used to regulate the flow of oil to specific areas of the reduction gearing, particularly if different components have varying lubrication requirements.
7. **Reduction Gearing:** This is the component being lubricated by the oil system. The oil is directed to critical areas like gear teeth and bearings to minimize friction and wear.
8. **Oil Return:** The used oil from the reduction gearing drains back to the reservoir through a return line.
9. **Filter Bypass (Optional):** This bypass valve allows unfiltered oil to circulate back to the reservoir in case the main filter becomes clogged. However, this is a safety feature to prevent system failure and should not be a normal operating condition.

This block diagram represents a typical oil system for reduction gearing. The specific components and their configurations can vary depending on the size, power rating, and operating conditions of the reduction gear unit.