JAN 2023 MDE

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)

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

1. **Improved Cooling:** Wet clutches are bathed in engine oil, which helps dissipate heat generated by friction during clutch operation. This is particularly beneficial for high-performance applications or situations involving frequent clutch engagement (e.g., stop-and-go traffic).
2. **Smoother Engagement:** The oil provides a dampening effect, reducing the abruptness of clutch engagement and creating a smoother feeling when starting or shifting gears.
3. **Reduced Wear:** The oil lubricates the clutch plates, minimizing wear and tear on the friction surfaces and extending clutch life.

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

1. **Power Loss:** Due to the oil's resistance, there's a slight power loss from the engine to the wheels compared to a dry clutch. This is a trade-off for the benefits mentioned above.
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 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.
2. **Gradual Engagement:** With multiple plates, engagement might feel slightly less direct compared to a single-plate clutch due to the need to overcome friction between more surfaces. This can be a subjective feeling, and some riders might prefer a smoother engagement.
3. **Complexity of Adjustment:** Depending on the design, adjusting engagement point or clutch play might involve manipulating multiple components compared to a simpler single-plate setup.

feb 2021

February 2021 MDE

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.
3. **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.

may 2021

May 2021 MDE

9. Sketch a hydraulically operated, multi-plate, friction clutch, labelling the main components. (10)

Main Components:

- **Pressure Plate:** This rotating plate applies clamping force to the clutch plates through the pressure spring.
- **Friction Plates (Multiple):** These interleaved discs with high-friction surfaces are responsible for transmitting torque between the engine and gearbox.
- **Driven Plate (Disc):** This splined disc connects to the gearbox input shaft and rotates with the engine when the clutch is engaged.
- **Pressure Spring:** This spring provides the clamping force between the pressure plate and friction plates, holding them together during clutch engagement.
- **Throw-Out Bearing:** This bearing, actuated by the hydraulic system, pushes against the pressure plate fingers to disengage the clutch.
- **Hydraulic Release Cylinder:** This cylinder converts hydraulic pressure from the master cylinder into mechanical force to operate the throw-out bearing.
- **Clutch Housing:** The housing encloses the entire clutch assembly and protects the components.

oct 2021

October 2021 MDE

9. With reference to an engine connected to a gearbox via a friction clutch, explain EACH of the following:

   (a) why vibration from the engine should be damped; (7)

   (b) how vibration damping is achieved. (3)

Vibration Damping in Engine-Gearbox Connection (Friction Clutch):

(a) Why Engine Vibration Needs Damping:

Uncontrolled vibration from the engine can have several detrimental effects on the engine, gearbox, and overall driving experience:

- **Increased Wear and Tear:** Vibrations can cause excessive wear on engine and gearbox components due to the rapid back-and-forth movements. This can lead to premature failure of bearings, gears, and other parts.

- **Noise Harshness:** Engine vibrations can transmit through the drivetrain and chassis, creating unwanted noise and a harsh driving experience for occupants.
- **Gear Shift Difficulty:** Vibrations can make gear changes rough and difficult, especially when the engine RPM doesn't synchronize well with the gearbox speed.
- **Damage to Connected Components:** In severe cases, excessive vibration can damage other parts connected to the engine, such as engine mounts, driveshafts, and radiator components.

(b) How Vibration Damping is Achieved:

There are two main ways to dampen vibration between the engine and gearbox using a friction clutch:

1. Engine Mounts:

- Engine mounts are strategically placed rubber or hydraulic mounts that connect the engine to the chassis.
- The rubber or hydraulic fluid in these mounts absorbs and dampens engine vibrations before they can be transmitted to the drivetrain and chassis.
- Different engine mounts are positioned at various points to address vibrations in different directions (vertical, horizontal, and torsional).

2. Friction Clutch Disc Design:

- The design of the friction clutch disc itself can also play a role in vibration damping.
- Some clutch discs incorporate features like:
    - **Damping Springs:** These springs are embedded within the clutch disc and help to absorb and dissipate torsional vibrations from the engine crankshaft.
    - **Friction Material Properties:** The specific material composition of the friction lining on the clutch disc can influence its ability to absorb some level of vibration.

By using a combination of effective engine mounts and a well-designed clutch disc, the overall vibration transmission between the engine and gearbox can be significantly reduced. This leads to smoother operation, increased component lifespan, and a more comfortable driving experience

jan 2019

January 2019 MDE

9. Sketch a hydraulically operated, multi-plate, friction clutch, labelling the main components. (10)

Hydraulically Operated, Multi-Plate Friction Clutch: Components and Function

A hydraulically operated, multi-plate friction clutch is a key component in the drivetrain of many vehicles, allowing for smooth and controlled engagement and disengagement of power between the engine and the gearbox. Here's a breakdown of its main components and their functions:

1. Pressure Plate: This rotating plate is directly connected to the engine flywheel. It houses the friction plates and applies clamping force to them through the pressure spring.

2. Friction Plates (Multiple): These are typically alternating steel and friction material discs stacked together. The steel plates have high strength and are splined to mate with the pressure plate. The friction material discs are bonded to the steel plates and provide the gripping surface for torque transmission.

3. Driven Plate (Disc): This splined disc connects directly to the gearbox input shaft. It rotates with the engine flywheel and pressure plate when the clutch is engaged.

4. Pressure Spring: A strong coil spring located behind the pressure plate. It provides the continuous force that holds the pressure plate and friction plates together, transmitting torque from the engine to the gearbox.

5. Throw-Out Bearing: This bearing is located on a fork mechanism and is the key component for clutch disengagement. It's positioned to push against the pressure plate fingers when actuated by the hydraulic system.

6. Hydraulic Release Cylinder: This cylinder is connected to the clutch pedal or a hydraulic control unit. It converts hydraulic pressure from the master cylinder (not shown) into mechanical force to operate the throw-out bearing.

7. Clutch Housing: This is a sturdy housing that encloses the entire clutch assembly, protecting the components from dirt and debris. It also provides a mounting point for the clutch to the engine and gearbox.

Operation:

- When the driver presses the clutch pedal, hydraulic pressure is generated in the master cylinder and transmitted to the hydraulic release cylinder.
- The hydraulic release cylinder pushes the throw-out bearing against the pressure plate fingers.
- This action overcomes the force of the pressure spring, forcing the pressure plate to move away from the friction plates.
- With the pressure plate disengaged from the friction plates, the connection between the engine and gearbox is interrupted, allowing gear changes or stopping the vehicle without stalling the engine.
- Once the driver releases the clutch pedal, the hydraulic pressure is relieved, and the pressure spring pushes the pressure plate back onto the friction plates. This re-establishes the connection between the engine and gearbox, transmitting torque and propelling the vehicle.

By utilizing multiple friction plates, this design increases the total clamping force and torque capacity compared to a single-plate clutch. The hydraulic actuation provides a smoother and more consistent clutch feel compared to a mechanical linkage system.

pnumatic clutch

oct 20203

October 2023 MDE

9. With reference to pneumatically operated friction clutches, explain the effects of EACH of the following:

(a) oil contamination of friction pads; (3)

(b) reduced air pressure; (2)

(c) distorted friction pads; (2)

(d) angular misalignment. (3)

Effects in Pneumatically Operated Friction Clutches:

Here's how each factor affects a pneumatically operated friction clutch:

(a) Oil Contamination of Friction Pads:

- **Reduced Frictional Coefficient:** Oil acts as a lubricant, reducing the friction between the clutch plates. This can lead to clutch slippage, where the engine continues to spin but fails to transmit full power to the drivetrain. The clutch will not engage fully, resulting in a loss of power and acceleration.
- **Glazing:** In some cases, oil contamination can cause the friction material to overheat and glaze over. Glazing creates a smooth, hard surface that further reduces friction and worsens clutch slippage.
- **Uneven Engagement:** Oil contamination might not be uniformly distributed on the friction surfaces. This can lead to uneven engagement and a grabby feeling when engaging the clutch.

(b) Reduced Air Pressure:

- **Incomplete Engagement:** Pneumatic clutches rely on compressed air pressure to create the clamping force between the pressure plate and friction plates. If the air pressure is insufficient, the clamping force won't be strong enough to hold the discs together effectively. This will lead to clutch slippage, similar to oil contamination, with a loss of power transmission.
- **Delayed Engagement:** With lower air pressure, it might take longer for the clutch to fully engage, causing a delay in power transfer and a sluggish response when changing gears or starting the vehicle.

(c) Distorted Friction Pads:

- **Warping:** Excessive heat, wear and tear, or manufacturing defects can cause the friction plates to warp. This can lead to uneven contact between the plates, creating a grabbing or shuddering sensation during clutch engagement.

- **Reduced Contact Area:** Warped plates may not make full contact with each other, reducing the effective friction surface area. This can lead to slippage and a decrease in torque capacity.
- **Noise:** Distorted plates can create grinding or scraping noises during clutch engagement due to uneven contact.

(d) Angular Misalignment:

- **Premature Wear:** If the clutch components, such as the pressure plate or flywheel, are not perfectly aligned, it can cause the plates to rub against each other at an angle. This leads to uneven wear and premature failure of the clutch components.
- **Increased Friction:** Misalignment can create unnecessary friction points between the plates, even when the clutch is disengaged. This can generate unwanted heat and contribute to wear and tear.
- **Clutch Drag:** In severe cases, misalignment might prevent the clutch from fully disengaging, causing the vehicle to continue creeping forward even with the clutch pedal depressed.

feb 2022

February 2022

9. With reference to pneumatic clutches used for medium speed main propulsion purposes:

   (a) describe the operating principle of the clutch; (5)

   (b) explain how this clutch may be engaged in the event of failure of the control system; (3)

   (c) state TWO interlocks necessary for clutch operation. (2)

Feb 2022

February 2020 MDE

9. With reference to pneumatic clutches used for medium speed main propulsion purposes:

   (a) describe the operating principle of the clutch; (5)

   (b) explain how this clutch may be engaged in the event of failure of the control system; (3)

   (c) state TWO interlocks necessary for clutch operation. (2)

(a) Operating Principle:

A pneumatic clutch for medium-speed main propulsion utilizes compressed air to control engagement and disengagement between the engine and the propeller shaft. Here's how it works:

1. **Compressed Air Supply:** The clutch is connected to a compressed air system that provides pressurized air.
2. **Engagement Cylinder:** An air cylinder (actuator) is connected to the clutch housing. When compressed air is directed into the cylinder, the piston inside the cylinder extends.
3. **Pressure Plate and Friction Plates:** The extending piston applies force to a pressure plate. This pressure plate clamps multiple friction plates between itself and a driven plate (connected to the propeller shaft).
4. **Friction and Torque Transmission:** The clamping force from the pressure plate creates friction between the interleaved friction plates, holding them together. This friction transmits

torque from the engine flywheel (connected to the pressure plate) to the driven plate and ultimately the propeller shaft.

5. **Disengagement:** When compressed air is vented from the actuator cylinder, the piston retracts due to spring pressure or compressed air from the opposite side of the cylinder (depending on the design). This allows the pressure plate to move away from the friction plates, disengaging the clutch and interrupting power transmission.

(b) Engaging Clutch During Control System Failure:

In case of a pneumatic control system failure, there are typically emergency engagement mechanisms to ensure minimal disruption to propulsion:

1. **Spring-Engaged Design:** Some pneumatic clutches are designed to be "spring-engaged, air-disengaged." This means a strong spring holds the pressure plate and friction plates together by default. Compressed air is used to overcome the spring force and disengage the clutch. In case of air pressure loss, the spring automatically forces the clutch into the engaged position, allowing the vessel to maintain some level of propulsion.
2. **Manual Override:** Some clutches might have a manual override mechanism. This could involve a lever or handwheel that allows the operator to directly apply mechanical force on the pressure plate, mimicking the effect of compressed air and engaging the clutch. This would require manual operation and wouldn't be as smooth as normal pneumatic actuation, but it could allow the vessel to maintain basic operability until repairs are made.

(c) Interlocks for Clutch Operation (2):

1. **Engine Speed Interlock:** This interlock prevents clutch engagement above a certain engine speed (RPM) limit. This is crucial to avoid excessive wear and tear on the clutch components during high-speed engagement. The clutch can only be engaged when the engine RPM falls within the safe operating range.
2. **Lubrication Oil Pressure Interlock:** This interlock ensures sufficient lubrication oil pressure before allowing clutch engagement. This protects the clutch components from damage due to dry operation and overheating. The clutch will only engage when the oil pressure reaches the minimum required level.

april 2022

April 2022 MDE

9. Describe, with the aid of a sketch, the operation of a diesel engine propulsion system air operated radial tyre type clutch. (10)

Oct 2018

October 2018 MDE

9. Describe, with the aid of a sketch, the operation of a diesel engine propulsion system air operated radial tyre type clutch. (10)

It's important to clarify a few points about the terminology used:

- **Radial Tyre Type Clutch:** This term is not typically used in diesel engine propulsion systems. Radial tire clutches are more commonly found in agricultural equipment and utilize the inflated shape of a tire to create clamping force.
- **Air Operated Clutch:** This is a more likely description for a compressed air-actuated clutch used in a diesel engine propulsion system.

Here's a breakdown of a typical air-operated clutch operation in a diesel engine propulsion system for a medium-speed application:

Components:

- **Compressed Air System:** Provides pressurized air for clutch actuation.
- **Air Actuator Cylinder:** A piston cylinder connected to the clutch housing.
- **Pressure Plate:** Clamps the friction plates against the driven plate.
- **Friction Plates:** Multiple interleaved discs with high-friction material surfaces.
- **Driven Plate:** Connects to the propeller shaft and rotates with the engine flywheel when engaged.
- **Control System:** Regulates compressed air flow to the actuator for engagement and disengagement.

Operation:

1. **Engagement:**
   - The control system directs compressed air into the actuator cylinder.
   - The pressurized air pushes the piston within the cylinder, extending the piston rod.
   - The extending piston rod applies force to the pressure plate through levers or linkages.
   - The pressure plate clamps the friction plates between itself and the driven plate.
   - Friction between the plates transmits torque from the engine flywheel (connected to the pressure plate) to the driven plate and ultimately the propeller shaft.
   - The engine and propeller become connected, propelling the vessel.
2. **Disengagement:**
   - When the control system vents compressed air from the actuator cylinder, the piston retracts due to spring pressure or compressed air from the opposite side of the cylinder (depending on the design).
   - This allows the pressure plate to move away from the friction plates due to spring force.
   - With the pressure plate disengaged, friction between the plates is eliminated, and the connection between the engine and propeller shaft is interrupted.
   - The engine can continue to run without propelling the vessel (idling).

Additional Points:

- **Spring-Engaged Design:** Some clutches might be designed to be "spring-engaged, air-disengaged." This means a strong spring holds the pressure plate and friction plates together by default. Compressed air is used to overcome the spring force and disengage the clutch. In case of air pressure loss, the spring automatically forces the clutch into the engaged position.
- **Interlocks:** Safety interlocks might be implemented. For example, the clutch might not engage until engine speed falls below a certain RPM or until lubrication oil pressure reaches a minimum level.

This description provides a general overview of an air-operated clutch in a diesel engine propulsion system. The specific design and control system might vary depending on the application and manufacturer.

jan 2023

JAN 2023 MDE

10. With reference to a reduction gearing and pneumatic clutch arrangement of a propulsion system:

(a) state FIVE protection devices fitted; (5)

(b) explain the need for EACH device stated in part (a). (5)

Protection Devices in a Reduction Gearing and Pneumatic Clutch Propulsion System (a):

Here are five common protection devices found in a reduction gearing and pneumatic clutch arrangement of a propulsion system:

1. **Overload Clutch:** This is a secondary clutch mechanism that automatically disengages when the system experiences excessive torque beyond its normal operating limits. This protects the reduction gears and other drivetrain components from damage due to overload.
2. **Low Oil Pressure Switch:** This switch prevents clutch engagement or disengages the clutch if the lubrication oil pressure falls below a minimum threshold. This safeguards the gears and bearings from wear and tear due to insufficient lubrication.
3. **High Engine Speed Interlock:** This interlock prevents clutch engagement above a certain engine speed (RPM) limit. This protects the clutch components from excessive wear and tear during high-speed engagement.
4. **Air Pressure Warning System:** This system monitors the compressed air supply for the pneumatic clutch and provides an alert if the pressure falls below a safe operating level. This allows the operator to take corrective action before clutch disengagement due to air pressure loss.
5. **Gearbox/Reduction Gearbox Temperature Sensor:** This sensor monitors the temperature of the gearbox or reduction gearbox. If the temperature exceeds a safe limit, an alarm might be triggered, or the system might automatically disengage the clutch to prevent overheating and potential damage.

(b) Explanation for Each Protection Device:

1. **Overload Clutch:** Protects the reduction gears and drivetrain from excessive torque that could cause gear breakage, shaft shearing, or other mechanical failures.
2. **Low Oil Pressure Switch:** Ensures proper lubrication of the gears and bearings to prevent overheating, excessive wear, and potential seizure.
3. **High Engine Speed Interlock:** Prevents clutch engagement at high RPMs where the rapid engagement forces can damage the clutch components and potentially lead to slipping issues.

4. **Air Pressure Warning System:** Allows for early detection of air pressure issues before complete clutch disengagement, preventing sudden loss of propulsion and potential safety hazards.
5. **Gearbox/Reduction Gearbox Temperature Sensor:** Protects the gearbox and reduction gears from overheating, which can lead to gear wear, lubricant breakdown, and potential component failure.

These protection devices work together to ensure safe and reliable operation of the propulsion system by safeguarding against various potential failures.