



HYDRAULIC OPEN LOOP CIRCUIT



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MARINE ENGINEERING DEPARTMENT
OF
POLITEKNIK UNGKU OMAR

HYDRAULIC OPEN LOOP C I R C U I T

ISBN 978-629-7635-00-2



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First Edition : Julai 2023

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Isbn : eISBN

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e ISBN: 978-629-7635-00-2

Published by:

Politeknik Ungku Omar

Jalan Raja Musa Mahadi

31400 Ipoh, Perak

Email: zuwan@puo.edu.my

e ISBN 978-629-7635-00-2



NICE TO MEET YOU!

Good day! I'm Mohd Redzuwan, and I'm delighted to share some information about myself with you. I'm an enthusiastic person who possesses a keen interest in the field of mechanical engineering. I have pursued accomplishment throughout my academic and professional careers and have worked to advance knowledge in my field.

I enlisted into the renowned University of Teknologi Malaysia (UTM) to pursue a degree in mechanical engineering in order to follow the path that I chose. I engaged myself in a variety of engineering disciplines while I was a student at UTM, collecting real-world experience and academic knowledge that would be beneficial to me in my future endeavours. The academic setting promoted an innovative mindset by promoting participation in research initiatives and teamwork with industry collaborators.

I was given the wonderful opportunity to teach at Politeknik Ungku Omar in Ipoh, Perak. I started working in the academic field in 2002, and I have been thriving in this position ever since. I have embraced this responsibility with excitement and perseverance. I had the honour of inspiring and mentoring the next generation of engineers as a lecturer. I have been in charge of a variety of tasks, including giving lectures, leading practical sessions, assisting students with their research projects, as well as offering academic mentoring. It has been incredibly gratifying to see how my students have developed and succeeded, which has strengthened my dedication to education and knowledge sharing.



A stylized, handwritten signature in black ink. The signature is cursive and appears to read 'Redzuwan'.

Mohd Redzuwan

Appreciation

The work would not have been possible without the assistance of the staff of Politeknik Ungku Omar's Marine Engineering Department. I am especially grateful to FESTO through FESTO SDN. BERHAD for their approval using their schematic layout of the components and to Semester 6 students for their input on sharing pictures of onboard ship machinery during their sea training. Special appreciation to Mr. Faisol Bin Saad, Head of the Department of Marine Engineering, who has been supportive of the writings and actively sought to give the teams the protected academic time they needed to achieve their goals. Most significantly, I want to thank all the Marine Engineering students for their never-ending inspiration.

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TOPIC 1 : INTRODUCTION

HYDRAULIC POWER IN MERCHANT SHIP

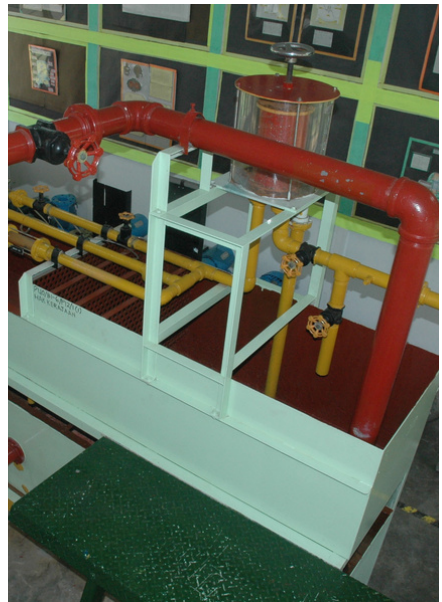
Hydraulic systems play a crucial role in merchant ships, offering numerous benefits which enhance their efficiency and safety. One of the key importance of hydraulic systems in these ships is their role in cargo handling. They are vital for loading and unloading cargo, powering cranes, winches, and other equipment used to handle heavy goods, thus making the process faster and more efficient. Moreover, hydraulic systems are responsible for the ship's steering mechanism, enabling precise and responsive control of the vessel, especially in challenging navigational conditions like narrow channels or adverse weather. Furthermore, hydraulic brakes are employed on many ships to ensure reliable and effective stopping power, particularly for large vessels with substantial momentum. This enhances safety during berthing and emergency situations.



Additionally, hydraulic systems are used for stabilisation purposes. They operate stabilizers which help reduce the ship's roll, improving passenger and crew comfort, especially in rough seas. Another significant application is in anchor handling, as hydraulic systems control the anchor and anchor winches, facilitating the process of dropping and raising the anchor, allowing the ship to secure itself in harbors or during emergencies.

In critical situations, hydraulic systems are integrated into emergency systems i.e watertight doors and fire-fighting equipment, to ensure the ship's integrity and safety during emergencies. Additionally, the demand for heavy physical labour is lowered by automating a variety of jobs with hydraulic systems, improving efficiency and lowering operating costs.

Modern merchant ships may also utilise hydraulic thrusters, aiding in maneuvering the ship in tight spaces such as ports or canals, making docking and undocking more manageable. On some ships, particularly in emergency situations when the primary power source might not be accessible, hydraulic power is harnessed to generate electricity.



Hydraulic systems are renowned for their reliability and durability; when properly maintained, they're capable of having a long lifespan, hence, minimising the risk of unexpected failures at sea. In conclusion, it is impossible to overestimate the significance of hydraulic systems in merchant ships. They significantly contribute to the vessel's operational efficiency, cargo handling, safety, and overall maneuverability. With their reliability and versatility, hydraulic systems are indispensable components of modern maritime technology, ensuring smooth and successful voyages for commercial ships worldwide.



FUTURE OF HYDRAULIC POWER IN MERCHANT SHIP



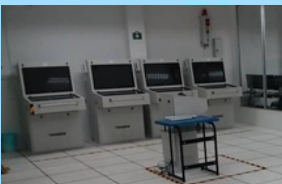
1. Electrification and Hybrid Systems:

The transition to electric and hybrid power systems is one notable development. Electric propulsion and hybrid systems which integrate hydraulic power with electric power have gained popularity as the maritime sector seeks for cleaner and more environmentally friendly alternatives. These systems possess the ability to utilise renewable energy sources, increase energy efficiency, and reduce emissions.



2. Energy Recovery Systems:

Future merchant vessels may have energy recovery systems integrated into their hydraulic systems. The system enables the energy which is typically lost during hydraulic operations (after the mechanical energy has been converted to thermal energy) to be collected and preserved. This allows for greater overall energy efficiency as well as reducing fuel consumption.



3. Smart Automation and Control:

Advancements in automation and control technologies will lead to more intelligent and precise hydraulic systems. This implies an improved and adaptive control, a decrease in energy waste, and an enhancement in the overall performance of the hydraulic components onboard.

THE FUTURE OF HYDRAULIC POWER IN MERCHANT SHIPS IS LIKELY TO BE INFLUENCED BY SEVERAL FACTORS, INCLUDING ADVANCEMENTS IN TECHNOLOGY, ENVIRONMENTAL CONCERNS, AND THE PURSUIT OF MORE EFFICIENT AND SUSTAINABLE SOLUTIONS.



4. Lightweight and Compact Designs:

Research and development efforts will likely focus on creating more lightweight and compact hydraulic components. This will help to reduce the ship's weight, which leads to the increase of fuel efficiency as well as improved overall performance.



5. Sustainable Fluids:

The use of more environmentally friendly hydraulic fluids could become increasingly common. Bio-based, biodegradable, or synthetic fluids with a low environmental impact may become more popular in the maritime industry.



6. Reduced Maintenance and Downtime:

Ships may require less maintenance and experience less downtime as a result of advancements in hydraulic system design and materials. This can lead to cost savings and increased operational efficiency.

7. Integration with Alternative Propulsion Technologies:

Hydraulic power systems may find application within innovative and alternative propulsion technologies such as air lubrication systems, enhanced wind propulsion, or fuel cells. This integration help optimize the overall propulsion system and improve fuel efficiency.



8. Regulatory Requirements:

The adoption of environmentally friendly technology, which includes more effective hydraulic power systems, may be influenced by stringent environmental restrictions such as emissions caps and carbon price mechanisms.

9. Continued Use in Critical Systems:

Despite potential advancements in other power systems, hydraulic power will likely remain a vital component for critical ship systems, particularly in emergency steering, anchor handling, and stabilizers. These crucial functions are well suited for it due to its reliability and durability.



QUIZ 1

Q. C1 : Answer all the question.

1

What are the key roles of hydraulic systems in merchant ships?

2

How do hydraulic systems enhance cargo handling in merchant ships?

3

What is the significance of hydraulic systems in anchor handling?

4

How do hydraulic systems contribute to safety in merchant ships?

5

What are the potential trends that could be seen in the application of hydraulic power in merchant ships?

6

Why are hydraulic power systems likely to remain vital in merchant ships, despite advancements in other power technologies?



TOPIC 2 :

FUNDAMENTAL OF HYDRAULIC POWER

PASCAL'S LAW IS THE FUNDAMENTAL PRINCIPLE OF HYDRAULICS. IT STATES THAT WHEN PRESSURE IS APPLIED TO A CONFINED FLUID IN AN ENCLOSED SYSTEM, THE PRESSURE IS TRANSMITTED EQUALLY IN ALL DIRECTIONS. THIS MEANS THAT ANY CHANGE IN PRESSURE AT ANY POINT IN THE FLUID WILL.

Pascal's law states that when pressure is applied to a fluid in a confined space, the pressure change is transmitted equally in all directions throughout the fluid. This implies that any changes in pressure within the fluid at any point will be distributed undiminished to all other regions of the fluid as well as the container's walls.

Pascal's Law in Hydraulic Power

Pascal's law is highly relevant to hydraulic power as it forms the foundation of how hydraulic systems function. Named after the French mathematician and physicist Blaise Pascal, this principle describes the fundamental behavior of confined fluids in hydraulic systems. It serves as a foundation for the successful transmission of force and energy in hydraulic systems.



Pascal's law enables the efficient transfer of force and energy from one component of the hydraulic system to another in the context of hydraulic power. When a force is applied to the hydraulic fluid in one part of the system (e.g., by operating a hydraulic pump), the pressure is increased in the fluid. This rise in pressure is equally spread throughout the fluid, comprising hydraulic motors or cylinders which are located throughout the system.

As a result, hydraulic cylinders and motors, which are the primary actuators in hydraulic systems, can convert the pressurized fluid into mechanical force and motion with consistent and proportional power. This allows for precise control over the movement of machinery, tools, and various components in hydraulic applications.

Pascal's law ensures that the hydraulic fluid acts as an efficient medium for transmitting power throughout the hydraulic system, thereby rendering hydraulic power a vital and efficient technology in a variety of mechanical and industrial applications.

Pascal's Law formula

Pascal's law can be mathematically expressed using a simple equation. The basic formula for Pascal's law is:

$$P_1 = P_2$$

Where:

- P_1 = Pressure at point 1 in the fluid (in Pascals or any pressure unit)
- P_2 = Pressure at point 2 in the fluid (in Pascals or any pressure unit)

This equation signifies that the pressure in a confined fluid remains the same at all points within the fluid. In other words, any change in pressure applied at one point in the fluid is transmitted undiminished throughout the entire fluid and the walls of the container holding the fluid.

In hydraulic power systems, Pascal's law plays a crucial role in transmitting force and energy through the hydraulic fluid. When the force is applied to the fluid at one point in the system, the pressure increases at that point. However, according to Pascal's law, This rise in pressure spreads throughout the fluid uniformly in all directions.

This implies that the pressure increase is not limited to the point where the force was applied; it is also felt at other points within the fluid, which includes the actuator (such as a hydraulic cylinder or motor) that is located at a different position in the system. As a result, the force generated by the hydraulic actuator is directly proportional to the increase in pressure caused by the force applied at the initial point.

Example:

Consider a simple hydraulic lift system as an example. A confined fluid (hydraulic oil) is passed between a small cylinder (cylinder A) and a bigger cylinder (cylinder B) in the system. Both cylinders have pistons, and the piston in cylinder B is under load.

When force is applied to the small piston of cylinder A by pushing it downward, it creates an increase in pressure in the hydraulic oil. According to Pascal's law, this pressure increase is transmitted equally to the larger piston in cylinder B. As the area of the piston in cylinder B is larger, the force exerted by the hydraulic oil on the piston of cylinder B becomes significantly greater.

This exemplifies how Pascal's law allows for the amplification of force in hydraulic systems. By applying a small force at one point in the system, you can generate a much larger force at another point, making hydraulic systems ideal for lifting heavy loads and performing various mechanical tasks with relatively low input force.

QUIZ 2

Q. C2 : Tray answer all the question.

1

The pressure at point 1 (P1) in a hydraulic system is 1200 kPa. Calculate the pressure at point 2 (P2) if the system operates according to Pascal's law.

2

A hydraulic lift system exerts a pressure of 8 MPa at the smaller piston (P1). If the larger piston (P2) has an area of 20 cm², Calculate the force applied to the larger piston.

3

A hydraulic system has a pressure of 50 bar. If this system is connected to two hydraulic cylinders with different areas (A1 = 12 cm² and A2 = 30 cm²), Calculate the force produced by each cylinder.

4

The pressure at point 1 (P1) in a hydraulic system is 2.5 MPa. Determine the pressure at point 2 (P2) when the fluid is transferred to another area of the system using Pascal's law.

5

In a hydraulic brake system, the pressure is measured at two different points: P1 = 1500 kPa and P2 = 1200 kPa. Does the system operate according to Pascal's law?

6

A hydraulic system exerts a pressure of 30 bar. Calculate the force applied to a piston with an area of 25 cm².



TOPIC 3 :

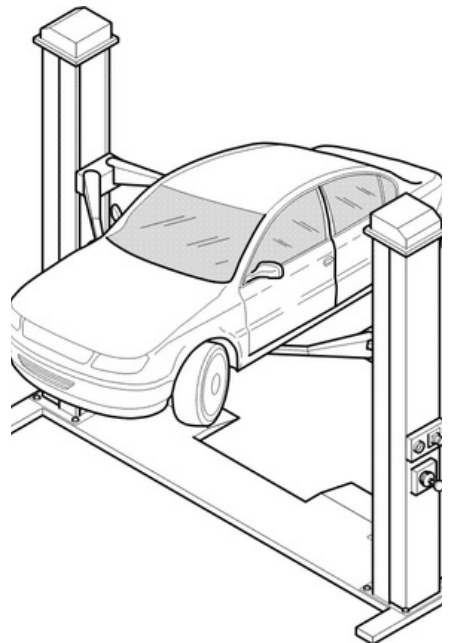
HYDRAULIC BASIC COMPONENTS

Introduction

Hydraulic components are mechanical elements or devices that are an integral part of hydraulic systems. These components are designed to control, generate, and transmit power using pressurized fluid, typically hydraulic oil. They play a vital role in converting mechanical energy into hydraulic energy and then back into mechanical force and motion, enabling precise control and efficient operation in various industrial, commercial, and transportation applications.

Hydraulic components comprises of items such as hydraulic pumps, hydraulic cylinders, hydraulic motors, hydraulic valves, hydraulic accumulators, hydraulic filters, hydraulic reservoirs, and hydraulic hoses and fittings. Each component serves a specific function within the hydraulic system; Their successful integration ensures the overall hydraulic system's successful operation.

UNDERSTANDING THE BASIC COMPONENTS OF HYDRAULIC SYSTEMS IS ESSENTIAL FOR DESIGNING, OPERATING, AND MAINTAINING THESE SYSTEMS EFFICIENTLY AND SAFELY.



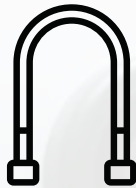
The fundamental parts of hydraulic systems function in harmony to transform mechanical energy into hydraulic energy, which is subsequently transformed back into mechanical force and motion. Understanding these components is essential to grasp on how hydraulic systems function effectively.

These components are necessary for hydraulic systems to operate in a variety of settings, including heavy machinery, industrial equipment, transportation systems, and aerospace.

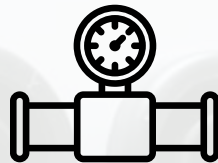
Some common hydraulic components include:



Hydraulic Power Unit



Hose



Valve



Actuator

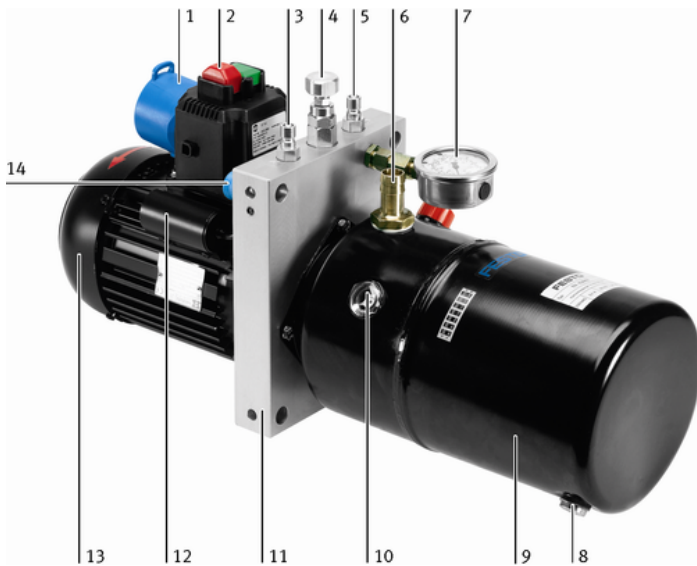
2.1 HYDRAULIC POWER PACK



A hydraulic power pack, also known as a hydraulic power unit (HPU), is a self-contained system that generates and controls hydraulic power. It consists of a motor, typically an electric motor or an internal combustion engine, coupled with a hydraulic pump, hydraulic reservoir, valves, and other accessories. The primary function of a hydraulic power pack is to provide high-pressure hydraulic fluid that can be transmitted through hoses or pipes to perform work in various hydraulic machinery and systems. These power packs are widely used in a variety of procedures and industries. For instance, in the construction industry, hydraulic power packs are used to operate hydraulic cranes, excavators, and concrete pumps, providing the necessary force and precision to lift heavy loads and maneuver equipment efficiently.

In manufacturing, Hydraulic power packs power presses, and other machinery, enable accurate material shaping and molding. Furthermore, hydraulic power packs are employed in automation systems, particularly in assembly lines, where they provide controlled movements and force to carry out specific tasks with accuracy and repeatability. Overall, hydraulic power packs are crucial components in diverse applications that require reliable and powerful hydraulic energy to drive machinery and achieve optimal performance.

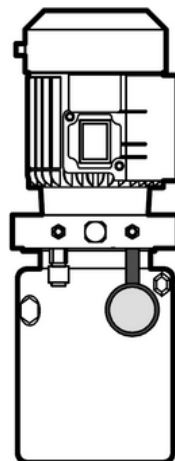
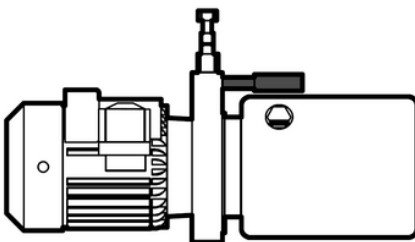




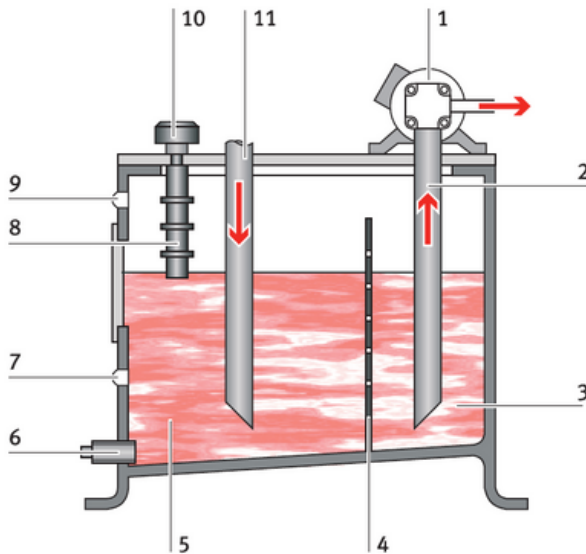
- (1) POWER SUPPLY PLUG,
- (2) ON/OFF SWITCH,
- (3) TANK CONNECTION T,
- (4) PRESSURE-RELIEF VALVE,
- (5) PRESSURE PORT P,
- (6) TANK CONNECTION (BLUE) FOR DISCHARGE MEASUREMENT TANK,
- (7) PRESSURE GAUGE,
- (8) DRAIN SCREW,

- (9) TANK,
- (10) SIGHT GLASS FOR LEVEL INDICATOR,
- (11) FLANGE,
- (12) CAPACITOR,
- (13) ELECTRIC MOTOR,
- (14) TANK CONNECTION (BLUE) FOR RESERVOIR TS.

Horizontal Position
Pressure gauge facing upwards.



Vertical Position
Electrical motor facing upwards

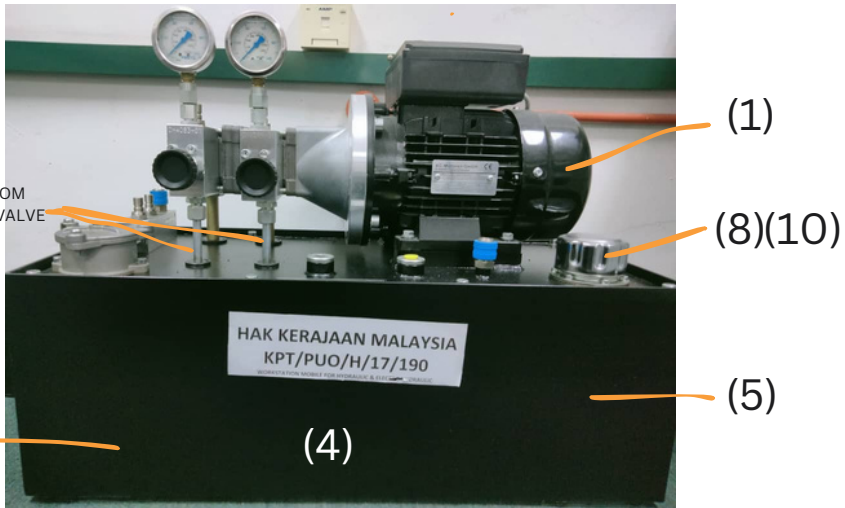


- (1) MOTOR AND PUMP,
- (2) SUCTION TUBE,
- (3) SUCTION CHAMBER,
- (4) MODERATING PLATE,
- (5) RETURN CHAMBER,
- (6) DRAIN SCREW,
- (7) FILL-LEVEL INDICATOR, MINIMUM FILL-LEVEL,
- (8) FILLING FILTER,

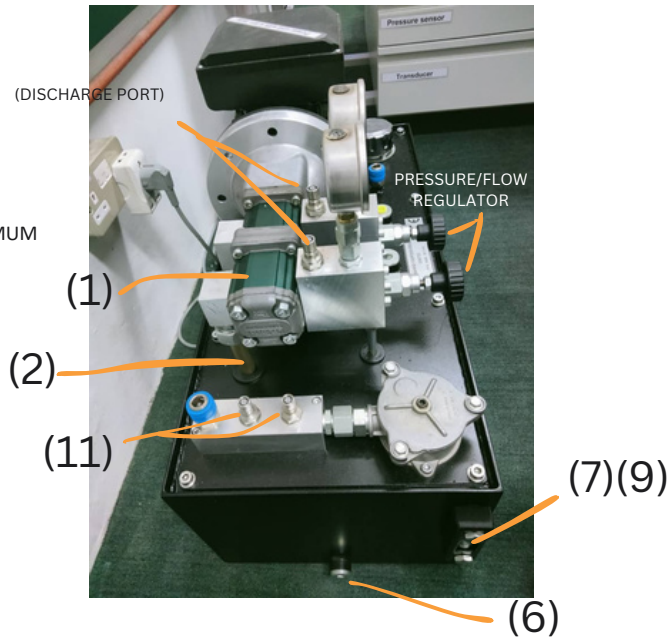
- (9) FILL-LEVEL INDICATOR, MAXIMUM FILL-LEVEL,
- (10) VENT WITH AIR FILTER,
- (11) RETURN LINE,

(1)





- (1) MOTOR AND PUMP,
- (2) SUCTION TUBE,
- (3) SUCTION CHAMBER,
- (4) MODERATING PLATE,
- (5) RETURN CHAMBER,
- (6) DRAIN SCREW,
- (7) FILL-LEVEL INDICATOR, MINIMUM FILL-LEVEL,
- (8) FILLING FILTER,



- (9) FILL-LEVEL INDICATOR, MAXIMUM FILL-LEVEL,
- (10) VENT WITH AIR FILTER,
- (11) RETURN PORT,

BASIC COMPONENT FOR HYDRAULIC POWER UNIT (HPU)

Hydraulic Pump

A hydraulic pump is a mechanical device designed to generate flow and create pressure within a hydraulic system. It plays a vital role in converting mechanical power into hydraulic energy, which is then used to operate various hydraulic machinery and systems. The pump operates by drawing in hydraulic fluid, typically oil, from a reservoir and forcing it through a system of valves and passages, thereby generating high-pressure output. This pressurized fluid is essential for transmitting force and energy to actuators, such as hydraulic cylinders or motors, which perform the desired mechanical work.

Hydraulic pumps come in various types, including gear pumps, vane pumps, piston pumps, and axial piston pumps; each offering specific advantages and suitability for different applications. They are widely used across industries, ranging from construction and manufacturing to aerospace and automotive, providing the power and efficiency required for heavy-duty tasks, precise movements, and smooth operation in numerous hydraulic systems.

Whether it's lifting heavy loads, powering industrial machinery, or controlling the movements of various equipment, hydraulic pumps are fundamental components that enable the reliable and effective functioning of hydraulic systems.

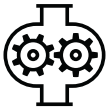


*Keep it simple. Do
more of what you love.*

- Redzuwan

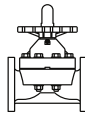
Types of Hydraulic Pump

Hydraulic pumps are mechanical devices that convert mechanical power into hydraulic energy, allowing the transfer of fluid under pressure to perform various tasks in hydraulic systems. These pumps, which are an essential part of hydraulic gear, come in a variety of types to accommodate a range of applications. Here are some of the common types of hydraulic pumps:



Gear Pumps:

Hydraulic gear pumps are simple to operate and widely utilised. They consist of two or more meshing gears within a tight-fitting housing. As the gears rotate, they create a low-pressure area that draws hydraulic fluid into the pump. The fluid is forced at a higher pressure via the pump and then into the hydraulic system as the gears mesh. Gear pumps are known for their compact size, high efficiency, and low noise levels. They are, however, best suited to low to medium pressure applications.



Vane Pumps:

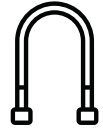
Vane pumps use a rotating vane inside a circular housing to create hydraulic pressure. The vane is usually made of metal or other materials; it slides in and out of the housing slots as it rotates. This action creates expanding and contracting chambers that draw in and push out hydraulic fluid. Vane pumps are relatively efficient, operate quietly, and are suitable for medium-pressure applications.



Piston Pumps:

Piston pumps are more complex but capable of handling higher pressure applications. They pressurise the hydraulic fluid using pistons operated by a spinning shaft. There are various designs of piston pumps, including axial piston pumps and radial piston pumps. Axial piston pumps have pistons arranged in a circular pattern around the drive shaft, while radial piston pumps have pistons that move perpendicular to the shaft. These pumps offer excellent efficiency and are often found in heavy-duty applications.

2.2 HYDRAULIC HOSE



A hydraulic hose is a critical component of a hydraulic system, which is used to transmit hydraulic fluid (usually oil) under high pressure from one part of the system to another. It plays a crucial role in maintaining the flow of fluid and transmitting force within hydraulic machinery and equipment. The purpose, standards, structure design, and safety issues are explained here.

The function of Hydraulic Hose:

The main function of a hydraulic hose is to carry pressurized hydraulic fluid between hydraulic components, such as pumps, valves, actuators, and cylinders. Hydraulic systems rely on the principle that is when pressure is applied to a confined fluid, it can transmit that pressure in all directions. This property enables the transfer of power and control in various machinery and industrial applications, such as construction equipment, agricultural machinery, manufacturing machinery, aircraft, and more.





Structure Design of Hydraulic Hose:

Hydraulic hoses are typically constructed with three layers:

Inner Tube: The innermost layer is constructed from a synthetic rubber material that is compatible with the employed hydraulic fluid. It is required to be chemically resistant and able to endure the pressure and temperature of the hydraulic system.

Reinforcement Layer: The reinforcement layer strengthens the hose and helps it withstand the internal pressure. It is usually made of one or more layers of high-strength steel wire braids or spirals.

Outer Cover: The outer cover protects the hose from external damage, abrasion, and environmental factors. It is also made of a synthetic rubber material that is resistant to weather, oils, and chemicals.

Standards for Hydraulic Hose:

Hydraulic hoses are made in accordance with a number of international standards established by organisations like the International Organisation for Standardisation (ISO) and the Society of Automotive Engineers (SAE), in order to assure industry safety and uniformity. Common standards for hydraulic hoses include:

SAE J517: This standard outlines the requirements for hydraulic hose construction, dimensions, performance, and temperature ranges.

ISO 18752: Specifies the performance characteristics of hoses and hose assemblies used in hydraulic systems.

EN 853 and EN 854: European standards that cover wire braid and wire spiral hydraulic hoses.

DIN standards: Set of German standards that cover various aspects of hydraulic hoses.



Safety Design Considerations:

Hydraulic systems operate at high pressures, which can be dangerous if not constructed and maintained appropriately. Here are some safety considerations for hydraulic hoses:

Pressure Ratings: Ensure that the hydraulic hose's pressure rating exceeds the maximum operating pressure of the hydraulic system to prevent failures and bursts.

Correct Hose Assembly: Use the right type and size of hose suitable for the specific application and system requirements.

Regular Inspections: Regularly inspect hydraulic hoses for signs of wear, damage, or leaks. Replace any damaged hoses immediately.

Proper Routing and Clamping: Rout the hoses away from potential sources of abrasion, heat, or pinch points. Use appropriate clamps to secure hoses and prevent movement.

Avoid Mixing Hose Types: Avoid mixing different types of hoses within the same hydraulic system, as they may have different pressure ratings and characteristics.

Maintenance and Training: Conduct regular maintenance and provide proper training to operators and maintenance personnel to handle hydraulic systems safely.



SICHERHEIT ZUERST!

2.3 HYDRAULIC VALVE

A hydraulic valve is a crucial component of a hydraulic system that controls the flow, pressure, and direction of hydraulic fluid within the system. It acts as a switch to start, stop, or regulate the flow of fluid, enabling the smooth operation and precise control of various hydraulic machinery and equipment. The purpose, types of valves, requirements, structure design, and safety issues are explained here.

Function of Hydraulic Valve:

The primary function of a hydraulic valve is to control the flow and pressure of hydraulic fluid within a hydraulic system. The fluid is then directed to the required hydraulic components (such as cylinders or motors) to carry out the desired tasks by opening, closing, or partially obstructing the flow pathways. By controlling the fluid's flow and pressure, hydraulic valves facilitate precise and efficient operation of machinery, allowing operators to control the speed, direction, and force of hydraulic actuators.



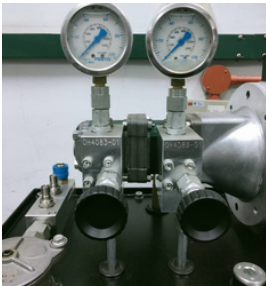
Types of Hydraulic Valve

Types of Hydraulic Valves:

There are several kinds of hydraulic valves, and each one performs a different purpose inside a hydraulic system. Some examples are:

1. Directional Control Valves:

These valves control the direction of fluid flow and determine which actuator (e.g., cylinder or motor) is activated or deactivated.

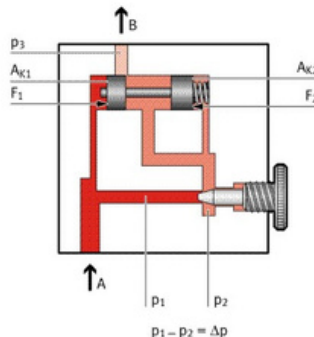
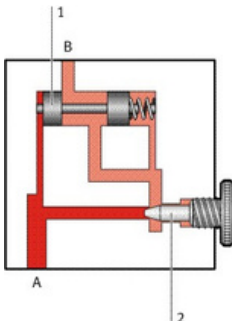


2. Pressure Control Valves:

These valves regulate the pressure of the hydraulic fluid, ensuring it stays within safe operating limits.

3. Flow Control Valves:

Flow control valves manage the speed of hydraulic actuators by adjusting the flow rate of the fluid.



STANDARDS FOR HYDRAULIC VALVES:

Hydraulic valves are designed and manufactured according to various international standards to ensure safety, performance, and interoperability. Some commonly used standards include those established by ISO (International Organization for Standardization) and the American National Standards Institute (ANSI).

The International Organization for Standardization (ISO)

Hydraulic ISO, in the context of the International Organization for Standardization (ISO), refers to the set of standards developed and published by the ISO related to hydraulic systems. ISO is an international standard-setting body that creates and promotes standards to ensure consistency, safety, and efficiency across various industries and technologies. The hydraulic ISO standards cover a wide range of topics, including hydraulic fluid power systems, components, and test methods.

ISO standards help ensure that these hydraulic systems are designed, manufactured, and tested to meet specific criteria, promoting compatibility and interoperability between different components and systems. The symbols defined in this standard make it easier for engineers, technicians, and manufacturers to understand and communicate complex hydraulic circuit diagrams.

Whether designing a new hydraulic system, troubleshooting an existing one, or assembling components, adherence to this standard ensures clarity and consistency in the representation of the system's components and their interconnections. This, in turn, helps to improve safety, efficiency, and communication within the industry.





The American National Standards Institute (ANSI)

The American National Standards Institute (ANSI) is a private, non-profit organization that oversees the development and implementation of voluntary consensus standards for various industries and technologies within the United States. ANSI serves as the coordinator and facilitator of the U.S. voluntary standardization system, ensuring that standards are developed through a fair, transparent, and consensus-based process.

Regarding hydraulics, ANSI plays a role in developing and adopting standards related to hydraulic systems, components, and practices. These standards help to establish uniformity, safety, and quality within the hydraulic industry. A variety of subjects are covered including design, performance, testing, and maintenance of hydraulic systems.

The ANSI hydraulic standards are typically developed by committees of experts, including representatives from industry, academia, government agencies, and other stakeholders. These committees work collaboratively to create documents that reflect the best practices and the latest advancements in hydraulic technology.

Hydraulic ANSI standards may include specifications for hydraulic components, such as pumps, valves, cylinders, and hoses, as well as guidelines for system design, installation, and maintenance. These standards are intended to be voluntary in nature, meaning they are not mandatory by law. However, many industries and organizations voluntarily adopt ANSI standards because they provide a common language and a framework for ensuring safety, reliability, and compatibility across different hydraulic systems.

Structure Design of Hydraulic Valves:

Hydraulic valves are designed differently based on their type and application. However, most hydraulic valves consist of the following components:

Valve Body:

The main body of the valve that houses the internal components and provides the necessary passages for fluid flow.

Actuator:

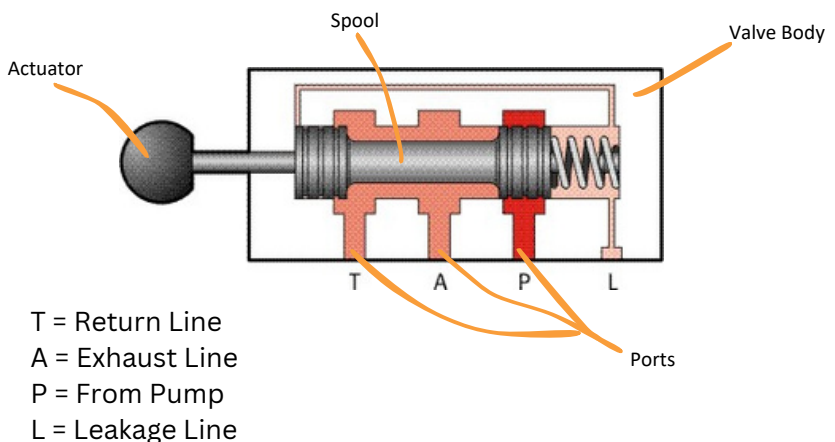
The mechanism responsible for opening and closing the valve which usually controlled by an electrical, mechanical, or hydraulic signal.

Spool or Poppet:

The internal element that regulates the flow by blocking or allowing the passage of fluid.

Ports:

Openings in the valve body where hydraulic fluid enters and exits the valve.



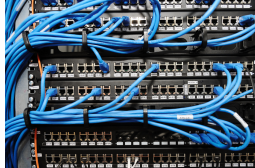
Safety Design Considerations:

The design of hydraulic valves considers safety as the primary objective because it is important in hydraulic systems. Here are some safety considerations:



Pressure Ratings:

Ensure that the valve's pressure rating matches or exceeds the maximum operating pressure of the hydraulic system.



Redundancy:

Critical hydraulic systems may incorporate redundant valves or safety circuits to ensure continued operation in case of valve failure.



Proper Maintenance:

Regularly inspect and maintain hydraulic valves to prevent malfunctions and potential safety hazards.



Load-Holding Valves:

Use load-holding valves in applications where the load must be held in position even if hydraulic pressure is lost.



Safety Standards:

Follow relevant safety standards and guidelines for hydraulic system design, including those related to fluid compatibility, materials, and construction.



Safety Relief Valves:

Install safety relief valves in high-pressure systems to prevent damage due to overpressure situations.

2.3 ACTUATOR



A hydraulic actuator is a mechanical device that converts hydraulic energy into mechanical motion. It is a type of actuator that uses a fluid (usually oil) to transmit and amplify force which enabling it to generate significant amounts of power and motion. Hydraulic actuators are commonly used in various industrial, automotive, aerospace, and construction applications where precise control of large forces or movements is required.

Types of Hydraulic Actuators:

Different types of hydraulic actuators are commonly found onboard ships;

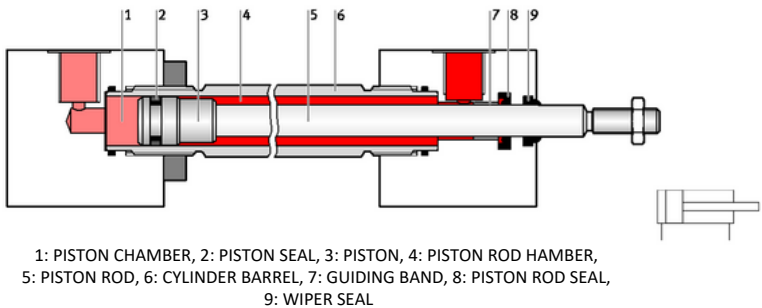
- Hydraulic Cylinders
- Hydraulic Motors
- Diaphragm Actuators



Hydraulic Cylinders

A hydraulic cylinder—also referred to as a hydraulic ram—is a type of mechanical actuator that transforms the pressure of hydraulic fluid into linear mechanical force and motion. It is made up of a cylindrical barrel, a piston or plunger that moves inside the barrel, and hydraulic fluid that fills the gap between the piston and the barrel. When hydraulic pressure is applied to one side of the piston, it generates a force that pushes or pulls on the piston, resulting in linear motion.

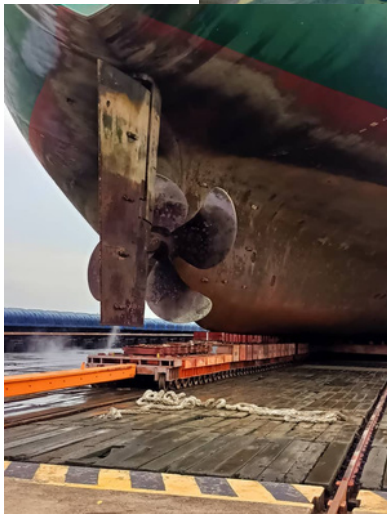
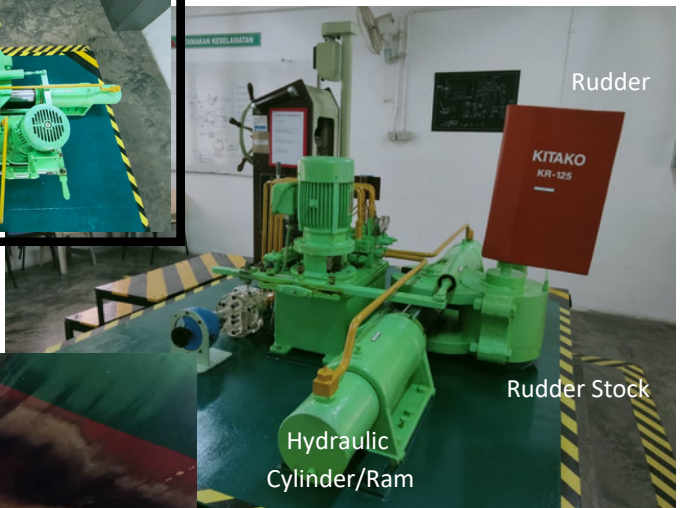
Here's a breakdown of the components and how a hydraulic cylinder works:



Double Acting Hydraulic Cylinder

Example: Steering Gear Actuator

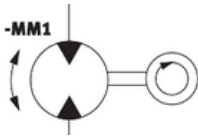
Application: Hydraulic cylinders are used in the ship's steering gear system to control the movement of the rudder. The cylinder is connected to the rudder stock, and hydraulic pressure is applied to one side of the piston to turn the rudder.



Single Ram Steering Gear

Hydraulic Motor

Hydraulic motors are designed to convert hydraulic pressure into rotational motion. It consists of a hydraulic inlet and outlet, a housing with internal components (such as gears, pistons, or vanes), and an output shaft.



Hydraulic Motor

Example: Winch Hydraulic Motor

Application: Hydraulic motors are used in shipboard winches to drive the winch drum. The motor is connected to the drum's shaft and converts hydraulic power into the rotational motion needed for winding and unwinding cables.



Hydraulic Gear Pump



Hydraulic Control Valve



Onboard Ship Winch

Hydraulic Winch

Example: Ship Crane Rotary Actuator

Application: Hydraulic rotary actuators are used in ship cranes to provide controlled rotation of the crane's boom. The actuator is connected to the base of the crane and provides the necessary torque for boom rotation.



Deck Crane

Hydraulic Valve actuators

Diaphragm actuators use a flexible diaphragm to transmit hydraulic pressure and create linear motion or force. The diaphragm separates the hydraulic fluid from the working environment.



Butterfly Valve

Example: Ballast Valve Actuator

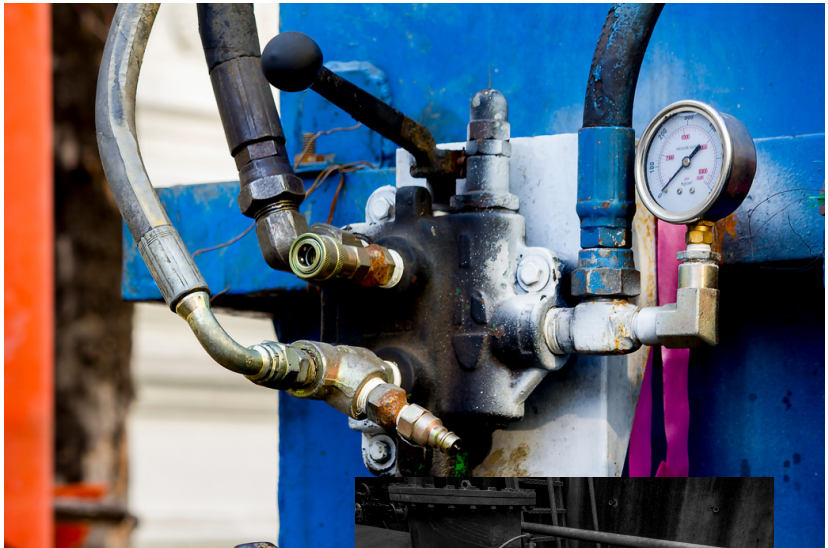
Application: A ballast valve actuator onboard a ship is a mechanical or electronic device used to control the opening and closing of ballast valves. Ballast valves are an integral part of a ship's ballast system, which is used to adjust the vessel's stability, draft, and trim by controlling the amount of water or other fluids loaded into specific compartments within the ship's hull. This improves the ship's performance, particularly when the cargo load or sea conditions change.



Discharge of ballast water

Example: Cargo Valve Actuator

Application: Diaphragm actuators are used in shipboard valves to control fluid flow. The diaphragm responds to changes in hydraulic pressure, which in turn controls the position of the valve.



Deck Crane



QUIZ 3

Q. C2 : Tray answer all the question.

1

What are hydraulic components, and what are their role in hydraulic systems?

2

Name some common hydraulic components and briefly explain their functions.

3

How does a hydraulic power pack function, and where is it commonly used?

4

Explain the role of hydraulic pumps in hydraulic systems and list some common types of hydraulic pumps.

5

Describe the function of a hydraulic hose within a hydraulic system and explain its structure design

6

What are hydraulic ISO standards and ANSI standards, and how do they contribute to the hydraulic industry?



ANSWER

Quiz 1. (PAGE 12)

Question 1. What are the key roles of hydraulic systems in merchant ships?

Answer: Hydraulic systems in merchant ships play crucial roles in cargo handling, ship steering, braking, stabilization, anchor handling, emergency systems, automation of tasks, and power generation during emergencies.

Question 2. How do hydraulic systems enhance cargo handling in merchant ships?

Answer: Hydraulic systems power cranes, winches, and other equipment used for loading and unloading cargo, making the process faster and more efficient.

Question 3. What is the significance of hydraulic systems in anchor handling?

Answer: Hydraulic systems control the anchor and anchor winches, facilitating the process of dropping and raising the anchor, which helps the ship secure itself in harbors or during emergencies.

Question 4. How do hydraulic systems contribute to safety in merchant ships?

Answer: Hydraulic systems are integrated into emergency systems like watertight doors and fire-fighting equipment, ensuring the ship's integrity and safety during critical situations.

Question 5. What potential trends are emerging in the application of hydraulic power in ships?

Answer: Some potential trends include electrification and hybrid power systems, energy recovery systems, advancements in automation and control technologies, and the use of more environmentally friendly hydraulic fluids.

Question 6. Why are hydraulic power systems likely to remain vital in merchant ships, despite advancements in other power technologies?

Answer: Hydraulic power systems offer robustness and reliability, making them well-suited for critical ship systems like emergency steering, anchor handling, and stabilizers, which are essential for the safe operation of merchant ships.

ANSWER

Quiz 2. (PAGE 16)

Question 1 : Correct answer: 1200 kPa

Question 2 : Force = Pressure \times Area = 8 MPa \times 20 cm² = 160 kN

Question 3 : Force in Cylinder 1 (F1): F1 = Pressure \times Area1 = 50 bar \times 12 cm² = 600 N

Force in Cylinder 2 (F2): F2 = Pressure \times Area2 = 50 bar \times 30 cm² = 1500 N

Question 4 : P2 = P1 = 2.5 MPa

Question 5 : (P1 = P2): No

ANSWER

Quiz 3. (PAGE 45)

Question 1: What are hydraulic components, and what is their role in hydraulic systems?

Answer: Hydraulic components are mechanical elements or devices that play a vital role in hydraulic systems. They are designed to control, generate, and transmit power using pressurized fluid, typically hydraulic oil. These components convert mechanical energy into hydraulic energy and vice versa, enabling precise control and efficient operation in various applications.

Question 2: Name some common hydraulic components and briefly explain their functions.

Answer: Some common hydraulic components include hydraulic pumps, hydraulic cylinders, hydraulic motors, hydraulic valves, hydraulic accumulators, hydraulic filters, hydraulic reservoirs, and hydraulic hoses and fittings. Each of these components serves a specific function within the hydraulic system, contributing to the successful functioning of the overall hydraulic setup.

Question 3: How does a hydraulic power pack function, and where is it commonly used?

Answer: A hydraulic power pack, or hydraulic power unit (HPU), is a self-contained system that generates and controls hydraulic power. It consists of a motor, hydraulic pump, reservoir, valves, and accessories. Its main function is to provide high-pressure hydraulic fluid for various hydraulic machinery and systems. It finds applications in industries like construction, manufacturing, and automation, powering equipment like cranes, excavators, and assembly lines.

Question 4: Explain the role of hydraulic pumps in hydraulic systems and list some common types of hydraulic pumps.

Answer: Hydraulic pumps convert mechanical power into hydraulic energy, enabling fluid transfer under pressure to perform tasks in hydraulic systems. Common types include gear pumps, vane pumps, and piston pumps. Gear pumps use meshing gears, vane pumps employ rotating vanes, and piston pumps use pistons to pressurize hydraulic fluid.

ANSWER

Question 5: Describe the function of a hydraulic hose within a hydraulic system and explain its structure design.

Answer: Hydraulic hoses transmit pressurized hydraulic fluid between components like pumps, valves, and cylinders. They consist of an inner tube for fluid compatibility, a reinforcement layer for strength, and an outer cover for protection. Standards like SAE J517 and ISO 18752 ensure safety and consistency in hydraulic hose design.

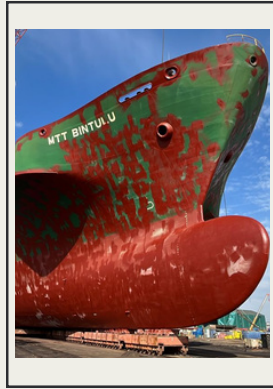
Question 6: What are hydraulic ISO standards and ANSI standards, and how do they contribute to the hydraulic industry?

Answer: Hydraulic ISO standards are developed by the International Organization for Standardization (ISO) to ensure consistency, safety, and interoperability in hydraulic systems. ANSI (American National Standards Institute) standards serve a similar purpose within the United States. These standards establish guidelines for components, system design, testing, and maintenance, improving safety, efficiency, and communication within the hydraulic industry.

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