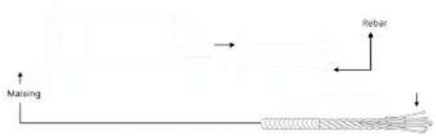
Study of Hydraulic Systems in Light and Medium Merchant Mill (LMMM)

An Industrial Training Report at RASHTRIYA ISPAT NIGAM LIMITED, VISAKHAPATNAM STEEL PLANT

Submitted by: BANDARU RISHIKESH VENKAT, DOPPALAPUDI RATHAN SASTRY, EMANI SUSHANTH MOHAN, SHAIKH AMAAN ALI, PAPPU CHARAN SAI

Under the guidance of Dr. D Murali Mohan, Asst. General Manager LMMM (Mechanical)

Abstract



This report details the study of hydraulic systems within the Light and Medium Merchant Mill (LMMM) at Visakhapatnam Steel Plant (VSP). LMMM is a rolling mill that processes blooms into billets and finished bar products.

The report covers the basic principles and working of hydraulic systems, including their core components like pumps, valves, and actuators. It also discusses the merits and demerits of these systems as applied in the mill.

Presentation Outline

- Introduction to Visakhapatnam Steel Plant (VSP)
- Major Production Departments of VSP
- Introduction to the Light and Medium Merchant Mill (LMMM)
- Detailed Study of Hydraulic Systems in LMMM
- Core Components: Pumps, Valves, Actuators
- Conclusion

Introduction to Visakhapatnam Steel Plant (VSP)

Visakhapatnam Steel Plant (VSP) is a 6.3 million-ton capacity integrated steel plant located in Visakhapatnam, Andhra Pradesh. Strategically situated on the East Coast near a deep natural harbour, it has excellent transportation and communication facilities.

- Founded in 1971.
- Conferred 'Navratna' status in November 2010.
- Focuses on producing value-added steel.
- The only integrated steel plant in the country to be certified for ISO 9001:2000, ISO 14001:2004, and OSHAS 18001:1999.

Major Products of VSP

VSP manufactures a diverse range of steel products that serve various industries.

Primary Products

- Pig Iron
- Blooms
- Billets

Finished Products

- Wire Rods
- Reinforcement Bars
- Rounds
- Equal Angles & Channels

Major Production Units of VSP

Coke Ovens

5 batteries of 67 ovens each, producing metallurgical coke.

Sinter Plant

3 Sinter machines that agglomerate iron ore fines into a suitable feed for the Blast Furnace.

Blast Furnaces

3 large Blast Furnaces for producing hot metal (liquid iron).

Steel Melt Shop (SMS)

3 LD converters for refining hot metal into liquid steel, and 6 continuous bloom casters.

Rolling Mills

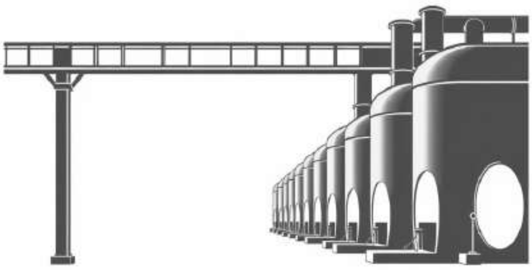
Includes Wire Rod Mill, Medium Merchant & Structural Mill, and the Light & Medium Merchant Mill (LMMM).

Raw Material Handling Plant (RMHP)

This vital department handles the massive volume of incoming raw materials required for steel production. It manages the unloading, blending, stacking, and reclaiming of materials like Iron Ore, fluxes, and coal.

- Handles 12-13 Million tonnes annually for 3 Million Tonnes of Liquid Steel.
- Ensures a consistent quality of feed materials for consumer departments.
- Equipped with Wagon Tipplers, Stock Yards, Crushing Plants, and Blender Reclaimers.

Coke Ovens & Coal Chemical Plant (CO&CCP)



This plant produces metallurgical coke, a crucial solid fuel for the Blast Furnaces. Coke provides the heat for reduction reactions and also acts as a reducing agent.

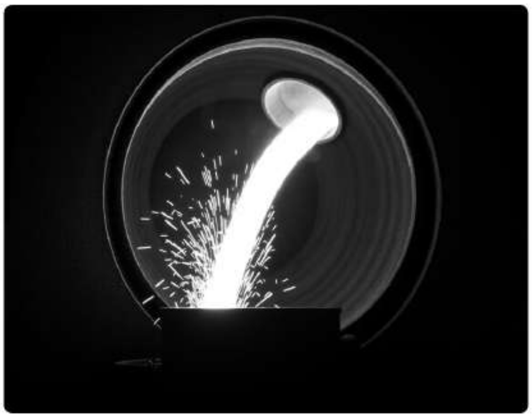
- Process: Coking coal is heated in the absence of air at over 1000°C for 16-18 hours.
- A Coke Oven consists of a coal chamber and an adjacent heating chamber.
- The process also yields valuable by-products in the Coal Chemical Plant.

Sinter Plant (SP)

The Sinter Plant agglomerates fine raw materials into a hard, porous material called 'Sinter'. Using sinter as feed in Blast Furnaces improves productivity and efficiency.

- Materials Used: Iron Ore fines, Coke breeze, Lime Stone fines, and metallurgical wastes.
- Process: The feed mix is heated on a continuous belt at 1200-1300°C.
- Benefit: Sinter is a better feed material than raw iron ore lumps, increasing BF productivity and decreasing coke consumption.

Blast Furnace (BF)

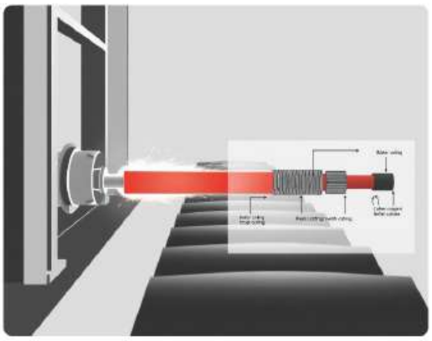


Blast Furnaces are tall, vertical furnaces where Hot Metal (liquid iron) is produced. Raw materials are charged from the top, and a hot blast of air is blown from the bottom.

- VSP has two 3200 cu. metre Blast Furnaces, named 'Godavari' & 'Krishna'.
- Capable of producing 9720 tonnes of Hot Metal daily.
- Hot blast is blown at 1100°C - 1300°C.
- Produces low-sulphur Hot Metal.

Steel Melting Shop (SMS) & Continuous Casting

In the SMS, impurities are removed from the Hot Metal to produce liquid steel. The liquid steel is then solidified into semi-finished shapes called 'blooms' in the Continuous Casting Department (CCD).



Steel Making

Impurities like Carbon, Silicon, and Sulphur are removed by oxidation in large LD Converters.

Continuous Casting

Liquid steel is poured into a water-cooled mould to create continuous strands of solid steel, which are then cut into blooms (e.g., 250x320 mm).

Introduction to LMMM

Light and Medium Merchant Mill

The LMMM is a versatile rolling mill designed to produce a wide range of products. It consists of two main units: a billet mill and a bar mill.

- Billet Mill: Rolls 250x320mm blooms into 125x125mm billets.
- Bar Mill: Rolls heated billets into finished products.
- Annual Production Capacity: 710,000 tons of finished products like rounds, re-bars, squares, flats, and angles.

LMMM: Charging and Furnace Area

The process begins with cold blooms (250x320mm, 6.3m long) being loaded onto charging grids. These blooms are then sequentially fed into one of two Walking Beam Furnaces to be heated for rolling.

- Blooms are placed on grids by magnet cranes.
- An elevator lifts the blooms to the elevated mill floor.
- Furnace 1 typically feeds the billet mill, while Furnace 2 feeds the bar mill.

The Walking Beam Furnace

The walking beam furnace heats the blooms to the required rolling temperature. It uses a mix of Coke Oven, Blast Furnace, and LD converter gas as fuel.

1. **Capacity & Temperature**

   Capacity of 200 tons/hr. Heats blooms to 1150°C - 1200°C.

2. **Heating Zones**

   Divided into Pre-heating, Heating, and Soaking zones for precise temperature control.

3. **Walking Mechanism**

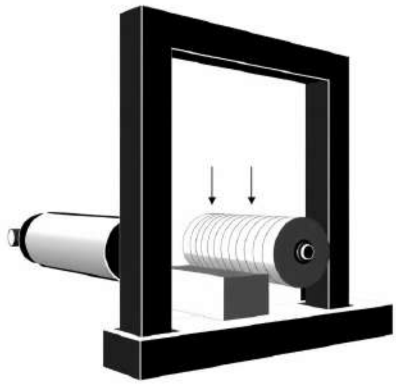
   Blooms are 'walked' through the furnace on a system of fixed and moving water-cooled skids.

LMMM: Breakdown Mill Area

After exiting the furnace, the hot bloom passes through a descaler to remove scale and is then fed into the breakdown mill. This mill reduces the bloom's cross-section.

- Consists of seven rolling stands (four horizontal, three vertical).
- Reduces the 320mm x 250mm bloom to a 125mm square billet.
- The process takes place in five 'box passes'.
- Finishing temperature is around 1100°C - 1200°C.

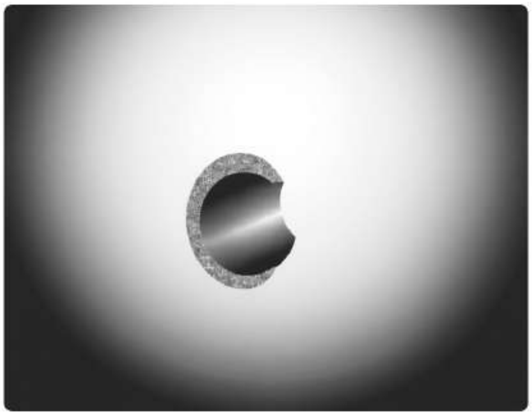
Breakdown Mill Stand Arrangement



The alternating horizontal and vertical stands ensure uniform reduction of the bloom on all four sides.

Stan d 1	Stan d 2	Stan d 3	Stan d 4	Stan d 5	Stan d 6	Stan d 7
Horiz ontal	Horiz ontal	Vertic al	Horiz ontal	Vertic al	Horiz ontal	Vertic al

LMMM: Bar Mill & Tempcore Process



Billets intended for the Bar Mill are reheated in a two-strand Roller Hearth Furnace to equalize their temperature. They then pass through roughing, intermediate, and finishing mill stands to be shaped into the final product.

Tempcore Process

After the final rolling stand, rebars enter 'Tempcore boxes'. This is a controlled water cooling process that quenches the surface of the bar, creating a hardened outer layer (martensite) and a ductile core (ferrite-pearlite). This heat treatment imparts high strength and good weldability to the rebars.

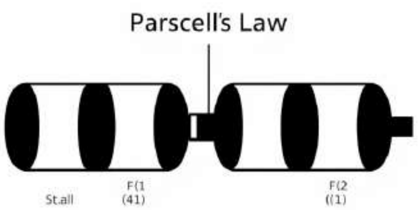
Study of Hydraulic Systems: Introduction

Hydraulics is the technology of transmitting and controlling force and movement using pressurized fluids. It is a cornerstone of modern industrial machinery.

Key Features of Hydraulics

- High force and torque generation in a small space.
- Ability to start movement under full load.
- Simple and effective overload protection.
- Suitable for rapid, controllable movements.
- Allows for energy storage using accumulators.

The Fundamental Principle: Pascal's Law

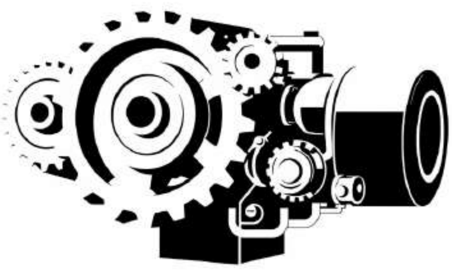


Hydraulic systems operate on Pascal's Law, which states:

"Pressure applied to a confined, incompressible fluid is transmitted equally in all directions throughout the fluid."

This principle allows for force multiplication, where a small force applied to a small area can generate a much larger force on a larger area. This is the key to the power of hydraulic systems.

Applications of Hydraulics in LMMM



Hydraulic systems are critical for numerous applications throughout the rolling process in the Light and Medium Merchant Mill.

- Pushing blooms from the charging grid to the rollers.
- Lifting blooms onto the elevated roller table.
- Charging and discharging blooms in the furnace.
- Roll balancing and clamping in horizontal and vertical stands.
- Shifting stands for different product sizes.
- Operating shears for cutting.
- Bar counting and stacking in the finishing area.

Basic Components of a Hydraulic System

Reservoir (Tank)

Holds the hydraulic fluid (oil), allowing it to cool and settle.

Pump

Converts mechanical energy into hydraulic energy by forcing fluid into the system.

Valves

Control the fluid's direction, pressure, and flow rate.

Actuator

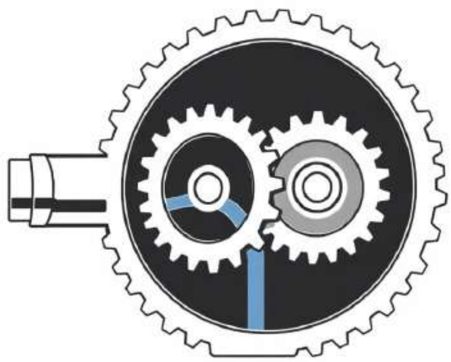
Converts hydraulic energy back into mechanical energy (motion or force), e.g., a cylinder or motor.

Hydraulic Pumps: The Heart of the System

A pump draws fluid from the reservoir and forces it through the circuit, creating flow and pressure. The choice of pump depends on the system's requirements for pressure, flow, and efficiency.

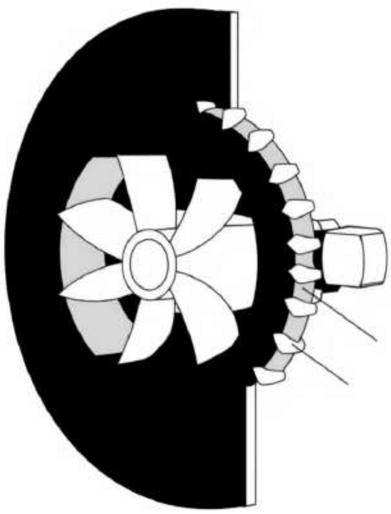
Gear Pumps

Simple and reliable, using meshing gears to move fluid. They are common and affordable but less efficient than other types.



Vane Pumps

Use a rotor with sliding vanes to create pressure. They offer a good balance of cost, efficiency, and pressure capability.

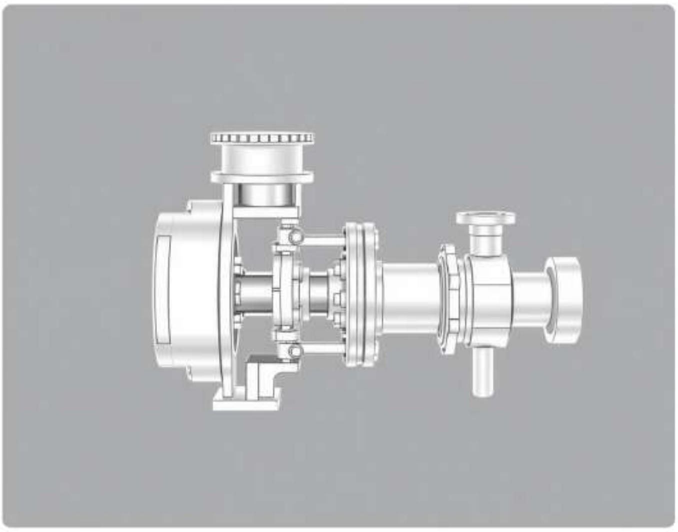


Advanced Pumps: Piston Pumps

For high-pressure and high-efficiency applications, piston pumps are used. They operate by reciprocating pistons within a cylinder block.

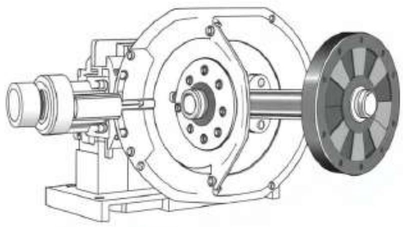
Bent Axis Pump

The cylinder block is arranged at an angle to the drive shaft. As the shaft rotates, the angle causes the pistons to reciprocate.



Swash Plate Pump

The pistons are pushed against an angled plate (swashplate). As the cylinder block rotates, the angle of the plate forces the pistons to move in and out.



Control Devices: Hydraulic Valves

Valves are the 'brain' of the hydraulic system, directing the fluid to perform work. They control the start, stop, direction, pressure, and flow rate of the hydraulic fluid.

Main Types of Valves

- Directional Control Valves: Determine the path of fluid flow.
- Pressure Control Valves: Regulate the pressure in the system or parts of it.
- Flow Control Valves: Control the speed of actuators by managing the flow rate.

Types of Directional Control Valves

Check Valve

The simplest type. It allows free flow in one direction and blocks flow in the opposite direction.

3-Way & 4-Way Valves

Use a sliding spool to direct pump flow to different ports, allowing for the control and reversal of actuators like hydraulic cylinders.

Pilot-Operated Check Valve

A check valve that can be opened by a separate pilot pressure signal, allowing reverse flow when needed. Often used to lock cylinders in place.

Solenoid-Actuated Valve

Uses an electrical solenoid to shift the valve's spool, enabling remote, automated control of the hydraulic circuit.

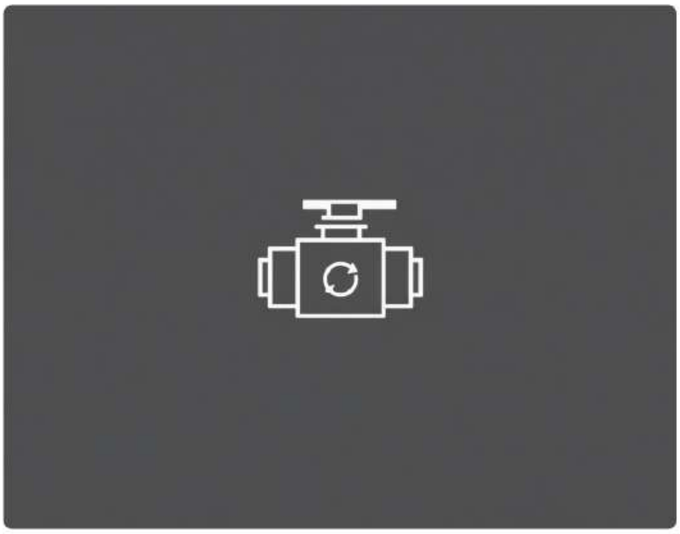
Pressure and Flow Control Valves

Pressure Relief Valve

A safety device that limits the maximum pressure in a system. It's a normally closed valve that opens to divert excess flow back to the tank when pressure exceeds a set limit.

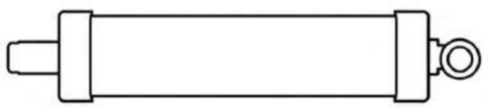
Flow Control Valve

Used to regulate the speed of an actuator by adjusting the volume of fluid that flows to it per unit of time. It is essentially an adjustable restriction in the hydraulic line.



Hydraulic Actuators: Doing the Work

Actuators convert the pressure and flow of the hydraulic fluid back into useful mechanical work. They are the 'muscles' of the system.



Linear Actuator (Cylinder)

Provides force and motion in a straight line. Consists of a piston moving within a cylinder barrel. The most common type of actuator.

Rotary Actuator (Motor)

Provides torque and continuous rotational motion. Essentially a hydraulic pump operating in reverse.

Auxiliary Devices: Accumulators

A hydraulic accumulator is a pressure storage reservoir. It holds hydraulic fluid under pressure from an external source, typically compressed nitrogen gas.

Key Applications

- Energy Storage: Stores energy when the system is idle and releases it during peak demand, allowing for smaller pumps.
- Leakage Compensation: Makes up for small leaks in a pressurized system over time.
- Emergency Power Source: Provides a limited supply of power in case of pump failure.
- Shock Absorption: Dampens pressure spikes and pulsations (hydraulic shock or 'water hammer') in the system.

Auxiliary Devices: Filters & Coolers

Maintaining the quality and temperature of the hydraulic fluid is essential for system longevity and reliability.

Filters

Filters remove contaminants like dirt and metal particles from the fluid. Clean fluid is critical to prevent damage to precision components like pumps and valves. Common types include suction, pressure line, and return line filters.

Heat Exchangers (Coolers)

Hydraulic systems generate heat. Coolers are used to maintain the fluid's temperature within an optimal range. Overheating can degrade the oil and damage seals, while fluid that is too cold can be sluggish and cause cavitation.

Conclusion

Hydraulic systems are a critical technology in the LMMM, enabling powerful and precise control over heavy machinery. The health and efficiency of these systems are paramount for uninterrupted production.

Key Takeaways

- A systematic approach is required to diagnose and troubleshoot problems.
- The cleanliness of the hydraulic oil (monitored by NAS number) is the single most important factor for system health.
- Regular maintenance and a thorough understanding of the system's schematics are essential for all personnel.
- Monitoring parameters like pressure and temperature provides early warnings of potential issues.