

# Rotodynamic Pumps for steel plants

In a developing country, the steel industry symbolises self-reliance. The steel industry is of strategic significance and key indicator of the economy. Iron and steel contribute more than 10% of GNP in our country.

Demand for steel is expected to grow steadily as per capita consumption is only 17 kg in India, compared to 500-600 kg in industrialised countries.

Steel is a rugged and tough material and one used in sizeable quantities. The equipment that is used to produce it must also be rugged, tough and large.

Pump plays an indispensable role in moving liquid fuel around a mill. Pumps are equally important on providing water at required locations to absorb waste energy, produced by normal inefficiencies in rotation. High pressure water is also required for blasting scale-off finished material before hot working. Pumps are also used as energy convertors. In the

hydraulic system of a mill. Valves, cylinders and sensors may be operated by high pressure oil. Pumps, either steam-turbine or motor-driven, convert the thermodynamic or electrical energy in the fluid pumped. Another important role for pumps is in the area of pollution abatement and treatment. In treating contaminated water the water must be moved through various pieces of equipment, such as filters and cooling towers, and then recycled to service, if possible. Pumps are also of vital importance in air pollution control when cooling of fan bearings, gas cooling and washing of dust-laden gases are considered. Following are raw materials and finished products during various operations in a steel plant.:

Raw material	Finished product, Metallurgical coke
Coal coking	Nut coke
Coal non-coking	Coke breeze
Iron ore	Coal tar
Limestone	Road tar and processed tar
Dolomite	Crude pressed naphthalene

Quartzite	Combustible mixture
Manganese ore	Sulphuric acid (Non-hydrato)
Fire-clay	Benzol
Bauxite	Sinter
Fluorspar	Cold pig iron
Runner stand	Hotter pig Iron
Water	Slag
Air	Slag aggregates granulated slag ingot, bloom, billets of different sizes Rails and structurals, squares and slabs, merchant products, wire rods, coke oven gas and other by - products.

The following section explores the use of pumps in modern integrated (raw material to finished product) mills.

## Pumps for Material Handling and coke over section

The Positive displacement pumps is used in car dumper hydraulic system

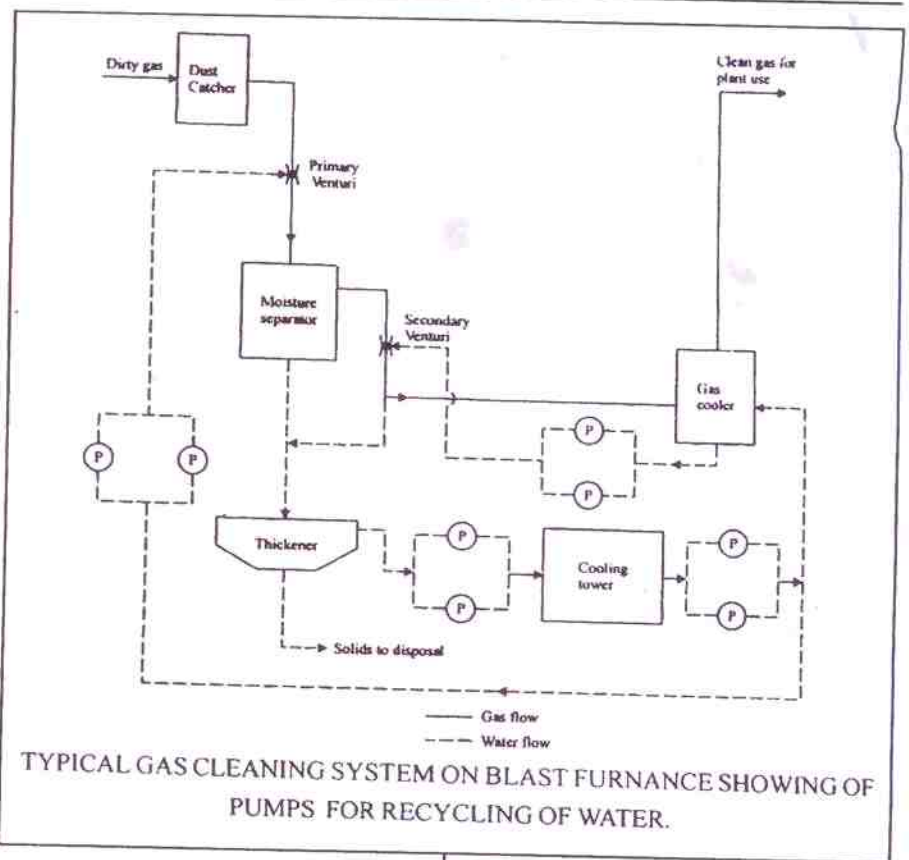
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## SPECIAL FEATURE

which we are not discussing here. Coke, after it is pushed from an oven into a car, is quenched with water from overhead storage tanks. Some of this water is vaporized and passes off into the atmosphere as steam. The balance of the water at 150 to 175 degree F is collected in a pit under the quenches and pumped back up to the storage tank. These pumps can be either horizontal or vertical depending on system layout. A typical pump would be a heavy duty. Horizontal, single stage, end suction centrifugal type. To provide abrasion resistance, the wearing parts should be fabricated of an alloy, such as 28% Cr material with a hardness of 550 to 650 BHN. To prevent abrasive material from wearing the shaft and sleeve, a lantern and liquid seal connection should be provided at the stuffing box. Either a lean source of water of filtered process water can be used as a seal water supply, possibly in conjunction with a booster pumps.

### Pumps for Blast furnace division

Gas cleaning is accomplished by means of a mechanical dust catcher and wet scrubber with recycling of water being main features of the system (Figure 1). The gas is first washed with water in venturi scrubbers and then cooled before sending it to the plant for use. Dirty Water from the venturi scrubbers is sent to a thickener, where solids are allowed to settle. The reasonably clear water effluent (normally to 50 ppm suspended solids, 100 ppm peak) from the thickener is pumped through a cooling tower to allow reuse. The



TYPICAL GAS CLEANING SYSTEM ON BLAST FURNACE SHOWING OF PUMPS FOR RECYCLING OF WATER.

tower hot well pumps are heavy industrial abrasive handling vertical turbine type. Direct motor driven with cast steel impellers and stainless steel AISI 410 (C6NM) bowl and impeller wear rings are recommended material. They are selected to provide greater abrasion resistance and thereby give longer pump life.

After passing through the cooling tower and being chemically treated, the water is combined with required make-up and pumped back to the gas cleaning system. Pumping is again accomplished by a set of vertical pumps (with installed spare) in the cold well of the tower. These pumps are identical in capacity and can be of the same type as those in the hot well except for the possible addition of a second stage which may be required because of an increased head. Vertical

pumps are recommended for both hot and cold well application because of their adaptability to a system design and layout featuring minimum space and high lift requirements.

Most of the cooled water goes to the gas cooler, with flow being controlled by exit gas temperature. The balance of the water is boosted in head and sent to the primary venturi scrubber. Booster pumps recommended are horizontal split case double suction centrifugal pumps. An 11-13% chrome steel can be used for the casing and impeller wearing rings while a hardened similar material can be used for the shaft sleeve. These special features are added to all iron pumps to provide longer life for the wearing parts.

More than half the water, that is

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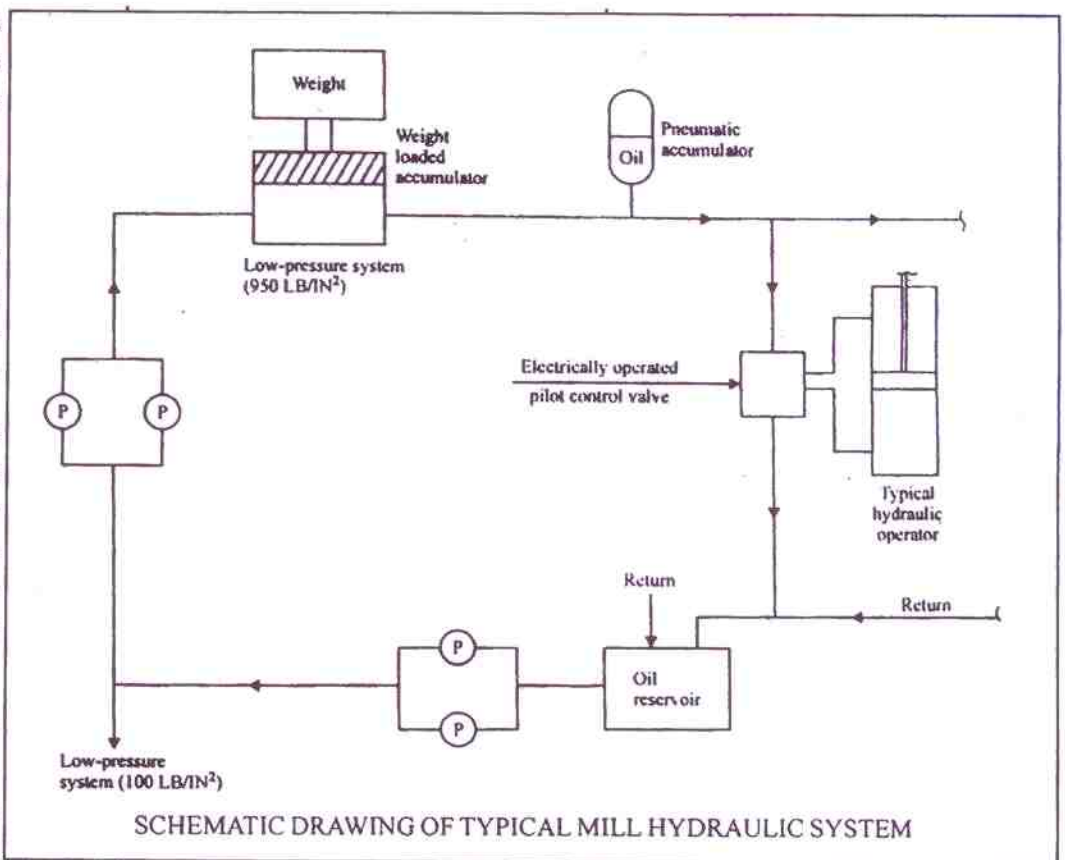
actually utilized in the gas cooler, is boosted in pressure and used as supply to the secondary venturi scrubber. These secondary pumps can be the same as the primary venturi boosters except for a material change. Which calls for use of a 2% nickel-cast iron casing and impeller.

Solids that settle out in the thickener are raked to a centre cone and under flow to slurry pumps. These pumps move the heavy slurry to vacuum filters for dewatering slurry pumps.

The slurry pumps can be heavy duty centrifugal type, provided with neoprene lining, to reduce the abrasive wear, caused by water that contains approximately 50% solids by weight. An auxiliary pumping system can be used for seal water in which a turbine type pump provides clean water at the required head for the seals. This type of slurry pump can also be used in transferring slurries in mixing operations.

### Pump for steel making (Open hearth furnace, Electric furnace of BOF)

One of the primary requirements for pumps is meeting cooling water needs for the oxygen lance. This lance, which is approximately 250 mm in diameter and perhaps 20 mm long, carries oxygen in a pipe in the lance centre. The oxygen pipe is surrounded by cooling water, approximately 3400 lpm being required



per lance at a system pressure of 12.5 kg/cm<sup>2</sup>. A pumping system would consist of several pumps connected in parallel (with an installed spare) each of which is directly driven by an electric motor. Double suction centrifugal pumps with cast iron casing and bronze impellers, equipped with standard grease lubricated line and thrust ball bearings, can be used for this service. The required pump pressure is the sum of water elevation differences, friction losses, etc., plus an allowance to maintain a lance, full of water under all conditions.

Another pump requirement in the BOF consists of water cooling gases generated during the oxygen blow. Water is sprayed into gas stream

(300F) and a portion is evaporated until the gas temperature is adiabatically cooled to 170F and the gas is ready for cleaning.

Gas cleaning can be accomplished by several means, the most frequently used being electrostatic precipitators and wet scrubbers. A system, using a wet scrubber, a thickener, a cooling tower and recirculating water for reuse, would be similar to that discussed in the blast furnace section.

Pumps for heavy slurry are generally volute type centrifugals, rated 180 lpm and total head of 25.0 m pumps would be motor driven by a sheave and belt arrangement (to allow future capacity changes and also for lower speed operation to cut down abrasion.).

### Pumps for slabbing Mills

As an ingot approaches the mill and is rolled, the scale that was formed during cooling and reheating, falls through the rolls of the mill approach and delivery tables into a flume. This flume is continuously flushed with water to move the scale to the mill scale pit. There the scale settles to the bottom, where it is cleaned out with a clam bucket on an overhead crane. The water in the pit overflows a weir into a clear well and is pumped directly back to the flume as the flushing water supply. Pumping from the clear well minimises the loadings, but specially hardened materials (nickel alloys) are required for the pumps casing, the impeller and wear plates to ensure long pump life. Two

end suction volute type centrifugal pumps can be used for this service, one operating and one standby. The pumps are controlled from level switches in the scale-pit in conjunction with a make up water supply.

Another mill-water recirculating system service the scarfer scale pit and provides scarfer flame flushing and foundation spray cooling. Pumping from the scarfer pit to the spray cooling etc. can be by horizontal single stage double suction split case centrifugal direct motor-driven pumps, with one operating and one standby. A double suction pump is recommended to reduce impeller thrust and reduce bearing maintenance. A hardened impeller

material is used for abrasion resistance and for the same reason stainless steel hardened impeller and casing rings and shaft sleeves are recommended.

Horizontal end suction centrifugal pumps are recommended for providing hydraulic fluid to low pressure cylinders and controls (Figure 2). Usually, pumps impellers are bronze and casings are cast iron.

These pumps are controlled in parallel, with one operating and one standby, and are controlled by their characteristic curves and system resistance.

In case of continuous casting machine system, there are two major requirements for pumps:

1. To Provide cooling water at sufficient pressure for mould, the spray cooling system and the many machine components such as rollers, torch, machine frame etc.
2. To convert electrical energy to pressure energy in a hydraulic system for use in operating roll positioners and other hydraulic equipment.

The mould cooling and machine cooling system are similar in that the cooling water does not touch steel, and hence, does not become contaminated. Constant cooling temperatures can be maintained by a simple heat exchanger bypass. Centrifugal pumps are, therefore, used with either a horizontal or vertical design, depending on system configuration. Pumps can be single stage double suction, bronze impellers. A vertical pump may be quite desirable in the well of a cooling tower or scale pit, but horizontal pumps would have a lower first cost of pumping from a tank above pump elevation.

The spray water cooling system is more complicated in that the water comes in contact with the slab and becomes mixed with scale. Vertical centrifugal pumps are utilised to move water from the pit through a cooling tower and from there through filters and back to the spray cooling system.

### Pumps for hot Rolling mills

High pressure water descaling is important to product quality. Providing this water is one of the more important functions of a hot rolling mill. Another pump requirement is

providing water for cooling rolls, used in shaping the product.

High Pressure descaling water is supplied by multistage horizontal centrifugal pumps. These are barrel type pump using 13% chrome steel impellers and forged carbon steel casing. Multiple pumps are provided for maximum demand flexibility. A typical capacity of one pump on a modern strip mill (for pumps in total) would be 6500 lpm with a head increase of approximately 150kg/cm<sup>2</sup>.

The steel rolls used in the hot-rolling process are subject to product temperatures as high as 2350 F and seldom lower than 1600F. To maintain 'cool' of the proper shape, water cooling is required continuously and must be thorough. Generally, pumps used to supply this water are horizontal centrifugal similar to those used for BOF lance cooling; are installed in multiple units and are motor driven. The pumps have cast iron casing and bronze impellers.

### Pump for cold rolling Mills

Most of the operations utilise hydraulically operated equipment and the hydraulic system may serve more than one facility. A major pump application is providing pressure to the hydraulic systems.

Pumps are required for circulating caustic cleaning solutions, acids, hot water and chemical treatment solutions from storage and make-up tanks to operating tanks and processes. There also needed for moving waste solutions to pollution abatement facilities.

A typical pumps, recommended for circulating fluids and for moving caustic cleaning solutions plating solutions, acid waters and chemical treatment solutions from storage tanks to line tanks is a horizontal centrifugal one with end suction. Material of construction varies to meet individual requirement. A 29% Ni and 20% Cr alloy have been used successfully on the casting and impeller, cover plate and gland or circulating pumps, handling tieline plating solution. The same construction could be used with a caustic solution or with a 4 to 13% solution of sulphuric acid encountered in a pickling operation. Pumps, such as these, that encounter abrasive or corrosive materials should be equipped with a double seal to allow the use of clear external water-supply of seal flushing.

### Power Plant water supply and other Utilities

Steel mill operations must be supported by reliable utilities—electricity, steam, water, air and fuels. The importance of the reliability of the supply stations must be emphasized strongly since a shutdown of any one of them can bring all production to a standstill.

There are many pump requirement in utility supply station. A water supply station is primarily a pumping station. Pump applications in captive power plant are : feed water pumping circulating water pumps, condensate extraction pumps, bearings cooling make up water and other miscellaneous pumps.