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Study of Fuel oil Handling System in Thermal Power Plants

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ABSTRACT

Study of fuel oil handling system (FOHS) in thermal power plants is intended towards achieving the goal of designing fuel oil handling system in thermal power plants. Designing & process parameters have been proposed in this study analysis. The overall system consists of three stages i.e. Fuel oil unloading, storage & forwarding. Three stages required heat tracing to make the heavy density fuel oil properties suitable to flow through pipes for process requirement in thermal power plants with the help of pumping media. Theoretically, it was found that the proposed Design of fuel oil handling system using electrical heat tracing shows better result as compared to steam heat tracing. The study was done to make existing system of FOHS more refined which is maintenance free and more reliable.

Keywords: *Power Plant; Heavy Fuel Oil; Electric Heat Tracing.*

1.0 Introduction

The fuel oil handling and storage system in a thermal power station covers unloading of the fuel oil, its storage and transfer to the day oil tanks. Heavy Fuel oil (FO/LSHS/HPS) are generally used for the initial startup of the boiler and up to a load of 30% MCR.

Fuel oil is also used for coal flame stabilization up to 40-50% MCR of the steam generator. In addition to above, light diesel oil (LDO) system, of 7.5% MCR capacity, is also provided to start the unit from cold condition when steam is not available for HFO heating.

Light Diesel Oil (LDO) is also used for auxiliary boiler (if envisaged). The fuel oil may be received in a power station by rail tankers or by road tankers or by ships for coastal plants depending on the logistics. Based on the kind of tankers received the unloading facilities are planned.

2.0 System Description

The Fuel Oil Handling system of a power station essentially consists different parts.

2.2 Fuel oil unloading system

Heavy Fuel oil (HFO/LSHS/HPS) is generally unloaded by rail tankers. Till recently, oil rake consisted of 80 wagons (TOH/TORX type) of 22.3 kL each.

Currently rakes consisting of 48 wagons (BTPN type) of about 58 kL each are also being received.

Unloading system involves heating of high viscosity fuels such as furnace oil, LSHS & HPS.

The heating is normally done by steam tapped off from the auxiliary steam header.

The unloading of oil rake is done in about 8 hours duration (wagon placement, heating & pumping).

Suitable unloading headers, about 700 meter long covering entire length of the rake, along the railway tracks are envisaged for quick unloading.

This process involves use of unloading pumps for transferring the fuel oil to the storage tanks.

In cases where coal transportation is not by rail, HFO unloading by road is preferred to eliminate the need of laying a railway track and associated marshalling facilities. The unloading of LDO is done by road only.

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2.3 Fuel oil storage and transfer to day tanks

The heavy fuel oil is stored in the storage tanks. These tanks are heated to maintain a suitable temperature by supplying steam through floor coil heaters. Heavy fuel oil tanks are also provided with suction heaters with steam as the heating source to heat the oil before sending it to transfer pumps. The fuel oil unloaded into main storage tanks is transferred to the day oil tanks for sending it to oil pressurizing station from where it is sent to the burners, as and when required. The oil is transferred from main oil tank to Day oil tank using the transfer pumps. During this process the fuel is freed from mechanical impurities by means of filters. The provision of day tank may not be required where fuel oil tanks are located close to boilers.

2.4 LDO Storage and transfer to day tanks

The light diesel oil is stored in the storage tanks. LDO is further transferred to the day oil tanks for sending it to oil pressurizing station from where it is sent to the burners, as and when required. The oil is transferred from main oil tank to day oil tank using the transfer pumps. During this process the fuel is freed from mechanical impurities by means of filters.

The provision of day tank may not be required where LDO tanks are located close to boilers. The LDO day tank is also provided for auxiliary boiler, if envisaged.

2.4 Steam and condensate system

The heating steam required for floor heater and suction heater in HFO/LSHS/HPS storage tanks, HFO/LSHS/HPS unloading headers, piping and pumps is supplied at about 16 kg/cm2 (a) at saturated condition from auxiliary steam header. Steam pressure is reduced to 4 kg/cm² (a) through a pressure reducing station, located near the fuel oil tank farm area, and distributed to the following heating applications:

a) HFO/LSHS/HPS unloading header and piping
b) HFO/LSHS/HPS railway wagons.
c) HFO/LSHS/HPS unloading and transfer pumps and valves.
d) HFO/LSHS/HPS storage tank floor heaters and suction heaters.
e) HFO/LSHS/HPS unloading and transfer piping upto the day tank.
f) Drain oil tank at main tank farm area.

2.5 Drain oil system

Clean oil spillage from unloading and transfer pumps in pump house is collected in a drain oil tank. This drain oil tank is located in the unloading pump house area. Drain oil pumps transfer the drained oil to either of the HFO/LSHS/HPS storage tanks. The drain oil tank is insulated and provided with steam coil heater to maintain the temperature for flow-ability inside the tank as required for those of HFO/LSHS/HPS storage tanks. Dirty oil spillage/ floor wash from unloading area and unloading/transfer pump house is collected in an oily sump.

3.0 Design Methodology of FOHS

3.1 Project reference

This report is prepared based on the specification of Indiabulls for Amravati TPP 5 x 270 MW[1] [2]. As such this report covers the scope of work and system design inline with the specification requirement.

3.2 Overview of process

The project comprises of setting up new storage and handling facilities for Heavy Fuel Oil (HFO) and Light Diesel Oil (LDO). Light Diesel Oil (LDO) is used for initial start up while heavy fuel oil (HFO) is used for flame stabilization, mill change over and during low load operation of boilers.

4.0 General description of fuel oil system

The fuel oil system will comprise of the following sub system:

1. HFO System
2. LDO System
3. Drain System

4.1 HFO system

HFO unloading accessories such as Neoprene rubber hoses, quick coupling, etc. for unloading Railway wagons and road tankers. Heating steam accessories such as metallic hoses, quick couplings, etc. for unloading Railway wagons and road tankers. Condensate accessories such as metallic hoses, quick couplings, etc. for unloading Railway wagons and road tankers. Six (6) nos. (4 x 150 + 2x 25 m3/hr) of HFO unloading pumps, positive displacement type screw pumps with electric tracing, simplex strainer in the individual pump suction. Two (2) nos. of vertical fixed cone roof HFO storage tanks , minimum effective capacity of 2000 m3 with thermal insulation up to 2m from the bottom of the tank.

4.2 Floor coil heater at the bottom of each HFO storage tank

Fuel oil suction heater at the outlet of each HFO storage tank Pressure reducing station for auxiliary steam system. All piping, valves and instruments as indicated in the P&ID for HFO system, All field instruments including pressure gauges, temperature element with transmitter, temperature indicator, level gauges, level transmitters, differential pressure switches, differential pressure gauge, pressure switch, level switch along with necessary accessories like isolating valves, pulsation dampeners , nipples, piping etc. Drive motors suitable for operation on 415 Volts with space heaters, complete with all standard accessories including motor terminal box and cable glands for HFO unloading pumps & inline with electrical specification requirement. Local Emergency Push Button for the operation of Motors shall be routed through MCC. Temperature control valves self-actuating on/off type for floor coil heater and suction heater along with I/P converters, air filter regulators, copper tubing etc. Common PLC based control Panel for HFO & LDO System with two (02) No. operator cum engineering work station located in control room of fuel oil forwarding pump House Control Room.

4.3 LDO system

LDO unloading accessories such as Neoprene rubber hoses, quick coupling, etc. for unloading road tankers.

Three (3) nos. (2 x 25 + 1x 10 m3/hr) of LDO unloading pumps, positive displacement type screw pumps with simplex strainer in the individual pump suction.

One (1) nos. of vertical fixed cone roof LDO storage tanks, minimum effective capacity of 1000 m3. All field instruments including pressure gauges, temperature elements with transmitter, temperature indicator, level gauges, level transmitters, differential pressure switches, differential pressure gauge, pressure switch, level switch along with necessary accessories like isolating valves, pulsation dampeners , nipples, piping etc.

Drive motors suitable for operation on 415 Volts with space heaters, complete with all standard accessories including motor terminal box and cable glands for LDO unloading pumps & inline with electrical specification requirement. Local Emergency Push Button for the operation of Motors shall be routed through MCC.

4.4 Drain system

- One (1) nos. underground , rectangular , carbon steel , drain oil tank of capacity 2 m3 with steam coil heating in the DOT in HFO Unloading pump House.
- One (1) nos. underground , rectangular , carbon steel , drain oil tank of capacity 2 m3 in LDO Unloading pump House.
- Two (2) nos. (1w + 1s) drain oil pump of vertical, single screw type of capacity 1 m3/hr for drain oil tank in HFO wagon/ road tanker unloading pump house.
- Two (2) nos. (1w + 1s) drain oil pump of vertical, single screw type of capacity 1 m3/hr for drain oil tank in LDO road tanker unloading pump house.
- Two (2) nos. (1w + 1s) oily water sump pump of vertical, single screw type of capacity 1 m3/hr for Oil water collection sump in HFO wagon / road tanker unloading pump house.
- Two (2) nos. (1w + 1s) oily water sump pump of vertical, single screw type of capacity 1 m3/hr for Oil water collection sump in LDO road tanker unloading pump house.
- Two (2) nos. (1w + 1s) oily water sump pump of vertical, single screw type of capacity 1 m3/hr for Oil water collection sump in Dyke area.

- Two (2) nos. (1w + 1s) recovery oil pump of vertical, single screw type of capacity 1 m3/hr for Oil water separator in HFO railway wagon unloading area.
- Two (2) nos. (1w + 1s) recovery oil pump of vertical, single screw type of capacity 1 m3/hr for Oil water separator in Dyke area.
- Two (2) nos. (1w + 1s) vertical centrifugal type pump of capacity 2 m3/hr for Recovered water in OWS of railway wagon unloading area.
- Two (2) nos. (1w + 1s) vertical centrifugal type pump of capacity 2m3/hr for Recovered water in OWS of tank farm area.
- Two (2) nos. oil water separator.

All field instruments including level switch, pressure gauges along with necessary accessories like isolating valves, pulsation dampeners, nipples, piping etc.

Drive motors suitable for operation on 415 Volts with space heaters, complete with all standard accessories including motor terminal box and cable glands for LDO unloading pumps & inline with electrical specification requirement.

Local Emergency Push Button for the operation of Motors shall be routed through MCC.

5.0 Standards and Codes Applicable for Fuel Oil System

The fuel oil dyke area shall be arranged as per petroleum act & rules, OISD 118, NFPA & TAC. The complete oil storage and supply system will meet the requirements of Indian petroleum rules.

LDO would be as per IS 1460, 1995 and HFO as per IS 1593,1982 grade HV and as both LDO and HFO belongs to class ‘C’ as per petroleum rules,2002,hence both LDO and HFO tanks would be located in one dyke separated by fire wall of height(600mm).

Specific approval from chief controller of explosives shall be arranged. The HFO/LDO unloading pumps shall be designed as per API 676.The HFO/ LDO storage tanks shall be designed as per API-650 / IS 803.

Normal and emergency venting as required shall be provided as per the applicable clauses of IS-803 and/or API: 2000.

Table 1: Standard Codes

API 650 (2007)	Welded steel tanks for oil storage
IS 803 (2007)	Code of practice for design fabrication and erection of vertical Mild steel cylindrical welded oil storage tanks.
API 2000(1998)	Welded steel tanks for oil storage
OISD-118	Oil industry safety directorate-Layouts for oil and gas installations
API 676	Positive displacement pumps-rotary
API 610	Centrifugal pumps for petroleum, heavy duty chemicals and gas Industry services

5.1 Unloading cycle time

Table 2: HFO Wagon Unloading Cycle Time

Sl. No.	Description	Parameters
1.	No. of Wagons	80
2	Capacity of each Wagon	22.3m3
3	Wagon retention time	5hrs
4	No. of wagons in a batch	20
5	HFO unloading pump capacity	650m3/hr (4x150+2x 25)
6	Active pumping & wagon	
7	heating and heating time Parallel pumping	220 min.
8	Shunting, coupling, decoupling	80 min

Considering wagon retention time of 5 hours for heavy fuel oil unloading from wagons. The wagons full rack shall be connected to the headers by quick couplings in hoses. The first batch of 20 wagons shall be heated to 40 deg C in 40 mins.After heating of the first batch of railway wagon,the same shall be unloaded by pumps in 45 mins. and the second batch of 20 nos, railway wagon shall be heated simultaneously. Similarly oil heating and pumping for the third and fourth batch would be performed simultaneously. Based on the above the balance 80 mins. shall be kept for coupling, decoupling shunting of railway wagons.

Table 3: HFO Road Tanker Unloading Cycle Time

Sl. No.	Description	Parameters
1.	No. of Tankers	5
2	Capacity of each Tanker	20m3
3	Tanker retention time	4.0hrs.
4	No. of batches	1
5	No. of tankers in a batch	5
6	HFO unloading pump capacity	50m3/hr (2
7	Active pumping & tanker heating	3hours.
8	Coupling, decoupling	60 min

Table4: LDO Road Tanker Unloading Cycle Time

Sl. No.	Description	Parameters
1.	No. of Tankers	5
2	Capacity of each Tanker	20m3/hr
3	Tanker retention time	2.5hours.
4	No. of batches	1
5	No. of tankers in a batch	5
6	HFO unloading pump	60 m3/hr
	Capacity	(2x 25+1X10)
7	Active pumping	1.6 hrs
8	Coupling, decoupling	30 min

6.0 Conclusions

In India, heat tracing of FOHS in almost all major thermal power plants has been done by steam heat tracing. Although substantial generation of steam for FOHS may not impact on the total steam generation cost by a boiler, but as we compared the EHT with SHT in former discussion, we have been arrived on a result that SHT for FOHS have so many drawbacks. Service life of SHT is limited & always remains prone to damage. SHT all the time required monitoring.

Few months back, boiler of the Bhusawal thermal power plant was on fire & damaged 40% due to the failure of FOHS system. HFO line to boiler was chocked due to non working of Steam heat tracing system. This kind of mishappening would be prevented if EHT were used instead of SHT.

In developed countries like America, Japan, france etc. FOHS system in thermal power plants are heat traced by EHT. The design & detail study of FOHS and FOHS system was done, The results are quite satisfying and to make it more efficient. Proper selection of insulation, so that there will be minimum loss of heat.

- Complete system could be more compact so that heat tracing area could be minimize which can save the EHT cost along with piping etc.
- More improvement in OWS design, so that there could be minimum wastage of HFO oil.

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