

HEAT RECOVERY FROM PULP MILL EFFLUENT AND AIR COMPRESSOR SYSTEM



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Abstract:

The temperature of pulp mill effluent which goes to effluent treatment plant (ETP) is 70 – 75°C. Due to high effluent temperature the temperature in aeration tank reaches about 45°C, biological treatment of the effluent is severely affected due to this. Waste heat from pulp mill effluent can be recovered to heat up the process water for utilising as boiler make up water and for meeting hot water requirement of paper mill, thereby reducing the process steam requirement. Oil in the air compressor system gets heated up to 100°C and same is cooled in after-cooler to bring down the oil temperature before recirculating in compressor. Instead of rejecting heat to surroundings for cooling of oil, thermal energy of oil is transferred to steam condensate water. Thereby temperature of condensate is enhanced from 65°C up to 85°C, thus reducing additional steam requirement for heating process water, this reduces the fuel (Furnace Oil) requirement of boiler and helps reduce GreenHouse Gas (GHG) emissions from combustion of the fuel.

Keywords: Heat Exchanger; Compressor oil; pulp mill effluent; condensate; energy conservation

1. Introduction:

Bank Note Paper Mill India Pvt. Ltd (BNPMIPL), a joint venture between Security Printing & Minting Corporation of India Limited (SPMCIL - a wholly owned public sector undertaking of Government of India under Ministry of Finance) and Bharatiya Reserve Bank Note Mudran Private Limited (BRBNMPL - a wholly owned subsidiary of

Reserve Bank of India (RBI)). BNPMIPL is involved in production of Currency / Bank Note paper to meet the requirement of the nation.

Pulp mill effluent is let out to effluent treatment plant (ETP) at a temperature of about 70 – 75°C. By the time the effluent reaches aeration tank for biological treatment, its temperature is about 45°C and above. The conducive temperature for biological treatment of effluent in aeration tank is about 35°C. Due to high temperature the biological treatment of effluent was not taking place as desired, and final treated water was not meeting desired quality level.

For optimal treatment of effluent, it was required to reduce the temperature of effluent to the desired level. Many options were thought of for the temperature reduction viz cooling tower, open channels etc. but it was decided to conserve the thermal energy rather than waste it by adoption of suitable heat exchanger.

It is a known fact that, in compressed air system only about 20% of the energy is utilised and remaining 80% of the input energy is lost mostly in the form of heat. In the process of air compression, the lubricating oil temperature goes up to about 100°C. After cooler is used to cool the lubricating oil before it is put back into circulation in compressor. Instead of removing the heat in after-cooler it was thought to utilise the waste heat by transferring it to steam condensate water by adoption of suitable heat exchanger.

2. MATERIAL AND METHODS

2.1 HEAT RECOVERY FROM PULP MILL EFFLUENT

Study has been conducted to identify the hot water requirement in plant. About 165 m³/day of hot water is required in entire plant (Table 1) at different temperatures.

Table 1

Hot water requirement in Process

Location	Requirement (m ³ /day)
Makeup water to boiler	40
Sizer roll shower	25
PVA batch cooking	5
CMC filter flushing	5
PVA dilution & transfer and cleaning	45
Broke preparation	35
Miscellaneous uses	10
Total hot water requirement for process	165

Steam was being used for heating water for process use wherein different water temperatures are required for different applications. The minimum water temperature requirement is about 60°C. It was decided to supply the hot water from the spiral heat exchanger where water is heated up by pulp mill effluent. This hot water is having temperature of about 60-65°C and additional heat requirement can be fulfilled by using steam.

The pulp mill effluent contains lot of dirt & fibres, it was understood that it would likely choke/clog the heat exchanger, hence before feeding the pulp mill effluent to heat exchanger, these dirt and fibre material are to be removed continuously using a suitable screening system. Suitable vibrating screening machine was installed (Make: Russel Finex Ltd.) for separating suspended solids from pulp mill effluent fed to spiral heat exchanger.

Since the heat is to be transferred from the effluent with high suspended solid content, the Plate Heat Exchanger (PHE) may not work due to less clearance between the plates which eventually choke the PHE and would necessitate frequent cleaning. There is possibility of damaging the plates as thickness of PHE plates is quite less. In view of this Spiral Heat Exchanger (SHE) was opted, SS 316L was selected as the MOC (Material of Construction) of effluent contact surface of SHE due to corrosive nature of effluent.

Project proposal was prepared wherein the effluent was proposed to be routed through heat exchanger which transfers the heat to the RO (Reverse osmosis water) water and supplied to the required locations in plant thereby reducing the steam requirement for water heating in process (Fig.1).

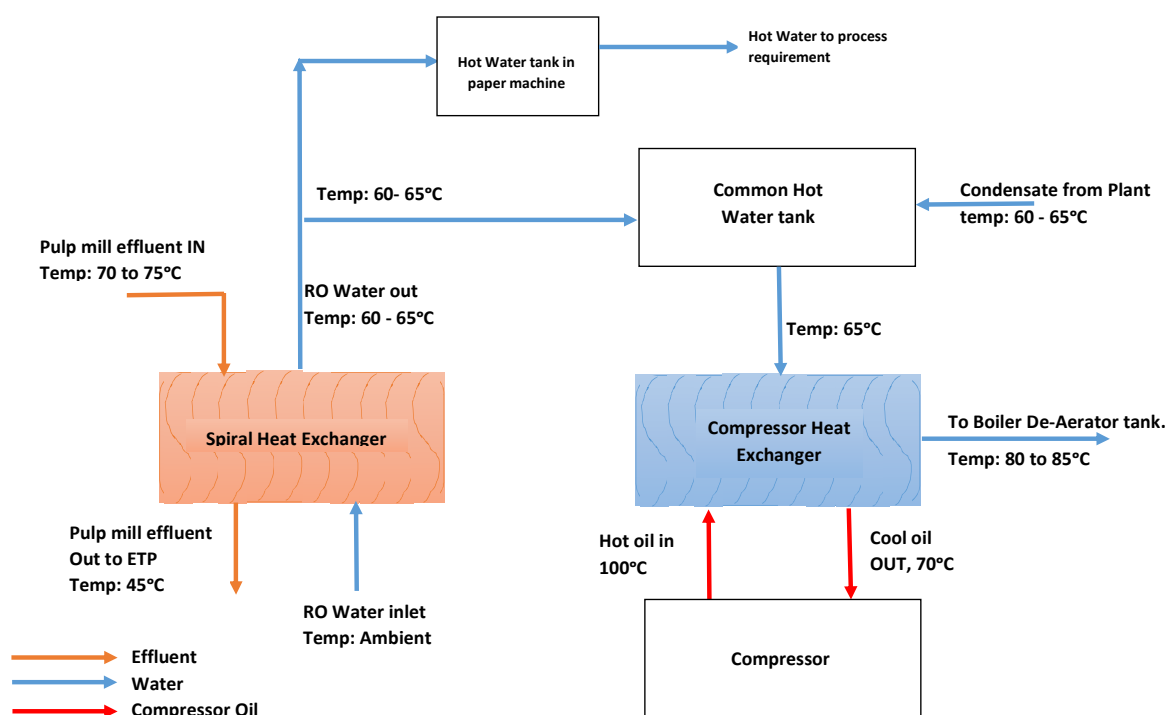


Fig. 1. Schematic diagram of thermal energy recovery from pulp mill effluent and air compressor system

Spiral heat exchanger was installed along with tank, effluent pump and suitable pipeline were laid till the hot water tanks located at different location in plant. The RO water is passed through spiral heat exchanger, wherein the heat transfer takes place from effluent to RO water. Existing steam supply network is kept intact for heating the water as per requirement to temperatures higher than the base temperature of about 60°C available at the outlet of spiral heat exchanger. Fig 2 shows the installation made for heat recovery from pulp mill effluent.

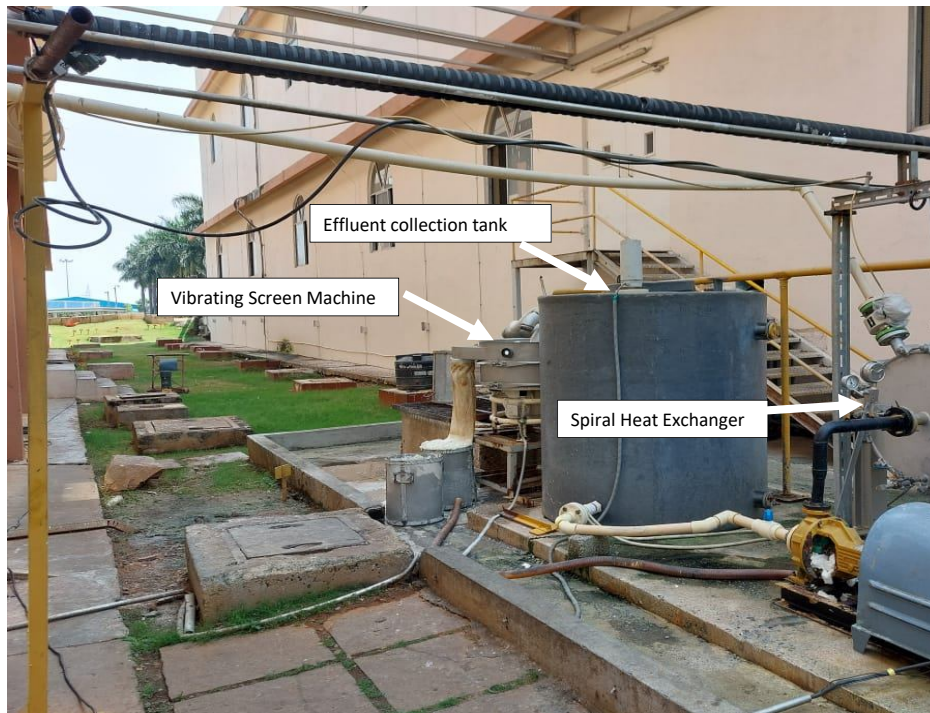


Fig. 2. Photograph of system installed for heat recovery from pulp mill effluent

The project was successfully commissioned in October 2020, and it is found that about 8,000 kg of steam has been reduced on regular basis.

2.2 HEAT RECOVERY FROM COMPRESSED AIR SYSTEM

BNPM has purchased oil flooded compressor with heat recovery system from M/s ELGI Ltd. The condensate water return from plant is at a temperature of about 65°C. Condensate water and part of hot water having temperature of about 65°C taken from spiral Heat exchanger (as boiler makeup water) is collected in common tank. The condensate & make up water so collected at common tank is passed through the compressor heat recovery unit where the temperature of condensate is raised up to 85°C from 65°C and sent to boiler. About 160 m³ of water is passed through the compressor heat exchanger for raising the temperature to 85°C from 65°C. Due to this project, steam consumption was reduced by about 5,000 kg. Fig 3 shows the installation made for heat recovery from air compressor system.

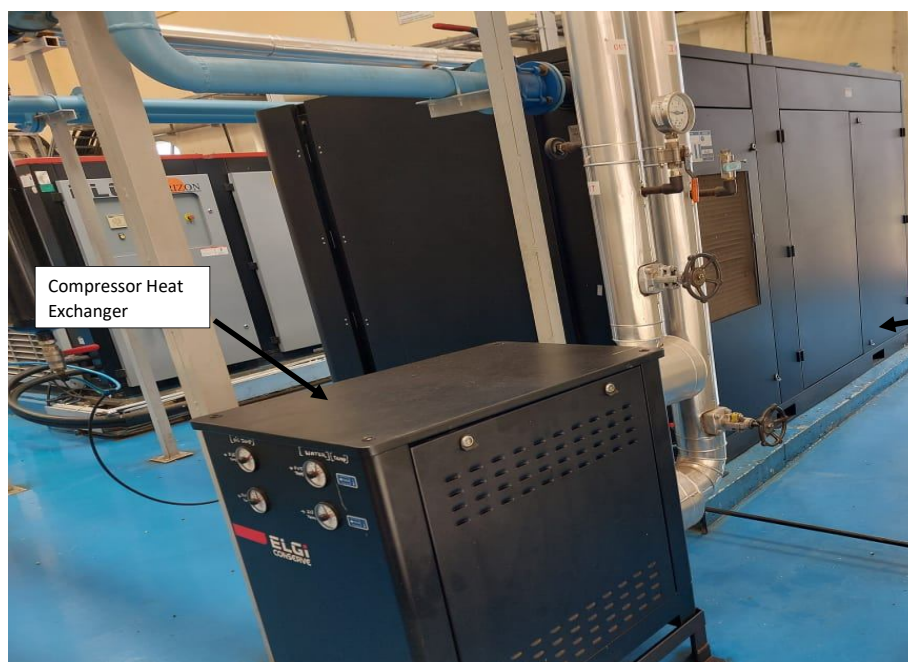


Fig. 3. Photograph of system installed for heat recovery from air compressor system

3. RESULTS

Trial was conducted wherein system was operated for 5 days without heat recovery and subsequently compared with system after incorporating all heat recovery systems as cited above. Following benefits were observed from the trial.

- By supplying hot water to meet the plant requirement, about 8,000 kg of steam consumption was reduced.
- By increasing the temperature of condensate water from 65°C to 85°C in compressor heat recovery system, about 5,000 kg of steam consumption was reduced.
- Overall, about 1,000 kg of furnace oil (FO) consumption was reduced with the implementation of above projects.
- Average cost of FO (Furnace oil) is about Rs. 50 per kg, accordingly the saving on regular basis is about Rs 50,000/-; annual saving is about Rs. 1,65,00,000 (Rupees one Crore sixty Five lakhs).
- Temperature of effluent has been reduced and now the temperature of effluent in aeration tank is about 35°C, which is conducive temperature for biological treatment for achieving desired BOD and COD reduction.

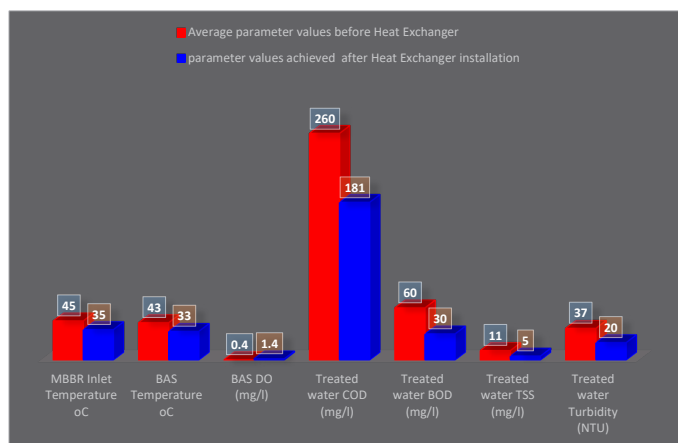


Fig. 4. Process improvement at ETP

- About 7-8 % of steam consumption was reduced.
- Every kg of FO generates about 3.11 kg of CO₂, accordingly about 1,100 MT of CO₂ emission reduction is achieved

annually apart from huge reduction in SO_x & NO_x. Combustion of FO leads to generation of gases having high potential for ozone depletion and that which have high global warming potential. Hence by reducing FO consumption, reduction in release of corresponding quantities of combustion by-products like CO₂, SO_x, NO_x etc. was achieved.

- Please find below the Fig. 4 giving the details of Average steam generation and average FO consumption with and without Heat Recovery units during the trial period with similar production pattern.

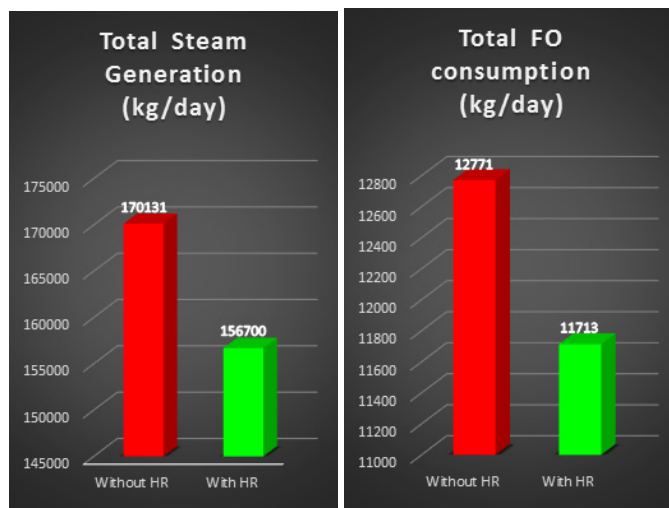


Fig. 5. Graph of reduction in steam generation and Furnace oil (FO) consumption achieved by installation of the above mentioned heat recovery systems.

4. CONCLUSIONS:

The system of heat recovery from pulp mill effluent and compressor lubricating oil is found provide good financial benefits and reduction in greenhouse gas emissions. This can be replicated in other industries as an energy conservation measure and will help the companies in reduction of their carbon footprint.

5. ACKNOWLEDGEMENT

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