Heat Recovery From Recovery Boiler Of Smelt Dissolving Tank Vent

S.BOOBALAN1,K.GOKUL2,T.GOKULAKKANNAN3,K.GOKULAKRISHNAN4 N.SAMPATHKUMAR5

1,2,3,4 student, Department of mechanical engineering

Assistant Professor, Department of mechanical engineering,
Jay Shriram Group of Institutions,
Tirupur, India

Abstract—A water cooled spout for the furnace of a recovery boiler, as used in a papermaking process. The usual internal cavity of a hollow pour spout is provided with a directing duct to direct a portion of the coolant liquid to an otherwise stagnant zone where thermal fatigue occurred in a typical prior art pour spout. Further, the radius of curvature of the lowermost portion of the trough of the pour spout is increased to a factor greater than two. Further, a different weld joint between the rearmost portion of the pour spout and a rear cover plate are made. In many cases, energy managers have exhausted conventional heat recovery measures making further efficiency gains more challenging to identify and implement within the mandated return on investment. This paper describes a unique project delivered by Thermal Energy International Inc. (TEI) to recover waste heat from a smelt dissolving tank vent with a return on investment of less than two years. In average heat recovery rate of 12 GJ/h, the project delivers significant energy cost savings as well as the added benefit of an 85% reduction in the visible plume produced by the smelt dissolving tank vent exhaust.

I. INTRODUCTION

Paper is a material made in thin sheet as an aqueous deposit from linen rags, wood pulp or other form of cellulose which is used for writing, printing and wrapping etc., Paper plays a vital role in communication purpose. Paper was invented by TSAI-LUN in LEI-YANG province of China. The first paper machine was invented by a French man, NICOLOUS-LOUIS ROBERT in 1799. In India the first paper machine was set up at Scram pore in West Bengal.

Meanwhile, in China people were using paper in more and more different ways. They were using it for kites, and even for toilet paper! Pulp and Paper manufacturing industry is one of the largest among the top ten in the world. Today the world paper production has crossed 300 millions per annum.

COMPANY PROFILE

To be the market leader in the manufacture of world class eco-friendly papers by adopting innovative technologies for sustainable development. TNPL was formed by the Government of Tamil Nadu in April 1979. The primary objective of the company is to produce Newsprint, Printing and Writing paper using bagasse a sugarcane residue as the primary raw material.

The factory is situated at kagithapuram in Karur district of Tamilnadu. In 1984 the TNPL Paper Company opened a 90,000 ton per annum. It has started the commercial production of newsprint on its new paper machine. The mill produces 2,45,000 tons per annum of emerged as the largest bagasse based paper mill in the world consuming about one million tons of bagasse’s every year.

RECOVERY BOILER

The mill has undertaken a number of measures to decreased their dependency on fossil fuel including the implementation of the smelt dissolving tank heat recovery project that is the subject of this paper. The project was implemented on a turn-key basis by TEI and was completed on budget and on list with the system going into commercial operation.

The heat recovery project was the smelt dissolving tank vent gas from one of the mill’s two recovery boilers. In the chemical recovery process, molten smelt formed in the recovery boiler is feed to a dissolving tank where the smelt is dissolved in weak wash to form green liquor. Before mixing with the weak wash, the smelt stream is broken into droplets with steam crash jets.

The high temperature of the smelt as it comes into the contact with the weak wash issue a large amount of heat in the form of water vapour. This hot vapour and the steam injected through the shatter jets are exhausted through the smelt dissolving tank vent.

Typically, the smelt dissolving tank exhaust is passed through a wet scrubber to contract the emission of particulate composed mostly of sodium compounds entrained in the exhaust. The exhaust leaving the scrubber is saturated with water vapour and cooled to roughly 80C.

Despite the relatively low temperature and flow is(approximately 6500 Nm3/h in this case), the exhaust carries a considerable amount of energy out the stack. The amount of energy recoverable is a function of the temperature to which the exhaust is cooled. As the saturated exhaust is cooled, water vapour is condensed releasing its later heat of vaporization of
roughly 1260 kJ/kg. Unlike sensible heat recovery, more heat is recovered in the first degree of cooling than from the next, and so on. Cooling a saturated exhaust from 80°C (T1) to just 60°C (T2) will recover approximately 1.25 GJ per 1000 Nm³ of dry gas. Any type of heat user below 60°C could be considered for a smelt dissolving tank heat recovery application.

In this case of the boiler makeup water was chosen for its relatively low seasonal temperature profile of 30°C to 45°C. Also, the average flow of over 1500 L/min was sufficient to use all of the heat recoverable from the smelt dissolving tank vent. The boiler makeup water was heated through a secondary plate and frame heat exchanger installed on the FLU-ACE water circuit.

The soda recovery boiler is a rational facility with energy and resources saving system by utilizing the lignin for an energy source and recovery solvent(soda). The boiler bourns a mixture of cooking chemicals and the lignin residue (black liquor) remaining after the separating pulp and paper mill. And recently this system enjoys a high reputation as a superb co2 reduction technology making use of biomass fuel s also from global environmental aspects. Kawasaki has delivered approximately 100 boilers since its first supply of the soda recovery boiler for a pulp and paper mill in 1949, having a history of the soda recovery boiler in japan. We have always supplied recovery boiler to meet users need-beginning from the murry waven type boiler for high pressure and high temperature steam features.

The capacity of a recovery boiler is getting larger year by year, reaching the maximum handling capacity of black liquor:2, 900 t/d, and the boiler evaporation capacity:475 t/h at the latest plant. And due to the improvement of anticorrosion technologies the steam pressure and temperature have reached 10.3mpa and 505deg.c respectively[5].

**EVAPORATOR UNIT**

A similar approach may be used for the removal of impurities in the boiler blow- down water. The boiler water removed from the steam drum is already a heat saturated liquid. The significance of the water’s temperature applies to the boiling process. If the blow-down water removed is a heat saturated liquid then only the required amount of enthalpy to boil the water needs to be added. This required amount of heat is known as the “latent heat of vaporization”. The system needed to add the required amount of heat to the boiler water is a heat exchanger tube.

If steam is used as a heat source the correct type of steam must be determined. Steam is used in a variety of applications in a steam powered vessel making multiple temperatures and pressures of steam readily available. The heating medium for this evaporator could come from a stage of one of the propulsion turbines or even be a small portion of the superheated steam being generated by the boiler. The steam from these locations is superheated and has a significant amount of enthalpy. Another possible source of steam is the steam condensing in the main condensers of the ship.

**SMELT DISSOLVING PROCESS**

In the dissolving tank, molten smelt from the recovery boiler is dissolved in water to generate green liquor. During this process a large amount of gases with high water vapour content are generated. These gases are laden with TRS gases and particulates.
Vent gas from the dissolving tank is first cooled in a direct condensing scrubber. Mechanical action in the scrubber also eliminate some particulates while contact with the alkaline scrubbing solution.

Smelting is a process for extracting usable ore from mixed deposits where people find ore bound with other metals, rock, and external material. It is very unusual to find deposits of pure ore and this method allows people to divide out useful metal. The invention of this process was an important step in the development of human societies, allowing people to make more complex metal products and alloys. In the smelting process people heat the material with an agent to trigger a chemical reaction. Although people often refer to smelting as another form of melting, simply melting material is not enough. The chemical reaction is the necessary to force the desired ore to precipitate out, and it may be helpful to add a flux to bind with particulate materials, forming slag, a mass of unwanted material that will settle to the bottom of the furnace where people do their smelting.

As the ore precipitates out and gathers together, density changes in the composition of the material will cause it to form layers, allowing the operator to skim off the desirable ore. After the smelting is complete, people can take out the byproducts and discard them, although sometimes there are uses for them, such as combining them in aggregate concrete mixtures. The yield from a given smelting run varies, depending on the quality of the base product and what kind of ore people are attempting to extract.[4]

**HEAT EXCHANGER**

In industries, heat exchangers are used in industrial process to recover heat between two process fluids. Shell-and-tube heat exchangers are the most widely used heat exchangers in process industries because of their relatively simple manufacturing and their adaptability to alternate operating conditions. But nowadays numbers of industries are searching for effective and less time consuming alternatives of designing of shell-and-tube heat exchangers. As per literature and industrial survey it is observed that there is need of effective design options for STHE. This section explains the details of existing industrial scenario of design of STHE.

The possibilities of corrosion and/or the formation of scale due to pH levels and the residual sodium salts in the scrubber exhaust were carefully considered in the design of the heat recovery system. An analysis of the anticipated water chemistry was done in consultation with Hercules, the mill’s chemical supplier. The results of the analysis pointed to a low risk of slow scaling in the system. Conservatively, allowances for manual and chemical cleaning of heat exchange surfaces were made.

![Heat Exchanger](image)

**Fig. 1.5 Heat Exchanger**

An inspection of the FLU-ACE® internals was conducted after six months of operation and the wetted heat exchange surfaces showed no signs of fouling. Based on the operation of the system to date and periodic water sampling, it is anticipated that any maintenance (if required) can be accommodated during regular scheduled plant maintenance shut downs. Based on this first inspection, regular packing cleaning may not be necessary at all.[1]

**HEAT EXCHANGER FLOW ARRANGEMENTS**

Two basic flow arrangements are Parallel and counter flow provide alternative arrangements for certain specialized applications. In parallel flow both the hot and cold streams enter the heat exchanger at the same end and travel to the opposite end in parallel streams. Energy is transferred along the length from the hot to the cold fluid so the outlet temperatures asymptotically approach each other. In a counter flow
arrangement, the two streams enter at opposite ends of the heat exchanger and flow in parallel but opposite directions. Temperatures within the two streams tend to approach one another in a nearly linearly fashion resulting in a much more uniform heating pattern. Shown below the heat exchangers are representations of the axial temperature profiles for each. Parallel flow results in rapid initial rates of heat exchange near the entrance, but heat transfer rates rapidly decrease as the temperatures of the two streams approach one another. This leads to higher energy loss during heat exchange. Counter flow provides for relatively uniform temperature differences and, consequently, lead toward relatively uniform heat rates throughout the length of the unit.

COMMERCIAL TERMS

This project was implemented under TEI’s Thermal AUD™ (Alternate Utility Delivery) Program. Under this program, the equipment is owned and operated by TEI over a term of several years. Over the term of the agreement, the recovered heat is metered and charged on a $/GJ rate basis that provides a significant energy cost saving to the user. Under this program, the project delivers an immediate benefit to the user without having to spend any internal capital.

APPLICATION

The Heat Recovery Boiler of waste heat from the exhaust is used to preheat boiler makeup water, reducing steam use in the de aerator. This resulted in remove of the mill’s consumption of No. 6 fuel oil and a commensurate decrement in greenhouse gas and other emissions equivalent to removing 2,085 cars from the road.

The project delivers annual energy cost savings of $1,400,000 as well as providing the added benefit of an 85% reduction in the visible plume previously produced by the smelt dissolving tank vent exhaust.

Utilizing TEI’s Thermal AUD™ (Alternate Utility Delivery) Program, the project was implemented on a turn-key basis and was completed on budget and on schedule with the system going into commercial operation in April 2008.

Under this program, the equipment is owned and operated by TEI over a given term whereby the recovered energy is metered and charged on a $/MMBtu rate basis that provides a continuous energy cost saving to the user. This provides an immediate cost savings benefit to the user without the requirement to deploy any internal capital - positive cash flow from day one!

“The equipment started up on time and on budget, with no impact on mill operations, reaching target heat recovery and savings from the get-go."Jean Pierre Benoit, Thurso Pulp Mill General Manager.[3]

BENEFITS

- In excess of 100,000 MMBtu/year waste heat delivered
- $1,400,000 in annual fuel savings, equivalent to
- 18,000 barrels of fuel oil/year
- Greenhouse Gas Reductions (CO2) of 10,400 tons/year
- Reduction in Nitrogen Oxides (NOx) by 22.9 tons/year
- Elimination of 131 tons/year of Sulphur Dioxide (SO2).

II. CONCLUSION

Provided there is a liquid or air stream at or below 60°C that can benefit from incremental heating, Thermal Energy International Inc. can provide a heat recovery solution around the smelt dissolving tank vent exhaust. Fouling (corrosion and scaling) can be controlled and managed, if not eliminated. Heat recovery rates of up to 2.5 GJ per 1,000 Nm³ of exhaust are achievable at a return on investment of less than two years.

III. REFERENCE

[1] Shravan H. Gawande, Design and Development of Shell & Tube Heat Exchanger for Beverage,

