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Study & Review of Heat Recovery Systems for SO_2 Gas Generation Process in Sugar Industry

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Abstract- *Today the demand of energy is increasing tremendously, but available energy lacks in supply. Hence, there is no option for proper and efficient utilization and conservation of energy. In this paper, the main stress is given on energy conservation by using technique of utilizing waste heat. This paper presents a review of various works focused on waste heat in industry for improving energy efficiency. In the present scenario energy crises is a severe problem across the globe. For the protection of global environment and maintain ecological balance, energy saving is one of the most vital issue. Therefore, it is essential that we should endeavor for waste heat recovery by making significant and concrete effort. Conservation of energy by waste heat recovery is the need of hour. The different reviews based on the aspects of heat recovery and the methodologies and technologies being employed for its optimization in industries also study through literature. The objective of this work is to hypothetical design of heat recovery system in SO_2 gas generation process.*

I. INTRODUCTION

Waste heat is defined as heat which is rejected from the process at a temperature above the ambient temperature to permit the extraction of additional useful energy from it.The recovery of waste heat is the most beneficial single energy conservation technique which can significantly help to conserve fuel and bring about substantial cost reduction in energy intensive industries. Waste heat is the heat which is produced in a process by combustion of fuel or exothermic chemical reaction and then rejected into the environment even though it can still be utilized for some useful and economic purpose. In most general case, waste heat is the energy associated with the waste streams of air, gases and liquid leaving the boundaries of a plant, section or building and lost to the environment. The strategy of recovery of this heat not only depends on temperature of waste heat sources but also on the economics involved behind the technology used. Even 1% energy saving in industries mean saving of lot of money.

Methods of utilization of waste heat:

1. Direct Utilization: For drying or process heating
2. Energy Cascading
3. Cogeneration
4. Recuperators: Shell and Tube, plate, heat exchangers
5. Regenerators: Stationary or rotating type
6. Waste Heat Boilers

II. FACTORS AFFECTING WASTE HEAT RECOVERY SYSTEM

Following parameters allow for analysis of the quality and quantity of the stream and also provide insight into possible materials/design limitations. For example, corrosion of heat transfer media is of considerable concern in waste heat recovery, even when the quality and quantity of the stream is acceptable.

A) Heat Quantity & Quality: The quantity, or heat content, is a measure of how much energy is contained in a waste heat stream, while quality is a measure of the usefulness of the waste heat.

B) Waste Stream Composition: Although chemical compositions do not directly influence the quality or quantity of the available heat (unless it has some fuel value), the composition of the stream affects the recovery process and material selection. The composition and phase of waste heat streams will determine factors such as thermal conductivity and heat capacity, which will impact heat exchanger effectiveness.

C) Minimum Allowable Temperature: The minimum allowable temperature for waste streams is often closely connected with material corrosion problems. Minimum exhaust temperatures may also be constrained by process related chemicals in the exhaust stream; for example, sulphates in exhaust gases from glass melting furnaces will deposit on heat exchanger surfaces at temperatures below about 510ºF [270ºC].

III. REVIEW METHODOLOGY

Zhongyi Su [1] carried out the case study on the waste energy utilization in industries at China. He has carried out

the analysis on the different industrial processes and finding out huge data for used of organic waste again in the industries. The conclusion of the study shows that reusing the potential wastes for the production is feasible.

Liang-Chen Wang [2] carried out the analysis on the reusability of the energy from the exhaust gas calciner for production of carbon. In this study, the analysis of exhaust is done or production of carbon with used of calciner. The present study aims to develop this method and a combustion model. To demonstrate the correctness of the method and the model, based on the data collected from the working calciners, the energy utilization ratio of a calciner with power of 1250 kW is analyzed.

Rakesh Jain [3] Carried out the performance improvement of a boiler through waste heat recovery from an air conditioning unit. In this study, the heat from the air conditioning unit of the boiler is used for heating the feed water in boiler. The results of the study concluded that efficiency of Boiler will increase from 76.33% to 76.53%.

Satish K. Maurya, [4] carried out the work on the analytical study on the waste heat recovery Combined Ejector and Vapour Compression Refrigeration System. The key advantage of the combined plant is the Financial and economical aspects also justify the heat recovery as in most of the cases as in most of the cases returns in term of savings are much greater than the investment costs

The paper [5] [6] explained about methods for recovering the heat of flue gases from boilers using heat of vaporization are analyzed. High profitability of the developed thermal circuit involving deep recovery of the heat of flue gases and its storage, as well as good prospects for using it, are demonstrated by a real example in this paper. It conclude that Use of a comprehensive approach for attacking the problem of deeply recovering the heat of boiler flue gases, including heat of vaporization and involving consideration of all elements participating in the heat supply cycle, makes it possible not only to solve this problem technically, but also to optimize the parameters of coolant.

D.Kumar and Rao,[7] The results from the energy audit of KOTHAGUDEM Thermal power station, Andhra Pradesh has been presented in this paper. The scope of any energy audit in a thermal power plant should include the study of the coal flow, air and flue gas flow, excess air factors and oxygen in the flue gas; study of the heat transfer, effectiveness, proportioning of heat and pressure drop in the heat-exchangers of the water-steam circuit; study of the auxiliary power consumption; the overall performance evaluation such as the gross and the net overall efficiencies, boiler efficiency, boiler feed pump efficiency, air compressor efficiency, evaporation losses and blow down losses of cooling tower etc. Results from such a study at a 500 MW power plant were presented in this report. A detailed analysis of the effect of the fuel on the boiler efficiency, the dry and the wet flue gas loss, combustion characteristics, the start-up and the shut-down losses, the radiation losses and the heat losses due to hydrogen in fuel, moisture in fuel, carbon monoxide in fuel were explained.

TABLE 1.1 WASTE SOURCE AND QUALITY

In considering the potential for heat recovery, it is useful to note all the possibilities, and grade the waste heat in terms of potential value as shown in the following Table

Sr.no	Source	Quality
1	Heat in flue gases	The higher the temperature, the greater the potential value for heat recovery
2	Heat in vapour streams.	As above but when condensed, latent heat also recoverable
3	Convective and radiant heat losess from exterior of equipment	Low grade – if collected may be used for space heating or air preheat
4	Heat losses in cooling water	Low grade – useful gains if heat is exchanged with incoming fresh water
5	Heat stored in products leaving the process	Quality depends upon temperature
6	Heat in gaseous and liquid effluents leaving process.	Poor if heavily contaminated and thus requiring alloy heat exchanger.

IV. BENEFITS OF HEAT RECOVERY SYSTEM

Benefits of 'waste heat recovery' can be broadly classified in two categories:

Direct Benefits:

Recovery of waste heat has a direct effect on the efficiency of the process. This is reflected by reduction in the utility consumption & costs, and process cost.

Indirect Benefits:

a) Reduction in pollution: A number of toxic combustible wastes such as carbon monoxide gas, sour gas, carbon black off gases, oil sludge, Acrylonitrile and other plastic chemicals etc, releasing to atmosphere if/when burnt in the incinerators serves dual purpose i.e. recovers heat and reduces the environmental pollution levels.

b) Reduction in equipment sizes: Waste heat recovery reduces the fuel consumption, which leads to reduction in the flue gas produced. This results in reduction in equipment

sizes of all flue gas handling equipments such as fans, stacks, ducts, burners, etc.

c) Reduction in auxiliary energy consumption: Reduction in equipment sizes gives additional benefits in the form of reduction in auxiliary energy consumption like electricity for fans, pumps etc.

V. PROPOSED RESEARCH WORK

The study is carried out on the research based on the waste heat recovery. The based literature study is implemented for developing the proposed research work. The proposed research work aims for performance analysis of waste heat recovery system for SO_2 gas generation process in sugar industry. The fig.1.1 shows the proposed research study model.

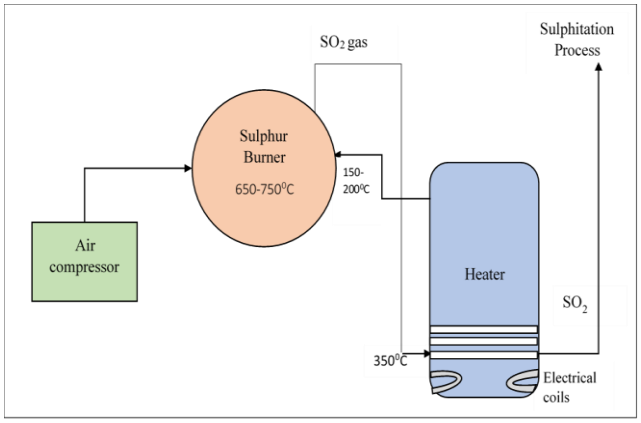

Fig.1.1: Block diagram of heat recovery system in SO_2 gas generation process.

The juice clarification is the heart of sugar processing from sugarcane for white consumption sugar. Various clarifying agents are used such as MOL, SO_2 gas in this process. The various existing designs of sulphur burner in a plantation of white sugar factory suffer from a number of draw backs including irregular SO_2 supply's, sublimation and incompatibility with automation. These at best are partially continuous and do not ensure supply of SO_2 gas in line with the throughput and process requirement. The sugar industry in India therefore has long been in search of a suitable design which is trouble-free and can ensure continuous supply of SO_2 gas exactly as per process requirement.

Heat recovery of sulphur burner in sugar industry is an important problem both from environmental and economic points of view. The combined heat and power system produces steam that provides heat to sulphur burner where compressed air mixed with sulphur and get SO_2 for sulphitation process which is useful for transformation of raw sugar to white sugar. In existing system hot SO_2 (400-500^0 c) from sulphur burner is cooled in condenser and then transformed to the sulphitation process but in this system heat energy of SO_2 get wasted. Hence it is decided to implement heat recovery unit for sulphur burner so that system will be economical.

CONCLUSION

Recovering Waste heat is the need of the day for the industries of developing countries. Extent of literature available shows a continuously increasing interest of researchers, managements and engineers in recovering the heat. Many big industrial plants have already realized the importance of heat recovery and they are effectively utilizing it in one or other way. Efforts are being done to improve the recovery efficiencies by using the latest technological advancements and optimization methods.

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