WASTE HEAT FROM SUGAR INDUSRTY TO DRIVE VAPOUR ABSORPTION ACS.

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Abstract — The demand for Air conditioning keeps rising, especially in developing countries where the standard of living has improved. This Results in an increased consumption of electricity and put further pressure on the power grid. Agro industry plays a crucial role in the industrialization process of developing countries. Sugar industry is second largest agro industry in the world. In sugar manufacturing plants there are various processes for production of sugar i.e. extraction of juice, clarification, evaporation, concentration of juice, forming and separating crystals etc. These processes consume energies in the form of mechanical energy, electrical energy and heat energy. So there are various sources of waste heat in sugar factory i.e. waste heat from hot flue gasses, hot water from evaporative body and boiler blow down. The large amount of waste heat passes from various devices of sugar factory causes decrease in the efficiency of sugar plants, and also increase the Global Warming which is very dangerous for our environment.

Most of the energies are utilized by the industries due to depletion of fossil fuels and increasing the fuel price to exploit the maximum presented energy from the waste heat source. The sugar industry exhausts excess water carry a considerable amount of thermal energy. This energy can be set in to positive use as a heat source for vapour absorption system to serves as cooling system.

The Identified excess water has a mass flow 10 kg/s and a temperature range of 70-95 C which is enough to provide cooling to factory office area. .The Result of the investigation also showed that the industry could invest in thermally driven cooling system with a payback time of between three to six years depending on the cost of the selected equipment. The Energy savings per crushing season would be nearly 64314kWh which equals to financial savings of above Rs.529304.22 per season.

Keywords—VARS; Waste Heat; Refrigerant; Refrigeration.

I. INTRODUCTION

The demand for air conditioning is also rising which puts further pressure on power generation and distribution. The use of air conditioning enhances productivity and well being but the main cooling device on the market, the vapor compression chiller, is powered by electricity. There are, however, alternative ways of producing cooling, for example thermally driven absorption technology that can use waste heat from already existing industries, instead of electricity [5].

In India, the energy usage has also increased over the years but electricity is in Short supply. Fossil fuels are the main source of energy, causing more emissions of carbon dioxide. Since 2003, the Indian government has initiated several projects to improve energy efficiency, which has successfully reduced the risk and number of blackouts. Still, there are not enough investments being made into renewable resources and the possibility of increasing the utilization of existing resources needs to be further investigated. One possible solution that would lower the electricity consumption caused by air conditioning would be to implement thermally driven cooling in the sugar industry. The sugar industry uses large quantities of water in the production process and It also produces sizeable amounts of waste water which often contain heat that is not utilized. The Indian sugar industries are already second largest among country processing industry.

The sugar industry processes sugar cane and sugar beet to manufacture edible sugar. More than 60% of the world sugar production is from sugar cane, the balance is from sugar beet. Sugar manufacturing is a highly seasonal industry, with season lengths of about 6 to 18 weeks for beets and 20 to 32 weeks for cane. Approximately 10% of the sugar cane can be processed to commercial sugar, using approximately 20 cubic meters of water per metric ton (m3/t) of cane processed. Sugar cane contains 70% water; 14% fiber; 13.3% saccharose (about 10 to 15%sucrose), and 2.7% soluble impurities. Sugar canes are generally washed, after which juice is extracted from them. The juice is clarified to remove mud, evaporated to prepare syrup crystallized to separate out the liquor, and centrifuged to separate molasses from the crystals. Sugar crystals are then dried and may be further refined before bagging for shipment [2].

In some places juice is extracted by a diffusion process that can give higher rates of extraction with lower energy consumption and reduced operating and maintenance costs. Sugar refining involves removal of impurities and decolonization. The steps generally followed include, affixation, melting, clarification, decolonization, evaporation, crystallization, and finishing. Decolonization method use granular activated carbon, powdered activated carbon, ion exchange resins, and other materials.

Absorption cooling is such a solution by utilizing thermally driven cooling where low-grade heat in water can be used to generate cold water, which is distributed to buildings through district cooling. The technology is not new but is still improving and becoming more efficient. There are now devices on the market that can use heat with a driving temperature of as low as 75 C to produce cooling of 6 C[4].

The coefficient of performance (COP) varies to a small extent (0.65-0.75) with the heat source and the cooling water temperatures. Single effect chillers can operate with hot water temperature ranging from about 70C - 95C when water is pressurized.

II. Literature Review

A. Waste Heat

Waste heat is heat, which is generated in a process by way of fuel combustion or chemical reaction, and then dumped into the environment even though it could still be reused for some useful and economic purpose. The essential quality of heat is not the amount but rather its value. The strategy of how to recover this heat depends in part on the temperature of the waste heat gases and the economics involved [2].

B. Benefits of Waste Heat Recovery

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[3].

C. Cooling Method

The most common product on the air conditioning market is the vapor compression method. There are alternative methods of cooling, for example the absorption method. This technology can use waste heat as a driving force.

D. Absorbing Cooling

Since the growing consumption of air conditioning leads to an increased electricity production and more emissions of carbon dioxide, it is pressing to and a better solution in order to achieve a sustainable energy system. An efficient solution would be to produce the energy by using renewable resources or waste products, and to produce cooling directly instead of first generating electricity. Absorption cooling is such a solution by utilizing thermally driven cooling where low grade heat in water can be used to generate cold water, which is distributed to buildings through district cooling. The technology is not new but is still improving and becoming more efficient. There are now devices on the market that can use heat with a driving temperature of as low as 75 C to produce cooling of 6 C. Like vapor compression cooling, the refrigerant in an absorption cooling system is evaporated at a low pressure as heat is absorbed to create a cooling effect. The difference is that the absorption chiller then uses a second refrigerant, the absorbent, which absorbs the first refrigerant, as seen in figure. After heat is emitted from the absorber, still at a low pressure, the solution is in liquid form, containing both the refrigerant and the absorbent. The solution is then pumped to the generator where external heat is added through a heat exchange by utilizing hot water. During this process the refrigerant evaporates and is separated from the absorbent under high pressure. The absorbent returns to the absorber and the refrigerant continues as a vapor to the condenser where heat is emitted and the refrigerant condenses under a high pressure and the entire process is then repeated [5].

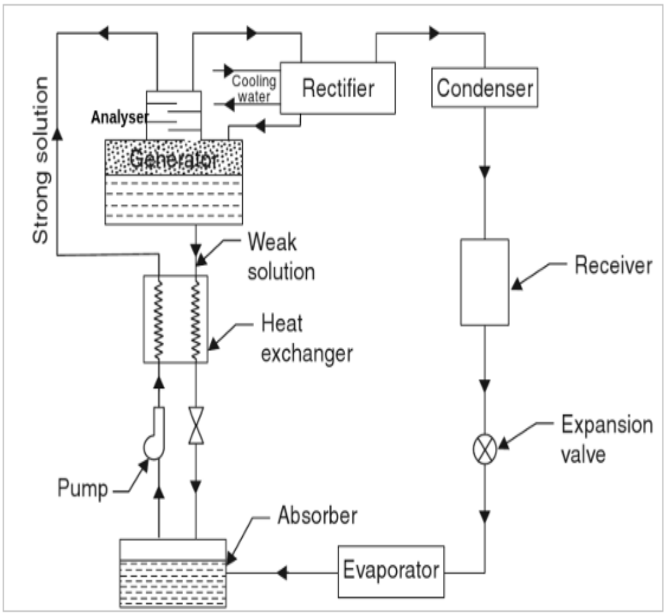

Figure2.D:- Vapour Absorption Cycle

III. Methedology

The study started with an extensive literature study, focusing on the technology of thermally driven cooling, the operational processes of a sugar industry and the effects of an increasing electricity and air Conditioning usage, worldwide and in India. During the project, a study visit was conducted at the sugar industry Karmayogi Shankarraoji Patil Sahakari Sakhar Kharkhana, Bijawadi Maharashtra in India. The crushing season, when the sugar industries produce sugar, usually lasts from the middle of November to March [1].

The mass flow and the temperature of the heated waste water from the sugar factory determine the amount of energy that can be retrieved and used for thermally driven cooling. The sugar concentrations between each process in the production were used to calculate the water mass flows [2]. In order to identify the excess water, separate investigations into certain processes were conducted. The pressure, temperature and mass flow of the water and the sugar juice were used to calculate the mass flow of the excess water which made it possible to determine the cooling supply that can be produced by using the waste heat from the excess water [7].

The capacity, and the amount of electricity needed to power these units, was determined. The cooling demand of the factory estimated by conducting visit & discuss with the employees at the factory. A model based on the calculated possible cooling supply and the estimated cooling demand was used to determine the amount of energy saved and the financial benefits of implementing the project. Thereafter, the results were discussed and conclusions were made based on the results.

IV. Objective

To utilize waste heat from the waste excess heated water and run the vapor absorption system for providing the AC in office factory.

V. Problem Formulation

The consumption of electricity increases even further as air conditioning ownership becomes more widespread, which causes a higher pressure on the power grid. In India, electricity is mainly produced from fossil fuels and the carbon dioxide emissions are substantial. The sugar industries in India produce a considerable amount of waste water that is rarely utilized. To lower the electricity consumption, the low-grade heat from the waste water could be used to produce cooling, but the necessary absorption technology does not exist in India. This study will investigate the potential of using waste heat from the sugar industries in India to implement thermally driven cooling [1].

VI. Aim of Study

The aim of the study is to investigate the possibility of utilizing waste heat from excess water produced by the sugar industries in India. The potential energy savings and financial benefits from utilizing the waste heat by distributing thermally driven cooling to the factory and factory offices are determined .The amount energy that can be obtained from the waste heat from the factory is calculated and compared to the estimated amount of energy needed to power the existing electricity-driven air conditioning units. The data needed is retrieved from one sugar factory, Karmayogi Shankarraoji Patil Sahakari Sakhar Kharkhana in India, but most models will be applicable to other similar sugar industries [1].

VII. Heat Loag Calculation

Table-1 Room Size Details

Length(mm)	78.6
Width(mm)	15
Height(mm)	12
Area(sq.unit)	1179
Volume(cubic unit)	14148
Bypass Factor	0.12
Contact Factor	0.88
Effective Room Total Heat +O.A. Heat	69432
Other Heat Gains@3%	2083
Grand Total Heat	71515
T.R.	5.05

Table-2 Heat Loads

Parameters	Sensible Load	Latent Load
Solar Gain Glass	74	-
Solar & Transmis -sion gain walls & roof	16390	-
Transmission gain expect walls & roof	6236	-
Internal heat	15096	448
Safety factor	4724	22

VIII. Quality of Water Available

Table-3 Water Quality Details

Sr. No.	Parameter	UoM	Results
1.	BOD	mg/lit	60.0
2.	COD	mg/lit	186.0
3.	Oil & Grease	mg/lit	BDL
4.	pH		6.8
5.	Suspended Solids	mg/lit	10.0
6.	Clorides	mg/lit	32.5
7.	Sulphates	mg/lit	62.4
8.	T D Solids	mg/lit	312.0

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