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REVIEW ON CONDENSATE HEAT RECOVERY TECHNIQUES IN STEAM DISTRIBUTION SYSTEM

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ABSTRACT

Condensate recovery is the advanced technique used to improve an efficiency and effectiveness of industry, where steam is a basic heating unit as source of energy. It is one of the technique to recover waste heat which emerging day by day due to its ample advantages. It plays vital role for saving expenditure of steam generation. The objective of this paper is to highlight the importance of condensate in steam distribution network and recover condensate instead of dumping Directly in the atmosphere It has possible to recover waste heat on the basis of fundamental heat transfer principles. The condensate recovery has highlighted by sequential process which mainly includes cross flow heat exchanger (shell and tube type heat exchanger). Understanding of reviewed data recovers 90% to 95% condensate will reuse which contains higher enthalpy and gives off sensible energy for heat transfer. The implementation of condensate recovery technique leads to save in running capital like water charges and fuel charges. Hence it reduces emission norms of polluting substances after burning of fuels such as SO_X, CO_2, NO_X, CO causing the steam distribution system more friendly to the environment.

KEYWORDS: Condensate recovery, Heat exchanger, Sensible energy.

INTRODUCTION

Steam is the most effective and efficient way to supply heat from boiler to the point of application. Steam is usually used for two purposes: 1. To generate electricity via steam power plant. 2. To supply heat via steam distribution system. In today's environmental conditions, steam is one of the cheaper source for heating application as compared to the other resources. Steam can transfer the heat via latent heat and remaining heat is stored in the form of sensible heat shown in Figure 1.

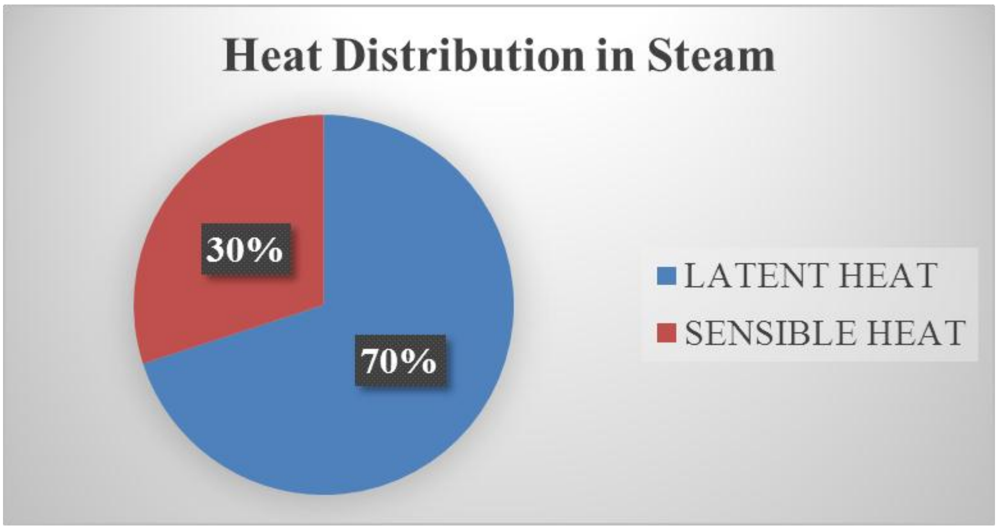

Figure 1: Heat Distribution in steam in steam in percentage.

When steam comes in contact with an atmospheric temperature, it cools and condenses due to which condensate is formed. This condensate contains low pressurized steam termed as flash steam and lot of energy in form of sensible heat which directly dumped to an atmosphere which totally wasted. Hence only partial amount of energy used for heating application. It is valuable resource that contains around 25% useful energy in original steam. In the chemical industry, mostly saturated steam is used which is giving its latent heat to the applications which contains ample proportion of heat. The remainder heat is collected in condensate in the form of sensible heat shown in Figure 2.

Figure 2: Steps to formation of condensate.

The energy in condensate observed more than 10% of total steam energy contains of typical steam. The graph highlighted heat remaining in the condensate at various condensate temperature shown in Figure 3.

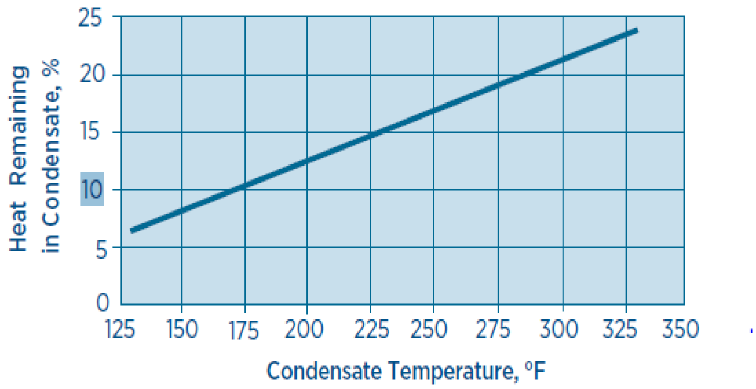

Figure 3: Heat content at various condensate temperatures.

Condensate had discharged through many sources like steam traps from higher pressure to lower pressure. Condensate had its own steam (at low temperature) called as 'flash steam' Condensate at 7 bar observed lose about 13% of its mass when flashed to the atmospheric pressure shown in Figure 4.

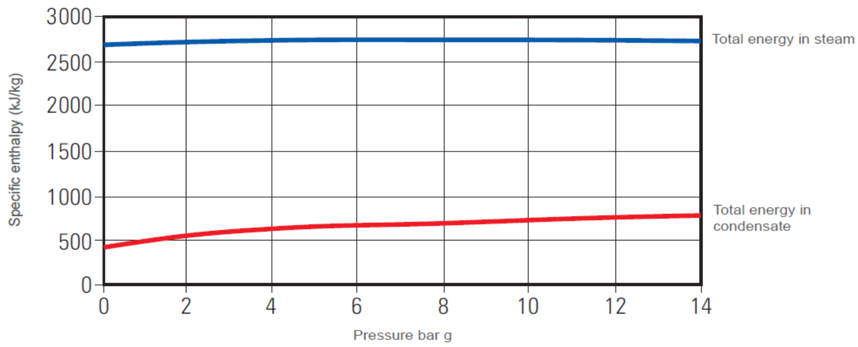

Figure 4: Heat content of steam and condensate at same pressure.

The amount of energy in a kilogram of steam and condensate at same pressure and percentage of energy in condensate to that in steam varied from 18% at 1 bar to 30% at 14 bar. Recovery of condensate retained waste heat for useful operations. Condensate recovery is one of the most energy saving or utilization technique which profitable to the industry and increases its efficiency. If 1 Kg/h of steam supplies to equipment for heating process then same amount of condensate has to discharge from the equipment. Condensate recovery is a process to reuse water and sensible heat contained in the discharged condensate. Condensate reduction occurred by many different ways like sending hot condensate back to the boiler, for any applicable heating system, reusing flash steam, for cleaning equipment or other cleaning application.

Benefits of condensate recovery

1. Condensate is the important resource which contains too much of heat. Recovery of that heat beneficial for the industry which does not produce same heat by boiler. This will save the cost of fuel and cost of water.
2. When ambient water feed into boiler, it required to raise its temperature by using extra heat This maximize boiler output and more steam produced from the boiler.
3. Condensate almost distilled water which does not contains total dissolved solids (TDS). Boilers need to be blow down to reduce their concentration at dissolved solids in boiler water. Thus condensate recovery reduces blow down losses and thus it reduces the energy lost from the boiler and less corrosion in the system.
4. It also serves fuel for heating up water. Thus polluting factors emitted such as SO_X, CO_2, NO_X, CO after burning the fuel which being very hazardous to human health. Hence less pollution will occur and it will make environment -friendly steam distribution system.
5. Condensate recovery line limits vapor clouds to reduce noise generated while discharging from steam strap and help to prevent accumulation of water on the ground, considerably improving a plants work environment.

Paper covered condensate recovery by returning condensate to the boiler from three different plants. Utilization of the sensible heat (approximately 30%) had revealed by used of cross flow heat exchanger which would recover 90% to 95% condensate.

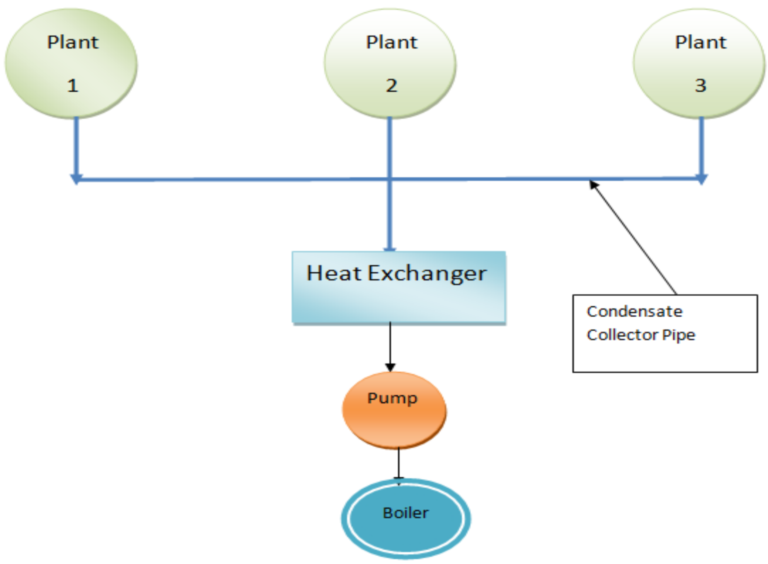

Figure 5: Sequential processing of C. R.

A balanced cross flow heat exchanger referred for condensate recovery. Hence final output temperature of condensate (hot water) observed lower down and output at temperature of cold water will be raised up This temperature in between input temperature of condensate and cold water temperature The value of effectiveness of heat exchanger is vital factor for this output temperature. i.e. effectiveness of heat exchanger is directly proportional to the output of temperature of both hot water and cold water which directly feed into the boiler. This would save in fuel by 7% to 9%.

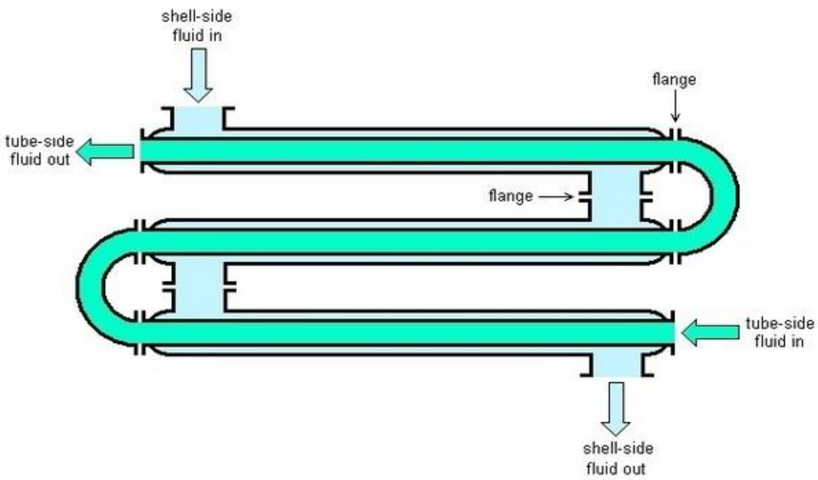

Figure 6: Cross flow heat exchanger.

LITERATURE REVIEW

Cecilia Arzbaecher and Ed Fouche[1] studied industrial waste heat recovery and its benefits and recent advancement. They collected information regarding heat recovery in US manufacturing industry. It confirms that systematic waste heat recovery projects on basis of thermodynamic principle which save energy cost of 10% to 20% with paybacks of 6 to 8 months. Recent advancement in heat recovery technology observed increase the energy saving by 5% to 10% like heat pumps for an industrial building, steam compressor heat pump, thermal oxidizer, heavy recovery boilers, heat exchangers, electric boilers and energy storage distributing generation. R. Loganathan and P. Sivakumar[2] worked on waste heat recovery steam generator in Sponge Iron Plant. Their work significant information about effective utilization of heat which available free of cost without fuel fired. The waste flue gases emitted from industry about 700℃ which had ample sensible heat conserved by implementing a new technology of 'WHRSG' (Waste heat recovery steam generator) for gas cooler by heat recovery and steam generation for better energy conservation and improved thermal efficiency in sponge iron plant. B. B. Yawalkar and S.S. Umale[3] analyzed energy conservation of industrial boiler and steam system. They highlighted recovery of heat by means of flash steam and utilized sensible heat of flash steam by feeding flash steam condensate to cooler storage tank directly. Hence the boiler efficiency had increased from 63% to 78% due to heat added water fed into boiler and amount of fuel saved 230000kg per year due to reduction in water get heated.

Feng Li and Lin Duanmu[4] revealed research and application of flue gas waste heat recovery in cogeneration based on absorption heat exchange Their conservative view of collecting information of heat transfer in process temperature difference. They recovered flue gases based on absorption heat exchange process. This technique had increased efficiency by 38.3% as compared with conventional system. The gas consumption had been decreased by 19.4 million N$m^3/year$ and co2 emission is reduced by 54.7 million.

Vineeth C. and M. G. Prince[5] experimented impact of condensate recovery on boiler fuel consumption in textile sector. They indicated effect on fuel consumption by condensate recovery. They implemented flash steam separator with condensate recovery pump to enhance the feed water temperature and to gain a payback normally less than a year. V. J. Sonawane and A. A. Keste[6] worked on waste heat recovery in textile industry. Steam required for different processes like dyeing, hot rinsing, etc. hence steam generation in boiler required huge amount of fuel. By optimized blow down rate of boiler, it possible to save huge amount of fuel per year. By used of condensate as a feed water for boiler, large saving in fuel had achieved condensate contains 16% of energy as that of steam When pressure reduced, it possible to recover heat from steam in the form of flash steam. Apart from saving of energy, they achieved sustainable development with waste heat recovery as dependence on fossil fuels reduced. They also suggested that, waste heat recovery was possible from hot exhaust air and cooling water. S. C. Walawade and B. R. Barve[7] worked on design and development of waste heat recovery system for domestic refrigerator. They investigated waste heat recovery system and experimented to recover condensate heat from domestic refrigerator of 165 liter. Waste heat rejected from a process at high temperature permitted recovery of energy for some useful purposes. The refrigerating unit rejected considerable amount of heat to the atmosphere through its condensing coil unit. So by suitably retrofitting the waste heat recovery system in the unit, waste heat recovered. Recovered heat utilized as food and snacks warmer, water heater, grain dryer, etc. Udie A. C. et. al.[8] worked on improving condensate recovery using water injection model at dew point pressure. He developed mathematical model equation for improving oil recovery in gas condensate reservoir. The primary input data of the model injected water invasion factor and permeability uniformity factor of the reservoir. This model would maximize pressure maintenance in any gas condensate reservoir and avoid retrograde condensation which could result in low recovery The application of the model good in most gas condensate reservoirs to study the reservoir characterization and estimate the overall fluid recovery factor. Validation of the model depends on successful forecast using the field and laboratory data available. Basil C. Ogbunude et. al.[9] studied enhanced condensate recovery of gas condensate reservoirs. It aimed at identifying the key variables that influence productivity of a gas condensate reservoir under a gas recycling scheme using the design of experiment approach. DOE represents a more effective method for computer-enhanced, systematic approach to experimentation, considering all the factors simultaneously.

CONCLUSION

Condensate heat recovery is an important technique to recover heat from condensate steam distribution system. Flash steam is one of the source of waste steam which is conserved for low pressure required application. Industrial process work incapable to use flash steam due to low pressure but it can be utilized by increasing pressure by pump. Steam distribution system has ample resources of heat which are directly dumped to the atmosphere becomes waste heat. Hence utilization/ recovery that waste heat necessary by adopting a new technique such as heat pump for industrial building, steam compressor heat pump. Thermal oxidizer heat recovery boiler, heat exchanger, electric boiler and energy storage distributing generators to minimize fuel consumptions, reduce harmful emissions (NOX, CO2, CO) and save in running capital for achieving strategic goal of an industry.

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