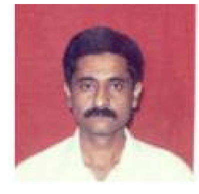
Name: **Harsh Malhotra**
Designation: Manager (PE)
Company name: National Fertilizer Limited, Vijaipur, Guna, MP
Complete postal address: C-80, NFL Township, Vijaipur Distt. Guna-473111, (MP)
Fax no: 07544-273059
Email ID : harshm63@sancharnet.in; harshmalhotra@nfl.co.in



Feasibility of using CHX technology for low temperature flue gas heat recovery in India

Condensing heat exchanger (CHE) was developed to recover waste heat from boilers. Fuel combustion typically produces acidic flue gas. Boilers are designed to avoid corrosion from acidic flue gas by being operated above that temperature at which any condensate can form the so-called dew point. This standard operating practice results in boiler flue gases being released to the atmosphere at temperatures typically between 150 and 200 °C. The consequent lost energy can be partially recovered in a CHE by using the otherwise wasted energy to heat a cold fluid, typically cold water. The most commonly used CHE commercially available uses low alloy construction, with the surfaces exposed to condensing flue gas being Teflon-coated. The company manufacturing this technology, CHX, markets it for heat economizing, but it is obvious that particulates can also be captured and removed with the condensate. CHE in an integrated design can be used for the purpose of combined heat recovery and pollution control, including particulate pollution control. Condensation also occurs on submicron-size particulate, enhancing their removal" by "causing particle growth through agglomeration, and ultimately removing the fine particulates" and also significant Hg removal efficiencies, of around~50%.

The low temperature and large quantities of make-up water present an opportunity to use the flue gases to preheat this water with use of CHX. Historically boiler efficiency has been limited due to the necessity of keeping the flue gas temperature above the water vapor dew point to protect the air heater or economizer from acid based corrosion. If water vapor were allowed to condense out, rapid deterioration, due to acid caused corrosion, of the outlet duct and stack would occur. In the last 10 years condensing heat exchanger (CHX) has been developed.

To prevent corrosion in the CHX, all gas-wetted surfaces are covered with Teflon. The Teflon covered CHX surfaces are impervious to acids normally resulting from the combustion of fossil fuels. This allows the flue gas to be cooled below the water vapor dew point with no subsequent corrosion of the CHX surfaces. The flue gas stream is redirected to the CHX where it is cooled below the water vapor dew point. The cooled flue gas is exhausted through an auxiliary fiberglass stack. This eliminates wet stack problems in the existing exhaust system.

The CHX installation will be used during times the boiler fires natural gas, during times the boiler files oil, the boiler will exhaust in the existing stack and no heat recovery will take place.

Breaking the Dew Point Barrier

Traditionally, recovering heat from exhaust gas has been economically viable only at temperatures above the acid dew point of the gas. Below this point, cold-end corrosion was inevitable, resulting in premature equipment replacement costs. Condensing Heat Exchanger (CHXTM) technology, using an advanced TEFLON® covering, break the dew point barrier, cost-effectively maximizing heat recovery potential, while at the same time helping to remove gas toxics.

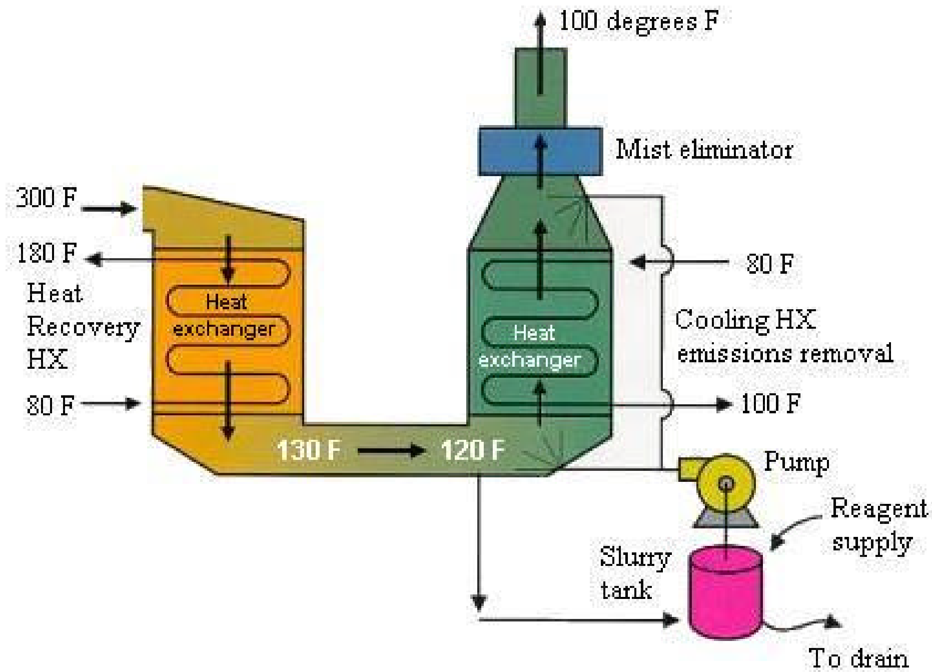
ECONOMIC AND TECHNICAL ADVANTAGES

- Recovers a much higher portion of sensible waste heat than was possible with previous technologies.
- Captures additional latent heat resulting from condensation of water vapor present in the exhaust gas.
- Removes particulates, acid gases and heavy metals to control stack emission
- Boiler operating efficiency of more than 90% can be obtained.
- Direct cash savings in fuel costs can be 10% or more.
- Toxic removal is, at a minimum, comparable to traditional scrubbing equipment and is improved for condensable air toxic substances.
- Return on investment is achievable in as little as 18 month

Cost Savings With CHX System	
Average Boiler Steam Load	45360 Kg / hour
Flue Gas Inlet Temperature	177 degrees C
Flue Gas Outlet Temperature	57 degrees C
Temperature of Water Inlet	16 degrees C
Temperature of Water Outlet	83 degrees C
Sensible KCal Recovery	1504877
Latent KCal Recovery	3,080,519
Fuel Cost	Rs 600 / GCal / Hr
Annual Saving	Rs 200 Lacs

Environmental Advantage of CHX

For superior environmental performance, the Integrated Flue Gas Treatment (IFGT) system expands on the inherent environmental capabilities of the CHX™. Two stages of Condensing Heat Exchanger combine to form a powerful emission fighter. Flue gas passes through one stage of the IFGT system, giving up its heat in preparation for the scrubbing stage. The gas then passes through a reagent spray, which saturates the flue gas in transition to the second unit. The regent spray, combined with condensation effects in the second stage, effectively reduces air toxics.



Over one hundred Condensing Heat Exchangers (CHX), using Teflon-covered tubes, is in use to recover waste heat from oil- and gas-fired flue gas, thereby improving the thermal efficiency of the combustion process. The Teflon coating protects the heat exchanger tubes and shell from acid corrosion as the flue gas temperature is reduced to the water vapor dew point or lower. The Integrated Flue Gas Treatment (IFGT) system uses two stages of condensing heat exchanger, and has demonstrated pollutant removal (SO2, acid gases, and particulate) as well as heat recovery.

Advanced CHXTM and IFGT systems can enhance the economics of power stations, cogeneration and waste-to-energy plants by improving thermal cycle efficiencies. Refineries, chemical plants, pulp and paper mills and other process applications are also excellent examples of industries where converting waste heat to usable energy slashes plant operating costs, while addressing today's critical environmental concerns. An economical solution can be achieved by CHX™ and IFGT systems, whether using oil, natural gas, wood, biomass, coal, refuse-derived fuel or municipal solid waste as fuel. Favorable results can be attained whether using recovered heat in steam cycles, general heating or process applications. Each system is custom-engineered to optimize performance, given the conditions an parameters for each particular application.

Cut Down on Global Warming, Greenhouse Cases

CO_2 is considered the main greenhouse gas which is contributing to the global warming effect. The combustion of fossil fuels is the primary emission source of CO_2. The only way to reduce CO_2 emissions is to Burn less fuel. The CHX™ Teflon covered condensing heat exchanger in a good application will allow less fossil fuel to be burned causing a direct reduction in CO2 and other greenhouse gases. In addition, boiler exhaust flue gases which have passed through the CHX heat exchanger typically enter the environment at 200 degrees F to 250 degree F cooler than from conventional boiler systems without condensing heat recovery. This greatly reduces "thermal" pollution also said to be detrimental to the earth's atmosphere.

USE OF CHX IN INDIAN CONTEXT

Natural gas is recent fuel used by Indian industry. Main use of Natural gas is in fertilizer manufacture (urea) and power production through Gas turbine combined cycle. In the combined cycle where exhaust from GT is used to produce steam in HRSG the CHX technology can be employed. In the stand alone power plants use of this low level heat will be to heat polish water.

For 1Nm³/hr of Natural Gas nearly 10Nm³/hr of combustion air is required. Further in the case of Natural Gas contains mainly methane for which every part of carbon dioxide two parts of water is generated. In the case of Natural gas heat taken by flue gas is much higher due to presence of water vapor formed due to hydrogen in fuel.

Natural gas is a cleaner fuel and use of CHX technology can be employed. In India Natural gas is mainly used for power production and fertilizer manufacture. In power plants boiler exhaust flue gas can be used to preheat the boiler feed water. However in fertilizer plant Natural gas is used as feedstock in primary reformer which is usually a balanced draft furnace having both ID / FD Fans for control of draft. Use of condensing heat exchanger may not be feasible with balance draft furnaces as a retrofit measure.

For natural draft furnaces the ambient temperature will be the constraint for recovering the amount of heat from the flue gases.

Condensing heat exchangers use for coal-fired flue gas, and the pollutant removal capabilities have not been well-defined. The major considerations are the removal efficiency of the condensing heat exchanger for a wide range of pollutants typical of coal combustion, and fly ash laden flue gas affects on the operating lifetime of the Teflon-covered tubes.

Studies have shown that the removal efficiency of the IFGT process for the acid gases SO2, HCl, and HF averaged greater than 95% using a soda ash reagent. SO2 removal averaged 88% using magnesium-enhanced lime reagent. Particulate removal was also quite high, averaging about 93% for coals. Removal of the finest particles smaller than 2.5 microns averaged about 75%. The IFGT process was also effective at removing trace elements in the particle phase, while vapor phase mercury removal ranged from 45% to 60%. Further studies with respect to wear test showed negligible degradation of the Teflon-covered tubes from coal fly ash, and the lifetime of the Teflon covering is not expected to be affected by the presence of fly ash in the flue gas stream. A preliminary economic analysis of the IFGT process compared to traditional limestone forced oxidation wet scrubbing for a 100-MWe plant was completed. The analysis showed the levelized cost of a soda ash based IFGT system to be about the same as limestone wet scrubbing, while a magnesium-enhanced lime IGHT system was about 1/3 less costly than traditional wet scrubbing.

In India bulk of power production is through thermal route (77000MW) and also in process industry coal boilers are used for generation of process steam requirements. Indian coal ash content is higher. This will adversely affect the performance of CHX exchangers due to higher fly ash content in flue gas. How ever integration of CHX with IFGT technology will be feasible depending upon the quality of coal.

Traditionally, the exit temperature leaving an air heater has been limited to around 270-300ºF (130-150ºC) to minimize the potential for acid dew point corrosion when high sulfur fuels were burned. This represents a potential additional source for efficiency improvement especially where a wet FGD system will be quenching the flue gas stream for SO_2 removal anyway. If the plant cycle can be adapted to use the thermal energy directly it is possible to increase plant efficiency by approximately 1% for each 40F (22C) reduction in flue gas temperature. If the energy recovered is incorporated into the steam cycle, however, this gain is significantly smaller. Teflon-coated CHX® heat exchangers offer one technology to recover the heat while preventing corrosion from the condensation of the flue gas acid gas constituents.

The region of the condensing heat exchanger that will experience the most severe wear and abrasion is at the flue gas inlet. This is the area where the flue gas and the particles first comes in contact with TEFLON covered heat exchanger tubes. It is also the region where the flue gas temperature and TEFLON temperature will be the highest.

Following points with respect to use of CHX technology is listed

- Fuel type: NG, OIL, COAL.
- Fuel Composition: Ash content, Sulfur content, C/H ratio.
- Ambient temperature.
- Furnace draft type
- Use of low level heat for preheating Boiler feed water.