Name: **Ramchandra V Nesari**
Designation: Dy. General Manager (Chemicals)
Company name: Rashtriya Chemicals & Fertilizers Ltd.
Complete address: 29A, Technical Building,
RCF, Trombay Unit,
Chembur, MUMBAI- 400074
Fax no: 022-25522235
Email ID : nesarirv@vsnl.net

We are asking our readers about the following:

1. Is this technology feasible to implement in India, if yes, how can we use this
2. Do you already know about this technology and have some practical experience on this?

Send your recommendations, about this technology, including risk factors, pricing, Indian conditions influencing the project (temperature, fuel) and technical practicality of the project in India.

Application of CHX Technology under Indian Conditions

The heat loss from the exhaust flue gas of a boiler is a major source of heat loss affecting the efficiency to the extent of about 15%, which may vary depending on the type of fuel used, its moisture content and ambient air conditions. Traditionally, it is considered that recovering heat from flue gas is technically and economically viable only at temperatures above the acid dew point of the flue gas. Below, this point cold-end corrosion is inevitable resulting into premature equipment failure, which results into more maintenance and replacement costs. Generally a temperature of about 150 ^{0}C to 180 ^{0}C is considered to be a safe lower level limit of the flue gas temperature depending on the type of fuel used. Therefore, the development of new technology CHX for recovering the sensible and latent heat from the waste flue gases is a good news particularly when energy prices are spiraling up. It is claimed that there are more than 130 CHX™ operating systems, which have improved efficiency for a wide spectrum of industries by recovering heat from boiler flue gas; incinerator, furnace and kiln exhausts, textile ovens and dryers; and other process equipment. However, as pointed out in the first paragraph of Issue# 18, adopting this technology under Indian conditions, one should review all technical aspects along with the commercial viability before implementing in their plants.

Analysis of the data given in the write-up o CHX technology along with the issue might be useful in giving an insight to application of CHX technology in Indian conditions vis-a vis conditions in USA. The write-up has included “CHX Performance Calculation Sheets' for four Indian proposal cases viz.for:

1) Tamil Nadu Petro Products.
2) Vardhman Acrylic Ltd.
3) SRF Ltd.
4) NTPC

The write-up has included two existing plants in USA where CHX technology is in use successfully for some years now. To understand the applicability of CHX technology in India, following aspects have to be looked into very carefully.

Technical feasibility:

A comparison is made of the data given in CHX proposals of Indian plants and the data of existing operating plants in USA. A summary of comparison is in Table 1.

Table-1: Summary of comparison of CHX in India and USA

	TN Petro Product	Vardh-man	SRF	NTPC	GE Co. Elect., USA		Anheuser Busch, USA	
					Winter	Summer	Winter	Summer
Flue gas inlet temp., ^{0}F	378	275	383	230	411	411	340	325
Flue gas outlet temp., ^{0}F	117.7	186.8	232.6	164.7	132.2	196.1	129.2	130.4
ΔT flue gas, ^{0}F	260.3	88.2	150.4	65.3	278.8	214.9	210.8	194.6
Design Flue gas water vapour dew point, ^{0}F	116.3	83.7	105.3	105.3	133.7	133.7	135	135
Feed water inlet temp. ^{0}F	86	111	181	104	49	77	40	70
Feed water outlet temp., ^{0}F	174.3	143	220.3	200	173.1	200	136.8	138.4
ΔT waterside, ^{0}F	88.3	32	39.3	96	124	123	96.8	68.4
LMTD, ^{0}F	92.5	101.3	96.7	43.5	147.2	160.7	137.7	111.9
Sensible Heat recovered, MMBtus/hr	2.2198	2.2940	7.4556	25.8405	12.456	9.6014	9.9078	7.2468
Latent Heat recovered, MMBtus/hr.	0.6370	0	0	0.6473	6.2025	1.4045	9.4301	6.4053
Total heat recovery, MMBtus/hr	2.8568	2.2940	7.4556	26.4878	18.659	11.005	19.337	13.6521
Latent heat recovery, % of total heat recovery	28.7	0	0	2.44	33.24	12.76	48.76	46.91
% savings in energy	16.93	10.09	10.63	10.29	19.12	11.2	29.87	28.39
Surface Area of CHX, ft^2	2289.6	2301.0	7670.0	57336	8608	8608	N.A.	N.A.
Overall Heat Transfer Coefficient*, Btu/hrft^2 ^{0}F	13.49	9.84	10	10.6	14.73	7.95	N.A.	N.A.

**Note: Overall Heat Transfer Coefficient is calculated without considering correction factor for cross flow for flue gas.*

It can be seen that in Indian plants, projected savings in energy is from about 10 to 17%. However, in most of the cases it is about 10%. In case of TN Petro Products only, latent heat recovery is about 16.93% of total heat recovery which is near to the existing GE operated plant in winter conditions. In summer conditions the energy savings in GE plant dropped to 11.20 % which are near to Indian conditions. In case of Vardhman and SRF, there is no latent heat recovery. Therefore, adopting to CHX technology in these two cases will not be beneficial. If there is no condensation likely at the exhaust flue gas temperature, it may be worthwhile to go for some other cheaper material which may be more cost effective than going for Teflon coated tubes.

The Indian climatic conditions have impact on the feed water inlet temperature. In most of the cases it is about 90 to 110 ^{0}F. It has influence on the flue gas outlet temperature.

It can be seen that in case of recovery of latent heat, the overall heat transfer improves substantially. Otherwise, it is about 10 Btus/hr ft^2 ^{0}F where only sensible heat is recovered.

As mentioned in the write up, CHX exchanger tubes are coated with Teflon material on the outer surface. The upper limit of operating temperature for Teflon material is 500^{0}F (about 250^{0}C). All care is required to be taken to not exceed this limit even during upset conditions and start-up and shut-downs of the plant installed with CHX exchanger.

At present in USA, CHX exchangers are in service for recovery of heat from oil or gas fired flue gas. The flue gas sent through CHX is required to be clean – free of suspended solid particles. CHX exchangers have not been used in coal fired flue gas. Teflon material may get damaged due to impingement of solid particles. The maintenance and repair aspects of CHX exchanger have to be seen carefully in case of tube failures.

The heat recovery from the flue gas is by heating the boiler feed water. In case of revamping the existing system, energy balance of existing system and the revamping case has to be examined in depth. By revamping the existing system, the overall energy input must reduce. In case of a totally new system, CHX can be incorporated to get the maximum benefit.

In case the heat recovery from flue gases with CHX exchanger generates polluted condensate, its disposal complying with statutory authorities has to be done.

Economic Feasibility

The economic viability has to be established once the technically suitability of CHX exchanger for heat recovery is decided. As mentioned above the application is at present only for heat recovery gas or oil fired flue gases. In the four cases of proposals for Indian industries, the fuel cost is US $ 2.30 to US $ 6.19 per MMBtu excluding the case of SRF where the fuel cost mentioned is US$ 0.0. Therefore, in case of SRF, there is no economic benefit to go for CHX.

In the write-up of CHX, an example is cited where the savings accrued on account of CHX system have been US$ 1000 per day and the payback period of 25 months. The equipment details of the system are not available. However, from the amount savings and the payback period, the investment of about US$ 750,000 and the fuel cost at about US$ 3.30 per MMBtu is estimated. In Indian condition, the heat recovery is not expected to the same level as that in US plant. Therefore the savings are likely to be 60 to 70% that in US plant. Also the equipment cost due to incidence of ocean freight, duties and taxes will be to the tune of 50 to 60% more than the cost in USA. Considering all these aspects the payback period may be order of 54 to 67 months at same energy cost of US$ 3.30 per MMBtu. In case the energy cost is lower as indicated in the case of Vardhman and NTPC, the payback period will be higher to the level of 78 to 96 months. However, if the energy cost is at US$ 6.19 per MMBtu as in the case of Tamil Nadu Petro Products, the payback period may be about 29 to 36 months, which appears to be attractive.

As it appears at present the CHX technology of heat recovery may be attractive for naphtha or oil fired flue gases due to high fuel cost to about US$ 7 to 8 per MMBtu.

The present gas prices in India are about US$ 2 to 2.50 per MMBtu. Therefore, for gas fired flue gases, CHX system may not be attractive in present scenario. However, in near future, due to insufficient indigenous sources of natural gas, India has to depend on Liquefied Natural Gas (LNG) through imports. LNG prices are likely to be higher to the level of US$ 4 to 4.50 per MMBtu. In the LNG scenario, CHX technology may be attractive.

Conclusion

The CHX technology has distinct advantages in recovering the heat from flue gases to the maximum extent including the latent heat of condensate. This is already proven in more than hundred plants in USA. However, its suitability in Indian condition has to be studied on a case to case basis considering the ambient as well as feed water conditions and the disposal of the condensate formed during recovery. In present conditions, it may be attractive in heat recovery from oil fired flue gases. But in future, it may be attractive for heat recovery from gas fired flue gases. For the heat recovery coal fired at present the technology is not yet well proven.