CHX – An American Technology

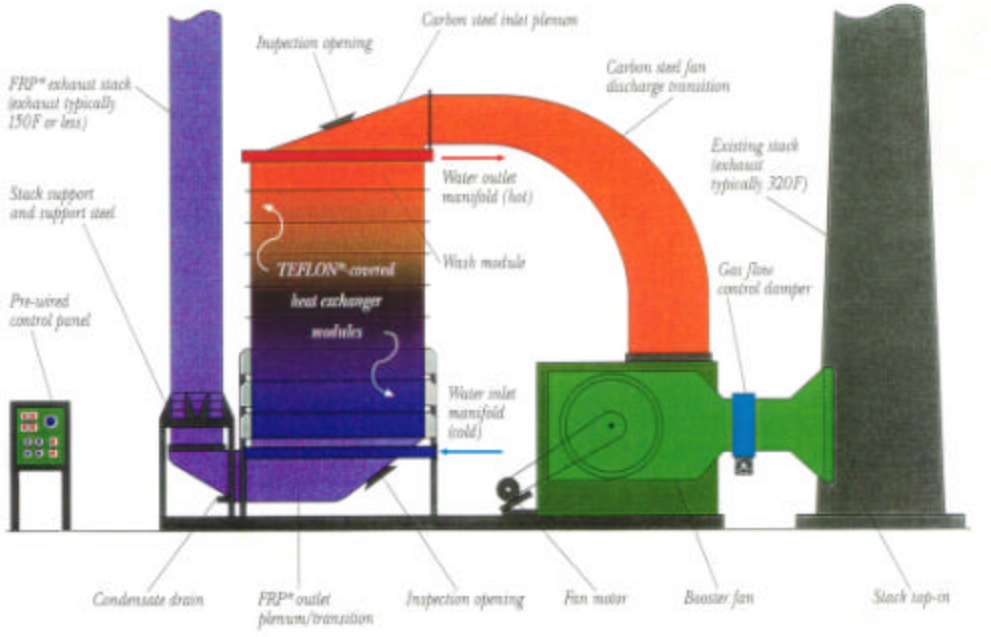
CHX® TEFLON® COVERED CONDENSING HEAT EXCHANGERS FOR FLUE GAS HEAT RECOVERY

Historically, boiler efficiency has been limited due to the minimum temperature allowed for the auxiliary equipment. Heat lost up the stack was in exchange for keeping the flue gas temperature above the water vapor dew point to protect the air heater or economizer from acid corrosion. If water vapor was allowed to condense out, rapid deterioration, due to acid corrosion, of the outlet duct and stack would also occur.

With the development of CHX® condensing heat exchangers, boiler efficiency can now exceed 90%. Approximately 1% gain in boiler efficiency can be expected for every 40º F reduction in flue gas stack temperature.

In the CHX® condensing heat exchanger, all gas wetted surfaces are covered with DuPont Teflon®. The Teflon covered heat exchanger surfaces are impervious to all acids normally resulting from the combustion of fossil fuels. This allows the flue gas to be cooled to below the water vapor dew point with no subsequent corrosion of the heat exchanger surfaces. If this heat is not recovered it will account for a boiler's second largest thermodynamic loss.

In contrast to a conventional flue gas heat exchangers, the CHX Teflon covered heat exchangers are unique in the fact that most cost effective applications have been for heating cold 55º F make-up or process water where latent heat recovery accounts for approximately 33% of the total energy recovered.



PRODUCT DESCRIPTION

CHX condensing heat exchangers use a single gas pass to remove both sensible and latent heat from the flue gas. The flue gas enters the Teflon covered heat exchanger through a carbon steel inlet plenum at the top and flows downward across the horizontal banks of heat exchanger tubes and exits the heat exchanger through an FRP outlet plenum on the bottom of the heat exchanger. The cold water flows through the heat exchanger tubing. For optimum heat recover, the heat sink fluid flows countercurrent to the flue gas.

As the flue gas temperature reaches the water vapor dew point at the tube surfaces, condensation occurs. Due to the hydrophobic nature of Teflon, droplets of condensate form and fall as a constant rain over the tube array. This provides two important advantages. It enhances the latent heat transfer and at the same time keeps the tube surface clean.

The modules are manufactured in a number of different sizes. The variety of module sizes and the modular construction allow the CHX condensing heat exchanger design to be optimized for each application.

The CHX tubing, in water-cooled applications, is 1.125 in. O.D. alloy C70600 covered with a 0.015 in. thick extruded layer of FEP Teflon. The inside surfaces of the heat exchanger shell are covered with a 0.060 in. thick sheet of PTFE Teflon. During fabrication, the tubes are pushed through extruded tube seals in the Teflon covered tube sheet to form a resilient Teflon-to-Teflon seal. This ensures that all heat exchanger surfaces exposed to the flue gas are protected against acid corrosion. Tube connections are made outside of the heat exchanger shell.

To protect the Teflon, maximum flue gas inlet temperature is limited to 500º F. The maximum water inlet pressure and the maximum water outlet temperature are 150 psig and 250º F respectively. CHX heat exchangers are installed as passive systems in order to assure that these limitations will always be met.

The CHX heat exchanger can also be used to heat air. The materials of construction and the maximum operating parameters vary somewhat from above.

APPLICATIONS

The most common application for a CHX condensing heat exchangers is the recovery of waste heat to preheat boiler make-up water. Preheating make-up water can increase boiler efficiency 3-5% or more. The heat recovered by a CHX condensing heat exchanger can offset much of the extraction steam required by a low-pressure feedwater heater or deaerator. This offset will reduce fuel consumption while maintaining a fixed net steam output, or when required, it can increase the net steam output by maintaining the same fixed fuel consumption.

Heating make-up water is not the only heat recovery application for a CHX condensing heat exchanger. CHX units can have a number of other uses in the plant environment. Applications range from building heat to heating process streams in food processing chemical plants, and various pulp and paper applications.

In one actual installation, a midsize industrial plant has been saving an average of $1,000 per day for the past 10 years in energy costs by heating process water with boiler flue gas. The passively installed system utilizes 160,000 pph of 333º F glue gas to heat 550 gpm of process water from 90ºF to 136ºF. The flue gas is cooled to 125 ^{0}F. The additional heat recovery has in effect increased the capacity of the plant without requiring the purchase of another boiler. This CHX heat recovery system paid for itself in less than 25 months.

CHX units can also heat water or process streams indirectly. When a process steam is incompatible with the CHX unit design, water or other liquid heat sinks can be circulated in a closed loop through a CHX condensing heat exchanger. A closed loop system can be used to heat process streams that are abrasive, corrosive or have a pressure higher than the CHX unit design pressure. A closed loop system can also be used for flue gas reheat or in some cases to cool flue gas to a lower temperature where required.

For the past 16 years CHX condensing heat exchangers have successfully demonstrated their ability to operate below the acid and water vapor dew point to recover low level heat from fossil fueled boilers, HRSG'S and process dryers. While a majority of CHX heat exchanger installations have been retrofit applications, there have been several cases where they were included in the heat balance design for new construction or plant expansion.

Based on our experience, the most efficient use for CHX condensing exchangers in the future will be for new construction or plant expansion when the customer and their A&E company engineers recognize in the design phase that there will be a continuous requirement to heat a large volume of cold water for a specific use. When the condensing heat exchanger is an integral part of the total project heat balance design it provides the opportunity to maximize the use of the heat recovered to the benefit of the total system heat balance. Another advantage is that the installation cost is typically lower than the cost to interface with existing equipment in a retrofit application.

Cogeneration operators sometimes sell steam or use steam for district heating when it is not possible or not practical to return the condensate back to the Co-Gen plant. These are ideal applications for CHX condensing heat exchangers however, they must be included in the original plant design so that the heat balance of the HRSG can be designed to obtain the maximum efficiency for the system when the condensing heat exchanger is included.

CHX PERFORMANCE CALCULATION SHEET

COMPANY	TAMIL NADU PETRO PRODUCTS
CHX PROPOSAL NO.	090902
REPRESENTATIVE	
PROPOSAL STATUS	PRELIMINARY
PROPOSAL DATE	SEPTEMBER 9, 2003
APPLICATION	HEAT BOILER MAKEUP WATER

CHX SYSTEM MODEL # 144-60 DW 12

DESIGN PARAMETERS

AVAILABLE FLUE GAS MASS	**33,266**	**LBS/HOUR**
FLUE GAS TEMP @ SOURCE	**378.0**	**DEGREES F**
MAXIMUM WATERFLOW AVAILABLE TO HX	65	GAL/MIN
FLUE GAS WATER VAPOUR DEWPOINT	116.3	DEGREES F
FLUE GAS DENSITY	0.0499	LBS/CU.FT
SPECIFIC HEAT OF FLUE GAS	**0.2556**	**BTU/LB DEG.F**
HOURS OF OPERATION FOR CASE	8400	HOURS/YEAR
FUEL FIRED		No.6 OIL
FUEL COST	$6.19	DOLLARS/MMBTU
EXISTING FUEL TO STEAM EFFICIENCY	83.52	PERCENT
EXISTING THERMAL EFFICIENCY	86.04	PERCENT

HEAT EXCHANGER PERFORMANCE

FLUE GAS MASS FLOW @ HX INLET	33,266	LBS/HOUR
FLUE GAS FLOW @ INLET TO HX	11,117	ACFM
FLUE GAS INLET TEMP	378.0	DEGREES F
FLUE GAS OUTLET TEMPERATURE	117.7	DEGREES F
WATERFLOW THROUGH HX	64.7	GAL/MIN
WATER INLET TEMPERATURE	86.0	DEGREES F
WATER OUTLET TEMPERATURE	174.3	DEGREES F
SENSIBLE HEAT RECOVERED	2,219,813	BTUs/HOUR
LATENT HEAT RECOVERED	636,993	BTUs/HOUR
TOTAL HEAT RECOVERY	**2,856,806**	**BTUs/HOUR**
SAVINGS FOR THIS CASE	$177,846	DOLLARS/YEAR

ENGINEERING DATA

WATERSIDE PRESSURE DROP	4.43	PSIG
THEORITICAL FAN POWER	19	HORSEPOWER
HEAT EXCHANGER FLUE GAS PRESSURE DROP	6.61	IN. W.C.
PLENUM, DUCT AND BREECHING LOSS	0.89	IN. W.C.
CONDENSATE FLOW RATE	1.3	GAL/MIN

TAMIL NADU PETRO 090902 SEPTEMBER 9, 2002

CHX MODEL NO.	144-60	DW 12
HEAT EXCHANGER SURFACE AREA	2,289.60	SQ.FT
NUMBER OF WATER MANIFOLD INLETS/BASE UNIT	18	CONNECTIONS
MINIMUM ALLOWABLE WATERFLOW FOR THIS UNIT	27.0	GAL/MIN
FAN DESIGN CAPACITY	11,17	ACFM
FAN DESIGN COLD STATIC PRESSURE	11.28	IN.W.C.

SYSTEM INFORMATION (EXCLUDING FAN ASSEMBLY)

HEAT EXCHANGER HEIGHT	18.82	FEET
HEAT EXCHANGER DEPTH	5.30	FEET
HEAT EXCHANGER WIDTH	3.00	FEET
DRY WEIGHT	9,127	POUNDS
FLOODED WEIGHT	12,355	POUNDS

Heat Energy recovered from the waste flue gases =2,856,806 BTUs/HR which is above 15% of the total heat generated by the system.

Explanation:

Available flue gases = 33,266 LBS/HR ----- 1
Specific Heat = 0.2556 BTU/LB DEG F ---- 2
Temperature difference = 378F – 100 F (Ambient)= 278 F --- 3

Total Heat in the flue gases = 1 x 2 x 3 = 2,363,776 BTUs/HR
Existing Thermal Efficiency = 86.04%
Therefore, total heat energy produced = 2,363,776 x 7.14
= 16,877,360 BTUs/HR
HEAT RECOVERED THROUGH CHX = 2,856,806 BTUs/HR

$$= \frac{2,856,806}{16,877,360} \times 100 = 16.93\%$$

ENERGY SAVED IN % = 16.93%

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CHX PERFORMANCE CALCULATION SHEET

COMPANY	VARDHMAN ACRYLICS LTD.
CHX PROPOSAL NO.	020203
REPRESENTATIVE	
PROPOSAL STATUS	PRELIMINARY
PROPOSAL DATE	FEBRUARY 2, 2003
APPLICATION	FEED WATER HEATING

CHX SYSTEM MODEL # 336-96 DW 3

DESIGN PARAMETERS

AVAILABLE FLUE GAS MASS	**106,100**	**LBS/HOUR**
FLUE GAS TEMP @ SOURCE	**275.0**	**DEGREES F**
MAXIMUM WATERFLOW AVAILABLE TO HX	143	GAL/MIN
FLUE GAS WATER VAPOUR DEWPOINT	83.7	DEGREES F
FLUE GAS DENSITY	0.0540	LBS/CU.FT
SPECIFIC HEAT OF FLUE GAS	**0.2450**	**BTU/LB DEG.F**
HOURS OF OPERATION FOR CASE	8000	HOURS/YEAR
FUEL FIRED		COAL
COST OF FUEL	$2.46	DOLLARS/MMBTU
EXISTING FUEL TO STEAM EFFICIENCY	80.00	PERCENT
EXISTING THERMAL EFFICIENCY	80.00	PERCENT

HEAT EXCHANGER PERFORMANCE

FLUE GAS MASS FLOW @ HX INLET		106,100	LBS/HOUR
FLUE GAS FLOW @ INLET TO HX		32,747	ACFM
FLUE GAS INLET TEMP		275.0	DEGREES F
FLUE GAS OUTLET TEMPERATURE		186.8	DEGREES F
WATERFLOW THROUGH HX		143.0	GAL/MIN
WATER INLET TEMPERATURE		111.0	DEGREES F
WATER OUTLET TEMPERATURE		143.1	DEGREES F
SENSIBLE HEAT RECOVERED		2,294,015	BTUs/HOUR
LATENT HEAT RECOVERED		0	BTUs/HOUR
TOTAL HEAT RECOVERY		**2,294,015**	**BTUs/HOUR**
SAVINGS FOR THIS CASE	$56,433	DOLLARS/YEAR	

ENGINEERING DATA

WATERSIDE PRESSURE DROP	2.20	PSIG
THEORITICAL FAN POWER	20	HORSEPOWER
HEAT EXCHANGER FLUE GAS PRESSURE DROP	1.54	IN. W.C.
PLENUM, DUCT AND BREECHING LOSS	0.76	IN. W.C.
CONDENSATE FLOW RATE	0.0	GAL/MIN

CHX MODEL NO.	336-96	DW 3
HEAT EXCHANGER SURFACE AREA	2,301.00	SQ.FT
NUMBER OF WATER MANIFOLD INLETS/BASE UNIT	42	CONNECTIONS
MINIMUM ALLOWABLE WATERFLOW FOR THIS UNIT	63.0	GAL/MIN
FAN DESIGN CAPACITY	32,747	ACFM
FAN DESIGN COLD STATIC PRESSURE	3.20	IN.W.C.

SYSTEM INFORMATION (EXCLUDING FAN ASSEMBLY)

HEAT EXCHANGER HEIGHT	11.20	FEET
HEAT EXCHANGER DEPTH	8.30	FEET
HEAT EXCHANGER WIDTH	6.50	FEET
DRY WEIGHT	9,286	POUNDS
FLOODED WEIGHT	12,265	POUNDS

Heat Energy recovered from the waste flue gases =2,294,015 BTUs/HR which is about 10% of the total heat generated by the system.

Explanation:

Available flue gases = 106,100 LBS/HR ----- 1
Specific Heat = 0.2450 BTU/LB DEG F ---- 2
Temperature difference = 275F – 100 F (Ambient)= 175 F ---- 3

Total Heat in the flue gases = 1 x 2 x 3 = 4549038 BTUs/HR
Existing Thermal Efficiency = 80%
Therefore, total heat energy produced = 4,549,038x 5
= 22,745,190 BTUs/HR
HEAT RECOVERED THROUGH CHX = 2,294,015 BTUs/HR

$$= \frac{2,294,015}{22,745,190} \times 100 = 10.09\%$$

ENERGY SAVED IN % = 10.09%

CHX PERFORMANCE CALCULATION SHEET

COMPANY	SRF LTD.
CHX PROPOSAL NO.	2103
REPRESENTATIVE	
PROPOSAL STATUS	PRELIMINARY
PROPOSAL DATE	MARCH 21, 2003
APPLICATION	FEED WATER HEATING

CHX SYSTEM MODEL # 2-336-96 DW 5

DESIGN PARAMETERS

AVAILABLE FLUE GAS MASS	**198,238**	**LBS/HOUR**
FLUE GAS TEMP @ SOURCE	**383.0**	**DEGREES F**
MAXIMUM WATERFLOW AVAILABLE TO HX	380	GAL/MIN
FLUE GAS WATER VAPOUR DEWPOINT	105.3	DEGREES F
FLUE GAS DENSITY	0.0470	LBS/CU.FT
SPECIFIC HEAT OF FLUE GAS	**0.2500**	**BTUs/LB DEG.F**
HOURS OF OPERATION FOR CASE	8050	HOURS/YEAR
FUEL FIRED		FUEL OIL
FUEL COST	$0.00	DOLLARS/MMBTU
EXISTING FUEL TO STEAM EFFICIENCY	80.00	PERCENT
EXISTING THERMAL EFFICIENCY	80.00	PERCENT

HEAT EXCHANGER PERFORMANCE

FLUE GAS MASS FLOW @ HX INLET	198,238	LBS/HOUR
FLUE GAS FLOW @ INLET TO HX	70,297	ACFM
FLUE GAS INLET TEMP	383.0	DEGREES F
FLUE GAS OUTLET TEMPERATURE	232.6	DEGREES F
WATERFLOW THROUGH HX	380.0	GAL/MIN
WATER INLET TEMPERATURE	181.0	DEGREES F
WATER OUTLET TEMPERATURE	220.3	DEGREES F
SENSIBLE HEAT RECOVERED	7,455,607	BTUs/HOUR
LATENT HEAT RECOVERED	0	BTUs/HOUR
TOTAL HEAT RECOVERY	**7,455,607**	**BTUs/HOUR**

ENGINEERING DATA

WATERSIDE PRESSURE DROP	5.04	PSIG
THEORITICAL FAN POWER	56	HORSEPOWER
HEAT EXCHANGER FLUE GAS PRESSURE DROP	2.56	IN. W.C.
PLENUM, DUCT AND BREECHING LOSS	0.80	IN. W.C.
CONDENSATE FLOW RATE	0.0	GAL/MIN

SRF LIMITED 2103 MARCH 21, 2003

CHX MODEL NO.	2-336-96	DW 5
HEAT EXCHANGER SURFACE AREA	7,670.00	SQ.FT
NUMBER OF WATER MANIFOLD INLETS/BASE UNIT	21	CONNECTIONS
MINIMUM ALLOWABLE WATERFLOW FOR THIS UNIT	63.0	GAL/MIN
FAN DESIGN CAPACITY	70,297	ACFM
FAN DESIGN COLD STATIC PRESSURE	5.36	IN.W.C.

SYSTEM INFORMATION (EXCLUDING FAN ASSEMBLY)

HEAT EXCHANGER HEIGHT	13.48	FEET
HEAT EXCHANGER DEPTH	8.30	FEET
HEAT EXCHANGER WIDTH	13.00	FEET
DRY WEIGHT	27,484	POUNDS
FLOODED WEIGHT	37,414	POUNDS

Heat Energy recovered from the waste flue gases =7,455,607 BTUs/HR which is about 10% of the total heat generated by the system.

Explanation:

Available flue gases = 198,238 LBS/HR ---- 1
Specific Heat = 0.2500 BTU/LB DEG F ---- 2
Temperature difference = 383 F – 100 F (Ambient)= 283 F ---- 3

Total Heat in the flue gases = 1 x 2 x 3 = 14025338 BTUs/HR
Existing Thermal Efficiency = 80%
Therefore, total heat energy produced = 14,025,338 x 5
= 70,126,690 BTUs/HR
HEAT RECOVERED THROUGH CHX = 7,445,607 BTUs/HR

$$= \frac{7,445,607}{70,126,690} \times 100 = 10.63\%$$

ENERGY SAVED IN % = 10.63%

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CHX PERFORMANCE CALCULATION SHEET

COMPANY	NTPC
CHX PROPOSAL NO.	111202-A
REPRESENTATIVE	
PROPOSAL STATUS	PRELIMINARY
PROPOSAL DATE	NOVEMBER 12, 2003
APPLICATION	FEED WATER HEATING

CHX SYSTEM MODEL # 4-416-240 DW 6

DESIGN PARAMETERS

AVAILABLE FLUE GAS MASS	**1,584,000**	**LBS/HOUR**
FLUE GAS TEMP @ SOURCE	**230.0**	**DEGREES F**
MAXIMUM WATERFLOW AVAILABLE TO HX	550	GAL/MIN
FLUE GAS WATER VAPOUR DEWPOINT	105.3	DEGREES F
FLUE GAS DENSITY	0.0576	LBS/CU.FT
SPECIFIC HEAT OF FLUE GAS	**0.2500**	**BTU/LB DEG.F**
HOURS OF OPERATION FOR CASE	7920	HOURS/YEAR
FUEL FIRED		NATURAL GAS
FUEL COST	$2.30	DOLLARS/MMBTU
EXISTING FUEL TO STEAM EFFICIENCY	80.00	PERCENT
EXISTING THERMAL EFFICIENCY	80.00	PERCENT

HEAT EXCHANGER PERFORMANCE

FLUE GAS MASS FLOW @ HX INLET	1,584,000	LBS/HOUR
FLUE GAS FLOW @ INLET TO HX	458,333	ACFM
FLUE GAS INLET TEMP	230.0	DEGREES F
FLUE GAS OUTLET TEMPERATURE	164.7	DEGREES F
WATERFLOW THROUGH HX	550.0	GAL/MIN
WATER INLET TEMPERATURE	104.0	DEGREES F
WATER OUTLET TEMPERATURE	200.0	DEGREES F
SENSIBLE HEAT RECOVERED	25,840,529	BTUs/HOUR
LATENT HEAT RECOVERED	647,260	BTUs/HOUR
TOTAL HEAT RECOVERY	**26,487,789**	**BTUs/HOUR**
SAVINGS FOR THIS CASE	$603,127	DOLLARS/YEAR

ENGINEERING DATA

WATERSIDE PRESSURE DROP	3.66	PSIG
THEORITICAL FAN POWER	380	HORSEPOWER
HEAT EXCHANGER FLUE GAS PRESSURE DROP	3.70	IN. W.C.
PLENUM, DUCT AND BREECHING LOSS	0.00	IN. W.C.
CONDENSATE FLOW RATE	1.3	GAL/MIN

CHX MODEL NO.	4-416-240	DW 6
HEAT EXCHANGER SURFACE AREA	57,336.00	SQ.FT
NUMBER OF WATER MANIFOLD INLETS/BASE UNIT	13	CONNECTIONS
MINIMUM ALLOWABLE WATERFLOW FOR THIS UNIT	78.0	GAL/MIN
FAN DESIGN CAPACITY	458,333	ACFM
FAN DESIGN COLD STATIC PRESSURE	4.82	IN.W.C.

SYSTEM INFORMATION (EXCLUDING FAN ASSEMBLY)

HEAT EXCHANGER HEIGHT	15.61	FEET
HEAT EXCHANGER DEPTH	20.30	FEET
HEAT EXCHANGER WIDTH	36.00	FEET
DRY WEIGHT	180,572	POUNDS
FLOODED WEIGHT	252,716	POUNDS

Heat Energy recovered from the waste flue gases =26,487,789 BTU/HR which is about 10% of the total heat generated by the system.

Explanation:

Available flue gases = 1584000 LBS/HR ----- 1
Specific Heat = 0.2500 BTU/LB DEG F ---- 2
Temperature difference = 230 F – 100 F (Ambient)= 130 F ---- 3

Total Heat in the flue gases = 1 x 2 x 3 = 51,480,000 BTUs/HR

Existing Thermal Efficiency = 80%

Therefore, total heat energy produced = 51,480,000 x 5
= 257,400,000 BTUs/HR
HEAT RECOVERED THROUGH CHX = 26,487,789 BTUs/HR

$$= \frac{26,487,789}{257,400,000} \times 100 = 10.29\%$$

ENERGY SAVED IN % = 10.29%

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CHX PERFORMANCE CALCULATION SHEET

(EXISTING PLANT OF GENERAL ELECTRIC CO. USA)

COMPANY	GENERAL ELECTRIC COMPANY
LOCATION	WATERFORD, NY, USA
CHX PROPOSAL NO.	091200
REPRESENTATIVE	STEAM PLANT SYSTEMS, INC.
PROPOSAL STATUS	FINAL DESIGN
PROPOSAL DATE	SEPTEMBER 12, 2000
APPLICATION	HEAT BOILER MAKEUP WATER

CHX SYSTEM MODEL # 144-108 DW8

AVERAGE WINTER PERFORMANCE (6 months)

DESIGN PARAMETERS

AVAILABLE FLUE GAS MASS	**224,424**	**LBS/HOUR**
FLUE GAS TEMP @ SOURCE	**411.0**	**DEGREES F**
MAXIMUM WATERFLOW AVAILABLE TO HX	302	GAL/MIN
FLUE GAS WATER VAPOUR DEWPOINT	133.7	DEGREES F
FLUE GAS DENSITY	0.0459	LBS/CU.FT
SPECIFIC HEAT OF FLUE GAS	**0.2658**	**BTU/LB DEG.F**
HOURS OF OPERATION FOR CASE	4380	HOURS/YEAR
FUEL FIRED		NATURAL GAS
FUEL COST	$5.56	DOLLARS/MMBTU
EXISTING FUEL TO STEAM EFFICIENCY	79.56	PERCENT
EXISTING THERMAL EFFICIENCY	81.04	PERCENT

HEAT EXCHANGER PERFORMANCE

FLUE GAS MASS FLOW @ HX INLET	168,095	LBS/HOUR
FLUE GAS FLOW @ INLET TO HX	61,020	ACFM
FLUE GAS INLET TEMP	411.0	DEGREES F
FLUE GAS OUTLET TEMPERATURE	132.2	DEGREES F
WATERFLOW THROUGH HX	302.0	GAL/MIN
WATER INLET TEMPERATURE	49.0	DEGREES F
WATER OUTLET TEMPERATURE	173.1	DEGREES F
SENSIBLE HEAT RECOVERED	12,456,800	BTUs/HOUR
LATENT HEAT RECOVERED	6,202,541	BTUs/HOUR
TOTAL HEAT RECOVERY	**18,659,340**	**BTUs/HOUR**
SAVINGS FOR THIS CASE	$571,160	DOLLARS/YEAR

ENGINEERING DATA

WATERSIDE PRESSURE DROP	11.95	PSIG
THEORITICAL FAN POWER	91	HORSEPOWER
HEAT EXCHANGER FLUE GAS PRESSURE DROP	6.08	IN. W.C.
PLENUM, DUCT AND BREECHING LOSS	1.00	IN. W.C.
CONDENSATE FLOW RATE	12.3	GAL/MIN

CHX PERFORMANCE CALCULATION SHEET

AVERAGE SUMMER PERFORMANCE (6 months)

DESIGN PARAMETERS

AVAILABLE FLUE GAS MASS	**224,424**	**LBS/HOUR**
FLUE GAS TEMP @ SOURCE	**411.0**	**DEGREES F**
MAXIMUM WATERFLOW AVAILABLE TO HX	302	GAL/MIN
FLUE GAS WATER VAPOUR DEWPOINT	133.7	DEGREES F
FLUE GAS DENSITY	0.0459	LBS/CU.FT
SPECIFIC HEAT OF FLUE GAS	**0.2658**	**BTU/LB DEG.F**
HOURS OF OPERATION FOR CASE	4380	HOURS/YEAR
FUEL FIRED		NATURAL GAS
FUEL COST	$5.56	DOLLARS/MMBTU
EXISTING FUEL TO STEAM EFFICIENCY	79.56	PERCENT
EXISTING THERMAL EFFICIENCY	81.04	PERCENT

HEAT EXCHANGER PERFORMANCE

FLUE GAS MASS FLOW @ HX INLET	168,095	LBS/HOUR
FLUE GAS FLOW @ INLET TO HX	61,020	ACFM
FLUE GAS INLET TEMP	411.0	DEGREES F
FLUE GAS OUTLET TEMPERATURE	196.1	DEGREES F
WATERFLOW THROUGH HX	179.0	GAL/MIN
WATER INLET TEMPERATURE	77.0	DEGREES F
WATER OUTLET TEMPERATURE	200.0	DEGREES F
SENSIBLE HEAT RECOVERED	9,601,379	BTUs/HOUR
LATENT HEAT RECOVERED	1,404,482	BTUs/HOUR
TOTAL HEAT RECOVERY	**11,005,861**	**BTUs/HOUR**
SAVINGS FOR THIS CASE	$336,888	DOLLARS/YEAR

ENGINEERING DATA

WATERSIDE PRESSURE DROP	4.34	PSIG
THEORITICAL FAN POWER	94	HORSEPOWER
HEAT EXCHANGER FLUE GAS PRESSURE DROP	6.38	IN. W.C.
PLENUM, DUCT AND BREECHING LOSS	1.00	IN. W.C.
CONDENSATE FLOW RATE	2.9	GAL/MIN
HEAT EXCHANGER SURFACE AREA	8,608.00	SQ.FT
NUMBER OF WATER MANIFOLD INLETS/BASE UNIT	52	CONNECTIONS
MINIMUM ALLOWABLE WATERFLOW FOR THIS UNIT	78.0	GAL/MIN
FAN DESIGN CAPACITY	61,020	ACFM
FAN DESIGN COLD STATIC PRESSURE	12.05	IN.W.C.
HEAT EXCHANGER HEIGHT	18.58	FEET
HEAT EXCHANGER DEPTH	9.00	FEET
HEAT EXCHANGER WIDTH	9.30	FEET
DRY WEIGHT	33,601	POUNDS
FLOODED WEIGHT	44,001	POUNDS
TOTAL SAVINGS FOR SUMMER & WINTER	$908,048	DOLLARS/YEAR

BENEFITS ACCRUED THROUGH CHX

WINTER CONDITION:

Heat Energy recovered from the waste flue gases =18,659,340BTUs/HR which is close to 20% of the total heat generated by the system.

Explanation:

Available flue gases = 224,424 LBS/HR ----- 1
Specific Heat = 0.2658 BTU/LB DEG F ---- 2
Temperature difference = 411 F – 100 F (Ambient)= 311 F --- 3

Total Heat in the flue gases = 1 x 2 x 3 = 18,551,741 BTUs/HR
Existing Thermal Efficiency = 81.04%
Therefore, total heat energy produced = 18,551,741 x 5.26
= 97582158 BTUs/HR
HEAT RECOVERED THROUGH CHX = 18,659,340 BTUs/HR

$$= \frac{18,659,340}{97582158} \times 100 = 19.12\ \%$$

ENERGY SAVED IN % = 19.12%

SUMMER CONDITIONS:

Heat Energy recovered from the waste flue gases =18,659,340BTUs/HR which is more than 10% of the total heat generated by the system.

Explanation:

Available flue gases = 224,424 LBS/HR ----- 1
Specific Heat = 0.2658 BTU/LB DEG F ---- 2
Temperature difference = 411 F – 100 F (Ambient)= 311 F --- 3

Total Heat in the flue gases = 1 x 2 x 3 = 18,551,741 BTUs/HR
Existing Thermal Efficiency = 81.04%
Therefore, total heat energy produced = 18,551,741 x 5.26
= 97,582,158 BTUs/HR
HEAT RECOVERED THROUGH CHX = 11,005,861 BTUs/HR

$$= \frac{11,005,861}{97,582,158} \times 100 = 11.28\ \%$$

ENERGY SAVED IN % = 11.28%

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CHX PERFORMANCE CALCULATION SHEET

(EXISTING PLANT OF ANHEUSER BUSCH INC., USA)

COMPANY	ANHEUSER BUSCH
LOCATION	BALDWINSVILLE, NY, USA
CHX PROPOSAL NO.	999-01
REPRESENTATIVE	STEAM PLANT SYSTEMS, INC.
PROPOSAL STATUS	FINAL DESIGN
YEAR OF INSTALLATION	1986
APPLICATION	PROCESS WATER HEATING
	400,000 LBS/HOUR

CHX SYSTEM MODEL # 416-160 DW 7

WINTER CONDITION

DESIGN PARAMETERS

AVAILABLE FLUE GAS MASS	**176,278**	**LBS/HOUR**
FLUE GAS TEMP @ SOURCE	**340.0**	**DEGREES F**
MAXIMUM WATERFLOW AVAILABLE TO HX	400	GAL/MIN
FLUE GAS WATER VAPOUR DEWPOINT	135.0	DEGREES F
FLUE GAS DENSITY	0.0500	LBS/CU.FT
SPECIFIC HEAT OF FLUE GAS	**0.2666**	**BTU/LB DEG.F**
HOURS OF OPERATION FOR CASE	2190	HOURS/YEAR
FUEL FIRED		NATURAL GAS
FUEL COST	$6.00	DOLLARS/MMBTU
EXISTING FUEL TO STEAM EFFICIENCY	81.11	PERCENT
EXISTING THERMAL EFFICIENCY	82.59	PERCENT

HEAT EXCHANGER PERFORMANCE

FLUE GAS MASS FLOW @ HX INLET	176,278	LBS/HOUR
FLUE GAS FLOW @ INLET TO HX	58,744	ACFM
FLUE GAS INLET TEMP	340.0	DEGREES F
FLUE GAS OUTLET TEMPERATURE	129.2	DEGREES F
WATERFLOW THROUGH HX	400.0	GAL/MIN
WATER INLET TEMPERATURE	40.0	DEGREES F
WATER OUTLET TEMPERATURE	136.8	DEGREES F
SENSIBLE HEAT RECOVERED	9,907,827	BTUs/HOUR
LATENT HEAT RECOVERED	9,430,083	BTUs/HOUR
TOTAL HEAT RECOVERY	**19,337,909**	**BTUs/HOUR**
SAVINGS FOR THIS CASE	$313,278	DOLLARS/YEAR

ENGINEERING DATA

WATERSIDE PRESSURE DROP	24.13	PSIG
THEORITICAL FAN POWER	43	HORSEPOWER
HEAT EXCHANGER FLUE GAS PRESSURE DROP	2.32	IN. W.C.
PLENUM, DUCT AND BREECHING LOSS	0.69	IN. W.C.
CONDENSATE FLOW RATE	18.6	GAL/MIN

CHX PERFORMANCE CALCULATION SHEET

SUMMER CONDITION

DESIGN PARAMETERS

AVAILABLE FLUE GAS MASS	**139,681**	**LBS/HOUR**
FLUE GAS TEMP @ SOURCE	**325.0**	**DEGREES F**
MAXIMUM WATERFLOW AVAILABLE TO HX	400	GAL/MIN
FLUE GAS WATER VAPOUR DEWPOINT	135.0	DEGREES F
FLUE GAS DENSITY	0.0510	LBS/CU.FT
SPECIFIC HEAT OF FLUE GAS	**0.2666**	**BTU/LB DEG.F**
HOURS OF OPERATION FOR CASE	2190	HOURS/YEAR
FUEL FIRED		NATURAL GAS
FUEL COST	$6.00	DOLLARS/MMBTU
EXISTING FUEL TO STEAM EFFICIENCY	81.11	PERCENT
EXISTING THERMAL EFFICIENCY	82.59	PERCENT

HEAT EXCHANGER PERFORMANCE

FLUE GAS MASS FLOW @ HX INLET	139,681	LBS/HOUR
FLUE GAS FLOW @ INLET TO HX	45,675	ACFM
FLUE GAS INLET TEMP	325.0	DEGREES F
FLUE GAS OUTLET TEMPERATURE	130.4	DEGREES F
WATERFLOW THROUGH HX	400.0	GAL/MIN
WATER INLET TEMPERATURE	70.0	DEGREES F
WATER OUTLET TEMPERATURE	138.4	DEGREES F
SENSIBLE HEAT RECOVERED	7,246,796	BTUs/HOUR
LATENT HEAT RECOVERED	6,405,281	BTUs/HOUR
TOTAL HEAT RECOVERY	**13,652,077**	**BTUs/HOUR**
SAVINGS FOR THIS CASE	$221,167	DOLLARS/YEAR

ENGINEERING DATA

WATERSIDE PRESSURE DROP	24.13	PSIG
THEORITICAL FAN POWER	23	HORSEPOWER
HEAT EXCHANGER FLUE GAS PRESSURE DROP	1.50	IN. W.C.
PLENUM, DUCT AND BREECHING LOSS	0.42	IN. W.C.
CONDENSATE FLOW RATE	12.7	GAL/MIN

BENEFITS ACCRUED THROUGH CHX

WINTER CONDITION:

Heat Energy recovered from the waste flue gases =19,337,909 BTUs/HR which is close to 30% of the total heat generated by the system.

Explanation:

Available flue gases	**= 176,278**	**LBS/HR**	**-----**	**1**
Specific Heat	**= 0.2666**	**BTU/LB DEG F**	**----**	**2**
Temperature difference	**= 340 F – 100 F (Ambient)= 240 F**		**---**	**3**

Total Heat in the flue gases = 1 x 2 x 3 = 11,278,972 BTUs/HR
Existing Thermal Efficiency = 82.59%
Therefore, total heat energy produced = 11,278,972 x5.74
= 64,741,299 BTUs/HR
HEAT RECOVERED THROUGH CHX = 19,337,909 BTUs/HR

$$= \frac{19,337,909}{64,741,299} \times 100 = 29.87\ \%$$

ENERGY SAVED IN % = 29.87%

SUMMER CONDITIONS:

Heat Energy recovered from the waste flue gases =13,652,077 BTUs/HR which is Close to 30% of the total heat generated by the system.

Explanation:

Available flue gases	**= 139,681**	**LBS/HR**	**-----**	**1**
Specific Heat	**= 0.2666**	**BTU/LB DEG F**	**----**	**2**
Temperature difference	**= 325 F – 100 F (Ambient)= 225 F**		**---**	**3**

Total Heat in the flue gases = 1 x 2 x 3 = 8,378,765 BTUs/HR
Existing Thermal Efficiency = 82.59%
Therefore, total heat energy produced = 8,378,765 x 5.74
= 48,094,111 BTUs/HR
HEAT RECOVERED THROUGH CHX = 13,652,077 BTUs/HR

$$= \frac{13,652,077}{48,094,111} \times 100 = 28.39\ \%$$

ENERGY SAVED IN % = 28.39%

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