Heat recovery in paper mills

with pillow plate heat exchangers

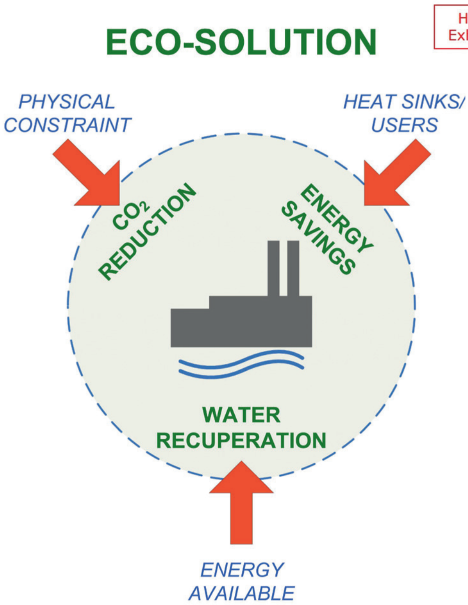
This article looks at the recovery of waste heat in the papermaking industry and stresses the advantages that can be achieved through using pillow plate heat exchangers in this process.

By Chelsey Kemper, Omega Thermo Products LLC, Lawrence Yane, Enerquin Air

The importance of heat recovery

A significant amount of waste heat is generated as a by-product of the papermaking process. Most of this heat cannot be reused directly in the process as it has a high level of humidity and/or contains unwanted gaseous or particulate contamination. Heat recovery equipment (Fig. 1) is a key element of energy-efficient mill operations, providing:

- Competitiveness through energy savings
- Greenhouse gas emissions reduction
- Reduced boiler load



» *Fig. 1. Energy savings in a paper mill.*

Planning economically-viable heat recovery projects

Planning a potential heat recovery project requires a quantitative analysis of the potential heat sources and heat sinks (see Table 1).

Return on investment is a key factor when comparing various potential heat recovery projects and depends on:

- Total project cost: in general, using a source having a higher heat capacity results in smaller, less expensive heat recovery equipment.
- Calculated annual energy savings: only recovered heat that is useful shall factor into this calculation (i.e. heat recovery for building ventilation is normally not required during the warmer months).

Multi-stage heat recovery

The largest consumer of thermal energy in the papermaking process is the dryer section. The dryer section/hood exhaust represents one of the largest sources of energy that can be recovered economically. Fig. 2 shows a concept involving multiple stages of heat recovery in series.

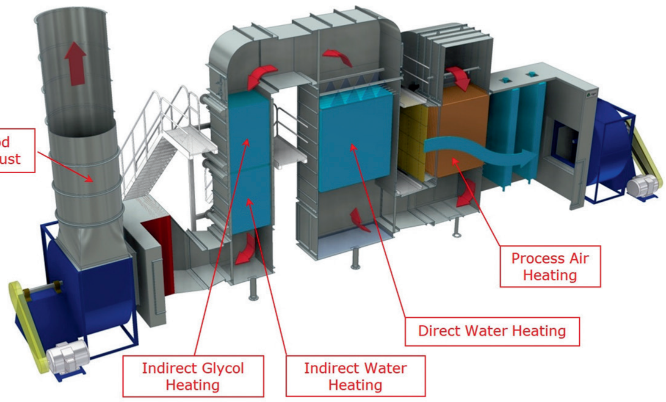


Fig. 2. Four stage heat recovery at a paper mill.

The first stage of heat recovery typically involves extracting sensible heat from the exhaust stream to preheat clean, dry process air that is required by the dryer section. The exhaust stream exiting this stage will be close to saturation, leaving primarily latent heat available for subsequent heat recovery. This latent heat can then be used to heat fluids using a direct exchange (Stage 2) and/or an indirect exchange (Stage 3). In a direct heat exchange process, some contaminants/fibers that are present in the exhaust stream will be transferred to the fluid that is being heated. In applications where the heated fluid must remain clean, indirect heat recovery is the ideal solution so post-process filtration systems become unnecessary.
The indirect heat exchange is done using laser welded stainless steel plate heat exchangers. The pillowed shape of the heat exchanger creates turbulence inside the plate so there is a high rate of heat transfer between the air on the outside of the exchanger and the fluid on the inside. Laser welding provides flexibility in design and baffles can be created to direct fluid flow in the plate for better efficiency as well as flexible placement of inlet and outlet connection

» *Table 1 - Potential sources and sinks for heat recovery projects.*

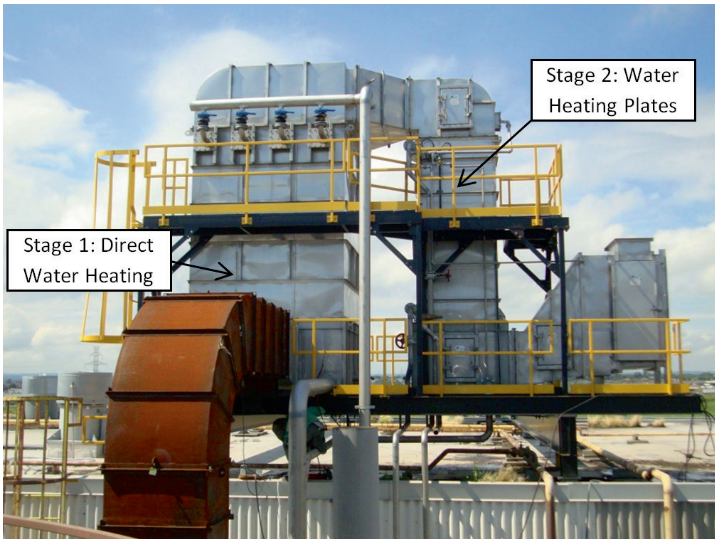
Heat sources	Heat sinks
· Paper or tissue machine hood exhaust	· Hood supply air
· Boiler exhaust	· Building air make-up
· Vacuum pump exhaust	· Wet end false ceiling supply
· Turbo blower exhaust	· Clean water
	· White water
	· Glycol for building heating

locations. These plates are on average approximately 0.35-inch thick. Several of these plates can be banked together with lengths up to 30 feet to achieve the required heating load. There is a common inlet and outlet header for the fluid and the plates are enclosed in ductwork for easy connection to the process air duct work. Heat recovery exchangers are customizable and manufactured on a case by case basis depending on customer needs.

Case study: indirect water heating plates

Heated water is often required at paper and tissue mills for various applications. Enerquin Air (Montreal, Quebec, Canada) supplied a two-stage heat recovery system to a tissue mill using hood exhaust as the energy source. Stage 1 used a direct water heat recovery process, where the heated fluid was mixed with white water as part of the pulp process.

Stage 2 used an indirect heat recovery process to heat water that would be used with cleaning showers. For this application, the heated water had to remain clean so as to minimize the risk of clogging the nozzles with contaminants from the exhaust stream. Omega Thermo Products was commissioned to provide water heating plates which would act as the centrepiece for this heat recovery tower (Fig. 3).

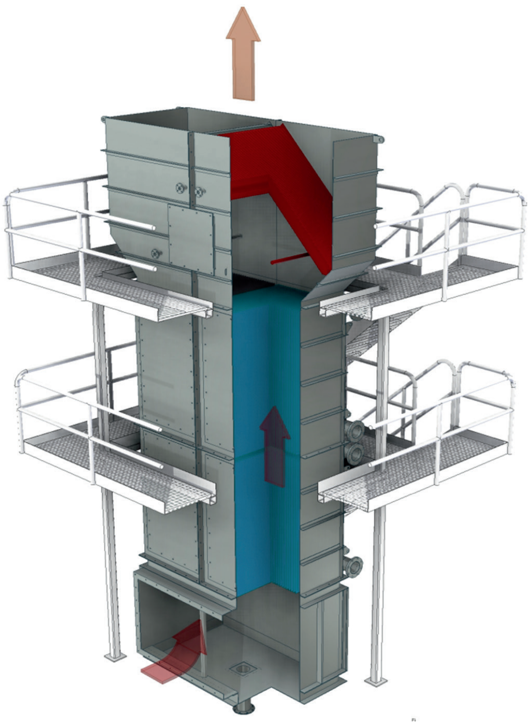


« Fig. 4. Indirect water heating tower (case study).

Results

The system was capable of heating 150 gallons of water per minute from 64F to 125F which is equivalent to 4.6 million BTU per hour of heat recovery (Table 2). As heated water is required continuously throughout the year by the mill, this results in a total of approximately 36,800 MBTUH of heat recovery per year.

« Fig. 5. Two views of the pillow plate heat exchanger.



«« Fig. 3. Indirect water heating tower (3D).

Conclusion

In paper and tissue mills, a significant amount of the energy present in exhaust streams is recoverable. While every heat recovery project is unique, pillow plate heat exchanger projects often have short return on investments, saving money, and reducing greenhouse emissions. «

	Parameter	Units	Result
Exhaust air	Capacity	[cfm]	14,074
	Dry bulb temperature in	[F]	147.9
	Wet bulb temperature in	[F]	147.9
	Dry bulb temperature out	[F]	128.2
	Wet bulb temperature out	[F]	128.2
Water	Flow	[USGPM]	150
	Temperature in	[F]	64
	Temperature out	[F]	125
Energy recovery	Heat recovered	[MMBTUH]	4.6

« Table 2. Heat recovery table of results.