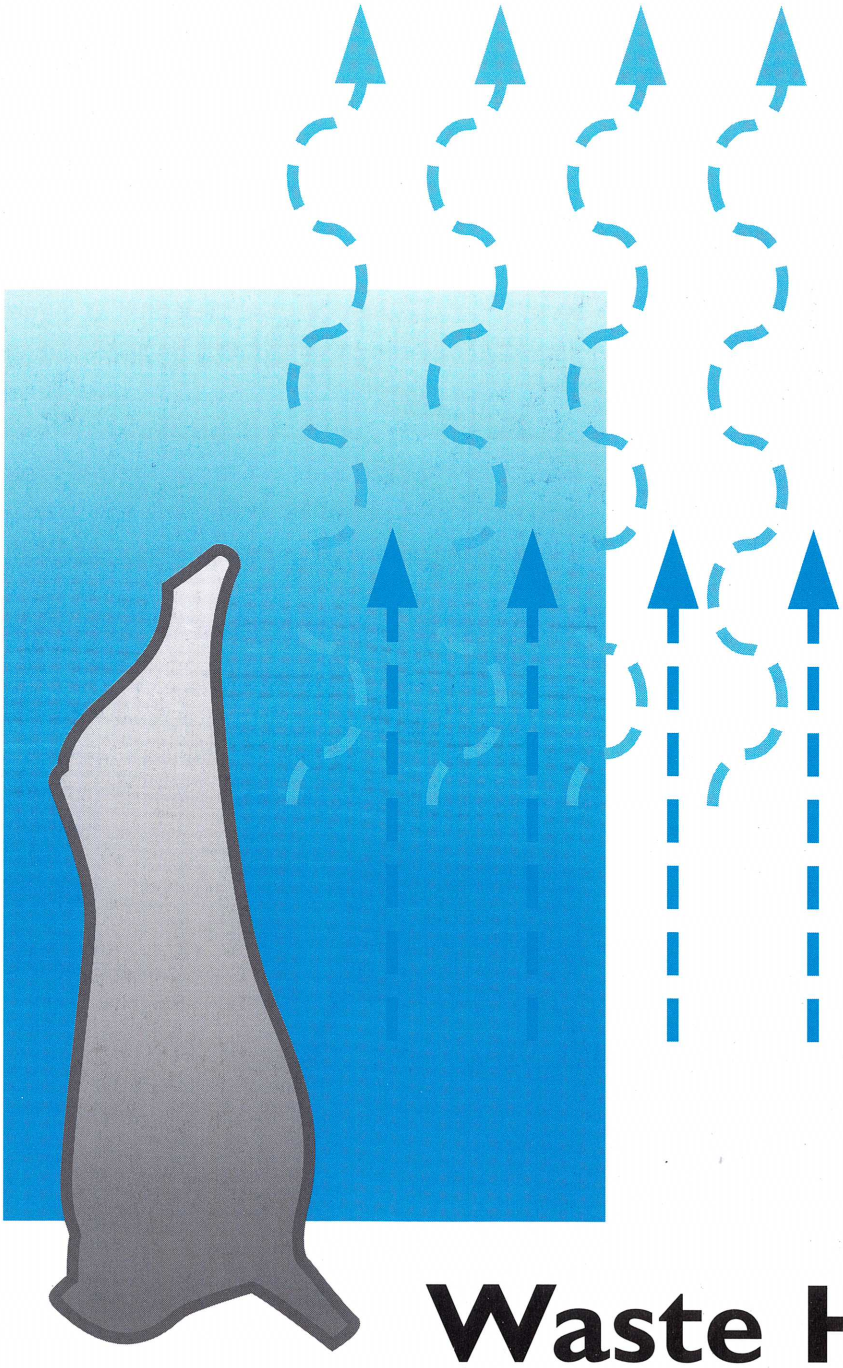


Waste Heat Recovery

1997

Meat Research Corporation

AMT
AUSTRALIAN MEAT TECHNOLOGY

Heat is generated in abattoirs, in significant quantities, from heat sources such as boilers and rendering cookers. A large proportion of this heat is wasted to the surrounding areas through evaporation, vessel walls and pipe walls.

Much of this waste heat can be recovered and used for pre-heating other streams to reduce total energy use throughout the plant.

Heat Recovery from Rendering

Rendering plants typically consume large amounts of steam (for cookers) and/or hot air (for blood drying). Significant amounts of waste heat can be recovered.

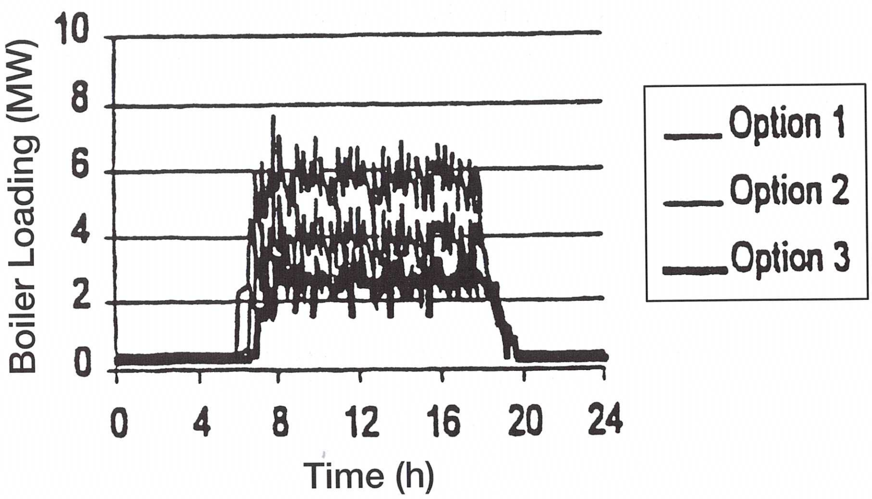
The rendering plant has two major waste heat sources: cooker vapours and flash steam. High temperature rendering cookers operate at temperatures up to 140°C. Significant quantities of the heat generated (in the form of vapours) are lost to the surrounds. Much of this heat could be recovered by capturing the vapours and flash steam and passing them through heat exchangers. This recovered heat can be used for heating purposes including generating hot water, preheating rendering vessels and preheating boiler feed water.

The drying processes in blood processing require significant heat energy, resulting in large amounts of wasted heat. The design of ring dryers, for example, consists of large lengths of tubular sheet metal through which blood particles travel in hot air flowing around the system. The metal, being a good heat conductor, will allow a considerable proportion of the generated heat to escape.

Analysis of heat energy flows for a case study plant was performed (Amos, 1997), with three operating scenarios. Each scenario was based on a beef plant slaughtering 540 head over a 12-hour day. The first used a batch dry rendering system without heat recovery and used steam-heated heat exchangers to generate hot and warm water. The second used the same batch dry rendering system as the first, but utilised heat recovery from rendering vapours for hot water generation and hot and cold water mixing for warm water generation. The third scenario replaced the batch dry rendering system with a low temperature rendering vessel for cooking the product and four batch dryers for drying the product. Heat recovery was performed in a similar fashion to scenario 2.

Results for these models are presented in Figure 1. The boiler loading was reduced by approximately 33% when using heat recovery techniques (from scenario 1 to scenario 2), and by a further 30% when using a low temperature rendering system (from scenario 2 to scenario 3). With each new scenario, a significant reduction in energy usage resulted.

FIGURE 1 Boiler loading for the case study plant for each of three plant set-ups (Amos, 1997)



Refrigeration and Other Low-grade Energy Sources

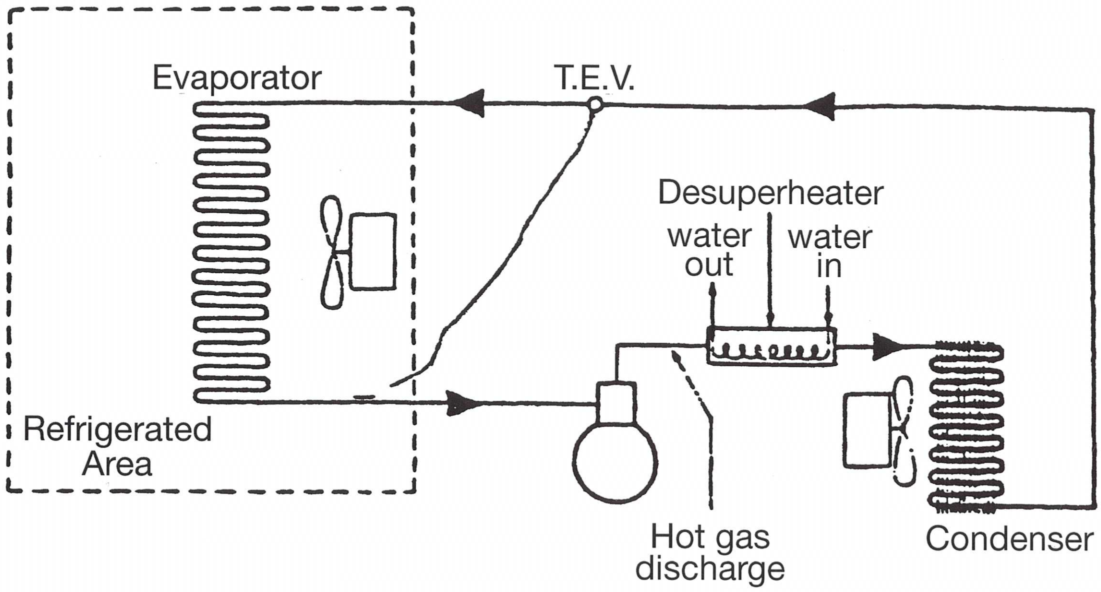
Heat recovery from energy sources such as refrigeration condensers, oil coolers and desuperheaters is also possible.

Often these heat sources are low-grade making them most useful for warm water generation and for preheating purposes.

Recovering heat from refrigeration condensers may be difficult as many Australian refrigeration units use evaporative condensers from which it is difficult to recover heat.

Refrigeration plants always act as heat pumps in that, by consuming power, they allow a quantity of heat to be moved from one place to another

FIGURE 2 Schematic drawing of a typical refrigeration system modified to provide hot water by means of a desuperheater (heat exchanger) positioned on the discharge side of the compressor (Laight, 1977)



(Laight, 1977). To maintain adequate cooling efficiency it is necessary to allow for a low-grade heat output. This heat output can be recovered for use elsewhere in the plant.

One example of a heat recovery system from refrigeration involves heating water from the discharge pipe of a compressor. Water temperatures of up to 60°C were obtainable in some cases (Laight, 1977). Figure 2 illustrates this principle, with the two basic items of equipment being a heat exchanger and a water storage tank, which are often combined in practice.

Other low energy sources include drains which carry hot and/or warm water to the wastewater treatment system. One example is the wastewater from a tripe sterilising process, which uses hot

TABLE 1 Results of applying pinch analysis to projects

Process	Facility*	Energy savings available $/yr	Capital cost expenditure or saving $
Organic bulk chemical	New	800 000	Same
Specialty chemical	New	1 600 000	Saving
Crude unit	Mod	1 200 000	Saving
Inorganic bulk chemical	New	320 000	Saving
Specialty chemical	Mod	200 000	160 000
	New	200 000	Saving
General bulk chemical	New	2 600 000	Unclear
Inorganic bulk chemical	New	200 000 to 360 000	Unclear
Future plant	New	30 to 40%	30% saving
Specialty chemical	New	100 000	150 000
Unspecified	Mod	300 000	1 000 000
	New	300 000	Saving
General chemical	New	360 000	Unclear
Petrochemical	Mod	Phase I 1 200 000	600 000
		Phase II 1 200 000	1 200 000

** New means new plant; Mod means plant modification.*

water to wash tripes before packing. The pipe carrying this hot wastewater could be jacketed to provide a pre-heating system for other processes requiring warm water.

Hot Water Storage

The storage of hot water is required more for plants which have a large time-variation in heat requirements, such as for batch rendering systems. A decision, influenced primarily by cost, will need to be made on whether to store hot water in a tank or use a heater to generate hot water on demand.

If a hot water storage tank is used, suitable insulation will be required to minimise heat loss and therefore reduce energy costs.

Process Integration and Pinch Analysis

Process integration and pinch analysis can be used to optimise energy usage and heat recovery from plants as a whole (Linnhoff et al., 1994). Hot and cold streams in the plant are identified, followed by the use of a systematic method to determine the process 'pinch', which represents the bottle-neck for heat recovery. Once the pinch is found, heat exchange networks and waste heat recovery techniques can be designed.

Table 1 lists the results of applying pinch analysis to different processes, either for new facilities or modifications to existing plants. (Linnhoff et al., 1994).

Only some of the processing facilities in Table 1 were built at the time of the analysis (1994), and all are in the U.K. where pinch technology was developed and commercialised. It was used in New Zealand in the late 1980s and has now been applied by a wide range of industries including those in the food and drink sector and the meat industry, mainly to analyse energy use at existing sites (Cleland and Kallu, 1997).

Pinch analysis is easiest to apply in plants with time-constant heating and cooling demands, e.g. petrochemical plants. Meat plants typically have time-varying heating and cooling demands, making it more difficult to apply pinch analysis without specialist skills and the use of computer prediction tools. Chadderton (1995), however, applied pinch analysis to case study beef and lamb plants and showed it to be a useful tool for optimising heat exchange networks between heating and cooling processes.

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