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REPORT
POTENTIAL APPLICATIONS FOR HEAT PUMPS IN THE DAIRY AND BREWING INDUSTRIES

Resumé of a report compiled of staff* of NEI Projects Ltd, Cuthbert House, All Saints, Newcastle upon Tyne, NE1 2DP, U.K., and International Research & Development Co Ltd., Fossway, Newcastle upon Tyne, NE6 2YD, U.K.

Abstract—This paper is a resumé of a report commissioned by the Energy Technology Support Unit in response to recommendations contained in the audit reports on the dairy and brewing industries [1, 2]. It was prepared by NEI Projects Limited with the assistance of International Research and Development Limited.

The purpose of the report was to promote the cost effective application of heat pumps to energy conservation in the dairy and brewing industries, by introducing heat pumps to dairy and brewery managers, and elaborating on the opportunities for heat pump applications in these two industries for the benefit of energy conservation systems suppliers and uses.

1. INTRODUCTION

HEAT pumps can be used to raise the temperature of waste heat so that it can be re-used for process or space heating purposes. Under suitable conditions they require far less energy (and cost much less to run) than boilers of the same heat output but the capital cost are greater.

Heat pumps may be single or multi-stage, and may be driven by electric motor or internal combustion engine. They may serve a single energy demand from a single waste heat source, or operate as a general plant utility.

Heat pumps work best where (1) there is a relatively steady demand for heat at around 70–90°C, (2) at the same time there is waste heat available at around 10–60°C and (3) heat recovery is possible for perhaps 4000 h/yr or more.

The above conditions are satisfied both in the dairy and brewery industries, providing superficially attractive opportunities for energy conservation using heat pumps.

2. HEAT PUMPS IN THE DAIRY INDUSTRY

There are over 300 significant milk processing and milk products manufacturing sites in England and Wales. Milk processing involves heat treatment (pasteurisation, ultra-high temperature treatment and sterilisation) prior to liquid milk distribution. Manufacture involves mainly the production of butter, cheese and condensed milk products, and the treatment of associated by-products. Refrigeration is used on a large scale.

The principal requirements for heat in dairy plant arise in connection with heat treatment, evaporation, general hot water supply for cleaning and washing, boiler make-up water pre-heating and space heating.

The principal sources of waste heat are the coolers serving the various items of heat treatment or evaporation plant, hot effluent streams from washing and the heat rejected by refrigeration plant.

2.1. *Industry structure*

The complete dairy production chain accounts for nearly 2% of the total United Kingdom primary energy demand [1].

Five regional Milk Marketing Boards serve as the interface between the milk producers and the manufacturing organisations. The Boards have a statutory obligation to buy all milk offered for sale by registered producers.

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Table 1. Classification of milk processing and manufacturing sites in England and Wales

	Processing	Manufacturing		
Rated milk intake (l./day)	Number of sites heat treating milk	Number of sites producing butter and skim milk	Number of sites producing cheese	Number of sites producing other products
Under 40000	172	1	23	3
40000–100000	67	1	6	1
100000–250000	53	8	9	10
250000–500000	7	11	8	5
500000 and above	0	12	3	0
Totals	299	33	49	19

The Milk Marketing Boards' own dairies and creameries handle some 24% of the total milk sold off farms. The remaining volume is handled by a number of organisations, among which Unigate, Express Dairies and Northern Foods are dominant.

The total farm sale of milk in 1979–1980 was 15160 million litres (12774 million litres attributable to England and Wales) [3]. This was divided between processing dairies and manufacturing creameries. The classification of milk processing and manufacturing sites in England and Wales is shown in Table 1.

Processing dairies heat-treat milk for liquid consumption. A number of methods are used as shown in Table 2. Pasteurisation accounts for 86% of throughput. The other processes are usually conducted in conjunction with pasteurising.

Manufacturing creameries produce primary and secondary food products from milk. The primary products are principally butter and cheese and the secondary products are skimmed milk and whey. The utilisation of milk for manufacture in England and Wales is shown in Table 3.

3. PROCESSES IN THE DAIRY INDUSTRY

3.1. *Pasteurisation*

A simplified flow diagram for a typical pasteurising plant is shown in Fig. 1. Delivered milk is first cooled to 4.5°C for storage in insulated silos. Pasteurisation is the heat treatment of milk to kill off harmful bacteria. During the process the milk is heated to 72°C, then cooled with chilled water to 4.5°C. Pasteurisers use either steam or hot water as heating mediums. Between 85 and 95% of the heat is recovered (re-generation) in counter current heat exchangers.

The bottling unit receives milk bottles from the washing plant where they are subject to a thorough sequence including two hot washes. After filling with milk the bottles are capped and then transferred to a cold store.

Table 2. Types of heat treated milk sold for liquid consumption in England

Type of milk	Million litres	%
Pasteurised	5354	86.2
Sterilised	423	6.8
Homogenised	391	6.3
Ultra heat treated	44	0.7
Total	6212	100.0

Table 3. Utilisation of milk for manufacture in England and Wales

Utilisation	Million litres	%
Butter	2977	47
Cheese	1891	30
Fresh cream	887	14
Condensed milk	354	6
Whole milk powder	141	2
Sterilised cream	13	0.2
Other products	50	0.8
Total	6313	100.0

Steam and water requirements for the several processes including space heating are provided by a central boiler installation.

The refrigeration plant supplies chilled water to the milk cooler and pasteuriser. The cold store often has its own refrigeration plant.

The process plant is cleaned and sterilised *in situ*. Cleaning-in-place (CIP) uses hot water solution at 50–70°C. Effluent streams at 28–35°C are treated before discharge from the system.

Simple (single stage) heat pump installations are unlikely to provide adequate returns at typical current energy costs, except possibly in the case of the largest sites. More complex, multi-stage heat pump systems however, provide good returns, as demonstrated in an existing installation. There are some 10–15 pasteurising sites in the U.K. where such installations merit detailed investigation. The investment is likely to be in the region of £70000 (1000 kW heat output).

3.2. *Sterilisation*

A flow diagram of a sterilising plant is shown in Fig. 2. As sterilising units are usually installed in conjunction with pasteurising plant the diagram omits common items of plant such as the steam boiler etc.

Hot water is used in a counter flow heat exchanger to preheat the milk from 3°C to 65°C. The ultra high-temperature (UHT) treatment procedure requires higher temperatures and therefore uses steam. Following preheating, this milk is homogenised and bottled.

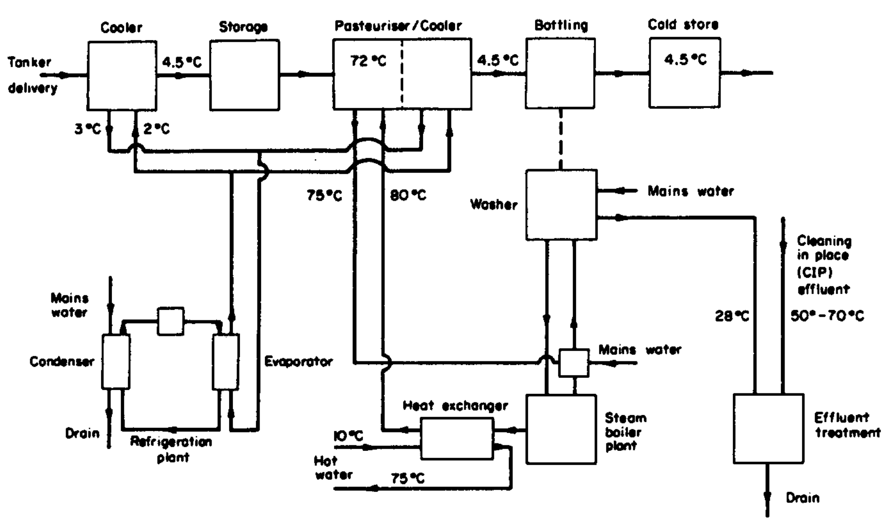

Fig. 1. Pasteurisation.

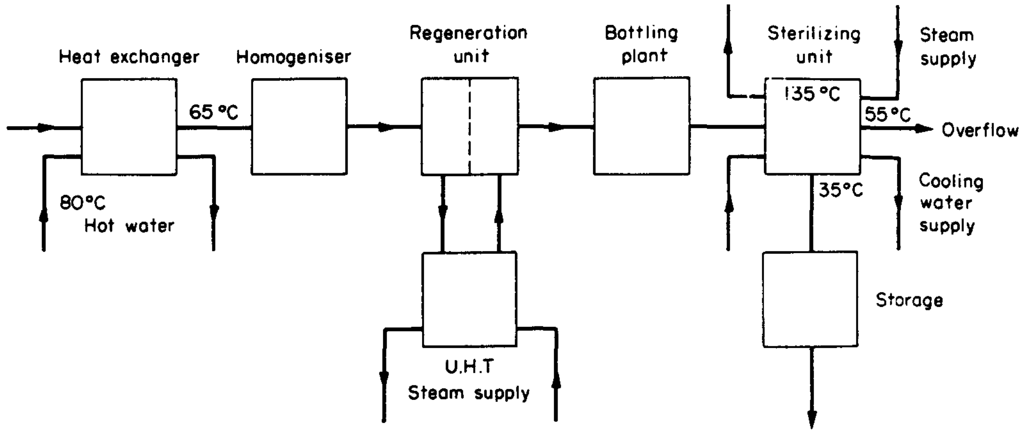

Fig. 2. Sterilising.

The bottled milk then passes into the steriliser and is heated to 135°C in a steam atmosphere, followed by cooling to 35°C in a water bath. A continuous overflow at a temperature of 55°C is usual with milk-in-bottle sterilisers.

Heat recovery from steriliser overflow for milk preheating using a simple single stage heat pump installation offers excellent financial returns. There are some sites in the U.K. where such installations may be viable. The investment is likely to be in the region of £20000 to £40000 (300–500 kW heat output).

3.3. *Butter*

Milk reception and storage facilities are similar to those at pasteurising sites. Whole milk from storage silos is separated into cream and skim milk. Following separation the cream is pasteurised and deodourised at 72°C and cooled to 4.5°C. Placed in ageing tanks for at least 12 hr the cream is then passed to the butter maker.

Skim milk is passed through a multiple effect evaporator which removes the majority of water. The concentrate is then atomised in a spray drier where evaporation of the remaining water takes place in a hot air stream at 22°C.

Plant requirements for steam, refrigeration and CIP are similar to those found at pasteurising sites.

There are numerous opportunities for heat recovery, using simple single stage heat pumps at butter manufacturing sites, giving excellent financial returns. There are sites in the U.K. where such installations should be considered as a matter of priority. There are attractive investment opportunities ranging from £10000 (160 kW) to over £100000 (in excess of 2000 kW) to suit almost any budget.

3.4. *Cheese*

Milk reception and storage facilities are similar to those at pasteurising sites. Following pasteurising the milk is cooled to 30°C and pumped to cheese vats where rennet is added for coagulation. Separation of whey from the curd occurs in the cheddar plant and the whey is pumped away for separate processing.

Whey contains a small amount of butterfat so it is removed for the manufacture of whey butter. The skim whey is concentrated in a multiple effect evaporator before flash cooling and spray drying.

Plant requirements for steam, refrigeration and CIP are similar to those found at pasteurising sites.

There are many opportunities for heat recovery using heat pumps at cheese manufacturing sites, some of these (notably pasteuriser cooling water recovery for general plant hot water production) offer excellent returns. There are sites in the U.K. where a more detailed feasibility study would be warranted. The investment opportunities range from

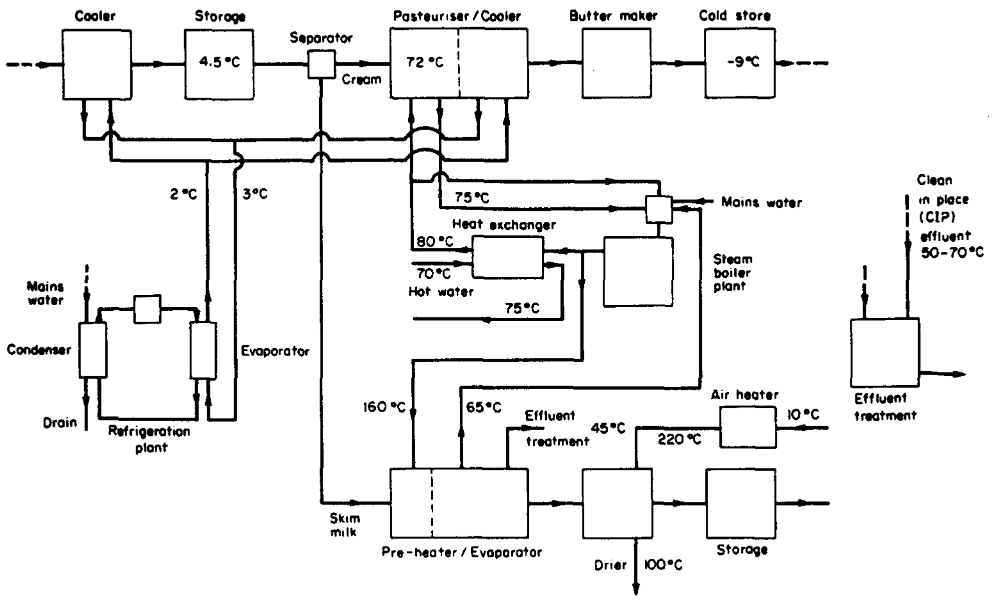

Fig. 3. Butter production.

around £12000 (170 kW) to approaching £140000 (2300 kW), giving a wide choice to the investment manager.

4. HEAT PUMPS IN THE BREWING INDUSTRY

4.1. *Industry structure*

The U.K. is the world's third largest brewing nation with an annual production of 40 million bulk barrels (66 million hectolitres) in 1978. This amounts to approximately 8% of the world's beer production.

In total there are 82 companies engaged in brewing in the U.K. Seven large groups dominate the industry: Bass Ltd; Allied Breweries (U.K.) Ltd; Courage Ltd (part of the

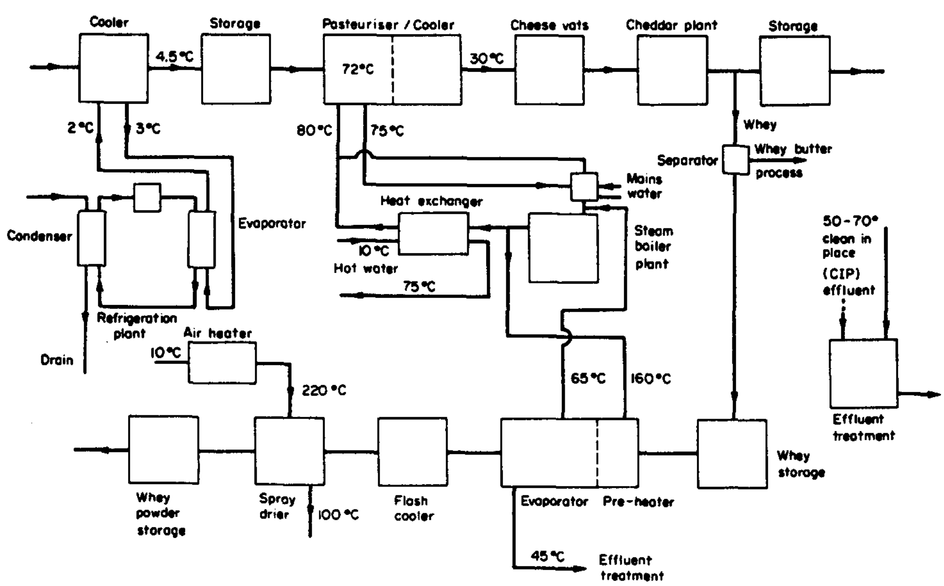

Fig. 4. Cheese production.

Table 4. Size distribution and production of breweries responding to the Brewers Society survey (1977)

Size category (hectolitres production)	Number of respondents	Production (million hectolitres)	Average production (thousand hectolitres)	Percentage of industry production by type of beer			
				*CF/P	CC†	L‡	All
0–99000	19	0.932	49	2	5	0	2
100000–199000	20	2910	145	4	11	1	5
200000–299000	11	2648	241	5	6	4	4
300000–399000	17	2418	345	5	6	0	4
400000–499000	12	5476	456	18	13	2	9
500000–999000	11	7941	722	9	23	13	13
1000000–1499000	11	12978	1180	17	19	22	21
1500000 +	11	27023	2457	39	18	59	43
Total	102	62346	611	100	100	100	100
No response	32**	1.8	5.6				

* CF/P = chilled filtered and chilled filtered and pasteurised beers.
† CC = cask conditioned beer.
‡ L = lager.
** excludes pub breweries and non-brewing breweries.

Imperial Group); Watney Mann and Truman Breweries Ltd (part of Grand Metropolitan); Arthur Guinness, Son & Co. Ltd; Whitbread & Co. Ltd and Scottish and Newcastle Breweries Ltd. These groups account for the major portion of brewing capacity and also have interests in other smaller breweries, soft drinks, and retail outlets such as public houses and clubs.

There are 143 wholesale breweries in the U.K. varying in size from the very small units to those producing more than 1 million hectolitres (610000 barrels) per annum. The size distribution of breweries responding to a survey is shown in Table 4. In addition there are also a few packaging and distribution centres which do not brew beer.

4.2. *Processes*

Beer is by definition 'any beverage made by alcoholic fermentation of carbohydrates which is predominantly derived from cereals and which is not distilled'. Various cereals can be used but in the main beer is brewed from malted barley with added hops for flavour and other grains and sugars as adjuncts or malt substitutes. The brewing process is shown schematic form in Fig. 5.

4.2.1. *Malting.* The starting raw material for brewing is malted barley. This is barley steeped in water to allow germination. This causes the production of certain essential enzymes. At a preset stage the germination is halted by drying the grain in a process known as kilning.

4.2.2. *Mashing.* The malt is then sent to the breweries. It is milled and mixed with hot water. The enzymes convert the starch grain to fermentable sugars in a process known as 'mashing', carried out in the mash tun. The sugar-containing liquor (known as wort) is separated from the spent grain and run off into a vessel known as the copper. Here hops are added and the mixture is sterilized by boiling.

4.2.3. *Fermentation.* The boiled wort is then transferred to a fermentation vessel where yeast is added. Fermentation converts the sugars into alcohol and carbon dioxide. This takes place at a controlled 10–20°C over a period of 3–7 days. The process is slightly exothermic and cooling is required.

4.2.4. *Finishing.* After fermentation the beer is clarified and may go directly into casks or may be brewery conditioned, pasteurised and placed in kegs or packaged in bottles or cans.

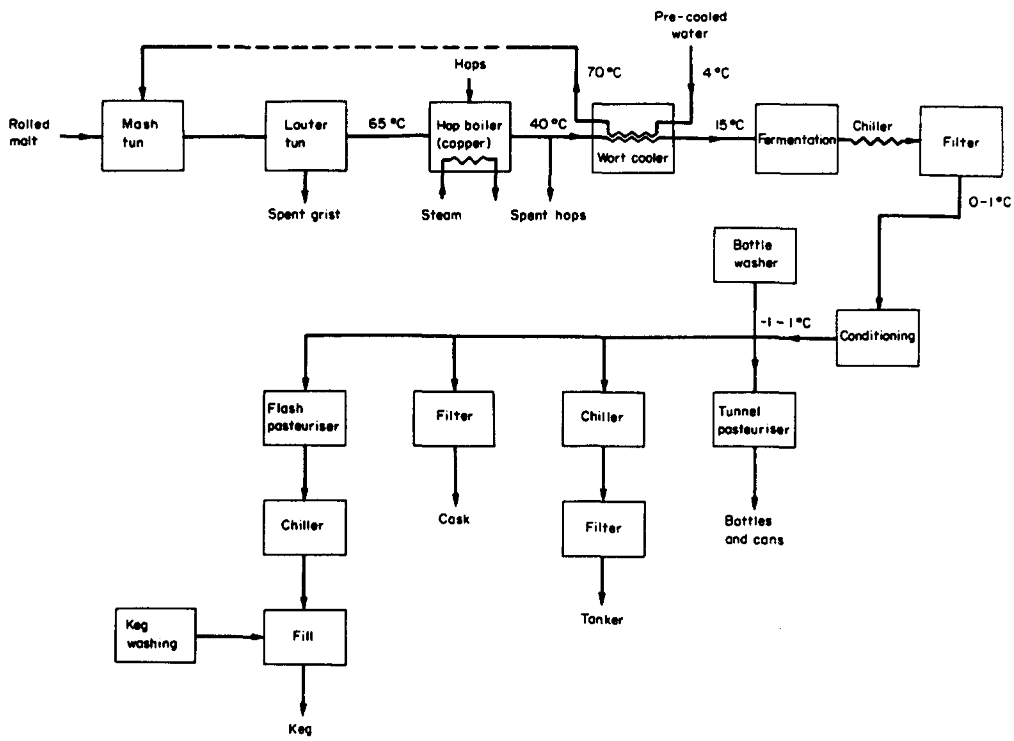

Fig. 5. Schematic diagram of the brewing process.

There are three basic types of beer produced in the UK: ales, lagers and stouts. Ales are top-fermented beers, amber or brown in colour, and are consumed a short time after brewing. These form the major proportion of beer production in the U.K. Lagers are bottom-fermented beers, light in colour and conditioned by storage at low temperature for several weeks before consumption. Stouts are dark beers brewed with roasted barley.

4.3. *Possible heat pump applications*

4.3.1. *General.* Consideration of the application of heat pumps in the brewing industry is restricted in this study to heat recovery from liquid streams in the range of 10–30°C and use in liquid process streams in the range of 60–80°C. One process use at 55°C has also been investigated (feed water to the steam boilers) to demonstrate the improved performance where the temperature rise is modest.

4.3.2. *Selection of model breweries.* Breweries may be split into eight size groups according to their production capacity as follows:

Category	Output of beer (Hl/yr)	Number of breweries
A	0–99 000	
B	100 000–199 000	46
C	200 000–299 000	
D	300 000–399 000	
E	400 000–499 000	23
F	500 000–999 000	11
G	1 000 000–1 490 000	22
H	1 500 000 upwards	

Heat pump applications were examined using four brewery sizes as models chosen to represent categories D, F, G and H. The models are

Brewery	Capacity, hl/year	Category
(B1)	4000000	H
(B2)	1400000	G
(B3)	550000	F
(B4)	300000	D

The breweries are assumed to operate an 8-h day, 5-day week and 52-week year. Information from the Brewers Society survey (1977) suggests that breweries of such sizes might typically produce the following mix of products.

	% Production					
Brewery	Keg	Bottles, cans	Cask cond.	Lager	Other	Total
B1	51	7	9	23	10	100
B2	53	4	18	25	—	100
B3	35	7	34	24	—	100
B4	44	20	32	2	2	100

Both keg and lager are assumed to be flash pasteurised.

4.3.3 *Process demands and source streams.* The following process demands and waste heat source streams were identified as being in the temperature range appropriate for this study:

(a) Waste heat sources
  (i) Refrigeration condenser (S1).
  (ii) Bottle and Can Pasteuriser (S2).
  (iii) Bottle washing (S3).
(b) Process demands
  (i) Space heating (P1).
  (ii) Bottle washing (P2).
  (iii) Flash pasteurisation (P3).
  (iv) Boiler make-up water (P4).
  (v) Bottle and can pasteurisation (P5).

The effluent from the keg washing process could be a source stream but because of its relatively high temperature (approximately 60°C) energy could best be recovered by the use of a conventional heat exchanger. Heat pumps should be considered only if there is a use for water at 90–95°C.

The availability of the above process and source stream during a winter working day is shown graphically, in Fig. 6. Table 5 shows the heat loads available during these times.

4.3.4. *Economic assessment.* The 15 possible combinations of sources and processes demands , together with the corresponding heat pump size and utilisation, for brewery B1 are given in Table 6. A summary of the better prospects for the smaller breweries is given in Table 7. The conclusions have ignored any indirect benefits (water saving, etc.) or the effect of future energy price rises. There would appear to be good opportunities for heat pump applications especially in large and medium sized breweries.

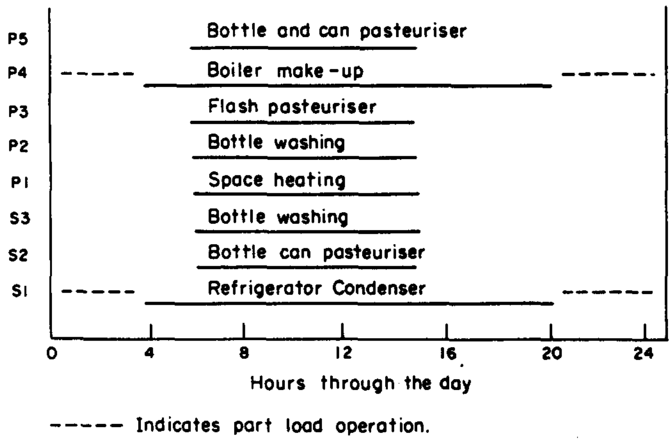

Fig. 6. Process demand and waste heat availability in a typical working day.

Table 5. Process demand and waste heat source heat loads

Brewery	B1	B2	B3	B4	Temperature (°C)	
Throughput (hl/yr)	4.0×10^6	1.4×10^6	0.55×10^6	0.30×10^6		
Process demands (kW)						
Space heating	2671	966	367	200	85	condensing
Bottle washing	172	34	24	37	83	condensing
Flash pasteurisation	415	153	45	29	80	condensing
Boiler make-up	855	606	199	108	55	condensing
Bottle and can pasteurisation	329	66	45	71	80	condensing
Waste heat source (kW)						
Refrigeration condenser	4915	1720	676	369	22	evaporating
Bottle and can pasteurisation	105	21	14	25	15	evaporating
Bottle washing	33	7	4	7	20	evaporating

Table 6. Possible heat pump applications in brewery B1

Process use	Process heat load (kW)	Source	Source size (kW)	Max o/p from given source (kW)	Hour (max) (kW)	COP	Utilisation* (h/yr)
Space heating	2671	Refrig. cond.	4915	7462	2671	2.93	4680
Space heating	2671	Bot. & can past.	105	171	171	2.58	2080
Space heating	2671	Bot. washing	33	51	51	2.81	2080
Bottle washing	172	Refrig. cond.	4915	7336	172	3.03	2080
Bottle washing	172	Bot. & can past.	105	171	171	2.60	2080
Bottle washing	172	Bot. Washing	33	50	50	2.90	2080
Boiler make-up	855	Refrig. cond.	4915	5867	855	6.16	4680
Boiler make-up	855	Bot. & can past.	105	134	134	4.62	2080
Boiler make-up	855	Bot. washing	33	41	41	5.33	2080
Flash past.	415	Refrig. cond.	4915	6798	415	3.61	2080
Flash past.	415	Bot. & can. past.	105	162	162	2.85	2080
Flash past.	415	Bot. washing	33	48	48	3.25	2080
Bot. & can past.	329	Refrig. cond.	4915	6798	329	3.61	2080
Bot. & can past.	329	Bot. & can past.	105	162	162	2.85	2080
Bot. & can past.	329	Bot. wash.	33	48	48	3.25	2080

* Utilization figures are based on a brewery working a 5-day week, 52 weeks a year.

Table 7. Summary

Brewery model	Process demand	Waste heat source	Heat output (kW)	COP	Payback (y)	Comments
B1	Space heating	Refr. cond.	2671	2.9	6	
	Bottle wash.	Refr. cond.	172	3.0	7	
	Boiler M.U.	Refr. cond.	855	6.2	1.0	Good prospect
	Boiler M.U.	B&C pt.	134	4.6	5.5	
	Flash pt.	B&C pt.	162	2.8	9	
	Flash pt.	Refr. cond.	415	3.6	6	
	B&C pt	Refr. cond.	329	3.6	7	
B2	Boiler M.U.	Refr. cond.	506	6.2	1.8	Good prospect
B3	Boiler M.U.	Refr. cond.	199	6.2	2.5	Good prospect
B4	Boiler M.U.	Refr. cond.	108	6.2	3.1	Good prospect

4.4. *Large breweries* (4000000 *hl/yr*)

Heat recovery from the refrigerator condenser for boiler make-up water preheating by means of a simple single-stage electrical heat pump offers excellent financial returns. The investment is likely to be in the region of £60000 (850 kW).

There are many other opportunities for heat recovery using heat pumps but at present energy costs it is unlikely that the application of simple (single-stage) heat pumps would be economical. However, experience in the dairy industry suggests that in such situations the installation of more complex, comprehensive heat pump heat recovery schemes involving two-stage systems can result in financially attractive projects. Investment in excess of £100000 would have to be envisaged.

There are believed to be some four or five breweries in the U.K. of a size comparable to the model used in the analysis.

4.5. *Medium breweries* (300000–1500000 *hl/yr*)

Heat recovery from the refrigerator condenser for boiler make-up water preheating by means of a simple single-stage electrical heat pumps offers very attractive financial returns down to the smallest size considered in this study. The investment is likely to be in the range of £7500 to £40000 (100–600 kW).

The exploitation of the many other opportunities for heat pump heat recovery would be economical only if considerable ingenuity were exercised in combining a variety of demands and sources and using two-stage rather than single-stage heat pumps. Investment approaching £100000 would have to be contemplated.

There are some 60 breweries operating in the U.K. with capacities in the range covered by the analysis, offering a very attractive market for heat pumps.

The analysis presented here provides a rough guide to the likely opportunities for applying heat pumps cost effectively in the brewery industry. Conditions vary from site to site, and a detailed feasibility study is required to select the best arrangement for each. Inclusion of additional facilities (for water recirculation for example) can often improve the financial returns.

REFERENCES

1. *The Dairy Industry*, Energy Audit Series Report No. 3, Department of Energy and Department of Industry, U.K. (1978).
2. *The Dairy Industry*, Energy Audit Series Report No. 8, Department of Energy and Department of Industry, U.K. (1978).
3. *United Kingdom Dairy Facts and Figures* 1980, The Federation of United Kingdom Milk Marketing Boards (1980).

Table 8. Review of escalated costs and benefits over a 10-year period April 1980–1990

Year	System benefits (£)	System costs (£)	Nett cash benefit/year (£)	Cumulative cash benefits (£)
1	73828	24147	49681	(49681)
2	82637	26079	56608	(106209)
3	92610	28165	64445	(170734)
4	103723	30419	73304	(244038)
				4 years—Payback 2 months period
5	116170	32852	88318	327356
6	130110	35480	94702	422058
7	146723	38139	107584	529642
8	162210	41384	121826	651468
9	182795	44695	138100	789568
10	219354	48270	171075	960642

APPENDIX 1

Heat pump installation on the Milk Marketing Board's Bamber Bridge dairy

The dairy operated by the Milk Marketing Board at Bamber Bridge is a bottling and cartoning depot serving retail outlets. It is a pasteurising plant. The Templifier heat recovery system installed by NEI Projects Ltd. employs two heat pumps with condensers in series. The evaporators utilize heat from separate sources. The installation operates in conjunction with a water recovery system installed by Wallis Associates.

Description

As illustrated in Fig. 7, effluent from bottlewashers, CIP and UHT units is passed through water treatment equipment and collected in a hold tank at a temperature of 24–26°C. This recycled water is pumped through both the evaporator and condenser sections of the first heat pump. The outlet water from the evaporator at 7°C is directed into the dairy supply tank where it is stored for cold water dairy services.

The water leaving the first heat pump condenser passes into the second heat pump condenser where its temperature is raised to 60°C. The evaporator water of the second heat pump is taken at 27°C from an ammonia condensing cooling circuit and cooled to 24°C. Most of the hot water from the second pump is used to heat boiler feed. Other uses are to maintain the temperature of a caustic tank and crate washer equipment. The total heat output of the heat pumps is 937 kW with a COP of 5.48.

The duties of the heat pump system as originally installed, may be summarised as follows:

1. Warm water supply throughout the production area for washdown purposes at 49°C.
2. 200 gal./h to the crate washer equipment at 82°C.
3. 200 gal./h to the CIP caustic tank at 52°C.
4. 600 gal./h at 60°C to boiler feed preheat which is lifted from 49°C to 57°C.
5. Preheat for welfare block services.
6. Preheat to the ducted warm-air system in the carton hall, main store and laboratory.

The installation was subsequently modified due to rescheduling of the production processes, and the introduction of a UHT line. The result has been an overall increase in water use from 135000 gal./yr to 170000 gal./yr (i.e. without water recovery). Gross annual savings increased proportionally.

Economic situation

The discounted cash flow technique forms the basis of the analysis. The rate of return is based upon the following data which refer to the plant as originally installed:

Total capital cost system—	
Heat pump	£98500
Water recovery	£160000
	£258500
Annual operation	3500 h/yr
Current cost of electrical power supply	2.2 p/kWh
Current cost of water supply and effluent treatment	£1.37/1000/gal.
Annual rate of escalation on electrical supply costs	8%/yr
Annual rate of escalation on gas, water and treatment costs	12%/yr
Current cost of gas supply	18.5 p/therm
Gas boiler efficiency	80%

(a) *Benefits*

Value of heat output from Templifiers:

$$\frac{31.99\ \text{therm/h} \times £0.185\text{p/therm}}{0.8\ \text{bir.effy}} = £7.40/\text{h} = £25900/\text{yr}$$

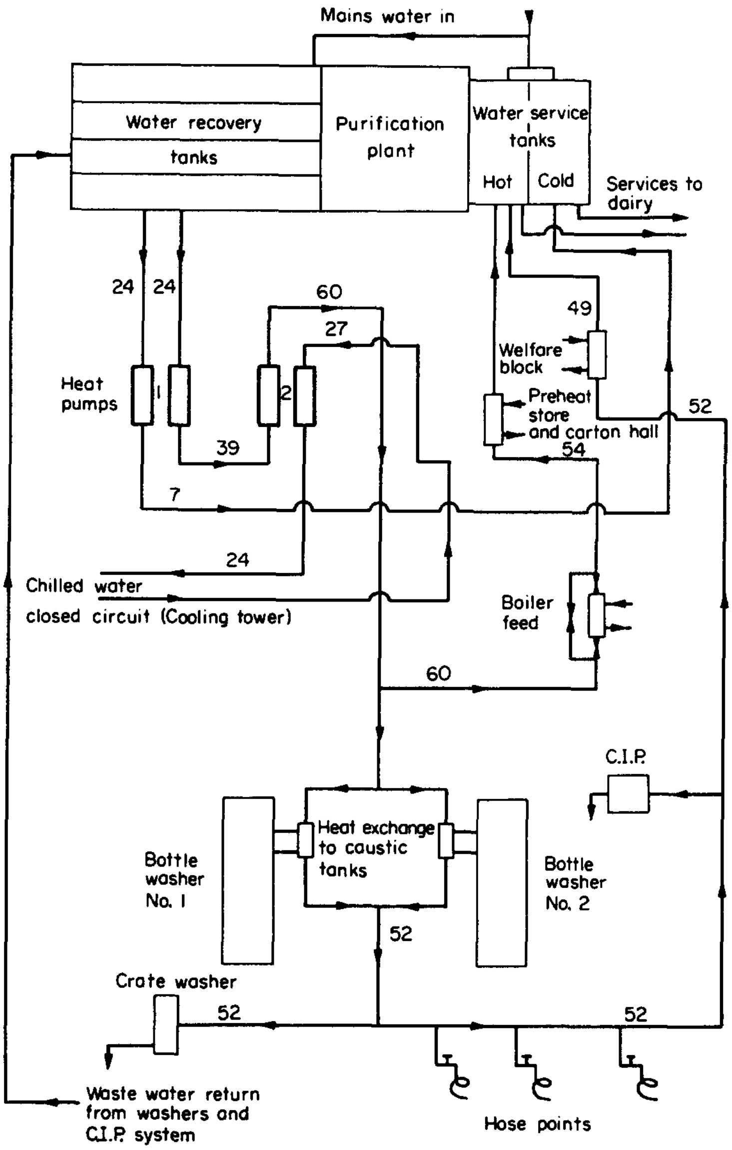

Fig. 7. Schematic layout of the water and heat recovery system at the Bamber Bridge dairy.

Value of reduction in water consumption:	
81 500 gal./day × £1.37/1000 gal. × 365 days	= £40 403/yr
i.e. Current value of system benefits	= £66 303/yr
(b) *Costs*	
Electrical power consumption of Templifiers:	
171.1 kW × £0.022p/kW.h	= £3.76/h
	= £13.160 yr
Operating cost of water treatment plant	= £8408/yr
Annual maintenance costs of Templifiers:	
Assessed costs taken as	= £790/yr
i.e. Current value of system costs	= £22 358/yr

CONCLUSION

The payback period, calculated on the basis of the capital cost (£258 500), is that time when the cumulative cash benefits become positive. This may be extrapolated from the data in Table 8 and is shown to be just over 4 years. Increases in fuel costs since 1980 have in fact brought the payback period down to approximately 2.5 yr.

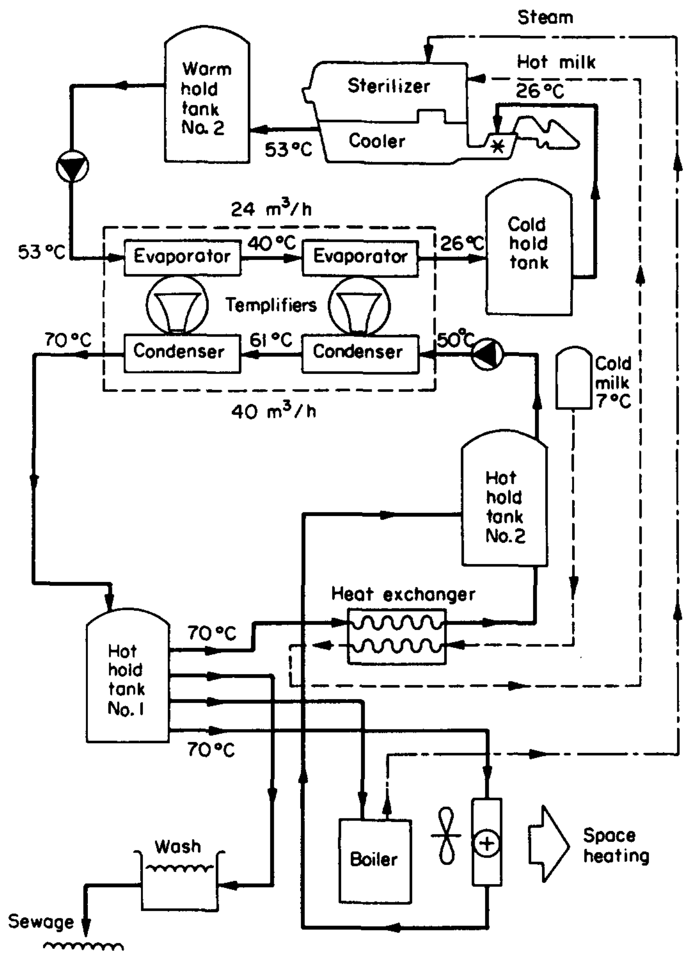

Fig. 8. Flow diagram of the water saving and energy conservation scheme at the Unigate dairy in Walsall, Midlands (U.K.).

APPENDIX 2

Heat pump at the Unigate Walsall dairy

NEI Projects Ltd. installed a Templifier heat pump heat recovery system at the Walsall dairy of Unigate Ltd.

At Wallsall, milk is processed in a Hydrolock sterilizer. In this system milk in plastic containers as loaded onto a tubular conveyor which passes into a steam chamber at the top of the Hydrolock. The temperature of the milk is raised to 125°C after which the conveyer passes into the cooling water chamber. After cooling, the processed milk is discharged from the conveyor. Cooling water is taken in at a temperature of 26°C and rejected at 53°C. The heat is recovered in a Templifier heat pump system. The scheme shown in Fig. 8.

Uses for hot water in the dairy were identified as preheat to boiler feed, preheating of milk, CIP water and space heating. As these heating requirements did not occur simultaneously it was necessary to provide 'hotwells' or hold tanks, and further, since space heating is a seasonal requirement, a cooling tower was included in the system to reject surplus heat in warm weather.

In the hot water system two hotwells are used, one having water at 70°C from which boiler feed, milk heat exchanger water and space heating water is taken. Water from the heat exchanger returns at 50°C to the second hotwell, which provides water for the heat pump condensers. The Hydrolock sterilizer does not operate 24 hr each day, and when waste heat is not available, hotwell No. 1 is maintained at 70°C by steam injection.

A packaged boiler, supplied by NEI, provided all the dairy steam requirements. The total heat output of the heat pumps is 923 kW with a COP of 5.7.