



BEGINNERS GUIDE TO HEAT RECOVERY FROM REFRIGERATION

Part 1

Summary

Heat recovery from refrigeration should be on the list of concepts for consideration of all food manufacturing businesses that use refrigeration and hot water. If the decision is based purely on cash, for anyone using oil, LPG or electricity to heat water, it is a must. If it is based on carbon reduction the scale of the contribution to your carbon management programme is defined by the amount of hot water you use and the amount of waste heat you can economically get at.

Basics

Ever thought it would be good to use energy twice? – well, you can, through heat recovery.

Waste heat rejected from refrigeration and air conditioning systems can be harnessed by intercepting it before it is vented to atmosphere by passing hot refrigerant gas through a heat exchanger to deliver heated water at 45-60C (or more)

The key to the selecting the right system for you is in what you want the water for. In short DK Heat Recovery Ltd specialises in systems that offer potable water as the output although combined and heating only system are in our list of activities.

To deliver potable water the system has to comply with two EU norms EN1717 and EN12897. See European Requirements later.

Why Recover Heat From Refrigeration?

To Save Money. It is not a crime to say that this is the main motivator for most energy saving projects, especially in today's economic climate (although morally you may feel a little sheepish!). The food industry is an energy intensive business with the bulk of consumption being in cooling: product, work rooms, storage; or heating things (and then cooling them). Most food businesses also use hot water in some form, be it for hand washing, cleaning or processing, including steam.

Heating 1000 litres of water to 50C costs between £1.50 and £4.50 depending on the energy source you use to heat it. See table below.

Energy price / kWhr	£ to achieve 50C*	£ with heat recovery	Kg CO ₂ emission*	CO ₂ emissions with heat recovery
Elec 7p	£32	£0	200	0
Gas 3p	£14	£0	90	0
LPG 7p	£32	£0	115	0
Gas Oil 9p	£42	£0	116	0

*subject to system efficiency

Sustainability and the Environment

Reduce energy consumption, save money, reduce carbon emissions. Simple.

But it isn't just about saving the energy to heat water. The run time on condenser systems will reduce with knock on life expectancy gains and reduced maintenance. Cooling towers will use less water and less treatment chemical. Boilers will last longer and need less maintenance. The oil delivery truck will visit less often and so it goes on.

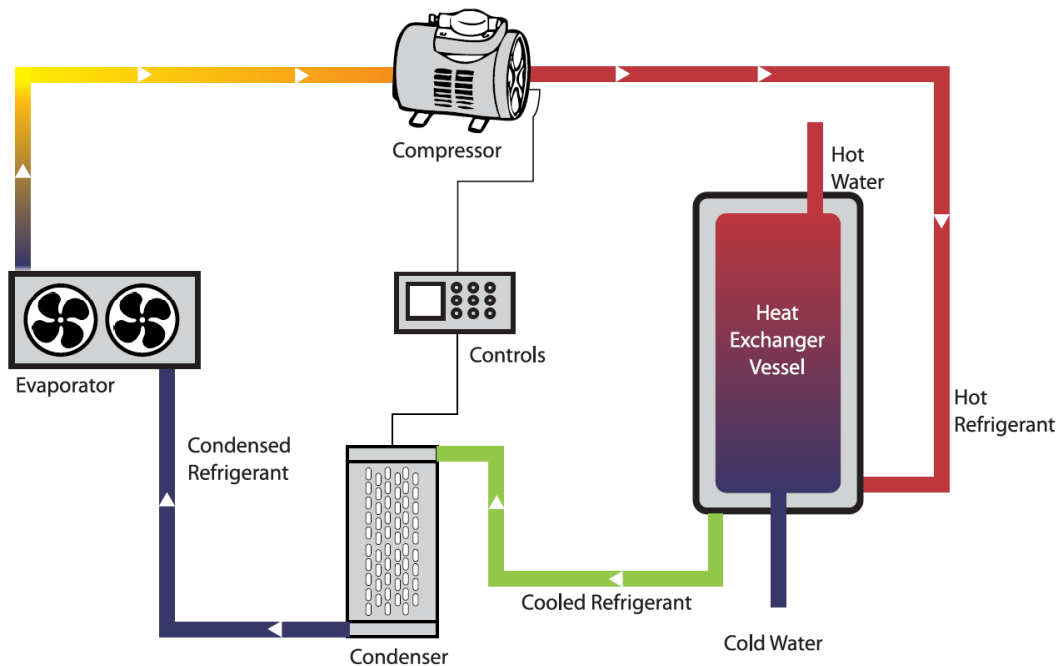
How Heat Recovery Works

The principle is the same for all types of heat exchangers. Bring a cool medium (water) and a hot medium (hot refrigerant gas) into close proximity and energy will transfer along the heat gradient to heat the cool water and cool the hot gas.

For maximum effect the heat exchangers are placed between the compressor and the condenser where the gas is at its hottest. This also has the effect of reducing the work done by the condenser.

By offering the water in counter current to the hot gas a greater proportion of the heat will be transferred.

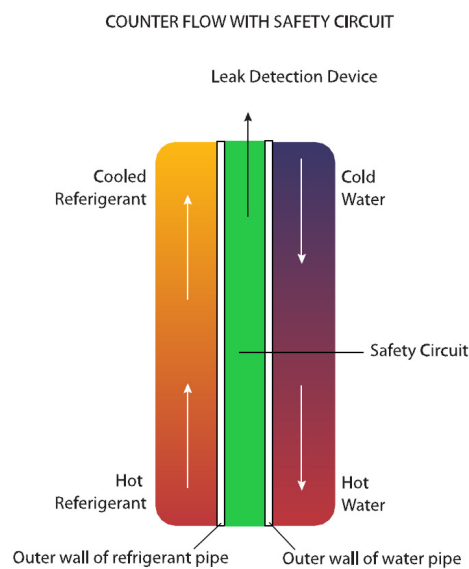
HEAT RECOVERY CIRCUIT SCHEMATIC



European Requirements

EN 1717 requires that refrigerants and potable water be separated by two impermeable surfaces. Single skin plate or shell and tube exchangers do not comply with this unless there is a second heat exchange later in the process to the final potable supply.

EN12897 defines the requirement for a safety circuit that ensures that any leakage is detected or cannot affect the potable water circuit. Only systems specifically designed to deliver potable water will feature the safety circuit.



Efficiency

The capacity (q) of the heat exchanger is defined by the equation

$$Q = A \times d \times \Delta t$$

Where A is the surface area of the exchanger, d is the heat transfer capability of the material it is made of and Δt is the difference in temperature of the two media either side of the exchanger surface.

It therefore follows that the most effective exchanger will be made from a material that has good thermal transfer properties, is also not corroded by water or the refrigerant and is malleable affording manufacture for the maximum surface area. For heat recovery systems that deliver potable water the material of choice is therefore copper. See later Refrigerants.



Other design features affect the efficacy of heat exchange giving a range of data for the effectiveness of different types of system from 20% up to near 100% collection of practical available heat.

Types of Heat Recovery Systems For Potable Water

For potable water then we are limited to those that comply with European requirements, are efficient and do not corrode i.e. in effect are specifically designed for this purpose rather than an adaptation of another technology.

The purpose built systems available in the UK that DK Heat Recovery are aware of are based on three different design principles.

1. The first is effectively a heating jacket wrapped around a water vessel, the safety circuit being that the jacket is a completely separate vessel to the water tank with thermal transfer being effected by a purpose made "glue". The manufacturer of these system states an effective heat collection capability of 50%. The capacity of the system, being dependent on the surface area of the jacket is therefore also dependent on the size of the vessel. For larger systems this dictates a big vessel, a potential issue when space is limited and a limiting factor when compared with other systems. The unique feature of this system is that it is that the vessel is fabricated from stainless steel rather than the lined steel vessels of others.
2. The second design is based on a thermo-siphon approach. The refrigerant is passed through the inner core of a co-axial tube. The safety circuit is the space between the inner and outer tube which is connected to a pressure sensor to identify a breach. The manufacturer claims that in 30 years a breach as never occurred. The co-axial is inside a third tube which carries the water. The system works by the heated water rising in the tube and being delivered to the top of the storage vessel. This manufacturer assembles a system from a fixed list of options which can make the design inflexible and again could be problematic, where space is of a premium. All the parts are manufactured by third parties and so there are two margins to finance.
3. The third manufacturer uses a coaxial approach but offers two options on how the heat exchanger is presented to the water.
 1. As an immersion "element" inside the water vessel
 2. As an external exchanger. This affords flexibility in how heat recovery is effected. This manufacturer builds the systems from scratch (with only one margin) and can design the solution to suit the installation.



Refrigerants

Ammonia. None of the above three systems can operate with ammonia due to being made from copper or due to the operating pressures involved. The manufacturer of system three does offer a stainless de-superheater for ammonia systems. We are aware of some heat pump systems that offer good results for ammonia systems but if you take into the overall life time cost and heat recovery benefits there is considerable evidence that Ammonia is not the most cost effective solution.

F gases. All of the above systems operate with F gases. A good time to install a heat recovery system is when replacing R22 as this will save a further intrusion into the fridge system and the consequent down time and cost. Heat recovery can also help replace the loss of efficiency seen in some systems with replacement gases.

CO₂. System three above is suitable for application with CO₂ with installations existing in Germany.

Legionella

Storing hot water below 60C is not a recommended activity! Heat recovery of the nature discussed above delivers water heated to 45-60C. It is therefore important that the system installed is design with a strategy in mind that eliminates this concern. Whether the solution is to use the system to pre-heat water for immediate further heating, to use the water as "black" water in a closed system or the water is generated for immediate use through a high flow system, there is a strategy that deals with this concern.

In Part 2 of this guide for beginners we will advise on how to assess your process for the application of Heat Recovery from Refrigeration and calculate the benefits.

For more information visit our website www.dkheatrecovery.co.uk

DK Heat Recovery Ltd

End Part 1



BEGINNERS GUIDE TO HEAT RECOVERY FROM REFRIGERATION

PART 2

Summary

Part 1 of this beginners guide set out to offer an insight into how heat recovery from refrigeration works and what it can deliver. In Part 2 we offer a starting point for your assessment of the application for your business and a means of calculating the benefits.

Will Heat Recovery Work For My Organisation

If you have refrigeration or air conditioning and need heating or hot water, yes, probably.

If you use a lot of hot water, yes, definitely.

For example, chicken processors use approximately 2 litres of water over 50C per chicken. A medium sized chicken plant will process 500,000 chicken per week so that's 1,000,000 litres per week at a cost of between £60,000 and £190,000 / year depending on whether they benefit from the great gas give away or have to use oil.

This same process will remove heat from those same chickens, which when combined with the other room cooling and freezing processes will generate more than enough heat to generate most of that hot water for free. A heat recovery system to deliver that heat would cost in the region of £100,000 installed (exc. water distribution).

Defining the ultimate system for you depends on where your fridge plant is, how big it is, how much water you need, where and when you want to use the hot water etc. but, the simplest starting point is with the heat source i.e. your fridge plant or air conditioning unit.

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GETTING STARTED

First, a thought. Think of the CO₂ involved in starting a project. It is probable that heat recovery will work for your business. However, it is always possible that it will not, and for many reasons. In 2012 the CO₂ emitted from travel that did not lead to installation of a heat recovery system was 8 tonnes.

There are two points at which you can start your journey toward saving money and reducing your CO₂ emissions through generating hot water from heat recovery from refrigeration.

But first prepare:

- ✓ Acquire / sketch / imagine a site plan that shows where the following plant is
 - Fridge / Air conditioning compressors and or condensers
 - Boiler / water heater system (s)
 - Main uses of hot water
- ✓ Write a list of all the uses for hot water in your business
 - Hand washing
 - Cleaning
 - Steam raising
 - Processes using steam / hot water
 - Defrosting freezers
 - Crate wash
 - As an ingredient
 - Heating
- ✓ Gather data on the price and usage of energy for your current means of water heating
- ✓ Note the refrigerant in use where possible. Our systems do not work with Ammonia

Starting Point Option 1

Identify likely source(s) of heat

This is the quickest way to get a feel for what heat recovery could do for your business. If you have only one source of heat find out what its "heat rejection" is OR what it's cooling capacity is in kW AND whether it is a direct, belt or shaft driven compressor. If you have multiple sources show them on the site plan and number them OR select a big unit or group of units in the same plant room.



If you cannot get the kW ratings let us know the compressor / unit make and model

Provide us with the following data

- kW cooling / heat rejection or make and model for each unit
- Water heating energy type and price per unit

We will be able to offer a "Quick Quote" for a basic system to use this heat which will define the estimated cost for an installed system (exc. water distribution), the cash and CO₂ saving and a payback scenario.

Starting Point 2

Calculate how much hot water you use

Using the list of hot water uses you created estimate usages for each category and calculate the total usage per day, week or year.

Provide us with the following data

- Total water use day, week, year
- What period this water is used over i.e. hours per day
- Your water heating energy type and price per unit

We will be able to offer a "Quick Quote" for a basic system to produce this heat which will define the estimated cost for an installed system (exc. water distribution), the cash and CO₂ saving and a payback scenario.

Alternatively down load the Cost and CO₂ Savings Calculator from our website

<http://dkheatrecovery.co.uk/heat-recovery/cost-and-co2-saving-calculator>

The more data you can gather the better we can define the system required and the likely benefit to your business. Once we have the illustrative figures we can discuss your degree of interest and if appropriate organise to visit your site for a general survey.

Download the "Getting Started" PDF from our website



<http://dkheatrecovery.co.uk/heat-recovery/getting-started>

Barriers To Success

The most common reasons for not progressing heat recovery projects that we encounter are

- Not a priority for the business
- Can't afford it (heard this one on a 9 month pay back offering!)
- Fridge contractor says it won't work
- We buy our gas so cheaply it's not worth investing in heat recovery

There are answers to all of these

- It will become a priority either through energy cost increases or pressure from other parties – and very soon!
- There are investment funds that offer loans and purchase and lease back based on savings made – no cash, off balance sheet options
- Get your refrigeration engineer to talk to our engineering support
- Gas prices WILL rise and through the life of the system you will see a huge benefit

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