Improving the Welsh Dairy Supply Chain

Heat Recovery Units (HRU)

Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig: Ewrop yn Buddsoddi mewn Ardaloedd Gwledig
The European Agricultural Fund for Rural Development: Europe Investing in Rural Areas

FARMING connect
cyswllt FFERMIO

Canolfan Datblygu Llaeth
Dairy Development Centre

DairyCo

Llywodraeth Cymru
Welsh Government

Dairy Development Centre
Gelli Aur
Carmarthen
Carmarthenshire
SA32 8NJ
Telephone: 01554 748570
E-mail: ddc@colegsirgar.ac.uk

www.ddc-wales.co.uk

November 2011

The Dairy Development Centre (DDC) acknowledges the contribution made by Farm Energy to the technical content of this booklet.

This project has received funding through the Rural Development Plan for Wales 2007-2013 which is funded by the Welsh Government and the European Agricultural Fund for Rural Development.

Contents

Introduction

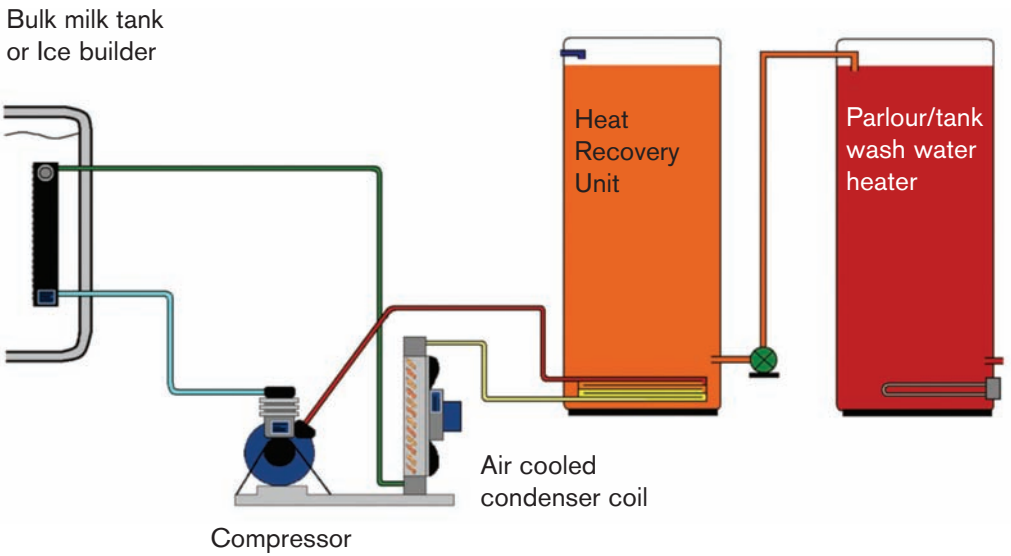
Where water is to be heated and milk is to be cooled, there is obvious potential for saving energy and money by transferring the heat energy between the two systems.

The heat normally lost by the refrigeration system can be captured to heat water for free – it also helps the cooling system to work more efficiently too.

Heat recovery involves the transfer of 'waste' heat from the hot refrigerant gases in the milk cooling system to heat water. To make this happen, a Heat Recovery Unit (HRU) is either mounted in the water storage tank or in the pipe feeding water to the tank.

Water temperatures of up to 60°C can be achieved from heat recovery, saving between 30% and 70% of water heating costs, depending on how much heat is available. Water temperature is 'topped up' using an immersion heater or conventional boiler system.

There are two basic types of HRU; flow and storage. Regardless of type, a HRU is installed in the refrigerant line between the compressor and condensing unit where the refrigerant is at its highest temperature, typically between 70°C – 80°C. The refrigerant is placed in thermal contact with the water and heat transfer takes place.



The type of milk cooling system used will determine how best to install and operate the HRU in order to give optimum performance. Two important factors to remember are:

- The operation of the HRU should not compromise the water heating systems ability to use night rate electricity, as this is the cheapest way to top up the temperature of the water.
- The water heater should always be full of water at the appropriate temperature and at the required time e.g. 85°C by the end of the morning milking for circulation cleaning.

Flow based HRU

As the name suggests, this type of HRU relies on a flow of water passing through the heat exchanger at the same time as hot refrigeration gas flows in the other direction. Heat from the refrigerant gases passes across the plate surfaces to warm the water. The construction of these heat exchangers is similar to that of the milk-to-water plate exchangers often used to pre-cool milk.

The temperature of the water from this type of HRU can be as high as 60°C. This must be stored in a well-insulated tank to minimise heat loss prior to use.

The key to obtaining the best performance from this type of HRU is to ensure that water flow occurs whenever the refrigeration compressor is operating.

The system can therefore be controlled by:

- A direct link to the compressor, switching on the water flow when the compressor starts.
- Fitting a time-switch to match normal compressor operating times.
- Installation of a thermostat which switches on the water flow when an increase in refrigerant temperature is sensed.

Two types of flow based HRU's are available:

Single pass - water is passed through the HRU once, at a very low flow rate and stored prior to use.

Circulation - water is circulated at a higher flow rate from a storage tank through the HRU and back again whenever the compressor is operating.

On balance there is little performance difference between the two systems.

A storage based HRU is essentially an insulated water tank with a heat exchanger built in to it. The two most common designs pass the hot refrigeration gas through either:

- A coil of copper pipe within the tank.
- A voided plate attached to the outer surface of the tank.

With this type of heat recovery system heat transfer will always take place when the compressor is running, as long as the stored water is colder than the refrigerant.

The HRU effectively becomes a hot water header tank connected to the conventional water heater.

This is a simple system therefore no special control system is necessary.

The water holding capacity of this type of HRU should be about the same as the water heater.

A HRU interacts very closely with the refrigeration system and it is advisable to take steps to ensure that both operate satisfactorily together:

- **Anti-vibration fittings** should be fitted to reduce the transmission of noise and vibration which can cause failure of the refrigerant pipes and fittings.
- It is possible to **over-cool** the refrigerant, and so reduce the cooling capacity of the bulk tank.
- It is possible sometimes for liquid refrigerant to **flow back** from the HRU into the compressor outlet, a non-return valve should be fitted to prevent this.

In many cases none of these are a problem but it emphasises the need to use an experienced refrigeration engineer who can advise you accordingly.

Water connections between the HRU and water heater should be insulated, as temperatures of over 60°C can be achieved.

Savings from installing a HRU

The following figures are based on the results from tests conducted on UK farms over a 12 month period and have been adjusted to reflect the requirements of a 100 cow herd size.

	Electricity saving kWh per annum	Cost saving £ per annum displacing 'night rate' electricity	Cost saving based on displacing 'day rate' electricity
Flow based HRU, single pass, IB tank	2330	£164	£267
Flow based HRU, circulation, DX tank	1464	£102	£167
Storage based HRU, IB tank	3041	£212	£349
Storage based HRU, DX tank	2329	£164	£267

Based on 7.0p p/kWh night rate, 11.5 p/kWh day rate