How to implement liquid pressure amplification to refrigeration plant

Compressors in refrigeration plant tend to operate at a higher delivery pressure than is needed. With liquid pressure amplification (LPA), compressors can run at a lower pressure and save energy.

The business case

Depending on the size of plant, its operating hours and the cost of electricity, financial savings can be substantial.

Generally, the larger the plant, the better the return on investment. On a 300kW plant, energy savings of up to 25% have been seen. With electricity at 8p/kWh, that works out at a saving of £30,000 a year. The capital costs would be around £25,000, giving a payback of under a year.

The technology

All mechanically operated refrigeration plant is made up of the following components:

- an evaporator that removes heat from an external body and transfers it to the refrigerant.
- a compressor that increases the gas pressure.
- a condenser that removes heat from the refrigerant and returns it to a liquid form.
- an expansion valve that expands the liquid before the evaporator. This reduces the pressure and temperature of the liquid to make it suitable for the evaporator conditions.
- a liquid receiver after the condenser to smooth out the flow of refrigerant.

The thermostatic expansion valve is central to the efficient and economical running of refrigeration plant because it regulates pressure and temperature.

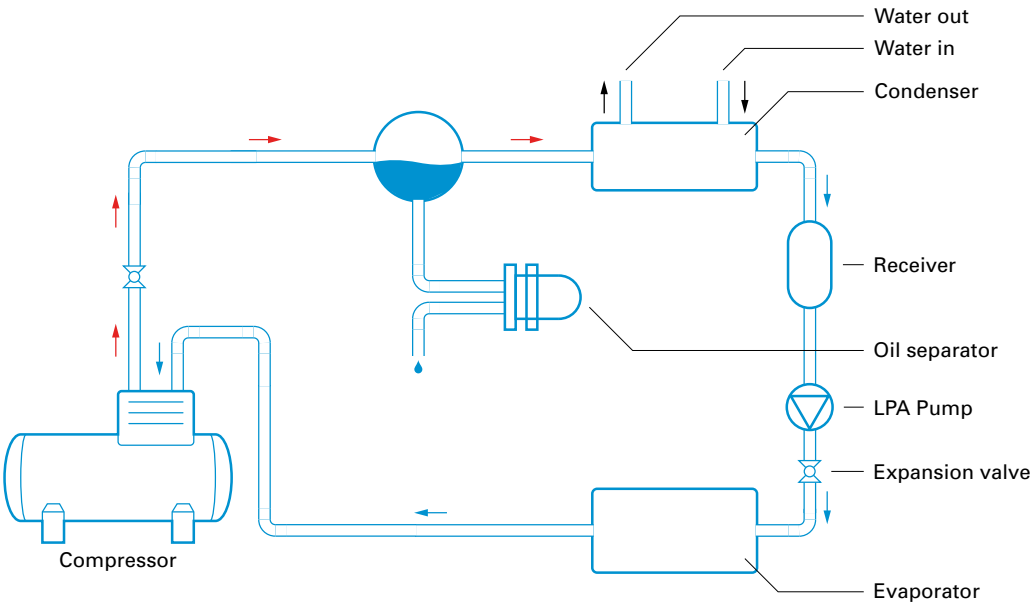
This expansion valve works more effectively if there is a constant pressure at its inlet. Pressure is maintained by the compressor, but to meet varying load conditions, the compressor operates at a higher delivery pressure than is always necessary, wasting energy.

Liquid pressure amplification (LPA) involves installing a pump in the outlet line of the condenser after the liquid receiver. The pump provides the stable pressure needed for the expansion valve and allows the condensing pressure (and hence compressor delivery pressure) to 'float' with ambient temperatures.

Figure 1 shows an LPA pump installed after the condenser. Pumps need to be hermetically sealed so that no refrigerant gas escapes from the system. The black arrows show the liquid refrigerant and the red arrows the refrigerant gas.

Although the LPA pump does need energy to operate, this is far outweighed by the savings from the compressor.

Figure 1 Refrigeration system with liquid pressure amplification



Applications

LPA can be applied to many types of refrigeration plant, including air conditioning systems. The benefits depend on the type of refrigerant used in the plant and the operating conditions. This is a specialist area, so you should get advice about the suitability for your plant from the equipment manufacturer or service contractor.

To make financial sense, the minimum size would usually be a compressor of at least 100kW electrical load, based on an 8,000-hour operating period.

Table 1 Specification checklist

Actions	Comments
Establish the size of the compressors.	This is important for checking feasibility.
Monitor the operating conditions.	Establish energy consumption and the operating parameters. This should include the electricity consumed by the unit and the operating hours.
Get advice from an equipment supplier or installer.	The benefits also depend on the type of refrigerant you use. Each refrigerant has different physical properties and these need to be considered before specifying a valve.
Specify the operating conditions of new pump system and decide on the size of pump.	The pump pressure needs to be decided during the design phase.
Ensure that contractors tendering for the installation are competent in handling the removal and re-injection of refrigerant.	If R22 is being used by the plant, consider replacing it at the same time. New R22 became unavailable from January 2010 and will be completely phased out by December 2014.

Commissioning checklist

Commissioning new plant or modifying existing equipment leads to changes in the refrigerant charge. New plant may come already charged or may need charging on site. Refrigerant in existing plant will need to be charged after modification. This should only be carried out by a competent contractor with the necessary training and certification.

- If the unit isn't charged with refrigerant, carry out a pressure test to ensure there are no leaks.
- Evacuate any gas used for the pressure tests.
- Charge the units with the correct amount of refrigerant.
- Check the operation of the expansion valve over a range of settings.
- Check that all pipes are insulated
- Operate each item of plant separately.
- Commission the overall system.
- Monitor energy consumption after commissioning to ensure you are getting the expected savings.

Common problems

For efficient operation and to maximise energy savings, check that:

- air and other non-condensable gases are properly evacuated from the system after the LPA pump is installed
- pumps are correctly placed to avoid reducing the efficiency of hot gas defrosts
- the surfaces of heat exchangers are clean
- filters in air handling systems are not blocked.

Finding a supplier

Most companies without in-house expertise will need the help of a specialist to design and install LPA pump systems. Your equipment supplier should be able to help. If not, the Institute of Refrigeration can supply a list of contractors.

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