

How to apply liquid pressure amplification to refrigeration plant

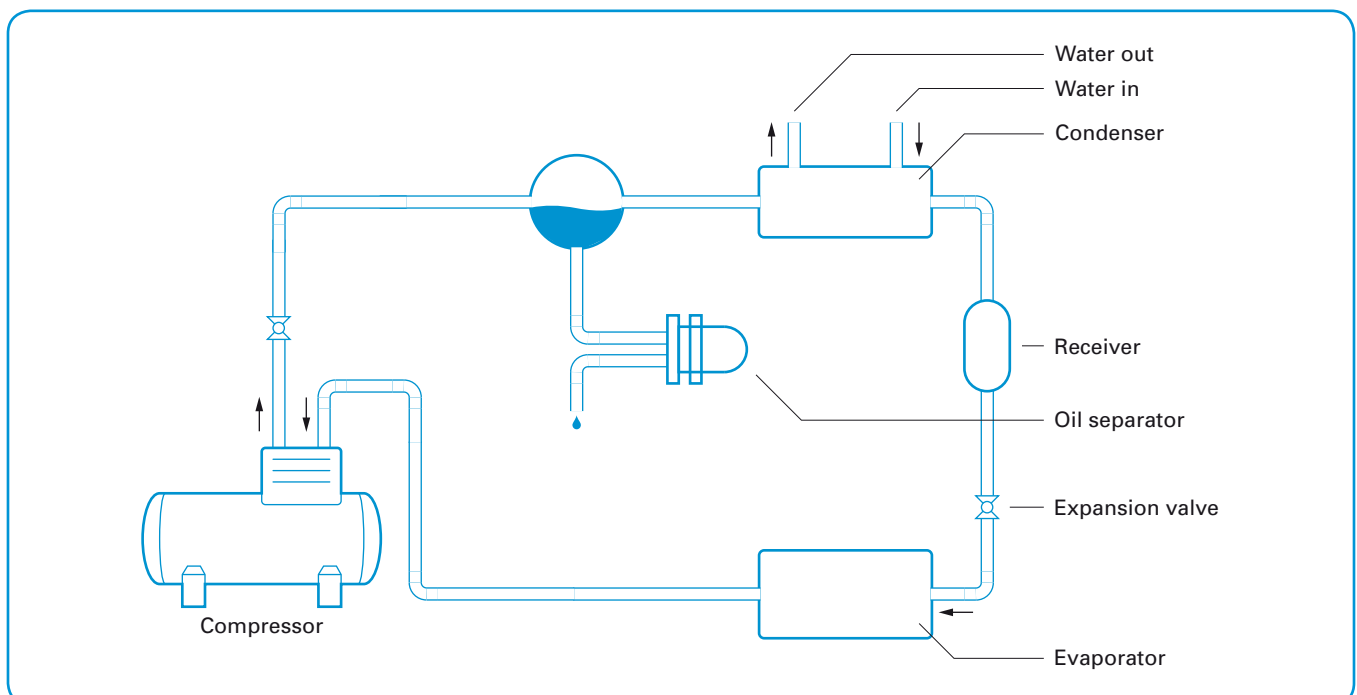
There are a number of common component parts in all mechanically operated refrigeration plants.

- An evaporator which 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.
- A thermostatic expansion valve that expands the liquid before the evaporator. This reduces the pressure and temperature of the liquid so that it is suitable for the evaporator conditions.
- A liquid receiver after the condenser to act as a buffer tank to smooth out the flow of refrigerant.

Figure 1 below, shows a thermostatic expansion valve after the receiver tank. This regulates pressure and temperatures and so is a critical component in the economical operation of refrigeration machines. 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 is operated at a higher delivery pressure than is always necessary, wasting energy.

The introduction of Liquid Pressure Amplification (simply the installation of a pump in the outlet line of the condenser after a liquid receiver) allows the compressor to be run at a lower delivery pressure, with the pump providing the required stable pressure for the expansion valve.

Figure 1 Refrigeration system without LPA



The technology

The installation of the liquid pressure amplification pump allows the condensing pressure (and hence compressor delivery pressure) to 'float' with ambient temperatures, saving energy as a result. A pressure controller is needed to ensure the correct operation of the pump. *Figure 2* below represents the installation of a pump after the condenser. Pumps chosen should be hermetically sealed to ensure that no refrigerant gas escapes from the system.

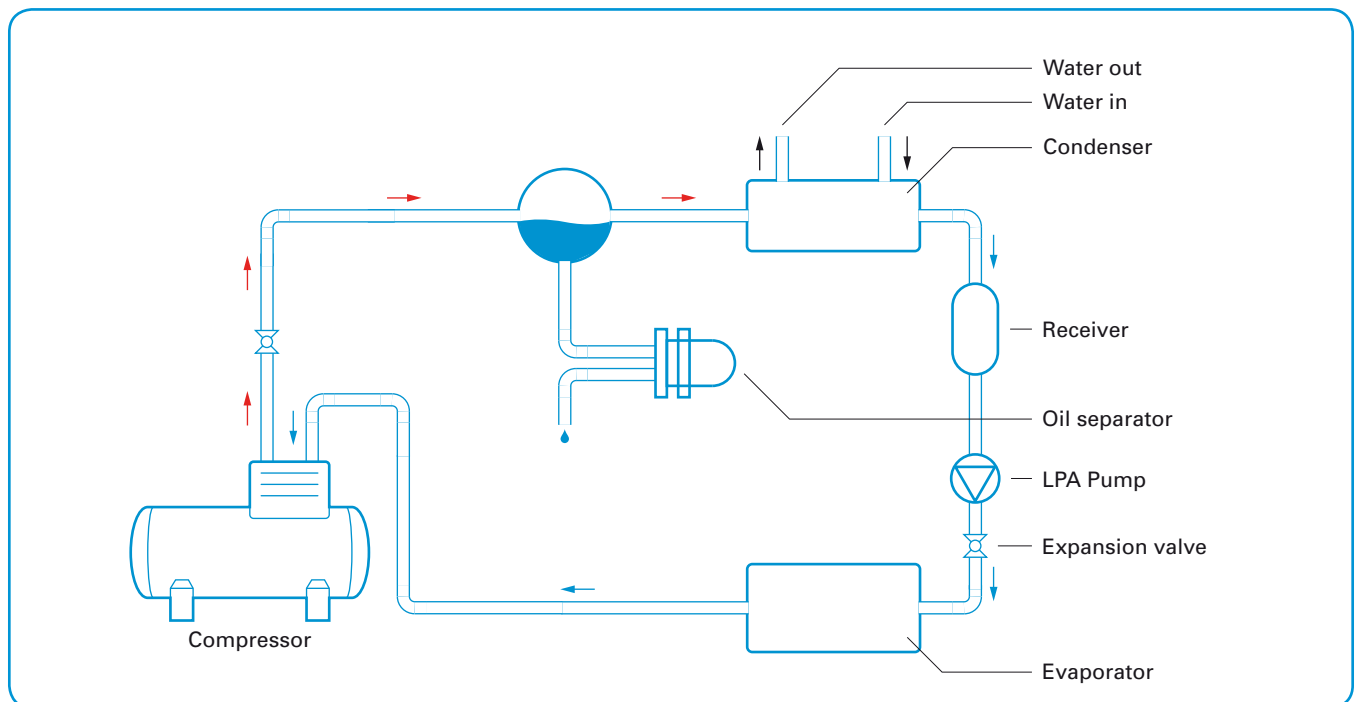
The blue arrows indicate the liquid refrigerant and the red arrows indicate the gaseous refrigerant.

Note that the liquid pressure amplification pump requires some energy to operate, but this is significantly less than that saved in operating the compressor.

Application

Liquid pressure amplification can be applied to many types of refrigeration plant, including air conditioning systems. The benefits depend upon the type of refrigerant being used in the plant and the operating conditions. This is a specialist area and advice should be sought from the refrigeration plant's manufacturer or service contractor to determine the applicability of LPA to any particular refrigeration system. The economic application depends upon the size of the chilling plant, the minimum size to consider installing LPA would be on a compressor of at least 100 kW electrical load, based on an 8,000 hour operating period.

Figure 2 Refrigeration system with LPA



Specification checklist

The specification for implementing a liquid pressure amplification project depends upon the type of refrigeration plant. The economic viability becomes better as plant size increases. *Table 1* below shows the areas to be considered when installing the system.

Commissioning procedure

The commissioning of either new plant or modification to an existing installation will result in some changes to the refrigerant charge. In the case of a new plant, the unit may come already charged or need charging on site. Any existing plant will need the refrigerant charging after any modifications are made. This should only be carried out by a competent contractor, who can

demonstrate that they have the required training and certification to undertake the tasks.

- If the unit is not charged with refrigerant, carry out a pressure test to ensure that there are no leaks.
- Evacuate any gas used for the pressure tests.
- Charge the units with the correct amount of refrigerant.
- Check that the LPA pump is rotating in the right direction.
- Check that all pipes are insulated.
- Operate each item of plant separately to ensure satisfactory operation.
- Commission the overall system.
- Monitor the energy consumption after commissioning to ensure that the savings are being realised.

Table 1 Specification checklist

Item No	Parameter	Comments
1	Establish the size of compressors.	Required to understand economic viability.
2	Monitor present operating conditions.	Establish the present energy consumption and operating parameters. This needs to include the electricity consumption and the operating hours.
3	Review suitability with equipment supplier or expert for fitting LPA.	The benefits will also depend upon the type of refrigerant being used.
4	Decide upon the LPA pump size.	
5	Ensure that any contractor tendering for the installation is competent in handling the removal and re-injection of the refrigerant.	If R22 is being used by the plant, consider carrying out a replacement of this at the same time. R22 is being phased out due to its Ozone Depletion Potential. No new R22 will be available from Jan 2010 and it will be completely phased out by Dec 2014.
6	Specify the operating conditions of the new pump system.	The pump pressure will need to be decided during the design phase.

LPA is a specialist technology that will most probably require expert advice to design and implement.

Common problems

The following are some of the common problems that may occur when installing and operating this type of system:

- The evacuation of air or other non-condensable gases from the plant is incorrect after the installation of the LPA, resulting in a reduction in performance.
- If hot gas defrosts are used on the plant, an incorrectly located pump will reduce the efficiency of the defrost unit.
- If surfaces of heat exchangers are allowed to become dirty, the process will become inefficient and savings will not be achieved.
- Blocked filters in air-handling systems will negatively affect the process efficiency.

Finding a supplier

This is a specialist technology, so that unless there is an 'in-house' capability for refrigeration engineering, then specialist expertise will be required. The equipment supplier should be able to provide this expertise, but if not, the Institute of Refrigeration can supply details of competent contractors. You can contact the Institute of Refrigeration on **020 8647 7033** or visit **www.ior.org.uk**

The business case

The business case will depend upon the size of the plant being considered, in the case of liquid pressure amplification, the larger the plant, the better the investment return. The cost of electricity will also have a major effect on the payback period. On a 300kW plant, savings on electricity of up to 25% have been seen. This could represent an annual saving of £30,000 per annum based upon an electricity cost of 8p/kWh. The capital costs would be in the order of £25,000, giving a simple payback of 11 months. The payback period will also be influenced by the plant operating hours, the higher the hours, the quicker the payback.