## Liquid Pressure Amplification in Refrigeration

### Scope of Document
This document is a short form explanation of liquid Pressure Amplification (LPA) application within refrigeration systems to increase efficiency and save energy.

### Preface
A basic understanding of the refrigeration cycle and component function within that cycle is assumed on behalf of the reader.

### Expansion Device
The primary cooling effect of a direct expansion cooling system is the release of pressure via a modulating orifice device expanding a high-pressure liquid refrigerant to a low-pressure vapour. The expansion phase of the cycle is the point at which energy is absorbed into refrigerant from its surroundings, i.e. the medium being cooled.

### Compressor
The system pressure difference is created by the compressor component. The suction side creates the low-pressure side and the discharge creates the high-pressure side. The difference between the 2 pressures is termed as the compression ratio. The compression ratio has a direct effect on the force required to perform the compression and therefore the higher the compression ration the more energy is required to turn the compressor.

### High-Pressure Side
The compressor compresses the vapour refrigerant from the evaporator into a high pressure-pressure vapour. This high-pressure has to be high enough for the vapour to be easily cooled by a condensing device back to a liquid state. The pressure is again held higher because a traditional refrigeration system also utilises the high-pressure to provide the driving force to push the liquid back to the expansion device. This is highly inefficient practice as it is using the compressor as a form of pump.

### Liquid Pump
The LPA system involves installing a comparatively small pump in the liquid line to the expansion device to perform the drive function. This gives the opportunity to reduce the high-side pressure by increasing the condensing function as the pump is now delivering the liquid to the expansion device. The compression ratio is reduced and the absorbed power to drive the compressor is reduced.

### Energy Benefits
The benefits of reducing the compression ratio is not only to reduce energy absorbed by the compressor but also the use of a pump to increase the liquid line pressure does not involve the input of compression heat previously generated by the compressor. This means the associated saturation temperature of the refrigerant is shifted in a beneficial fashion. This means the liquid refrigerant has more potential refrigeration effect prior to passing through the expansion device. Therefore the system absorbs less energy at the compressor for a greater refrigeration effect.

### System Benefits
The reduced compression ratio not only reduces the energy absorbed but also puts less stress and temperature differentials on the compression component. These devices are usually the most expensive to purchase and maintain within the refrigeration system. The reduced wear directly improves the system runtime between failures and greatly reduces the risk of system failure due to component damage.

### Savings
The extremely variable type and configurations of refrigeration systems means there are no set savings figures that can be expected when installing LPA. To date, the savings monitored and reported range between 15% & 50%. A small number of systems that have particularly unusual criteria have demonstrated savings of 80% .

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