AIR CONDITIONING AND REFRIGERATION
Journal
The magazine of the Indian Society of Heating, Refrigerating and Air Conditioning Engineers

Issue : October-December 1998

Evaporative Pre-cooling for Air Cooled Condensers

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Like the weather, many talk about the need to cut energy use, but can do little about it. The technique described in this article has been tested in the field and has decreased energy consumption substantially. Along with energy saving, the required refrigeration plant size can be lowered. The play back period is normally less than two years.

Systems with air cooled condensers have a lower EER (Energy Efficiency Ratio - Btu/watt) than water cooled systems for the same ambient conditions. The difference gets worse in hot dry summer months when the cooling load is at its maximum.

Effect of High Condensing Temperature

As the ambient dry bulb temperature rises to 45 deg. C in summer, the EER reduces to less than 8 for an air cooled system, while it is above 13 for a water cooled system because the ambient wet bulb is only 26 deg. C. Thus the difference in EER is over 65% while the actual cooling capacity reduces by over 43% **Fig. 1** shows how these figures are obtained from the performance curves of a 3 TR hermetic compressor.

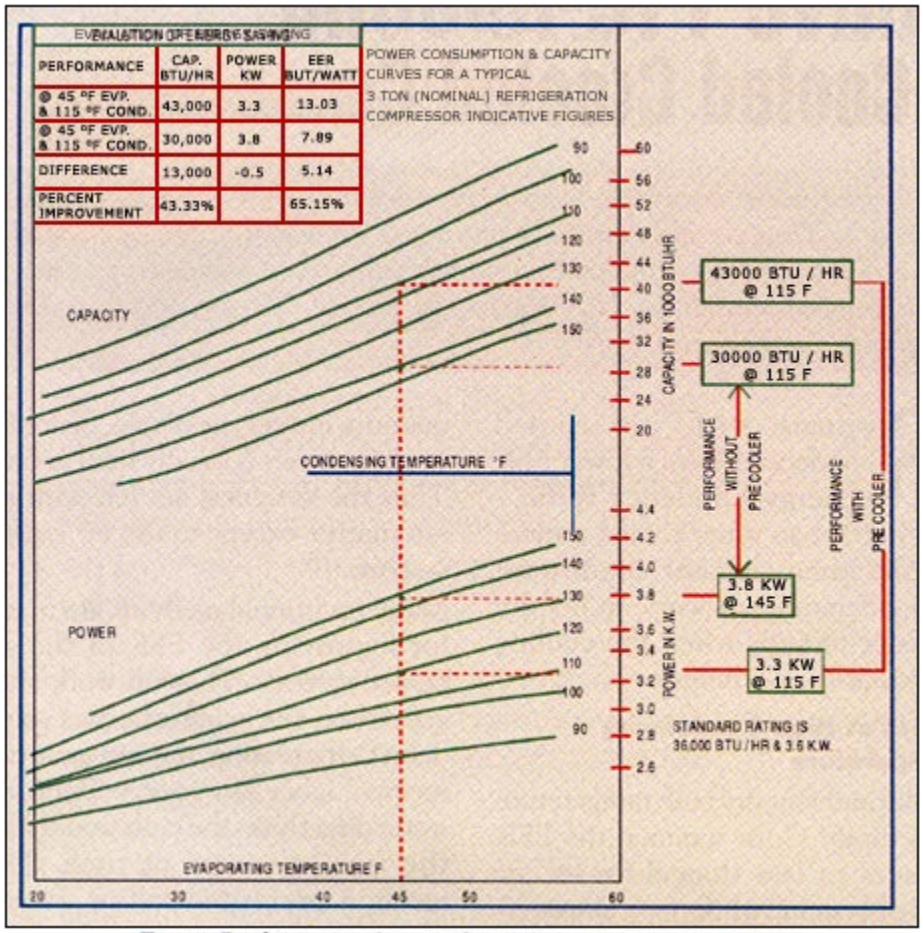

Fig. 1: Performance Curve of a 3TR Hermetic Compressor

For example, this compressor of 3 TR nominal rating will provide only 2.5 tons of cooling at a condensing temperature of 62.8 deg C (145 deg. F) It will consume 3.5 kW, yielding an EER of 7.9 BTU/watt. The same compressor will give over 3.5 kW if the system has a water cooled condenser Thus the EER now goes up to 13, an improvement of over 65% in energy efficiency.

At one time, all packaged units and central plants used to be water central plants used to be water cooled. Now soft water in sufficient quantity is rarely available. Space for cooling towers is usually hard to find. Thus the designers are left the alternative except to use air cooled systems.

Many traditional methods are in use for improving the EER of the air cooled systems. They all work after a fashion, but each one has some defect. Increasing the air quantity means higher fan energy. Spraying water directly on the coils would ruin the fins in curse of time. The method presented below avoids direct contact but seeks to improve the EER by lowering the dry bulb temperature of the air via adiabatic saturation before it passes over the condenser coil.

How is Evaporative Pre-cooling applied

To understand the concept, just imagine that a desert cooler, which can work with hand water, is placed such that its free discharge as directed at an air cooled condenser say

about one foot away, without any physical connection or ducting. If the output of the 'desert cooler' is sufficient, the air entering he condenser will be near its wet bulb temperature. Then the performance of the air cooled condenser improves very nearly to that of a water cooled system. A thermostat will cut out the 'desert cooler' during cooler weather, saving water and power. Since the condenser air flow remains unhindered due to the gap between the condenser and the cooler, its normal performance does not deteriorate. As such, the pre-cooling would be required only for a few hours a day for the summer months and taper off as the weather turns cooler.

Miserly Water & Power Consumption

In comparison, the water cooled units must have the condenser water systems running as long as the unit is operating. Thus one can get the energy efficiency of a water cooled system out of an air cooled one at lower capital, energy and water cost by part time use of a 'desert cooler', so to say. The water quality is not important. It can be sourced from a bore well or even a waste water recycling system where available. The quantity required is very low, less than 40 liters/ton/day, as compared to a cooling tower which needs approximately 125 liters per ton for 10 hr. and 200 liters per ton for 24 hr. approx. The cooling tower is eliminated along with its associated pump and piping.

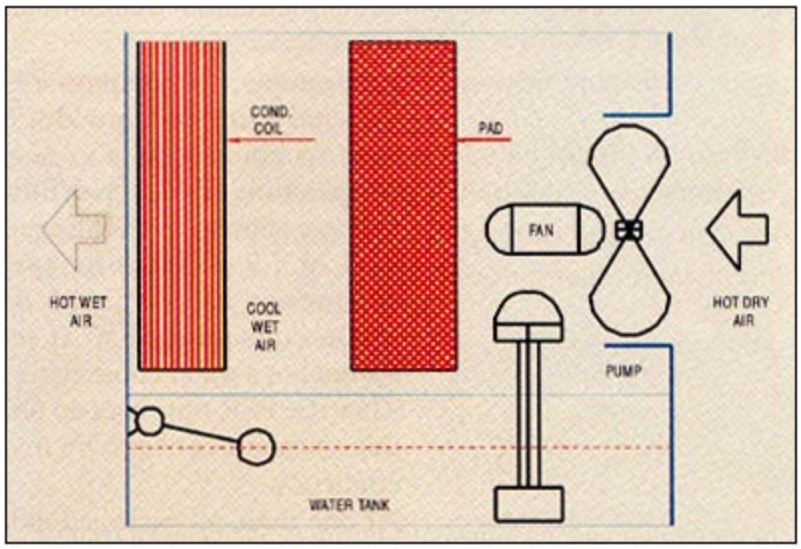

Fig. 2: Schematic of a Pre-cooler

Practical Aspects

While an air cooler can be used directly as described above in some cases, can add on unit specifically designed for a particular product would blend in better. Several add on attachments are working in the field. In one instance a three ton air conditioner is adequately cooling a 58 m²(600 sq.ft.) showroom at Ahmedabad in the peak summer with 45 deg. C ambient. **Fig.2** shows an illustartion of the unit. However, more development, work is needed to design a mass production unit. It would be necessary to integrate the adiabatic saturation elements and controls within he condenser cabinet in

such a manner that the normal air flow is not affected. Corrosion protection and elimination of wood wool pads will produce an elegant, long lasting product.