PACKAGED AIR-COOLED UNITS PERFORMANCE AT HIGH AMBIENT TEMPERATURE CASE STUDY

The weather data source for sizing the air-conditioning equipment is an ASHRAE Handbook, which is updated every four years (the latest issue is 1997). There are three options for selecting outdoor design temperatures, and they are based on the temperature frequency of occurrence. Up to 1997, the frequency of occurrence was identified as 1% of the time; 2-1/2% of the time; and 5% of the time. Since 1997, the temperature frequency of occurrence is identified as 0.4%; 1%; and 2%.

Each year temperatures above 110°F (43°C) are to be expected at locations with high summer design temperatures. In addition to this, the radiation from the roof surface could increase the condenser intake temperatures with 10°F to 20°F (5 – 15°C) above the ambient temperature.

Trane Co. equipment data indicates proper unit operation up to a maximum ambient temperature of 115°F (46°C). Problems should be expected only at temperatures above 115°F (46°C). This is a typical limitation for an air-cooled DX packaged unit. Over-sizing the unit cannot be an answer to the problem. The only solution to the problem is reducing the condenser intake air temperatures by means of pre-cooling. This effectively will increase the condenser capacity. Installation of a pre-cooling system for the condenser intake air will have an additional benefit of reducing the power consumption by the refrigeration compressors.

This situation is typical for project locations with high summer design temperatures only (above 100°F / 37°C).

The only way to reduce the ambient temperature of given circumstances is to use the ability of dry air to absorb water vapors to a point near saturation. This process of energy balance allows the dry bulb air temperature to drop.

There are two conceptually different methods of accomplishing this - injecting water in the air of low pressure (40 - 80 psi / 2.5 – 5.5 Bar) and injecting water in the air at high pressure (800 - 1,000 psi / 55 – 70 Bar).

The low-pressure system has one big disadvantage - the water is carried by the air stream and deposited on the condenser coil where the evaporation takes place. This causes calcification, corrosion and reduces the efficiency as well as the life of the condenser coil.

The high-pressure system causes flash-evaporation of the water in the air. The mixture of water and air reaching the condenser coil is in a gas phase with a lower temperature. There is no evaporation taking place on the condenser coil and therefore there is no calcification and corrosion.

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We have analyzed the performance of the Trane units SXHGC75 and SXHGC1O5. The reduction of the ambient temperature from 115°F to 90°F (46 – 32°C) improves the efficiency by 14% for a 75-ton unit, and by 13.4% for a 105-ton unit. The reduction of ambient temperature from 105°F to 90°F (40 - 32°C) improves the efficiency by 8% for both units.

The projects in locations with high ambient temperatures (above 100°F / 37°C) have total installed capacities from 450 tons to 650 tons of refrigeration, depending on the size of the facility. The savings generated by operation at lower ambient temperatures will be based on reduction of 41 to 60 tons of refrigeration for the facility (estimated average improved efficiency of 9.2%).

The use of the high-pressure system will not only assure reliable operation of high ambient temperatures, but will also reduce the utility cost, without the penalty from condenser coil corrosion and eventually replacement.

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