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THE EFFECT OF DEFROST CONTROL ON COMPRESSOR OPERATION

On any refrigeration system operating with evaporating temperatures below 30° F., frost will accumulate on the evaporator surface, and some means of defrost must be provided. While air defrost is possible in some medium temperature applications where close temperature control is not too critical and sufficient off cycle time can be provided, most commercial refrigeration applications require a fast, positive means of defrost.

It is important when selecting the method of defrost that the effect on system operation be carefully considered, and adequate provisions must be made to avoid possible damage to the compressor.

Field experience indicates that excessive liquid refrigerant reaching the compressor is probably the biggest single source of compressor failure. On commercial applications the defrost cycle is undoubtedly the cause of most liquid control problems.

Hot Gas Defrost

In the search for fast and efficient means of defrost, designers are always attracted by the tremendous heat potential of introducing hot gas into the evaporator and condensing it to a liquid. But the critical question is, just what do you do with that liquid? An all too common practice has been to return the liquid to the compressor, hopefully at a controlled rate, and rely on the motor heat and the heat of compression to evaporate the liquid.

A compressor will tolerate some slight amount of liquid return for a short period of time without serious problems. Unfortunately it isn't always a slight amount of liquid, and as the size of the compressor and the system increase, the problem becomes more critical. The situation is complicated by the fact that even though sufficient liquid is returning to wash the bearings free of lubricant, the oil pump may still develop sufficient pressure with the mixture of oil and refrigerant to prevent a trip of the oil pressure safety control. There may very well be a condition where the compressor has lost lubrication which no protective device can sense.

The basic solution is to provide some source of heat to re-evaporate this liquid without returning it to the compressor. In the supermarket fixture where multiple evaporator circuits are employed, an ideal solution has been a control system to defrost only a few cases at a time, returning the condensed liquid to operating evaporators. Some type of heat source in the suction line is also an acceptable approach. Proprietary systems of this type are available on the market, but unfortunately have not been widely used.

The majority of systems utilizing hot gas defrost provide only a suction line accumulator. There is growing evidence that the accumulator alone does not represent an acceptable long term solution, particularly on larger low temperature systems where hot gas defrost is a major source of early compressor failure.

Unless some means of re-evaporating the liquid is provided, the compressor life expectancy may be reduced by a tremendous factor. Compressor failure due to loss of lubrication in systems not providing adequate protection against liquid refrigerant must be considered a customer responsibility.

Electric Defrost

Even with electric defrost, liquid refrigerant control remains a hazard. The most effective means of compressor protection is a pumpdown cycle at the time of defrost, thus isolating the refrigerant charge in the condenser and receiver. If pumpdown control is not used, then at a minimum a liquid line solenoid valve which is closed during defrost should be provided, together with a suction line accumulator capable of holding whatever refrigerant might be in the evaporator.

If the evaporator can become warmer than the suction line during defrost (which might occur due to low ambient temperatures, electric heaters in contact with the evaporator, or insulated suction lines) the resulting pressure difference can force liquid from the evaporator into the suction line with subsequent flooding on start-up. Even if the liquid refrigerant does not leave the evaporator, some liquid flooding from the warm evaporator immediately after defrost is almost impossible to avoid until such time as the system again stabilizes, and the liquid metering device regains control.

Defrosting Truck Eutectic Plates

One of the worst abuses frequently encountered is the practice of defrosting eutectic plates in truck applications with steam or hot water without pumping the system down. Plate circuits are almost always filled with liquid refrigerant because of the low temperature of the frozen eutectic solution, and the high temperature and consequent high pressure of the refrigerant in the plate resulting from the defrost drives the liquid refrigerant into the compressor crankcase, frequently with fatal results for the compressor on start up.

Because of the large volume of refrigerant in the plates, an accumulator, if provided, is frequently flooded. Pumpdown prior to defrost is the only safe solution.

Air Switch Controls

Defrost controls actuated by air switches sensing either velocity or pressure may create oil return problems in systems not properly designed for this type of control. The air switch is actuated only when sufficient amount of frost has accumulated on the coil, and depending on the circumstances this may occur in a few hours or a few days.

On many low temperature systems, a portion of the oil in circulation gradually accumulates in the evaporator and suction line during operation. Refrigerant velocities often are not high enough to prevent some oil logging, but usually this is not a major problem since normally the oil lying in the evaporator will be returned during a defrost cycle because of the increased liquid refrigerant flow. If the defrost cycles occur at regular and frequent intervals, an adequate oil level can be maintained in the compressor despite some loss of oil between defrosts. But with the air switch control, defrost may occur infrequently, and the compressors may run completely out of oil before the next defrost cycle occurs.

The only positive cure for this type of problem is the proper design of the evaporator and suction piping to insure gas velocities which will return 100% of the oil in circulation to the compressor. If this is not possible, an oil separator may greatly lengthen the safe operating period between defrosts.

WARNING: Before using a defrost control system which can result in long periods of time between defrost cycles, the system operation must be analyzed to make certain the system design will insure adequate oil return to the compressor. If oil trapping can occur, tripping of the oil pressure safety control or failure of compressors without such controls can be expected due to lack of lubrication.

Ultra-Low Temperature Applications

At ultra-low temperature conditions, -60°F. and below, it may be impossible to return oil without warming the evaporator. An oil separator must be used on ultra-low temperature applications in order to minimize the oil circulation. Since oil separator efficiencies are considerably less than 100%, in extremely critical applications, two or more oil separators can be used in series to increase the overall efficiency and prolong the periods of safe operation, but for continuous operation, regular defrost periods are usually a necessity.

On two-stage systems, since the suction gas returns directly to the low stage suction chamber, without passing through the motor chamber, liquid refrigerant control after defrost is even more critical. Suction accumulators are recommended on all two-stage systems for protection against liquid flooding.

Motor cooling on two-stage compressors is dependent on an adequate feed of liquid refrigerant from the desuperheating expansion valve. If a hot gas defrost system is used, it is imperative that a solid head of liquid is maintained at the desuperheating valve at all times.

In general, an electric defrost system on two-stage systems is much less complicated and therefore usually more dependable, and is recommended on all field installed systems.

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