# REFRIGERATION REVIEW

## Compressor Lubrication Systems

by Hank Bonar and Greg Robison

The advent of screw compressors brought in some new technology for lubricating systems for compressors. Reciprocating compressors were basically designed in keeping with the automotive industry's internal combustion engines. They use compression rings for minimizing blow-by, and oil rings to facilitate lubrication of the cylinder walls. Automotive compression ratios for gas-driven engines generally top out at a compression ratio of about 11:1. The heat of compression is dissipated in automotive engines through the cylinder walls via a water jacket or air cooled fin arrangement. Diesel engines operate at much higher compression ratios -- upwards of 20:1 -- which is designed to create high enough temperatures for ignition of the fuel.

Ammonia reciprocating compressors are generally limited in their compression ratio to about 8:1 for 1800-rpm machines. For those of you that can read a Mollier Diagram, is a chart which depicts the path of the refrigeration cycle in terms of pressure and enthalpy. Ideal compression on the graph follows the constant entropy path, which deviates from the loss of efficiency, and will clearly show what temperatures can be expected at the end of compression. Quite often this is called Heat of Compression. Basically, the compressor is pushing the molecules closer together, which, per the Kinetic Theory of Gas, will provide higher temperature. Old oil separators have been inspected that would be carbonized from oil that was driven to 400°F that, had it had an ignition source, of course, would have ignited, but deposited out into the oil separator. Probably it was caused by a bad valve or piston rings of the compressor. Attached is a typical Mollier Diagram for a single stage compression cycle.

Screw compressors with injection cooling can operate with a compression ratio of upwards of 20:1. The difference, of course, is in the oil cooling system, which traditionally with reciprocating compressors, was a simple oil separator, which by impingement would fall out of the refrigerant gas ammonia and return to the crankcase by float devices.

Screw compressors, on the other hand, tend to homogenize oil and refrigerant in the blow-by created between the rotary gears and between the barrel and rotary gears.

This creates a much smaller oil mist and of course, requires a more sophisticated demister pad arrangement for separation. The separation is also facilitated by cooling of the oil and generally, a 140°F maximum discharge temperature is required to adequately separate oil from the discharge.

Various methods have been used for cooling the oil, including direct injection of refrigerant into the barrel of the screw compressor, indirect cooling via heat exchanger using a secondary fluid such as glycol, and more recently thermosyphon cooling using condenser liquid refrigerant via a heat exchanger.

The spin-off of this technology has permitted the use of coalescent oil separators for reciprocating compressors and has greatly enhanced oil recovery in refrigeration systems.