REFRIGERATION REVIEW

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SYSTEM COMPONENT DESIGN REVIEW

COMPRESSOR SELECTION

by Henry B. Bonar, II

Compressor selection is probably the single greatest influence on power consumption costs in a refrigeration system design. With large numbers of competent "engineering contractors" providing refrigeration services to the industry, it is occasionally disenchanting to see competition "force" end users into purchasing systems which could easily carry a 10 to 15% operating cost penalty because of compressor selection (sizing and type).

For years refrigeration systems were distinctly characterized by either single stage for high temperature applications, or two stage for lower temperature applications. Up until the late 1960's/1970's, the use of high compression ratio reciprocating machines, such as Howe and Frick's HDI series and Kohlenberger's on the west coast, were wide spread. Generally, two stage systems were provided with either compound piston machines, or two stage systems using rotary boosters for the first stage of compression and piston machines on the second stage. In the last twenty years, the use of screw compressors has had a profound effect on the application of compressor types and sizes. Screw compressors undoubtedly marked the end of the high compression ratio 10 to 12 to 1 (Frick HDI type compressor). With its lack of discharge valves and use of oil cooling and liquid injection, the screw compressors can provide for a wide variety of compression applications. This has influenced the compressor selection process as much as any single event in refrigeration compression technology in the last 100 years. We are, however, still learning how to use this technology for its best useful purposes.

An emergence of a second technology has somewhat benefited, however, complicated and slowed the learning curve, in proper application of screw compressors. This is the advent of PC controllers or microprocessor control of screw compressors. The compressor industry is probably looking at its fourth and fifth generation of microprocessor control of screw compressors, and we are looking at the second and third generation of refrigeration systems and process controls with undoubtedly many more to come.

In the past, the use of pressure switches for compressor cycling and step controllers, such as Vilter's "Unimatic" or the more generic, "Barber Coleman" type of controllers, have certainly provided good control methods. However, these are far less versatile than programmable type controllers using pressure transducers. Very often, the perception conveyed when a PC control system is used for refrigeration control or energy management is that a large amount of energy has been eliminated. In reality, this is often not the case, particularly in screw compressor applications. We have seen many installations with three or more suction requirements having compressors which average less than 75% full load. A screw compressor will use 25 to 50% more power (KWH) consumption than in its 100% load position. (Note, We have measured consumption by screw compressors with "Journal Bearings" in lieu of **Ball Bearings** to be as much as 36% more than a reciprocating compressor when the screw compressor was **fully** loaded.) All to say, a 400 HP screw averaging 75% unload could easily consume 50% more power which is 1,752,000 KWH per year **wasted.** At $.05/ KWH, this equals $87,600/year. Obviously, this is enough to have justified another, perhaps smaller, compressor.

MECHANICAL SHAFT SEALS USED FOR AMMONIA

by John P. Ryffel

Shaft seals, a vital part of refrigeration systems, are both expensive to replace and costly to stock in case of seal failure. Bonar Engineering, Inc. is proud to announce the opening of its seal research lab facility. The lab incorporates factory training, state of the art equipment, failure analysis, quality control testing, a file to document all rebuilds and causes of seal failure, as well as parts for emergency seal repair. This service is provided by Bonar Engineering to help keep operating costs down while providing reliable seal designs and reconditioned replacements.

With today's economically cautious times, many

Continued on Page 4

Mechanical Refrigeration: The Research Begins

The following is an excerpt from Industry in the Cold, prepared by the International Institute of Ammonia Refrigeration, Chicago, Illinois.

The development of a thermometer by Galilei Galileo in 1597 marked the beginning of 300 years of research that led eventually to the modern mechanical refrigeration system.

Early highlights of these experiments include the development of the standardized thermometer scale in 1709 by instrument maker Gabriel Daniel Fahrenheit, and the isolation of ammonia, oxygen and carbon dioxide gases in 1773 by Englishman Joseph Priestly.

One of the phenomena observed by the "natural philosophers" of the 18th Century was the ability of volatile liquids such as ether to freeze water when allowed to evaporate while in contact with the water. This observation, combined with Englishman Michael Faraday's successful liquefication of ammonia and carbon dioxide gas by means of pressure, formed the basis for the refrigeration research of the 19th Century. Most of this work took place in Europe and especially in England and France. The United States, with its abundance of harvested ice, complacently ignored most refrigeration research during this time. Two Americans, however, did make worthwhile contributions.

Early Pioneers

In 1834 Jacob Perkins, an American living in England, built the first vapor compression machine which actually worked. Although his achievement was not mentioned in print for nearly 50 years, Perkins' machine, which was charged with ether, employed the four principal parts used in every compression installation to this day: a compressor, a condenser, an expansion valve and an evaporator.

Dr. John Gorrie is credited with the first ice machine patented in the United States in 1851. The first public demonstration of his machine occurred in Apalachicola, Florida, on Bastille Day in 1850 at a party held by a French cotton buyer, Monsier Rosan.

Rosan, a personal friend of Gorrie, had made a wager with other cotton buyers that there would indeed be iced champagne in spite of the delayed arrival of the ice shipment from the North. Rosan won the wager with several pounds of ice from Gorrie's new machine, which used the rapid expansion of compressed air in the presence of water to create the ice.

Unfortunately Gorrie never was able to build a large version of his machine because of the rumored manipulations of the northern ice merchants. His work was not totally in vain, however. It is reported that Monsier Rosan, upon his return to France, described Gorrie's machine to one of the Carre' brothers, thus giving stimulation and impetus to their own ice-making research.

The Carre' brothers also benefited from the work of Leslie and Vallance in vapor absorption refrigeration techniques. With the demand for "ices" in the cafes of Paris outstripping the capabilities of hand-cranked preparation there was a definite need for ice-making machines. The Carre' brothers perfected the Vallance technique and brought out the forerunner of the ammonia absorption plant, which relies on the rapid evaporation of liquid ammonia hastened by the absorption of the ammonia gas into an absorbent such as water. The ammonia/water mixture then enters a generator where heat is applied, causing the separation of the ammonia and water. The ammonia gas, under greater pressure, enters the condenser where it is cooled and condenses into a liquid which is slowly fed back into the evaporator and the cycle begins anew.

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WORD DEFINITIONS

Anhydrous ammonia - water-free ammonia consisting of one molecule of nitrogen to three molecules of hydrogen (NH_3).

Compressor - a machine that raises the pressure on a vapor by pushing the vapor into a smaller volume.

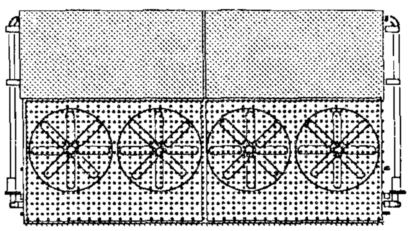
Condenser - part of a closed refrigeration system where vapor discharged by the compressor is cooled by water or air to a point where the vapor returns to a liquid state.

EVAPORATIVE CONDENSER MAINTENANCE

by R. Walter Eckles and David Frackelton

Bonar Engineering rarely recommends "post" chemical treatment of sanitary water make-up supplies for evaporative condensers. Municipal and private water supplies which have been treated with chlorine and the use of galvanized metal in the condenser will normally provide adequate "algae" control. We **do** recommend a bleed-off of at least 1/6 the evaporation rate of water supply. (Some areas, such as California, are wanting to limit this to zero and use oxidizers to drop out "hard" chemicals.) Generally, the use of acids is intended to decrease pH to keep calciums suspended. Municipal waters high in chlorine sometimes are so acidic they will attack metals, even stainless steel, and need to be neutralized with a base such as caustic soda. Control of the PH is obviously the most important aspect of "preserving" the life of a condenser, and a **failure** in the **treatment** method, generally, more often causes a shorter life in condensers than no treatment at all. We know of one instance where an owner was paying $60,000 a year for water treatment and getting seven years of life out of condensers. Without any kind of treatment or cleaning, the condensers will often last 15 to 20 years, easily. Alternates to treating include intermediate chemical cleaning and mechanical cleaning.

Both recommended methods of chemical **cleaning** and **mechanical** (thermo) cleaning will be discussed in the next issue of ***Refrigeration Review***.



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A TIME TO REMEMBER....

Reflecting on discussion may be helpful to maintain a perspective that would otherwise be lost in the archives of time.

The following is a reprint from an April, 1956, issue of "Industrial Refrigeration".

NH3 Production Figures

It is to be appreciated that ammonia manufacturers in preparing ammonia for refrigerating purposes distill their product repeatedly, to secure a stable quality ammonia. At such times when circumstances arise and it is not too well distilled, the consequences will be much "foul gases" being released into the refrigeration system. This observation is an old complaint of many "old time" operators, and not entirely a figment of imagination, as the writer came to learn. In 1956, United States manufacturers will produce about 4,500,000 tons of anhydrous ammonia, a figure up about 200 percent in the past five years.[1] Less than 0.3 percent of this quantity is produced for refrigeration purposes.

Blames Free Hydrogen For Post Explosion Flash Fires

The solubility of nitrogen and hydrogen in ammonia can explain many explosions which follow a violent rupture in an ammonia system, and one in which too frequently much "foul gas" has evidenced itself. The sudden release of high pressure over ammonia liquid saturated with "foul gases" affords the release of considerable volumes of free hydrogen. It is hydrogen gas alone which so readily ignites and detonates. It well explains the "flash fires" so often associated with a rupture in a high pressure liquid line.

[1]Chemical Engineering News

COMING NEXT ISSUE

CONDENSERS - CONTINUED

OSHA REQUIREMENTS SIMPLIFIED

Shaft Seals - Continued from page 1
companies in various industries are trying to reduce operating costs. In the industrial refrigeration industry, very few parts can be bought in the aftermarket. One, however, that has been infiltrating refrigeration has been mechanical shaft seals. Shaft seals are expensive due to the engineering and special materials used for specific applications. Original equipment manufacturers go to great lengths in the research, engineering, and testing of the materials and designs of the shaft seals. Aftermarket seals may look like originals. Visually, correct materials cannot be identified.

There are hundreds of combinations of materials that can be used in seal designs. Carbon is black, however it does have many grades and bonding agents. Most O-rings are black, but which material is specified for your particular application?, etc. Protect your personnel and equipment - - use only OEM seals and **certified** rebuilders.

Rotating shaft seals used for ammonia closed refrigeration cycles are becoming increasingly important with ammonia's expanding use as a refrigerant. Shaft seals, whether they contain gas or liquid, are becoming increasingly reliable as material technology improves. Engineering, research, and many years of experience have developed sealing systems which offer a high degree of reliability. With proper materials, proper pump application and installation, new and rebuilt seals can help maintain good working environments without excessive risk from the pungent odors or hazards of ammonia refrigerant.

Many questions are asked pertaining to seals. Some of the most frequent are answered in the following discussions.

Question #1 When is carbon carbon?
Question #2 What is a black "O" ring?
Question #3 Why are mechanical shaft seals expensive?

Answer #1 There are many different grades of carbon and bonding agents (some specifically for ammonia applications). To make carbons "blister resistant", the bonding agent needs to be compatible with the fluids it is sealing. Quite obviously, carbon best suited for sealing ammonia may not be as suitable for oils or vice versa. The placement of the carbon and flush points in the seal assembly is equally important to its ability to withstand refrigerant flashing when it is used for cooling the seal cavity.

Answer #2 Most "O" rings used in seal configurations are black in color, however, like carbon, many different materials are used, depending on application. The most frequently used material for ammonia is Neoprene . Some ammonia pumps using "double" seal configurations have oil on one side and ammonia on the other. The same fluid and fluid temperatures provide a more consistent condition for "O" rings.

Answer #3 The cost of mechanical shaft seals reflect material and production costs, as well as many hours of engineering and testing. Manufacturers of equipment in the ammonia refrigeration industry go to great lengths testing and re-designing shaft seals to minimize seal failures. Seals may appear the same by visual inspection, however, they can be completely different in the materials and how they are applied.

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