Acids

The use of desiccants is an accepted procedure[45] for removal of acids and other products produced during burnouts of hermetic motors.

Another method involves flushing of the equipment with a suitable solvent.[45] Both methods are widely used. The mechanisms involved in the removal of acids by desiccants has only recently received research attention.

In order to be effective in the cleanup of a burnout, desiccants and other parts of the drier must remove: (1) inorganic acids, hydrofluoric, hydrochloric; (2) organic acids due to oxidation of oil, and a thermal decomposition of organic insulation; and, (3) other decomposition products. Essentially the same requirements may be made, on occasions, of a liquid line drier.

Recent research by Hoffman[46] and Mays[47] shows that hydrochloric acid is adsorbed by silica gel. It is first adsorbed and then chemically reacts with activated alumina and the Zeolytes. Adsorption by the latter is very limited. The action of hydrofluoric acid was not investigated, due to the experimental difficulties involved in handling this acid. Hoffman[46] showed that organic acids are adsorbed with no evidence of a later chemical reaction. Oils taken from machines in the field were shown to contain in some instances both organic and inorganic acids; in others, only organic acid. Adsorption isotherms were determined for an organic acid containing oil and various desiccants. Similar adsorption and chemical reaction isotherms were made for an oil of known organic and inorganic acid content. This work proves that the acid content of an oil can be reduced to a low level by means of desiccants. Very little research has been devoted to the problem of what becomes of the water produced by the reaction of inorganic acids and desiccants. It may be speculated that this water is adsorbed by the portion of the desiccant that has not reacted with the acids. If the acid reaction is excessive, then adsorption of water by the suction line drier may no longer be possible. Under this circumstance, the water may pass through the compressor and be adsorbed by the liquid line drier. In view of this uncertainty, the liquid line drier installed during and after the cleanup operation should be larger than usual.

Colors

Colors are adsorbed by activated alumina, silica gel and, to a minor extent, by calcium sulfate. Because of this, leak detectors which act through an oil soluble dye, lose their efficiency in machines equipped with driers containing one of these desiccants. The color is completely removed from the oil-refrigerant mixture and held firmly by the desiccant.

Colloids

There is scant evidence that desiccants remove colloids from refrigerating systems, but the appearance of numerous samples of silica gel and activated alumina taken from driers makes this a distinct possibility.

Oil Deterioration Products

Oil in a refrigerating system may deteriorate, producing substances which are adsorbed by activated alumina, silica gel, and calcium sulfate;[48] this is due to factors that are not fully understood at the present. The adsorption of the substances makes the desiccant incapable of taking up liquid water, but the effectiveness of the desiccant in removing moisture from the refrigerant is only slightly reduced.

Chemicals

Desiccants are used industrially for the adsorption of numerous chemicals. Hence it is not surprising that chemical compounds are adsorbed by desiccants in refrigerating systems. Acrolein, extensively used in the past as a warning agent with methyl chloride, is adsorbed by silica gel and activated alumina. Methanol is preferentially adsorbed over moisture by these same desiccants. Refrigerants are adsorbed by these desiccants and a considerable temperature rise of the drier may result when the refrigerant is first admitted to it. This temperature rise is not due to moisture in the refrigerant, although it has been so misinterpreted many times. Oil additives may be adsorbed by silica gel and activated alumina. Because of small pore size, the Zeolyte type desiccants do not adsorb additives or the oil.

DRIERS

A drier is a mechanical device containing a desiccant. Its mechanical features are important but are not discussed here. While the primary purpose is to collect and hold moisture, nevertheless all of the properties inherent to the desiccant, automatically accrue to the drier. Since all driers serve as filters this becomes an important function. Acid removal has assumed greater importance within the last few years principally in connection with the cleanup of burnouts. Since acids may also be present in a machine which has not burned out, the liquid line drier must function to remove these acids. In order to prevent moisture from freezing the expansion valve or capillary tube, a drier is ordinarily located in the liquid line close to these devices. Hot locations must be avoided. Driers also function on the low side of the metering devices, but this has never been the preferred location, certainly not for field operations. The oversized drier, which is used for the cleanup of burnouts is installed in the suction line. At the same time, a larger than usual drier is put in the liquid line. Liquid line driers are usually installed permanently and are replaced only when they lose their effectiveness. Suction line driers are removed when they fail to function, and always after a cleanup has been completed.

The position of the drier on the machine is important. A liquid feed line should enter the drier in such a manner as to assure uniform contact between refrigerant and desiccant. When the drier is in a vertical position, the liquid inlet should be at the bottom. If a drier is placed vertically in the suction line, the feed should be at the top and the exhaust at the bottom so that the oil can be easily blown through the drier.

Moisture is reduced to a low level by one pass of the liquid refrigerant through a drier. Since the moisture is usually distributed throughout the entire refrigerating system, time is required for the circulating oil-refrigerant mixture to bring it to the drier. Krause, Guise, and Beacham[49] measured the rate of removal of moisture from laboratory equipment set up to simulate a refrigerating system. They showed that considerable time is required to produce moisture equilibrium in a machine. The actual time varies with the rate of refrigerant flow, internal area of the system, and size of the drier. Brisken[50] studied the migration of moisture in a hermetic system while Pennington[51] observed the role of the adsorption type desiccant in refrigerating units. These studies confirm the opinion long held by the industry, that removal of moisture to a safe level of operation requires a minimum of several hours.

SELECTING A DRIER

Manufacturers of driers normally issue selection charts which are generally printed on, or inserted in, the drier container. Additional information is contained in their literature. A selection chart should list the amount of desiccants, the refrigerants, refrigerant flow capacity, filter area, water capacity, and a specific recommendation covering the type and tonnage rating of the machine for which the drier is designed.

All of the following are considered in the design and production of a drier. Their consideration is a must for the manufacturer and their proper understanding is of great value to the user. The desiccant is the heart of the drier and its careful selection therefore is of paramount importance. Its properties have been discussed in the section on Desiccants in this chapter.

The water capacity of a drier is determined by ARI Standard 710.[44] It is given in drops of water for Refrigerants 12 and 22, at EPD of 15 and 60 ppm, respectively for the temperatures 75 and 125 F. These reference points are arbitrary. They were set to prevent confusion arising from determinations made at other points. A separate EPD is required for each additional refrigerant. It should be noted that the specific refrigerant, the amount of desiccant, and the effect of temperature are all considered in the statement of water capacity.

Flow capacity is determined in tons per minute, at two pounds pressure drop across the drier, by the official procedures of ASHRAE[43] and ARI.[44] Jones[52] developed a method for determining flow capacities in which Refrigerant 113 is used, and the results converted to Refrigerants 12 and 22.

Flow capacity may be quickly reduced when critical quantities of solid and semi-solid are filtered out by the drier. There is no way of predicting what this will amount to or when it may occur. It is obvious that whenever the flow capacity drops below the requirements of the machine, the drier should be replaced.

Filter area is very important since a drier acts as a filter for the oil-refrigerant mixture in the liquid line, and for refrigerant gas and oil when installed in the suction line. A large filter area is able to filter out more material than is possible with a small one without cutting down the flow capacity of the drier to the point where the efficiency of the machine is seriously reduced. A solid core drier has a larger filter area than the older conventional loose desiccant type. However, some of the latter have been modified to substantially increase their filter areas. In addition to quantity removal of solids and semi-solids, size of particles is important. Almost any filter arrangement will take out the larger particles. Nothing has been published concerning the lower limit of particle size, but most manufacturers advertise ability to filter out particles in the low micron range. Obviously all particles capable of causing trouble in the system must be removed. The filter action of a good drier takes care of this.

Acid removal is seldom listed in selection charts. The drier manufacturer should be consulted for information.

TESTING AND RATING

Methods of testing desiccants will be found in Reference 43. Methods of rating driers will be found in Reference 44. Minimum standards for listing of refrigerant driers will be found in Standard for Refrigerant Containing Components, Subject 207 (Underwriters' Laboratories).

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