1001 N. Fairfax St., Suite 503 • Alexandria, VA 22314
703-312-4200 • F: 703-312-0065
www.iiar.org

INTERPRETATION: IIAR SC 2021-3, IIAR 5, Evacuation and Dehydration

FINALIZED: May 13, 2021

SUBJECT: Evacuation and Dehydration of Industrial Ammonia Refrigeration Systems

BACKGROUND: IIAR-5 2019, Chapter 5, Section 5.5.6, addresses evacuation and dehydration of closed-circuit ammonia refrigeration systems. Section 5.5.6.1 specifies two evacuation levels required to achieve evacuation and dehydration.

QUESTION 1: There was a change in the requirements for evacuation and dehydration from IIAR 5-2013 to IIAR 5-2019. The change is significant. What was the basis of the change? Is the proposed level of evacuation truly necessary to insure a properly evacuated system? Why are the evacuation and dehydration levels no longer separate values? And why is dehydration now mandatory when it was formerly required only when water removal was necessary?

ANSWER 1: The members of the IIAR standards committee have taken varying views of the approach to evacuation and dehydration. The development of IIAR 5-2019 drew many of its provisions from both normative and informative information in older IIAR publications. The development of IIAR 5-2019 relied on the most conservative approach to evacuation and dehydration found in the older information and has since been reviewed and re-considered.

A recent review of field experience, industry publications, and engineering calculations has revealed that:

- The primary goal of evacuation in an ammonia system is to remove non-condensable gases (e.g., air and/or test gases) from a closed-circuit system prior to startup (the secondary goal of evacuation is to remove water vapor). While the removal of water vapor is important, ammonia refrigeration systems can operate well with some amount of water in them because of the affinity of water to ammonia. Most systems are equipped with an automatic air purger that will eventually remove trace amounts of non-condensable gases. However, removal of most of the non-condensable gases prior to startup of such systems is necessary because too much non-condensable gas in the system prior to startup can prevent the system from functioning properly.

- A vacuum of 125,000 microns (approximately 25”Hg gauge) can be readily attained and is adequate for ammonia systems equipped with purging capability.

- The water vapor remaining after evacuating an ammonia system to a level of 125,000 microns (25”Hg gauge) is minute relative to the system volume. However, at this level of evacuation, non-condensable gases (mostly in the form of dry air) would impose an un-necessary energy penalty and/or condenser capacity penalty if they are not purged after startup. If purging after startup is not an option, evacuation to at least 5000 microns is required. This level of vacuum will remove all but trace amounts of non-condensable gases.

- Studies suggest a small amount of water [in the range of 0.2% (2000 ppm)] in an ammonia refrigeration system may be beneficial in mitigating stress corrosion cracking.

- Until the percentage of water in an ammonia refrigeration system approaches 2% (20,000 ppm), there is no appreciable loss of capacity nor increase in power consumption.

Excessive liquid water in a system is undesirable because it increases the possibility of exceeding recommended limits of water concentration in ammonia. The best practice for preventing excessive water in a closed-circuit ammonia refrigeration system is to prevent introduction of liquid water during installation by ensuring that the system and components are protected from the entry of precipitation or other unforeseen sources of water entry. Equipment that has been hydrotested should be checked for incomplete water removal before installation. If liquid water is found in equipment, it should be removed. If water has accidentally entered the piping network, the installation of drains in the piping network could be considered. Pressure and leak testing should be accomplished using an

1001 N. Fairfax St., Suite 503 • Alexandria, VA 22314
703-312-4200 • F: 703-312-0065
www.iiar.org

inert gas or dried compressed air. When best practices are followed, an acceptable moisture level will result from a proper installation and evacuation.

Dehydration using vacuum pumps is common practice on refrigeration systems using fluorinated or other refrigerants. It is not practical, and not normally necessary, for ammonia refrigeration systems. Vacuum dehydration requires a very deep level of vacuum to boil out standing water at common installation temperatures. The lower a system's temperature (and thus water temperature) the deeper will be the vacuum required to boil out the water. At 5000 microns, water will boil if the system temperature is greater than 34°F. Note that vacuum dehydration will not work on a system that is 32°F or less.

If standing water is suspected within a system component, a less deep vacuum can be used to boil out the water if heat is applied to the portions of a system that have the standing water. Steam tables can be used to aid in determining the level of vacuum needed and the temperature required to boil out the water.

COMMITTEE ACTION:

Change IIAR 5 during the next scheduled revision to reflect the position of this interpretation.

Review IIAR 4 and consider a requirement to check hydrotested equipment for standing water prior to installation.

Revise the title of IIAR 5, Section 5.5.6 to be "Evacuation" and remove "and Dehydration" from the section title.

Consider/revise a separate informative section pertaining to dehydration evacuation, and purging.

Section 5.5.6.1 will be changed to read: The system shall be evacuated to a pressure of 125,000 microns [25" Hg (gauge)]. For systems not equipped with a means to purge non-condensables, evacuation to at least 5000 microns [29.7" Hg (gauge)] is required. The evacuation pressure level shall be maintained for one (1) hour after the level of vacuum has been achieved and the system has been isolated from the vacuum pump(s). The effects of ambient temperature changes affecting gauge pressure shall be considered when determining if the system has held the vacuum.

Section 5.5.3.3 will be changed to read: A suitable inert dry gas, such as nitrogen or ***dry (dehydrated)*** compressed air, shall be used as the medium for pressure and leak testing.