AL-43
(Rev. A)

SMITH PUMPS USED IN LIQUEFIED NH_3 TRANSFER SERVICE

GENERAL. Due to the relative ease by which Anhydrous Ammonia is condensed to a liquid, and the absorption of heat when it evaporates, this colorless, odorous, gaseous, alkaline compound of Nitrogen and Hydrogen (NH_3) is used extensively in refrigeration. Traditionally, it is said to be mostly produced as a by-product of the gas and coke industry, and that it plays an important role in mass production of ammonium salts and organic derivatives.

Our Engineering Department asks that whenever an order or quotation request is placed for a new installation, to please send a rough sketch or drawing indicating equipment sizes and relative elevations, with complete liquid specifications, including percentages, types, and viscosities of oils or other chemicals, contaminants, and impurities. Determination of application suitability, and required use-specific modifications depend upon this kind of information. SMITH NH_3 pumps are for *Anhydrous* (waterless) Ammonia, and for this reason adequate on site precautions must be taken to insure the handled product does not become moisture-contaminated, as otherwise corrosion fatigue can cause pump seizure. SMITH pumps are well over-designed for handling good quality liquefied NH_3, with or without oil, in non-destructive surroundings; however, *always contact the factory regarding suitability under special conditions*. *Never use SMITH pumps in a hostile environment, or for handing Aqueous Ammonia.* SMITH Anhydrous Ammonia pumps are mostly used to transfer clean fluids within a -25º F. to +100º F. range, and application data stamped on pump tags usually reads “Max. allowable pressure: 400 psi / 28 bar; Max. differential pressure: 75 psi / 5 bar”. We have supplied units for higher and lower temperatures, greater differential pressures, and continual vacuum conditions to 4 PSIA. SMITH pumps for liquefied gases can readily be modified to withstand temperature ranges between -150° F. to +400° F., and pressures to 600 PSIG, with an ample margin of safety.

Optional incorporated SMITH NH_3 pump modifications are in accordance with specific service conditions such as when there could be a substantial volume of entrained oil, or whether the temperature of the transferred fluid is from -25º F. to +100º F. or higher, -25º F. to -40º F., or below -40º F.. SMITH pumps originally altered for particular circumstances are identified by an additional letter “S” in the model number stamped on the tag, such as “MC-1044H**S** NSSA”. *These units may give unsatisfactory performance if not used as originally intended*. For example, entrained oil in fluid transferred at below -40° F. could require increased gear clearances, which might then lead to poor performance in different systems at higher temperatures, or with *pure* NH_3.

Entrained oil could render impractical the use of a pump inlet line strainer, and might require installation of oversized piping. Supply tank pressure can affect the determination of inlet line size, and vapor displacement of liquid delivered to pump suction. Handled liquefied NH_3 should not contain abrasive contaminants, especially where it is continually recirculated. For continuous duty and/or vacuum (negative pressures less than “0” PSIG associated with temperatures below -25º F.), in order to acquire longest pump life, 750 – 1000 RPM drive speed range is highly recommended, provided differential pressures remain under 40 PSID. Due to necessary “slippage” flow across the gear faces, higher differential pressures within standard combined viscosity ranges under 110 Cks. may require faster drive speeds to prevent vapor locking. If it is theoretically determined that at a certain speed the pump will lose 50% of its nominal output due to pressure and viscosity characteristics, a somewhat higher or the next standard direct drive speed should be used. In non-continuous and highly intermittent service, greater pressure differentials at higher RPM can be realized without sacrificing unit longevity (1800 RPM is the maximum drive speed for most models). Differential pressures of 150 PSID or more may be acceptable, but depend entirely upon the fluid make-up, and the use conditions. In any event, drive speeds must always be properly matched with use intervals, viscosities, and developed pressures. Contact the factory for additional information.

A very unique and practical feature of the SMITH NH_3 pump is its pre-tested integral shaft, ball bearing, and seal assembly (“shaft-seal assembly”). This three-piece mechanical seal has many advantages over familiar two-piece designs. For example, most SMITH pumps utilized for Anhydrous Ammonia transfer can be purposely installed so the mechanical seals are exclusively exposed to either entering, or exiting fluid, in accordance with drive shaft rotation. SMITH NH_3 mechanical shaft-seal assemblies are manufactured completely in-house, specifically for the intended service. The very adaptable three-piece design cuts the surface speed of the mating seals to half that of a two-piece assembly. The net result is prolonged mechanical shaft seal life, with proportionally less frictional heat generation. Optionally modifiable seal assemblies can be custom-constructed to simultaneously handle such conditions as intermittent or continuous vacuum, thermal shock, highly variable viscosity, and unusually broad temperature ranges. SMITH NH_3 pumps have only one mechanical seal assembly, which can be easily replaced from the drive end of the pump without disturbing the gearing and without removing the pump from the piping system. Mechanical seal leakage activates an auxiliary rotary seal, preventing subsequent ball bearing damage, and relieves to atmosphere exclusively through an adaptable leak detection port out of the casing near the drive shaft exit.

PUMP INLET PIPING DESIGN. With SMITH pumps in liquefied NH_3 service, "flooded suction" is absolutely essential to insure proper internal lubrication and cooling effects. The *dynamic* inlet pressure of the fluid being handled has to remain at or above its natural vapor pressure. Therefore, the pump liquid supply system must have the lowest possible resistance to flow, taking into account any additional friction from entrained oily residues. Outlet lines though not as critical must be correspondingly designed.

Low capacity pumps for liquefied NH_3 have ¾" FNPT inlet and outlet connections. Some medium capacity (1-1/2", 2", and 2-1/2" FNPT) as well as high capacity (2", 2-1/2", and 4" FNPT) models have inlets sized larger than outlets. The pump inlet line must be at least the same size as the pump inlet port. The pump should be as close as possible to a properly sized, bottom outlet supply tank, which should never be pumped completely dry. The lower the liquid vapor pressure, the higher the flow, or the further the pump is from the liquid source, the more difficult it is to provide sufficient NPSHA (additional energy, primarily gained through fluid elevation) to cancel flow resistance and to maintain 100% liquid at pump suction. The NPSHA can be highly variable, requiring careful attention, especially when there is minimal vapor pressure. Standard recommendations to prevent "pump starvation" are applicable to Anhydrous Ammonia transfer, but mostly when pump supply tank pressure is above atmospheric pressure. For example, in a typical case where NH_3 supply tank temperature below -25º F. would cause a vacuum (negative vapor pressure below "0" PSIG), if the cold NH_3 could not be "blanketed" with higher pressure from an independent source, an average installation handling liquid at temperatures between -25º F. to -40º F. would require a minimum of 6 Ft. liquid elevation above the pump centerline. Thereafter, for every -5º F., or fraction thereof below -40º F., an additional foot of liquid elevation would be required.

Handling conditions, which can cause dynamic variances in liquid quality, available head pressure (NPSHA), and required head pressure at pump suction (NPSHR), include but are not limited to (1) inlet line length; (2) pump duty cycle; (3) differential pressure requirements; (4) size and/or shape of the supply tank; (5) type, quality, or lack of piping insulation; (6) line sizes including the tank outlet and all other related components; (7) location and style of supply tank outlet(s); (8) contamination, (9) other simultaneous operations using the pump supply tank; (10) pump efficiency; (11) environment; etc.. With variables such as these, any attempt to specify a minimum head requirement, without first completing the necessary study of the piping system, transferred liquid qualities, projected use intervals, and environmental conditions, could be misleading.

NOISE. At *rated RPM* (maximum design speed with most SMITH rotary gear pumps) the inherent displacement principle can lend itself to noise more so than other designs. However, sound pressure values are greatly reduced by operating SMITH pumps at *less than maximum design speed*. Levels of under 58 dB(A) can be realized through lower drive speeds, proper piping, and adequate isolation.

See SMITH literature such as, but not limited to "CP-1", "CP-3", "AL-3", "Al-17A", "AL-36", "AL-40", "AL-41", "AL-93B", "AL-201", and "AL-204" for additional information on topics previously discussed, and related aspects. Smith Precision Products Company, Inc. is not responsible for the design, construction, or use of piping systems. This bulletin and all other SMITH literature relating to low-pressure liquefied gases, whether containing empirical or theoretical data, are from a pump manufacturer's standpoint, and are for concept presentation, only. Certain installations may not be acceptable in all areas, and could have to be modified. Illustrations should not be taken literally. Completeness of such information cannot be guaranteed. Proper system design, construction, and use require a site-specific engineering study with due regard for all of the current component manufacturers' application data, and all applicable safety codes and regulations, such as but not limited to those promulgated by the NFPA, DOT, and ANSI; including all other applicable federal, state, provincial, or local standards, codes, regulations, and laws.

SMITH PUMPS

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