CHART ENERGY & CHEMICALS

GENERAL DERIMING PROCEDURE

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1.1 THE REASON FOR DERIMING – EQUIPMENT CONTAMINATION

Oils, heavy hydrocarbons, moisture, carbon dioxide, solids, and other materials are potential contaminants to Cryogenic Systems featuring Brazed Aluminum Heat Exchangers (BAHX) and other sensitive equipment such as control valves or distillation columns where cooling may occur. At temperatures conducive to solid formation, fluid contaminants solidify onto the equipment, and the solids lodge into the tight clearances present internal to the BAHX, control valves, or distillation stages. The main consequences of contamination are plugging and heat transfer loss in BAHX, plugged control valves, and loss of stage efficiency and capacity in distillation columns as the mass transfer devices are plugged. Plugging and heat transfer loss in a BAHX is observable as increasing temperature approaches and higher pressure drops in the BAHX. In multiple parallel BAHX assemblies, what should be identical outlet temperatures from the parallel BAHX may also spread apart. In the worst cases, temperature differences may become so large due to the plugging and heat transfer loss that the BAHX is thermally stressed and could lead to thermal fatigue resulting in an undesirable leak.

Cryogenic Systems generally feature upstream systems to remove contaminants continuously to such low levels that they will not create consequences in the Cryogenic System; however, these upstream systems are often subject to failure or excursions above limits as specified for contaminants for a particular process. The plant operations group should establish plans to respond to the various possible excursions with the upstream treatment equipment. For example, if an upstream drier goes to sending out 1.0 ppmv moisture for a 1 hour period when the specification is 0.1 ppmv, it is unlikely a serious degradation of performance would occur and the operations group may decide to continue, but if the drier breaks through and sends 1,500 ppmv moisture continuously, then a total shutdown is probably justified to avoid a rapid degradation of performance.

To monitor buildup of contaminants in a Cryogenic System, baseline temperature and pressure profiles should be recorded for the plant immediately after startup and subsequently evaluated at periodic intervals. The plant operations group may set targets on these profiles for when shutdowns are justified to clear frozen material and other contaminants to restore performance.

To clear most frozen contaminants, “deriming” is performed to melt the frozen material and purge it from the system. This requires shutting down the Cryogenic System and warming up the equipment to temperatures that are significantly above the freezing point temperatures of the potential contaminants to melt the frozen materials. For water Chart usually recommends warming the equipment to at least 60 °F. After warming, it is important to thoroughly purge the equipment with a clean and dry fluid to clear the contaminants. All available points should be purged and checked where possible for evidence of melted contaminants. “Online deriming” has been considered in some facilities, but is highly discouraged as this usually just transfers the contaminants to other parts of the Cryogenic System that are still cold, where they again freeze or liquefy and could lead to severe equipment damage (for example, transferring frozen material out of upstream separators into downstream rotating equipment). For this reason, it is imperative to purge the melted contaminants from the system so they do not once again freeze onto the equipment or create other problems.

Certain contaminants such as oils may “stick” to equipment even after “deriming” and require chemical (solvent) cleaning to clear effectively. A qualified contractor should be consulted for any chemical cleaning activities in a Cryogenic System. Effective arrangements usually require a system to re-circulate a solvent to thoroughly wash out the equipment. Contact Chart whenever solvent cleaning is considered. Solvent cleaning is not discussed further in this document.

Solid contaminants, such as dirt, scale, general construction debris, weld slag, and other materials that are solid at ambient temperatures are only cleared by shutting down the Cryogenic System, opening the equipment, and physically removing the solids. “Deriming” is ineffective for removing these contaminants. Though some solid material may be manually removed easily, more often a “back-puffing” procedure is required to extract solids that are thoroughly embedded into the BAHX. Back-puffing is a process of pressurizing the equipment with a gas to an appropriate pressure (generally in the range of 25 psig to 100 psig), then rapidly releasing the pressure in reverse of the normal flow path to draw the material out of the equipment, usually via a rupture disk. Contact Chart whenever a back-puffing procedure is being considered. Back-puffing is not discussed further in this document.

Other forms of contamination that lead to severe performance degradation or potential failure in Cryogenic Systems, such as mercury contamination, are not discussed in this document.

1.2 DERIMING

Deriming a Cryogenic System begins with a warm-up and purge. A shutdown of the system per plant procedures precedes deriming. The system should be isolated as much as possible from other systems to limit the volume of equipment requiring a warm-up and purge.

To expedite the warm-up process, the best course of action is often to first purge the equipment of large volumes of cold process fluids by draining and depressurization. All equipment limitations must be respected in this effort, and BAHX in particular must follow the recommendations for maximum rate of temperature change, generally less than 108 °F per hour with allowance up to 9 °F per minute, and maximum adjacent stream temperature difference, generally less than 50 °F. When a cold liquid is in contact with BAHX it is generally advisable to drain the liquid before depressurization, as depressurizing first may significantly lower the boiling point of the liquid resulting in rapid cooling and large temperature differences.

A copy of the piping and instrumentation diagram (P&ID) is usually used to plan the deriming procedure. Flow paths are usually highlighted to indicate where deriming fluid is flowing into and out of the system, how valves are positioned, as well as anywhere a pressure reduction in the deriming fluid may need to take place to stay within equipment pressure limitations. All potential areas where contaminants may have entered and frozen are included in the deriming process by establishing deriming fluid flows through these areas. Flow paths are setup from the deriming fluid injection point to a point of isolation such that the entire system is cleared, and every drain along this path is used as a designated purge point. Take care to limit pressure reductions in the deriming fluid as it flows through the system as any pressure reductions may result in Joule Thomson (JT) cooling and associated difficulty in warming up the equipment.

Deriming fluid, often a gas, is supplied to the system for the purpose of warm-up and purge after all the available isolations and clearing of cold process fluids take place. Limit the pressure of the warm-up fluid in the equipment. The general recommendation is to limit the deriming fluid pressure to a maximum of 80% of the equipment MAWP, 80% of the relief valve set pressure, or 80 psig, whichever is less, and also limit the temperature within the equipment design temperature limits. The warmer the temperature for the deriming fluid, the more effective it is in general for deriming the system. Deriming fluids must be free of any contaminants that could further collect in the system so that no new contamination is introduced and so the existing contaminants are effectively drawn to the contaminant free deriming fluid. For example, when water (moisture) is a problematic contaminant in the system, the deriming fluid is supplied with as low of a water dewpoint as possible. Filter the deriming fluids entering BAHX with the equivalent of an 80 mesh strainer or better to prevent solid contamination. The deriming fluid is often fed to the system by connecting the supply to an appropriate location with hoses, though in some cases the normal feed to the system is simply fed in without refrigeration to warm-up the system. Dry, oil free nitrogen is a typical deriming fluid as it is usually readily available and safe in flammable environments, though every situation is different and alternative deriming fluids may be considered. For example, in a natural gas liquefaction (LNG) plant, many times the dry feed natural gas is directed through the system in the absence of refrigeration to warm-up the system. As another example, dry feed air is fed through an air separation system as there are no hydrocarbons present to create a flammable mixture. As before, all equipment limitations must be respected in this effort, and BAHX in particular must follow the recommendations for maximum rate of temperature change, and maximum adjacent stream temperature difference as mentioned earlier in this section.

Continue with the warm-up process until the entire Cryogenic System has been warmed up to an appropriate temperature for the contaminants of concern (a general suggestion is 60 °F or greater for water) and the temperature has stabilized. With the entire Cryogenic System warmed up to the appropriate temperature, it is likely that the majority of the contaminants have been melted and are now purging from the system. Collect the contaminants for analysis when possible prior to purging. If drains are not already open to establish the flow of deriming fluid out of the system, open all the drains identified in the deriming procedure planning P&ID to begin purging melted contaminants while continuing deriming fluid input and maintaining a positive pressure on the system to prevent ambient air ingress. Open instrument vents as well to purge the instrument lines of any contaminants. Continue with the purging from all points for an appropriate time (a general suggestion is to assume at least 2 hours, or longer as per individual system experience) or until analysis of the spent deriming fluid indicates contaminants have been adequately purged, then close all drains and vents from the system, and finally shutoff the deriming fluid while maintaining a positive pressure on the system to prevent ambient air ingress. This concludes the deriming process.

An exemplary situation of deriming where analysis of the spent deriming fluid for contaminants is used to set the deriming procedure duration is moisture. Note that this particular example procedure in the absence of an initial warmup phase is the same as a "dryout" procedure. Monitoring for other melted contaminants such as CO2 or heavy hydrocarbons leaving the system with the spent deriming fluid is usually not practical and so a deriming duration is usually set for these contaminants based on experience. In the case of moisture, a suitable portable moisture analyzer is used to check the water dewpoint of the spent deriming fluid at various points in the system during the deriming process. A target dewpoint to indicate the completion of deriming that is reasonable for the system is specified, usually -90 °F though sometimes this is not practical. A high-quality moisture analyzer is ideally used that can reliably and accurately detect dewpoints below the target dewpoint so there is no question of the moisture analyzer providing a false or arbitrarily limited reading. The moisture analyzer is first used to confirm the water dewpoint of the entering deriming fluid as the "minimum possible" dewpoint. If the deriming fluid is not sufficiently dry (i.e. drier than the target dewpoint) then another deriming fluid is selected, or the target is revised. Next, the purge points closest to the deriming fluid injection points are checked, working outwards from the deriming injection point towards the final exhaust point in each deriming circuit. The dewpoint results for each point are methodically tabulated as regularly as possible. As the dewpoints of the purge points closest to the deriming fluid injection point reach their dewpoint target, they are closed off to send more deriming fluid forward to the other points. This process repeats, closing off the points closest to the injection point as they meet the target dewpoint, until all points meet the dewpoint target and are closed.