Proliferating opportunities are justifying helium recovery

All commercial helium is recovered from natural gas. Not all natural gas, however, contains recoverable quantities of helium. Typically, natural gas that contains economically recoverable amounts of helium also contains high quantities of nitrogen. When the level of nitrogen exceeds a certain level, it must be removed to meet btu per scf requirements. The process applied to remove nitrogen also concentrates the helium; thereby, making helium more valuable and recovery economical.

Nitrogen and helium are concentrated as a vented stream during the production of large quantities of LNG in other parts of the world as well. Again, the helium is concentrated to an economically recoverable stream that would not otherwise justify recovery from unprocessed natural gas.

The impurities that must then be removed from the helium-rich stream include moisture, methane, nitrogen, hydrogen, and neon. Most facilities remove the hydrogen by reacting it with oxygen over a catalyst bed to produce water. The methane and all of the nitrogen are removed through a combination of cryogenic condensation and pressure swing adsorption. These impurities (moisture, nitrogen, and methane) must be removed before liquefaction to prevent freeze-ups in the low temperature equipment.

The only remaining impurity is neon, which is present in all helium-bearing natural gas. The neon is adsorbed on charcoal at very low temperatures (minus 420F). Otherwise, it would freeze at liquid helium temperatures. Should any residual hydrogen remain as well, it too would be adsorbed on the charcoal.

Liquid helium is considered pure

Since all possible impurities freeze at liquid helium temperatures, liquid helium is considered to be pure. However, production plants experience upsets from time-to-time, and conceivably, impurities could leave the liquefier in the liquid helium as "ice." All production plants transfer helium directly into large storage tanks, rather than into liquid transports.

Years ago, almost all helium was sold in its gaseous state and filled for transport into tube trailers. Since that helium was not liquefied, neon remained as an impurity. Neon represents the greatest impurity in "Grade A helium," Usually in the range of 20 to 25 ppm.

In current practice, the overwhelming majority of helium is shipped as a liquid, and can be considered as pure.

Despite this practice, the possibility of contamination remains. Transfer hoses that are not purged adequately can admit air into the transport. Plant upsets can result in the release of neon into the liquid. Once in the transport, contaminants exist in the solid form as frozen particles. They may stick to the inner tank, float on the surface, or sink to the bottom.

The widely held belief is that contaminants can accumulate during transport. However, once a liquid transport is theoretically emptied of the liquid helium, 15 percent of the helium still remains in the transport tank. This is attributed to the fact that the density of helium vapor at liquid helium temperatures is so great.

Action before helium removal

Before this residual helium can be removed, warm gas needs to be pumped into the container where it mixes with the cold helium vapor and raises its temperature to approximately minus 420F. The higher temperature results in an increase in pressure, which transforms the vapor to a gas that can then be pumped out.

At minus 420F, helium density is so low that almost all of it can be removed. However, at that temperature any frozen neon present will evaporate and contaminate the residual helium. To prevent this, some transports are warmed to a greater temperature, which may permit the frozen air to evaporate.

Another source of contamination may occur during transport unloading. As the liquid is withdrawn, warm helium gas is added to maintain a suitable pressure above the liquid. This helium itself may contain impurities.

Some organizations, such as NASA, often require that liquid be withdrawn through a filter to capture any frozen contaminants.

Once the liquid helium is withdrawn from the transport, it is either vaporized and compressed into tube trailers, or it is filled into dewars or small storage tanks. Most transfill or bulk facilities have four- or five-stage reciprocating compressors that pump the helium into tube trailers or cylinders. The transports are maintained at low pressure, so the inlet pressure of these compressors is less than five psi - often as low as one psi.

Contamination is possible from two sources. If the suction pressure drops into a vacuum, even temporarily, air may be ingested into the helium. The compressors are lubricated, usually with a synthetic lubricant with a low vapor pressure. The lubricant is removed through a combination of coalescers and activated carbon at the compressor discharge. Such systems will reduce any lubricant present to less than five parts per billion (ppb). Sloppy maintenance, of course, can permit additional contaminants to pass into the cylinder or tube trailers.

Air may leak in

The final sources of contamination may consist of air aspirated into valves and fittings during the filling process, as well as residual contaminants that may be present in the cylinders or tube trailers. Aspiration of air can occur at high pressures due to loose fittings or the venturi phenomenon. This contamination occurs most often during filling of very high purity helium. It can be eliminated or minimized by limiting the number of mechanical joints in the transfill system and avoiding the use of valves with diaphragm seals.

Cylinders and tube trailers usually return to their fill plants with some residual product inside. Since the residual product may be contaminated, most large distributors vent the residual gas in their returned cylinders and evacuate them before refilling. Tube trailers are analyzed before they are filled again to ensure that the residual helium is still pure. ......