



Activated Carbon for Mercury Removal

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Mercury Removal

In years past, the presence or absence of mercury received little attention in the oil and gas industry. In the early seventies, natural gas processors began to use cryogenic techniques utilizing aluminum core heat exchangers (cold boxes). After the failure of several cold boxes, metallurgists determined that mercury corrosion was the source of the problem. Initially, it was believed that the mercury was present due to leaking instrumentation; however, further testing revealed mercury was present in the reservoir.

Extremely low levels of naturally occurring elemental mercury in the inlet gas can change to a solid phase or liquid phase under normal plant operating conditions. When the mercury accumulates as a liquid in the heat exchangers, it can amalgamate with the aluminum and destroy the heat exchangers. The exchanger *is* not only extremely expensive to replace or repair, but a failure *is* an obvious safety hazard as well. Traditionally, it was believed that only Indonesian and North African gas contained sufficient amounts of mercury to cause equipment problems. However, several Gulf Coast gas and olefin plants have experienced cold box failures which have been traced to mercury corrosion within the past two years. Unacceptable levels of mercury have also been detected in tertiary oil recovery plants in the western United States.

The suspected mechanism of mercury corrosion *is* multi-step. Being an extremely heavy metal with a very high vapor pressure, mercury tends to accumulate in pipe bends and along the welds of elbows, areas where the aluminum may already be stressed.

For liquid metal embitterment (LME) or intergranular mercury corrosion to occur, the mercury must be present in a liquid state (i.e., above -40°F), and must wet the surface of the aluminum. Aluminum is slightly soluble in mercury and amalgamates with the mercury. The aluminum then forms an aluminum oxide and frees the mercury to attack the next layer of metal. Mercury *is* not permanently bound with the aluminum, but actually acts as a catalyst for the corrosion or embitterment to occur.

Even minute amounts of mercury in the gas can threaten the integrity of the plate-fin aluminum exchangers. Conditions which favor amalgamation are: temperatures in excess of -40°F , an oxide free or stressed aluminum surface, presence of moisture or air at the mercury/aluminum interface, small amounts of mercury in the liquid state.

Granular activated carbon is effective at physically adsorbing trace components from gas streams due to its high population of micropores; however, the capacity is low. By impregnating the granular activated carbon with a compound that will chemically react with the mercury, capacity can be enhanced. It is imperative that not only must the mercury be removed to non-detectable levels but that it is adsorbed in a form which will not elute from the activated carbon bed under fluctuating conditions. In order to obtain long bed life and high removal efficiencies, activated carbon is required with a pore structure that can accept substantial amounts of suitable impregnant while allowing access of the process gas to the complex pore structure. Sulfur impregnated activated was specifically designed for this service. Under normal operating conditions, a properly designed activated carbon bed will remove mercury for many years. Activated carbon has been used successfully since 1975 to protect aluminum exchangers from corrosion due to low-level mercury contamination in LNG and, more recently, olefin plants.

A south Texas pipeline company had a failure of their aluminum cold box, which through metallurgical analysis, was traced to mercury corrosion. Through on-site analysis it was determined there was over 50pg/Nm³ of mercury in the natural gas. Using the operating conditions of a granular activated carbon mercury removal system was designed and it was determined that the best location of the system in the plant. The mercury removal system has been operating since 1984 removing mercury to non-detectable levels.