

MERCURY REMOVAL FROM GAS STREAMS

Why is Mercury a Problem?

The presence of elemental mercury in wellhead natural gas has been well documented. Mercury induced corrosion of LNG aluminum alloy cryogenic exchangers has led to numerous instances of equipment failure. Mercury present in a hydrogen or hydrocarbon gas stream will also dramatically shorten the useful life of many precious metal catalysts.

Mercury removal may be necessary from a worker safety or environmental perspective. The U.S. Occupational Safety and Health Administration (OSHA) has set the following exposure regulations for inorganic mercury compounds:

Description	Value
Permissible Exposure Limit (PEL) Ceiling	0.1 mg/m ³
Time Weighted Average (TWA) (vapor)	0.05 mg/m ³

Mercury compounds are also regulated as an air toxic under the Clean Air Act Amendments. In many instances, the removal of mercury from the source is important to minimize process emissions.

Where Does the Mercury Come From?

Trace quantities of metals are known to exist in natural gas fields. Wellhead mercury concentrations have been found to vary in the range of 0-2000 µg/Nm³. Typical concentrations are:

Location	Hg (µg/Nm ³)
Algeria	50-80
Sumatra, Indonesia	200-300
Far East	0.02-193
Middle East	1-9
Groningen, Netherlands	180
Northern Germany	15-450
Southern Germany	<0.1-0.3
South America	69-119
North America	0.005-40
Eastern Europe	1,000-2,000

How Does Mercury Corode Metal?

The corrosion process through which mercury attacks aluminum and its alloys is called Liquid Metal Embrittlement (LME). LME occurs when liquid elemental mercury penetrates the aluminum oxide protective coating and comes in direct contact with aluminum metal. The amalgamation reaction occurs instantaneously, resulting in the formation of an invisible “crack” consisting of mercury-aluminum amalgam, a metal alloy with more brittle characteristics than the original aluminum or aluminum alloy. The attack occurs at temperatures above the freezing point of elemental mercury (approx. 40° C), usually during maintenance periods when cryogenic equipment is shut down and warmed up for repairs or to remove accumulated ice. When placed back in service, the additional stress from normal operation causes the metal to separate at the LME “crack” and catastrophic failure of the cryogenic unit occurs.

How Can Calgon Carbon Help?

Calgon Carbon Corporation has been actively helping companies solve their mercury problems for many years. Not only has Calgon Carbon designed products to remove mercury, but we have also developed improved mercury detection methods. Our procedure, using a NIC WA-4 mercury detector, allows reliable mercury concentration measurements to be made down to 0.01 µg/Nm³ and lower. Calgon Carbon supplies two versions of sulfur impregnated carbon, HGR® and HGR®-P. HGR® carbon is a granular carbon material in a 4x10 US Mesh and the HGR®-P is a 4 mm diameter pellet. In operation, the sulfur impregnate reacts with mercury to form a mercury sulfide that is fixed in the high energy adsorption pores of the activated carbon. Both HGR® and HGR®-P effectively remove elemental and organic mercury present in hydrocarbon gas streams. Adsorption systems using either product can be designed to reduce mercury concentrations to below 0.01 µg/Nm³ in the treated gas.

HGR®-P is compatible with systems designed to use Calgon Carbon Type HGR® granular activated carbon. HGR®-P will result in a lower pressure drop compared to HGR®. Figures 1 and 2 illustrate typical pressure drops at different pressures for both HGR® and HGR®-P.

Services and Applications

Visit our website at www.calgoncarbon.com, or call 800-422-7266 to learn more about our complete range of products and services, and obtain local contact information.

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Figure 1

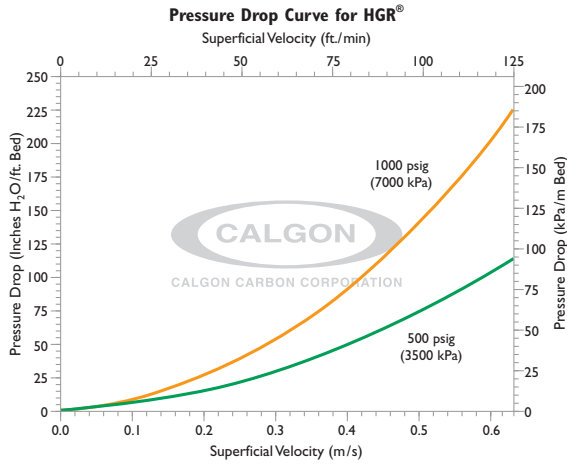


Figure 3

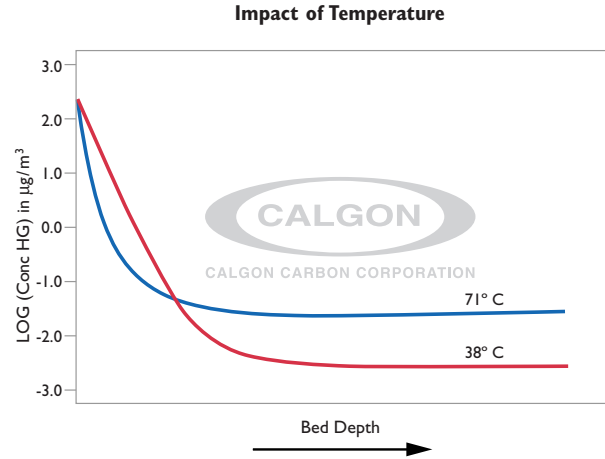


Figure 2

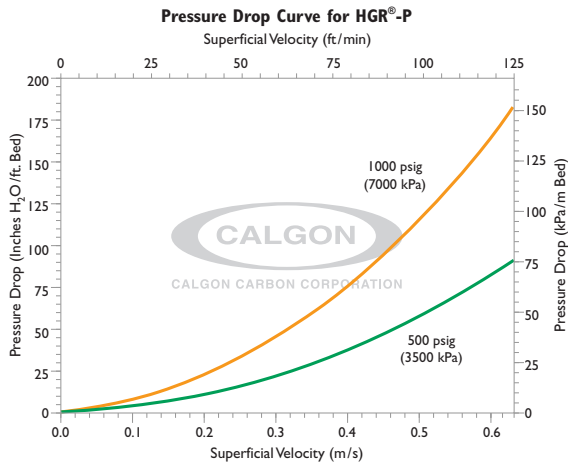
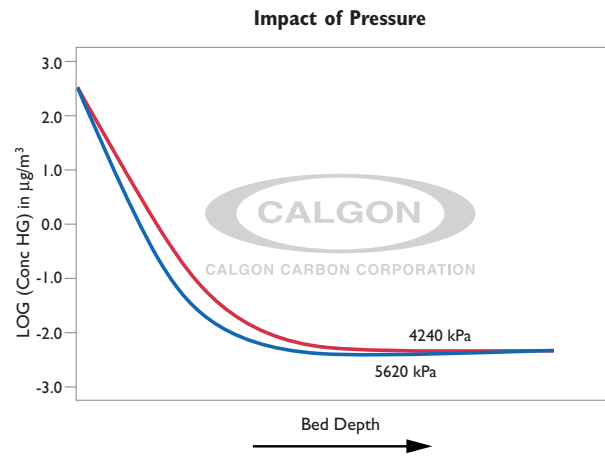


Figure 4



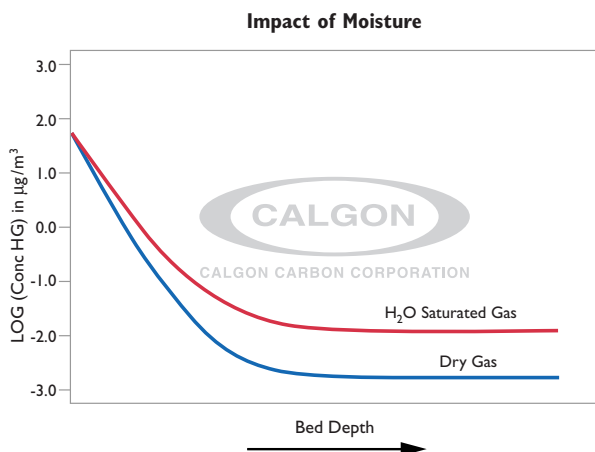
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Where Can These Products Be Applied

In natural gas treatment, HGR[®] and HGR[®]-P are used to reduce mercury concentrations. These impregnated carbons work well on “wet” (locations prior to glycol contractors or mole sieve moisture removal processes) as well as “dry” predominately aliphatic gas streams that are typically produced at gas processing plants.

In the production of chlorine using the mercury cell process, HGR[®] and HGR[®]-P can be used to eliminate mercury emissions from the production process and to scrub the by-product hydrogen stream. Mercury capacity for both HGR[®] and HGR[®]-P is as high as twenty weight percent. Similar applications exist in the battery, catalyst, fluorescent lighting, and electrical industries to protect employees and to eliminate process emissions.

Figure 5



Where Are The Influences On Performance?

Regardless of the inlet mercury concentrations, an HGR[®] or HGR[®]-P mercury removal system can be designed to achieve mercury removal to $<0.01 \mu\text{g}/\text{Nm}^3$ under optimum conditions. The operating conditions that are known to effect mercury removal performance have been described below:

Temperature

As can be seen in Figure 3, gas temperature above 50°C reduces the mercury removal efficiency of the carbon resulting in higher effluent mercury concentrations. Mercury concentrations between 0.01 and $0.1 \mu\text{g}/\text{Nm}^3$ can be achieved at temperatures above 50°C . The treatment of gas below 50°C will result in the lowest possible effluent mercury concentrations of $<0.01 \mu\text{g}/\text{Nm}^3$. Continuous operation above 70°C is not recommended.

Pressure

The mercury removal efficiency of HGR[®] has been found to be relatively insensitive to pressure variations within the range where most LNG plants operate. This is illustrated graphically in Figure 4.

Moisture Level

As is evident in Figure 5, the mercury removal limit is also increased when the natural gas stream contains relatively high water vapor concentrations. Water vapor concentrations ranging from 50% to 100% of saturation increases the mercury removal limit to between $0.01 \mu\text{g}/\text{Nm}^3$ and $0.1 \text{g}/\text{Nm}^3$, up from $<0.01 \mu\text{g}/\text{Nm}^3$ when the water vapor is below 50% “RH” in the treated hydrocarbon gas stream.

H₂S Generation

In most cases, a bed of HGR[®] or HGR[®]-P will not generate H₂S. Under specific conditions - excess hydrogen, moisture, and the presence of a catalyst - the formation of H₂S can occur. For these process conditions, contact your Calgon Carbon Technical Sales Representative who can either review the design of your adsorption system or recommend other more suitable impregnated carbons.

For additional information about mercury removal, please contact the Calgon Carbon Technical Sales Representative for your area.

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Safety Message

Wet activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low oxygen spaces should be followed, including all applicable Federal and State requirements.

Limitations of Liability

The Supplier's liability and the Purchaser's exclusive remedy for any cause of action arising out of this transaction, including, but not limited to, breach of warranty, negligence and/or indemnification, is expressly limited to a maximum of the purchase price of spare parts or equipment sold hereunder. All claims of whatsoever nature shall be deemed waived unless made in writing within forty-five (45) days of the occurrence giving rise to the claim. In no event shall the Supplier, for any reason or pursuant to any provision of the warranty, be liable for incidental or consequential damages or damages in excess of the purchase price, nor shall the Supplier be liable for loss of profits or fines imposed by governmental agencies.

Visit our website at www.calgoncarbon.com



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