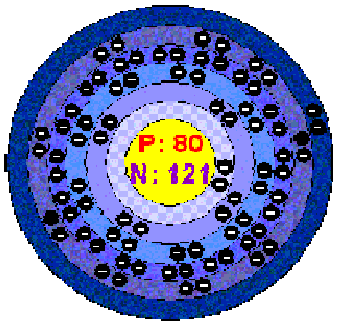
NUCON International, Inc

7000 Huntley Road - Columbus, OH 43229
Ph: 614-846-5710 - Fax: 614-431-0858 - www.nucon-int.com

MERSORB® Mercury Adsorbents

Design and Performance Characteristics

MERSORB®-1.5
MERSORB®-3
MERSORB®-4
MERSORB®-LW
MERSORB®-LH
MERSORB®-HT
MERSORB®-CR



NUCON Bulletin 11B28 – 2012

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Table of Contents

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BACKGROUND

Mercury is a historically important and useful industrial material. Mercury and mercury compounds have been used for thousands of years as pigments in inks (cinnabar, red sulfide), as aids to early metallurgy (gilding copper), and instrumentation (thermometers, barometers).

Mercury is the only metallic element that is liquid at room temperature. It is present throughout the earth.

Mercury is toxic and human ingestion and exposure must be prevented. When present in industrial process fluids, mercury causes corrosion and should be removed to prolong the life of the equipment.

Mercury has low vapor pressure and low solubility. Therefore, any mercury removal process must be effective at very low concentrations. Adsorption is such a process. Unimpregnated activated carbon is a fair adsorbent for mercury. But its capacity is significantly increased by impregnation with a material that chemically reacts with, and holds, the mercury. The choice of impregnant is dictated by the process conditions and the composition of the fluid. Sizing of adsorption equipment is determined by the flow rate and mercury content of the fluid stream and the desired operational life of the adsorbent.

This bulletin describes NUCON® products and processes for control of mercury and its compounds.

INTRODUCTION

Mercury is found in many industrial processes and products including:

Calibration of laboratory glassware
Chlor-alkali Plants – mercury cell type
Ethylene Plants
Electric Power Generation – coal-burning plants
Fluorescent Lamp Manufacturing & Recycling
Gas To Liquid Hydrocarbon Production
Gold Mining & Gold Refining
Liquefied Natural Gas Production
Mercury Recycling: batteries, catalysts, switches, manometers, contaminated soils
Natural Gas Production & Processing
Oil Refining
Synthesis Gas Production: Coal-To-Liquid Fuels Production
Synthetic Natural Gas Production
Waste Incinerators

Mercury is hazardous. The Threshold Limit Values-Time Weighted Average (TLV-TWA), established by AIGCH, is 0.05 mg mercury per cubic meter air.[2] The typical concentration of mercury found in urban air is 0.000007 mg mercury per cubic meter.[3] (In remote and rural areas it is approximately 10% of that level). These levels are considered harmless because they are 10 million times less than the TLV. However, in some industrial environments, concentrations as high as 5 mg per cubic meter of air have been measured. This level is 100 times the TLV.

Many hydrocarbon sources contain mercury. Mercury concentrations in natural gas have been found to be as low as 2 $\mu g/m^3$ to over 5,000 $\mu g/m^3$. Mercury is also present in condensates and natural gas from other parts of the world such as South America, Africa, South East Asia, the Middle East and Australia..

The exhaust gases from waste incinerators and coal burning power plants contain mercury. It is estimated that half of the global emissions of mercury come from fossil fuel combustion. Although the total quantity emitted by waste incinerators is less, the concentrations are much higher. Mercury emissions also occur in high temperature destruction of chemical munitions and various mixed wastes from DOE facilities.

Mercury can amalgamate with metals used in process equipment, causing corrosion and failure. Therefore, natural gas processing and liquefaction plants use mercury adsorbents to protect their “cold box” heat exchangers. It is a poison for some catalysts used in hydrocarbon processing. Catalysts are protected in some ethylene plants, synthesis gas and steam reforming units and for hydrogen and ammonia production

PHYSICAL PROPERTIES

Table 1. Physical Properties of Mercury

Solubility in water	0.064 mg per liter[4]
Saturation concentration, 20° C	14 mg/m^3 air
Melting point	-38.9° C
Boiling point	356.6° C
Density	13.5 g/ ml
Molecular Weight	200.59

Table 2. Solubility of Mercury in Organic Liquids, mg/l[5]

Heptane	1.3
Benzene	2.4
Iso Octane	0.8
Isopropyl Ether	1.0

Typically, the solubility of mercury in hydrocarbons is much greater than in water. Since some geologic formations contain both liquid mercury and hydrocarbons, the natural gas and hydrocarbon liquids recovered can have very high mercury content.

CONTROL METHODS

Most mercury control techniques use adsorbents (plain or impregnated) in some form. The high surface area of the adsorbents attracts the mercury and facilitates physical adsorption or chemical reaction. The most common base material is activated carbon. Impregnants are chosen for suitability in a particular environment.

NUCON International, Inc. (NUCON) has developed the MERSORB® family of adsorbents for essentially every type of mercury removal application.

For processing natural gas, hydrocarbon liquids, and small air streams, fixed beds of pelleted MERSORB® adsorbents are used. Even though the adsorbents are optimized for maximum mass transfer rates, the relatively slow reaction rate of the mercury vapor with the impregnant requires a relatively long residence time. The amount of adsorbent required to achieve high removal efficiency will generally give a very long service life.

When mercury is present at very low concentrations in relatively large gas streams (such as effluent gases from coal fired power plants or waste incinerators), powdered adsorbents can be used. The powdered adsorbents can be injected into the gas stream and, after an appropriate residence time, filtered out in a dust collector. Tests have shown various degrees of effectiveness.

GAS PHASE APPLICATIONS

Various diffusion processes control the rate of mercury removal by impregnated carbons. Bulk diffusion to the surface of the particle, pore diffusion, and reactant and reaction-product diffusion in the deposited impregnant layer all affect performance. NUCON base adsorbents have been selected for their optimized pore structure.

MERSORB® adsorbents:

- Are well suited for protecting catalyst beds and aluminum heat exchangers
- Remove mercury from various gas and liquid streams.
- Have high capacity and removal efficiency, and low-pressure drop.

Long-Term Laboratory Tests

Mercury removal efficiency and adsorption capacity testing, using radioactive mercury, have been performed in the NUCON radioisotope laboratory using ^{159}Hg.

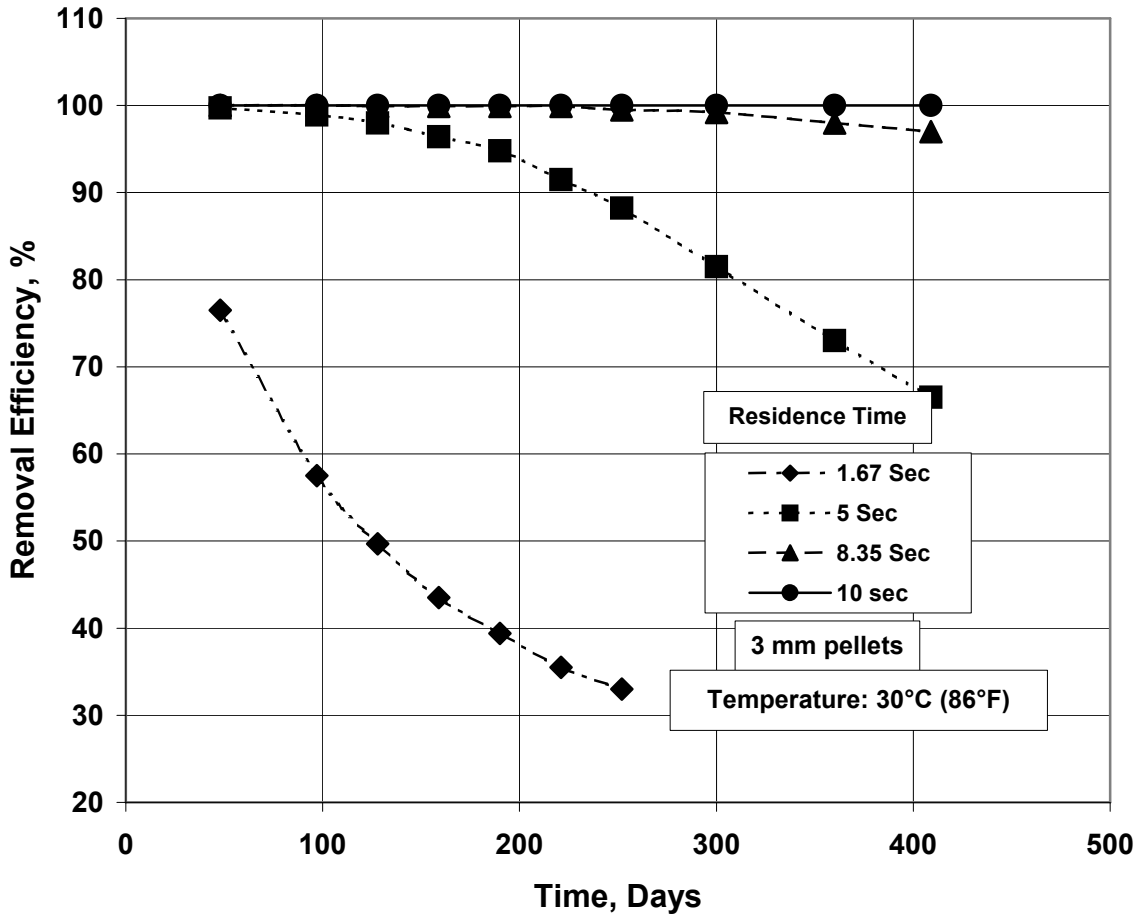
The test parameters were:

Temperature:	30° C (86° F)
Bed Diameter:	25 mm (1 in)
Bed Depth:	150 mm (6 in)
Particle Size:	3 mm pellets
Inlet Concentration:	32 mg Hg./m^3 air (2.4 e^{-6} lbs/cu ft.)
Pressure:	1.0 ATM
Linear Velocity:	.015 m/sec (3 ft./min)

Tests were conducted using six bed segments, each being 25 mm (1 in) deep and 25 mm (1 in)diameter.

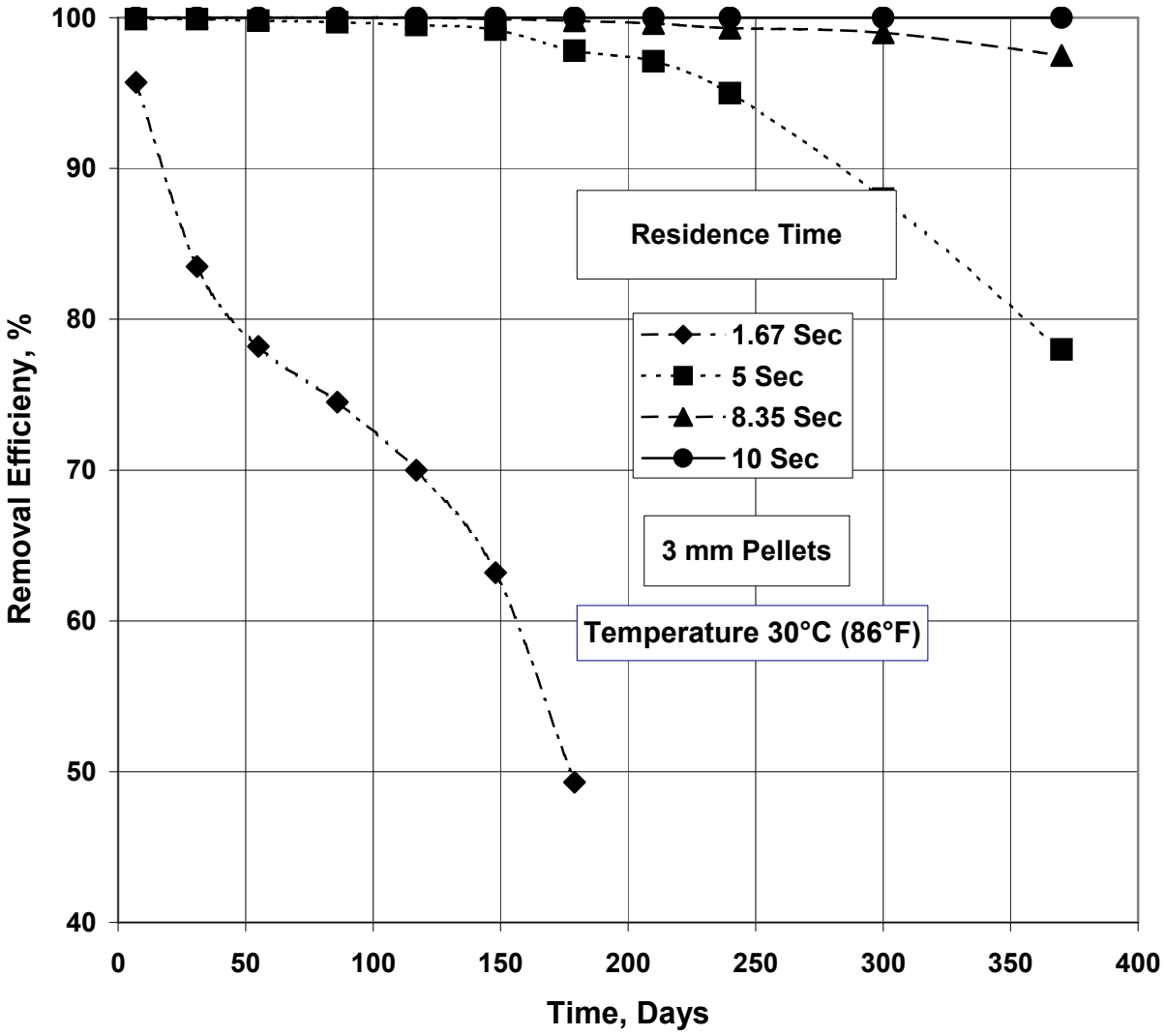
The radioactive isotope content of the bed segments was analyzed at periodic intervals. The results of the tests for mercury removal from air are shown in Fig 1.

Figure 1 Mercury Removal Efficiency from Air
MERSORB® Mercury Adsorbents



Similar tests for mercury removal efficiency and capacity from natural gas have also been performed. The test parameters were the same as in the air tests. Results are shown in fig 2.

Figure 2 Mercury Removal Efficiency from Natural Gas
MERSORB® Mercury Adsorbents



For both air and natural gas, when the gas stream is saturated with mercury, an 8-15-second residence time is typically used to achieve complete removal of the mercury. At these high concentrations, MERSORB® adsorbent removed 99.99+% of the mercury for over one year. In most commercial applications the mercury concentration is only a fraction of the saturation level, and the life of the MERSORB® adsorbent is typically several years.

An alternate approach can be used if removal efficiencies of less than 100% are acceptable. A smaller bed will give adequate performance for a slightly shorter period of time. For example, a 5 second residence time provided 240 days life at efficiencies above 95% in the natural gas tests (Figure 2). Similarly, at low mercury concentrations, 100% removal can be achieved at less than 10 seconds residence time.

Adsorption Capacity

Dynamic adsorption capacity data for the extended tests are shown in Table 3.

Table 3. Dynamic Adsorption Capacity of MERSORB® 3 mm Pellets

	Air	Natural Gas
Test Duration, days	**407**	**365**
Bed Segment No.	**Amount Adsorbed, g Hg/100 g MERSORB®**	
1	23	31
2	19	28
3	15	19
4	15	14
5	14	12
6	0.3	0.3

Each Bed Segment is 25 mm deep (1 in)

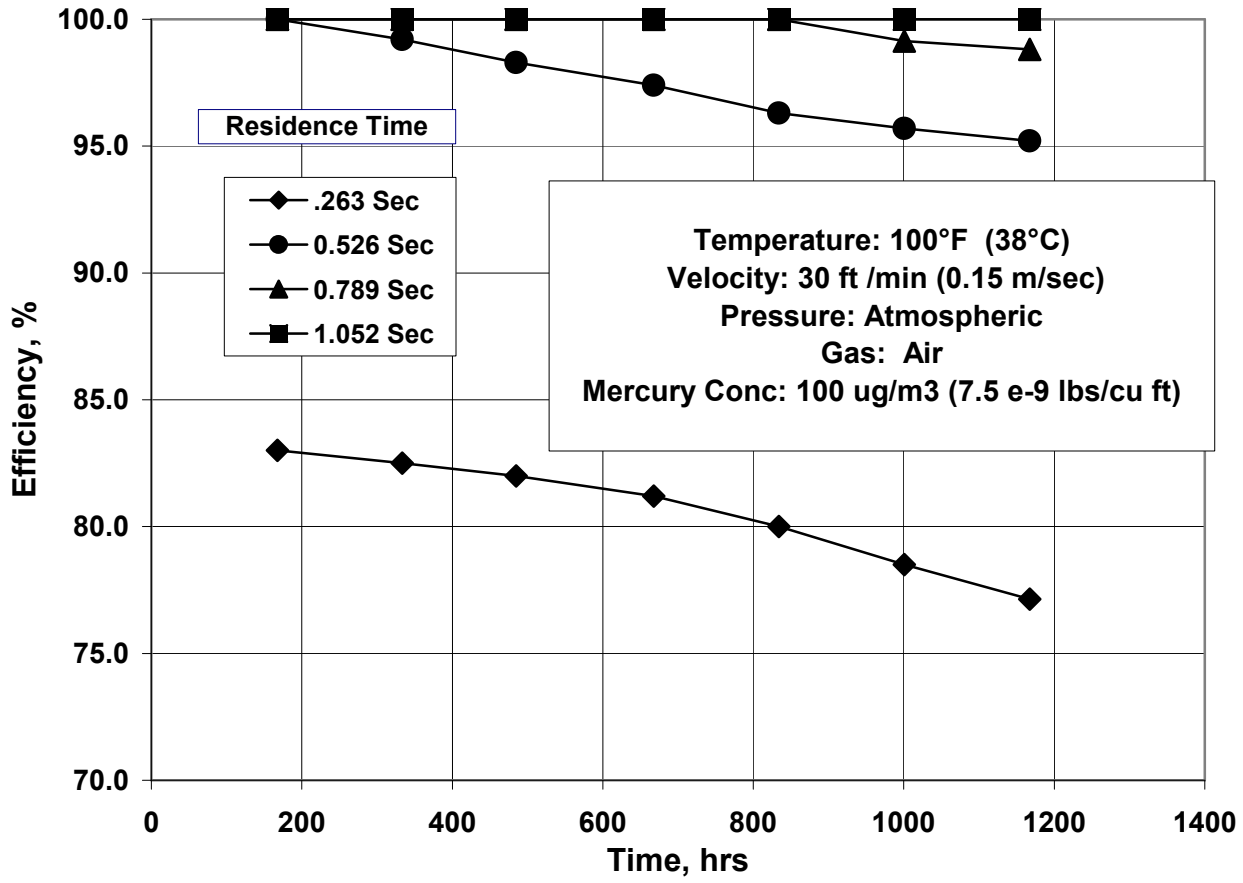
A mercury capacity of 23-g/100 g carbon has been confirmed during pilot plant testing for mercury removal from the off gas of a hazardous waste destruction process.[12]

There was no detectable breakthrough from the column at the end of either test at the limit of mercury detectability of 2 nanograms Hg/Nm3 (0.002 µg Hg/Nm3)

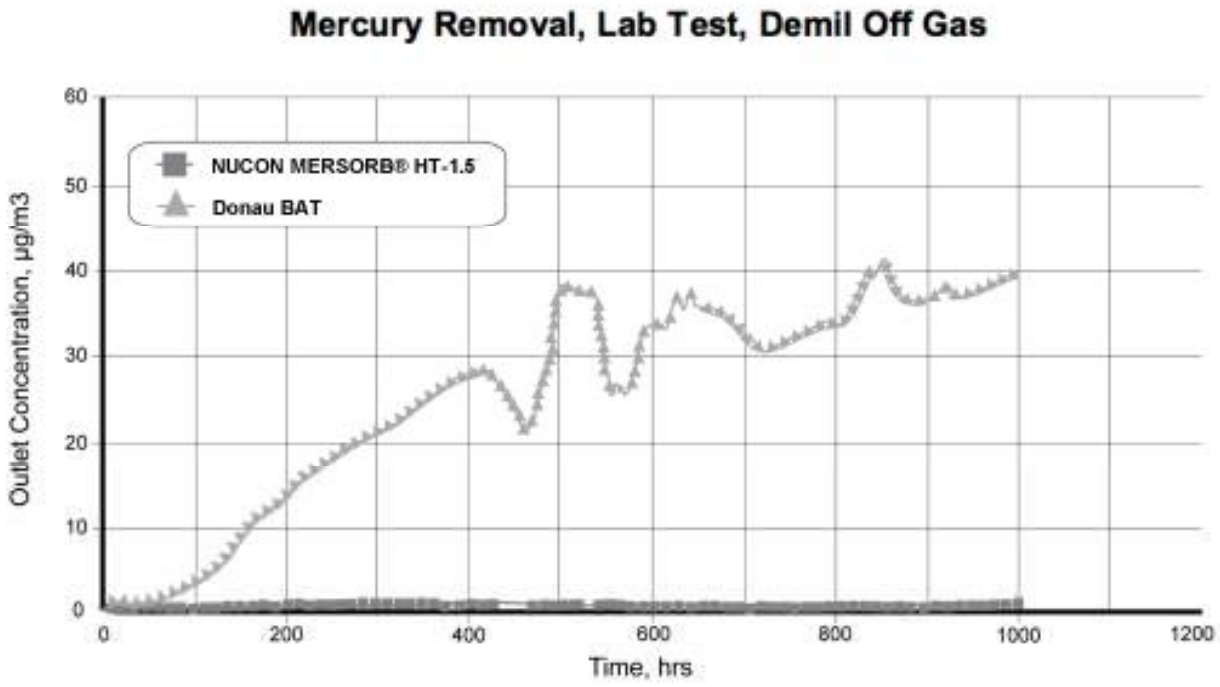
Low Concentration tests

In most situations, the concentration of mercury in air streams is much below the saturation values used in the previous tests. NUCON selected a concentration of 100 µg/m^3 for another series of tests using ^{159}Hg, as in the high concentration tests, in order to be able to measure extremely low concentrations. Various MERSORB® adsorbents and pellet sizes were tested. The data from the 3 mm tests are shown in Fig 3.

Fig 3 Mercury Removal Efficiency, MERSORB® 3mm



A series of tests were performed to determine the performance of NUCON MERSORB® HT-1.5 and a competitive material for removing mercury in the exhaust gas from the thermal destruction of chemical warfare munitions[6]. The test was conducted at a temperature of 250°F (121°C), atmospheric pressure, and a linear velocity of 40 ft/min (0.2 m/sec) through a 3.75 in (99.5 mm) diameter column. The bed depth was 6 in (152.4 mm The inlet concentration of mercury was nominally 20 mg/dscm (1.5 e^{-6} lbs/cu ft). Test results are shown below.



The 6" deep bed of MERSORB® HT-1.5 mercury adsorbent reduced the outlet concentration to essentially undetectable levels for the entire test period. For the competitive carbon, the outlet concentration from the deeper 12" bed reached 40 µg/dscm in the same period. During this test, in NUCON's opinion, a process upset occurred causing moisture to condense in the column with the NUCON carbon. While no corrosion of the components of the column was observed, there was corrosion of the flow measuring orifice plate downstream of the test apparatus.

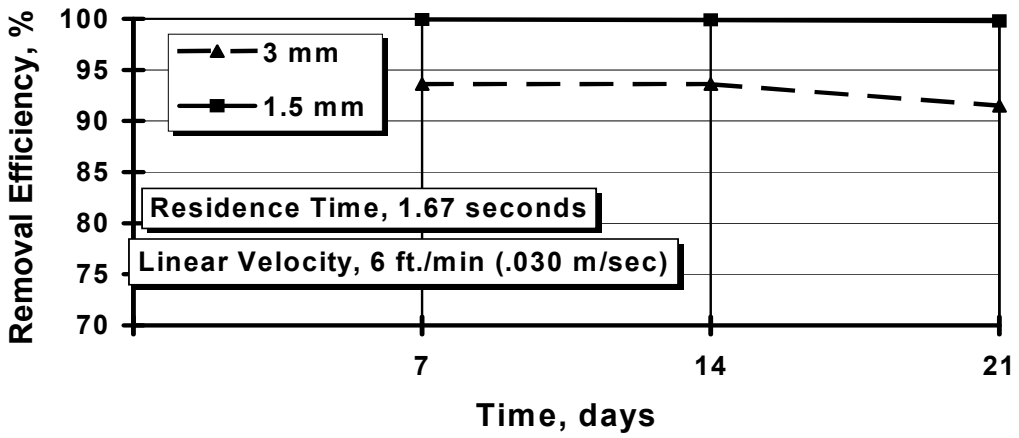
Particle Size Effects

The particle size of the MERSORB® adsorbent affects several operating parameters. Data concerning the two most important criteria, performance and pressure drop, has been developed.

Performance

The dynamic performance of small particle size adsorbents is always better than for that of larger sizes. Figure 5 shows the difference between MERSORB® 1.5 mm and 3 mm pellets. These tests were conducted using air saturated with mercury at 30°C. The test bed dimensions were 25 mm diameter by 25 mm deep.

Figure 5 – Effect of Particle Size on Mercury Removal from Air
MERSORB® Mercury Adsorbents



The difference is very noticeable at short residence times. The initial efficiency for 1.5 mm pellets at 1.67 seconds residence time is 100%, while for 3 mm it is around 93%.

Natural gas processing is normally done at high pressure. For estimates of pressure drop, please contact your MERSORB® application engineer

Velocity Effects

NUCON ran laboratory tests on 4 mm MERSORB® pellets using two different gas velocities with the bed depth of 12 inches. The comparative results after 30 days of testing are shown in Table 4.

Table 4. Effect of Velocity on Dynamic Adsorption

	Removal Efficiency (%)	
Residence Time, sec	**3 ft/min (0.015 m/sec)**	**6 ft/min (0.03 m/sec)**
1.67	42.8	58.4
3.33	80.3	88.7
5.00	90.7	100.0

Removal efficiency is generally perceived as a function of the residence time. However, at higher superficial gas velocity, the removal efficiency at a given residence time improves due to favorable diffusion effects.

Temperature Effects

Weight Loss

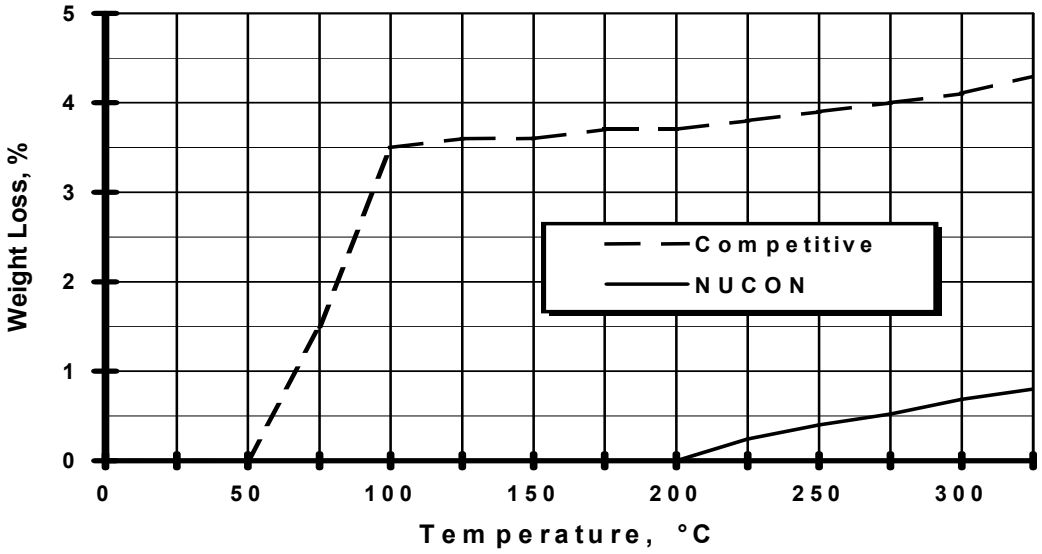
Operation of mercury removal systems at high temperatures is sometimes necessary. There are two major effects upon performance at elevated temperatures. The sulfur impregnant can:

- Vaporize in inert atmospheres, or
- Oxidize in air atmospheres.

In general, chemical reaction rates increase with temperature. And so it is with MERSORB® mercury adsorbents; higher temperatures provide faster chemisorption kinetics. Competitive sulfur-impregnated Hg adsorbents advise that their Hg removal performance decreases as temperature is increased. The reason this counter-intuitive performance occurs with the competitive products, is because the competitive products begin to lose their sulfur at relatively low temperatures. MERSORB® mercury adsorbents are made by a different process and are quality control tested at 200°C (392°F), so our product retains its sulfur and is thus able to take advantage of the faster reaction kinetics at elevated temperatures. This performance has been demonstrated in a hot synthesis gas pilot plant with operating temperatures above 100°C (212 °F).

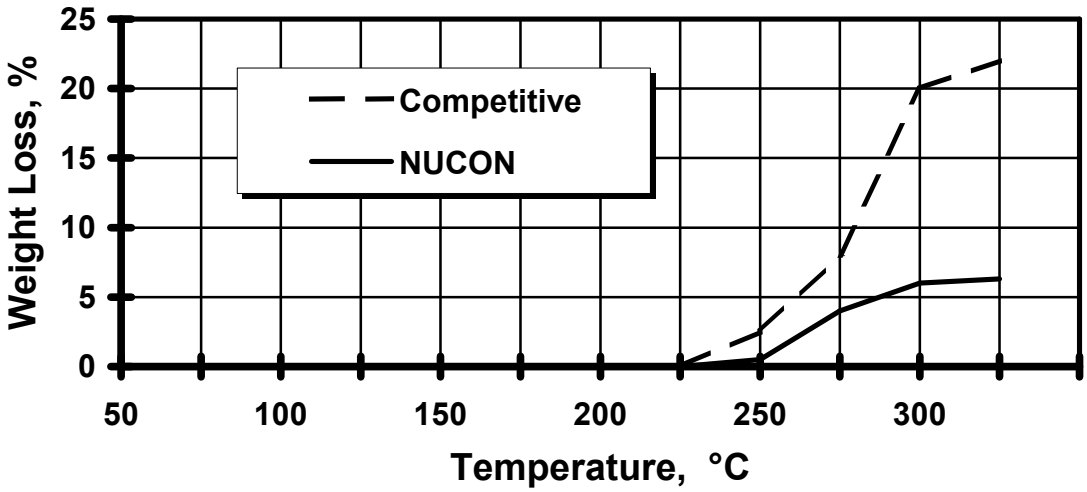
The results of thermogravimetric analysis of samples of 3 mm MERSORB® mercury adsorbent and a competitive 4x10 mesh size granular adsorbent are shown in Figure 7. For the competitive (granular) product, almost half of the impregnant was lost at temperatures around the boiling point of water. On the other hand, the MERSORB® adsorbent shows no weight loss until the temperature exceeds 200° C.

Figure 6 – Weight Loss of Mercury Adsorbents in Inert Atmosphere



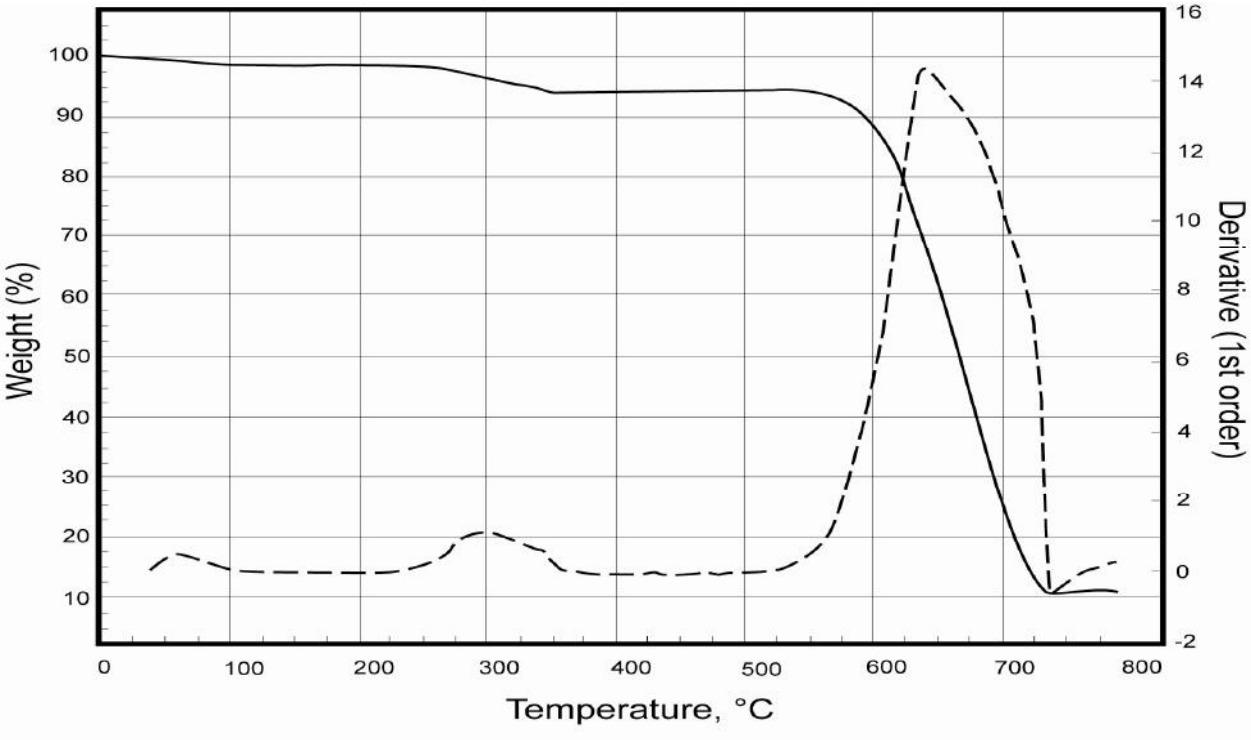
The differences are even more noticeable for tests conducted in air (See Figure 8). The weight loss at temperatures above 275°C (527°F) for the competitive product indicates that both the sulfur impregnant and some of the carbon is being oxidized. For the NUCON MERSORB® material, only a small portion of the sulfur is lost at that temperature.

Figure 7 – Weight Loss of Mercury Adsorbents in Air



A type of impregnated activated carbon, MERSORB® HT, is available for high temperature applications {greater than 150 °C (205°F)}. Through a unique manufacturing process, the sulfur is converted to a form that is very stable. The weight loss of MERSORB® HT when subjected to a temperature of 200 °C (392°F)is typically 5%. A TGA analysis is shown in Figure 9[11].

Figure 8 – Weight Loss of MERSORB® HT in Air



Loss of moisture accounted for the slight weight change at 100°C (212°F). There was no further change until the temperature reached 300°C (572°F). At that level, the loss of loosely bound sulfur represented about 20% of the total impregnant, leaving 10% sulfur on the carbon. There was no additional weight loss until the temperature of the adsorbent reached the ignition temperature of 550°C (1022°F). The same ignition temperature value has been measured in ASTM D3466 Ignition temperature tests for MERSORB® HT.

Other tests were conducted with a stream of methane flowing through a bed of MERSORB® 1.5 pellets at 150°C (302°F). After 24 hours, the impregnant loss was only 0.5%.

The MERSORB® sulfur impregnated adsorbents are quality control tested at 200°C (392°F) to insure stability of the impregnant. The typical loss of impregnant for MERSORB® HT in this test represents 4 % of the total weight.

LABORATORY TEST RESULTS

The results of laboratory tests performed on several simulated gas streams have been used as a basis for the design of mercury removal processes. They include offgas from mixed waste incineration, a plasma enhanced melter, ventilation of a hot cell, and a chemical munitions incineration process. Table 5 shows the results of these tests.

Table 5. Laboratory Experiments, Gas Phase Mercury Removal

Application	Mixed Waste Incineration[8]	Mixed Waste Incineration[9]	Hot Cell Vent SNS Facilities[10]	Plasma-Enhanced Incineration[11]
Gas	Inert Off Gas	Inert Off Gas	Air	Syngas
Impurities	NO_2, HCL			Nitrogen
Mercury Conc., mg/cu m	10	16	0.055	0.55
Temperature, °C	150	107	38	30
Residence Time, sec	0.99	0.63	0.7	20
Test Duration, hr	1000	100	60	9
Mercury Removal Eff., %	99.9	99.997	99.8	99.99

In all cases, extremely high efficiencies were obtained even though the test conditions and gas types were different. Even at high concentrations, the efficiency is very good at elevated temperatures because of the high chemisorption rates. But even at low temperatures, the efficiency is good for low concentration steams at residence times of less than 1 second.

LIQUID PHASE APPLICATIONS

NUCON also produces mercury removal adsorbents for liquid phase applications.

- MERSORB® LW for liquid phase, water solutions
- MERSORB® LH for liquid phase hydrocarbons

The standard LW, LH, and CR grades are supplied as 1.5 and 1.0 mm diameter pellets. Custom particle sizes are available.

Mercury Removal from Water

MERSORB® LW mercury adsorbent is used to achieve low mercury concentrations in wastewater from a variety of industrial processes and from ground water. This mercury adsorbent is a high surface area (1,000 m2/g) activated carbon pellet that is impregnated with elemental sulfur by a proprietary method. Our impregnation method creates a high level of dispersion of the sulfur inside the micro pores of the activated carbon substrate, making the impregnant more available to remove mercury.

Typical particle sizes of MERSORB® LW mercury adsorbent used in water treatment service are 1.5 mm & 1.0 mm diameter pellets. These pellet sizes provide mercury removal efficiencies of up to 99+% at a pressure drop within the limit specified by the client. The pellets have high crush resistance, wet and dry, and are low in dust.

The mercury adsorption capacity of MERSORB® LW is concentration dependent. Typical design contact times are in the range of 20-40 minutes at ambient temperature. The MERSORB® LW grades can be used at temperatures up to 90° C (194F). We recommend that the feed water be adjusted, as necessary, to achieve a neutral pH of 7.0 +/- 0.5. Certain common ions can damage the mercury adsorbent and its performance efficiency if operated outside of this pH range.

To achieve the highest levels of mercury removal efficiency, particle filters should be installed upstream and downstream from the mercury adsorbent vessels. Particles may contain mercury and must be removed upstream of the adsorber vessels. We recommend a 1 micron Absolute Pre Filter, but lab tests can be used to determine the optimum Pre Filter size and configuration for a particular installation. A Post Filter of 0.45 micron Absolute size catches any small particles shed by the mercury adsorbent, thus insuring that the treated water stays within the required treated water Hg concentration limit.

If large amounts of dissolved organic material are also present in the aqueous streams, an unimpregnated carbon (NUSORB® GC60-1.5) should be used as a guard bed to increase the life and efficiency of the MERSORB® LW for mercury removal.

The effect of other ions in the water on mercury adsorption can be substantial. Contact your MERSORB® applications engineer for advice in these cases.

Mercury Cell Chlorine Caustic Plant Waste

Wastewater discharges from the HoltraChem chlor-alkali plant in Maine exceeded the newly established mercury concentration limits imposed by the EPA [7]. An extensive process system was installed which included optimization of the sulfide pre-treatment step, adjustment of pH and the addition of 0.5 micron particle filters, followed by a polishing bed of MERSORB® LW mercury adsorbent. The result was a reduction in the effluent concentration to below 0.05-ppbw Hg. Process conditions for the MERSORB® adsorber were:

Flow:	22.7 m^3/hr (100 gpm)
Residence time	45 minutes
Inlet Mercury Concentration	8 ppbw
Mercury Removal Efficiency	98.64%

CASE HISTORIES

Water from Air Scrubbers

For some small medical waste incinerators, the exhaust gas is passed through a water scrubber to remove particulates and water-soluble compounds. Any mercury present in the waste is contained in the scrubber water. During a four-month demonstration project, scrubber water containing an average of 300 ppbw Hg was passed through a column of MERSORB® LW to remove the mercury. An average effluent level of less than 2 ppbw Hg was maintained over this period.

Mercury Cell Hydrogen

High purity hydrogen chloride (HCl) is manufactured by reacting hydrogen and chlorine. A facility using hydrogen from chlorine/caustic mercury cells must remove the mercury in the hydrogen to meet specifications for the HCl. Mercury concentrations up to 300 ppb were reduced to less than 0.01 ppb in a single column of MERSORB® 3 mm diameter pellets. This system has been in operation for over eight years with no change in removal efficiency.

LNG Production Plant—Hg in Natural Gas

A western USA natural gas processing plant produces LNG in order to reject nitrogen from the gas. This plant has its mercury removal section upstream of the CO_2 removal section. The plant was using a competitive mercury adsorbent and suffered mercury corrosion downstream due to poor mercury removal efficiency. Sulfur contamination in the NGL was also observed, due to loss of sulfur from the mercury adsorbent caused by water-glycol carryover. The plant installed MERSORB® mercury adsorbent and sulfur contamination of their NGL was eliminated and the concentration of mercury in the treated gas is consistently < 2 nanograms per cubic meter.

Mine Atmosphere

A gold mining plant in Nevada encountered concentrations well above the TLV in the enclosed processing area. An air purification system containing MERSORB® 3 mm pellets was installed. The mercury level has been reduced to below the TLV.

Mixed Waste Disposal

Many of the DOE sites have generated mixed waste materials in the process of making nuclear weapons, which must be destroyed. At Idaho National Laboratory, they used an incineration and scrubbing system initially but needed an improved process to complete the disposal. Based on laboratory tests, they chose the "Thor" steam reforming process. A pilot plant was built and operated. Based on the test results[12], the full-scale plant was designed and will be operated. NUCON MERSORB® HT-3 was chosen as the adsorbent based on the extensive testing and on its ability to meet the MACT standard of 8.3 µg/dscm outlet mercury concentration.

Mercury Waste Recycler—Hg in Hot Retort Off-Gas

A recycler plant uses a retort to process its mercury-bearing wastes. Using a competitive mercury adsorbent to filter the 121°C (250°F) off-gas, they experienced repeated bed fires. After lab testing all available mercury adsorbents, they switched to MERSORB® mercury adsorbent. There have been no further problems with bed fires and mercury emission requirements are being met.

Mercury Waste Recycler—Hg in Water

Treating retort condensate water for mercury removal using a competitor's product did not achieve the desired performance. After installing MERSORB® LW mercury adsorbent, the user reduced mercury levels in the treated water from as high as 1,000 ppbw Hg to less than 1 ppbw Hg.

Fluorescent Lamp Recycling System OEM—Hg in Air

An OEM tried several competitive mercury adsorbent products and decided to use MERSORB® mercury adsorbent. Over 20 systems installed all meet mercury emissions regulations. Even with a three-shift lamp recycling operation, the mercury adsorbent lasts several years.

Fluorescent Lamp Manufacturing Plant—Hg in Air

The plant needed to control the mercury emissions from their fluorescent lamp curing ovens. An air collection system was installed, including an adsorber containing MERSORB® LH mercury adsorbent. Mercury concentrations around the unit were reduced from > 100 micrograms Hg/cubic meter to non-detectable levels of < 1 microgram Hg/cubic meter, even though the treated air temperature was over 71°C (160 °F).

Mercury-Cell Chlor-Alkali Plant—Hg in Brine, Hg in Water

The plant needed to drastically reduce the mercury emissions in its spent brine. A 22.7 m^3/hr (100-gpm) secondary treatment system using MERSORB® LW mercury adsorbent was installed. The process reduced mercury levels in the brine from > 50 ppbw Hg to < 50 pptw Hg

Oil Refinery: Sour Water Stripper Wastewater

An aromatics production facility in Thailand installed two Mercury Removal Systems One was sized to treat ~2.3 m^3/hr (10 gpm) and the other to treat ~ 22.7 m^3/hr (100 gpm) of wastewater. With 200 ppbw Hg in the inlet water, the treated water measures < 5 ppbw Hg, a Mercury Removal Efficiency of 98%.

Natural Gas Processing: LPG Recovery & Nitrogen Rejection

A Natural Gas Processing plant in Wyoming replaced a competitor's 4x10 mesh granular mercury adsorbent with MERSORB® 4mm mercury adsorbent. The plant now sees less than half the pressure drop across the unit than they did with the 4x10 granular, and now achieves 99.98% mercury removal efficiency with an inlet Hg concentration around 25 µg Hg/Nm^3 and an outlet gas containing 0.005 µg Hg/Nm3. The plant processes over 5.4 mmNm^3/day (200 mmscfd) of feed gas with m.w. of 26 at about 55 Barg (800 psig) and 19°C (66 °F).

Gold Mine

A gold mine in Nevada installed MERSORB® HT 3mm pellets in a brand new Mercury Removal Unit. The Unit treats 13,900 m^3/hr (8,200 ACFM) of exhaust air at 240°F (116 °C). During 1 year of operation, the unit has demonstrated 3 orders of magnitude lower mercury emissions than any mercury control unit in Nevada. The outlet Hg concentration is 0.002 µg Hg/Nm^3. The Nevada DEP considers this unit as a model for the Best Available Control Technology.

OPERATING GUIDELINES

The following are general guidance for typical applications. Contact us to discuss MERSORB® adsorbent applications tailored to your specific operating conditions.

1. Do not use these products for acidic solutions without first testing in the lab.. Acids reacting with sulfur compounds can generate hydrogen sulfide (H_2S), which is poisonous. Removal efficiency for ionic mercury decreases at a pH below 7. For elemental mercury, a pH as low as 4 can be used.

2. When non-mercury impurities must also be removed, it may be desirable to use "guard" adsorbent beds in service upstream of the MERSORB® adsorbent beds to remove these impurities and increase the life of the mercury adsorption bed.

3. Mercury removed by the sulfur impregnated MERSORB® is converted by the adsorbent to mercuric sulfide, a naturally occurring compound. Spent adsorbent should be handled according to appropriate disposal procedures and according to applicable safety and transportation regulations.

4. For optimum removal efficiency, it is always preferable to operate a deep bed at high velocity rather than shallow adsorbent bed at a low velocity.

5. It is important to have effective liquid knockout upstream of gas phase mercury adsorption beds. Liquid hydrocarbons can dissolve the sulfur impregnant. Any liquids entering or condensing in the adsorbent bed interfere with the mercury adsorption rate and capacity. It is also common for natural gas streams to be saturated with water. To minimize the potential for moisture condensation, it is important to raise the temperature of the gas enough to reduce the relative humidity less than 90%. This will also minimize the possibility of getting liquid water on the adsorbent beds. It is also helpful to heat trace the piping between the heater and the adsorber to prevent cooling and condensation.

6. The MERSORB® mercury adsorbents have been shown to be effective at relatively high operating temperatures. Please contact your MERSORB® applications engineer for specific product recommendations for your particular situation.

TECHNICAL SUPPORT

MERSORB® applications engineers can provide:

1. ADSORPTION PROCESS DESIGN: Identification of the adsorbent that provides the required level of contaminant removal efficiency and optimum adsorption capacity. We will recommend the number & size of adsorber vessels required and estimates of the adsorbent life.

2. VESSEL DRAWING REVIEW: Review of mechanical drawings and P&ID of existing or newly designed vessels, advise suitability or recommend improvements.

3. START-UP ASSISTANCE: Advice on adsorbent loading and unloading techniques & hazards.

4. TROUBLE SHOOTING: Determine the cause and suggest solutions to solve a number of operating problems such as early contaminant breakthrough, excessive pressure drop and poor performance. We can also advise concerning adsorbent changeout decisions.

5. OPERATOR TRAINING: Subjects covered in our training programs include:
   How the adsorption unit affects & is affected by other operating units
   How adsorbents work
   How adsorption & regeneration processes work
   How to diagnose & deal with common operating problems

6. ON-SITE TECHNICAL SERVICES: Experienced Engineers and Technicians can come to your site and provide consulting services regarding the operation of your Mercury Removal System.

7. PILOT SCALE ADSORBERS: The best method for measuring the mercury content of gas and liquid streams is to pass a slipstream through a small adsorber for a period of time and then analyze the adsorbent for mercury content. We can provide the equipment and analytical services. Analysis of used carbon samples can also be provided.

Our personnel are Members of ASTM Committee D-28 on Activated Carbon

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