Featured Article - Low Level Mercury Removal

Understanding the new air quality rules, transport cycle, related health issues and clean air removal applications for this highly toxic substance.

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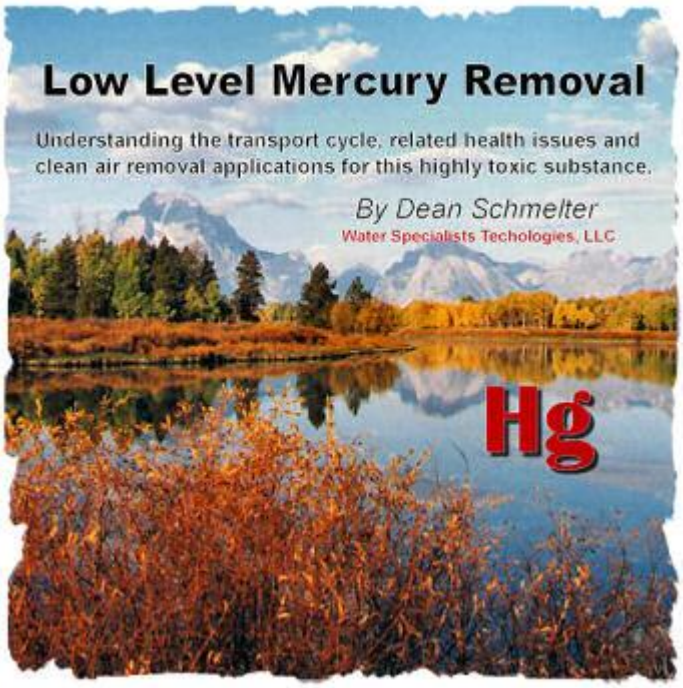

- **On March 10, 2005, the EPA issued the Clean Air Interstate Rule (CAIR),covering 29 states in the Eastern United States. CAIR will permanently cap emissions of sulfur dioxide (SO2) and nitrogen oxides (NOx)**

- **On March 15, 2005, the EPA issued the Clean Air Mercury Rule to permanently cap and reduce mercury emissions from coal-fired power plants for the first time ever.**

- **Together, the Clean Air Interstate Rule and the Clean Air Mercury Rule create a multi pollutant strategy to improve air quality throughout the USA.**

Low level Mercury Removal

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New Air Quality Rules Overview

On March 10, 2005,the EPA issued the **Clean Air Interstate Rule (CAIR**), a rule that will achieve the largest reduction in air pollution in more than a decade. CAIR will permanently cap emissions of sulfur dioxide (SO2) and nitrogen oxides (NOx) in the eastern United States. Upon full implementation, CAIR will reduce SO2 emissions by over 70 percent and NOx emissions by over 60 percent from 2003 levels. Under the cap-and-trade approach in CAIR, the EPA will allocate to each state, emission allowances for SO2 and NOx. The states will distribute those allowances and the affected sources can then trade them.

On March 15, 2005, the EPA issued the **Clean Air Mercury Rule** to permanently cap and reduce mercury emissions from coal-fired power plants for the first time ever. The new rule is intended to reduce power plant mercury emissions from 48 tons a year to 38 tons by 2010, followed by additional reductions to less than 25 tons by 2018.

The rule includes a model cap-and-trade program allowing a mercury emissions budget for each state. The mandatory emissions caps in the Clean Air Mercury Rule, together with significant noncompliance penalties, will ensure that the rule's mercury reduction requirements are achieved and sustained. Also, strict emissions monitoring and reporting requirements ensure that data are accurate, that reporting is consistent and that the emission reductions occur. Emissions budget allowance trading creates financial incentives for coal-fired power plants to look for new and low-cost ways to reduce emissions and improve the effectiveness of pollution control equipment.

Mercury Transport Cycle

To understand the health risks from mercury exposure, we must first understand the mercury transport cycle.

1. The majority of Hg is transported to the atmosphere in gaseous form. Most man made mercury transformation occurs in the atmosphere from combustion of fossil fuels or combustion of waste products. The mercury is transferred in the elementary or non-valent state.

2. Hg forms strong bonds with organic/inorganic substances and particles. Once the airborne particles settle in water and tie up with organic and inorganic substances and particles, the mercury is converted into the bi-valent state.

3. At this time the biological process, Hg to methyl mercury occurs. Once the particles have tied up with substances, the biological process takes place where Hg is methylated by microbiological or abotic process into methyl mercury that leaches into water. This process is accelerated in lower pH waters created from acid rain, certain types of sediment and warmer hemispheres.

4. The methyl mercury contamination remains in sediment and is gradually released. Sedimentary materials and plants are consumed by small fish, which are consumed by larger fish and, ultimately, by humans.

5. Each step in the food chain concentrates the methyl mercury. With each step, the concentration of methyl mercury increases as more and more of the contaminated food source is consumed, this is called bioaccumulation.

Health Issues caused by methyl mercury

Methyl mercury is a highly toxic substance that can poison wildlife and cause brain and nervous system damage in humans. People are exposed to methyl mercury primarily by eating contaminated fish. Methyl mercury poisoning results in a condition similar to cerebral palsy with potential blindness and deafness. Children exposed before birth have an increased risk of poor performance on

neurobehavioral tasks, such as those measuring attention, fine motor function, language skills, visual-spatial abilities and verbal memory. Other long-term effects of methyl mercury poisoning are; loss of appetite, diarrhea, gum inflammation, lack of coordination of movements, impaired speech, hearing and walking; muscle weakness, memory loss and possible brain damage.

Since women of childbearing age and infants are most at risk, they should eat small amounts of fish. The rest of us should be aware of the symptoms.

Mercury Reduction

The majority of mercury emitted to the environment in the US each year is from:

A. Medical waste incinerators (25% of Hg emissions)

B. Municipal waste incinerators (20% of Hg emissions)

C. Hazardous waste incinerators (5% of Hg emissions)

D. Coal fired electric generators (40% of Hg emissions)

E. Industrial boilers (10% of Hg emissions)

Since 1990, mercury from the above sources has been reduced by up to 90%. Further reduction of mercury levels to the new proposed limits of 60% lower than current levels becomes a real challenge.

Currently 5-100 ppb of mercury is emitted from various types of incinerators and coal fired electric generators. Many incinerators and generators have taken one or all of the following steps for pollution control.

1. Precipitation/baghouses for particulate control
2. Flue gas desulphurization for SO2 control
3. Selective catalytic reduction for NOx control

Further removal of mercury can be achieved by one of the following options that can be used in conjunction with one or all of the above pollution control systems

1. Scrubbers – besides removal of SO2, scrubbers can be used to remove Hg if certain conditions that bring the valent state of

mercury to the Hg++ di-valent state are considered.

2. Chemicals can be added to oxidized flue gases from wet scrubbers to remove mercury (Hg++) to less than 1 ppb. In most wet scrubber applications the mercury generated from the stack gas scrubbing is 15-60 ppb. When Polythiocarbonate chemistry is added, after PH adjustment and coagulation, the polythiocarbonate reacts with the Hg++ and forms an insoluble metal salt, which can then be removed by any liquid solid separation device, which is most often a slant plate clarifier. The solids are pressed and added to the ash from the boiler, where they will pass a TCLP test, and the water can then be diverted to the permitted discharge. This process application has been used in over 25 trash to steam applications throughout Europe for more than 10 years to meet the stringent discharge limit of 1 ppb maximum.

3. In coal burning electric generators, using higher grades of coal can reduce mercury concentrations.

4. Sorbents can be injected to absorb mercury upstream of the particle collector. These materials can be costly because of the volume needed and the generation of unwanted sludge volumes.

Two other low level mercury removal applications that have been successful using the polythiocarbonate chemistry mentioned earlier are:

1. Mercury removal in gold mine tailing ponds:

When gold is mined, quite often mercury is found with the precious gold ore. In the tailing ponds there is still generous amounts of gold to be claimed but removal of the mercury is required to obtain the pure gold. Using Polythiocarbonate as a threshold treatment for removal of the mercury will allow for the extraction of the gold from the useless tailing pond wastewaters that are all to often left alone because of no economical way to extract the gold.

2. Oil and gas processing waters:

Using Polythiocarbonate to remove Hg++ in oil and gas process waters has helped petroleum companies stay within many new strict mercury level limits. The process of adding the polythiocarbonate under the right conditions has allowed the petroleum companies to meet low mercury limits before the water is discharged.

Conclusion:

The proposed EPA mercury reduction targets are achievable in both incinerator and coal fired electric generators. Mercury is such a highly toxic substance that industry must work through the above choices and institute changes to lower mercury emissions and thereby help make the environment a safer place for us and our offspring.