



Bromine-based Products for Mercury Emissions Reduction



Great Lakes Solutions, A Bromine Leader

For close to a century, we have helped our customers meet their needs with a broad portfolio of products and solutions. We manufacture and market flame retardants, bromine and brominated derivatives.



Key Products	Key End-Use Markets
<ul style="list-style-type: none">◆ Bromine & Derivatives◆ Flame Retardants	<ul style="list-style-type: none">◆ Clean Energy◆ Electronics◆ Building & Construction◆ Oilfields◆ Agriculture◆ Pharmaceuticals◆ Catalyst for Polymer Production

Key Drivers for Growth:

- › Mercury control regulation
- › Greener innovation
- › Flame retarded energy efficient thermal insulation
- › Increased global fire safety standards



Great Lakes Solutions: GeoBrom[®]

Mercury Control for a Cleaner, Greener Future

- Coal-fired boiler operations striving to reduce mercury emissions to meet federal clean air regulations can rely on Great Lakes Solutions GeoBrom[®] product line for a U.S. supply of brominated products for mercury control.
- Our proven commitment as a global, sustainable supplier in the United States includes more than \$100 million of American infrastructure investment, with an additional \$170 million planned for 2013-2015, along with an experienced organization able to provide superior customer support.



Brominated Technologies: Most Successful and Most Widely Used

Technology	Mercury Control%	Preferred Coal Type	Comments
Activated Carbon	Up to 80%	Bituminous	Limited by mercury oxidation; fly ash impacts for resale; particulate control required
Br Activated Carbon	Up to 95%	Sub-bituminous Lignite	Issues with SO ₃ impacts; fly ash Impacts for resale; particulate control required
Nalco ³ CaBr	Up to 95%	Sub-bituminous Lignite	Scrubber or particulate control required
Alstom ² (Vosteen) CaBr	Up to 95%	Sub-bituminous Lignite	Scrubber or particulate control required
Chem Mod ¹ CaBr	Up to 95%	Sub-bituminous Lignite	Scrubber or particulate control required
48% HBr	Up to 90%	Sub-bituminous Lignite	Dry sorbent injection; particulate control required
Other Br Sorbents	Up to 75%	Bituminous	Particulate control required
Sulfur Technology	Up to 75%	Bituminous	Scrubber technology
Dry Sorbent Injection	Co-benefit	Bituminous	Particulate control required

¹<http://www.chem-mod.com/results/current-results.html>

² Pearson, T.E., Air Quality VIII Conference, 10/24/27/2012, Arlington, VA

³Reference: Nalco Case Study CH-980

⁴ GeoBrom[®] is intended for general mercury control application. Great Lakes Solutions does not endorse any particular emission control technology. Please consult your technology provider regarding proper application and technology rights.

The GeoBrom[®] product line has been demonstrated in all three major calcium bromide technologies at commercial scale and is approved for use in manufacture of brominated sorbents

Our Portfolio has a Product for Every Technology

GeoBrom® HG 520

- *Calcium Bromide solution (52% by weight aqueous product)*

GeoBrom® HG 52S

- *Calcium Bromide dry powder product*

GeoBrom® HG 400

- *Sodium Bromide solution (40% by weight aqueous product)*

GeoBrom® HG 40S

- *Sodium Bromide dry powder product*

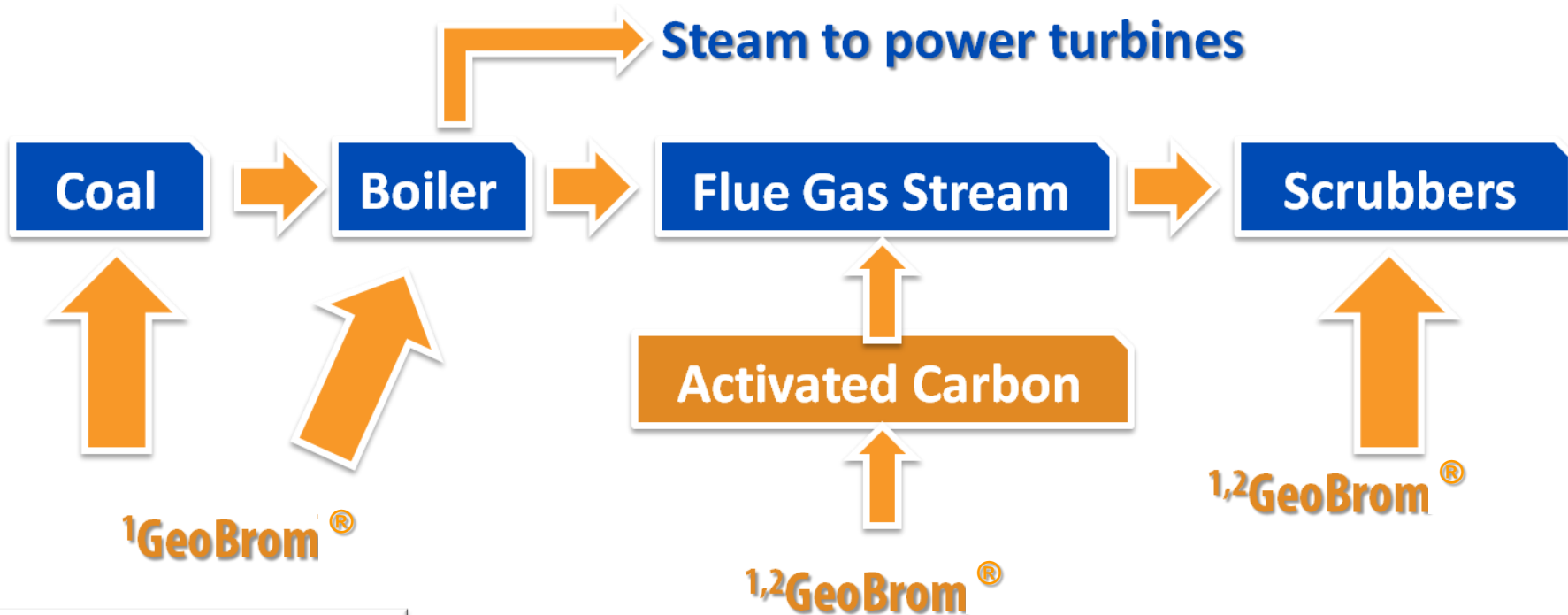
GeoBrom® HG 480

- *Hydrobromic Acid (48% by weight aqueous product)*

Other Bromine Derivative products available

- *Other concentrations of Sodium Bromide solutions, inorganic bromides*

GeoBrom[®] Performs in All Mercury Control Technologies



Calcium Bromide

¹GeoBrom[®] 520
¹GeoBrom[®] 52S

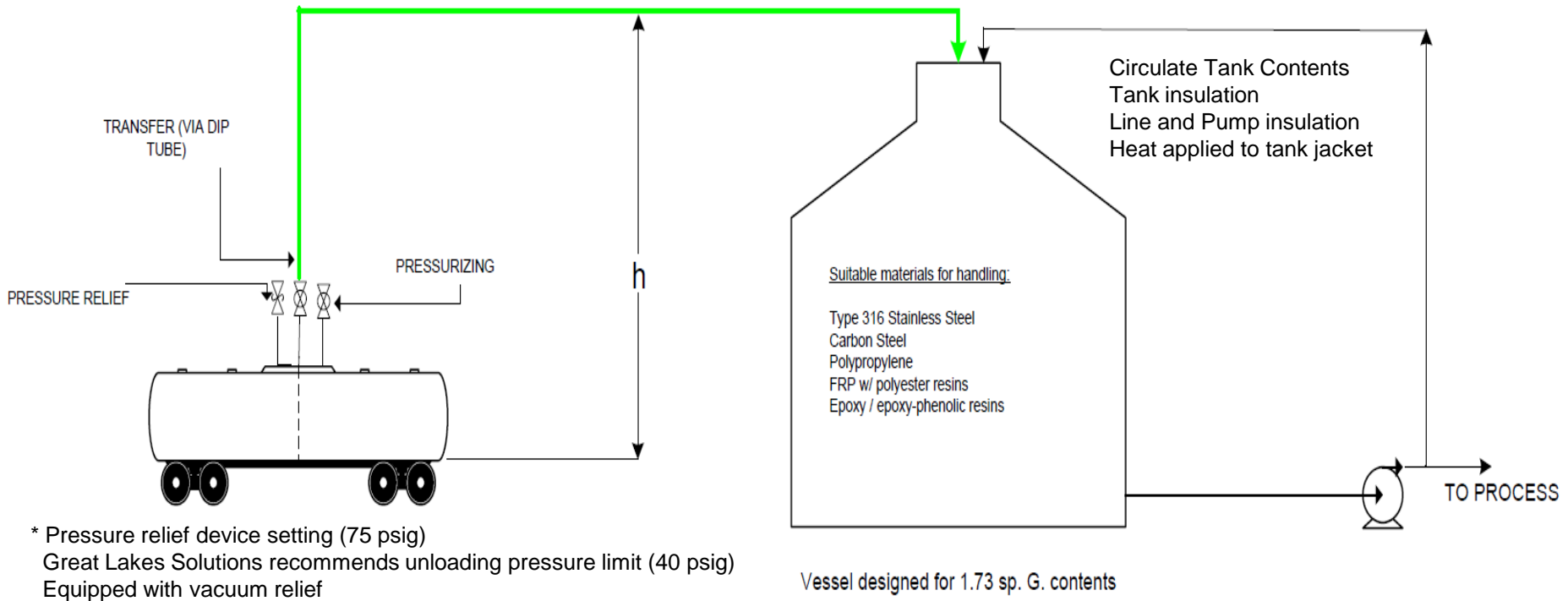
Sodium Bromide

²GeoBrom[®] 400
²GeoBrom[®] 40S

*Effective in the boiler, on activated carbon products,
and in other downstream addition technologies*

GeoBrom[®] Storage System

*Follow all equipment manufacturer recommendations



- Pressure (p) needed to lift product: $p = \text{specific weight} \times \text{height} = 106.2 \text{ lb}_f / \text{cu ft} \times h$
i.e. height of 20ft $p = 2,124 \text{ lb/ sq ft}$ or 14.8 psig

Main Points of Storage/ Transfer System

- Products non-regulated for transport
- Railcar recommended transfer from dip-tube, truckload from bottom valve
- Proper PPE for employees
- Secure connections and monitor transfer
- Density and crystallization temperature – HG520 (14.2 ppg and est. 10-20 °F) and HG400 (12.5 ppg and est. 27 °F)
- Properly insulate and/or circulate the tank in colder regions
- Materials of construction – equipment available off-the-shelf
- Air pressure or pump to lift to desired height
- Adequate back-flow prevention
- Great Lakes Solutions on-site support and expertise available

Great Lakes Solutions

We Build Customer/Partner Relationships

▪ Domestic supply

- Great Lakes Solutions has the strongest U.S. bromine position
- Secure, established U.S. operations
- More than \$100M in investments 2009-2011 in the U.S., and plans for another \$170M in the future

▪ Supply Security and Sustainability

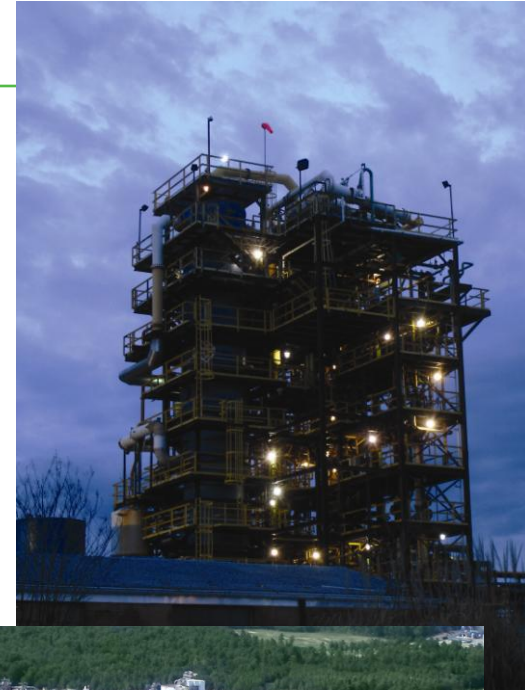
- Multiple carrier options
- Inventory in multiple strategic locations
- Three U.S. bromine plants, two additional bromine sources
- Multiple sources for calcium bromide plants in the U.S.

▪ Expertise with CaBr and NaBr Products

- Equipment and training
- Handling and technical support
- More than 30 years experience handling tens of thousands of tons/year

▪ Flexibility and Customization of Solutions

- Ease of order process
- Delivery accommodation
- Logistics and product support for test trials
- Flexibility with logistics
- Product expertise to support customer facilities
- Customer service - assigned representatives for each customer
- Ability to support site specific storage where required
- Broad package range: drums to bulk in trucks and railcars



We will be here for you for the long haul...

The Value of GeoBrom® and Great Lakes Solutions for Mercury Control

GeoBrom® products have been designed for incorporation into new technologies that use bromine or brominated derivatives products for the efficient reduction of toxic mercury emission from coal-fired boilers and power plant installations.

The GeoBrom® product line provides sustainable, secure, U.S. manufactured brominated products for mercury control by a company with proven ability to solve complex customer logistical challenges and requirements.

- **Effective and proven at commercial scale in technologies**
- **Reliable U.S. supply**
- **Cost-effective solutions for mercury control**
- **Flexibility to meet customer needs**
- **Customer support and creativity for all facets of the order and delivery process**

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