Mercury Reduction Strategies in the Base Metal Smelting Industry

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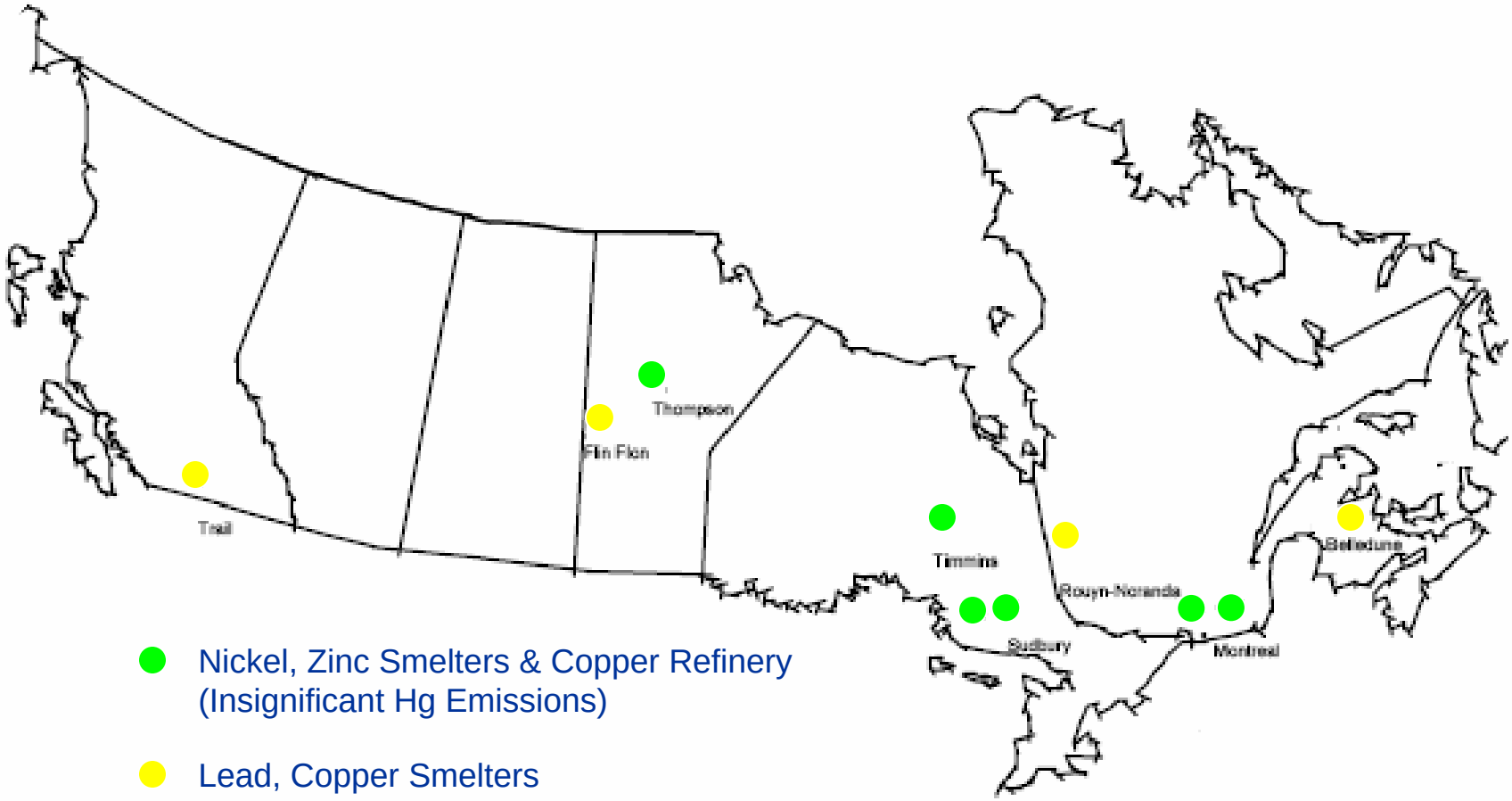
Mercury Content in Ores

- Factor of geological formation (region) as well as metallic species
- Typical concentrations:
  - Lead 0.1 – 10 ppm
  - Copper 0.1 – 1 ppm
- Insignificant in Nickel and most Zinc ores

Locations of Canadian Smelters and Refiners



- Nickel, Zinc Smelters & Copper Refinery (Insignificant Hg Emissions)
- Lead, Copper Smelters

Significant Reductions from Base Metal Smelting

- Significant reductions have been achieved by action at largest sources
- Ore processing (at minesite) is considered small source although data is lacking.
- Primary Production (Smelting) results in release of Mercury naturally contained in certain ores.

Industry Commitment and Action

The Base Metals Smelting Sector has implemented numerous pollution prevention and pollution control initiatives over the period of interest through major process changes as well as significant improvements to environmental control devices.

In addition to the process and environmental control changes, the facilities in the Base Metals Smelting sector have implemented structured environmental programs over the past few years.

As of year 2000, all base metals smelting facilities had an Environmental Management System (EMS) in place.

Trends in Releases

The sector as a whole has experienced substantial decreases in releases of all relevant *CEPA* toxics since the base year of 1988

There are several factors that contribute to the significant changes in emissions. These include:

- Major process changes
- Significant environmental control devices
- Significant environmental programs
- Changes in feed materials
- Changes in production

Canadian Environmental Protection Act

The Base Metals Smelting Sector (BMSS) releases the following substances that have been deemed toxic under the ***Canadian Environmental Protection Act*** (***CEPA***):

- Lead (Pb)
- Mercury (Hg)
- Inorganic arsenic (As) compounds
- Inorganic cadmium (Cd) compounds
- Inorganic Nickel (Ni) compounds
- Particulate Matter
- Sulphur dioxide

Industry / Government Initiatives

- ARET – Accelerated Reduction and Elimination of Toxics
- CWS – Canada Wide Standards (Hg)
- SOP – Strategic Options Process

ARET Commitment

Release Reduction Targets and Schedules

Total releases of the *CEPA* Substances from Base Metal Smelters should be reduced from 1988 levels by 80% by the year 2008 and by 90% beyond 2008 through the application of technically and economically feasible methods.

Canada Wide Standards for Mercury

- The voluntary application of a number of process changes and stack treatments have contributed to reduce mercury emissions by the Base Metal Smelting sector by more than 90% since 1988.
- Due to reductions from this sector, Canada has complied with its obligations under the UNEC Heavy Metals Protocol

Canada Wide Standards

- Existing Facilities:
  - Best available P2 and Control techniques economically achievable to achieve source performance of 2g Hg/tonne finished metal
- New Facilities:
  - Application of best available P2 and control techniques to achieve source performance of 0.2 g Hg/tonne finished metal (Zn, Ni, Pb) and <1 g Hg/tonne finished metal (Cu)

Strategic Options Process

- Industry and government recommended development by CCME of “Environmental Source Performance Guidelines” that reflect application of best available techniques.
- Endorsed the Canada Wide Standards (CWS) for Mercury.

BEMAG

- Gazette Notice (April 29, 2006) requiring the preparation and implementation of P2 Plans in respect of certain toxic substances released from base metal smelters.
- Incorporates CWS into development of P2 Plan.
- Establishes SO_2 and Total Particulate Matter Release Targets for each Base Metal Smelter for the years 2008 and 2015.
- Establishes Annual Air Release (Hg) Target for one smelter for 2008.

Release Reductions

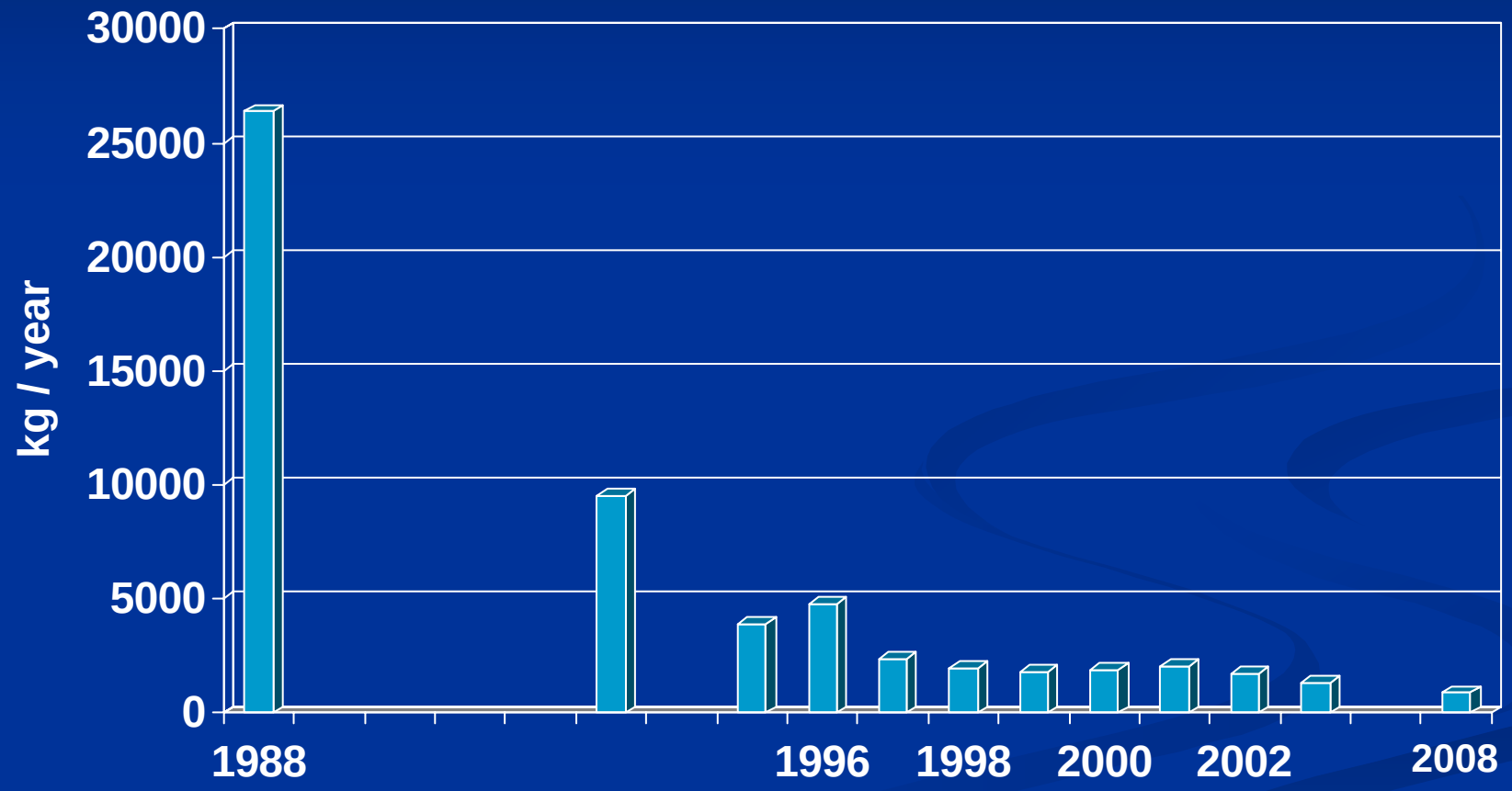
Major release reductions occurred as a result of the implementation of new process technologies. When this type of initiative is undertaken, it results in a step change to releases.

Smaller changes in releases can occur through the changes in feed and through efficiency gains.

The key factors, which account for the reductions in emissions from this sector, are changes to process technologies and changes to pollution control equipment.

Technologies used to control particulate matter or Sulphur dioxide emissions have the added benefit of controlling the toxics contained in the particulate matter and the off-gas stream.

Mercury Release
Base Metal Smelting



Examples of Pollution Prevention Initiatives

Date	Facility	Pollution Prevention Initiative
1993	Hudson Bay Mining and Smelting	Hudson Bay Mining and Smelting implemented a two-stage zinc pressure leach facility. Replacement of the former roast-leach-electrowinning facility resulted in a decrease in emissions from 1993 to 1994
1997	Teck Cominco	Cominco started-up its Kivcet lead smelter replacing the traditional sintering, blast furnace technology. The Kivcet process is characterized by continuous operation and lower gas volumes. This change reduced the levels of arsenic, cadmium, lead, and mercury emitted to the environment.
1997	Noranda Horne	In 1997, Noranda Horne began commissioning the Noranda Converter to process reactor matte. This process, developed by Noranda was designed to reduce SO_2 and PM emissions from the Peirce Smith converters and direct more off-gases to the sulphuric acid plant.

Examples of Pollution Control Initiatives

Date	Facility	Pollution Control Initiative
1993-1994	Noranda Horne	Peirce-Smith converter modifications were implemented in 1993. Noranda constructed major indoor copper concentrate storage areas and commissioned mercury removal towers in the gas cleaning section of the acid plant in 1994.
1999	Teck Cominco	Installed a new state-of-the-art baghouse for the capture of fume from the fuming furnace associated with the Kivcet Smelter.
2001	Teck Cominco	Major upgrade to one of the key baghouses associated with the lead smelter.
2001	Hudson Bay Mining & Smelting	Materials handling, commissioned improvement systems for gas which resulted in a 30% decrease in total particulate matter releases and the associated *CEPA*-toxics.
2001	Noranda Horne	At Noranda Horne, the secondary gases from the Noranda reactor and the Noranda continuous converter are now collected and treated through a baghouse with lime injection and directed through the converter stack. Emissions were reduced and local air quality was improved. Results indicate that mercury emissions from the reactor taphole were reduced as a result.

Several other examples of Pollution Control activities at all smelters to achieve Incremental reductions in Mercury emissions.

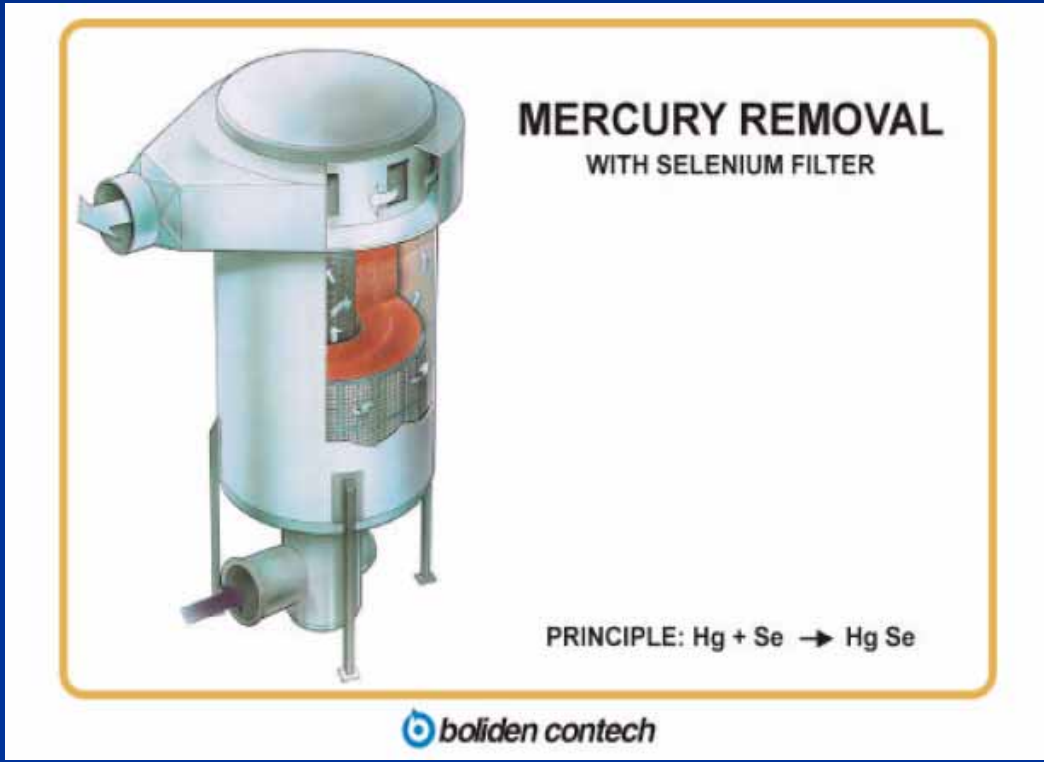
Feed Selection

- Purchase of Secondary Feeds for smelters has the potential to increase Mercury input.
- Selection of Secondary Feeds under rigid scrutiny for minor elements such as Mercury.
- Feeds are rejected due to minor element content

Recycling

- Electronics recycling becoming increasingly important in smelting business.
- Mercury bearing components are removed prior to shredding.

Typical Mercury-Specific Control Technologies



- Proprietary technology removes elemental Hg from the gas stream. A stable intermetallic reports to the weak acid bleed.
- A Boliden-Norzink mercury tower reduces the Hg concentration in sulphuric acid:

$$HgCl_2 + Hg^0 \rightarrow Hg_2Cl_2$$

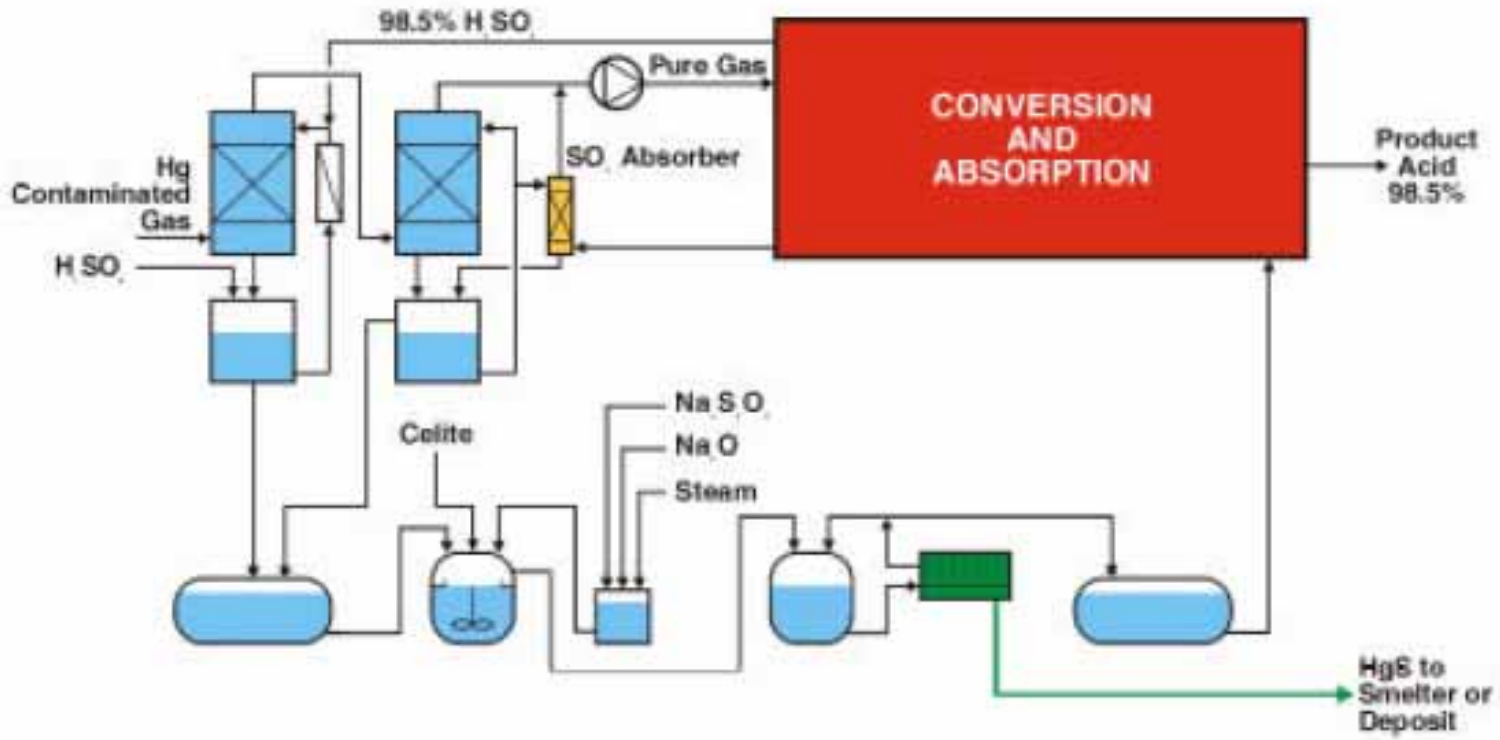
- Selenium injection.
- Secondary gases are processed in a baghouse. Lime injection reduces emissions.

Mercury Towers are effective only with higher concentrations in gas stream

Mercury Removal BAT

- Selenium Scrubbing efficiency can be as high as 90-95%
- Low incoming Hg decreases efficiency significantly.

Mercury Removal from Sulphure Acid
BOLIDEN Thiosulphate Process



boliden contech

Summary

- Base metal smelting sector has decreased Hg emissions by 95% since 1988.
- Significant reductions have occurred at 3 smelting facilities with largest historical emissions.
- 1 facility has Target reduction for 2008.
- Base metal smelting sector will potentially continue to be significant in the pack of industries due to natural properties of certain ores.