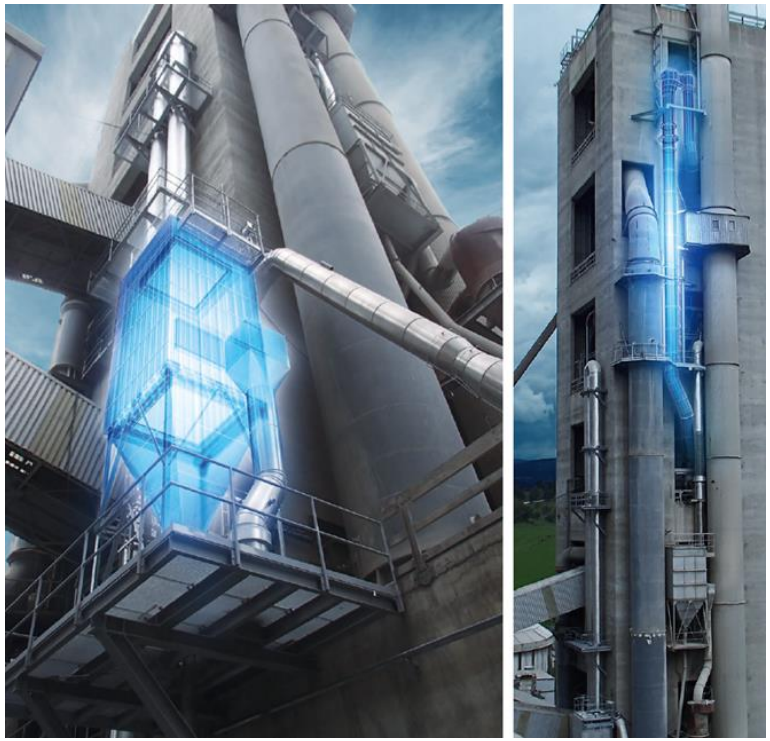
Measures to Reduce Mercury Emissions in Modern Cement Plants



ExMercury / Scheuch

Waltisberg Consulting

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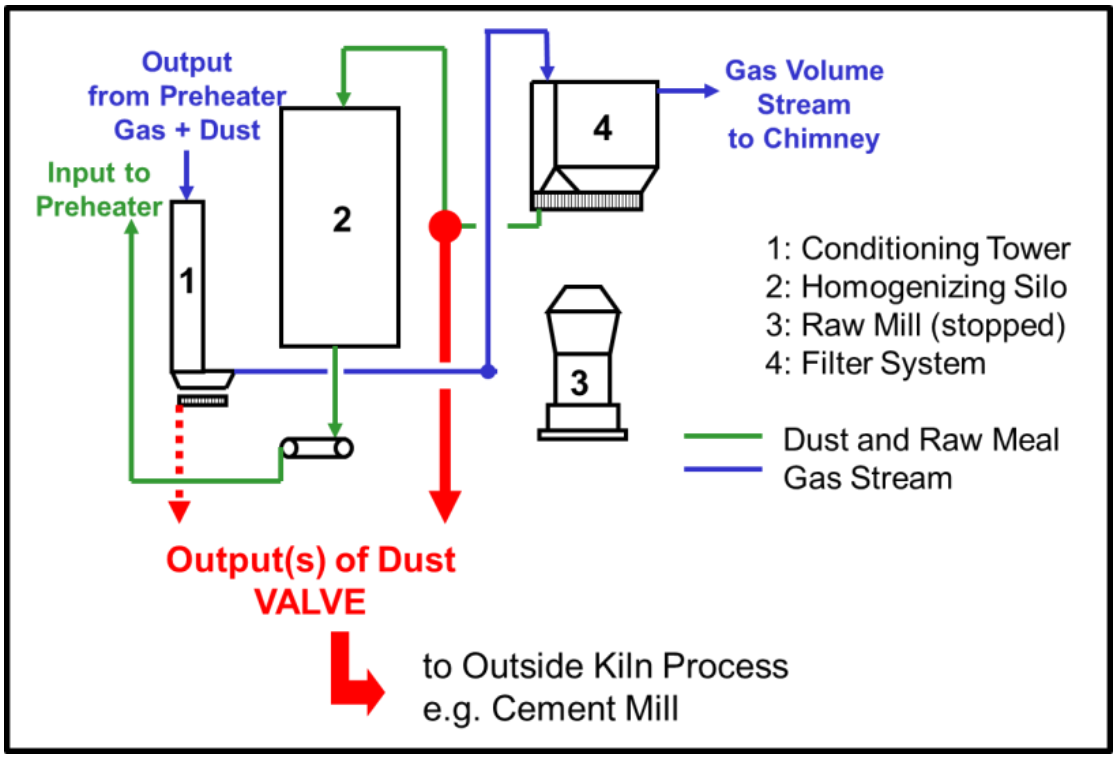
Mercury Reduction Systems using the Cement Kiln Dust

**(Dust in Direct Operation Mode;
Stopped Raw Mill)**

Extraction of Mercury from the System

- The element enriches in the outer cycle between the preheater and the filter system. Especially during direct operation the highly volatile and carcinogenic element mercury is enriched and leads to high emissions. Both the strong enrichment and high emissions must be prevented in any case, what can be done via a so-called **«Dust Valve».**



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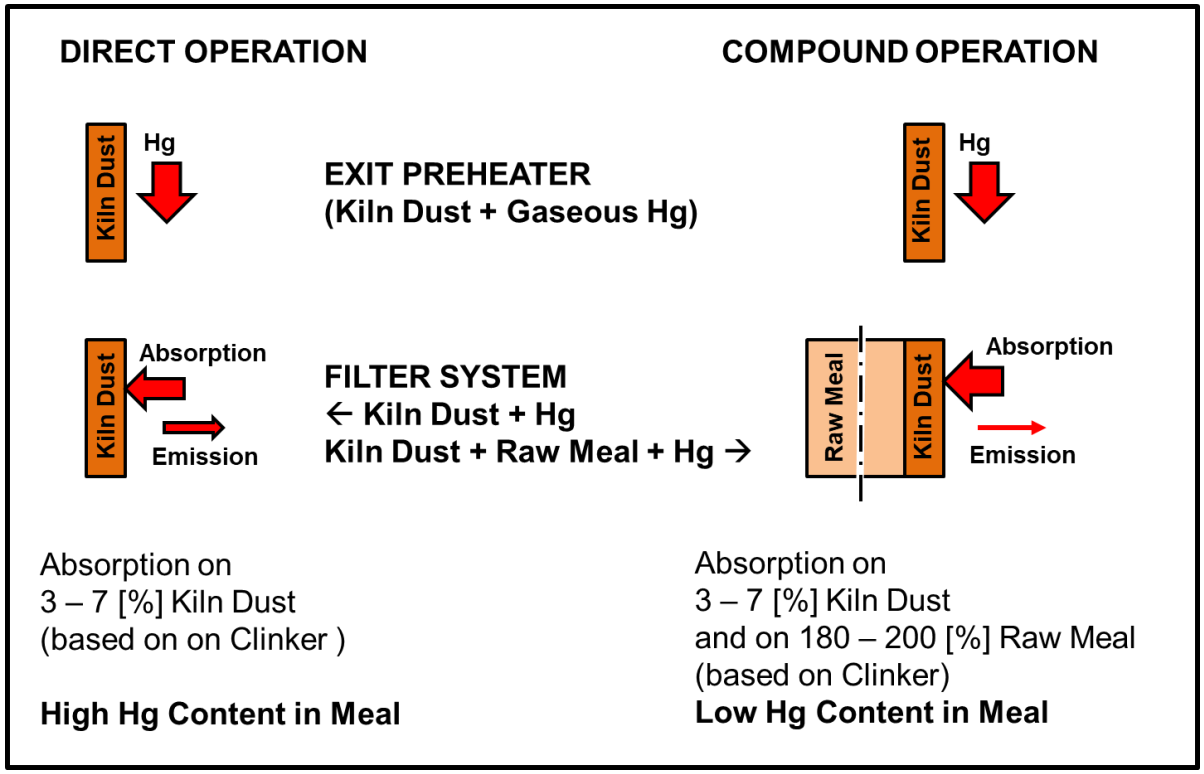
High Mercury Content in the Kiln Dust

- **Direct Operation:** The gaseous mercury from the preheater is partially absorbed in the kiln dust
  → High mercury content in the filter dust
- **Compound Operation:** The gaseous mercury from the preheater is additionally mixed with the raw meal in the mill
  → Low mercury content in the filter dust



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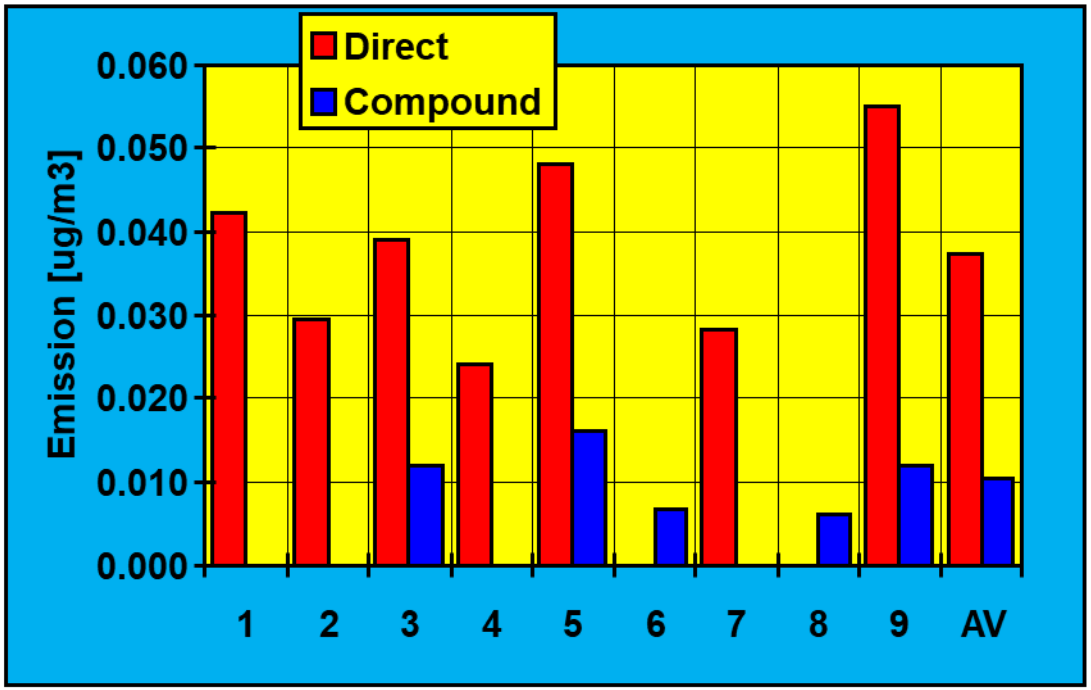
Example of an Emission Measurement

Large difference between emissions in combined and direct operation

Averages (AV):

- Compound operation
  temperature ~ 110 [°C] ; emission 0.011 [mg/m^3]
- Direct operation
  temperature ~ 160 [°C] ; emission 0.037 [mg/m^3]



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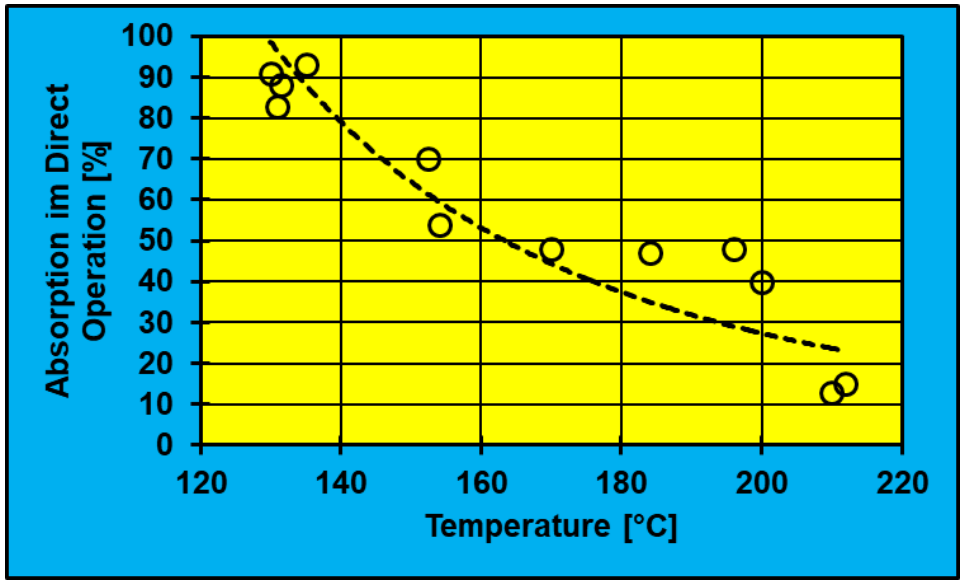
Increase of the Hg Extraction via «Dust Valve»

- The total mercury reduction depends on the content of cement dust (dust in direct operation).
- The content can be increased by lowering the gas temperature and thereby increasing the absorption of dust.

M. Oerter: Influence of Raw Materials on the Emission of Mercury
Presented at the seminar of the European Cement Research Academy (ecra) on 26 April 2006

Problem: Conditioning Tower; length for evaporation (height of tower)of more water is often too short , risk to get slurry



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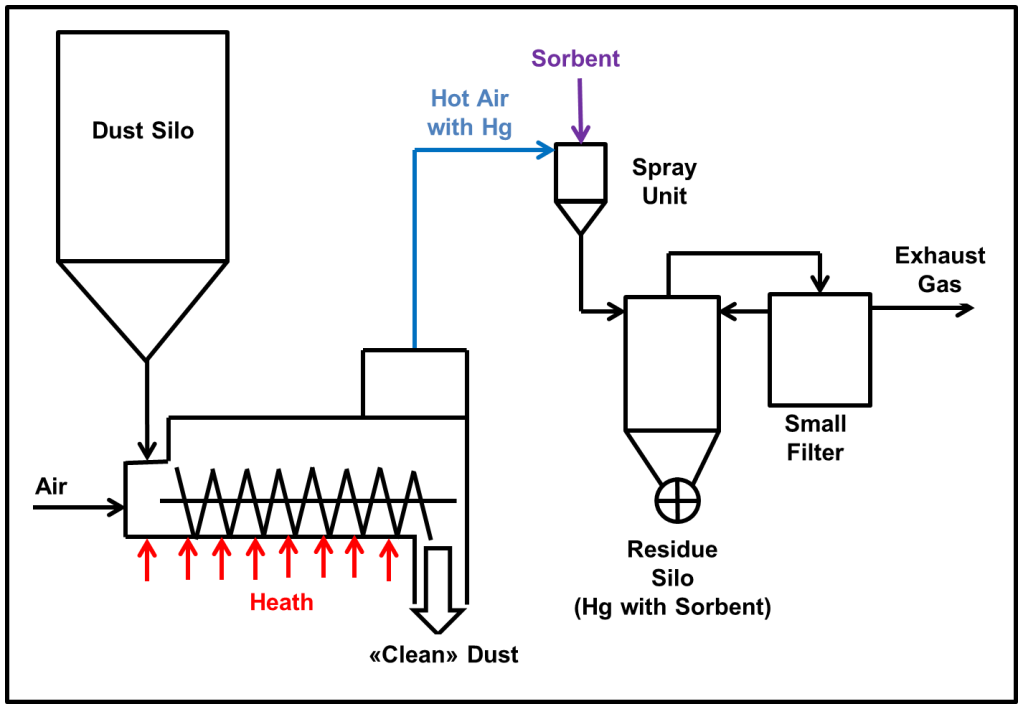
Treatment of Enriched Dust

1. Heating up to ~ 400 [°C]→ Mercury becomes gaseous
2. Separation of the «Clean Dust»
3. Mixing with sorbent (e.g. PAC = Pulverized Activated Coal)
4. Separation of solids in a filter system
5. Residues = Sorbent with mercury



Literature:
CH.Poling, Th. Lesniak, M. Harrison
An Innovative Approch for Mercury Capture
2013 World of Coal Ash (WOCA) Conference; April 22-25; Lexington/Kentucky/USA

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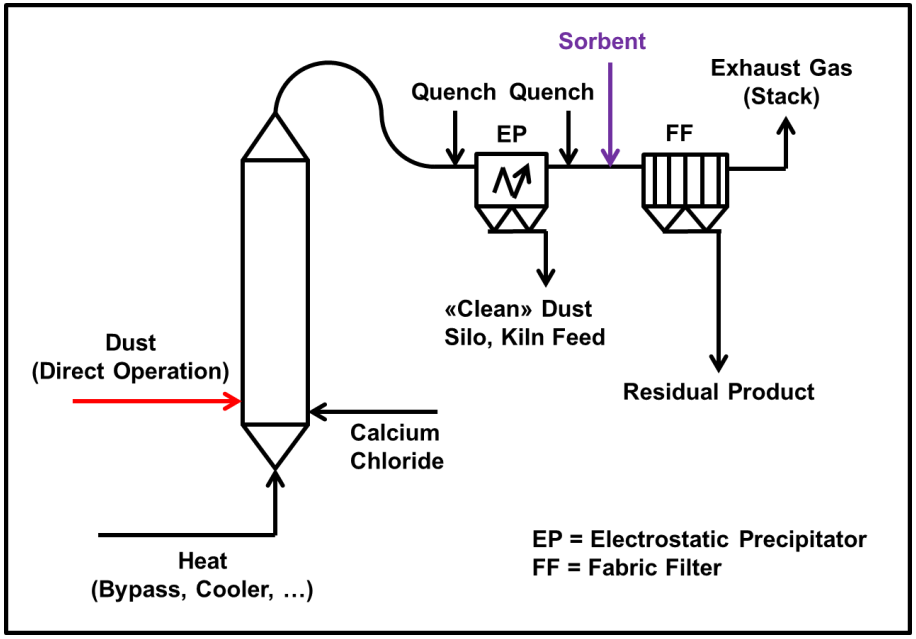
Hg Roaster from FLSchmidt

- The filter dust is mixed with calcium chloride in a reactor and heated with heat from the cement kiln system (e.g., cooler exhaust air).
- The mercury is expelled from the dust and reacts with the calcium chloride.
- In the EP the «clean» dust is separated from the mercury-laden gas and returned to the raw meal silo or directly to the kiln feed.
- The mercury is mixed with a sorbent and then separated from the gas in a fabric filter
- More than 95 [%] of the mercury has been removed from the filter dust and has been shown to reduce mercury emissions by up to 75 [%]



Literature:
P. Paone, FLSmidt Inc.
Mercury Emissions Controls for Cement Production
MARAMA/ICAC Control Technology Workshop
May 18-19, 2011, BaltimoreUSA

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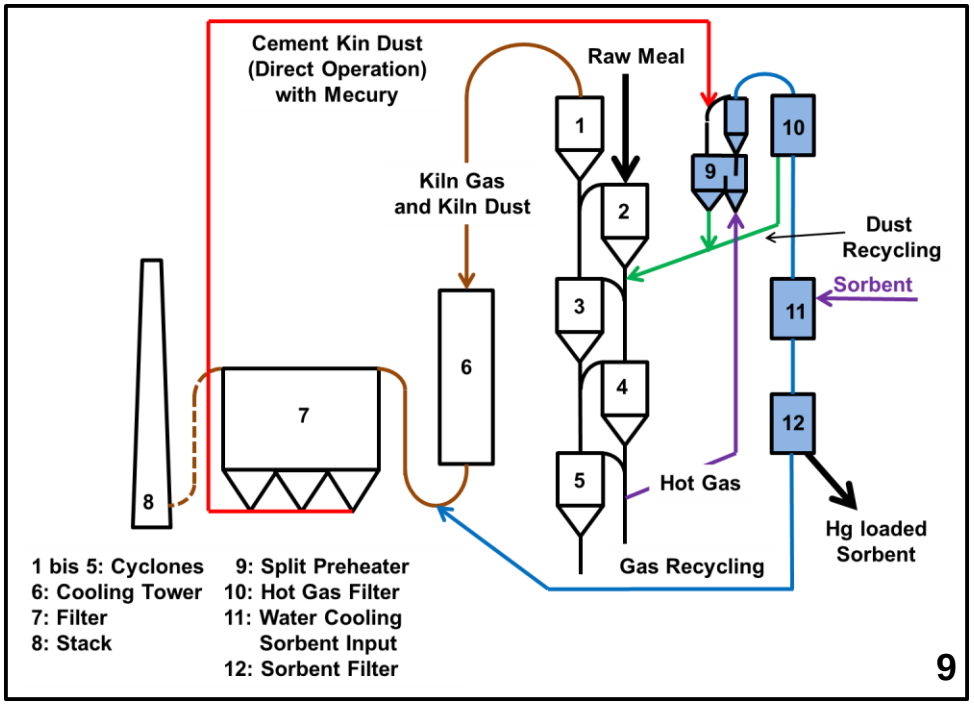
ExMercury System (Scheuch)

The kiln dust is removed from the system in direct operation («Dust Valve») discarded and in the «Ex-Mercury system» the mercury is separated from the dust, with the «clean» dust returned to the kiln system.

1. Two-stage split preheater (item 9): Heating of kiln dust to maximum 400 [°C] → Mercury becomes gaseous.
2. Hot Gas Filter (item 10): Separation gas/dust Dust returned to preheater
3. Highly concentrated gas is cooled down to about 100 to 120 [° C] and a sorbent is injected (item 11)
4. Sorbet Filter (item 12): Separation sorbent/gas; gas recycled to kiln system



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ExMercury System (Scheuch)

Mercury reduction depends on:

- the temperature levels in direct and compound operation mode
- the time ratio between direct and compound operation
- the mercury components that occur (metallic mercury, ionic mercury, etc.).

Under the conditions at the Wietersdorf plant (Austria), a total reduction of 80 [%] can be achieved.

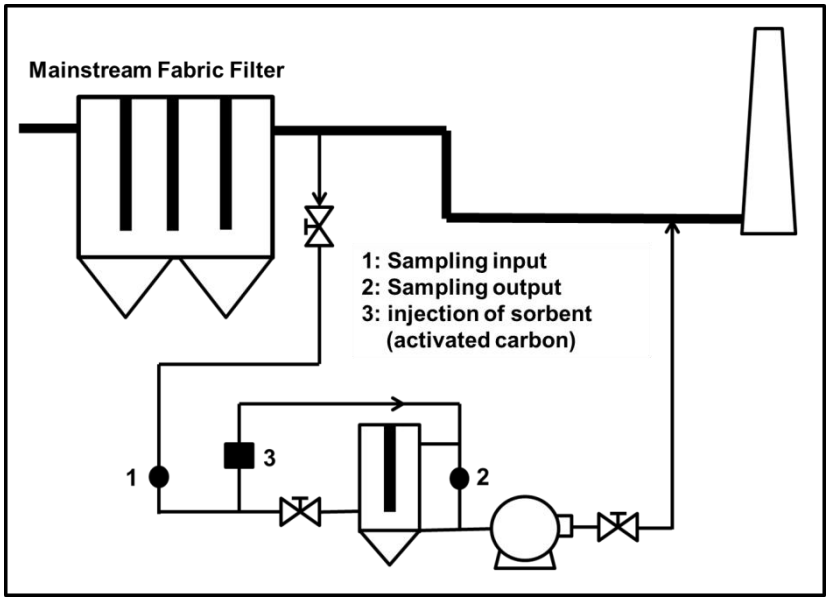
Literature:

- ExMercury; Splitted Preheater System; Austrian Cooperation with Help to Reduce Mercury Emissions
  www.atec-ltd.com
- ExMercury; F. Willitsch, H. Reinhold; Splitted Preheater System; A new solution for Emission Reduction in the Cement Industry
  www.atec-greco.com, www.scheuch.com, www.wup.at
- St. Kern, F. Salzer, H. Reinhold; Breaking the mercury cycle for emission abatement with the “ExMercury – Splitted Preheater System”
  Zement-Kalk-Gips 9/2015

Mercury Reduction Systems at «Tail-End» of the Cement Process

Reduction in the Clean Gas

- The Ash Grove Cement plant in Oregon (USA) emits because of unfavorable raw materials (Limestone between 0.6 and 1.6 [ppm]) between approximately 0.4 and 1.2 [mg/m^3]
- Pilot plant: About 1 [%] of the exhaust gas flow extracted and the mercury activated carbon reduced. Reductions:
  - About 90 [%] during compound operation
  - About 60 [%] in direct operation mode
  - Approximately 77 [%] as a weighted average



Energy and Environmental Research Center (EERC)
Ash Grove Mercury Reduction Advisory Committee's Report, December 21, 2007
State of Oregon, Department of Environmental Quality, Air Quality Division

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Reduction in the Clean Gas

Assessment of the solution

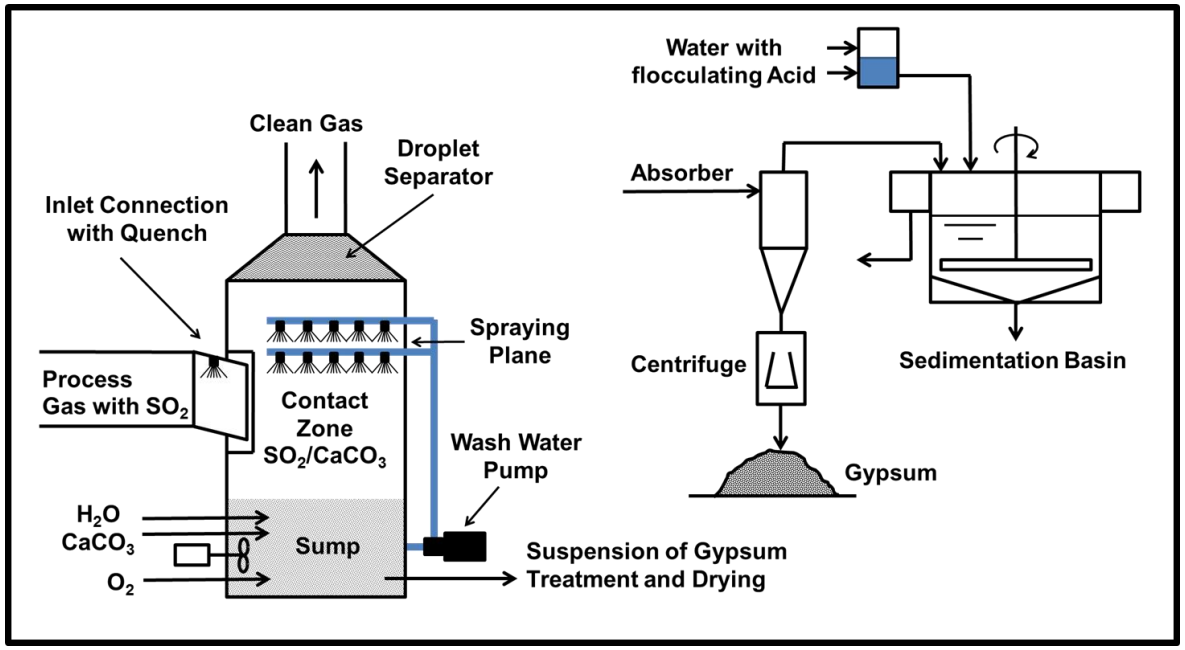
- Only with this equipment, the mercury problem of this plant can not be solved. A two-stage solution should be tried, namely a «dust valve» (direct operation) in combination with the proposed solution at the end of the process.
- In plants with «normal» mercury emissions, the proposed installation can be a solution.
  Disadvantage: The entire exhaust gas of the kiln must flow through a second fabric filter, which must be about the same size as the main filter.

Combination Desulfurization and Hg Reduction

- Cement plants generally have low emissions and therefore no desulfurization plant. In cement plants with slightly increased emissions, hydrated lime (or similar material) can be added directly to the preheater.
- Desulfurization is required only in exceptional cases. Today, wet scrubbers are used mostly.
- Reference plants (SO_2 scrubber, Hg reduction not known):
  - Holcim plant Untervaz / Switzerland
  - Holcim Plant Midlothian, Texas / USA
  - Cementa AB: Slite, Sweden
  - Lehigh Cement: Mason City, Iowa / USA

Combination Desulfurization and Hg Reduction

- Gaseous compounds of ionic mercury are water-soluble and can be absorbed in the aqueous slurry of a wet scrubber system and thus reduced.
- Gaseous elemental mercury is insoluble in water and therefore does not sorb in such slurries. In order to remove the metallic mercury, suitable sorbents must be used.
- The problem: Mercury in the product gypsum



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Thank you for your attention!

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