CSIC CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

INCAR

Influence of air combustion and oxy-fuel combustion flue gas constituents on Hg^0 re-emission in WFGD systems

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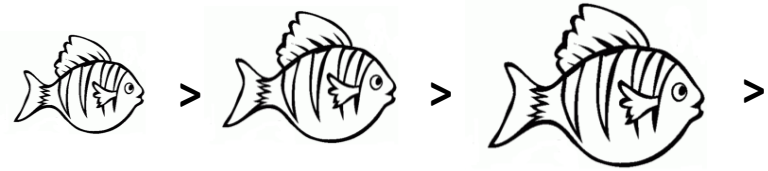
INTRODUCTION: properties and toxicity of mercury

High volatility

High environmental persistence

CH_3Hg^+



Bioacumulation

Biomagnification

Kidneys damage

Nervous system alterations

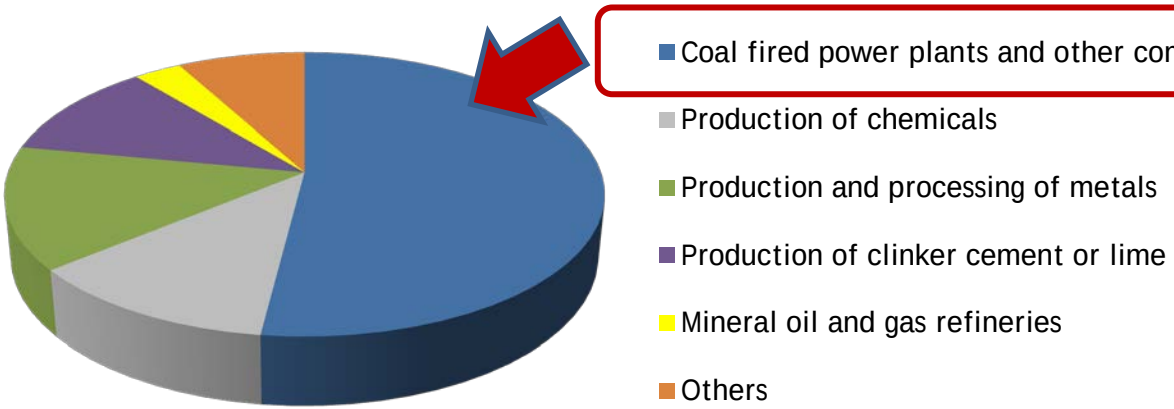
Cardiovascular diseases

Fetus alterations

INTRODUCTION: sources of mercury

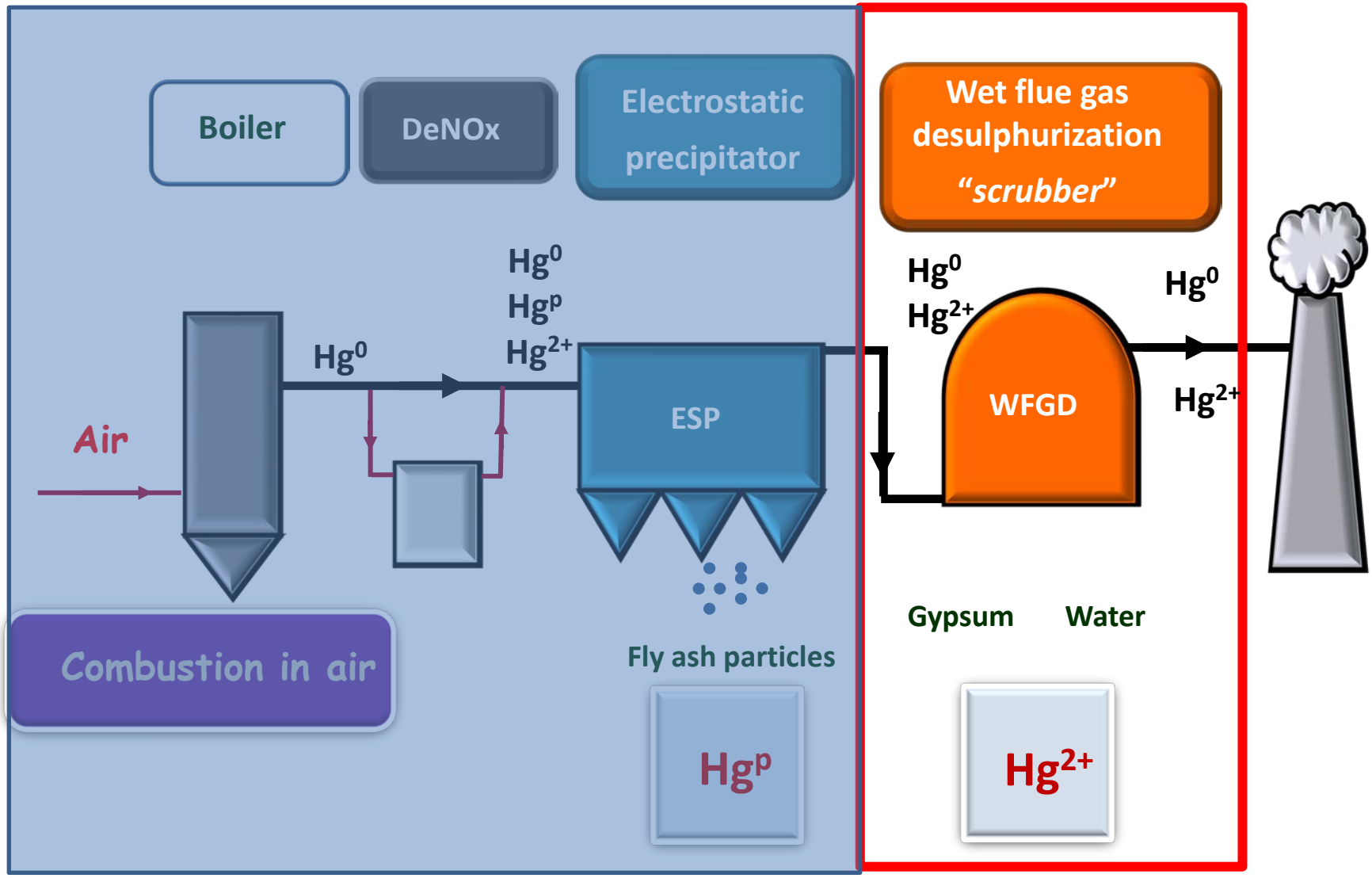
Natural sources

Anthropogenic sources

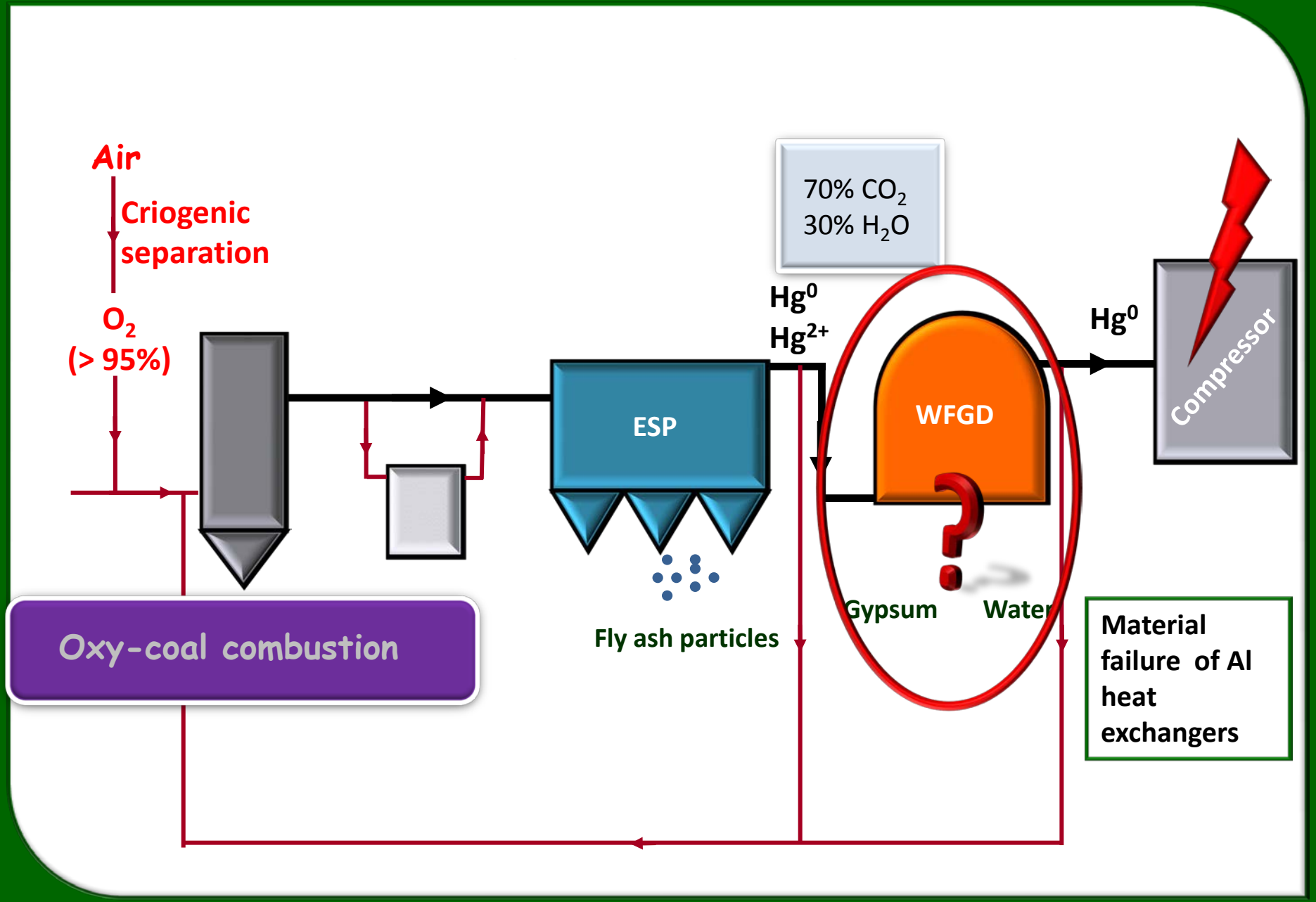


Mercury emissions to air in Europe (2009). Source: The European Pollutant Release and Transfer Register (E-PRTR).

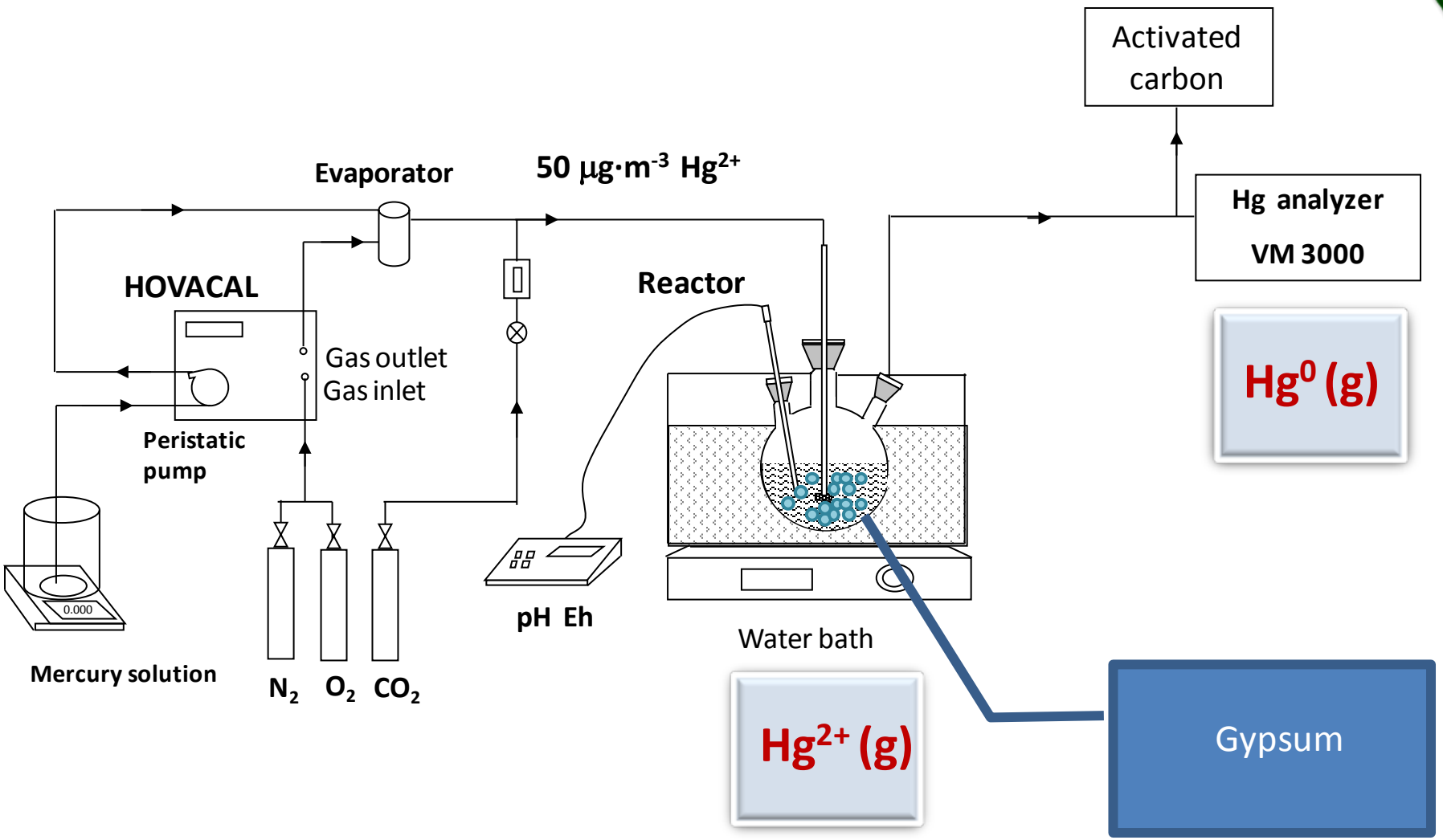
INTRODUCTION: mercury behaviour in coal combustion systems



INTRODUCTION: mercury behaviour in oxy-coal combustion systems



EXPERIMENTAL: laboratory scale sytem



Previous laboratory results

In a slurry containing: Gypsum (98%), limestone (2%) and sulphate ions,

Atmosphere: N_2, H_2O and $HgCl_2$ (Hg^{2+})

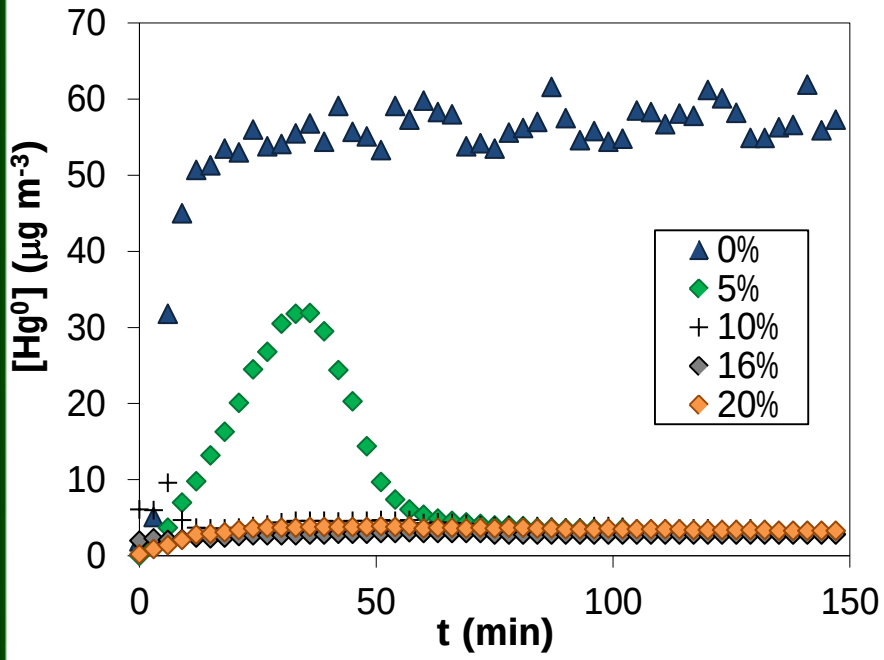
<u>Mercury reduction might be caused by:</u>

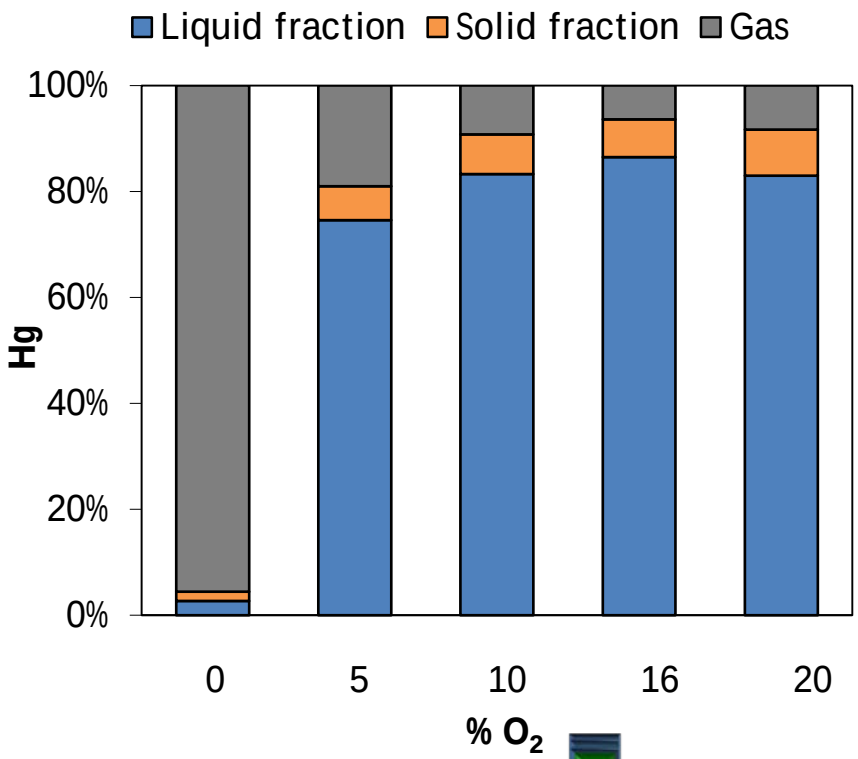
The presence of metal impurities derived from limestone (Fe, Mg…).

$$2Me^{2+}(aq) + Hg^{2+}(aq) \rightarrow Hg^{0}(g) + 2Me^{3+}(aq)$$

To ascertain whether the gas composition (oxy-combustion), can influence the mercury reduction process.

RESULTS: influence of O_2 concentration (N_2 balance)

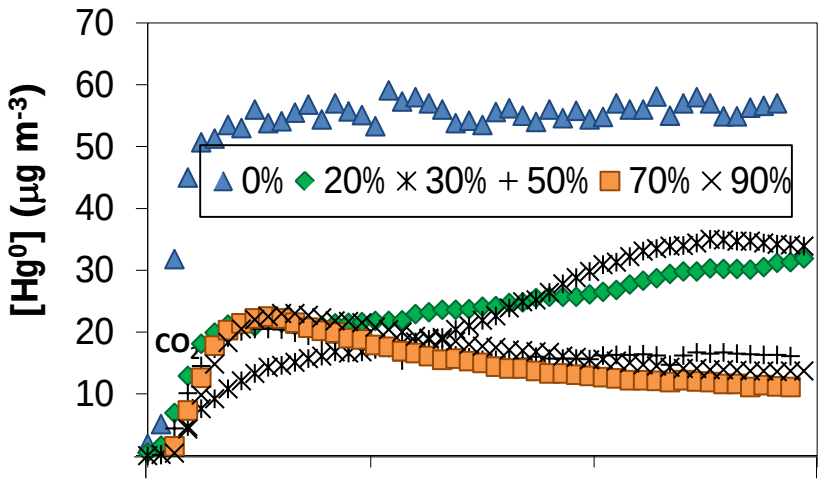


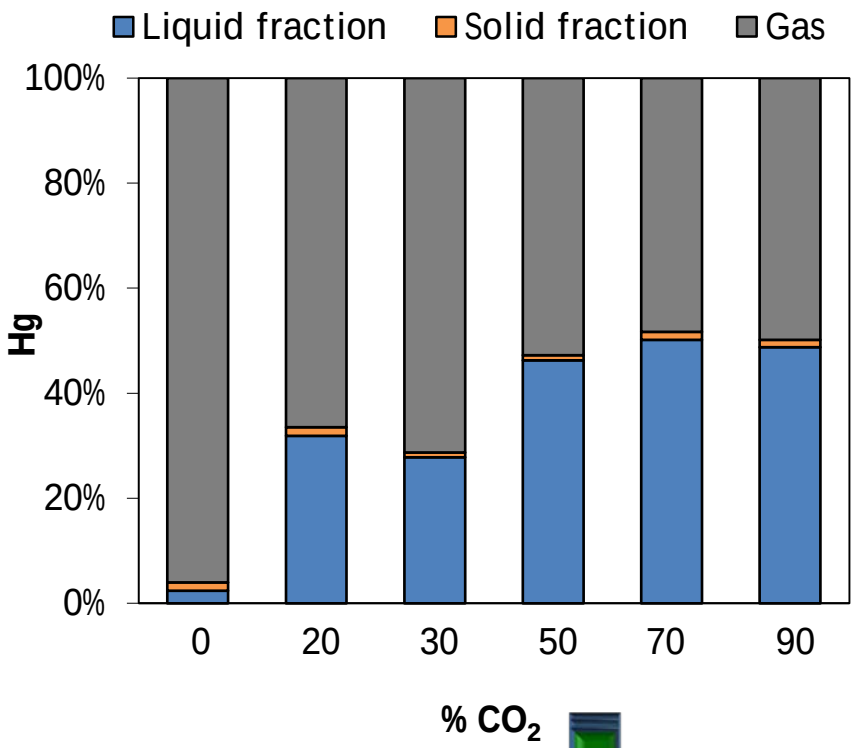


$$2Me^{2+}(aq) + Hg^{2+}(aq) \rightarrow Hg^{0}(g) + 2Me^{3+}(aq)$$

↑ Concentration of O_2 → ↓ Re-emission of Hg^0 → Hg slurry

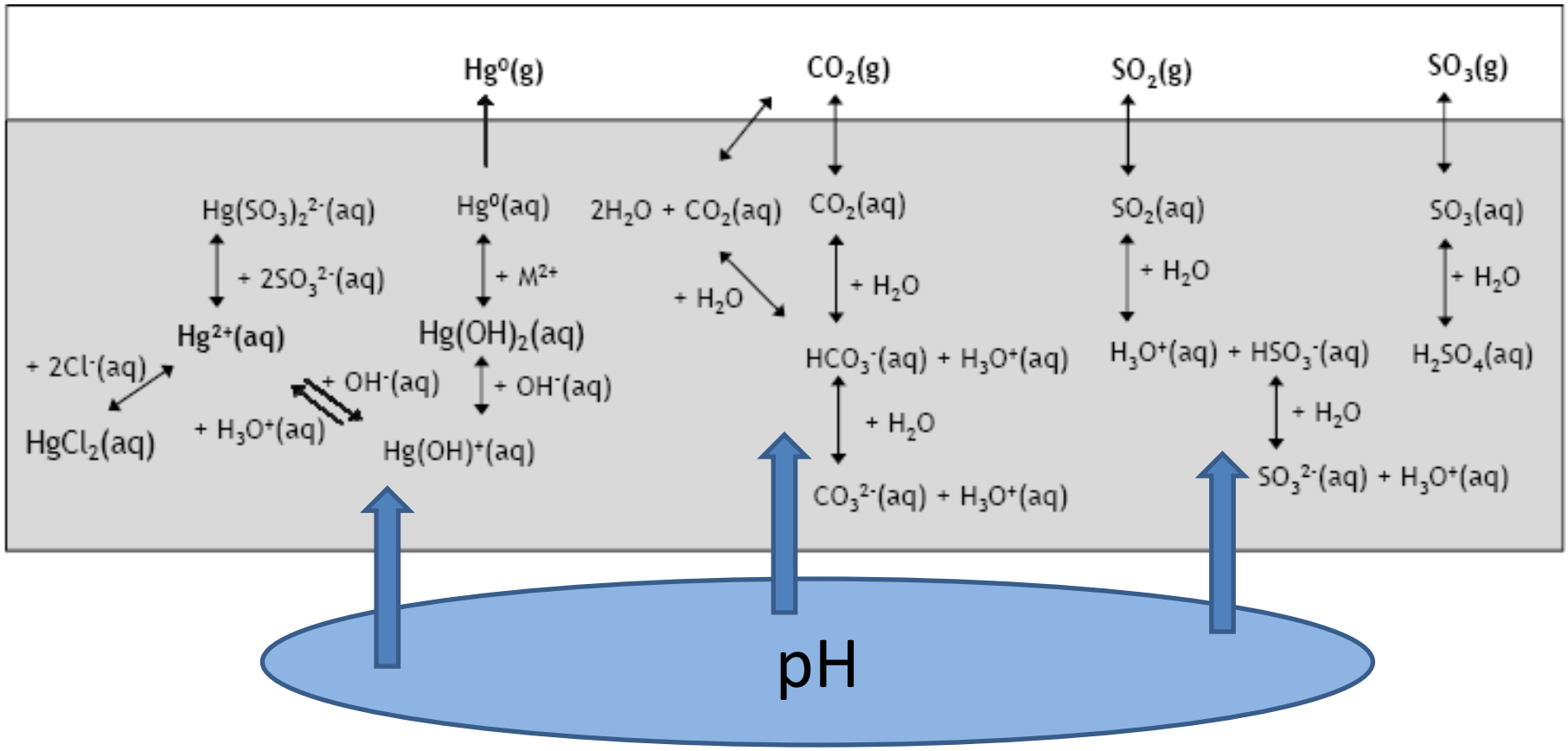
RESULTS: influence of CO_2 concentration (N_2 balance)





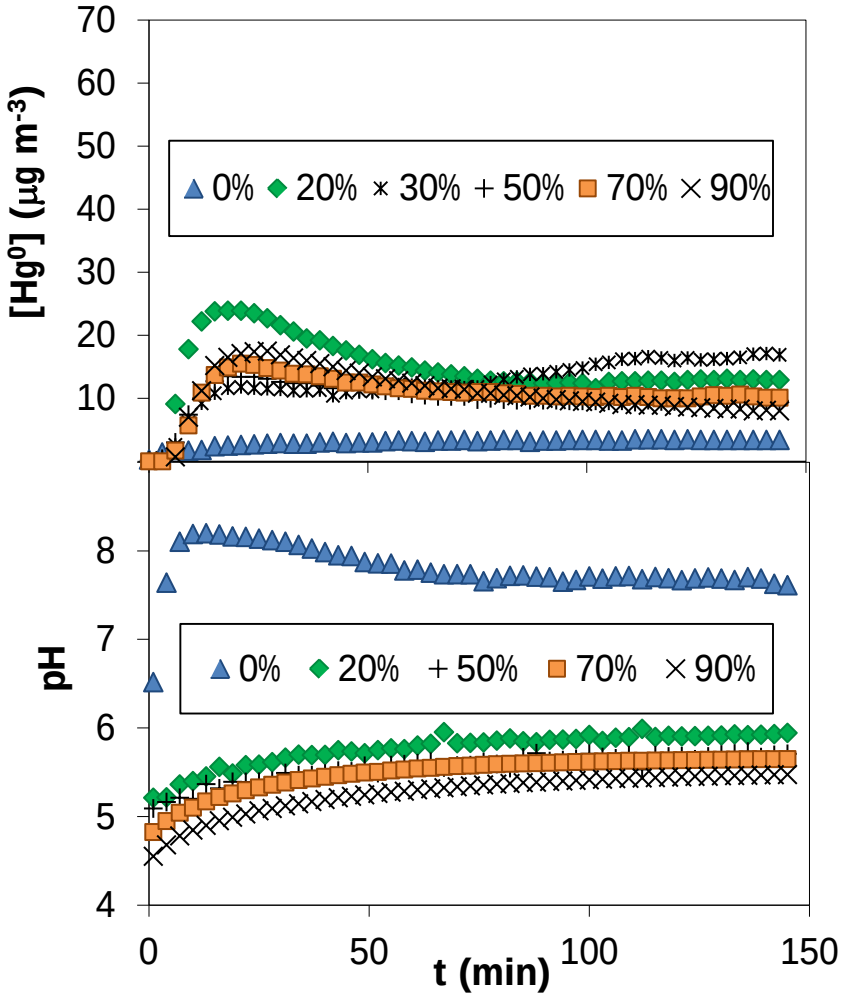
↑Concentration of CO_2 → ↓ Re-emission of Hg^0 → Hg slurry

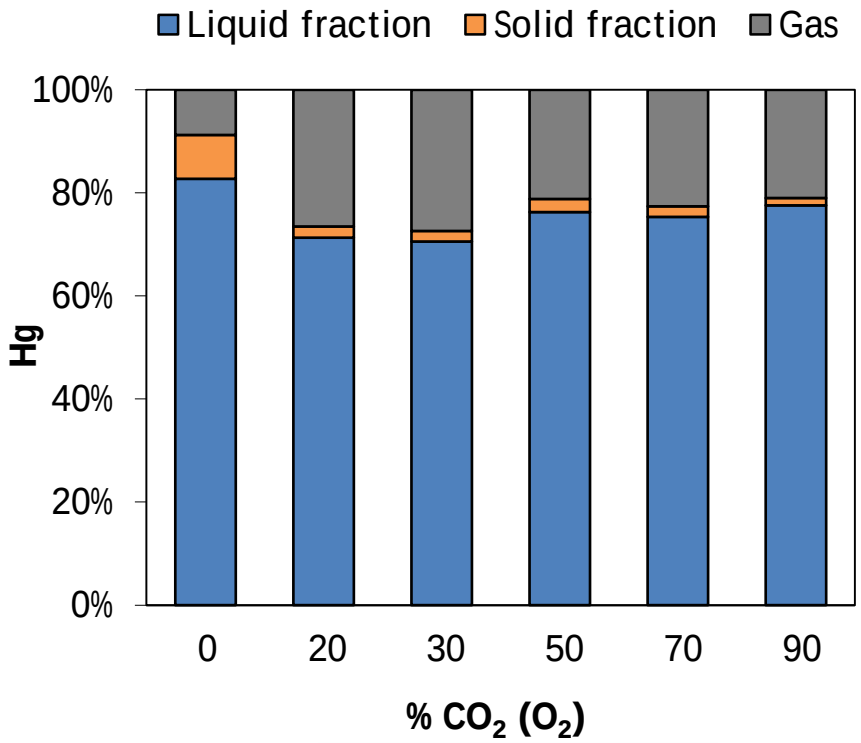
RESULTS: influence of CO_2 concentration



↑ Concentration of CO_2 → ↓ Re-emission of Hg^0 ← ↓ pH

RESULTS: influence of CO_2 concentration (O_2 balance)



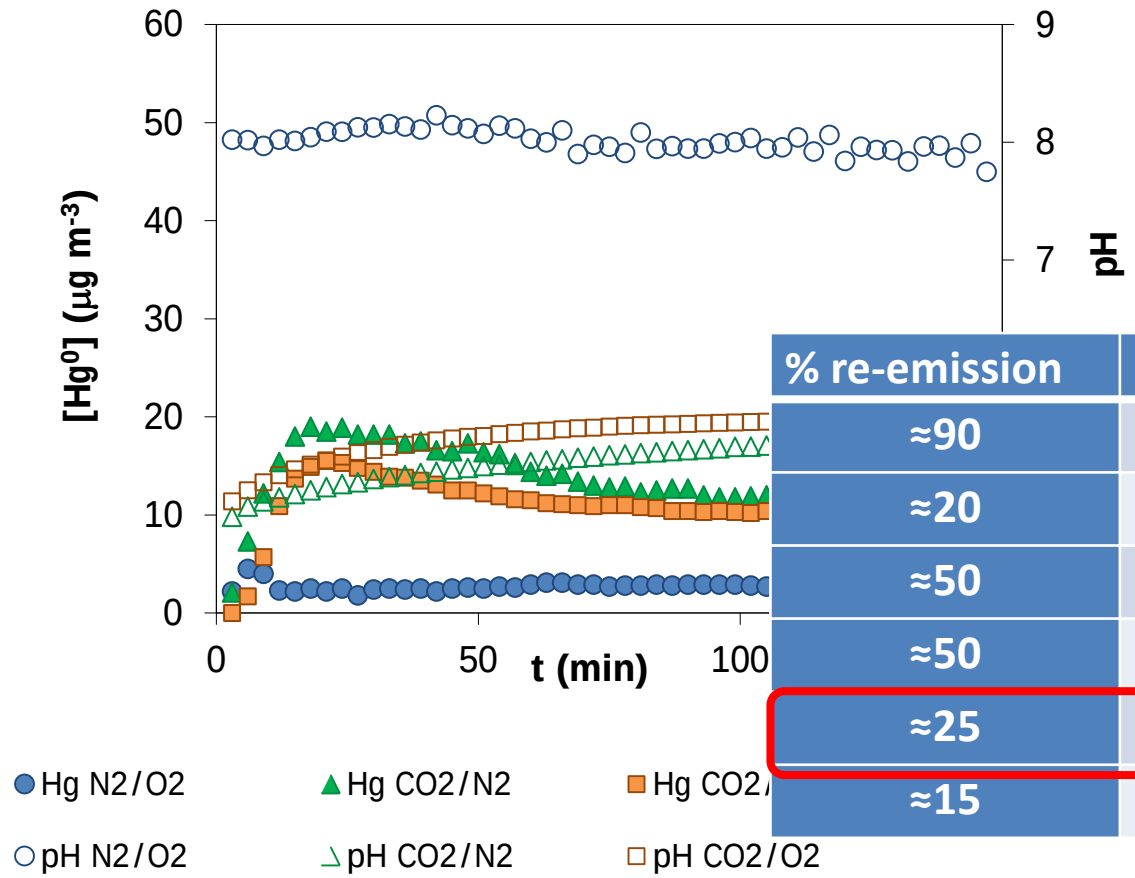


Hg slurry

Re-emission of Hg^0 is affected by the pH and the concentration of O_2

↓ pH → ↓ Re-emission of Hg^0

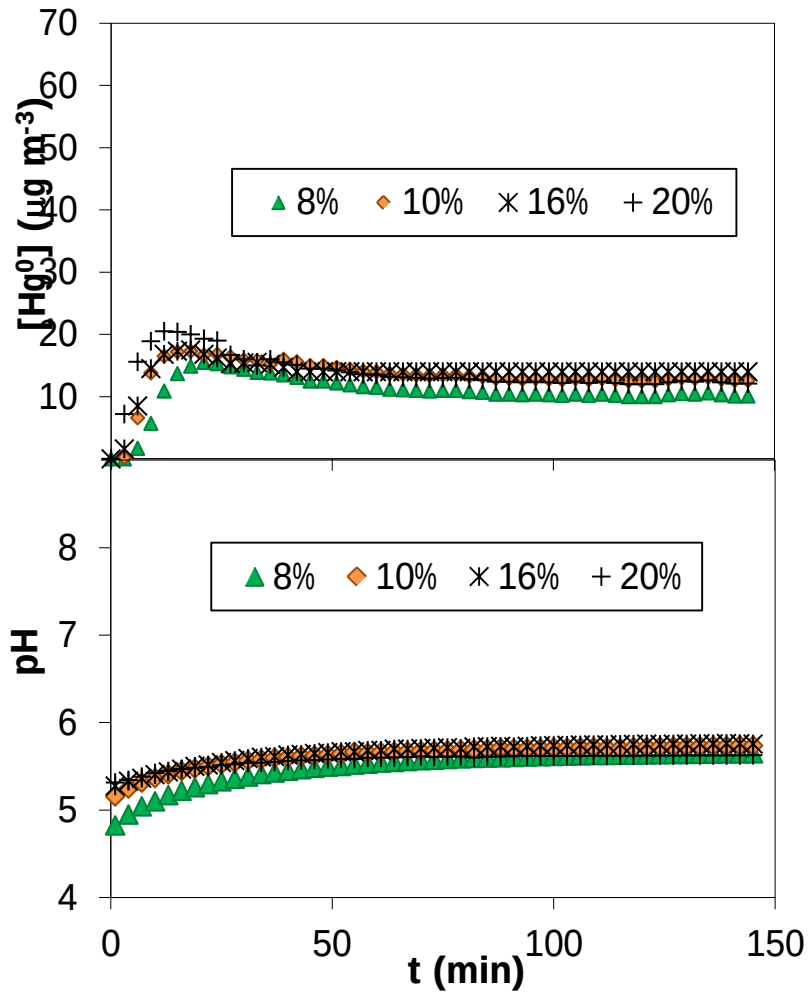
RESULTS: influence of flue gas composition

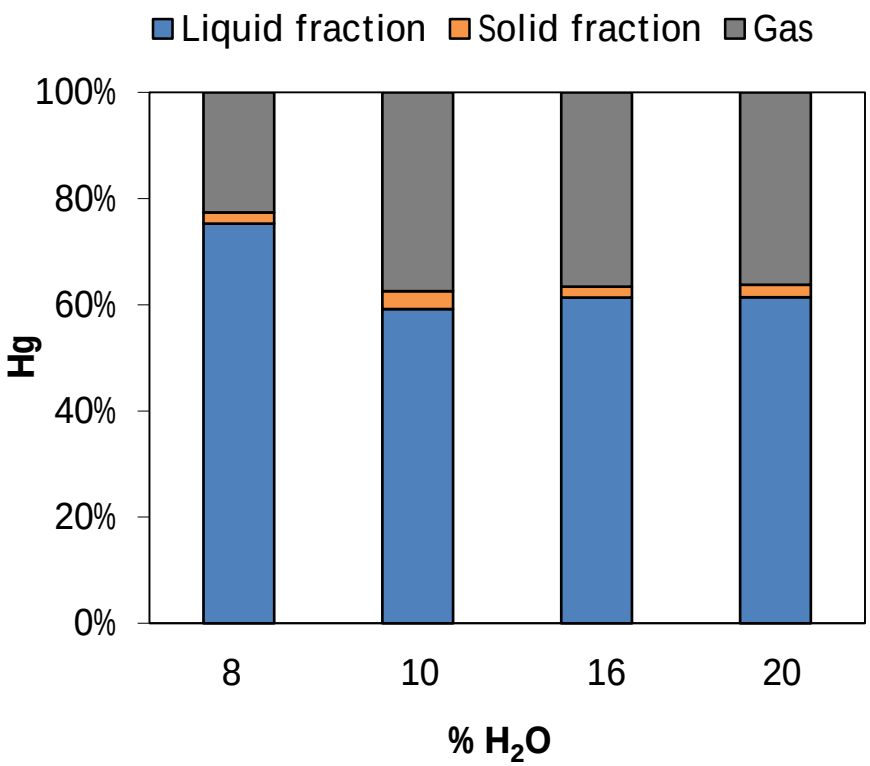


% re-emission	% CO_2	% N_2	% O_2
≈90		100	
≈20			100
≈50	90	10	
≈50	70	30	
≈25	70		30
≈15		80	20

O_2 --- pH → ↓ Re-emission of Hg^0

RESULTS: influence of H_2O concentration





Hg slurry

High water vapor concentrations in the flue gas do not produce a significant effect on the re-emission of Hg

SUMMARY

The effect of the CO_2, O_2 and water vapor on the reduction of Hg^{2+} species by metallic impurities from limestone was determined.

- ***High concentrations of O_2 in the flue gas prevent the re-emission of Hg^0 due to its destabilizing effect on the metals present in low oxidation states.***

- ***High concentrations of CO_2, which cause a decrease in the pH of slurries reduce the amount of Hg^0 is re-emitted***.

→ The high concentrations of CO_2 in oxy-fuel combustion may help to decrease the amount of Hg^0 re-emitted.

→ The amount of metals present in limestone and the pH of slurries need to be strictly controlled to reduce Hg^0 re-emissions at power plants operating under oxy-fuel combustion conditions.

Thank you!

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