Imperial College London

BCURA B73 Research Contract

"The Selection of Low Cost Sorbents & Process Conditions for Mercury Capture from Flue Gases"

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Previous Work on Trace Element Emissions

Partitioning of trace elements in co-combustion of coals with wide range of waste and biomass fuels

Agricultural (e.g. chicken litter) and Forestry (e.g. wood bark) residues

Industrial waste (e.g. plastic waste, pulp sludge)

Municipal Waste (e.g. sewage sludge)

Suspension Firing Reactor

Percentage Retention of Trace Elements in Ash

Relative Enrichment of Trace Elements on Fine Ash

Hg, As, Be, Cd, Co, Cu, Cr, Mn, Mo, Pb, Se, Ti, Tl, Zn,

Trace Element Sorbent Studies

Hot Gas Clean-Up for IGCC

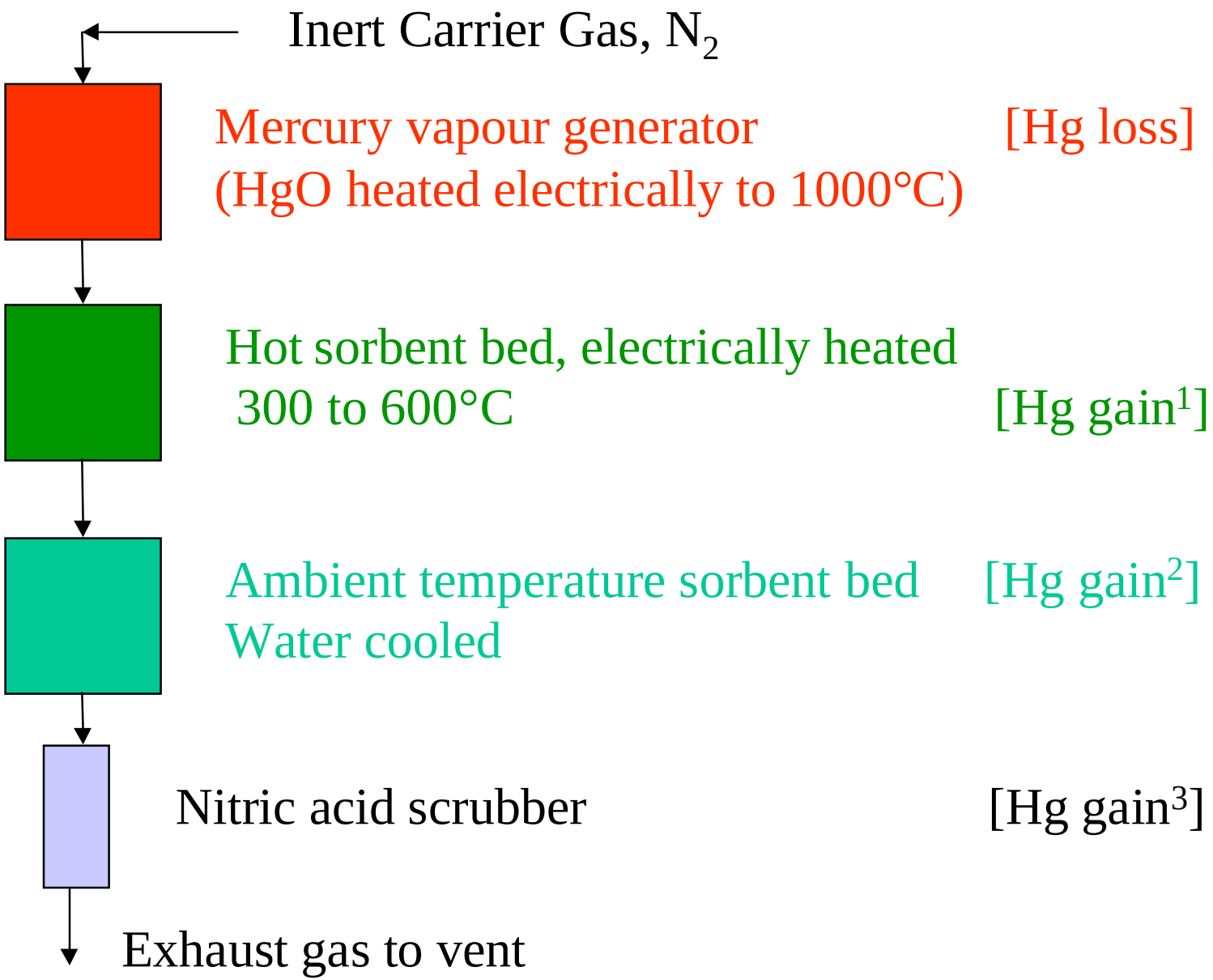
Bench Scale Quartz Reactor for Sorbent Tests

Temperatures from ambient to 600°C

Active Carbon, Meta-Kaolin, Coal Fly Ash

Leaching tests on contaminated sorbents – considering stability of sorbed metal ions in spent sorbents in presence of ground waters in landfills

Trace Element Sorption Reactor



Mercury Behaviour

Hg retention on Kaolin
32% at 300°C and 450°C, falling to 29% at 600 °C

Hg retention on Activated Carbon [coconut shell]
60% at 300°C, falling to 45% at 450°C and
28% at 600 °C

Earlier work suggests that:
Up to 100% Hg(II) and 60% Hg^o captured at 100°C by active C

Leachability of trace element varies with bed capture temperature [but Hg not tested]

Mercury Leaching from Spent Sorbent

- **Miniature version of US-EPA compliance testing standard – batch**

- **100 mg dust subjected to 16 hour exposure to de-mineralised water with pH modified by acetic acid (initial value 5). Rotated 40 rpm. 20:1 leachate sample ratio**

- **Leaching as function of water pH**

BCURA PROJECT OBJECTIVES

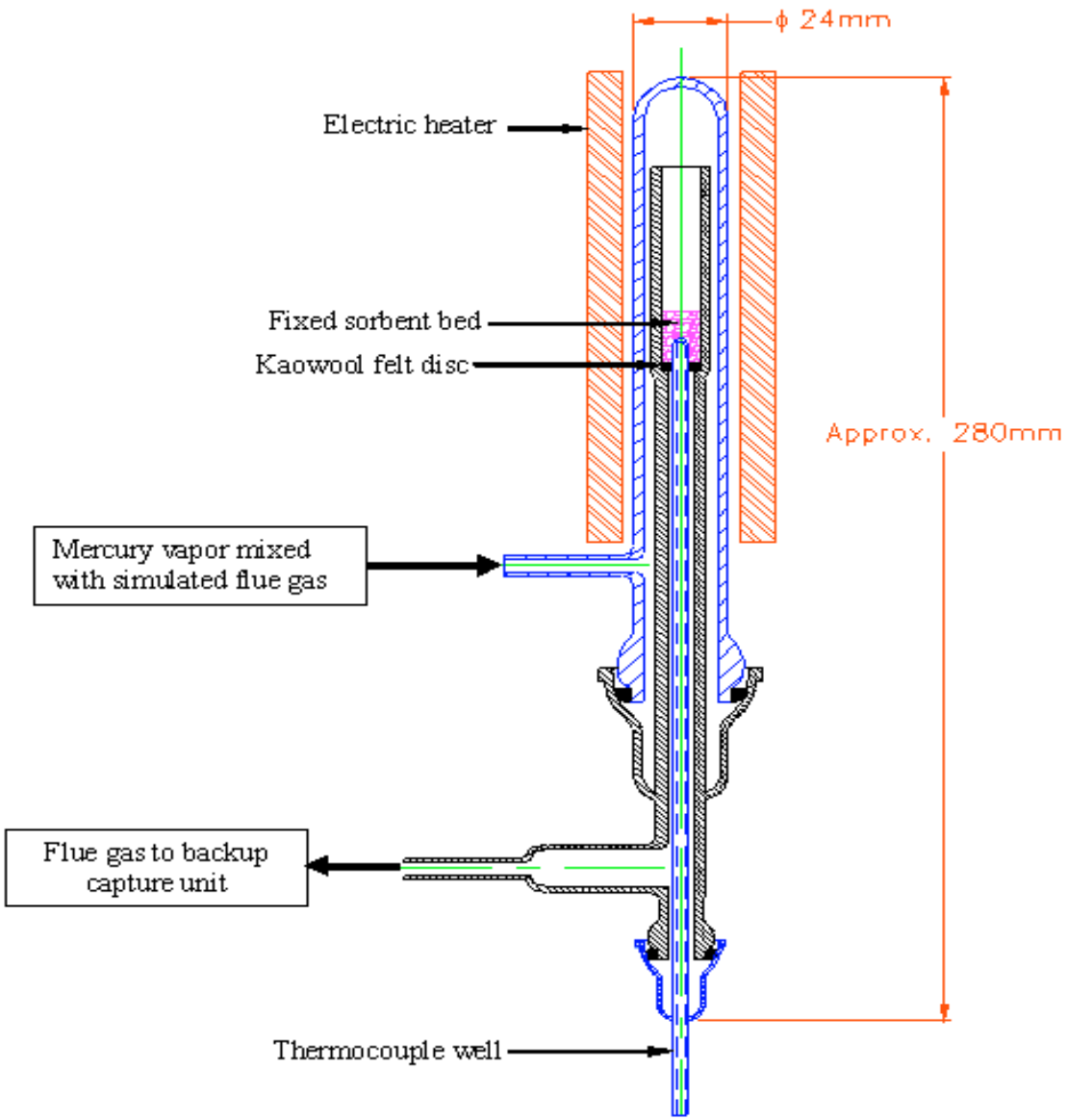
- **Identification and testing of low cost Hg sorbents suitable for removal of Hg from the flue gases of large pf fired boilers:**
- **Dusts generated within process itself, i.e. pfa or sulphur capture sorbents**
- **Sorbents injected separately for Hg sorption in flue gas duct**

Flue gas dusts; Recovered ash [C-in-ash];Limestone and alkaline sorbents; Low cost carbons e.g. carbon black from scrap tyres, or from cheap wastes such as sewerage sludge

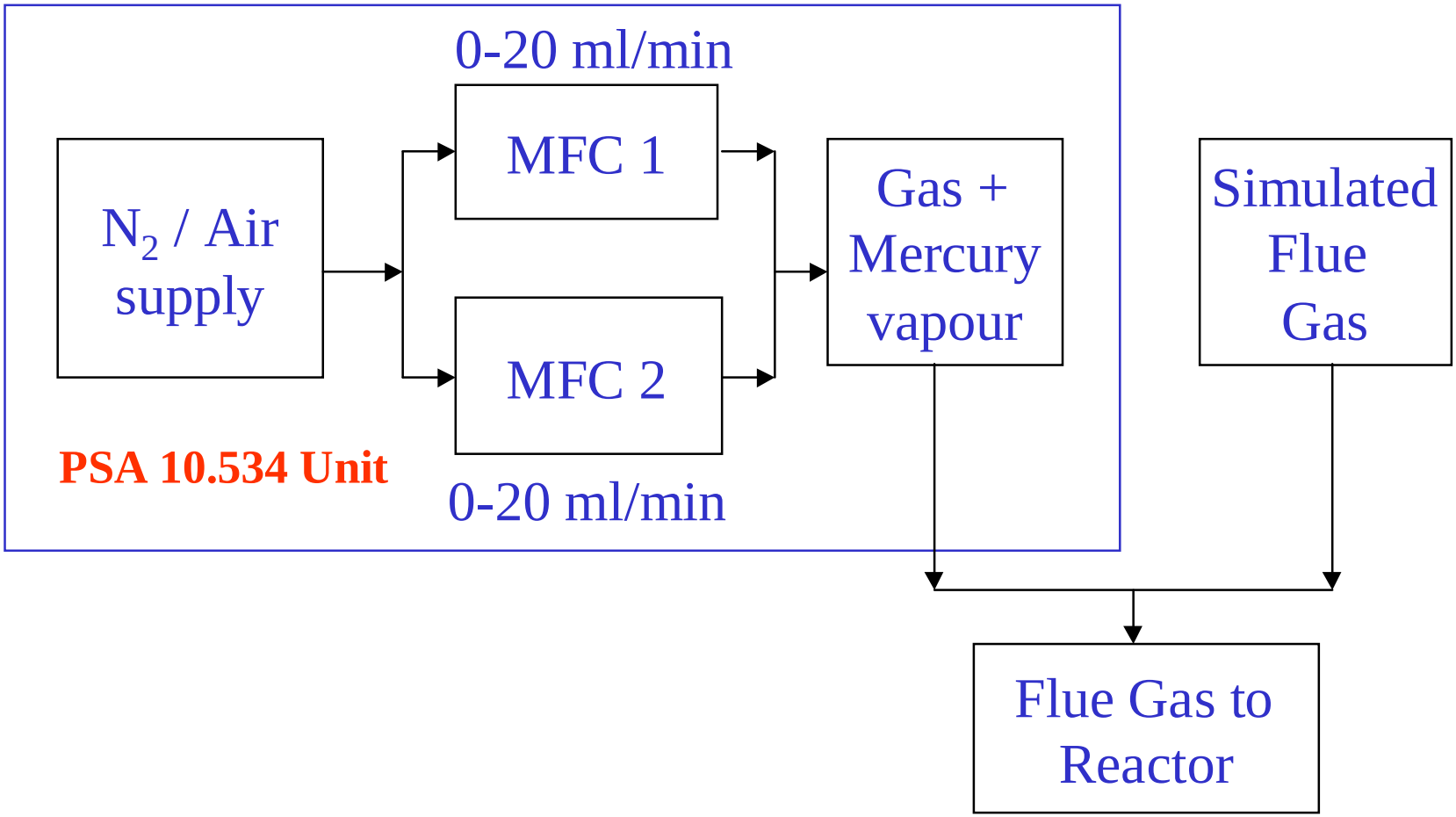
PRINCIPAL ACTIVITIES

- **Identification and sourcing of suitable sorbents**
- **Hg retention capability measured as a function of temperature, flue gas composition [e.g. HCl and SO_2] and Hg speciation [hopefully]**
- **Characterisation of promising sorbents, e.g. SEM, BET, TGA**
- **Measurement of leaching stability of Hg from spent sorbent**

Low Temperature Hg Capture Reactor



Mercury Vapour Generator



MERCURY ANALYSER

LECO AMA 254 analyser
Hg released from sample by thermal treatment in pure oxygen (catalytic) is captured on gold amalgamator

Subsequent release by heating of gold foil.
Released Hg quantified by AAS [254 nm absorb]
Lower limit of detection – 0.05 ng, but 4-5ng used
e.g. Blind Canyon, Hg = 0.037 +/- 0.012 ppm
Pittsburg #8, Hg = 0.333 +/- 0.013 ppm

Solid samples – 100 to 200mg

Preliminary Data with Norit FGD

Emphasis on commissioning new system: controlled mercury release into reactor and checking mercury mass balance.

Norit FGD used as reference standard

Initial runs give 300 ng of mercury into system [in N_2]. 95-105% capture on Norit FGD plus KI-impregnated carbon back-up at room temperature

First Test Sorbents

Activated carbons generated from:

Sewage Sludge and Waste Tyre Rubber [S content]

Activated in-house:

Typical conditions for 200g batch:

Pyrolysis under N_2 [500ml/min] at 5 °C/min to 700 °C followed by activation by CO_2 or steam/N_2 [also at 500ml/min]

Project plans

	MONTH
Re-design and Commission new reactor	1 - 10
Sourcing of Sorbents	1 - 18
Testing of Sorbents	11- 30
Sorbent Characterisation [by TGA, SEM, EDX, BET, porosimetry]	12 - 30
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