ADSORBING DIOXIN WITH ACTIVATED CARBON AND COKE PROCESSES

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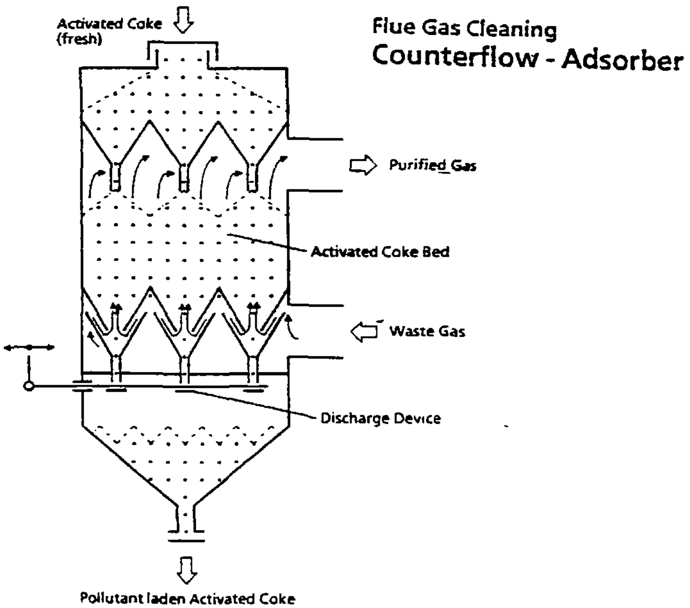
1. Introduction

About 400 g/y dioxin is generated by waste incineration in West Germany. Modern flue gas cleaning downstream of waste heat boilers allows dioxin emissions to be limited to 1 ng/m^3 NTP TE. This typical value has been achieved for instance by the flue gas cleaning plant commissioned by Lurgi in Coburg in 1989. Between 0.1 and 0.2 mg/m^3 NTP durst is emitted through the stack; most of the dioxin is generated in gaseous form. Three processes using activated carbon and running at temperatures of between 100 and 120 ^{o}C can be installed for the adsorption of dioxin to reduce emissions to 0.1 ng/m^3 NTP TE.

2. Lentjes counter-current adsorber system

The flue gas reacts with activated carbon in a fixed bed operating according to the counter-current principle with the flue gas flowing from bottom to top and the activated carbon from top to bottom (Fig. 1).

Fig. 1



Various reactions take place: first dioxin is adsorbed onto the surface of the carbon, producing a thin layer of contaminated carbon; then heavy metals - especially mercury -, HCl and SO_2 react further up in the layer of carbon, thus achieving low emission. The thickness of the bed is about 1,5 m and the velocity of flue gas between 0,1 - 0,4 m/s. The consumption of activated carbon is defined by the pressure drop between inlet and outlet of the filter which gradually increases in line with the dust burden. Measurements taken in a plant with a capacity of 2000 m^3/h NTP are given in table 1.

Table 1

	Raw gas ng/m^3 TE NTP	Clean gas (ng/m^3 TE NTP (BGA)	Removal (%)
1	2,5	0,039	98,44
2	2,8	0.025	99,1

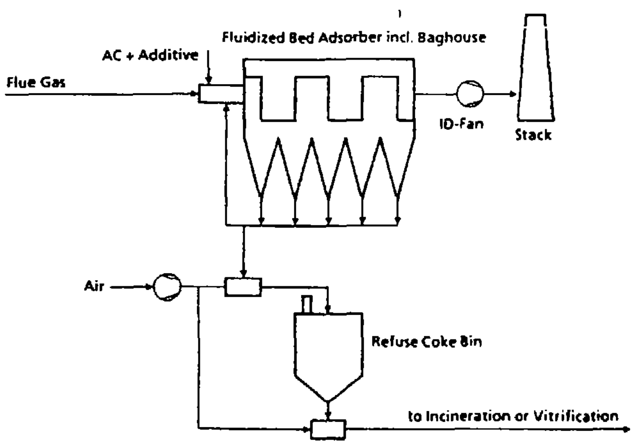
Several plants have been engineered according to this principle and reactors with a capacity of 4 x 145.000 m^3/h NTP have been built in Düsseldorf-Flingern.

3. Transport reactor

A mixture of fine activated carbon and inert material is carried by the flue gas to a baghouse to be separated (Fig. 2).

Fig. 2

Dioxin- and Mercury Removal by Transport Reactor



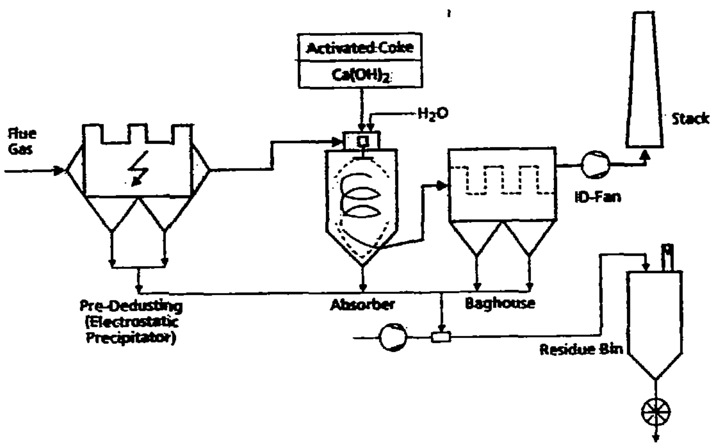
Dioxin and mercury are removed both on their way to the baghouse and by the cake in it. The inert material is necessary to reduce the risk of inflammation and to absorb any heat generated by the formation of sulfuric acid. Some of the material removed in the separator can be recycled to reduce activated carbon consumption.

An application could be considered behind a waste incineration plant with wet scrubbing for HCl and SO_2-removal with following flue gas reheating.

A further application of this adsorber type is in spray absorption with a baghouse where activated carbon is atomized together with milk of lime (Fig. 3).

Fig. 3

Flue Gas Cleaning
Semi dry Process with Dioxin-Removal



We have taken many measurements in industrial plants; typical results are given in table 2.

Table 2

Flue Gas Cleaning
Dioxin-Removal

Plant	Flue Gas Cn (mg/Nm³)	Purified Gas Cn (mg/Nm³)	Removal Efficiency %	Gas Flow (Nm³/h)
MVA - 1	2,96	0,068	97,7	60 000
TE / Nato CCM	2,73	0,08	96,6	
MVA - 2	8,12	0,12	98,5	90 000 non optimized
TE / BGA				
MVA - 3	3,26	0,0105	97,7	100 000
TE / Nato CCM	2,48	0,0093	99,6	

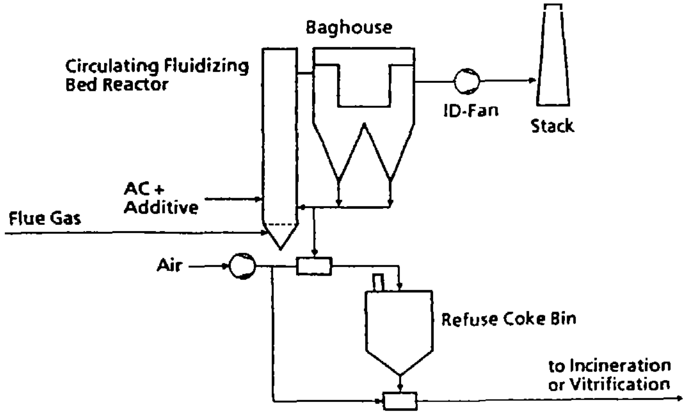
Activated Coke Dosage: 0,25 - 0,45 g/Nm³

After optimization, various plants achieve emission levels of 0,1 ng TE/Nm³.

4. Circulating fluidized bed

The circulating fluidized bed can be classified between the fixed bed and the transport reactor: the relative velocity between gas and solids is the highest of the three (Fig. 5), as is consequently also the case for gas diffusion into the inside of the particles. The gas velocity for such a reaction is between 4 - 6 m/s. The flue gas is distributed through a grate and a mixture of activated carbon and inert material (eg. sand, calcium carbonate, calcium oxide among other things) is stirred up by the gas. A baghouse is not only used as a separating but also as a second reaction device. The adsorbent is then recycled to the fluidized bed (Fig. 4).

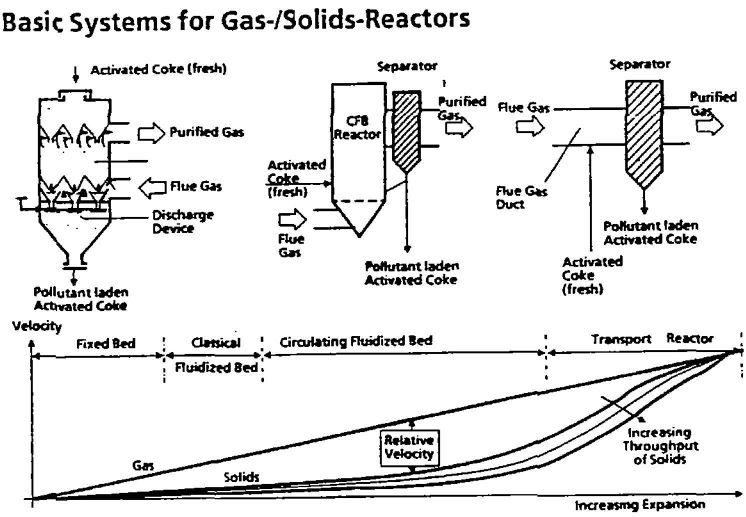
Fig. 4 Dioxin- and Mercury-Removal by Circulating Fluidized Bed and downstream Baghouse



A first plant with a capacity of 1500 m^3/h NTP has been installed downstream of a flue gas cleaning unit in a hazardous waste incineration plant. First results show that similar results to the counter current adsorber can be obtained, especially for dioxin removal, with lower activated carbon consumption.

A general explanation of the principal properties of the a.m. various beds will be given by the examples in Fig. 5.

Fig. 5



5. Conclusion

It has been shown that o,1 ng TE/m^3 NTP dioxin emission at the stack can be achieved with three processes which can be installed at the end of the flue gas cleaning plant. In order to optimize activated carbon consumption and as a consequence to reduce the amount of waste produced in the plant, continuous dioxin measuring equipment has to be developed.