Ten Years of Experience of Dioxin Removal in Dry Scrubbers

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1. First experiences - SYSAV

Experiences of effective air pollution control technique for reduction of dioxins and heavy metals took place in Sweden in the early 80 is.

By SYSAV, the most southern Swedish Energy from Waste plant, Fläkt (at that time) made tests with dry injection of sorbent and fabric filter. The results were so good that a full size Air Pollution Control installation was commissioned in 1981. In 1983 a waste heat boiler was installed which decreased the temperature in reactor and fabric filter to about 160°C.

Early measurements made 1982--85 gave very low emissions of heavy metals and organics. As the measurement technique developed the accuracy of the dioxin measurement improved. In 1985-86 the detection level was as low as 0,02 ng 2, 3, 7 , 8 TCDD/m^{3}norm. The stack emission in SYSAV was measured and the results were below the detection limit for 2, 3, 7, 8, TCDD as well as for TEQ (Eadon). (Ref. 1)

2. Air Pollution Control Development

In 1985 Fläkt was given the possibility to participate in a test campaign in Quebec City managed by Environment Canada. The purpose with the tests was to investigate the capabilities of spray dryer and dry scrubbers at a conventional MSW-stoker combuster. (Ref. 2) The extremely good results regarding heavy metals and organic matter which were obtained are particularly interesting of course.

At the same time or 1985 Fläkt installed and operated a pilot plant (600 m^3/h of the total flow) at one of the three combustors at Gärstadsverket, Linköping - an Energy to Waste plant own and operated by the City of Linköping, Sweden. The pilot was first operated with a slip stream of the cleaned gas from outlet of the electrostatic precipitator that is with hydrated lime powder only. The results were not promising at all but by sucking out the flue gas from the raw gas side, that is before the electrostatic precipitator, corresponding results as in SYSAV were obtained. From these activities in Linköping we learnt that the unburnt carbon in the ash is a must for an effective removal of chlorinated organics and gaseous mercury (Ref. 3).

With the early experiences from SYSAV, Quebec and Linköping the installations of DRY SCRUBBERS have continued. Normally dioxin guarantees have been and are given. Most of the Swedish 21 Energy from Waste plants are equipped with Dry Scrubbers and almost all have now fabric filters. With the installation of effective APC equipment the dioxin/furan emissions from the Swedish Energy from Waste plants have been reduced considerably according to the following figure 1.

Source/year	1987	1989	1991	1993
Energy from Waste (EfW)	50 - 100	10		<5
Cars	5 - 15	5 - 15		
Iron and steel	15 - 40	15 - 40	10 - 15	
Non iron	5 - 20	5 - 20		
Iron foundries	1 - 10	1 - 10	1 - 5	
Cement/lime	5 - 10	5 - 10		
Pulp and paper (air)	4 - 6	4 - 5	4 - 5	
Pulp and paper (water)	15 - 30	5	1 - 2	
Power stations (coal)	1	1		
Hospital waste	10	10		
Hazardous waste	2 - 6	2 - 6		<1
Total	113 - 248	63 - 132		85
EfW in % of total	~50	~10		~5

Fig. 1 Emissions of PCDD/F in g TEQ/year from Swedish sources. (Ref. 4)

Emission guarantee measurements at the recent EcoDAS APC installation at the waste fired power station in Karlskoga, Sweden (fig. 2 and 3) have given extremely low emissions.

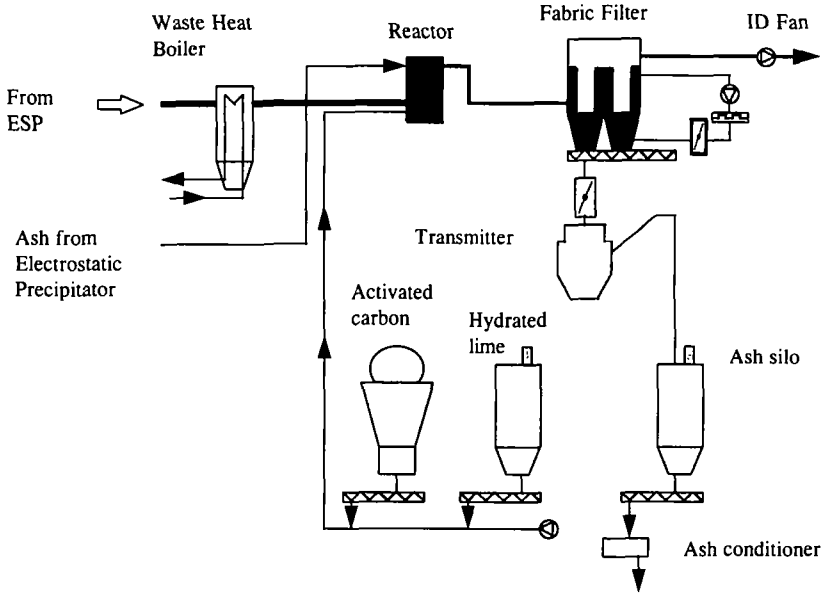


Fig. 2 ABB EcoDAS at Karlskoga Waste fired power station. Flow diagram.

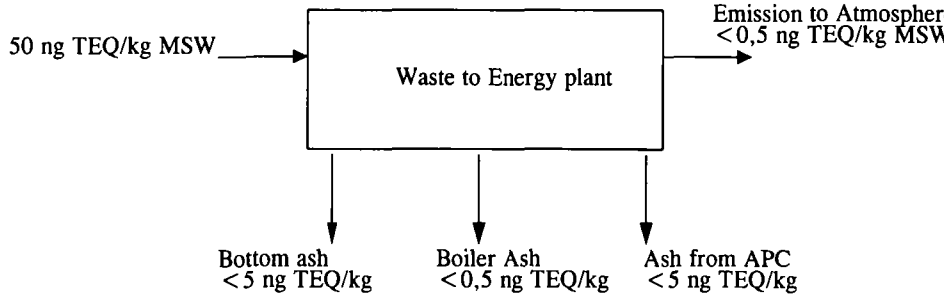
Component	Measured concentrations mg/m³n 10% CO_2 dry gas but Dioxin in ng/m³n 10% CO_2 dry gas	
	Outlet ESP	Stack
Dust	1 - 10	<1
HCl	700 - 1200	<5
SO_2	250 - 550	<20
Hg tot	0,04 - 0,16	<0,02
TEQ Dioxin	10 - 20	<0,05

Fig. 3 ABB EcoDAS at Karlskoga Waste fired power station. Results from guarantee measurements (Ref. 5).

The installation and total costs for EcoDAS systems are often favourable in comparison to other methods e.g. wet-dry and wet. This facts are particularly true if the recovered heat is incorporated in the steam cycle. Then up to 30% electricity can be produced.

3. Dioxin Balance

It is difficult to take representative samples of municipal solid waste (MSW). In Bielefeld in Germany the MSW is chopped, milled and mixed by a ball mill before burnt in a conventional stoker boiler so representative samples can be taken. Investigations in 1989 resulted in a dioxin concentration of 50 - 100 ng TEQ/kg of MSW (Ref. 6). The following dioxin balance can be made for a modern Waste to Energy plant (Ref 7).



Total amount of TEQ dioxin into the plant > 50 ng/kg MSW

Total amount of TEQ dioxin out from the plant < 10,5 ng/kg MSW

Minimum TEQ destruction efficiency $= 1 - \frac{10,5}{50} = 80\%$

Fig. 4 Dioxin balance for 1 kg Residual Waste in a modern Waste to Energy installation.

4. Filsorption

Based on the excellent performance of ABB Dry Scrubbers at waste incinerators, ABB has been able to improve plants with wet scrubbers. By installing an EcoDAS/FF unit with a mixture of carbon and lime emissions to atmosphere can be minimised. One example of this combination is the Waste to Energy plant in the University city Uppsala, Sweden. As calculated extremely low emissions was and is measured (Ref. 8).

	Concentrations in mg/m^{3}n dry gas 10 % CO_2		
	Before WHB	**After FF**	**Dutch regulation**
Dust	15	1	5
HCl	680	< 1	10
SO_2	180	10	40
HF	3,8	< 0,1	1
Hg	0,08	< 0,001	0,05
Σ 7 HM in dust		< 0,02	< 1,0 (10 HM)
DIOXIN TEQ ng/m^{3}n	3,9	0,04	0,1

Fig. 5 Results of emission guarantee measurements at Uppsala, Sweden
WHB = Waste Heat Boiler FF = Fabric Filter

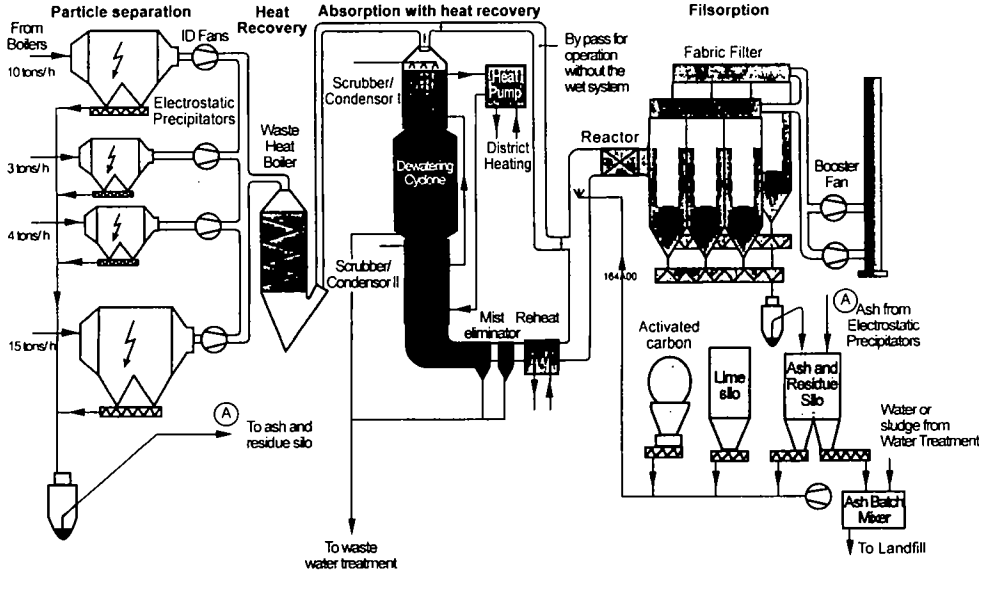


Fig. 6 Uppsala MSW incinerator, Sweden - Filsorption II unit downstream of a wet scrubber.

5. Ash Treatment

Dry scrubbers do not produce any waste water but all removed impurities become concentrated in the fly ash. Dry scrubbers can operate without a precollector for the fly ash. The removal of fly ash and acidic gases with hydrated lime - the common method - results in a complex residue with respect to stability in a landfill. Some heavy metals, particularly lead, can leach out. Dioxins/Furans are bound to the particles very hard and have never given any difficulties (Ref.9).

6. Conclusion

Dry scrubbers (cooling by waste heat boiler or water spraying), plus dry injection- Fläkt EcoDAS or CDAS - or Spray Dryer Absorber - Fläkt Drypac - plus fabric filter can comply with any country's actual emission regulations for waste incineration.

The combination of
- moderate cost
- very high reliability
- very low emissions to atmosphere
- no effluent to water
- recycling possibilities for the ash

makes the DRY SCRUBBER with FABRIC FILTER a very attractive air pollution control system for many waste to energy plants in the future as well.

7. References

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