ADSORPTION TECHNOLOGY BRINGS WASTE INCINERATORS INTO COMPLIANCE - STEAG'S /a/c/t™-PROCESS IN EUROPEAN FACILITIES -

Hermann Brüggendick, Ralf Gilgen
STEAG AG
Ruettenscheider Strasse 1 -3
45128 Essen, Germany

Keywords: Flue Gas Cleaning, Adsorption Technology, Carbon Fixed Bed Adsorber

ABSTRACT

Due to the stringent emission limits for waste incinerators in Europe, the use of activated carbon technology became necessary.
STEAG is a licensor for the design and construction of an activated carbon fixed bed adsorber , the so called /a/c/t™-process with licensees in Europe and the United States.
The following paper provides a short desription of this technology and experience in commisioning and operation of the system.
The effectiveness of the /a/c/t™-process is demonstrated.

Emission control is an issue affecting many different sectors of industry. Some of the most stringent regulations apply to waste incinerators and Waste-to-Energy facilities.

Activated carbon technology is used in Europe to comply with these regulations. This technology makes it possible to reduce dioxin, furan, heavy metal, sulfur and acid emissions far below the required limits. Activated carbon processes are installed in Europe downstream of the flue gas desulfurization at medical, hazardous and municipal waste incineration plants.

The development of this technology occurred when the legal emission limits in Germany, the Netherlands, and Austria were tightened significantly.

Table 1 shows a comparison of the current legal emission limits in Europe and the United States.

STEAG has nearly 20 years experience in carbon technology. Since 1978 STEAG operates pilot plants to investigate the efficiency of this technology and to optimize the process. This resulted in the the "know-how" needed to design a cost effective adsorption system with guaranteed safe operation. Although STEAG has licensee AE&E (Austrian Energy and Environment), K+L (Kessler and Luch, Germany), and Black & Veatch (Kansas City, USA), STEAG has been involved in the design and commissioning of all /a/c/t™ facilities.

The proprietary fixed bed design is shown in figure 1. It is a cross flow fixed adsorber system. The flue gas flows horizontally through it. The bed consists of three vertical layers of activated carbon. Each layer is subdivided by perforated plates and each layer has it own coke discharge equipment so it can be moved and extracted separately and independently from the others. The first layer - the inflow layer - removes particulates, gaseous heavy metals and dioxins and furans, the second layer removes sulfur oxides (SO_2/SO3) and the third layer halogenated hydrogen (acid gases). The adsorbent in each layer can be replaced according to its capacity, providing the most efficient use of the carbon. The adsorption unit is designed to hold a supply of fresh carbon in a hopper at the top of the bed, which continually replenishes the supply. Each layer can be replenished individually, based on the conditions at the gas inlet. The carbon supply hopper needs to be filled only periodically. The unit's unique, patented features ensure the safe and efficient use of activated carbon while operating at temperatures between 215 to 300 F.

Since 1990, when the first contract was signed, STEAG and their licences have installed /a/c/t™-systems at 8 different sites in Europe with a total flue gas volume of more than 2.2 million dscm. Black & Veatch signed a contract to construct the first carbon adsorber of its kind in the United States. This was a team effort between Black & Veatch and STEAG.

In table 2 a reference list of the /a/c/t™--systems installed downstream of Waste Incineration plants in Europe is shown.

Following is a brief description of the operating experience at three of the European sites.

THE MUNICIPAL WASTE INCINERATOR AT AVR ROTTERDAM

This facility is the largest municipal waste incineration plant in Europe. It consists of 7 independent units, all equipped with roller grate incinerators, electrostatic precipitators, two-stage wet scrubbing systems, /a/c/t™-systems, and a low temperature SCR-DeNO$_x$. This facility has a total capacity of over 1,000,000 tons of waste per year (20 to/hr per unit).

Each unit has an a/c/t™-system consisting of two beds, which are installed parallel to the flue gas flow. The main dimensions of the adsorber are 52 ft (length), 16 ft (width), and 88 ft (height). The total filter surface is approximately 5340 sqft.

The guarantee measurements were carried out separately for each unit between April and October 1994. Table 3 presents actual measured emission values.

It can be seen, that all the emissions are clearly far below the legal emission limits and the specified levels. The carbon consumption is about 1.65 lbs/t of burned waste.

This state-of-the-art flue gas cleaning system shows impressive results, proving it is possible to operate even an old incinerator while protecting the people and the environment most effectively from air pollution.

THE HAZARDOUS WASTE INCINERATOR AT AVR ROTTERDAM

At the same site there are three rotary kilns for incineration of industrial and chemical wastes with a total capacity of approx. 80,000 tons per year of hazardous waste.

The relevant main components of this hazardous waste incineration plant are as follows: rotary kilu, waste heat boiler, spray quencher, electrostatic precipitator, two stage wet scrubbing system, /a/c/t™-system.

Trial operation of this hazardous waste incineration plant ended in October 1992, the results are shown in table 4. Several series of emission measurements have shown that the actual levels are clearly far below the emission standards and the specified levels.

The /a/c/t™-system is not only able to clean flue gases but also any other gases containing air pollutants.

The HCl-production facility consists of a combustor, which burns liquid chlorinated hydrocarbons. In a two stage wet scrubber with acid recirculation a purchasable hydrochloric acid is formed. The gas cleaning system consists of two-stage neutralization and an /a/c/t™-system in order to remove dioxins, furans, and other organic substances.

The /a/c/t™-system is a single bed adsorber with a height of 63 ft, a width of 17 ft, and a length of 8 ft. The total filter surface is approximately 360 sqft.

Table 5 shows a comparison of the legal emissions limits, the guaranteed values and the results of the emissions measurements

The /a/c/t™-system removes the air pollutants with a very high efficiency and helped to increase the acceptance of this facility in the surrounding region.

CONCLUSION

With the /a/c/t™-system STEAG and their licensees can provide a state-of-the-art flue gas cleaning technology with the highest removal efficiency available. This system can clean all kinds of gases containing air pollutants or odorous substances and can be operated safely and with minimum maintenance.

TABLE 1: Legal Emission Limits for Waste Incinerators

Substance	Unit [1]	Germany[6]	Netherlands[7]	Austria[8]	European Union [3][6]	USA [4]
Total dust	mg/dscm	10	5	15	10	12
HCl	mg/dscm	10	10	10	10	32
HF	mg/dscm	1	1	0.7	1	-
SO_2	mg/dscm	50	40	50	50	67
NO_x	mg/dscm	100 [2]	70	100	-	288
Hg	mg/dscm	0.05	0.05	0.05	0.05	0.06
Cd, Tl	mg/dscm	0.05			0.05	0.01
Dioxins, Furans	mg/dscm	0.1 [5]	0.1 [5]	0.1 [5]	0.1 [5]	0.16

[1] related to 11 % oxygen, dry at 273 K and 1 atm [2] general value-depending on local standards

[3] guideline [4] municipal waste incinerators only [5] corrected by toxic equivalent factors

[6] one day mean value [7] one hour mean value [8] half hour mean value

TABLE 2: Reference list of the /a/c/t™--systems installed downstream of Waste Incineration plants in Europe.

Type	Location	Owner/Operator	Commissioning	Flue gas Volume/dscm
Medical waste	Heidelberg, Germany	University	Oct 1991	2 x 6,500
Hazardous waste	Rotterdam, Netherlands	AVR Chemie	Oct 1992	1 x 77,000
Industrial flue gas	Freiberg, Germany	NE-Metall GmbH	Jun 1993	1 x 1,500
Municipal waste	Rotterdam, Netherlands	AVR	Nov 1993	6 x 155,000
Municipal waste	Essen, Germany	RWE-Energie AG	May 1995	4 x 168,000
Municipal waste	Wels, Austria	WAV	Jul 1995	1 x 55,000
Municipal waste	Mannheim Germany	RHE	Jun 1995	1 x 295,000
Municipal waste	Rotterdam, Netherlands	AVR	Aug 1995	1 x 155,000
Industr. flue gas	Rheinberg, Germany	Solvay GmbH	Apr 1995	1 x 15,380
Crematory	Gießen, Germany	Stadt Giessen	Dec 1993	1 x 1,500
Liq. hazard. waste	Southeast, USA	Commercial Fac.	N/A	1 x 28,000

TABLE 3: Results of the Emission Measurements at AVR Rotterdam (unit 1 to 6, unit 7 under construction)

Substance	Unit	RV[1] 1989	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
Dust	mg/Nm³	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
HCl	mg/Nm³	10	0.9	< 0.7	1.0	1.8	< 0.5	< 0.6
HF	mg/Nm³	1	< 0.4	< 0.2	< 0.4	< 0.4	< 0.1	< 0.1
SO_x (as SO_2)	mg/Nm³	40	12	< 5	23	11	< 5	< 5
SO_x (as NO_2)	mg/Nm³	70	36	32	36	41	23	26
Cd	mg/Nm³	0.05	< 0.003	< 0.001	< 0.003	< 0.003	< 0.001	< 0.001
Hg	mg/Nm³	0.05	0.03	0.003	0.002	0.004	0.001	0.001
As, Co, Cu, Cr, Mn, Ni, Pb, Sb, Se, Sn, Te, V	mg/Nm³	1	0.030	< 0.050	0.03	0.04	< 0.050	< 0.050
PCDD/F (TEQ)	ng/Nm³	0.1	0.01	0.030	0.01	0.015	0.013	0.009

[1] RV means: Dutch legal emission limits All values refer to standard condition (273 K, 1013 hPa dry) and 11 % O_2

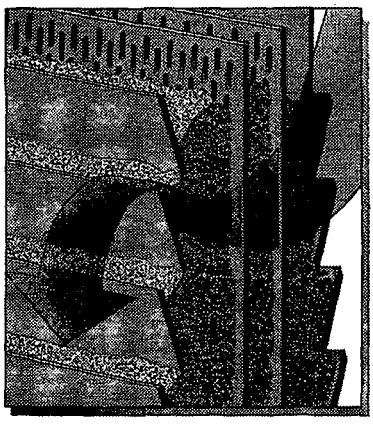
TABLE 4: Emission Measurements at AVR Rotterdam Hazardous Waste Incineration Plant

	Unit	RV 1989	Results of the accept. measurements Dec. 1992
Dust	mg/Nm³	5	< 0.5
HCl	mg/Nm³	10	0.19
HF	mg/Nm³	1	0.05
SO_2	mg/Nm³	40	6
Cd	mg/Nm³	0.05	< 0.0001
Hg	mg/Nm³	0.05	0.0022
Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V, Sn, Se, Te	mg/Nm³	1	< 0.025
PCDD/PCDF in TEQ	ng/Nm³	0.1	0.03

RV means: Dutch legal emission limits

TABLE 5: Comparison of the legal emissions limits, the guaranteed values and the results of the emissions measurements

Chemical Compounds	Unit	Emission Standards as per Clean Air Act 17. BImSchV	Guaranteed Emissions	Measured Emissions Mean values over the sampling time
Total Dust	mg/dscm	10	5	< 1
HCl	mg/dscm	10	10	4
HF	mg/dscm	1	0.1	not detected
SO_2	mg/dscm	50	5	not detected
Hg	mg/dscm	0.05	0.03	not detected
Dioxins, Furans	ng/dscm TE	0.1	0.05	not yet measured



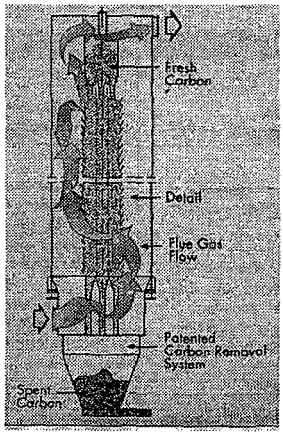


Figure 1: STEAG's /a/c/t™-process