SOUR II

Dioxin reduction in domestic waste incineration plants - the AVA Nijmegen plant as an example

Martin Tartler
Noell-KRC Energie- und Umwelttechnik GmbH, Alfred-Nobel-Str. 20, 97080 Würzburg, Germany
Marinus Vermeulen
Vermeulen Ingenieursbureau B.V., Postbus 120, 1230 Loosdrecht, The Netherlands
Ton van Winden
ARN BV, Postbus 7006, 6503 GM Nijmegen, The Netherlands

1. Introduction

In the opening discussion, thermal waste treatment (incineration), particularly because of the difficulties with dioxins as emissions, will be shown to cause an excessively high amount of environmental damage.

Measured dioxin emissions in the 1980s were between 10 - 50 ng/m^3 i.N.tr.

Using AVA Nijmegen as an example, it will be shown how a modern flue gas cleaning plant contributes to reduce the emissions associated with domestic waste incineration.

Relatively new environmental regulations set strict limits for dioxin emissions (0,1 ng TE/m^3 i.N.tr., in Germany: 17.BlmSchV, in Holland: Richtlijn Verbranden). These stricter regulations resulted in a reduction of dioxins of more than 99 %, reducing the yearly dioxin emission in Germany from approximately 400 g/h to 3,6 g/h.

2. Flue gas cleaning at the AVA Nijmegen plant

In December 1992, Noell-KRC Energie- und Umwelttechnik GmbH undertook the task of design, delivery, installation and commissioning of both flue gas cleaning lines at the domestic waste incineration plant at ARN Nijmegen (Netherlands). This project was completed in 30 months.

Waste incineration Line 1, including a flue gas cleaning plant and waste water treatment plant, already existed. The flue gas cleaning plant in Line 1 was replaced from the flue gas scrubber forward, by a new more efficient plant. Line 2 was built completely new. It has approximately double the waste throughput as Line 1 and therefore about double the flue gas flow. The sequence and layout of the components in the two flue gas cleaning lines are the same, with the exception of the spray dryer and its accompanying electric precipitator 2, which are only present in Line 2.

The waste water treatment plant was also renovated so that the acidic waste water from both lines, which also contains dissolved heavy metals, can be cleaned before flowing into the flue gas spray dryer in Line 2.

2.1 Flue gas treatment

In both lines, hot flue gas enters the flue gas treatment plant after exiting the boiler.
In Line 1, the dust is first removed in the existing lone electric precipitator, then goes to the flue gas scrubber.

In Line 2, a two-field electric precipitator first removes much of the dust from the hot flue gas. After the electric precipitator, there is a spray dryer in which the waste water from Lines 1 and 2 is completely evaporated. The flue gas, thus cooled to 170 °C, then flows into the next two-field electric precipitator, where the remaining dust is almost completely removed.

After electric precipitator 2, the flue gas, as in Line 1, enters the two stage flue gas scrubber. The almost completely dust free hot flue gas enters the lower part of the scrubber, the so called acid scrubber. In this wash stage in an acid environment, the remaining dust particles, the HCl and HF, and the heavy metal compounds (especially Hg) are removed. A pH value of 1 is held constant through dosages of limestone powder. A portion of the acid wash suspension must also occasionally be discharged to the waste water treatment plant.

After flowing through the acid wash stage, the flue gas enters the neutral wash stage. Here, as a result of a limestone excess, the SO_2 is absorbed from the flue gas. SO_2 is also oxidised in the absorber feed tank to create gypsum. A portion of the neutral wash suspension is periodically discharged to a centrifuge or to the spray dryer. The flue gas passes then through a multi-stage mist eliminator where the wash suspension droplets are disentrained from the gas.

After the two stage flue gas scrubber, the flue gas is pre-warmed in a steam/gas heat exchanger (DAGAVO), raising its temperature by about 33 °C to approximately 100 °C before entering the nitrogen oxide removal plant.

The removal of nitrogen oxide from the flue gas is accomplished by selective catalytic reduction (SCR). Here, the flue gas is mixed with an ammonia solution, the reducing agent. During the flow of this mixture through the catalyst layers, the nitrogen oxide and ammonia are converted to nitrogen and water vapour. The operating temperature of the catalyst is about 300 °C, the heating of the flue gas being achieved using a regenerative gas/heat exchanger (REGAVO) and an oil burner. After deoxidation and being cooled to around 133 °C in the afforementioned REGAVO, the already well cleaned flue gas flows into the duct-injection filtering process, where the aforementioned reduction rates are achieved.

The dust-injection filtering process affects the adsorption of existing organic compounds, particularly dioxins. In addition, any remaining acidic components or heavy metals are removed. In this process, adsorbent is injected into the flue gas, so that in the filter which follows, a layer of adsorbent accumulates on the surface of the filter bags as the flue gas passes through this layer of adsorbent, the above mentioned substances are absorbed before the flue gas, now completely clean, flows through the chimney and into the atmosphere.

2.2 Waste water treatment

The wash suspension which is discharged from the scrubber's acidic wash stage is fed into a waste water treatment plant. There, the waste water is neutralised and the heavy metals are removed. Next, the precipitate and other dangerous materials are removed from the water through sedimentation. The clarified water is channeled to the spray dryer and the thick sludge is sent to the waste material treatment plant. This sludge, together with the other waste products, is then prepared for storage, as described below.

2.3 Waste material treatment plant

The waste products from both lines (filter dust from electric precipitator 1, waste products from the spray dryer and electric precipitator 2, spent adsorbent from the dust-injection filtering process, gypsum from the flue gas washer and the sludge from the waste water treatment plant) are treated in the waste material treatment plant so that they can be stored at the ARN landfill site.

The different types of waste materials are mixed together and, if necessary, additives are blended in to improve solidification of the mixture. After being mixed, the residues are filled into Big Bags for storage or, alternatively, proportionate amounts can be filled into Big Bags and dryed or moistened so that further processing can be done.

It is also possible to treat each type of waste product alone and dispose of them separately.

3. Results from reduction of dangerous emissions at the AVA Nijmegen plant

Removal of pollutants in the flue gas cleaning plant line 1 [1) 2)]

component	after electric precipitator	after flue gas scrubber	after Denox plant	chimney	removal efficiency (%)	required clean gas concentration	environmental regulations Richtlijn Verbranden
dust [mg/m^3]	29	4,9		1,3	96	5	5
SO_x [mg/m^3]	146	1,7		0,8	99,5	40	40
HCl [mg/m^3]	709	1,3		0,28	99,96	5	10
HF [mg/m^3]	0,93	< 0,2		< 0,2	>79	0,5	1
NO_x [mg/m^3]	262	262	57	60	77	70	70
heavy metals [mg/m^3]	1,40	0,27		< 0,08	>94	1	1
Cd [mg/m^3]	0,04	0,007		<0,005	>87,5	0,05	0,05
Hg [mg/m^3]	0,1	0,028		0,0016	98,4	0,05	0,05
PCDD/F [ng/m^3]	4,4			0,015	99,7	0,1	0,1

all figures refer to: mg/m^3 dry, 1 atm O°C and 11 Vol % O_2

Removal of pollutants in the flue gas cleaning plant line 2 [1) 2)]

component	before electric precipi-tator 1	after electric precipi-tator 1	after spray dryer	after electric precipi-tator 2	after flue gas scrub ber	after Denox plant	chimney	removal efficiency (%)	required clean gas concen-tration
dust [mg/m³]	1000	52	1250	3.7	3,1		<1,25	>99,9	5
SO_2 [mg/m³]		327	323	230	3.2		0.9	>99,7	40
HCl [mg/m³]		1100	1100	1080	3,5		<0,17	>99,98	5
HF [mg/m³]		2,4	< 0.2	< 0,2	< 0,2		< 0,16	>93,3	0,5
NO_x [mg/m³]		234			234	53	62	77,8	70
heavy metals [mg/m³]		3.1	3,0	0,13	0,2		< 0,07	>97,7	1
Cd [mg/m³]		0.08	0,06	0,06	0,022		<0,0049	>93,9	0,05
Hg [mg/m³]		0.16	0,23	0,06	0,022		0,0005	99,7	0,05
PCDD/F [ng/m³]		4,0			2,2	0,84	0,018	99,6	0,1

all figures refer to: mg/m³ dry, 1 atm 0°C and 11 Vol % O_2

All environment regulations governing emission values (Richtlijn Verbranden '89) have been satisfied and in many cases the measured emission values remain well below the given limits.

4. References

1) W. J. Burgers
KEMA Environmental Services
Guarantee measurements of the flue gas cleaning installation of the waste incineration plant ARN

2) W. H. Burgers
KEMA Environmental Services
Aanvullende metingen op de garantiemetingen ten behoeve van de beoordeling van de afzonderlijke onderdelen van de rookgasreinigingsinstallaties van Afvavererking Regio Nijmegen

3) Heinz Köser
Dioxine in mehreren Schritten zerstören - Energie, Jahrgang 44, Nr. 5

4) B. Johnke
Dioxinemissionen aus Hausmüllverbrennungsanlagen
VGB Kraftwerkstechnik 70 (1990), Heft 6

5) Dr. H. Fahlenkamp, Dr.-Ing. K. Horch, Prof. Dr. H.P. Hagenmaier
Wie wird die Müllverbrennung zu einer Senke für Dioxine

6) B. Johnke
Ergebnisse und Schlußfolgerungen zum bundesweiten Dioxin-Meßprogramm bei thermischen
Abfallbehandlungsanlagen, VDI-Tagung 1992 „NOx- und Dioxinminderung"