Formation of PCDD/PCDF in the process of chemical waste incineration

Faiz Khizbullin, Valery Maystrenko, Irina Khasanova, Ludmila Chernova, Juri. Dmitriev*

The Institute of Applied Ecology Problem and Natural Resources Use, Bashkortostan Republic, 12/1, 8 Marta, Ufa, 450005, Russia
*JSC "Caustic", Sterlitamak, Russia

Introduction

Recent researches have shown, that Bashkortostan Republic (Russia) has places of high environmental pollution with dioxin and other toxic substances. Municipal and industrial waste in Ufa and Sterlitamak arise great anxiety. High concentration of dioxin was discovered in the soil of toxic industrial waste landfill sites in Sterlitamak (1-28 ppb). The same preoccupation is arisen by accumulation of processing waste in special metal containers. An attempt of hazardous industrial waste disposal at the landfill site of Joint-Stock company, Ltd "Caustic" incinerator unit was made in summer 1996 (City of Sterlitamak).

The burning unit consists of burning furnace, utilization boiler and block for two-step exhaust gas washing. Acid scrubber serves for HCl absorption and has two separate columns, where water is delivered by counterflow. Washing from SO_2 is conducted with alkaline water. Before blowout into atmosphere exhaust gas are passing through separator. Sewage water from the burning unit is delivered to the reprocessing unit of sewage water.

Burning takes place at the atmosphere pressure, temperature equal to 1100-1300^{0}C, time of being operating zone equal to 2-3 sec. The unit capacity is equal to 1 ton/hour, operating mode is permanent. Waste represent viscous mass with the average content - $C_{2,38}$ $H_{3,63}$ $Cl_{1,91}$, which from the storage pass into a tank, where it is mixed with the help of a pump and then is transferred to the nozzles of the burning furnace.

Experimental

The samples of exhaust gas, scrubber and alkaline water were obtained at the established operating mode of burning unit.

Exhaust gas samples were obtained by filters, made of non-woven ultrafibrous quartz material of SKV TU 6-1115-192-82, saturated with polydiethylenesuccinate. Sampling system consisted of a condensate trap, an aspirator, a thermometer and a filter. Atmosphere pressure, overpressure in the pipe, temperature and transferred gas volume were registered while sampling. Gas volume (50-200 m^3) was normalized. Isotope labeled standard mixture - ^{37}Cl-2,3,7,8-TCDD, $^{13}C_{12}$-2,3,7,8-TCDD, $^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD, $^{13}C_{12}$-OCDD were put on the filters for control of sampling and sample preparation.

The samples of scrubber and alkaline water were obtained simultaneously with exhaust gas. There was visible soot solid particle sediment, which was filtered, dried and analyzed separately

Filters with soot and filters after exhaust gas sampling were extracted in Soxlete apparatus with acetone and toluene during 24 hours. Then acetone and toluene were substituted for hexane.

Filtered water samples with isotope-labeled standards were extracted with hexane. Hexane extracts were concentrated and purified in multilayered silicagel and coal columns.

The analysis was carried out with the of Incos-50 chromato-mass spectrometer, equipped with gas chromatograph of Varian 3400 type, capillary column DB5-MS 60 m×0,25 mm or 30 m×0,25 mm and Split-Splitless injector. The results are represented in the table 1 and in figures 1-6

Results and Discussion

According to isomeric composition high chlorinated dibenzofurans in the volume of 0,020-0,385 ng/Nm^3 (TEQ) prevail in the samples of exhaust gas. The exception is sample №5, which visually differs by higher soot volume both in exhaust gas sample and in the sample of scrubber and alkaline water. PCDD/PCDF content in exhaust gas increased up to 2,314 ng/Nm^3 (Table).

Soot presence in exhaust gas, scrubber and alkaline water is accounted for, in the first place, by incomplete burning waste. It should be noted, that during at this process low volatile components of burning are adsorbed on the soot. Soot, while washing of exhaust gas, is transferred into scrubber and alkaline water.

Table 1.

Isomeric composition of PCDD/PCDF in exhaust gas samples

Isomers	Content, ng/m^3					
	Sample number					
	1	2	3	4	5	6
2,3,7,8-TCDD	n. d.	n. d.	n. d.	n. d.	n. d.	n. d.
PeCDD	n. d.	n.d.	n.d.	n.d.	0,002	n.d.
HxCDD	0,004	n.d.	n.d.	n.d.	0,271	0,016
HpCDD	n.d.	n.d.	n. d.	n.d.	2,47	0,214
OCDD	0,077	0,028	n.d.	0,030	5,069	0,388
2,3,7,8-TCDF	0,778	0,028	n.d.	0,025	0,694	0,246
PeCDF	0,461	n.d.	n.d.	n.d.	0,303	0,079
HxCDF	2,561	0,284	0,201	0,142	14,253	1,346
HpCDF	3,946	0,601	0,475	0,291	61,756	1,455
OCDF	2,710	0,343	0,938	0,694	119,988	14,872
TEQ, ng/m^3	0,385	0,038	0,029	0,020	2,314	0,196

Thus, for the sample №6 soot part in scrubber water was 0,015 and in alkaline water - 0,021% of weight. The obtained results show, that the same isomer PCDD/PCDF composition as in exhaust gas is preserved on soot (fig. 2-6). There is an adsorptive removal of PCDD/PCDF to soot, obtained as a result of incomplete waste burning.

It is known that jet injection of absorbent coal into exhaust gas or scrubber water provides ~90% decrease of PCDD/PCDF emission.

Thus, proceeding from the received results, one can make the following conclusion. The largest volume of PCDD/PCDF falls on soot (up to 98%) and only small volume of PCDD/PCDF (up to 0,25%) is discharged into the atmosphere with exhaust gas (fig. 1).

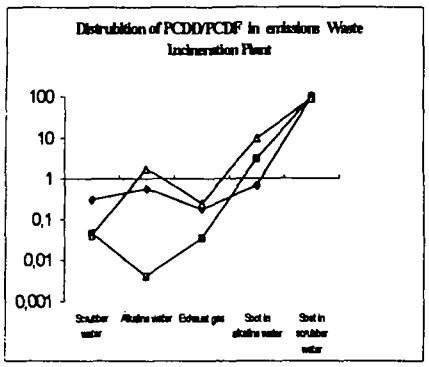

Fig. 1

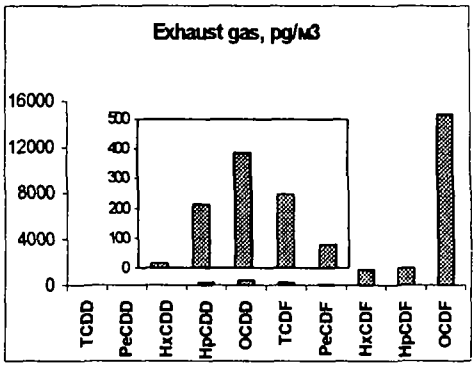

Fig.2

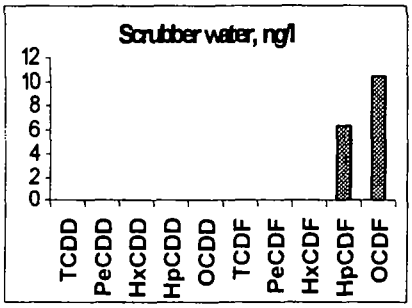

Fig. 3

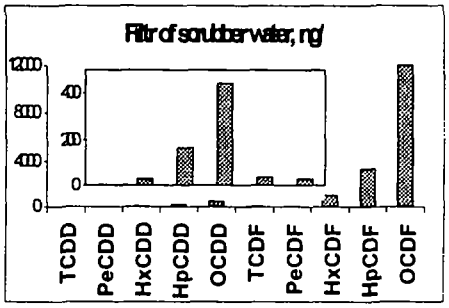

Fig.4

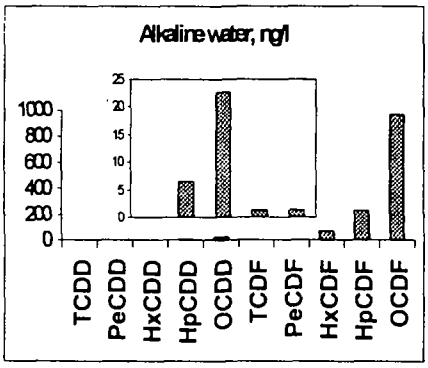

Fig.5

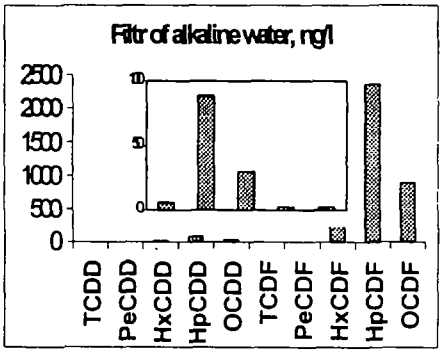

Fig.6