Content of chlorine and polychlorinated organic compounds in (automotive) shredder residue versus content of polychlorinated organic emissions when combusted in a laboratory scale reactor.

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Introduction

Every year, around 150 000 end-of-life vehicles are scrapped in Sweden. When scrapping those cars, dismantling and shredder processes are used. Today 70-75% of the scrapped car is recycled as iron and other metals and automotive shredder residue (ASR) is deposed. The 1st of January 1998 a legislative producer responsibility was introduced in Sweden with the aim to recycle 85% of the car weight by 2002 and 95% by 2015 (1). A Swedish project, called ECRIS (Environmental Car Recycling in Scandinavia), investigated whether it was possible to convert ASR or refined ASR into a fuel fraction, feasible to burn in a Swedish municipal solid waste (MSW) incinerator (2). See figure 1 for heat values. To compare the environmental impact of scrapped cars versus other shredder residue, the content of chlorine and polychlorinated organic compounds in the fuel fractions was estimated versus the content of polychlorinated organic compounds in the flue gas emissions from co-combustion of shredder residue (SR) and artificial MSW. The fuel fractions originated from SR and from non-ferrous materials (NF). See table 1 for composition of used fuel fractions. Furthermore the fuel fractions originated from end-of-life vehicles (set no. 3), white goods (set no. 5) and industrial waste (set no. 6). A mixed fraction (set no.4), containing on third of each was also used.

TABLE 1: Composition of used fuel fractions.

Cars 1	**71.5% SR; 28.5% NF**	**Cars 2**	**100% SR**
Mixed 1	**73.7% SR; 26.3% NF**	**Mixed 2**	**100% SR**
White goods 1	**78.3% SR; 21.7% NF**	**White goods 2**	**100% SR**
Industrial waste 1	**68.7% SR; 31.3% NF**	**Industrial waste 2**	**100% SR**

Eight sets of recycling materials were shreddered at two different plants with different refining processes. Each set was divided into around 10 parts from which the most energy rich parts were united into one fuel fraction. In contrast to normal shreddering, refining processes for ASR were used in this study. The fuel fractions were characterized in order to estimate their heat value, content of chlorine and polychlorinated organic compounds. After characterization of the fuel fractions, co-combustion with artificial MSW was performed in laboratory scale fluidized bed reactor.

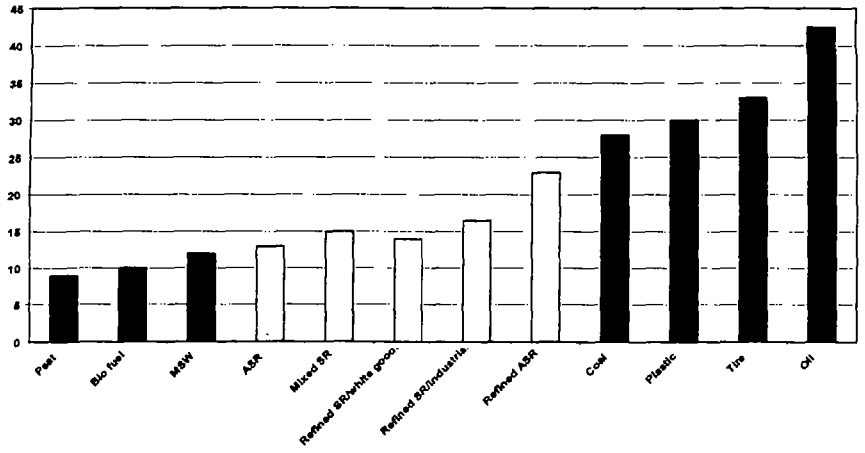

FIGURE 1: Heat value in different fuel fractions.

Materials and Methods

Before shreddering, dismantling of the end-of-life vehicles took place. Set no. 3 was dismantled as the shredder delivery rules demand at that time. Other scrap fractions were not separated before shreddering. The white goods, set no. 5 and the industrial waste, set no. 6, consisted of mostly metals. The forth (no. 4) set consist of one third of end-of-life vehicles, one third white goods and one third of industrial waste. Elemental analyses of chlorine and heat value were performed of 15 respectively 20 different fractions. The fuel fractions were also characterized in order to estimate the content of polychlorinated organic compounds; PCDD/F, PCB; PCBz, PCPh and PAH. Each fraction was extracted in a soxhlete extractor 24h with toulene. Then the samples were extracted by SPMD for three days in cyclopentane. The samples were cleaned up according to Marklund (3) and analysed for PCCD, PCDF, PCB and PCBz.

Combustion was performed in a 5kW fluidized bed reactor (4). The refined SR fractions were co-combusted with 80% artificial municipal solid waste (5). Sampling and analysis of flue gases were performed according to Marklund et al (6).

Results

Content of Chlorine, PCB, PCBz and PCDD/F in fuel fractions

The content of chlorine in 4 plus 4 different fuel fractions fluctuating between 0,5 – 5,0 percent. The fuel fractions contained almost no dioxins or furans, on the contrary some PCB and PCBz. There were significant connection between the levels of chlorine and the levels of PCBs or PCBz. Fuel fractions originated out industrial waste and white goods contained higher levels of chlorine and PCBs. Fuel fractions from the second plant contained also higher levels of polychlorinated organic compounds, especially PCBs, where levels were increased until three times, compared to the fuel fractions of the first plant.

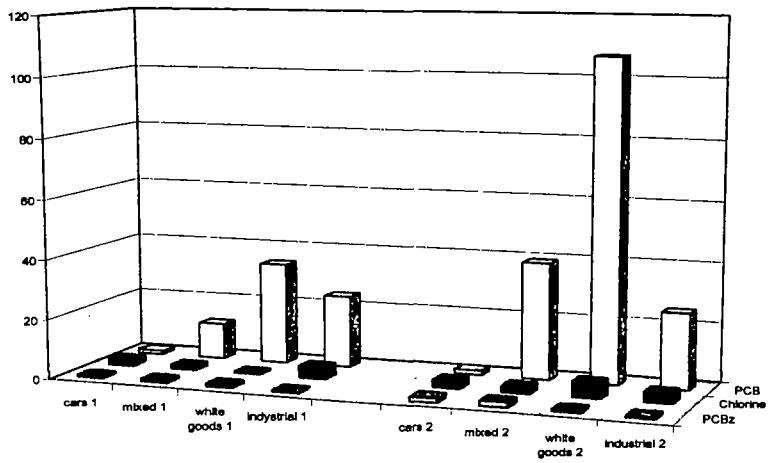

FIGURE 2: Content of chlorine (%), PCB (ng/g), PCBz (μg/g) in 4 different refined shredder residue fractions from two different plants.

Pilot scale combustion

Seven different fuel fractions were co-combusted with 80% artificial MSW. Pure MSW were combusted as a reference. The emissions from incineration 20:80 did not show any increased emission levels comparing to incineration of 100% MSW. The incineration efficiency seems to be a more potential factor for influencing the emissions than the real content of chlorine or polychlorinated organic compounds.

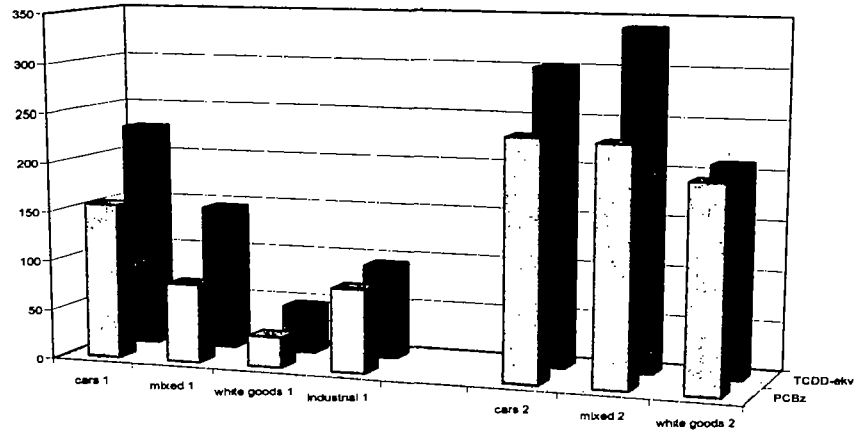

FIGURE 3a: Emissions of PCBz ($\mu g/m^3$) and TCDD-equivalents (ng/m^3) when co-combustion of fuel fractions and artificial municipal solid waste.

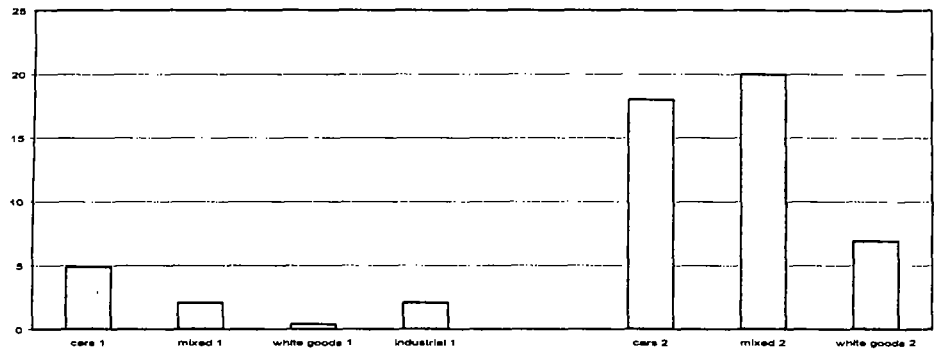

FIGURE 3b: Emissions of PCB ($\mu g/m^3$) when co-combustion of fuel fractions and artificial municipal solid waste.

Conclusions

Co-combustion of 20% fuel fractions (mostly SR) with 80% municipal solid waste in a laboratory scale reactor is possible without any increased levels of PCDD/F, PCB and PCBz in flue gas emissions. Though higher levels of chlorine and PCBs in raw materials from industrial waste respectively white goods, there are not any increased levels of polychlorinated organic compounds in those emissions. The heat value in refined SR is that high that this material is interesting as fuel for energy recovering if feasible techniques are available. A difference between fuel fractions originating from plant 1 and plant 2 could also be seemed. Though the input is almost the same, the differences could depend on different refining processes.

Discussion

Co-combustion of refined ASR is necessary due to the higher heat value and also a heterogeneous and complex material. For instance, ASR contents of plastics, PUR, fabrics, wood, rests of metals and glasses. The complexity of SR or ASR also makes it difficult to recycle materials. If recycling of materials is one alternative, the waste streams have to be large enough for economic and environmental profitable. An explanation of lower levels of polychlorinated organic compounds in flue gas emissions could be the high residue of metals in fraction 5 and 6. If partly almost no organic, it is difficult to generate any organic emissions. By other hand, metals could function as catalysts for these compounds, therefor the levels should increase.

References

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