PCDD/F Pollution Prevention Strategy for Iron Ore Sinter Plants

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Introduction

In past years waste incineration plants have attracted much of public awareness as one of the major cause of dioxin emissions into the environment. More recently systematic investigations of the ambient air situation in industrialized regions, however, revealed sintering plants as the main dioxin emitters [1,2,3,4,5].

Sintering is one of a number of iron ore agglomeration processes used in the iron and steel industry. Furthermore, sinter plants play an important role in residue recycling (i.e. mill scale, iron-bearing flue dust and sludges) within iron & steel works. However, this waste management practice introduces organic compounds into the process which in connection with traces of chlorine in the iron ore are responsible for the generation of PCDD/Fs.

Depending on the composition of residues (i.e. organic compounds from oil-contaminated by-products) PCDD/F emissions of up to 70 ng TEQ/m^3 have been reported [1]. Compared to waste incineration plants exhaust gas flows for sinter plants are much higher (up to 1,000,000 m^3/h) resulting in high PCDD/F emission loads. It is estimated that, if all European sinter plants have PCDD/F emission concentrations of 3 to 10 ng /Nm^3 TEQ, then the total emission load from sintering plants would be greater than 1 kg TEQ / year. This total load is greater than the sum of all other identified European thermal sources of PCDD/Fs. In comparison waste incineration plants would emit approx. 600 g TEQ / year without flue gas treatment.

As a consequence it is anticipated that stricter environmental regulations comparable to waste incineration plants are demanded by authorities in the near future underlining the necessity for effective emission prevention and control measures.

Mechanism for PCDD/F Formation

Detailed studies were undertaken to identify possible precursors for PCDD/F formation (i.e. chlorine and organic compounds). This led to the optimization of the sintering process with the goal of minimizing PCDD/F formation, even at high in-plant recycling rates of oil-containing by-products.

Measurements at various sinter plants have shown a proportional relationship between the content of hydrocarbons in the sinter feed mix and PCDD/F emissions in the off-gas stream (**Fig 1**). The congener profiles of flue gas samples show that PCDFs are predominant.

The amount of volatile hydrocarbons generated is a function of hydrocarbon contained in the sinter burden. Most of this material evolves from the mill scale and blast furnace dust as part of the burden. The hydrocarbon content can vary from 1% up to 15% depending on the quality and origin of residues.

Pollution Prevention Measures

Simply reducing in-plant recycling ratios (especially oil-containing by-products) is a short sighted argument. It would shift by-product management to other processes, which are more costly (e.g. waste management practices such as de-oiling of residues in a rotary kiln), often lack proven reliability on a commercial scale, and which also have a negative impact on the environment.

Two-layer sintering

Various options of mixing by-products (i.e. direct mixing, double sintering, two-layer sintering) with the sinter feed material and their residual hydrocarbon emissions were tested as shown in **Fig 2**.

The most effective solution to suppress hydrocarbon emissions and thus reduce PCDD/F formation is the so called two-layer sintering process developed by VAI.

A second layer (approx. 5-10 cm) which contains separation iron (30%-40% Fe_{met}), mill scale and blast furnace dust is placed on the traveling sinter feed mix at the position before the burn-through point of the first sinter layer and ignited. Best results were obtained with a mixture ratio of **1 : 1 : 6** (separation iron / mill scale / blast furnace dust).

Separation iron acts a good solid fuel and is added to further improve agglomeration of the sinter mix. This technique guarantees effective combustion of hydrocarbons and thus reduces phenol and PCDD/F formation. Aerosols and dust formation is also reduced in comparison to directly mixing mill scale and flue dust into the sinter feed material.

Results and Conclusion

The effectiveness of the two-layer sintering process is demonstrated in **Fig 1 and 2**. Hydrocarbon emissions are nearly constant, almost independent of the amount of oil-containing residues present in the sinter mixture. The corresponding results for PCDD/F emissions are shown in **Fig 1**.

Two-layer sintering is an environmentally and economically efficient option to reduce PCDD/F formation even at high recycling rates of oil-containing mill scale and other residues, while maintaining high quality of sinter. While two-layer sintering is an efficient measure to limit PCDD/F emissions to approx. 2-3 ng/Nm^3 TEQ, in addition effective control measures have to be applied for further PCDD/F reduction.

Thus, effective measures to reduce PCDD/F emissions require an integrated concept based on both pollution prevention by suppression of precursor formation (e.g. phenols, etc.) and control of residual emissions.

A two step approach has proved to be the most efficient solution for effective PCDD/F emission reduction, while maintaining a high in-plant recycling rate of by-products.

- First, volatile organic compounds (hydrocarbons) are drastically suppressed in a two-layer sintering process.

- Second, the remaining noxious gas compounds are effectively separated (cleaned) from the off-gas stream in a wet fine scrubber system (*AIRFINE®*), ensuring lowest PCDD/F emissions. Under optimized conditions a target value of 0.1 ng/Nm^3 TEQ is realized.

References

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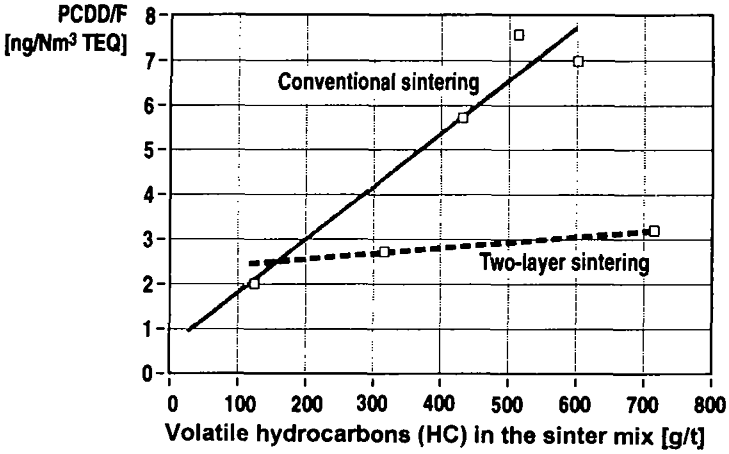

***Figure 1**: Correlation of volatile hydrocarbons in the sinter mixture and the resulting PCDD/F emissions for conventional and for two-layer sintering.*

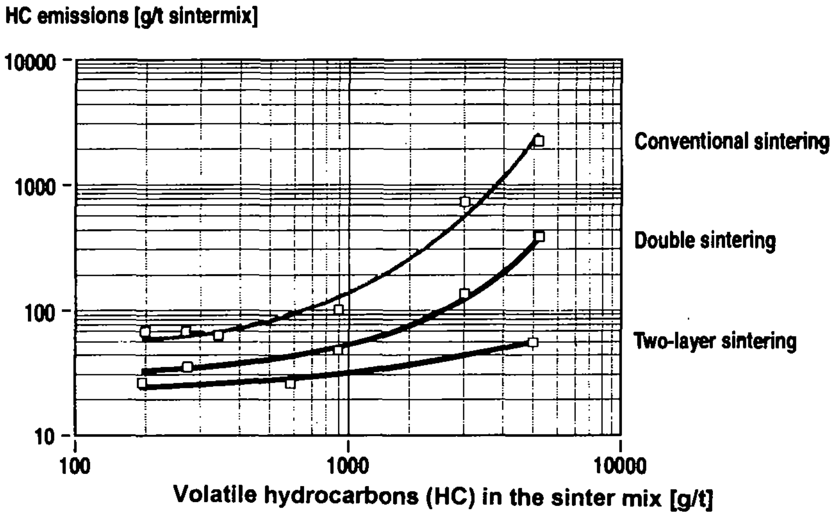

***Figure 2**: Volatile hydrocarbon emissions for different sinter processes (techniques). Lowest HC emissions are achievable with a two-layer sintering process.*