PCDD/F Emission Reduction 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 the agglomeration of fine grained raw materials (i.e. iron ore fines) and by-products (i.e. mill scale, flue dust) suitable for the blast furnace burden. Furthermore, sinter plants play an important role in residue recycling within iron & steel works. The major pollutants emitted from sinter production are fine dust (mean size ~ 0.2 µm) and aerosols (formed by NaCl, KCl vapors), HCl, HF, heavy metals, SO_x , NO_x and PCDD/F. 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 dioxin emission loads. Thus 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 control measures.

Development of a New Gas Cleaning Process

A new gas cleaning system based on a fine scrubber with dual flow nozzles was pioneered in 1989 by VAI and VOEST-ALPINE Stahl (VAS) Linz / Austria for application at the latter company's sinter plant. Since its start-up in August 1993 the first full-scale plant (exhaust gas 500,000 m^3/h standard) has been continuously operating, proving the effectiveness for PCDD/F emission reduction (Figure 1).

At the VAS sinter plant exhaust gas is ducted from the sinter strand to the new wet cleaning system after passing a coarse dust separator (preinstalled electrostatic precipitator). The main components of the gas cleaning system include (Figure 2):

- Quenching system for coarse dust separation, waste gas cooling and saturation
- Fine scrubber system for fine dust separation and simultaneous gas cleaning
- Water treatment facility for by-product separation and recovery.

The heart of this process is a fine scrubber system where specially developed dual flow nozzles eject water and compressed air as high-pressurized mist jets into the cooled waste gas stream. This allows for the removal of the finest dust particles and noxious gas components (PCDD/F, heavy metals, HCl, HF, SO_2) to a degree of efficiency which is unattainable by employing conventional systems such as electrostatic precipitators or fabric filters. Industrial water used as the scrubbing liquid is cleaned in a water treatment plant and recirculated to the process. By-products are recovered and separated. Ferrous components are recycled to the sinter strand, considerably reducing waste volumes. Unusable residues are immobilized.

Results and Conclusion

The integrated technological concept enables effective PCDD/F reduction, both minimizing precursors for PCDD/F formation and thermal destruction of residual organic compounds.

This is achieved by different measures as follows:

- Rapid exhaust gas cooling below 50° C in the quench
- Separation of heavy metal containing coarse dust, which acts as a catalyst on PCDD/F formation in the presence of hydrocarbons and chlorine
- Precipitation of PCDD/F on fine dust particles (aerosols) and efficient separation of particulates from the gas stream, both in the quench and fine scrubber
- Separation of catalytic precursors from the recycling stream in the water treatment facility
- Recycling of organic compounds to the sinter strand (and / or blast furnace) followed by thermal destruction in the burning zone at about 900° C - 1100° C.

At many sinter plant sites it is common practice to directly recycle fine dust from the electrostatic precipitator to the sinter strand. However, this practice usually results in secondary emissions (heavy metals) which have a positive catalytic effect on the formation of PCDD/F formation in the presence of hydrocarbons and chlorine. Experiments have shown an increase of PCDD/F emissions by a factor of 1.2 to 1.8.

PCDD/F formation and separation has been studied in detail, first at the pilot plant and later at the commercial plant. PCDD/F emission reduction strongly depend on the removal efficiency of fine dust particles in the fine scrubber. Excellent results are achieved yielding PCDD/F reduction of up to 90% and corresponding emission figures < 0.5 ng/Nm3 TEQ without additional measures. Figure 1 displays operational results on PCDD/F emission reduction measured at Linz works (VAS). Various measures were tested to optimize this performance.

Under normal operating conditions PCDD/F raw gas concentrations of 2.5 ng/Nm3 TEQ is measured. Chlorinated roasting was tested in order to increase the PCDD/F raw gas potential resulting in emissions figures of 5 ng/Nm3 TEQ. For both cases corresponding clean gas contents of approx. 0.5 ng/Nm3 TEQ are realized without additional measures. Waste gas cooling prior to gas cleaning results in lower emission figures (0.15 ng/Nm3 TEQ) on the clean gas side. By addition of coke fines (coke dust) in the waste gas stream further emission reduction down to a target value of 0.1 ng/Nm3 TEQ is realized.

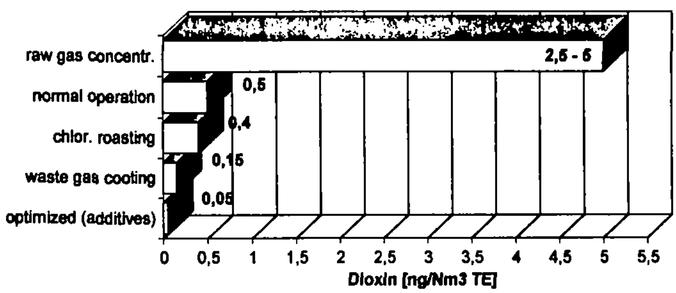

Figure 1: PCDD/F emission reduction for iron ore sinter plants (results measured at VAS Linz works / Austria)

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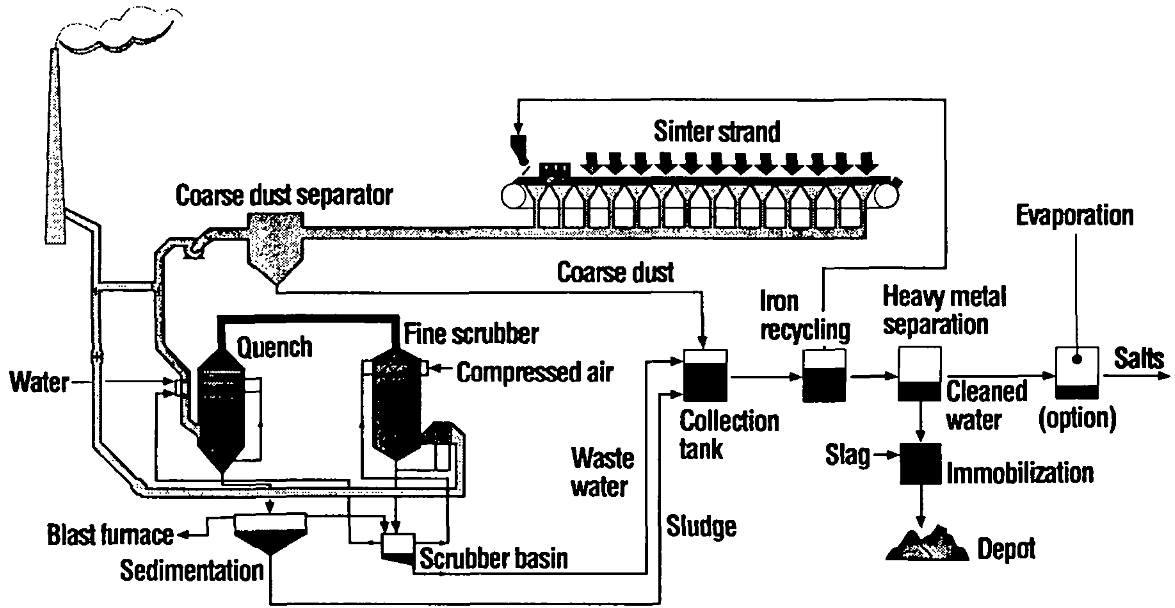

Figure 2: Flow sheet of a new wet type gas cleaning system for iron ore sinter plants