Dioxin at Sinter Plants and Electric Arc Furnaces – Emission profiles and removal efficiency

K. Hofstadler, A. Friedacher, W. Gebert and C. Lanzerstorfer

VOEST ALPINE Industrieanlagenbau GmbH, PO Box 4, 4031 Linz, Austria

Introduction

A major source of dioxins in the iron and steel industry are sinter plants. In these plants a mixture of iron ore, recycling material of the steel work, lime and coke are ignited under the ignition hood and forming sinter on the travelling grate. The Figure 1 shows a process Diagram of a sinter plant with a modern off-gas cleaning system through which the strict environmental regulations could be meet. Through this treatment the dioxin emissions are reduced to a level of 0.2 to 0.24 ng I-TEQ/Nm^3.

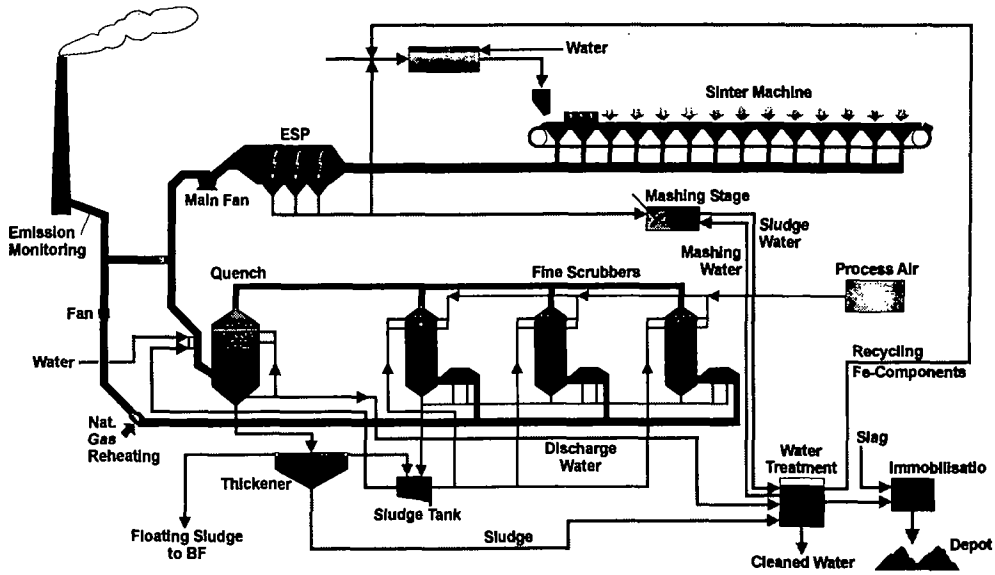

Figure 1: Process Diagram from a Sinter Plant

Another source of dioxins in the iron and steel industry are steel works with electric arc furnace (EAF). Since the increased application of the EAF-technology for the production of steel, which is mainly based on scrap (containing oil, plastic and other organic components), also the request of effective off-gas solutions for this process and its special problems has been stated. Especially the introduction of scrap-pre-heating technologies in the late 1980s resulted in increased demands for VOC and Dioxin reduction technologies. Depending on the type of furnace – conventional furnace (AC as well as the high performance DC furnace) and the furnace with scrap-pre-heating – special request to the cooling of the primary gases as well as the separation of coarse particles have to be considered. (Figure 2)

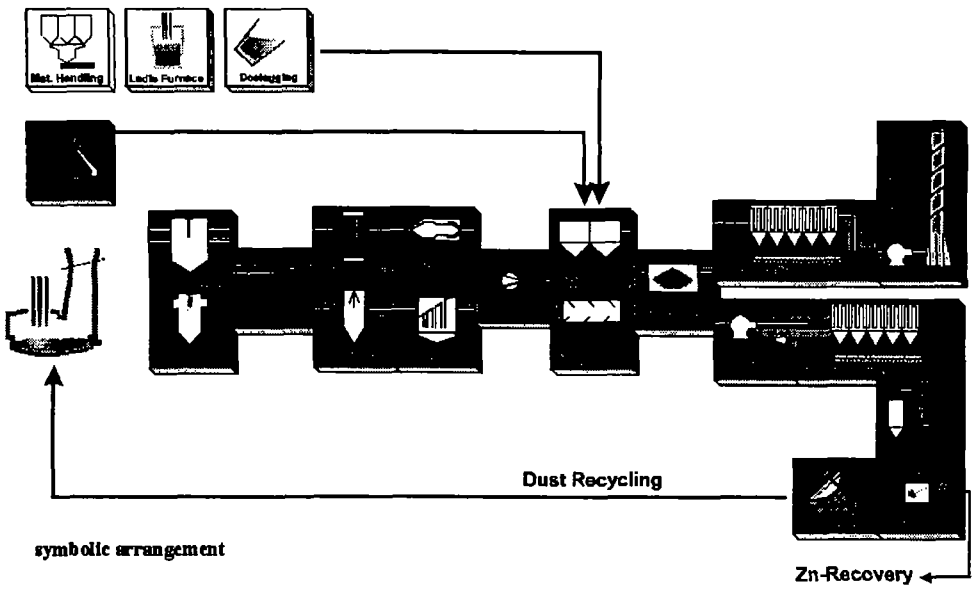

Figure 2: Modular EAF Off-Gas System

Materials and methods

All dioxin measurements in the raw gas (inlet of scrubbing system at sinter plants or inlet of filter before the adsorbents injection at EAF´s) and clean gas (in front of stack) were done according to VDI 3499 respectively DIN-EN 1948.

Results and discussion

PCDD/F Emission from the sinter plant

At a clean gas dust concentration higher than 50 mg/Nm^3 a reduction of the fine dust particles from the flue gas in the fine scrubber, reduce the PCDD/F-content in the clean gas strongly. **[1]**
The first reason for the correlation between the dust and dioxin removal is the extremely large surface of the fine particles available for adsorption and condensation, during the quench-cooling. The second reason is the large surface of the droplets at the fine scrubber, which is again available for condensation, and/or adsorption of the gaseous PCDD/F. Additionally the low temperature during the dust separation in the fine scrubber enhances the dioxin removal.
The comparison of the PCDD/F-congeners (ng congener / ng total PCDD/F) from measurements in the raw gas and the clean gas of a scrubber system, shows no difference in the removal efficiency for each congener. The small differences are only statistic oscillations. (Figure 3)
Within the congeners the furans with about 80% predominate clearly, the main furan congener is 2378 TCDF´s and the main dioxin congener is OCDD.

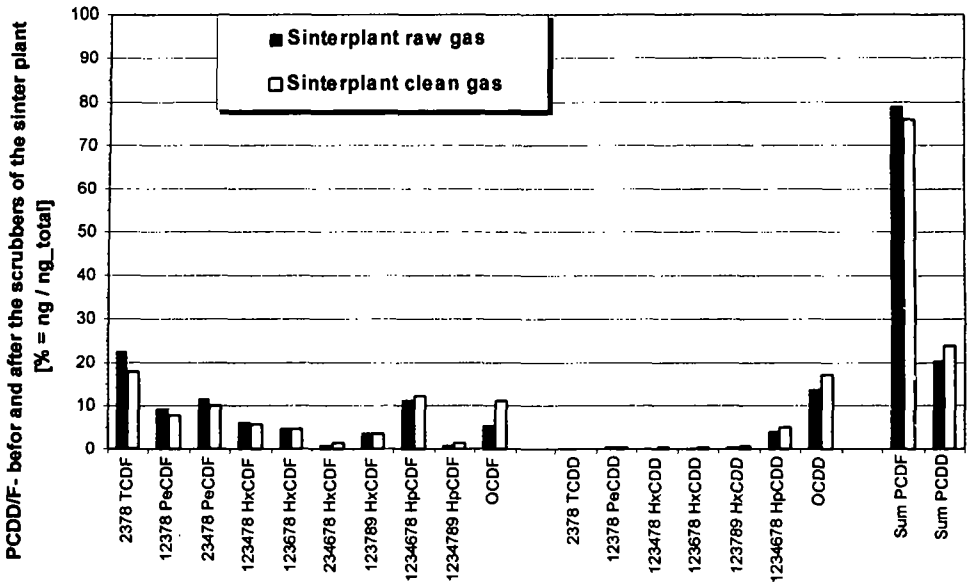

Figure 3: Emission profile of a sinter plant

PCDD/F Emission from the electric arc furnace

The scrap-pre-heating, but also the charging of scrap with high oil portion in conventional EAF's, generates PCDD/F's in the off-gas. Various experiments and installations have shown, that the most efficient way of reducing these portions is to apply a post combustion immediately after the furnace. The decomposed PCDD/F fractions may re-form to PCDD/Fs again. In order to prevent the "De-Novo-Synthesis" the respective temperature window for the off-gas coolling has topassed within short time. In order to achieve the appropriated cooling rates the application of spray coolers which inject approx. one lt./h of water per one Nm^3/h off-gas have shown to be very efficient to cool down the off-gas from 650 to 200°C within less then one second retention time. The application of dual flow nozzles will additionally increase the cooling rate significantly.[2] Still remaining or re-formed organic components may be removed by injection of adsorbents such as activated carbon, special type of coke, lime or others. By injection of such adsorbents a fast and homogeneous distribution of adsorbents within the off-gas stream has to be ensured.

At modern EAF off-gas-systems it is possible to reach with a fabric filter a clean gas dust concentration less then 7 mg/Nm^3. A further reduction of this small clean gas dust concentration will not reduce the PCDD/F-content in the clean gas significantly. [1] The PCDD/F-congeners distribution in the EAF raw-gas is nearly the same as it is at the raw gas of the sinter plant. Consider the congener removal efficiency there is a difference between the operation without or with injection of an adsorbents. (Figure 4)

Without injection: The removal behaviour is like at the sinter plant, that means that the differences are mainly statistic oscillations.

With injection: The congener distribution of the clean gas moves to higher dioxin parts as a result of the higher furan load in the raw gas. Trough the injection the PCDD/F emission could be reduced to a value clearly below 0,1 ng I-TEQ/Nm^3, that means a removal efficiency of about 99%. (removal efficiency: dioxin about 97,8% and furan about 99,8%)

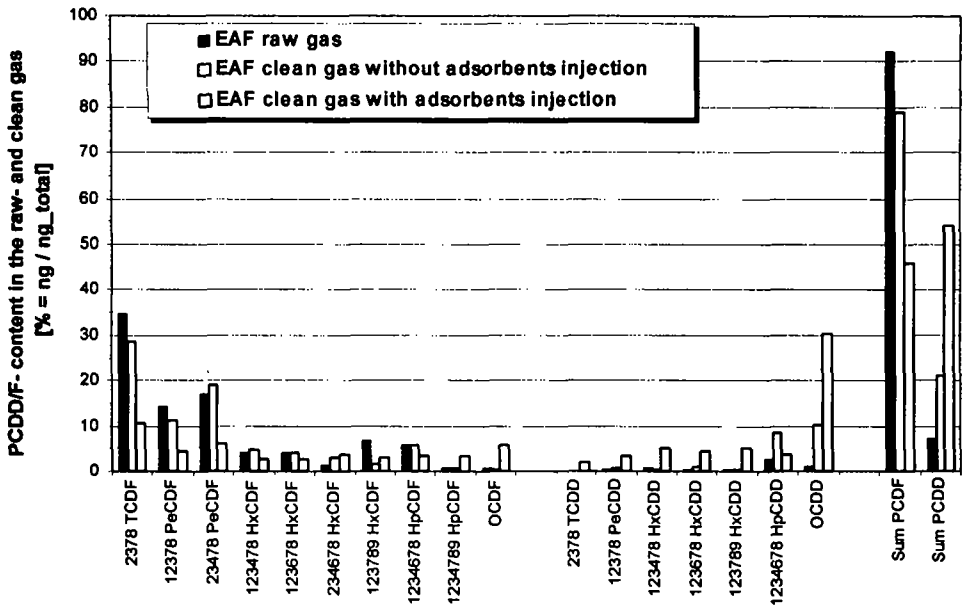

Figure 4: Emission profile of an electric arc furnace without / with adsorbent injection

A very important parameter for the PCDD/F reduction on the fabric filter is – especially by operating without adsorber injection – the filter inlet temperature. The temperature should be less than 80°C.

Conclusion

Effective dust removal and low temperature reduce the PCDD/F-emissions from the sinter plant by using the AIRFINE technology under the limiting value of the authorities is proven. For the EAF process a thermal off-gas treatment in combination with an adsorbents injection unit - or in some cases only a adsorption injection unit - represent one way to guarantee a PCDD/F-concentration under the authorities limiting value.

Acknowledgement and references

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[2] P.L. Steger, A. Friedacher, J. Lehner, W. Gebert: "Waste Gas Purification and Waste Free Plant Concept for EAF", Middle East Steel Congress 23. to 25th of May 1999, Qatar

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