

## **Annex 14: Ranges of emissions and reduction techniques**

### **Cement Plants, Generation of Air Emissions and Respective Reduction Techniques**

#### **Point Source Dust**

- Reasons for emissions: The cement production process includes thermal treatment (drying, heating, calcining, clinkerization, cooling) of materials through direct contact with hot gases. It also includes pneumatic material transports and material classification/separation. At the end of these processes air/gas and pulverized materials have to be separated again. Incomplete separation gives rise to dust emissions (kiln/raw mill main stack, clinker cooler stack, cement mill stacks, material transfer point dedusting air outlets).
- Ranges of emissions: Outdated dedusting equipment may emit up to several 100 mg/Nm<sup>3</sup>. Electrostatic precipitation easily reaches < 50 mg/Nm<sup>3</sup>. Bag filter dedusting produces values < 20 mg/Nm<sup>3</sup>. The visibility limit for point source dust is generally assumed to lie around 80 mg/Nm<sup>3</sup>.
- Reduction techniques: Bag filters and electrostatic precipitators for all kiln types and input materials.

#### **Fugitive Dust**

- Reasons for generation: Material spills from inadequately dedusted and/or worn out material transfer points/material feeding points, material storage areas, dusty transport roads etc. with subsequent wind erosion/dispersion.
- Ranges of emissions: Hard to quantify, mainly short range in-plant impacts (coarse dust).
- Reduction techniques: Preventive and quick reactive maintenance, wetting of stockpiles, roof covering of stock piles, vacuum cleaning systems, etc.

#### **SO<sub>2</sub>**

- Reasons for emissions: Volatile sulfur in raw materials roasted off at material preheating. Wet kilns only: 10 to 50% of total sulfur inputs are emitted
- Ranges of emissions: Dependent on content of raw materials of volatile sulfur compounds. Mostly below 300 mg/Nm<sup>3</sup>. Sometimes up to 3000 mg/Nm<sup>3</sup>.
- Reduction techniques: Hydrated lime addition to kiln feed for small gaps (<700 mg/Nm<sup>3</sup>). Wet sulfur scrubbers for large gaps.



## **NOx**

Reasons for emissions:	Thermal NO is produced in the main flame of all cement kilns in varying quantities dependant on sintering zone and flame temperatures. Some fuel NOx might be added via precalciner fuels.
Ranges of emissions: (unabated)	300 to 2000 mg/Nm <sup>3</sup>
Reduction techniques:	With limited effect: ⇒ Water cooling of main flame ⇒ Low-NOx burner ⇒ Reducing zones (mid kiln, transition chamber, low-NOx calciner)  With good effect: ⇒ Selective non-catalytic reduction (SNCR) with ammonia or urea injection in appropriate temperature window. ⇒ <800 mg/Nm <sup>3</sup> achievable with existing SP/PC kilns. ⇒ <500 mg/Nm <sup>3</sup> achievable with new SP/PC kilns.

## **VOC**

Reasons for emissions:	Volatile organics in raw materials roasted off at material preheating (idem SO <sub>2</sub> ). No products of incomplete combustion from main or precalciner firing.
Ranges of emissions:	Dependant on content of raw materials of volatile organics. Mostly below 50 mg/Nm <sup>3</sup> . Sometimes up to 500 (+) mg/Nm <sup>3</sup> .
Reduction techniques:	No cost effective end-of pipe techniques available to date, therefore avoid use of critical input materials or feed them together with the fuels.

## **HCl**

Reasons for emissions:	Chlorine may be present in raw materials as well as in alternative fuels (spent solvents, plastic) If inputs exceed the (low) carrying capacity of the clinker/kiln system then emission might result.
Ranges of emissions:	SP/PC kiln systems: <10 mg/Nm <sup>3</sup> Wet kilns: Up to 80 mg/Nm <sup>3</sup>
Reduction techniques:	No direct HCl abatement technique available, but sulfur wet scrubbers also reduce HCl emissions.

## **NH<sub>3</sub>**

Reasons for emissions:	Some natural raw materials (particularly clays) may contain NH <sub>3</sub> which is partially roasted-off at material preheating. Other NH <sub>3</sub> might be NH <sub>3</sub> slip (loss) from a SNCR NOx reduction installation.
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Ranges of emissions: <1 to 15 mg/Nm<sup>3</sup> as a rule with exceptions up to 40 mg/Nm<sup>3</sup>.

Reduction techniques: Keep enrichment in outer circulation low by extracting dust from a suitable point in the process and feeding to the transition chamber.

### **Benzene (C<sub>6</sub>H<sub>6</sub>)**

Reasons for emissions: Benzene might be present in conventional and alternative raw materials and is partially roasted off at material preheating.

Ranges of emissions: Normally 1 to 2 mg/Nm<sup>3</sup>, up to 3 and more mg/Nm<sup>3</sup> in rare cases

Reduction techniques: No reasonable abatement technique, input limitation with raw materials is the option.

### **Dioxines and Furans**

Reasons for emissions: Dioxins, furans or advanced precursors might be present in conventional (rarely) and alternative raw materials and are partially roasted off at material preheating. Reactive forms at chlorine (Cl<sub>2</sub>) present in the exhaust gases might expedite PCDD/F formation or modification.

Ranges of emissions: From below detection limits up to around 20% of the often adopted emission limit value of 0.1 ng/Nm<sup>3</sup>. Sometimes values up to 2 or 3 ng/Nm<sup>3</sup> can be found.

Reduction techniques: Same as benzene.

### **Heavy Metals**

Reasons for emissions: Heavy metals are ubiquitous in all cement kiln input materials. Since clean gas dust (i.e. dust after the dedusting equipment) is an input materials fraction, it also contains heavy metals. In addition, semi-volatile and volatile heavy metals are evaporated and condense (predominantly) on the fine dust fraction.

Ranges of emissions: Most heavy metal emissions (typically 80%) remain below the detection limits. All (with one exception) remain safely below generally adopted limit values. The one exception is mercury, which can exceed limit values in case of excessive inputs with materials.

Reduction techniques: Efficient dedusting equipment and limitation of mercury inputs in feed materials.