

# BAT in the European Cement Industry, outcome of the BREF

**revision: dust, NO<sub>x</sub> abatement, energy efficiency, trace elements, alternative fuels and materials, ...**

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## Introduction

The first revision of the Cement and Lime BREF (Best Available Techniques Reference Document) was finally approved by the IEF (Information Exchange Forum) on 1 April 2009 after almost 4 years of exchange of information under Article 17(2) of Council Directive 2008/1/EC (IPPC [Integrated Pollution Prevention and Control] Directive). The kick off meeting of the TWG (Technical Working Group) took place in September 2005. The TWG then held an “interim meeting for immediate consensus” in January 2007.

The first draft, covering sections 1 to 4 (General Information, Process and Techniques, Current consumptions and emissions, Techniques to consider in the determination of BAT [Best Available Techniques]) and 6 (Emerging Techniques), was issued for consultation in September 2007. The second part of this first draft was issued for consultation in May 2008 (this covered the revised section 4 on Techniques to consider in the determination of BAT and section 5 on BAT). The final TWG meeting was held in September 2008.

The present article aims at summarising the principal BAT conclusions and the associated consumption and emission levels applicable to the cement industry.

The BREF addresses industrial activities specified under Section 3.1 of Annex I to Directive 2008/1/EC, namely: “3.1. Installations for the production of cement clinker in rotary kilns with a production capacity exceeding 500 tonnes per day”.

The present article refers to the exact sections of the BREF for easy cross referencing.

## BATAELs versus ELVs

It has to be highlighted that the BREF does not propose ELVs (emission limit values). The best available techniques and the emission or consumption levels associated with best available techniques (BAT-AEL [Associated emission levels] ranges) are related to installations with different kiln sizes, different operating conditions and capacity utilisation. Special local considerations cannot be taken fully into account in such a generic document. The determination of appropriate permit conditions will involve taking into account local, site-specific factors, such as the technical characteristics of the installation concerned, its geographical location and the local environmental conditions. Even the single objective of ensuring a high level of protection for the environment as a whole will often involve making trade-off judgements between different types of environmental impacts, and these judgements will often be influenced by local considerations.

The BREF will assist in the determination of appropriate ‘BAT-based’ conditions for the installation or in the establishment of general binding rules under Article 9(8) of the IPPC Directive. It is foreseen that new installations can be designed to perform at or even better than BAT levels. It is also considered that existing installations could move towards BAT levels or do better, subject to the technical and economic applicability of the measure/techniques in each case.

While the BAT reference documents do not set legally binding standards, they are designed to provide guidance to the industry, Member States and the public on achievable emission and consumption levels when using specified measures/techniques. The appropriate permit conditions for any specific case will need to be determined taking into account the objectives of the IPPC Directive and local considerations.

‘Best Available Techniques’ for a specific installation will usually be the use of one individual BAT or a combination of BATs.

Where measures/techniques identified individually as BAT can be used in combination, the effects of such combinations should be considered when drawing conclusions on BAT based permit conditions for individual cases.



## BAT conclusions

### Introduction

BAT associated emission levels are expressed on a daily average basis and standard conditions. The definitions regarding the standard conditions applied are given in Table 1:

**Table 1**

Nm <sup>3</sup> /h	Volume flow: if not otherwise mentioned in this section, the volume flows refer to 10 vol-% oxygen and standard state
mg/Nm <sup>3</sup>	Concentration: if not otherwise mentioned in this section, the concentrations of gaseous substances or mixtures of substances refer to dry flue-gas at 10 vol-% oxygen and standard state.
standard state	Refers to a temperature of 273 K, a pressure of 1013 hPa and dry gas.

### Process selection and Energy Consumption

For new plants and major upgrades, a dry kiln with multistage preheater and precalciner is considered as BAT. Under regular and optimised operational conditions, the associated BAT heat balance value is 2900 - 3300 MJ/tonne clinker (BAT 5 under Section 1.5.3.1).

### Co-processing of alternative fuels and raw materials

Co-processing was not covered by the first BREF. It has since been fully integrated into the revised document and is now considered as BAT in the cement industry.

Quality assurance systems shall be put in place to guarantee the characteristics of waste: constant quality, physical and chemical criteria (BAT 10 under Section 1.5.4.1).

The BREF also recommends the following:

- use of the appropriate feed points to the kiln in terms of temperature and residence time depending on kiln design and kiln operation (BAT 11 a under Section 1.5.4.2),
- feed waste materials containing organic components that can be volatilised before the calcining zone into the adequately high temperature zones of the kiln system (BAT 11b under Section 1.5.4.2),

- operate in such a way that the gas resulting from the co-processing of waste is raised in a controlled and homogeneous fashion, even under the most unfavourable conditions, to a temperature of 850°C for 2 seconds (BAT 11c under Section 1.5.4.2),

- raise the temperature to 1100°C, if hazardous waste with a content of more than 1% of halogenated organic substances, expressed as chlorine, is co-processed (BAT 11d under Section 1.5.4.2),

- feed waste continuously and constantly (BAT 11e under Section 1.5.4.2),

- stop co-processing waste for operations such as start-ups and/or shutdowns when appropriate temperatures and residence times cannot be reached, as noted in BAT 11 a-d (BAT 11f under Section 1.5.4.2).

It is also BAT to apply safety management for the handling, e.g. storage, and/or feeding of hazardous waste materials, such as using a risk based approach according to the source and type of waste, for the labelling, checking, sampling and testing of waste to be handled (BAT 12 under Section 1.5.4.).

### Dust emissions

For dust emissions, the BREF distinguishes channelled dust emissions from dusty operations (BAT 14 in Section 1.5.5.2), dust emissions from kiln firing processes (BAT 15 under Section 1.5.5.3) and dust emissions from cooling and milling processes (BAT 16 under Section 1.5.5.4).

For channelled dust emissions in general, the BREF requires the establishment of a maintenance management system which specifically addresses the performance of filters. Taking this management system into account,

#### NO<sub>x</sub> BATAELs (Table 2)

Kiln type	Unit	BAT-AEL (daily average value)
Preheater kilns	mg/Nm <sup>3</sup>	<200 – 450 <sup>2)</sup> <sup>3)</sup>
Lepol and long rotary kilns	mg/Nm <sup>3</sup>	400 – 800 <sup>1)</sup>

<sup>1)</sup> Depending on initial levels and ammonia slip

<sup>2)</sup> BAT-AEL is 500 mg/Nm<sup>3</sup>, where after primary measures/techniques the initial NO<sub>x</sub> level is >1000 mg/Nm<sup>3</sup>

<sup>3)</sup> Existing kiln system design, fuel mix properties including waste, raw material burnability can influence the ability to be in the range. Levels below 350 mg/Nm<sup>3</sup> are achieved at kilns with favourable conditions. The lower value of 200 mg/Nm<sup>3</sup> has only been reported as a monthly average for three plants (easy burning mix used)

BAT is to reduce channelled dust emissions from dusty operations to less than 10 mg/Nm<sup>3</sup> (BAT-AEL), as the average over the sampling period (spot measurement, for at least half an hour) by applying dry exhaust gas cleaning with a filter. For small sources (<10000 Nm<sup>3</sup>/h) a priority approach has to be taken into account.

For the main stack (kiln firing), the BAT-AEL daily average value is <10 – 20 mg/Nm<sup>3</sup>. The BREF specifies that the lower level is achieved when applying fabric filters or new or upgraded ESPs (electrostatic precipitators).

For the clinker cooler and the mills, the BAT-AEL daily average value or average over the sampling period is <10 – 20 mg/Nm<sup>3</sup>, (spot measurements for at least half an hour). Here again, the BREF specifies that the lower level is achieved when applying fabric filters or new or upgraded ESPs.

The BREF further specifies that for ESPs or hybrid filters, the frequency of CO trips shall be minimised and their total duration shall be kept below 30 minutes annually, by applying the measures/techniques which are listed in BAT 21 a-c under Section 1.5.6.3.1.

### NO<sub>x</sub> levels

NO<sub>x</sub> emissions shall be reduced by applying measures/techniques individually or in combination i.e.:

- primary measures/techniques such as flame cooling, low NO<sub>x</sub> burners, mid kiln firing, addition of mineralisers and process optimisation,
- staged combustion (conventional or waste fuels), also in combination with a precalciner and the use of optimised fuel mix,
- SNCR (Selective Non-Catalytic Reduction).

All those measures are listed in BAT 17a to d under Section 1.5.6.1.

The emission levels associated with SNCR are given in Table 21 (BAT 17 under Section 1.5.6.1).

In terms of NH<sub>3</sub> slip, the BREF specifies that NH<sub>3</sub> slip shall be kept as low as possible but below 30 mg/Nm<sup>3</sup>, as the daily average value. The document further specifies that the correlation between the NO<sub>x</sub> abatement efficiency and the NH<sub>3</sub> slip has to be considered and that depending on the initial NO<sub>x</sub> level and on the NO<sub>x</sub> abatement efficiency, the NH<sub>3</sub> slip may be higher up to 50 mg/Nm<sup>3</sup>. For Lepol and long rotary kilns, the level may be even higher (BAT 18 c under Section 1.5.6.1).

- SCR (Selective Catalytic Reduction) will only be considered as BAT subject to appropriate catalyst and process development in the cement industry.

### Trace elements

Emissions of metals from the flue-gases of the kiln firing processes shall be controlled by applying the measures/techniques which are listed in BAT 26 a - c under Section 1.5.8 individually or in combination. The BAT-AELs for metals are given in Table 3:

BATAELs for Heavy Metals (Table 3)

Metals	Unit	BAT-AEL (average over the sampling period (spot measurements, for at least half an hour))
Hg	mg/Nm <sup>3</sup>	<0.05 <sup>2)</sup>
∑ (Cd, Tl)	mg/Nm <sup>3</sup>	<0.05 <sup>1)</sup>
∑ (As, Sb, Pb, Cr, Co, Cu, Mn, Ni, V)	mg/Nm <sup>3</sup>	<0.5 <sup>1)</sup>

<sup>1)</sup> Low levels have been reported, see Sections 1.3.4.7, 1.3.4.7.1 and 1.4.7.

<sup>2)</sup> Low levels have been reported (see Sections 1.3.4.7, 1.3.4.7.1 and 1.4.7). Values higher than 0.03 mg/Nm<sup>3</sup> have to be further investigated. Values close to 0.05 mg/Nm<sup>3</sup> require consideration of additional measures/techniques such as those described under Sections 1.3.4.13, 1.3.9.1 and 1.4.7.

### SO<sub>2</sub> levels

Absorbent additions and wet scrubber are considered as BAT in the cement industry. The following emission

levels are BAT-AELs (daily average value): <50 to <400 mg/Nm<sup>3</sup>. The range takes into account the sulphur content in the raw materials.

### Other pollutants

#### Dioxins/ Furans

PCDD/F (Polychlorinated dibenzo-p-dioxins [PCDD] and dibenzofurans [PCDF]) emissions shall be controlled by applying the measures/techniques which are listed in BAT 25 a-f under Section 1.5.7 individually or in combination. The BAT-AELs are <0.05 - 0.1 ng PCDD/F I-TEQ/Nm<sup>3</sup>, as the average over the sampling period (6 - 8 hours).

#### HCl/ HF

HCl (Hydrogen chloride) emissions shall be kept below 10 mg/Nm<sup>3</sup> (BAT-AEL), as the daily average value or average over the sampling period (spot measurements, for at least half an hour), by applying the measures/techniques which are listed in BAT 23 a and b under Section 1.5.6.5 individually or in combination.

HF (Hydrogen fluoride) emissions shall be kept below 1 mg/Nm<sup>3</sup> (BAT-AEL) expressed as HF, as the daily average value or average over the sampling period (spot measurements, for at least half an hour), by applying the primary measures/techniques which are listed in BAT 24 a, b under Section 1.5.6.5 individually or in combination.

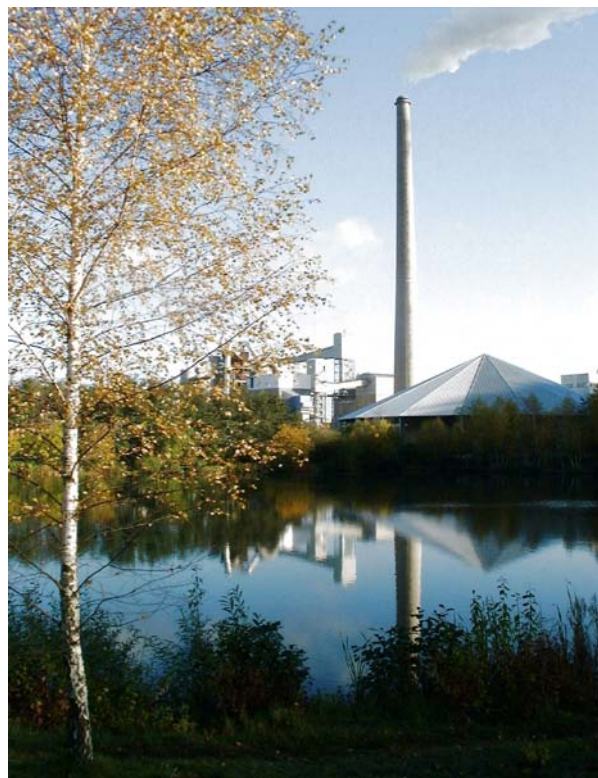
#### TOC

TOC (Total organic compounds) emissions shall be controlled by avoiding the feeding of raw materials with a high content of volatile organic compounds into the kiln system via the raw material feeding route.

### Others

The BREF also specifies that it is BAT to adhere to and implement an Environmental Management System (standard for all European BREFs).

Finally, the BREF contains a few recommendations in order to reduce noise emissions.



## Conclusions

The first revision of the Cement and Lime BREF was finally approved by IEF on 1 April 2009.

CEMBUREAU is rather satisfied with the BAT conclusions, which are to be seen as ambitious. No split views were recorded.

It is important to highlight that the Cement and Lime BREF was the pioneer for the review of the first series of BREFs.