D. Lechtenberg, MVW Lechtenberg Projektentwicklungs- und Beteiligungsgesellschaft mbH, Mülheim an der Ruhr, Germany

SUMMARY

This article is the first excerpt from MVW Lechtenberg & Partner's "Alternative Fuels and Raw Materials Handbook for the Cement and Lime Industry" [1] amended by new developments on emission regulations. Further excerpts of the book will be published in forthcoming issues of CEMENT INTERNATIONAL. The transition of the European Industrial Emission Directive (IED) into German law and new environmental legislations in the US are again launching the discussion about the costs of environmental protection versus the protection of jobs. The author describes the recent developments compared with emission regulations in other countries. A short guideline is given on emission monitoring as well as on authorisation issues for the use of alternative fuels.

ZUSAMMENFASSUNG

Der vorliegende Bericht ist der erste Auszug aus dem Band 1 des „Alternative Fuels and Raw Materials Handbook for the Cement & Lime Industry" [1]. Weitere Buchauszüge werden in den kommenden Ausgaben der CEMENT INTERNATIONAL veröffentlicht werden. Aufgrund der Aktualität der Thematik wurde der vorliegende Beitrag um neueste Entwicklungen im Bereich der Emissionsregelungen erweitert. Die Umsetzung der Europäischen Richtlinie für industriellen Emissionsschutz in bundesdeutsches Gesetz und neue Emissionsschutzregelungen für die Zementindustrie in den USA haben erneut die Diskussion über „bezahlbaren" Umweltschutz entfacht. Der Autor beschreibt die aktuellen Entwicklungen und vergleicht Emissionsschutzstandards verschiedener Länder. Des Weiteren werden Techniken zur Überwachung bzw. zum Monitoring der Emissionen sowie Hinweise für Genehmigungsverfahren für den Einsatz von alternativen Brennstoffen vorgestellt.

(English text supplied by the author)

Alternative Fuels Guide – Part 1: Environmental regulations and emission limits

Ratgeber alternativer Brenn- und Rohstoffe – Teil 1: Umweltgesetze und Emissionsgrenzwerte

1 Introduction

Alternative fuels, consisting of biomass or "refuse-derived fuels" (RDF) have been used as a substitute for fossil fuels for around 30 years, especially in the cement industry and also to a small extent in the lime industry. As strict quality standards are set for cement clinker and lime products, the raw materials and fuels which are fed into the burning process need to be most precisely specified and to be subject to constant monitoring.

Rotary kilns in particular offer the ideal preconditions for recycling alternative fuels at extremely high temperatures with long residence times and in an environmentally friendly fashion. One of the indispensable prerequisites for this is securing the composition of the alternative fuels in compliance with the prescribed specifications, thereby minimising any possible negative effects on both emissions and end products.

Some environmental associations impose strict measures for avoidance of all kinds of detrimental environmental effects resulting from the employment of alternative fuels. But as is widely known, detrimental environmental effects cannot be avoided in any combustion process. In order to minimise these effects, for many years the cement and lime industry has been working on emission reducing measures.

The topic of co-incineration particularly of waste-derived, alternative fuels has recently again become a controversial issue. The reason for this is on the one hand the new "MATS-Regulation" for the cement industry in the U.S. and on the other hand the implementation of the Industry Emission Directive of the EU Commission into German law.

The European Union passed the Industry Emission Directive (in the following: "IED") in 2010. The IED regulates the integrated avoidance and decrease of emissions produced by the industrial sector in air, water and soil.

The directive is based on the former Integrated Pollution Prevention and Control Directive (in the following: "IPPC-Directive"). It covers some former independent directives, i.e. the directive on large-scale firing plants, which regulates emissions of power plants, or the Waste Incineration Directive. The IED came into force on 6th of January 2011 and must be implemented into national law within two years. In order to meet this requirement the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (in the following "BMU") generated a realisation draft.

The law providing guidelines and the first omnibus act were concluded by the cabinet on 23rd of May 2012 and are now to be passed by the Federal Council of Germany ("Bundesrat"). The first draft of the second regulation is still subject to internal voting by the government, but is planned to be added to the proceeding at a later date.

The present realisation draft sets a number of stricter emission limit values which particularly affect the cement industry. At present this sector covers more than 60 % of its demand for thermal energy from waste and waste-derived fuels respectively. This development was allowed due to an exception clause for the cement industry in Annex II 1.1 of the Federal Immission Control Act (in the following "17th BImSchV"). For TOC (total organic carbon) in particular, exception clauses were granted due to the fact that TOC emissions mostly result from natural raw materials (e.g. limestone, marl). In the future, such exception clauses ought to be prohibited. The TOC concentration ought to be controlled more strictly by performing calcination tests on the natural raw materials continuously. The same proceeding would also apply to the alternative raw materials used for clinker production. ➐ Table 1 shows an excerpt of published emission data of a German cement plant.

According to the realisation draft in hand, NO_x-values ought to be reduced radically to 100 mg NO_x/m^3 (stp) – a complicated task since the currently applied SNCR-technique ("Selective Non-Catalytic Reduction") already results in high costs. Also the flue gas cleaning systems, which

Table 1: Excerpt of published emission data at standard conditions of a German cement plant (MVW)

Emissions	**Acc. to approval/17. BImSchV**	**Average concentration**
Continuous measurements acc. to § 5a and Annex II 1.1	Emission limit value	Annual average value
Dust	12 mg/m^3	2.0 mg/m^3
Sulphur dioxide (as SO_2)	400 mg/m^3	204 mg/m^3
Nitrous dioxide (as NO_2)	500 mg/m^3	478 mg/m^3
Mercury (Hg)	0.03 mg/m^3	0.0069 mg/m^3
TOC (C_{ges})	–	13 mg/m^3
Individual measurements	Emission limit value	Ø of all individual measurements
Chloride (HCl) acc. to Annex II 1.1	12.0 mg/m^3	6.2 mg/m^3
Fluoride (HF) acc. to Annex II 1.1	1.4 mg/m^3	0.07 mg/m^3
∑ Cd + Tl acc. to § 5 (1) No. 3a	0.05 mg/m^3	0.0023 mg/m^3
∑ Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V, Sn acc. to § 5 (1) No. 3b	0.5 mg/m^3	0.13 mg/m^3
∑ As, Benzo(a)pyrene, Cd, Co, Cr acc. to § 5 (1) No. 3c	0.05 mg/m^3	0.009 mg/m^3
Dioxins/furans acc. to § 5 (1) No. 4	0.1 ng/m^3	0.0015 ng/m^3

Table 2: Calculation of flue gas agent consumption with different emission limit scenarios in an RDF power plant; to reduce NO_x emissions from 400 mg/m³ (stp) to 100 mg/m³ (stp) approx. 4.5 kg/t RDF of flue gas agents at a current value of approx. € 1.5 are needed

Reference:				
RDF: Calorific value = 12.09 GJ/kg, moisture = 12.9 %				
1 t of RDF results in flue gas	5 428 m³/t stp (448 m³/GJ stp) at 8.05 % O_2 (dry) Air ratio: 1.6			
Assumptions:				
400 mg/m³ stp of NO_x (as NO_2) which must be reduced in dry RG to 200 mg/m³ stp of NO_x (as NO_2)				
→ Reduction	1.09 kg/t 0.084 kg/GJ			
Calculations:				
Molecular weight	NO_2 46 kg/kmol; NH_3 17 kg/kmol			
Stochiometry	1.05			
Ammonia demand	0.421 kg/t RDF 0.032 kg/GJ			
Ammonia water	25 mass % 1.68 kg/t RDF 0.13 kg/GJ			
Scenarios:	Waste with CV of 13 MJ/kg		Waste with CV of 11 MJ/kg	
	kg/t*)	kg/GJ*)	kg/t*)	kg/GJ*)
400 to 200 mg	1.68	0.13	1.68	0.15
400 to 100 mg	2.53	0.19	2.53	0.23
750 to 200 mg	4.63	0.36	4.63	0.42
750 to 100 mg	5.48	0.42	5.48	0.5

*) kg of ammonia water/t RDF

use ammonia or urea, produce further emissions – the ammonia slip, limited to 30 mg/m³ (stp) – have to be classified as problematic in many plants at present. A NO_x-reduction on the one hand results inevitably in a higher ammonia slip on the other. Further NO_x-reduction can therefore only be achieved by optimising the injection/process control and by feeding higher amounts of compounds containing ammonia (❱ Table 2). If this is not an option, significant investments have to be made in order to modernise or rather upgrade the flue gas cleaning systems from SNCR-technology to SCR-technology ("Selective Catalytic Reduction").

To make a long story short, lowering of limit values (❱ Table 3) – especially for TOC and NO_x – would have severe technical and financial impacts on the German cement industry which could result in a stop of co-incineration in some plants, which would mean a loss of competitiveness and would be similar to a close-down decision.

In the U.S., the cement industry and all other enterprises using fossil fuels have to observe the MATS-regulations. The new act which is named Utility MATS – short for Mercury and Air Toxics Standards, was published on 16th of February 2012 as National Emission Standards for Hazardous Air Pollutants from Coal- and Oil-Fired Electric Utility Steam Generating Units. This law covers not only mercury, but also dust, SO_2 and HCl.

The radical reduction of emission limit values for facilities is a direct result of the systematic identification of the best technology for flue gas cleaning systems (MACT – Maximum Achievable Control Technology). According to Vosteen

Figure 1: Dust emissions cement plant Africa, 2012 (MVW)

and Hartmann [2] coal-fired power plants which are already in operation ought to comply with a limit value (30 day rolling average) of 1.5 µg of Hg/m³ (stp) while a limit value of 25 ng of Hg/m³ (stp) applies to new plants (both limit values at an O_2-level of 5 volume %). The latter however, is still subject to discussion according to a survey and petition dated

Table 3: Comparison of emission limits in Germany including the respective consequences of the new IED regulations

Parameter	Limit value before amendment (RDF use > 60 %)	Limit value before amendment (RDF use < 60 %)	Limit value acc. to new IED regulation
Dust	10 mg/m³ (d)	20 (d)	10 mg/m³ (d)
NO_x	200 mg/m³ (d)	500 (d)	200 mg/m³ (d)
SO_2	50 mg/m³ (d) (1)	50 mg/m³ (d) (1)	50 mg/m³ (d)
HCl	10 mg/m³ (d)	10 mg/m³ (d)	10 mg/m³ (d)
HF	1 mg/m³ (d)	1 mg/m³ (d)	1 mg/m³ (d)
Hg	0.03 mg/m³ (2)	0.03 mg/m³ (2)	0.02 mg/m³ (d)
Cd+Tl	0.05 mg/m³ (2)	0.05 mg/m³ (2)	0.05 mg/m³
Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V+Sn	0.5 mg/m³ (2)	0.5 mg/m³ (2)	0.5 mg/m³
TOC	10 mg/m³ (d) (1)	10 mg/m³ (d) (1)	10 mg/m³ (d)
Dioxins/furans	0.1 TEQ ng/m³ (2)	0.1 TEQ ng/m³ (2)	0.1 TEQ ng/m³
CO	50 mg/m³ (d) (1)	50 mg/m³ (d) (1)	50 mg/m³ (d) (1)
Source	[3]	[3]	[4]

(d) = Daily average values
(1) Exemptions possible if emissions derive from raw materials
(2) Average of the sampling period
(3) Measurement conditions: Temperature 273 K, pressure 101.3 kPa, 10 % oxygen, dry gas

PROCESSING

Table 4: Emission limit values (daily averages) in various countries

Para to meter	Unit	Pakistan	Philippines	European Union [3]	Germany			
					> 60 % RDF use [3]	< 60 % RDF use [3]	Limit in permits	Emission values from kilns in operation
Dust	mg/m^3	300	150	30 (d)	10 (d)	20 (d)	15 to 20	1 to 15
NO_x	mg/m^3	400 to 1 200 (depending on fuel)	1 000 (existing plants) 500 (new plants)	800 (d) (existing plants) 500 (d) (new plants)	200 (d)	500 (d)	500 to 800	300 to 600
SO_2	mg/m^3	400	1 000 (existing plants) 200 (new plants)	50 (d) [1]	50 (d) [1]	50 (d) [1]	350 to 400	100 to 400
HCl	mg/m^3	400	10	10 (d)	10 (d)	10 (d)	10	0.3 to 5
HF	mg/m^3	150	50	1 (d)	1 (d)	1 (d)	1	0.1 to 2
Hg	mg/m^3	10	5	0.05 [2]	0.03 [2]	0.03 [2]	0.03 to 0.05	0.005 to 0.03
Cd+Tl	mg/m^3		only Cd: 10	0.05 [2]	0.05 [2]	0.05 [2]	0.05	< 0.001
Sb+As+Pb+ Cr+Co+ Cu+Mn+Ni+V	mg/m^3	Pb: 50; Cd: 20 As: 20; Cu: 50 Sb: 20; Zn: 200	Sb: 10; As: 10 Pb: 10; Cu: 100 Ni: 20; Zn: 100	0.5 [2]				
Sb+As+Pb+ Cr+Co+Cu+ Mn+Ni+V+Sn	mg/m^3				0.5 [2]	0.5 [2]	0.05	< 0.002
TOC	mg/m^3			10 (d)	10 (d) [1]	10 (d) [1]	9.2 to 60	
Dioxins/furans	TEQ ng/m^3		0.1	0.1 [2]	0.1 [2]	0.1 [2]	0.05 to 0.1	0.001 to 0.01
CO	mg/m^3		500	50 (d)	50 (d) [1]	50 (d) [1]		
Source		[5]	[6]	[7]	[3]	[3]	[8]	[8]

(d) = Daily average values
(1) Exemptions possible if emissions derive from raw materials
(2) Average of the sampling period
(3) Measurement conditions: Temperature 273 K, pressure 101.3 kPa, 10 % oxygen, dry gas

16th of April 2012 by the Institute of Clean Air Companies (ICAC) which has more than 100 members amongst U.S. air pollution prevention companies. The petition suggests a noticeably higher, actually measurable limit value of 0.35 µg of Hg/m^3 (at an O_2-level of 5 volume %).

While some countries provide clear emission limit values as well as regulations on the use of alternative fuels and alternative raw materials, many cement production facilities, particularly in developing countries and newly industrialised countries, have to lay the groundwork for the substitution of fossil fuels with such alternative materials.

Permissible emission limit values show a wide variety when compared in various countries (➧ Table 4). The table also shows ranges of emission values for various cement plants in Germany. The emission ranges within which the kilns operate; depend largely on the nature of the raw materials, the fuels, the age and design of the plant but also on the requirements laid down by the permitting authority.

2 Monitoring of emissions

According to the EU directive on the incineration of waste, the emissions of total dust, SO_2, NO_x, TOC, CO, HCl and HF have to be measured continuously in the exhaust gas of co-incineration plants, e.g. a cement kiln which uses alternative fuels. However, the directive provides for certain exemptions and as a consequence the requirements can differ from one European country to another [9].

Figure 2: Tanks for flue gas agents (SNCR) Germany, 2012 (MVW)

PROCESSING

Figure 3: Gas probe (kiln inlet), 2012 (MVW)

There are two ways of emissions monitoring: On the one hand, there are continuous measurements which are made possible by modern analysis devices. Relevant continuous measuring principles are infrared (IR) and ultraviolet (UV) photometry as well as fourier transform infrared spectrometry (FTIR) and flame ionisation detection.

According to the EU directive the installation and functioning of the automated monitoring equipment has to be monitored by an annual surveillance test. Calibration has to be done by means of parallel measurements with reference methods at least every three years [9].

According to the European Cement Research Academy ("ECRA") there are, on the other hand, the so-called individual measurements which cannot be conducted continuously but only in defined periods. Trace metals belong to this group as well as dioxins and furans. HF and HCl are subject to periodic measurement only because it has been proved that emission concentrations are very low due to the alkaline atmosphere in the kiln and the preheaters [9].

ECRA further points out that measurements have to follow the provisions of CEN standards or, in case CEN standards are not available, according to ISO standards, national or international standards. These procedures should ensure the provision of data of an equivalent scientific quality. During each periodical measurement it is necessary to determine the relevant exhaust gas parameters. Beside the gas volume flow, the current temperature and water vapour of the gas flow, as well as the surrounding pressure and the gas density have to be measured. These parameters are important to determine the total mass flows but also to standardise the measuring results to 273 K, 1 013 mbar and dry gas [9].

Bolwerk [8] illustrates a further distinction made between first-time and repeat measurements, function tests and calibrations as well as measurement for special reasons, e.g. to determine the emissions of exhaust gas components which are not continuously monitored. The relevant parameters to be considered in measurement planning are derived from regulatory requirements, e.g. the operating permit, information from the technical supervisory body responsible for the plant and from on-site inspection. All emissions measurement results are related to exhaust gas volume at standard temperature and standard pressure conditions (273 K, 1 013 mbar), referred to dry gas and 10 % oxygen content.

Continuous measurements are recommended for the following parameters [8, 10]

- Exhaust gas volume
- Moisture
- Temperature
- Total dust
- Oxygen concentration
- NO_x (nitrogen oxides)
- SO_2 (sulphur oxides)
- CO (carbon monoxide)
- Hg (mercury and its compounds)

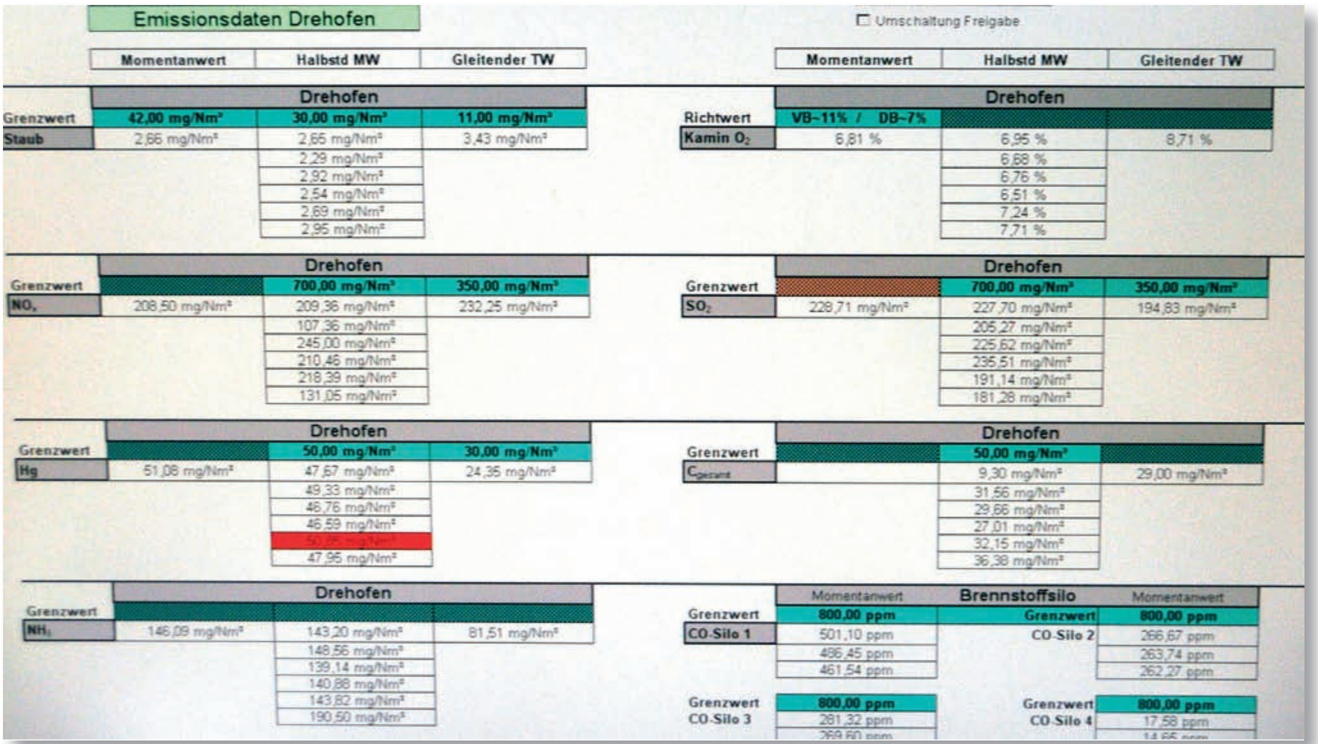


Figure 4: Online emission monitoring in a German cement plant, 2012 (MVW)

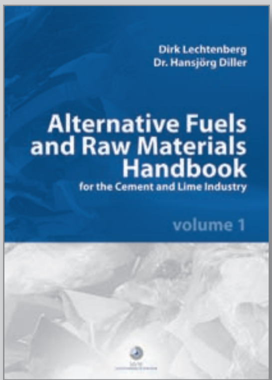
The authors: Dirk Lechtenberg
Dr. Hansjörg Diller

Purchase order form

Alternative Fuels and Raw Materials

HANDBOOK

For the Cement and Lime Industry



The substitution of fossil fuels by alternative fuels in the cement and lime industry is increasingly coming into focus for companies. The reason for this is a growing general awareness of both the necessity for sustainable limitation and control of CO_2 (and other) emissions as well as of the increasing shortage of fossil fuels. Yet the implementation of alternative fuels is a complex undertaking which requires taking into account a broad range of factors.

The Alternative Fuels and Raw Materials Handbook is the most comprehensive reference work on alternative fuels and raw materials for the cement and lime industry to date. It brings together research results from the most diverse sources combined with the knowledge and long-term pertinent experience of the authors in an indispensable guide on alternative fuels and raw materials. This book is primarily aimed at technologists and engineers as well as industry decision makers who use alternative fuels and alternative raw materials or who plan their implementation.

The first volume at hand provides detailed and objective information on, among others, preconditions for utilisation, production technologies, effective quality management, logistical requirements, storage, metering, feeding, drafting of contracts and emission controls. Furthermore it imparts the basic understanding required for the second volume, in which the special material characteristics of a large number of suitable raw materials and alternative fuels are precisely and individually addressed.

A must-have for every Alternative Fuels Manager!

2012, 531 pages, 16,5 x 23,5 cm, 160 pictures, 89 figures, 111 tables
ISBN 978-3-7640-0550-4, Hardcover, € 690,00

volume 1

Essential information regarding alternative fuels and raw materials combined in a two-volume AFR Handbook, based on 20 years of experience!

Consolidated knowledge, including among others characteristics of more than 80 different substances to be used as alternative fuels or raw materials, basic conditions for using alternative fuels and state-of-the art technologies.

VERLAG BAU+TECHNIK

Order now:
www.verlagbt.de ▸ bookshop

PURCHASE ORDER FORM

Please complete this form in capital letters and return it to

Verlag Bau+Technik GmbH
Fax: +49 (0)211-92499-55
eMail: vertrieb@verlagbt.de

Please state how many copies you wish to order

☐ **Alternative Fuels and Raw Materials Handbook** **Volume 1**
€ 690,00 net price per unit
(already available)

☐ **Alternative Fuels and Raw Materials Handbook** **Volume 2***
€ 650,00 net price per unit
(appears in the 2nd half of 2012)

Terms of payment:
Please transfer the invoice amount to the specified account. Volume 1 of the AFR Handbook will be dispatched as soon as possible after receipt of the invoice amount. All bank charges must be paid by the customer.

VAT (7 %) applies for companies based in Germany and those based within EU if the EU-VAT ID. Number is not provided; shipping costs (insured package) depend on the resprective target country.

Payment must be in euros and cannot be made by cheque or credit card.

Company Name

Contact Person / First Name | Contact Person / Surname

Address / Street

Zip / Post code / City / State / Country

Phone | Fax

eMail Address (necessary for confirmation of purchase order)

EU – VAT ID. No. (applies only to companies with the premises in EU)

Date, place | Signature, company stamp

Verlag Bau+Technik GmbH
P.O. Box 12 01 10
40601 Düsseldorf, Germany

Tel.: +49 (0)211-92499-20
Fax: +49 (0)211-92499-55
eMail: vertrieb@verlagbt.de
www.verlagbt.de

VERLAG BAU+TECHNIK

***Delivery of Volume 2**
Volume 2 of the AFR Handbook has not yet been published but your order will be booked. Publication is planned for the 2nd half of 2012. You will receive the corresponding invoice directly after publication of Volume 2 of the AFR Handbook. Once again, delivery will be made immediately after receipt of payment.

Figure 5: Cement plant without dust filters (installed by now), Syria, 2010 (MVW)

Undertaking regular periodical monitoring is appropriate for the following substances:

- Metals, metalloids, and their compounds
- TOC (organic substances)
- HCl (hydrogen chloride)
- HF (hydrogen fluoride)
- PCDD/F (polychlorinated dioxins and furans)

Measurements of the following substances may be required occasionally under special operating conditions:

- BTX (benzene, toluene, xylene)
- PACs (polycyclic aromatic hydrocarbons)
- Other organic pollutants (for example chlorobenzenes)
- PCB (polychlorinated biphenyls) including coplanar congeners, chloronaphthalene and others

ECRA underlines that there is currently a certain tendency within the European cement industry to install multicomponent gas analysers. This development is mainly driven by the fact that European and national authorities keep asking for more components to be monitored continuously. While a few years ago it was sufficient to monitor dust, NO_x and SO_x, nowadays additional components such as TOC also have to be measured. Additionally, the growing development of flue gas abatement techniques also leads to further measurement requirements.

3 Permitting issues

According to current practice in Germany, the requirements for permits differ for each plant. These requirements have to be examined and defined as part of the licensing procedure in accordance with the local laws and provisions. An environmental compatibility test is compulsory as the alternative fuel project has to be made public. It has to be ensured that the project does not involve disadvantageous effects on human beings, animals or plant life, soil, water, air, the climate or the landscape – including any interactive effects – or on cultivation and property. In such cases the application for a licence must be accompanied by a description of the local environment and its features including the anticipated effects of the project on the above-mentioned factors which require protection. An essential component of the environmental assessment analysis (EAA) is the determination and evaluation of the background with the help of limit values and guide numbers as well as the investigation of harmful effects of pollutants in the plant's sphere of influence. The application for a licence has to provide a comprehensive specification of the operating requirements for the cement plant to ensure safe combustion of the residues, together with a description of the necessary operational measures with regard to the following criteria [8]:

- Calorific value and quantity (kg/h) of alternative fuels used
- Content of pollutants (e.g. trace elements, chlorine, PCB)
- Information on the identity of the material used
- Properties of the alternative fuels (physical, chemical, toxic and ecotoxic properties)
- Combustion conditions and destruction efficiency
- Recirculation systems leading to concentration
- Possible ways of purging material and relieving the recirculation systems

PROCESSING

Figure 6: Coconuts and tyres as alternative fuel, Philippines, 2009 (MVW)

Figure 7: Greenfield plant; according to IPPC Standards, Pakistan, 2011 (MVW)

- Operating processes with cut-offs (CO cut-off)
- Effect and type of exhaust gas cleaning processes

Potential faults in the combustion process that could interrupt or alter the flow of material through the rotary kiln are to be documented in detail. Where recirculation processes are necessary, plausible descriptions must be given of measures for prevention of increased emissions, e.g. by way of strategic material purging.

4 Applying for a permit

Use of alternative fuels requires the agreement of the appropriate permitting authorities. Depending on the country, in addition to local authorities such as the mayor's office, these can also be state environment bureaux or ministries. Owing to the numerous authorities in charge and permitting channels, here only the generally valid permitting types and processes are mentioned. Each cement and lime plant should have an open discussion with the pertinent local authorities about the intended alternative fuel and/or raw material project prior to a possible approval process. This discussion should be supported by solid information on the environmental influence in utilising alternative fuels, such as

- General information (e.g. from Cembureau)
- Brochures on the usage of alternative fuels from other plants inside or outside of the country
- A strategy plan of the plant with information on the background of the use of alternative fuels (Why? What is intended? Which materials? When? Who is involved?)

The application for permitting of alternative fuel co-incineration is most inconsistent worldwide. In many countries the permitting authorities have no knowledge about the use of alternative fuels. Based on experience one should therefore expect a certain mistrust and reserve. On the other hand in other countries co-incineration of certain alternative fuels or wastes is uniformly approved countrywide and only needs to be notified by the plant's operators. In India for example the "Central Pollution Control Board" released the "Guidelines on Co-processing in Cement/Power/Steel Industry" [11]. They provide constantly updated information on waste types which can generally be thermally recycled in the cement industry – whilst complying with the published limit values [12].

As a rule the application process for a permit corresponds to or leans towards the IPPC process. The Integrated Pollution Prevention and Control (IPPC) is a regulatory system that employs an integrated approach to controlling the environmental impact on air, land and water of emissions arising from industrial activities. It involves determination of the appropriate controls for industry to protect the environment through a single permitting process [13].

In the context of the regulations, emissions are defined as being the direct or indirect release into the environment of substances, heat or noise from individual or diffuse sources in an installation. IPPC has been implemented to meet the following environmental objectives:

- Protection of the environment as a whole by preventing or minimising emissions to all media (air, land and water)
- Encourage reductions in raw materials and energy use and increased recycling and reuse
- Promote the use of clean technology to reduce pollution at source
- Encourage innovation by leaving significant responsibility for the development of satisfactory solutions to environmental issues with industrial operators
- Provide a "one-stop shop" to administer applications for permits to operate
- Simplify and strengthen the role of the competent authorities (regulators)

In order to obtain a permit to operate an installation, the operator completes the permit application that demonstrates how they will:

- Ensure satisfactory environmental management of the installation
- Prevent or minimise waste production
- Prevent accidents or minimise their effect
- Ensure that closure of the installation does not leave residual pollution
- Promote energy efficiency, waste minimisation and management
- Ensure compliance with other EU directives, community and national environmental quality standards (EQSs) and domestic regulations
- Apply Best Available Techniques (BAT)

As part of the application process, permit operating conditions are agreed with the regulator and must include:

- Emission limit values for pollutants
- Measures for the protection of soil and groundwater as well as management of waste
- Requirements for monitoring and obligation of the operator to supply the data for checking compliance measures relating to non-standard events such as accidents, start-up conditions or closure of the facility

The operator must also consider the condition of the site at the time of the original application. This will contribute to assessing the need for restoration if the installation closes. In determining the application, the regulator must be satisfied that the operator has addressed the points above appropriately. It is therefore the operator's responsibility to demonstrate that this is the case. Once the regulator has issued a permit, the operator of an IPPC installation will have to perform monitoring activities to demonstrate compliance with the permit conditions. Regulators will also carry out their own monitoring and inspections, and have a range of enforcement powers.

Within the framework of the permitting process, the Environmental Impact Assessment (EIA) plays a central role. Environmental assessment is a procedure which ensures that the environmental implications of decisions are taken into account before the decisions are made. Environmental assessment can be undertaken for individual projects, such as a dam, motorway, airport or factory, on the basis of e.g. Directive 85/337/EEC [14] (known as 'Environmental Impact Assessment' – EIA Directive) or for public plans or programmes on the basis of Directive 2001/42/EC [15] (known as 'Strategic Environmental Assessment' – SEA Directive). The common principle of both directives is to ensure that plans, programmes and projects likely to have a significant effect on the environment are made subject to an environmental assessment, prior to their approval or authorisation. Consultation with the public is a key feature of environmental assessment procedures.

The directives on environmental assessment aim to provide a high level of protection to the environment and to contribute to the integration of environmental considerations into the preparation of projects, plans and programmes with a view to reducing their environmental impact. They ensure public participation in decision making and thereby strengthen the quality of decisions.

The EIA Directive (85/337/EEC) [14] has been in force since 1985 and applies to a wide range of defined public and private projects which are defined in its Annexes I and II:

> **Mandatory EIA:** All projects listed in Annex I are considered to have a significant effect on the environment and require an EIA e.g. long-distance railway lines, motorways and express roads, airports with a basic runway length ≥ 2 100 m, installations for the disposal of hazardous waste, installations for the disposal of non-hazardous waste – which is the case in most alternative fuel and raw materials projects in the cement and lime industry.

Generally one can assume that an Environmental Impact Assessment has to be carried out for an alternative fuel and raw materials project in the cement and lime industry.

Figure 8: Old brick plants; burning waste as fuel without any emission control, Pakistan, 2007 (MVW)

Even in cases where an EIA is not required by the permitting authorities the operators should carry out such a process on a voluntary basis. This is time- and cost-intensive (in general we estimate costs of around € 150 000 plus costs for emission measurements), but offers legal security and compliance with CSI Standards.

The environmental impact analysis focuses on comparing the expected evolution of the area with and without the implementation of the project. The impact will be addressed in accordance with the operation phases. Whenever applicable, the various types of impacts will be categorised or classified in accordance with the cause of the impact (direct versus indirect) and/or type of impact (positive versus negative, short versus long term, reversible versus irreversible, temporary versus permanent). The expected environmental parameters or issues that are typically associated with the implementation of the proposed project include, but are not limited to:

- Air quality impact (degradation of air quality due to emanation of air pollutants)
- Surface waters and groundwater
- Introduction of substances into surface waters and groundwater
- Waste materials, solid wastes and wastewater
- Quantity and nature of waste materials, solid waste and wastewater produced
- Natural resources, landscape and visual intrusion
- Noise and vibration
- Flora and fauna (loss or disturbance of terrestrial habitats due to construction activities)
- Health and safety of employees
- Transport and traffic planning
- Socio-economic impact (increase in job opportunities for example)

Environmental Impact Assessment studies usually consist of the following:

- Executive summary
- Definition of existing policies, legal and administrative framework
- Description of the proposed project
- Definition and analysis of baseline environmental conditions
- Identification and analysis of potential types of impact

- Analysis of alternatives
- Mitigation plan – protective measures
- Environmental monitoring plan
- Environmental management and training plans
- Public involvement and participation
- Air quality monitoring methodology
- Simulation of AFR use
- Air quality assessment
- Continuous monitoring of pollutants
- Authority follow-up and re-evaluation of results

For the execution of the Environmental Impact Assessment (EIA) it is recommended – if available – to cooperate with a local engineering office/specialist so that the local network can be used. Employing external, foreign specialist firms or accredited experts of emission measurements is also advisable. For example the VDZ Forschungsinstitut der Zementindustrie GmbH (Cement Industry Research Institute), Düsseldorf, Germany offers to perform emission measurements complying with EU Directive 2000/76/EC.

Within the framework of the permitting grant, as a rule, conducting burning trials (i.e. test usage of alternative fuels) is performed or requested.

5 Final remarks

More and more industrialised countries set stricter emission limitations according to the "Best Available Technical Standard". However, the situation is different in less industrialised and developing countries. Such countries usually have very wide emission limits – if they have any regulation on this topic at all. Cement companies, mostly cement groups, which do business in these countries, not only comply with but exceed these laws since they are already subject to stricter values in their corporate sustainability standards than those passed by the respective government. This brings up a question: Do country-specific emission limits make sense? At this point it might be worth considering the determination of transnational minimum standards which have to be complied with by the industries. Simple minimum standards and the "Best Available Technical Standard" are worlds apart though with regard to costs and benefit. However, CO_2-emission trading has shown that a system exists which could also be used for the limitation of other emissions. It all depends on clear standards to be set up by the responsible governments.

LITERATURE / LITERATUR

[1] Alternative Fuels and Raw Materials Handbook for the Cement and Lime Industry, Volume 1. MVW Lechtenberg and Verlag Bau+Technik GmbH, Duesseldorf, March 2012, ISBN 978-3-7640-0550-4.

[2] Vosteen B. W.; Hartmann T. C.: Bromine Enhanced Dry Mercury Capture. 9th Mercury Emissions from Coal International Experts Workshop (MEC9), St. Petersburg, May 2012.

[3] 17. BImSchV – Siebzehnte Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Verordnung über die Verbrennung und die Mitverbrennung von Abfällen) (Ordinance on the Emission Control Law). Germany, 31. January 2009.

[4] Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit IG I 2 – 50 121/20 Verordnungsentwurf der Bundesregierung, Zweite Verordnung zur Umsetzung der Richtlinie 2010/75/EU des Europäischen Parlaments und des Rates vom 24. November 2010 über Industrieemissionen (integrierte Vermeidung und Verminderung der Umweltverschmutzung) (Neufassung) (ABl. L 334 vom 17.12.2010, S. 17)

[5] Pakistan Environmental Legislation and the National Environmental Quality Standards. Government of Pakistan, October 1997.

[6] Guidance Manual on the Use of Alternative Fuel and Raw Materials in Cement Kiln Co-processing. Industrial Technology Development Institute, Department of Science and Technology in cooperation with Cement Manufacturers Association of the Philippines (CeMAP), Inc. Environmental Management Bureau, 2008.

[7] Directive 2000/76/EC of the European Parliament and of the Council of 4. December 2000 on the Incineration of Waste. The European Parliament and the Council of the European Union, Official Journal of the European Communities, 2000.

[8] Bolwerk, R.: Waste Incineration and Emission Control by Cement Plants in Germany. 13th World Clean Air and Environmental Protection Congress and Exhibition in London, 2004. Available at http://www.umad.de/infos/cleanair13/pdf/full_48.pdf (checked in August 2011).

[9] ECRA – European Cement Research Academy: Waste incineration is subject to tight emission monitoring. ECRA Newsletter No. 3, Duesseldorf 2004.

[10] Leitfaden zur energetischen Verwertung von Abfällen in Zement-, Kalk- und Kraftwerken in Nordrhein-Westfalen, 2. Edition. Ministerium für Umwelt und Naturschutz, Landwirtschaft und Verbraucherschutz des Landes Nordrhein-Westfalen, Düsseldorf 2005.

[11] Guidelines on Co-processing in Cement/Power/Steel Industry. Cf. Central Pollution Control Board, Ministry of Environment & Forests, Government of India, February 2010.

[12] Some examples: www.cpcb.nic.in/Highlights/2008/chapter-12.pdf (checked in January 2012); www.cpcb.nic.in/divisionsofheadoffice/pci1/Min_third_TF_oil_ref_petrochem.pdf (checked in January 2012); www.cpcb.nic.in/Grainbaseddistilleries.pdf (checked in January 2012).

[13] Integrated Pollution Prevention and Control (IPPC) – Guidance for the Cement and Lime Sector. Environment Agency, April 2001.

[14] Council Directive 85/337/EEC on the Assessment of the Effects of certain Public and Private Projects on the Environment. The European Parliament and the Council of the European Union, 27. June 1985.

[15] Directive 2001/42/EC on the Assessment of the Effects of certain Plans and Programmes on the Environment. The European Parliament and the Council of the European Union, 27. June 2001.