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Alternative fuels - What about the environment? - Part 2

Alternative fuels are now a firmly-established reality in well-developed cement industries around the world and increasing amounts of alternative fuels are also being used in developing economies. In the second part of his research into the use of alternative fuels in the German cement industry, MVW Lechtenberg & Partner's Dirk Lechtenberg explores the legal aspects of alternative fuel use and delves deeper into emissions limits. Part 3 of Dirk Lechtenberg's research will be published in the December 2013 issue of *Global Cement Magazine* and Part 1 was featured in the October 2013 issue.

Evaluation of legal data

The following parameters apply in Germany as a legal basis for the measurement and transmission of emissions data: **1.** The 13th decree for implementation of the Federal Emissions Protection Law prescribes that facilities covered by it must be equipped with measuring devices for continuous monitoring of emissions and that on an ongoing basis the measurement results must be registered, automatically evaluated and possibly also telemetrically transmitted. **2.** The 17th decree for implementation of the Federal Emissions Protection Law (decree covering combustion installations for waste and similar combustible materials) prescribes that facilities are to be equipped for continuous monitoring, evaluation and ascertainment of emissions as well as with devices for the assessment of the required parameters needed for orderly operation. Furthermore it is prescribed that on an ongoing basis the measurement results must be registered, automatically evaluated and possibly also telemetrically transmitted. **3.** Common requirements for measurement or evaluation devices for measurement of dust-bearing and gaseous emissions are also defined for the type and implementation of the measurement devices as well as for measurement data transmission among others, on the basis of the Guidelines Series VDI 4203 - suitability checks according to DIN EN 15267-3.[1]

As a result, 'compliance with minimum requirements of suitability testing with at least two identically-constructed measurement or evaluating devices must be proven during a test in a laboratory and in a field test at least every three months.'[1]

Environmental information for all

This regulation is controlled through the Environmental Information Law (UIG) in Germany. According to the UIG everyone has free access to environmental information.

The Federal Government and regions have issued rules that say that international law guidelines implement the Environmental Information guideline 2003/4/EG of the EU. One has to distinguish between the Environmental Information Law (UIG), which controls access to environmental information at a Federal level, and Environmental Information Laws of the Federal Republic, which apply to obligatory information sites in the regions. The general Freedom of Information Law (IFG) applies to other official information from Federal authorities.

Environmental information in this context is data on air, atmosphere, water, soil, landscape and natural areas of habitation as well as information on noise, energy, materials and radiation. Citizens can also access environmental information on plans and programmes that actually or possibly affect the environment, on the implementation of environmental law and cost-benefit analyses of environmental projects.

At a European level, a register for the capture of 'Air Pollutants,' The European Pollutant Release and Transfer Register (E-PRTR) also exists. The E-PRTR is the new Europe-wide register that provides easily accessible key environmental data from industrial facilities in EU member states as well as those in Iceland, Liechtenstein, Norway, Serbia and Switzerland. It replaces and improves upon the previous European Pollutant Emission Register (EPER). The new register reportedly makes data available to the public on around 28,000 facilities from 65 different industrial segments via a website.[2] However, till now, only a limited amount of data has been published.

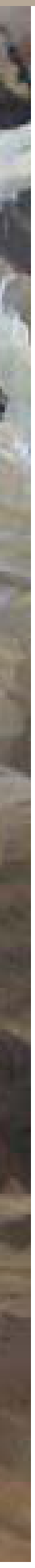
Basis of the data

The Federal Association of Citizens' Environmental Initiatives, a registered NGO in the form of a merger of many independent German citizens' initiatives has, through painstaking work, gathered the entire environmental data from 34 German cement plants for the years 2008-2010, plus 2011 in part. The following environmental information was compiled: Production capacities; Legal emission protection approvals (wholly or in part); The results of continuous emissions measurement for the years 2008 – 2010 (and 2011 for two plants) and; The results of annually-recurring emissions measurements through approved independent measurement sites for some plants.

The collected information is the most comprehensive collection of actual, independently measured environmental data ever compiled. As a basis for comparison, only the adjusted daily average values of the cement plants were utilised in order to perform a uniform evaluation.

Which limit values need to be complied with?

The Federal Emissions Protection Law (17.BImSchV)[3] prescribes the emission limit values for coincineration of wastes in the German cement and lime industries. Annexe 3 to the 17.BImSchV, 'serves the definition of emission limit values for waste coincineration plants. If a firm emissions limit value or a firm reference oxygen content is already prescribed in this plant for certain emissions parameters, this emissions limit value or reference oxygen content replaces the constructed ascertainment of the emissions limit value for this emissions



parameter. The prescribed firm emissions limit values in this plant apply to the respective waste coincineration plants, taking into account the named exceptions.'

As long as there are no firm emissions limit values or firm reference oxygen content prescribed in the annexe 3 the following formula (rule of mixtures) is to be applied. The law of mixtures is applied to calculate the emissions limit values (C) for every controlled emissions parameter as well as for the calculation of the reference oxygen content. See below right for parameters.

$$\frac{(V_{Waste} \times C_{Waste}) + (V_{Method} \times C_{Method})}{V_{Waste} + V_{Method}} = C$$

In this way it is assured that the emissions data are determined according to precisely-defined reference values such as a defined oxygen content in the off-gas stream.

In 'plants for manufacturing of cement clinker or cements as well as in plants for calcination of lime in which wastes or materials are coincinerated' a clear rule applies that the emissions due for monitoring are based on a firm reference oxygen content of 10%. Also, defined emissions limit values apply for the summarised harmful material groups heavy metals, benzopyrene, polychlorinated dibenzodioxins and dibenzofuran, taking a defined reference oxygen content of 10%.[3]

The determination of the actual emissions values is defined for certain parameters in annual average values, daily average values and half hour values.

Firm emissions limit values (annual average values in mg/m^3) are for example stated for the emissions parameter/s: $NO + NO_2$ (stated as NO_2) = $200mg/m^3$.

Deviating from the emissions limit values for nitrogen monoxide and nitrogen dioxide, stated as nitrogen dioxide, an emissions limit value of $350mg/m^3$ applies to plants for the calcining of lime in rotary kilns with a grate preheater. The firm emissions limit values are presented in Table 1 as daily average values.

For daily average values, further exceptions to the rules are permitted, 'such as when these are required owing to the composition of the natural raw materials and it can be ruled out that additional emissions of mercury arise through utilisation of wastes and materials and a daily average value of up to $0.05mg/m^3$ is not exceeded. The half hour values are presented in Table 2.

In addition to the above, the operator of a given facility can 'apply exceptions for mercury, SO_2 and total carbon, as long as these exceptions are required by the composition of the natural materials and it can be assured that no additional total carbon and sulphur dioxide emissions arise through the burning of wastes or materials.'[3] Exception rules for mercury up to $0.1mg/m^3$ are fairly common.

Data evaluation

Representative of the total measured harmful materials, three harmful materials, NO_x, dust and mercury, were evaluated as an example. In order to quantify the exact amounts of these harmful materials, the off-gas volume flow was also evaluated.

NO_x

Nitrogen oxides derive from chemical reactions of oxygen and nitrogen at combustion temperatures above circa 1000°C. Excess air or fuels provide the nitrogen. Actually, every technical combustion produces nitrogen oxides. Their main sources are burners and firing systems for coal, oil, gas, wood and wastes. In highly populated areas road traffic is the most significant source of NO_x. In cement plants NO_x arises through the combustion of fossil or waste-derived fuel at high temperatures, mainly at the kiln burner.

Health risk: NO_x concentrations arising in the environment are problematic for asthmatics and allergy sufferers, as NO_x makes bronchial tubes more irritable.

Effects on ecological systems: NO_2 in particular can damage plants and among other effects can cause a yellowing of the leaves (so called necrosis). In animals it can cause premature aging and an increase in anxiety. In addition NO_2 contributes to overfertilisation and acidification of soils and in modest amounts, also of bodies of water.

Dust

The primarily emitted and secondarily formed fine dust is summarised under the term 'fine dust.' Primary fine dust is released immediately at source, for example in burning processes. If the particles arise through gaseous precursors such as sulphur, nitrogen oxide and ammonia they are described as secondary fine dust.

Emittents: Fine dust is mainly produced by human activity. Primary fine dust arises through emissions from heavy vehicles, power plants and district heating plants, kilns and heating systems in residential housing, in metal and steel production or through handling of bulk materials. However, it can also be as a result of natural causes (for example as a consequence of soil erosion).[4]

In concentrated population areas, traffic is the dominating source of dust. Here, fine dust reaches the air not only from (mainly diesel) engines, but also from brakes and tyre wear and from dust on the road surface. An additional important source is agriculture. Emissions of gaseous precursors, in particular ammonia emissions from animal husbandry contribute to secondary fine dust generation.[4]

Health risks: The health effects of fine dust range from inflammation of airways to increased plaque formation in blood vessels. A multitude of effects arises from the fact that particles penetrate into human organs depending on

Emission parameters	C
Total dust	10
Gasesous inorganic chlorine compounds stated as HCL	10
Gaseous inorganic fluorine compounds stated as HF	1
$NO + NO_2$ stated as NO_2	
in clinker / cement plants	200
in lime calcining plants	350
$SO_2 + SO_3$ stated as SO_2	50
Organics stated as total carbon	10
Hg and its compounds stated as Hg	0.03
Ammonia, only that employed for the reduction of emissions of nitrogen oxides, a process for selective catalytic or non-catalytic reduction	30

Above - Table 1: Firm emissions limit values (daily average values in mg/m^3).[3]

Emission parameters	C
Total dust	30
Gasesous inorganic chlorine compounds stated as HCL	60
Gaseous inorganic fluorine compounds stated as HF	4
$SO_2 + SO_3$ stated as SO_2	200
Hg and its compounds stated as Hg	0.05

Above - Table 2: Firm emissions limit values (half hour average values in mg/m^3).[3]

Formula parameters:

V_{waste} = Flue gas volume of waste inclusive additional fuel needed for waste combustion.

V_{method} = Remaining flue gas volume.

C_{waste} = Emission limit value according to appendix 8 of 17.BImSchV.

C_{method} = Emission value according to annexe 3 of the 17. BImSchV.[3]

their size. PM_{10} (dust with a diameter of less than 10µm) can penetrate the nasal cavity and airways in humans. $PM_{2.5}$ can get into small bronchial tubes and bronchioles. Ultrafine particles even reach the alveoles and may reach the blood stream. Much investigation has proven a more marked presence of airway and heart cardiac cycle maladies during fine dust concentrations. Persons with preexisting illnesses are especially vulnerable. Studies that modelled the effects of fine dust on the population reported a calculated reduction in life expectancy in Europe.[4]

Cement plant dust sources: Dust comes from the burning process and arises from grinding processes/mechanical processing of pulverulent goods such as limestone/cement, gypsum and other materials.

Mercury

Mercury is a naturally occurring element. It is the only metal and one of only two elements that is a liquid at standard conditions. (The other is bromine). Mercury is one of the 'rare' elements yet is found everywhere worldwide, including in regions that have not been influenced by humans.

Mercury is used in the manufacture of energy saving lamps, batteries, rectifiers, switches, lighting tubes, thermometers, barometers and as a binder in gold and silver extraction. It is also used in the manufacture of basic materials for paint production, the cathode material in chlorine alkali electrolysis, in dental medicine and in a multitude of chemical compounds like pesticides and plant stains. However, in many countries the use of Hg has declined.

Emittents: Human activity counts for some 30% of annual Hg emissions.[5] This includes emissions from combustion processes in traffic, power and heating plants and gold mining. 10% of the emissions derive from natural geological sources and 60% are from re-emissions of previously released Hg that has built up in soil and water.[5]

The secondary contamination of mercury in cement production is problematic. Naturally-present mercury in limestone and fossil fuels is additionally enriched by the ingress of mercury by anthropogenic sources like mercury in waste-sourced alternative fuels. More mercury has recently been seen in household waste due to non-compliant disposal of energy-saving bulbs.

Health risks: High volumes of mercury can be fatal to humans, but relatively low volumes of mercury-contaning compounds can also impact a developing nervous system. There are investigations into possible negative effects on the heart circulatory system, the immune system and the reproductive organs.

Mercury and its compounds affect the central nervous system, the kidneys as well as the liver and can interfere with the processes of the immune system. It causes tremors, paralysis, sleeplessness and emotional fluctuations and weakens sight and hearing capabilities. In pregnancy mercury compounds cross the placental barrier and can disrupt the development process of a foetus. This process leads to disruption of alertness levels and developmental delays in childhood.[6] Methyl mercury is lipophilic and fortifies itself via the nutrition cycle in human fatty tissue.

Fundamental pollution: The Cooperative Programme for Monitoring and Evaluation of Long-range Transmission of Air Pollutants in Europe (EMEP) published a report entitled Long-term Changes of Heavy Metal Transboundary Pollution of the Environment (1990-2010) in 2012.[7]

The aim of the report is the support of the 1998 Protocol on Heavy Metals from the UN ECE Convention on Long-range Transboundary Air Pollution that 'identifies specific measures to be taken by parties to cut harmful effects of heavy metal emissions on the environment and human health. Heavy metals targeted by the Protocol are lead, cadmium and mercury.'[7]

According to the country-specific report,[8] which complements the aforementioned report,[7] the EMEP-Model computations showed that in 2010 in Germany a total of 5.4t Hg was disposed of into the atmosphere. Of this, 3.2t of Hg originated from direct anthropogenic emissions from the EMEP region (2.1t Hg from Germany), while the remaining 2.2t Hg (i.e. 38% of the total precipitation) came from natural, global and historic emissions sources. For the time period 1990 to 2010 using the EMEP-Model, a reduction in average mercury total precipitation in Germany was calculated to be around 55%, from 34g Hg/km^2 in 1990 to 15g Hg/km^2 in 2010.

Despite generally decreasing 'large emissions sources' the increase in mercury emissions through diffuse, anthropogenic emissions has been observed worldwide.

Part 3 of *'Alternative fuels - What about the environment?'* will be in the next issue of *Global Cement Magazine.*

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