CONTRIBUTION OF A CEMENT WORKS TO THE AIR POLLUTION SITUATION IN ITS VICINITY

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Introduction

To ensure good air quality, very strict air quality limits have been specified by the European Union in the "Air Quality Directive" /1/ and the subsidiary guidelines relating to this /2/. These regulations have by now been adopted into German Law /3/. However, in contrast to the situation in other European countries, German environmental law links the observance of these air quality limits with the approvability of industrial plants. Thus, in Germany approval for the erection and the operation of a plant is normally only granted if the air quality limit values are observed in the vicinity of the plant. In areas where these are exceeded, of which in Germany there are a large number particularly as regards fine dust (PM 10), new approvals for industrial plants in the future are only possible under special conditions.

In approval procedures, the observance of the air pollution values has to be demonstrated by ambient air quality measurements. These measurements are as a rule very costly. Also, in order to obtain reliable information, the concentrations of the various atmospheric pollutants must be measured over a long time period – mostly over one year. However, in the air pollution measurements, the contributions of all emitters – industrial firms, road traffic and private households - are included, Figure 1. Differentiation between individual emitters is only rarely possible.

Figure 1: Industrial firms, road traffic and private households influencing the ambient air pollution

The impact of individual plants to the air pollution situation in the vicinity can be determined by dispersion calculations. In a dispersion calculation, the propagation of the exhaust gas plume through the atmosphere is simulated by a mathematical model, which can also take account of complex topographies and wind conditions. For the new construction of a plant, the sum of the calculated impact of the new plant and the existing ambient air concentrations must lie below the specified air pollution value.

Air pollution Measurements

The days when one could recognise a cement works from a considerable distance from the dust deposits on the house roofs are long gone. However, to what extent does a cement works contribute to the ambient air situation in its vicinity nowadays?

The exhaust gases from clinker burning process are dedusted and emitted from the main stack. In addition, a modern cement works has further stacks, through which the waste gases or exhaust air from cement grinding plants are emitted. Apart from this, there is a large number of small sources like dust filters at discharge points or silos, which often far exceed 100 in number, Figure 2.

Figure 2: Chimneys of a cement plant

By way of example, the contribution of a cement works with an annual production of approx. 1 million tons of cement to the air pollution situation in the vicinity is presented below. The results are based on an ambient air measurements and various dispersion calculations.

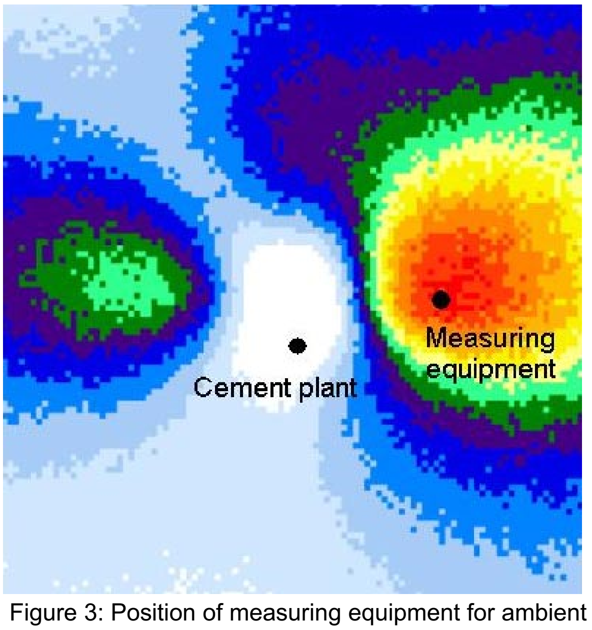

Figure 3: Position of measuring equipment for ambient air concentrations

The place of maximum impact from the cement works is usually chosen as the location for the ambient air measurement equipment. To determine this point of maximum impact, a dispersion calculation was first performed, the result of which is shown in Figure 3. Depending on the height of the stack, as a rule between 50 and 120 m, the place of maximum impact lies 1000 to 3000 m away from the cement works in the direction of the prevailing wind.

The results of the ambient air measurements are shown in Figure 4 assessed by wind direction. For the component sulphur dioxide, a ambient air concentration peak which is attributable to the cement works was observed, albeit at a low level. At 6 µg/ m³, the mean measured sulphur dioxide concentration was very low even in comparison to rural areas. Owing to the sulphide content of the raw material, the sulphur dioxide emissions of the rotary kiln installation under consideration amounted to approx. 400 mg/m³.

At the time of the measurements, the NO_x emission level of the cement works were just below the then applicable limit value of 0.80 g/m^3. As can be seen from Figure 4, the impact of the cement works to the ambient air situation can be established from the wind direction-dependent distribution for the ecologically less relevant component nitrogen monoxide. In contrast, for the component nitrogen dioxide, the impact of the cement works appears considerably less and markedly overlaid by other emission sources. Evidently, the residence time of the waste gas in the atmosphere from the stack to the measurement point was so short that the nitrogen monoxide emitted was only partly converted to nitrogen dioxide. Moreover, in the ambient air quality measurements, a marked daily variation was seen in the nitrogen oxide concentration measurements, which suggests that road traffic was the main culprit.

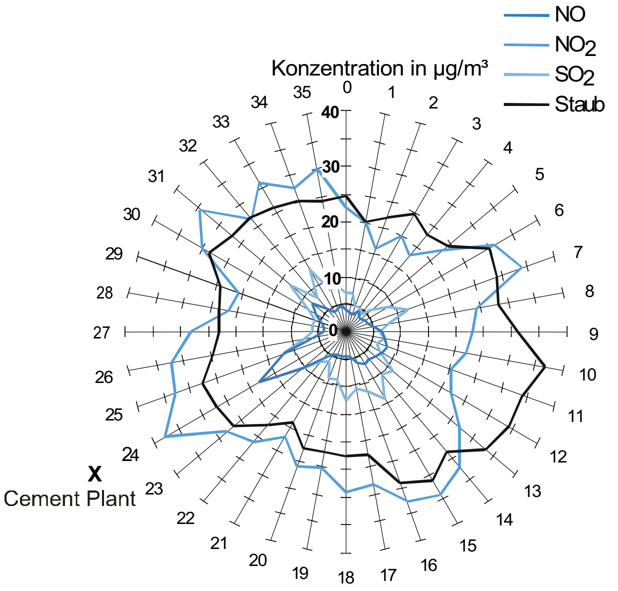

Figure 4: Distribution of ambient pollution concentration of NO, NO_2, SO_2 and dust related to wind direction

Further, it is clear from Figure 4 that for airborne dusts no contribution from the cement works to the ambient air quality situation could be observed. During the measurement period, the dust emission level in the kiln waste gas was approx. 10 mg/m³.

In addition to the dust emissions from the rotary kiln plant, diffuse sources can also provide a contribution to the ambient air quality in the vicinity of a cement works. Because of their low source height, these emissions are not transported far and are mostly deposited in the direct vicinity of the cement works. Figure 6 shows the results of dust deposition measurements in the vicinity of a cement works. The position of the main stack is marked by a red dot. The area around the cement works was divided into a grid of side length 1000 m, and dust deposition measurements were made at the grid intersections. In the middle of each grid square, the mean value of the dust deposition at the four grid intersections is shown in mg/(m²·day). From the figure, it can be seen that in the close vicinity of the cement works somewhat higher dust deposition values were measured than in the further vicinity. However, at all measurement points, the values were markedly below the national TA Luft limit value of 350 mg/(m²·day).

Assessment

In order to determine the maximum impact of a cement works to the ambient air quality, dispersion calculations are as a rule carried out in the context of the approval procedure. The assessment of this impact from the cement works is based on guide and precautionary values which have been laid down in European guidelines, national directives /4/ or by the World Health Organisation (WHO) /5/. In addition, this impact is compared with natural ambient air concentrations in regions far from emitters. It is considered to be environmentally acceptable if a cement works impact is not more than 3 % of the corresponding guide and precautionary values or if the air pollution contribution of an installation is less than 10 % of the natural background ambient air concentration /6/.

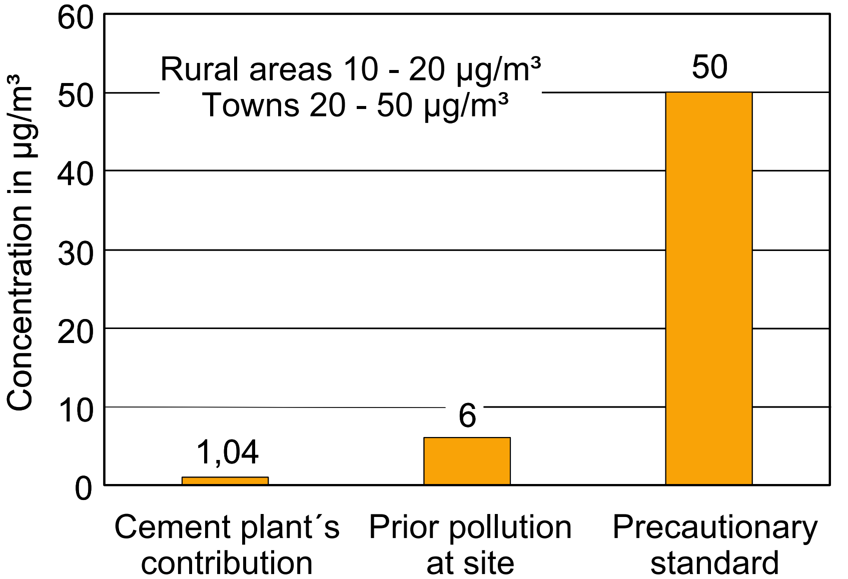

Figure 5: Cement plant´s contribution to ambient SO_2 pollution

For SO_2, an assessment of the cement works contribution to the ambient air concentration at the point of maximum impact is shown in Figure 5. On the basis of the SO_2 emission limit value, a maximum impact from the rotary kiln of about 1 µg/m³ was calculated in this example. However, the ambient air quality measurement gave an average concentration of 6 µg/m³. In comparison to this, SO_2 concentrations of 10 to 20 µg/m³ are normally measured in rural areas and 20 to 50 µg/m³ in towns. The ambient air quality limit value laid down in the national TA Luft for precautionary reasons is 50 µg/m³. Thus the impact of the cement plant makes only up for approx. 2 % of this limit value.

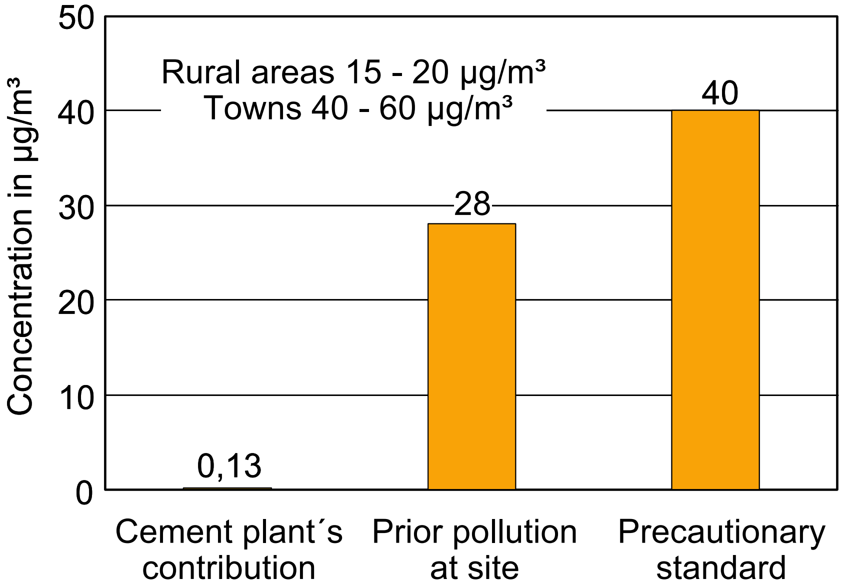

Figure 6: Cement plant´s contribution to ambient NO_2 pollution

For nitrogen dioxide Figure 6 gives a picture. The impact of the cement works amounts to only 0.13 µg/m³. In the air pollution measurements, an ambient air concentration of 28 µg/m³ was measured. In the "Air Quality Directive", an air quality limit value of 40 µg/m³ is specified.

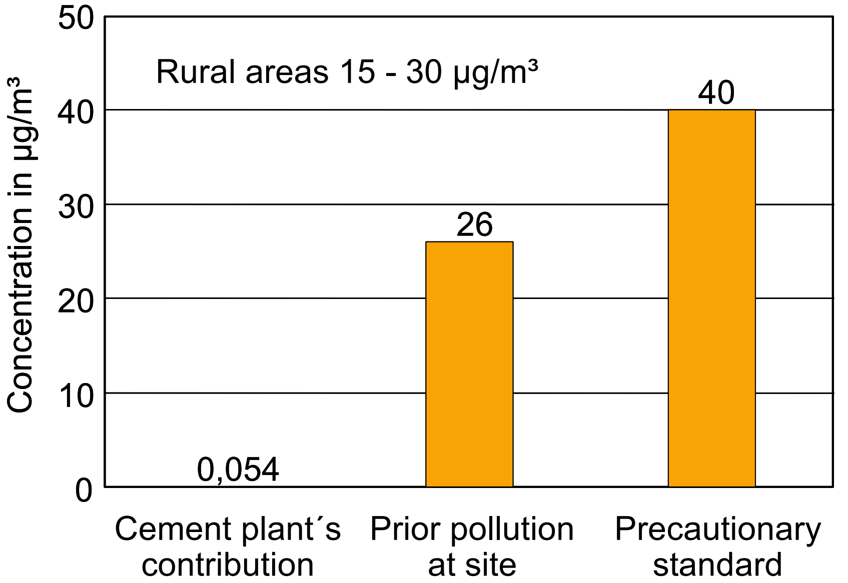

Figure 7: Cement plant´s contribution to ambient dust pollution

For airborne dust, Figure 7, a maximum impact from the rotary kiln of 0.05 µg/m³ was calculated, based on a dust emission concentration in the stack of 20 mg/m³. From the figure, it can be seen that with these low clean gas concentrations usually the impact from the rotary kiln to the ambient air quality is so low that it can no longer be detected with the currently used measurement techniques.

Apart from the emitted dusts, the substances contained in the dusts must also be considered. With the exception of mercury, which is largely present in gaseous form in the waste gas from rotary kilns, practically all other trace elements are bound in particle form. Due to the low dust concentrations in the clean gas these elements are only emitted in very low concentrations. Thus in emission measurements trace elements, apart from mercury, can mostly not be detected in the clean gas.

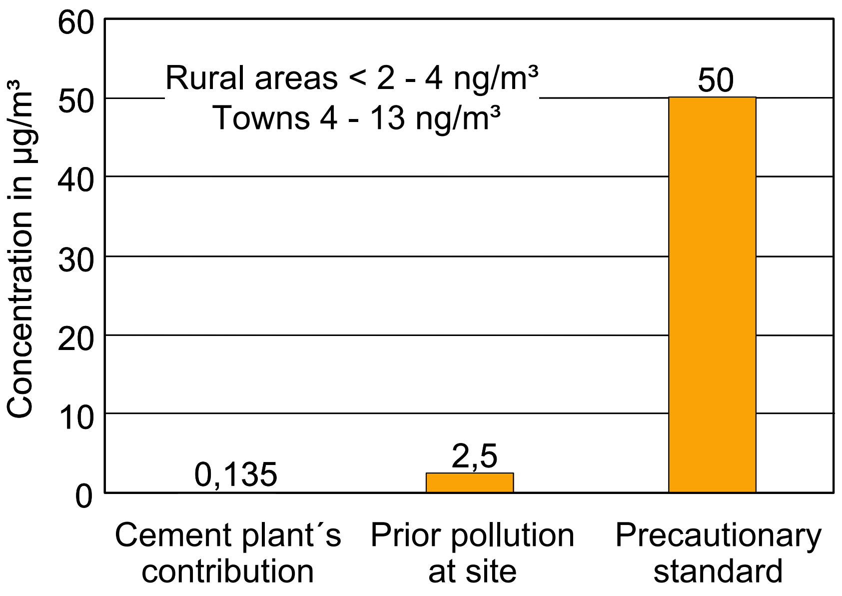

Figure 8: Cement plant´s contribution to ambient Hg pollution

Figure 8 shows the impact of a cement works to the ambient air situation for mercury. As the ambient air quality standard in Germany a value of 50 ng/m³ has been laid down. According to the air quality measurements, the ambient air concentration of mercury at the site is 2.5 ng/m³. The impact of the cement works was 0.135 ng/m³, calculated by means of dispersion modelling assuming a mercury emission limit value of 50 µg/m³ in stack. From the figure, it can be seen that the contribution of the cement works makes up of less than 1 % of the the precautionary standard.

The results presented here of course apply only for this specific cement works. However, the dispersion calculations which were carried out in the context of a total of 7 permitting procedures on other cement works led to comparable results.

	Unity	Cement plant´s contribution *	Precautionary standard	Relation to pre-cautionary standard
Dust	µg/m³	0,006 – 0,08	40	0,02 – 0,2 %
Hg	ng/m³	0,045 – 0,28	50	0,09 – 0,56 %
Cd	ng/m³	0,001 – 0,003	20	0,005 – 0,015 %
As	ng/m³	0,006 – 0,046	2,5	0,24 – 1,04 %
Ni	ng/m³	0,006 – 0,064	10	0,06 – 0,64 %
Pb	ng/m³	0,013 – 0,22	500	0,003 – 0,043 %
Cr	ng/m³	0,001 – 0,16	17	0,006 – 0,94 %
SO_2	µg/m³	0,27 – 2,1	50	0,54 – 4,2 %
NO_2	µg/m³	0,084 – 0,186	40	0,2 – 0,46 %
PCDD/F	fg/m³	0,0003 – 0,083	7,8	0,004 – 1 %

* Predicted or measured values

Figure 9: Assessment of air pollution by a cement plant

In Figure 9, the impact of a cement plants to the ambient air quality is shown for the different pollutants. The and the degrees of utilisation ambient air quality standards and precautionary values are also given. As is clear from the figure, the impact from a cement works is, as a rule less, than 1 % of the ambient air quality standard or precautionary value and can therefore be regarded as irrelevant.

Summary

Results from a series of environmental impact assessment studies that the Cement Industry Research Institute has carried out in the last few years show that the cement production process is associated with very small effects on the environmental situation in the vicinity of modern cement works. Using dispersion calculations, it has been shown that the additional impact of a cement works is as a rule less than 1 % of the recognised ambient air quality standard and thus can be regarded as irrelevant in ecological terms.

References

[1] Guideline 1996/62/EG of 27 September 1996 concerning the assessment and control of air quality (Air quality – overall policy)

[2] Council Guideline 1999/30/EG of 22 April 1999 concerning limit values for sulphur dioxide, nitrogen dioxide, particles and lead in the atmosphere – Official Gazette of the European Community L 163/41 of 29 June 1999

[3] First general administrative directive on Federal Antipollution Law (Technical Instruction for Prevention of Air Pollution – TA Luft) of 1 October 2002

[4] Assessment of pollutants for which no air pollution values are laid down; Regional Committee for Prevention of Pollution 1990, published by the North Rhine Westphalia Regional Ministry for the Environment, Development and Agriculture, 392/90, Düsseldorf.

[5] Air quality guidelines for Europe; WHO. Regional Office for Europe, WHO regional publications. European series, No. 23; Copenhagen 1987

[6] Kühling, W.; Peters, H.: Assessment of air quality in environmental compatibility tests, UVP Special, No. 10, 1994.