Modern methods of dedusting combustion gases in the cement industry

Until the mid-nineties, the cement industry constituted a serious source of pollution – mainly dusts. This results from the lack or insufficient efficiency of purifying equipment, the lack of appropriate legal requirements, and a low ecological awareness. The utilisation of dedusting equipment required considerable investment outlay, which in that decade was not always available. The situation changed following the privatisation of this sector of the economy.

The main sources of dust emissions in the cement industry are cement kilns and coal, raw material and clinker mills. Sources of emissions (in particular disorganised emissions) also include all sorts of feeding devices, packaging installations and silos.

Depending on the type of technological installation, two different types of equipment are used for dedusting in the cement industry. These are electrofilters and bag (fabric) filters.

Until the end of the nineties, combustion gases from cement kilns were treated primarily using electrofilters. Their method of operation consists in loading dusts suspended in the gas with electrical charges. Under the influence of the electrical field, the loaded particles settle on the collecting electrode. The rate of flow towards the collecting electrode depends on the difference in voltage between the discharge electrode (electron emitting) and the collecting electrode on which the dusts settle. The dust gathered on the collecting electrode and, to a lesser extent, on the discharge (corona) electrode is brushed off mechanically to a funnel terminating in a conveyor or feeding device. In older constructions, the discharge (corona) electrode was a wire with a diameter of 2–4 mm, while the collecting electrode was a pipe or plate. The disadvantage of this solution consisted in the deflection of the discharge electrode to the collecting electrode. In the latest constructions, the discharge electrode is a rigid band, while the collecting electrode is shaped in the form of corrugated steel sheet. Constructions of this type are characterised by considerable rigidity (no deflection towards the collecting electrode) and the uniform creation of a corona along the entire length of the discharge electrode. A characteristic feature of the electrofilter is the difference in potential between the electrodes.

Electrofilters ensure numerous advantages, thanks to which they have found such wide application in the cement industry. The main advantages are:

- small flow resistances, approx. 100–200 Pa,
- operation in high temperatures, even up to 400°C,
- relatively high efficiency – they collect a wide range of dust particle fractions,
- possibility of attaining relatively low dust concentrations at the outlet (10–50 mg/m³),
- ease of access to elements subject to periodic replacement.
From amongst these factors, the first two in particular were of decisive importance for the wide application of electrofilters for the dedusting of combustion gases generated by cement kilns. At the same time, however, this solution had a number of disadvantages. These included:

- high investment costs,
- high operating costs (considerable consumption of energy),
- necessity of putting them out of operation (i.e. removing the voltage) in the event of a high CO concentration, which resulted in considerable dust emissions,
- relatively low efficiency of treatment.

The two last disadvantages in particular made it necessary to find new solutions. This was also connected with the introduction of new legal acts concerning environmental protection, which were based on standards valid in EU countries.

The other type of equipment widely used in the cement industry to dedust air are bag filters. These filters are characterised by a very high cleaning efficiency, which – depending on the type of dust – can even by as high as 99.99%. However, a factor which considerably limits their application is the temperature of treated gases. Nevertheless, technical development in the field of unwoven fabrics has considerably widened their field of application. Currently there are fabrics which support a working temperature in excess of 200°C.

The following factors are primarily decisive for the quality of operation of bag filters:

- type of filtering fabric used,
- area of filtration,
- construction of bag baskets,
- type of bag regeneration (i.e. shake off) system.

The last of these elements has led to the marking out of the so-called pulsatory group of dedusters. The technical solution applied in a pulsatory deduster consists in introducing to filtration bags (of any shape) of a quantity of air, usually in the form of a pulse lasting approx. 0.1 second, which ensures the brushing off of dust gathered on the entire filtration surface, thereby recovering its filtering ability. Filters of this type are particularly widely used in all technological processes in the cement industry - including the clinker burning process.

The usage of filters of this type for the treatment of combustion gases generated by clinker burning was influenced by two factors. The first of these was the introduction of a filtering fabric resistant to high temperatures, while the second concerned
configuration errors, lack of regeneration, wrong construction of bag baskets)
– incorrect filter selection (too small filtering area),
– usage of an inappropriate filtering fabric,
– excessive gas humidity.
An important factor that should be considered when selecting the filtering area concerns the selection of the appropriate filtering speed. These should be as follows:
– for a dust concentration > 100 g/m³ filtering speed 1 m³/m²/min
– for a dust concentration from 50 to 100 g/m³ filtering speed 1.2 – 1.4 m³/m²/min
– for a dust concentration < 50 g/m³ filtering speed 1.5 m³/m²/min

Thanks to their advantages, pulsatory bag filters may be used in every technological process connected with the manufacture of cement. Of decisive importance in this regard is their high treatment efficiency, safety and ease of operation. Thus, they tend to replace electrofilters during modernisations of production facilities with ever greater frequency. Thanks to this trend, the manufacture of cement is becoming an environmentally friendly technology.