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Description of different technologies and their development potentials for reducing nitrogen oxides in the exhaust gas from waste incineration plants and RDF plants with regard to performance, cost and energy consumption

Summary

by

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Summary

In the further development of the immission directives the NO_x emission limit values for waste incineration plants and RDF (refuse derived fuels) power plants will be reduced among the other emission sources. The new law stipulates, that the plants for incineration and co-incineration of waste with a combustion capacity of more than 50 MW, which will be put into use or subjected to a substantial structural change after 12/31/2012, an annual average of 100 mg/m³ (STP, dry) NO_x (indicated as NO_2 related to 11 volume-percent O_2) must not be exceeded.

With regard to further limit reduction - 100 mg/m³ (STP, dry) NO_x as a daily average - it is necessary to examine, how far and at what cost this limit value in waste incineration plants and RDF power plants can comply with the modern NO_x reduction measures. From extensive literature research and statements by manufactures of NO_x reduction system it can be concluded, that the emission values of NO_x in waste incineration plants and RDF power plants can be lower as the requested limit value - 100 mg/m³ (STP, dry) NO_x - with the SCR technology as well as with the modern SNCR technology. The injection of gaseous ammonia is not considered here.

With an acoustic gas temperature measurement system and multiple injection levels or variable injection lances the limit values of 100 mg/m³ (STP, dry) NO_x and 10 mg/m³ (STP, dry) NH_3 slip can be maintained by SNCR process in waste incineration plants and RDF power plants. It should be noted, that the use of SNCR technology in large boilers, such as in coal-fired power plants, is currently being tested. The injection of urea dilution is a possibility of optimization because of the greater penetration into the combustion chamber compared to the ammonia water. In addition, the storage of urea dilution is much easier than by ammonia water with regard to the procedural components and the safety requirements. This can reduce the investment costs of SNCR system.

The performance limit of the modern SNCR technology is at a NO_x reduction rate of maximum 85 %, when the NO_x inlet concentration does not exceed 400 mg/m³ (STP, dry). At higher NO_x inlet concentrations the SNCR reduction performance depends strongly on the combustion regulation and the dimension of combustion chamber. As further development potentials there are new nozzle designs and the integration of injection system into combustion regulation to be mentioned.

The NO_x reduction process can occur with the help of catalysts at lower temperatures. The high reduction performance of the SCR technology allows the new NO_x limit values - 100 mg/m³ (STP, dry) NO_x and 10 mg/m³ (STP, dry) NH_3 - relatively easily to fulfill. Depending on the dust content in the exhaust gas three switching configurations can be distinguished in the SCR processes. For some reasons, which were explained in the study, the tail-end model had been established in waste incineration plants. However, this variation has come under criticism for the large energy consumption of gas reheating.

Through the use of new types of catalysts, such as plate catalyst and low-temperature catalyst, the application of the SCR process in waste incineration plants can be much

more flexible and optimized energetically. In the study, a concept of exhaust gas purification with low-temperature catalyst is given as an example. In this process the costs of operation materials have been reduced considerably by elimination of the reheating. Furthermore, the use of high-dust configuration in the waste incineration plants is currently being considered again, since the plate catalysts are less sensitive to deposition opposite the honeycomb catalysts.

The new regulation of NO_x limit values can be fulfilled with modern reduction measures. But the question is, at what cost this can be done. This can be answered exemplarily with the balancing of the two selected exhaust gas purification concepts and their cost analysis.

The operating data for the balance calculation are provided by the manufacturers of NO_x reduction systems. From the balancing results it can be seen, that the further lowering of limit value to 100 mg/m³ (STP, dry) NO_x as a daily average has not significant impact on the operating costs. The investment costs for a 100/10-capable SNCR system is twice as high as the costs for the system, that must comply with the limit value of the 17th BImSchV (German Federal Air Pollution Control Regulation). The investment costs and the operating costs in the SCR process increase only slightly due to lowering the NO_x limit value.

The operating costs are proximately in the same order of magnitude, which are calculated from the mass and energy balances for the two considered exhaust gas purification concepts. At the same reduction efficiency, with that the new NO_x limit values 100/10 can be fulfilled, the investment costs (without reducing medium storage) of a SCR system are expected to be higher than that of a SNCR system. However, the SNCR process requires more reducing mediums and thus larger amounts of compressed air because of the over stoichiometric dosage. The dilution water of reducing mediums decreases the heat output of the boiler. But in the SCR process the electrical energy requirement is higher due to pressure loss in the catalyst. With regard to the NO_x reduction performance the denitrification with catalyst is still the leading technology.

A recommendation for a specific NO_x reduction technology cannot be made on the basis of the balancing in this study, because a denitrification system is always a part of a total system, in which it has to be usefully integrated. The mass and energy balances, also the cost analysis results are influenced by the entire exhaust gas purification concepts. Depending on the combination of desulfurization and denitrification, and the switching variations of the SCR system, diverse gas purification concepts can be yielded for waste incineration plants. The operating temperatures of individual procedures and their demands on the exhaust gas quality influence the other purification stages in the process chain. For example, if a wet scrubber is applied for the desulphurization, a low-dust configuration with electric filter will be used, because the exhaust gas must be dusted off before the scrubbers. Therefore the cost of electric filter should not be considered to the denitrification.

However, besides the costs other parameters, such as the flexibility of the technologies opposite the load fluctuations and the pollutant concentration peaks, the operating stability, the performance limits, etc. still need to be taken into account.

According to the BImSchV (German Federal Air Pollution Control Regulation) the measured concentrations of the pollutants, whose emissions are reduced and limited by exhaust gas purification systems, e.g. secondary measures, can be converted only for the time, in which the measured oxygen content is higher than the reference oxygen content. Because the oxygen content in exhaust gas from waste incineration is in general below 11 volume-percent, the emission values cannot be converted. In other European countries, e.g. in the Netherlands, Austria, etc., where the NO_x limit value is 70 mg/m³ (STP, dry), the measured values of pollutant concentrations after exhaust gas purification relate always to the reference oxygen content (11 volume-percent O_2). This NO_x emission value seems to be tighter than the specified emission level in Germany. Actually because of the conversion it is at the same level as the value in Germany, which is usually determined at the operational oxygen content. In the future, a uniform regulation for the emission limit values in the EU should be stipulated.