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NO_X REDUCTION

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In modern world environmental problems are paramount. State of environment has a direct impact on health and demographic indicators of the urban population, on the development potential of the economy and, in turn, depends on the degree of development of the productive forces and the scientific and technological advance.

People have been polluting the atmosphere for thousands of years. However, the greatest air pollution started with the beginning of industrial enterprises development, such as thermal electric power stations, nuclear power plants, and others. Today share of harmful substances from thermal power stations in cities is about 43% of the total amount of air pollution.

At the moment, a serious threat to the ecological situation is the emission of harmful substances such as nitrogen oxides (NOx), carbon, sulfur, aromatics and others.

The damage caused by emissions from power plants to the atmosphere leads to the fact that there is an infringement of natural processes. There are human health deterioration, reducing their activity; the process of biodiversity losses; disappearance in certain types of plants and animals, disturbing ecosystems, degradation of flora and fauna.

Nitrogen oxides contribute to respiratory and lung diseases, they contribute to the appearance of asthma and other respiratory problems.

Emissions of nitrogen oxides contribute to the loss of ozone in the atmospheric surface layer. NOx compounds with atmospheric moisture cause acid rains. Nitric acid of these rains turns salts in the soil into nitrates, which are absorbed by plants.

The two elements, nitrogen and oxygen typically do not react with each other at normal temperatures but when high temperature combustion occurs, the elements combine to form this toxic oxide.

Active sources of environmental impact are power boilers of heating systems of cities. The sources of nitrogen oxides are mainly burnings and thermogas dynamic processes in furnaces and devices of combustion of solid, liquid and gaseous fuels.

For these reasons, particular attention should be paid to the mechanisms of NOx combustion of hydrocarbon fuels in power plants, and looking for ways to reduce the quantity of emissions from flue gases. Reduction of NOx emissions from even a relatively small number of power plants provides a way to improve the quality of ambient air.

In 1997 the Kyoto Protocol classified NOx as a greenhouse gases, and also called for a worldwide effort to reduce the amount that was being released into the atmosphere. In the United States the Environmental Protection Agency (EPA) regulates it. They have set levels, which can legally be released by companies. If the company does not comply with the regulations they can have sanctions and significant fines leveled against them.

Amount of generated nitrogen oxides in the thermal power boilers depends on the fuel specifications, operational and design parameters of the combustion chamber. That’s why calculation of the estimated emissions of nitrogen oxides and search of measures to reduce them at the stage of design or reconstruction of boilers is used. The emissions of nitrogen oxides should be reduced to an amount, which is not exceeding the standards of the specific NO emissions into the atmosphere.

These standards are established by country's legislation, which controls the maximum allowable emissions of various pollutants and ambient air quality. In Russia the main provisions of this legislation for large coal-fired industrial boilers is as follows: since 2016

NOx emissions will be limited to a value of 200 mg/m3 for all thermal power plants. Now limit is 500 mg/m3. It has a significant impact on the operation of thermal power plants; because they have to organize the process of burning fossil fuels in a way that would have a wide range of operating parameters in order flue gases have low toxicity.

Nitrogen oxides' reduction technologies can be grouped into two broad categories: combustion modifications and post-combustion processes.

Combustion Modification

- Optimization of the boiler;
- Low toxicity burners (LNB);
- Reburning (two or three-stage compression – TSC);
- Flue gas recirculation (FGR);

Post-Combustion Treatment

- Selective Catalytic Reduction (SCR);
- Selective Noncatalytic Reduction (SNCR);
- Hybrid Processes

Each action has its percentage of effectiveness and limitations for use. Beforeconsideringtheactivemeasuresofsuppressionisveryadvantageoustooptimizetheoperation oftheboilerinordertoachievethelowestemissionswithoutanylossincombustionefficiency. Optimization of boiler operation requires reliable sensors, flame scanners.

LNBs are designed to control the mixing of fuel and air to achieve amounts to staged combustion. This staged combustion reduces both flame temperature and oxygen concentration during some phases of combustion.It can be expected to reduce NOx emissions by 40-50% by using well-understood technologies of low-emission burners. On new boilers it is installed at once.

In the reburning process, part of the boiler fuel input is added in a separate reburn zone. The fuel-rich reducing conditions in this zone lead to the reduction of nitrogen oxides formed in the normal combustion zone.TSC technology reduces emissions by 50% compared to the levels that provide LNB.

FGR, in which part of the flue gas is recirculated to the furnace, can be used to modify conditions in the combustion zone (lowering the temperature and reducing the oxygen concentration) to reduce nitrogen oxides' formation.

In SCR, a catalyst vessel is installed downstream of the furnace. Ammonia is injected into the flue gas before it passes over the fixed-bed catalyst. The catalyst promotes a reaction between nitrogen oxides and ammonia to form nitrogen and water vapor. Nitrogen oxides' reductions as high as 90% are achievable, but careful design and operation.

In SNCR, a reducing agent (typically ammonia or urea) is injected into the furnace above the combustion zone, where it reacts with nitrogen oxides as in the case of SCR.

SNCR and SCR can be used together with some synergistic benefits. Also, either process can be used in conjunction with LNBs.

Low toxic burner is the most preferred technology. To provide limits after 2016 is likely to require additional measures inside burner based technologies and flue gas cleaning. Currently SCR is the only widely known and commercially available technology that can provide the required level of emissions. Using these modern reduction methods it is now possible to remove 70 to 95% of the nitrogen oxides that are released into the environment. So far, SCR technology is still relatively expensive, and may have to look for new ways to reduce emissions of nitrogen oxides.

Now industries and manufacturers are really focused on NOx reduction in their operations. It has helped to improve environmental conditions around their operations, and has helped to improve the health of people living in affected areas.

References

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