Scientists reduce harmful emissions from HPPs

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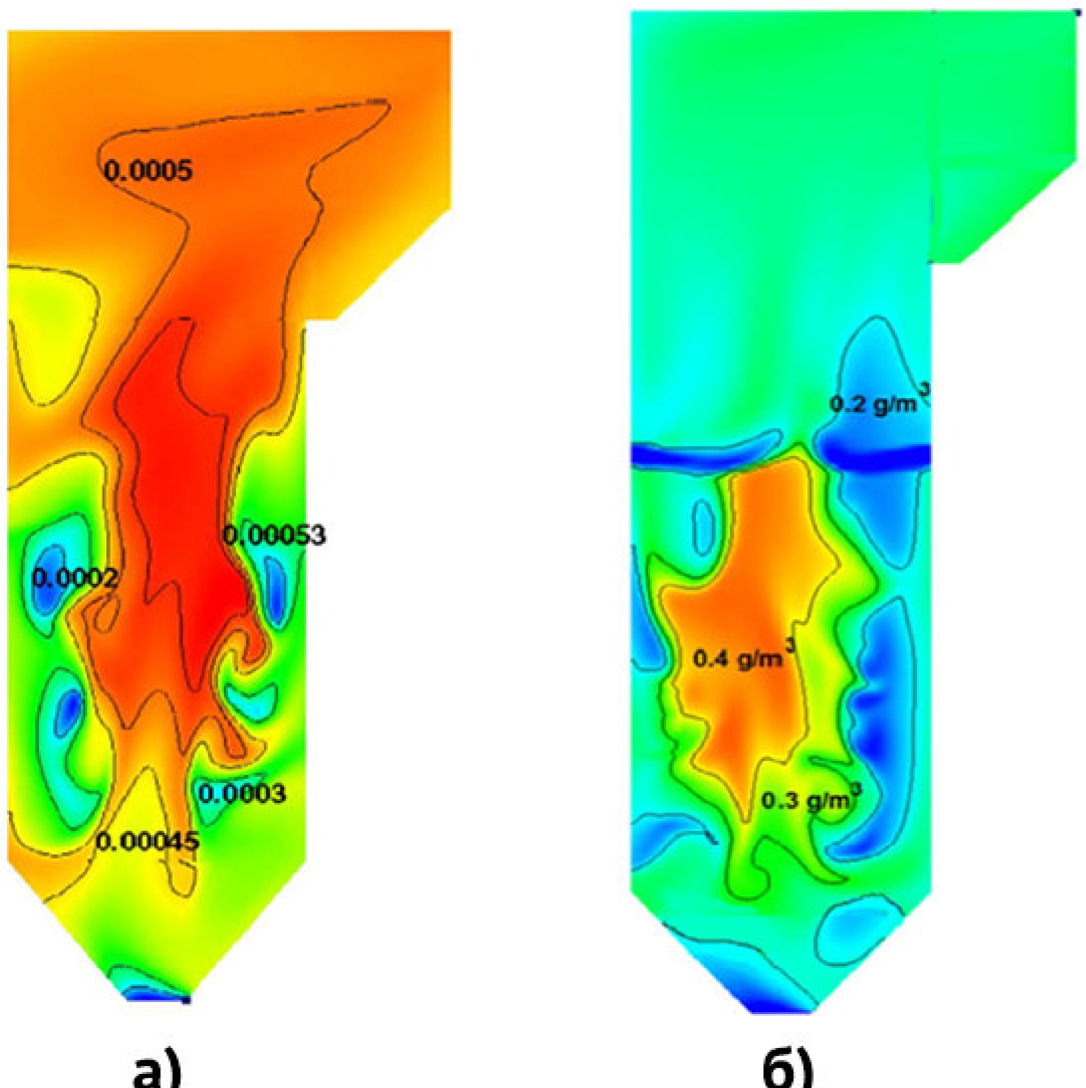

The results of modeled distribution of NOx in a combustion chamber:a) regular boiler, kg/m3;b) three-step combustion boiler with the use of mechanically activated micro-milled coal, g/m3. Credit: Alexander Dekterev

A team of scientists from Siberian Federal University (SFU) and their colleagues from Novosibirsk and the Netherlands modeled the process of coal burning in HPP boilers and determined which type of fuel produced less harmful emissions. The study was published in *Fuel*.

Heat power plants (HPPs) supply electrical energy to many cities around the world. The production of heat and electricity starts with burning coal in a combustion chamber. Generated heat warms up the steam and smoke mixture that moves the turbine. This is how electricity is produced, and the warmth is used for heating. However, burning coal at HPPs releases harmful nitrogen oxides into the atmosphere.

A promising emission-cutting technology is post-combustion or three-stage fuel combustion. After the first combustion stage, during which the main part of the coal burns out and the air is scarce, the remains of the fuel are transferred to a special area above the combustion chamber with additional fuel. Nitrogen oxides react with the hydrocarbon, forming hydrogen cyanide and molecular nitrogen, and the volume of nitrogen oxide emissions drops by about 10 percent. "The environmental impact of oil and gas post-combustion is more evident, but we also have to work with coal. It has a great practical importance as many HPPs use it," said Alexander Dekterev, a co-author of the article.

Scientists have previously conducted experiments to understand which properties of coal and combustion techniques provide maximum emission reductions. Recently, physicists milled coal down to microparticle scale (20-30 microns). This technique provides for a more stable flare in HPPs, as coal microparticles mix better and burn more quickly.

Previously, this effect was demonstrated in small, experimental boilers. The flame from the burning of coal micro-particles resembled that of burning oil, and the particles were almost invisible. Still it wasn't clear whether the effect would be the same in regular HPP boilers, and the scientists from Krasnoyarsk decided to model that.

They took a standard steam boiler BKZ-500-140 of Krasnoyarsk HPP-2 as a model, as all experimental data on it was available. The data were loaded into the model, which was then reconfigured taking post-combustion data into account. In the new model, the basic fuel was brown Kansk-Achinsk coal, and the post-combustion fuel was formed by jet coal from Kuznetsk. According to initial calculations, the mathematical model implemented by the authors of the article in the in-house software correctly described the processes in the boiler.

The team modeled three burning schemes—regular coal, micro-particle coal, and mechanically activated fuel. The latter variant proved to be preferable and led to 50 percent reduction in Nox emissions compared to the basic variant and by 20 percent to the regular coal. The work might be of interest for developers and engineers working on the improvement of the existing boiler equipment and design of power blocks. The authors continue to develop mathematical modeling methods to improve burning technologies both for widely used and unconventional fuel types.

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