Politechnika Śląska
Instytut Maszyn i Urządzeń Energetycznych

Rozprawa doktorska

Analiza numeryczna procesu redukcji tlenków azotu w technologii SCR dla bloków węglowych

Mgr inż. Paweł Pilarz

Promotor: prof. dr hab. inż. Tadeusz Chmielniak

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Abstract

The climate policy of the European Union is strongly focused on the low-emission electricity generation combined with high efficiency of converting chemical energy of fuels. Due to the nature of the Polish economy it is extremely difficult to significantly change the structure of the energy sector. Therefore, for the next few years, owners of power facilities will have to modernize their units or will be forced to assign them to a natural derogation process.

According to the BAT guidelines, the SCR technology is one of the best methods to reduce nitrogen oxides from exhaust gases of coal-fired power plants. This recommendation is due to the high process efficiency and non-waste, because the products of this method are ultimately N_2 and H_2O. The disadvantage of this solution is the price, because the reactor layers are covered with a catalyst usually composed of V_2O_5 or WO_3. A comprehensive approach to the process of modernization of the exhaust gases treatment system may allow to avoid additional operating costs.

This dissertation presents a series of analyzes related to the selection of the location of the SCR reactor in the system of exhaust gas purification connected with the possible impact on other installations. The sensitivity of the deNO_x process to change the flue gas parameters at the inlet to the SCR was also demonstrated. An important issue is also increasing the flexibility of the coal-fired units as a response to increasing the share of renewable energy in the Polish energy system. The use of heat accumulation in tanks allows for faster response to changes in the demand for electricity. A new aspect is the demonstration of the impact on emission (including NO_x) during dynamic load change.

The SCR reactor CFD-model was also built based on design and measurement data, turbulence models and using kinetics of chemical reactions occurring on the catalyst surface. Comparative analyzes have shown the effect of the geometry of the SCR reactor channels on the reduction of NO_x. It was also proved that the deNO_x system was modernized by extending it with another catalytic layer. The achieved emission result for nitrogen oxides (90 $mgNO_x/m^3_n$) reaches the future emission standards presented in the BAT Guidelines (85–150 $mgNO_x/m^3_n$). The SCR reactor model can be used for further analyzes related to testing other variants of catalyst modernization in the direction of increasing its efficiency.