Combustion of Coal in a Bubbling Fluidized Bed

Durda, Tomáš
2014

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Student: Ing. Tomáš Durda
Supervisor: Prof. Ing. Václav Janda, CSc.
Supervisor–specialist: Ing. Michael Pohořelý, Ph. D.

The greenhouse effect is caused by the so-called greenhouse gases; e. g., CO_2, CH_4, N_2O. Their concentrations in the atmosphere have recently significantly increased and therefore, in order to stop this increase, the general aim is to limit their sources. The emissions of CO_2 are produced the most by conventional coal combustion. In terms of the European policy concerning climate changes and energy, the main goal is to reduce the emissions of CO_2 coming from coal combustion.

For this purpose, it is possible to use one of the following technologies of CO_2 capture: (1) post-combustion capture, (2) pre-combustion capture or (3) oxy-fuel combustion capture. The technology of **post-combustion capture** is especially suitable for completion of the existing coal-burning facilities. This CO_2 capture technology is based on the chemical absorption of CO_2 in an appropriate solvent from the flue gas. **Pre-combustion capture** technology can be used in the Integrated Gasification Combined Cycle (IGCC). Coal is gasified and a so-called producer gas is formed; then, CO is converted into CO_2 during the homogenic water gas reaction together with the conversion of H_2O to H_2. Physical absorption follows in order to separate CO_2 from the producer gas before its combustion and its use in a gas turbine. This approach benefits from lower volumes of producer gas compared to the resulting flue gasses. The third technology allowing a seizure of CO_2 is the so-called **oxy-fuel combustion process**. Oxy-fuel combustion is characterized by the utilization of a mixture of pure O_2 and CO_2-rich gas (from the flue gas recycle). The temperature of combustion process is regulated by CO_2-rich recycle flue gas instead of being modulated by N_2 from the air. The CO_2-rich recycle flue gas ensures the process of fluidization in the case of the fluidized bed technology. Oxygen is separated from air using the established cryogenic methods.

The presented work deals with oxy-coal combustion process and in addition, with enriched-air-coal combustion. This enriched air is available in industrial practice as a by-product of nitrogen separation from the air. Nitrogen can be obtained from air using vacuum swing adsorption (VSA) or pressure swing adsorption (PSA) or vacuum pressure swing adsorption (VPSA). Enriched air could be used as combustion gas for the combustion with the heat output of 5–50 MWt.

This work is specifically focused on the comparison of the efficiency of the combustion process and the emission of pollutants under different combustion atmospheres (air, enriched air, pure oxygen). Concerning the efficiency of the combustion process and the emission of pollutants, the best results were achieved when coal was burnt in enriched air atmosphere (30 vol. % of O_2 and 70 vol. % of N_2). The oxy-fuel combustion process (with 21 vol. % of O_2 and 79 vol. % of CO_2) was evaluated as the least effective process. Coal combustion by air (21 vol. % of O_2 in 79 vol. % of N_2) led to better results than oxy-fuel combustion (with 21 vol. % of O_2 and 79 vol. % of CO_2), but worse results than the oxy-fuel combustion (with 30 vol. % of O_2 and 70 vol. % of CO_2) and of course worse results than the combustion with enriched air.