Co-gasification of lignite and used car tires by H2O/air thermal plasma

Viktor Popov*[1], Dmitry Subbotin[1,2], Alexander Surov[1], Sergey Popov[1], and Evgeny Serba[1]

[1]Institute for Electrophysics and Electric Power of the Russian Academy of Sciences – Russie
[2]St. Petersburg State Technological Institute – Russie

Résumé

In recent decades, the recycling of used tires into energy products is being actively investigated. Its can be subjected to gasification in reactors of various types. To reduce the amount of tars in the produced synthesis gas, it is desirable to use downdraft gasifier. However, in this case, the reducing bed required for the decomposition of the tars will not be formed. This problem is solved by adding solid fuels (for example, lignite) as raw materials. To increase the hydrogen content in the synthesis gas, it is desirable to use steam as a gasifying agent, and for input of energy to use plasma torches. On this basis it is advisable to use air-steam plasma produced by the AC plasma torch. Its operating electrical characteristics, dependence of the thermal efficiency on arc current, flow rates and composition of the plasma-forming mixture were determined. Steam flow rate is 3.55 - 5.8 g/s, air flow rate is 1 - 3 g/s, arc current is 28 - 29 A, arc voltage drop is 1.15 - 1.85 kV, power is 57.6 - 87.5 kW, thermal efficiency is 94.3 - 95.3%.
Thermodynamic estimation of co-gasification of used car tires and lignite was carried out to evaluate the work of the plasma torch as part of a plasma gasifier. Lignite, a low-calorie fuel, was chosen deliberately to show the effectiveness of plasma gasification. Available enthalpy of blowing agent without regard to heat loss was 12.5 MJ/kg (steam: air = 5: 1 wt.). Further experiments are planned to carry out in the downdraft reactor, it was therefore it was provisionally selected the ratio of used car tires: lignite 30% to 70% wt. The inorganic portion of used car tires is assumed for iron and ash lignite is assumed for silicon dioxide.
As a result of calculations it was established that for 1 kg of mixed fuel it is necessary to supply about 8.3 MJ of energy, the synthesis gas is substantially free of ballast gases (nitrogen and other), lower heat value of product gas is 10 MJ/kg, the total concentration of H2 + CO is about 74% (in dry condition is 90%). In the case, if more high calorie fuel applies the results will be significantly better, in the first place, the water content in the product gas will be less. Subsequently, more powerful facilities on the basis of developed plasma torches operating with a wide range of gasifying agents can be designed, that allows to produce synthesis gas with higher molar ratio of H2/CO.

*Intervenant