THERMODYNAMICS OF THE CARBONACEOUS WASTE TREATMENT PROCESS USING PLASMA TECHNOLOGY

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The report is devoted to the development of technologies for the processing of carbonaceous wastes, including hazardous ones, using plasma energy sources. In particular, plasma-steam equipment provides complete environmental safety and high quality of the synthesis gas produced.

Modern technologies of the waste treatment are oriented on their gasificationas “Waste to Energy” process. One of its advantages is that the temperature range at which the gasification processes are effectively carried out is quite high and usually exceeds 1000 °C.This automatically meets the requirements of the Directive 2000/76/EC according to which the temperature should be maintained at 1100 °C in case of incineration of waste containing more than 1% wt. of halogenated organic substances under conditions of chloride. This is necessary for dioxins and furans, which are formed before at lower temperatures, to be effectively decomposed into HCl.

The special problem of the sewage sludge is heavy metals in its compound. Low temperature processing of this waste leads to the formation of high toxic ash. If this toxic residue is heated to a very high temperature, then their main components, including minerals and toxic heavy metals, melt and take on a glassy appearance. This requires temperatures above 1700 K, which are not available in the most incinerators, but are easily achieved in plasma reactors.

The process of plasma-steam gasification can be represented by the gross equation in a sufficiently general form:

$$CH_xO_y + wH_2O + mO_2 = n_1H_2 + n_2CO + n_3CO_2 + n_4H_2O + n_5CH_4 + n_6C - Q_{TR},$$

where $Q_{TR} = Q_R + Q_{PL}$ is the total thermal energy that is released as a result of the chemical reactions Q_R and due to plasma jet Q_{PL}, so that the reaction mixture reaches the desired temperature T_P of the gasification products, w and m – the amount of water and oxygen, per 1 kmol of waste, n_1, n_2, n_3, n_4, n_5 and n_6 are the coefficients for the corresponding reaction products. Among the latter are gases, most often obtained in the composition of gasification products, and soot. The energy term in the form presented allows distinguishing the role of an additional source of energy ΔQ in viewpoint of achieving the optimal, predictably perceived, temperature T_P of the gasification process.