INCINERATION OF HAZARDOUS SUBSTANCES EMPLOYING PLASMA TECHNOLOGY

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Plasma technology employed to treat, remediate, or recycle hazards is still a new, advanced, developing and promising technology that has a defined niche in the world wide market [1]. The plasma method of destroying toxic materials has been useful in cases when the traditional combustion causes harm to humans and environment or in cases when the mixture of hazardous substances is unable to identify [2]. In various design configurations, plasma technology units can be used on a wide variety of hazards, and can either destroy toxicity or produce a product from the treatment of waste materials [3]. Plasma equipment can be operated in a manner that has fewer impacts on the environment than conventional thermal destruction technologies. Lower gas emissions and a stable solid residue have been achieved using plasma treatment.

Researchers of the Lithuanian Energy Institute have developed plasma system for hazardous waste treatment [4] consisting of the stream-reactor of 1.8 m length and 0.2 m diameter with a line of ZrO_2, two, three or more plasma sources, heat exchanger and auxiliaries (Fig.1).

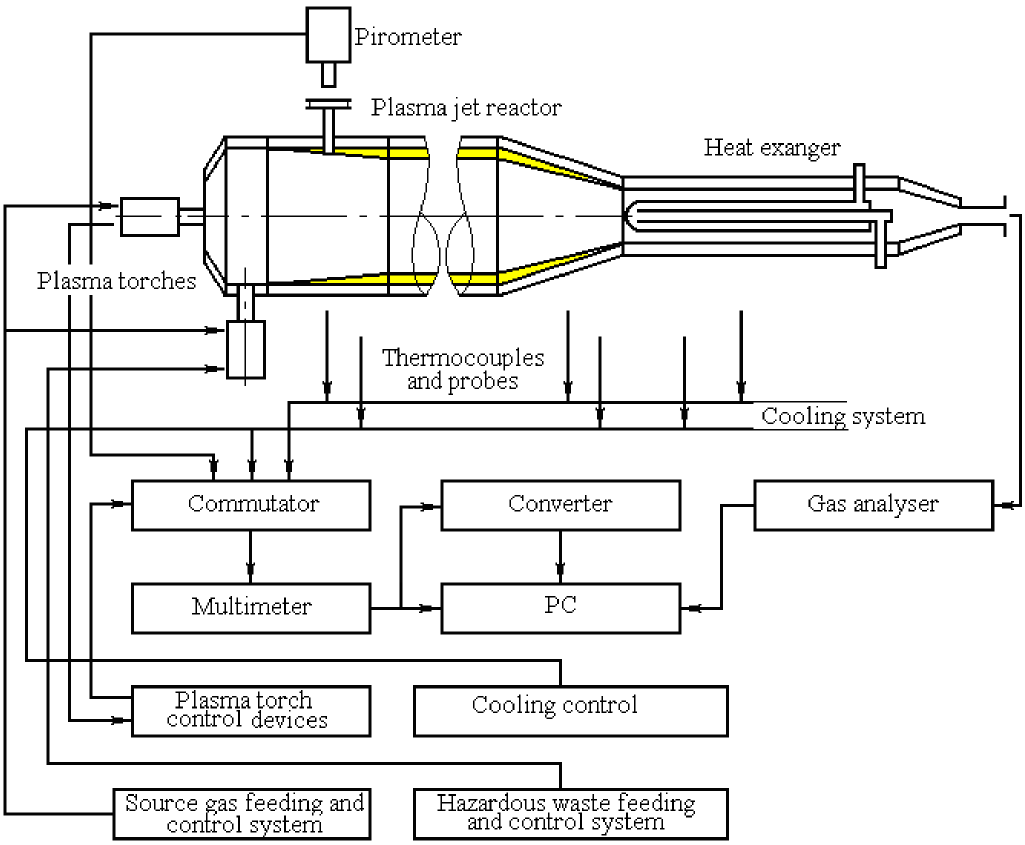

Fig. 1. Schematic presentation of hazardous substances processing system

The specific reactor chamber is a cylindrically shaped, its walls are made of steel sections. Steel walls form jacketed vessels with circulating water to maintain a safe operating temperature. An inner shell is covered with the mixture of heat-resistant zirconium and aluminum oxide. The layer close to the steel wall consists of asbestos.

Devices producing stable and exactly recurrent high temperature reacting gas flows are required for support of stabile thermal processes. The recent development of plasma processing technologies has encouraged research in the field of plasma sources inventory. Researchers of the Lithuanian Energy Institute collaborated for a long time with the groups of scientists belonging to the Zhukov and Yas'ko scientific research schools in the design, construction and investigation of PT carrying out heat transfer investigations of dissociated gases flowing in the heat exchanger elements and around various surfaces. A variety of non-transferred plasma torches (PT) have been manufactured for the purposes of destruction of hazards [5, 6]. The linear DC ARC heaters (Fig.2) were used for heating air, nitrogen, water vapour or their mixtures up to 5000K for the reactor described here. By achieving the gas temperature over 4000K, molecules of hazardous substances decay to atoms, radicals, electrons and ions so that it appears ability to obtain a simple combination of harmless chemicals.

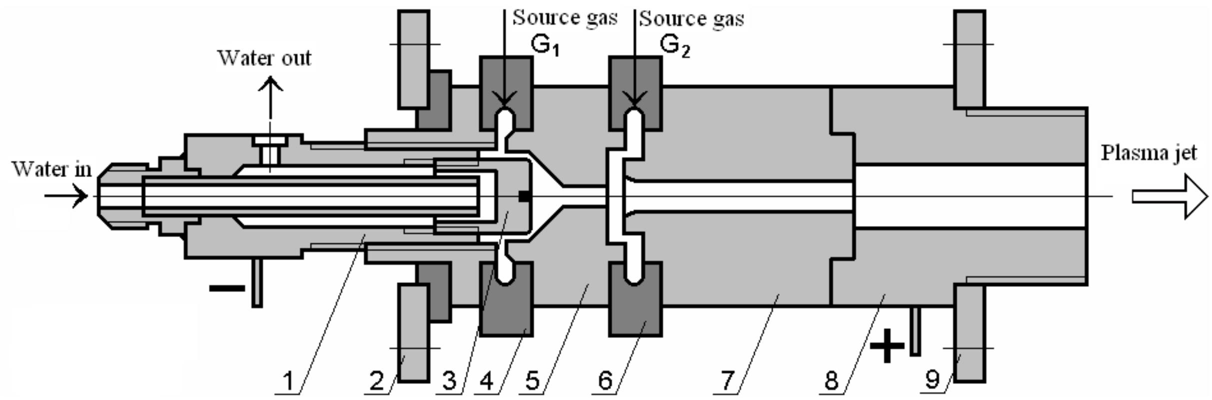

Fig. 2. Cross view of the linear DC plasma torch. 1 – cathode junction, 2,9 – flanges, 3 – cathode with hafnium emitter, 4,6 – insulating rings for gas injection, 7,8 – step-formed anode

The described hazards treatment system has the ability to accept a wide range of waste materials and as such can be regarded as mobile and flexible. This system can be applied to treatment of high toxic wastes containing both organic and inorganic substances. The results on heat balance and heat transfer showed that the combustion process takes place over all the reactor volume. The incineration process finishes through the entrance section ($x/d<1$) of the reactor chamber.

Two different plasma systems were also proposed as a possible alternative to the plasma jet reactor described above. The first one is a volume reactor with the linear, non-sectional plasma torch at 150 kW of power. As the further development we may propose the second system – catalytic combustion reactor loaded with the bundle of oxide catalysts located at the exhaust section of the installation. The results show that hazards treat technology can process highly toxic organic and inorganic substances with the efficiency of 99.99%.

Acknowledgement

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References

[1] Rutberg P. (2002) High Temp. Material Processes 6, p.431.
[2] Moustakas K., Fatta D., Malamis S., Haralambous K., Loizidou M. (2005) Journal of Hazardous Materials, Article in press.
[3] Mosse A.L., Shimanovich V.D., Ermolajeva L.M., Knak A.N., Krasovskaya L.I. (2003) High Temp. Material Processes 7, p.373.
[4] Valincius V., Kezelis R., Juskevicius R. (1999) Third Baltic Heat Transfer Conference, p. 104.
[5] Valatkevicius P., Valincius V., Kezelis R. (2001) ISPC-15, p.1585.
[6] Valincius V., Krusinskaite V., Valatkevicius P., Valinciute V., Marcinauskas L. (2004) Plasma Sources Science and Technology, p. 199.