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This principle provides the flexibility of the equipment by transforming internal and external structure of a plant depending on its purpose. Temperature processes can be adjusted from 500 °C to 5,000 °C.

Conclusion

The following conclusion is related only to the areas, which have been described in this overview. For the last decade a big progress was made by introducing RF plasma to some of bio-medical, water treatment and waste-to-energy applications. Efficiency of plasma processes is one of the critical factors for existing and new plasma systems. The combination of RF and DC plasma with other heat sources is one of the way to optimize the treatment systems.

Plasma Gasification of Fuel Biomass

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The aim of the work was to conduct complex thermodynamic and experimental studies of FW plasma processing, comparison of the calculated and experimental data and the development of technological process recommendations. In this paper we discuss the results of thermodynamic analysis of high-calorific fuel gas production by gasification of fuel biomass (FBM) in air. Also experimental installation is presented and the results of experiments on gasification of FBM in air plasma compare with the computation.

A typical chemical composition of FBM is represented by the following components, wt.%: C – 49.88, O – 43.81, H – 5.98, N – 0.10, K_2O – 0.01, CaO – 0.12, MgO – 0.02, MnO – 0.01, Fe_2O_3 – 0.01, Al_2O – 0.01, SiO_2 – 0.01, SO_3 – 0.01, P_2O_5 – 0.02, Na_2O – 0.01. The organic part of FBM is represented by carbon, oxygen and hydrogen with a total concentration of 99.7%, whereas the mineral part is only 0.3%

Software package Terra [1] was used to perform thermodynamic calculations of FBM plasma air gasification. Calculations were carried out in the temperature interval 300–3,000 K and a pressure of 0.1 MPa. The aim was to determine the integral parameters of the gasification process: equilibrium composition of the gas phase of the gasification products, the degree of carbon gasification and specific power consumption for the process. The calculations showed that the maximum yield of the synthesis gas at plasma gasification of fuelwood in air medium is achieved at a temperature of 1,600K. At the air plasma gasification of FBM synthesis gas with a concentration of 77.1% (CO – 42.0, H_2 – 25.1) can be obtained. Specific heat of combustion of the synthesis gas produced by air gasification amounts to 9,450 kJ/kg. At the optimal temperature (1,600 K), the specific power consumption for air gasification of FBM constitutes 1.53 kW h/kg. Found parameters and discovered patterns of the process of plasma gasification of FBM have been used to design an experimental plasma installation.

Experimental studies of FBM gasification were performed on the installation, main elements of which are a plasma chemical reactor with productivity by FBM up to 50 kg/h and long live DC plasma torch of 70 kW nominal power [2].

Gas analysis showed the following composition of the gas at the exit of plasma installation, vol.%: CO – 42.0, H_2 – 25.1, N_2 – 32.9. Specific heat of combustion of the synthesis gas produced by air gasification amounts to 9,450 kJ/kg. The total concentration of the synthesis gas was 77.1%, which agreed well with the calculations.

Carbon content of the slag in the sample was 1.13 wt.%, which corresponded to the degree of FBM carbon gasification 96.6%. Specific power consumption for FBM gasification in the plasma reactor according to the results of experiments amounted to 1.53 kWh/kg of working substance. In the experiments, as well as in calculations, no harmful impurities were found in the products of FBM plasma gasification.

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References

[1] M. Gorokhovski, E.I. Karpenko, F.C. Lockwood, V.E. Messerle, B.G. Trusov, A.B. Ustimenko "Plasma Technologies for Solid Fuels: Experiment and Theory", *Journal of the Energy Institute*, vol.78, no.4, pp. 157–171, 2005.

[2] V. E. Messerle, A. L. Mosse, A. B. Ustimenko "Municipal Solid Waste Plasma Processing: Thermodynamic Computation and Experiment" *IEEE T Plasma Sci,* vol. 44, no. 12. pp. 3017–3022, 2016.

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Trash-to-Gas: Efforts for Long Duration Space Logistical Waste Conversion

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Currently on human spaceflight missions, logistical and mission waste are stored in cargo transfer bags until a disposal vehicle is ready to be detached and jettisoned from the International Space Station, and the trash is burned up in Earth's atmosphere. On a long duration deep space or planetary habitat mission, more logistical items, including food, hygiene, and supplies will be required for crew transport, which means more waste generation. Trash disposal strategies are being investigated for different mission scenarios.[1] On a long duration space mission, a four person crew will produce approximately 2,500 kg of waste materials in one year, consisting of food packaging, used clothing, hygiene items, human waste, life support system supplies and other crew supplies.[2] Jettisoning trash from a vehicle during transit to a deep space location (i.e. Mars) could become an orbital debris issue for future missions, and also requires an air lock which uses energy for pressurization and depressurization. Leaving waste on a planetary surface also risks the violation of planetary protection rules. The reuse of discarded materials on a long duration or planetary habitat is beneficial as it will reduce the overall mission mass, increase usable spacecraft and habitat volume, and can be converted to fuel, water and repurposed construction materials. A space technology alternative for converting trash and other waste materials into high-value products was investigated by the National Aeronautics and Space Administration (NASA). Six technologies for waste-to-fuel production were initially investigated, including catalytic wet air oxidation, pyrolysis, ozonation, incineration/gasification, and steam reforming. [3]–[5] These technologies were part of the Trash to Gas (TtG) project and were mainly thermochemical processes that converted the raw elements of a uniform waste simulant into new products. Other options investigated compressing waste into radiation shielding material via a heat melt compactor.[6], [7]

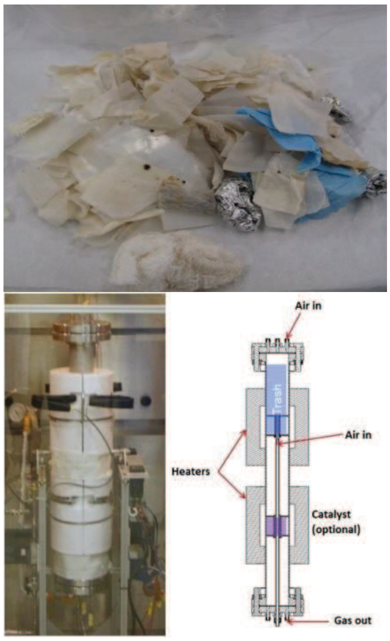

Fig. 1. Top: 100g of high fidelity waste simulant.

Bottom: Steam reforming reactor and schematic at KSC

TtG provided stabilization of all combustible waste including human metabolic wastes and brine, volume reduction of waste, and production of useful gases for