Toward negative CO_2 emissions and circular carbon economy by carbonization of low-value organic waste in the presence of zinc-based molten salts

Prestigiacomo C.[1], Picaro T.[2], Franzè I.[1], Ruvio D.[1], Scialdone O.[1], Galia A.[1]
[1]Dipartimento di Ingegneria, Università degli Studi di Palermo, Palermo, Italy;
[2] United Renewable Technologies, Australia

Catalytic carbonization in molten salts offers a new and emerging technology approach for treating organic wastes to achieve negative CO_2 emissions and a circular carbon economy by converting the low-value carbon content of the waste into high value solid carbon materials which can be reused, and also converting the hydrogen content of the waste into a low-carbon hydrogen-rich fuel gas. In the work herein, the use of pure molten $ZnCl_2$ in batch reactors was studied for this purpose. A proper reaction apparatus was designed and realized. The $ZnCl_2$ was provided by VWR Chemicals (>97% of purity) and C16-C18 saturated hydrocarbons and synthetic polyolefins were used as model compounds to carry out a preliminary investigation of the effect of kinetic severity, tuned by changing reaction temperature and time, on the performances of the process evaluated in terms of yield of gaseous hydrogen and solid carbon in the residue. TGA analyses of pure $ZnCl_2$ and high density polyethylene (HDPE) and of their binary mixtures demonstrated the catalytic activity of $ZnCl_2$ made evident by an improvement of the mass loss rate. Exploratory carbonization experiments of high density polyethylene showed that, when the reaction temperature increased from 300 to 380 °C for 30 min, the gaseous H_2 yield increased from 0,3% to 1,1 %w/w, the limiting theoretical value being 14% w/w. When the reaction time was further increased from 30 min to 3 h an enhancement in the production of light olefins in the place of hydrogen was observed. Preliminary results indicate that $ZnCl_2$ can catalyze the carbonization of polyolefins.