Solar-assisted thermocatalytic conversion of plastic wastes: study of the utilization of $ZnCl_2$-based heat transfer fluids as reaction media and catalysts

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The global polymer production has sharply increased over the years due to the wide application of plastics in many sectors. The higher the productivity the higher is the waste generation.

$ZnCl_2$-based molten salts have been proposed as thermal storage media for next-generation high-temperature heat-transfer fluids (HTF) for concentrating solar power or thermal (CSP/CST) plants (Journal of solar energy Engineering 2016, 138 (5), 054501). Zinc chloride has been discovered to have catalytic properties for the conversion of biopolymers at mild temperature conditions (ACS Omega 2018, 3, 2984−2993). $ZnCl_2$-activated thermochemical conversion of polymers may offer a new and emerging technology approach to achieve negative CO_2 emissions and a circular carbon economy by converting the low-value carbon content of the plastic waste into high-value solid/liquid carbon materials to reuse. In the work herein, a methodology to handle pure $ZnCl_2$ in batch reactors and to study molten salt-assisted pyrolysis of HDPE was established. The $ZnCl_2$ used for this purpose was provided by VWR Chemicals (>97% of purity). Pellets of HDPE were provided by HDPE Rigidex HD5502S from Ineos (density 23°C ISO 1183-1: 954 kgm^{-3}).

Experiments were performed at 400°C with 2 and 10 % w/w loading of HDPE in $ZnCl_2$, changing the reaction time from 30 min to 360 min. When the reaction time increased from 30 to 360 min, the permanent gases yield changed from 3 to 10 %, while the cumulative amount of C2+ hydrocarbon products decreased. Other detected products were liquid and carbonaceous solids. The polymer and the molten salt are immiscible and the control of the phase behavior of the reaction mixture was crucial to improve the performance of the process as liquid and carbonaceous solid yields increased with stirring.

Collected preliminary results suggest that molten $ZnCl_2$ can be effective catalytic media to valorize waste polyolefins. However, additional investigation is necessary to characterize carbonaceous waste and to explore operational limits of the process.

Keywords: *Concentrated solar heat, heat transfer fluid, molten salts, plastic wastes, waste valorization.*

Acknowledgement: Project code PE0000021, Concession Decree No. 1561 of 11.10.2022 adopted by Ministero dell'Università e della Ricerca (MUR), CUP B73C22001280006 , Project title "Network 4 Energy Sustainable Transition – NEST"