Overview of Development Progress of Molten Chloride Salts for Thermal Energy Storage

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In next generation concentrated solar power (CSP) plants, thermal energy storage (TES) and heat transfer fluid (HTF) materials with higher thermal stability limits (>800°C) and lower prices than the commercial TES/HTF materials - nitrate salt mixtures (decomposed at ~550°C) are required to increase efficiency of thermal to electrical energy conversion of the power block and to reduce the levelized cost of energy (LCOE) [1]. In this poster presentation, some development progress of molten chloride salts for TES in next generation CSP plants is presented.

In our research work [2-6], a promising chloride salt mixture containing NaCl/KCl/$MgCl_2$ (20/20/60 mole%, ~0.3 Euro/kg) has been extensively investigated, particularly in corrosion mechanisms [2-3] and mitigation methods [4] of metallic alloys in this molten salt at high temperatures (e.g., 700°C), since the higher TES/HTF operating temperature leads to significantly higher corrosion rates of metallic structural materials in contact with the molten chloride salts due to corrosive impurities. Moreover, an electrochemical method based on cyclic voltammetry is developed for in-situ monitoring the concentration of $MgOH^+$ - the main corrosive impurity in the molten salt [5-6], while an electrochemical method based on electrolysis using a Mg-electrode is applied to reduce the concentration of corrosive impurities [7-8]. These corrosion mitigation and monitoring methods could assist to efficiently control the corrosion of metallic structural materials in contact with the molten chloride salts.

Besides corrosion studies, a study on simply and efficient selection of promising chloride salts has been performed regarding their thermophysical properties, material costs and hygroscopicity [9], before the optimization of chloride salt mixtures for next generation CSP. Currently, the optimization of the NaKMg//Cl salt is being performed based on literature review, thermodynamic simulation, thermophysical experiments, and the available data (e.g., large-scale prices of chloride salts), in order to determine the optimal salt composition. More results of the salt optimization is presented by Dr. Carolina Villada Vargas in another poster presentation of our group [10].

References

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