PROTECTIVE PEO COATINGS WITH CARBON-BASED THERMAL CONDUCTIVITY PROMOTERS FOR SPATIAL METAL STRUCTURES IMPROVING LATENT HEAT STORAGE

Currently, there is a growing demand for energy all over the world and an ever-increasing pressure to use renewable energy sources due to environmentally damaging human activities. For this reason, many attempts are being made to store energy that is surplus to requirements in industrial processes or, for example, by using solar panels or photovoltaics on sunny days. The surplus energy collected can then be used at night, o, in the form of thermal energy on colder days to heat rooms. Similarly, in the case of manufacturing processes - excess heat, generated e.g. during the combustion or sintering of materials, can be stored and reused to heat office premises or in a subsequent technological process. This requires thermal energy storage, referred to in the literature as TES (Thermal Energy Storage). Heat storage in TES magazines is carried out using phase change materials, PCM (Phase Change Material). PCMs are materials that store heat through a phase transition, i.e. a change in the state of aggregation, such as melting.

The use of PCMs in solar energy storage requires the selection of materials with a suitable phase change temperature. These are typically salts and their eutectic mixtures and salt hydrates. In addition to their high phase transition enthalpy (the amount of heat they accumulate per change of phase), they have low thermal conductivity and high corrosivity. To improve conductivity, metal heat exchangers of various shapes are used, which, due to their complex shape, can be made by investment casting. Such structures are placed in a salt bed in metal containers prepared for this purpose. The project proposes to coat heat exchangers with a ceramic layer using the PEO (Plasma Electrolytic Oxidation) method, i.e. development of an oxide layer on light metals and their alloys (aluminium, magnesium, titanium) by electrical discharge in low concentration electrolyte solutions. Such coating, with the addition of carbon-based particles such as carbon nanotubes, MX phases or graphite, will not only protect against corrosion but also, thanks to the addition of thermally conductive particles, positively influence heat transfer.

MX structures are innovative two-dimensional materials that are composed of nitrides or carbides of transition metals, such as titanium or chromium. This is a young group of materials - the first MX-type structure was created in 2011. So far, just over 30 MXs have been created. These materials were obtained by etching MAX phases (MX-like compounds that contained an aluminium Al molecule between the nitrogen or carbon and the transition metal). After etching, MX structures were obtained in the form of flakes. They resemble graphene in structure (they are two-dimensional) and are characterised by hydrophilicity and excellent thermal conductivity.

The proposed project aims to select appropriate parameters for the production of such coatings on exchangers with geometries defined in the first phase of the project. In addition, electrolytes will be selected in which the coating process will be carried out using carbon-based fillers (e.g. MX phases, carbon nanotubes, graphite). The coatings will be subjected to microscopic analysis - their composition and structure will be checked. Additionally, hardness and corrosion resistance will be determined. Selected samples will be subjected to tests on the influence of molten salts on the behaviour of the sample surface. The degree of corrosion will be determined by microscopic examination. The selected coatings with the most favourable parameters will be tested in a heat accumulator on a laboratory scale.

As a result, it is expected to obtain a coating with high strength and durability, which will protect the metal exchanger from the corrosive action of the PCM material, while not improving the heat transfer, for which the coated exchanger is responsible.