

Abstract of the PhD thesis

„Studies on the preparation of zinc-free anticorrosive pigments”

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Corrosion is a natural process that causes irreversible damage to all structures, especially those made of metal. It can lead to construction disasters and cause great losses. In addition, corrosion products have a negative impact on the environment. Their presence in ecosystems can affect the proper development of plants and animals, especially when corrosion products enter surface waters. Therefore, the use of corrosion control measures is important from both economic and environmental perspectives.

One of the most popular methods of corrosion protection is the use of anti-corrosive pigments. The materials used so far contained chromates or zinc phosphate. However, they have a harmful effect on the environment. In 2008, $\text{Zn}_3(\text{PO}_4)_2$ was classified as very toxic to aquatic organisms (symbol H400) and toxic to aquatic organisms with long-term effects (symbol H411) under the European CLP Regulation. This had a major impact on the development of anticorrosive phosphates, in which the zinc cation was replaced by other cations, making them more environmentally friendly.

This doctoral dissertation deals with the synthesis and characterization of phosphate anti-corrosive pigments that do not contain zinc. The literature section discusses the corrosion phenomenon and ways to counteract it. An overview of publications on the most commonly used anti-corrosion pigments is also given. Based on available data, the market for protective coatings and anti-corrosion pigments is described.

In the experimental part, four main sections can be distinguished. The first concerns research aimed at increasing the efficiency of the process for obtaining selected phosphate pigments and at adapting the physicochemical properties of the pigments to the requirements placed on this type of materials when used in protective coatings. In this work area, the focus was on describing the change in the raw material previously used in the synthesis of aluminum-containing pigments. In addition, the influence of surface modification and spray drying of selected materials on their application properties was discussed. These measures produced the expected effect for most of the pigments studied.

The second section of the experimental part of the work dealt with the preparation of new modified calcium phosphates with different physicochemical properties. These were strontium

and calcium phosphates and ammonium and aluminum phosphates with the addition of fillers; blends of calcium phosphates and silica and/or calcium silicates; mixtures of calcium hydrogen phosphate and calcium molybdate as well as mixtures of aluminum phosphate and calcium molybdate. Investigation of the anti-corrosive properties has shown that most of them are characterized by good anti-corrosion properties and could be used as pigments that prevent corrosion.

The third section of the experimental part describes the extended studies of the anti-corrosive properties. The most commonly used construction material is steel, and the main recipient of anti-corrosion pigments is the marine industry. Therefore, epoxy and polyurethane coatings with the addition of obtained pigments were tested in the salt chamber and cyclic chamber. This made it possible to perform so-called accelerated aging tests under ship-like conditions, where the hulls coated with protective coatings are exposed to salt water.

The last area addressed in the PhD thesis was the study of obtaining anti-corrosive pigments on a quarter-technical scale. As part of the Tango 1 project, a pilot plant was built on the premises of Grupa Azoty Zakłady Chemiczne "POLICE" S.A. Six compositions of protective pigments were synthesized and their properties were compared with analogous materials produced on a laboratory scale. Mass and heat balances were made, and consumption rates and costs for production and sale of the obtained products were calculated. The syntheses performed confirmed the legitimacy of the proposed process for the synthesis of phosphate anticorrosive pigments containing aluminum, strontium, and calcium.

Based on the data collected during the research, it was found that the obtained materials can be successfully used as anticorrosive pigments. The protective properties of most of them were very good, often similar or even better than those of the commercial pigments commonly used in anti-corrosion coatings.

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