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Optimization of Effectiveness Evaluation Method for Intumescent Fire Retardant Coating

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Abstract. An optimized method for assessing the fire protection efficiency of intumescent coatings has been proposed, which can be applied during the development and research of new formulations of fire retardant compositions. To achieve this goal, a critical analysis of existing methods for evaluating the fire protection efficiency of intumescent fire retardant coatings has been conducted, both those approved by regulatory documents and those used by researchers for the fire protection agents effectiveness rapid assessments. Based on the analysis of the studied methods advantages and disadvantages, an optimized method for evaluating the intumescent fire-resistant coatings efficiency has been proposed to reduce the time for preparing and processing experimental results. The proposed optimized method involves the use of an electrical furnace with an insulated test chamber for heat accumulation as a source of thermal radiation, which allows obtaining temperatures on the reverse side of the metal plate exceeding 950 °C. As a criterion for fire protection efficiency, it is proposed to use the comparison of the time to reach the critical temperature (500 °C) on the outer side of metal plates protected by fire retardant coatings. The efficiency of fire protection of the metal plate has been investigated using the proposed method for three samples of intumescent fire protection agents: a coating based on epoxy oligomer, ammonium polyphosphate, aluminum hydroxide, and intercalated graphite, a coating on a styrene-acrylic basis of industrial production, and a well-known coating based on epoxy oligomer filled with monoammonium phosphate and intercalated graphite. The results of the experiment allowed a comparative assessment of the studied coatings fire protection efficiency. The use of the optimized method significantly simplifies the experiment and reduces the time spent on sample preparation and processing of its results.

Introduction

Metal structures are widely used in industry and construction. However, under fire conditions, unprotected metal structures lose their bearing capacity within 0.1 to 0.4 hours [1–4], since the critical temperature for structures made of various steels averages 470-550 °C, and for aluminum alloys – 165–225 °C. Thus, the fire protection efficiency of coatings for fire protection of metal structures will be determined by the time interval from the onset of temperature impact to the moment the structure reaches critical temperature [5–7]. The most promising way to achieve the regulatory fire resistance limit of building structures, which does not burden the structures and can be applied to complex configurations, is fire protection using intumescent fire retardant coatings (IFRC) [8–11]. These types of agents swell under flame action, forming a fireproof thermal insulation layer on the surface of the building structure. Intumescent fire retardant coatings are complex in terms of the interaction of their main components: film-forming agent, carbonizing agent, catalyst (acid source), carbon source, and blowing agent. This causes certain difficulties during research for developing new formulations of IFRC, particularly in studying the multiplicity of their swelling under flame temperature effects, the structure and strength of the formed coked