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THE STUDY OF THEORETICAL AND PRACTICAL ASPECTS OF THE OCCURRENCE OF INTERNAL STRESSES IN POLYMERIC AND PAINT-AND-LACQUER MATERIALS AND COATINGS BASED ON THEM, WHICH HAVE A SIGNIFICANT IMPACT ON THEIR DURABILITY

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Abstract
In polymer and paint coatings on a rigid substrate, internal stresses act, which have a significant impact on their durability.

Keywords: polymer, temperature, internal stresses, polymer and paint coatings, linear expansion.

Introduction

There are two main sources of internal stresses in polymer and paint coatings:

1. A decrease in the volume of the film formed on the surface of the substrate-substrate due to the evaporation of solvents and, as a result of chemical reactions, as well as due to the formation of supramolecular structures.
2. Thermal contraction with an increase in the temperature of film formation on the surface of a solid substrate-substrate due to the difference in the coefficients of linear expansion of the film and substrate.

With an increase in internal stresses in polymer and paint coatings ceteris paribus, the durability of the coating decreases. The most common cause of the destruction of polymer and paint coatings for various purposes is the cracking of the cover film and its delamination from the substrate [1-5].

The Main Part

Cracks occur when the magnitude of internal stresses in polymer and paint coatings exceed the cohesive strength of the film under certain operating conditions [6-11]. With an increase in the coating thickness, the force that shifts the coating from the substrate increases due to the action of internal stresses, which reduces the adhesion and strength.

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The process of delamination of the coating, as well as the rupture of the film, is of a temperature-time nature. The durability of the coating is determined by the formula as follows:

$$\frac{U_0 - \gamma - \sigma}{k - T}$$

$\tau = \tau_0 - e$

τ_0 - a constant depending on the nature of the polymer or adhesive bond;

U_0 - a constant that determines the energy barrier that must be overcome so that thermal fluctuations can destroy the cover film or adhesive bond;

Υ - constant sensitive to structural changes in the coating or surface layers of the adhesive joint;

k - Boltzmann's constant;

T - the absolute temperature.

The magnitude of internal stresses in polymer and paint coatings is influenced by technological, design and operational factors.

The most widely used cantilever method for determining internal stresses in polymer and paint coatings of metals, when stresses are determined by the deviation of the free end of an elastic plate with another fixed end [12-19].

In anti-corrosion coatings, film thickness has a significant impact on durability. With an increase, up to a certain value, of the thickness, the durability of polymer and paint coatings increases due to an increase in the duration of the diffusion of the corrosive medium to the adhesive joint. With an increase in the thickness of the coating, at a constant thickness of the substrate. the magnitude of the error in determining the internal stresses by the cantilever method increases sharply.

Taking this into account, as well as a decrease in film tension due to substrate bending in the cantilever method, which leads to changes in the conditions for the occurrence of relaxation processes in the cover film, the authors of the State Unitary Enterprise "Fan va tarakkiyot" DUK at the Tashkent State Technical University. Islam Karimov, with the participation of the author of this dissertation, developed a technique and designed instruments for measuring internal stresses in polymer coatings on an elastic metal substrate by the force developed by the end of a cantilevered sample [20-27]. The value of internal stresses is determined by the formula:

$$\sigma = \frac{P - l[E_1 - t^3 + 3E_2(t + \Delta t)^2 - \Delta t]}{3b(E_1 - t_3 + E_2 - \Delta t^3)(t + \Delta t) - \Delta t}$$

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Where:

P - the magnitude of the force developed by the free end of the substrate;

l - the length of the substrate;

B - the width of the substrate;

t - thickness of the substrate;

Δt - coating thickness.

E_1 and E_2 - are the elastic moduli of the substrate and coating material, respectively.

By measuring the effort on the free end of the substrate, you can determine to pour internal stresses into polymer and paint coatings. However, for practical calculations, internal stresses to polymer and paint coatings it is necessary to preliminarily determine the value of the modulus of elasticity of the coating in given horses specific conditions. It is difficult to determine the elasticity modulus of the coating at various stages of the experiment [28-35].

By analogy with bimetallic elements, it is proposed to use samples in which the ratio between the thickness of polymer and paint coatings and the thickness of the substrate is expressed by the following equation:

$$\frac{\Delta t^2}{t^2} = \frac{E_1}{E_2}$$

Then the equation for determining the internal stresses of polymer and paint coatings will be simplified:

$$\sigma = \frac{P - l}{\Delta t - b} - [\frac{t}{3(t + \Delta t)^2} + \frac{1}{\Delta t}]$$

Denoting:

$$K_0 = \frac{l}{\Delta t - b} - [\frac{t}{3(t + \Delta t)^2} + \frac{1}{\Delta t}]$$

Get

$$\sigma = K_0 - P$$

The last equation is convenient for calculations during experiments. The accepted assumption about the constancy of the modulus of elasticity of polymer and paint coatings does not lead to large errors [36-44].

So, with an actual decrease in the elasticity modulus of polymer and paint coatings by 50%, the error in determining internal stresses in them will be only 0. 8%, and with a decrease in the elasticity modulus by 80%, no more than 1. 5%.

By analogy with samples of normal bimetal, samples with anti-corrosion coatings, the parameters of which obey the above ratio, are also called normal coatings.

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In practical terms, the occurrence of internal stresses in polymer and paint coatings leads to a deterioration in their adhesive and cohesive properties and, accordingly, a decrease in performance and durability, for which it will be necessary to deeply study the occurrence of internal stresses in coatings depending on their composition and the influence of technological modes of their production.

Existing methods and installations fully qualitatively determine the value of internal stresses in polymer and paint coatings. In this regard, there is a need to develop a more efficient method and installation for determining internal stresses in polymer and paint coatings, which would make it possible to determine their value.

Considering [45-51] that it is proposed to take internal stresses as a criterion for evaluating the durability of polymer and paint coatings, the development of coatings with high durability can be limited to the study and determination of internal stresses in the resulting coatings [49-54].

Therefore, to develop polymer and paint coatings with high adhesive and physical-mechanical properties, it is necessary to conduct in-depth studies of the occurrence of internal stresses and to study new methods and installations that are being created, which make it possible to develop polymer and paint materials based on them with high performance and durability.

Conclusion

In order to analyse the occurrence of internal stresses and develop a new method and installations, below are the results of studying and analysing the occurrence of internal stresses and existing methods, instruments and installations for determining internal stresses in polymer and paint coatings.

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