Polymer Silicate Paints for Interior Decorating

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Abstract

Provides information about the properties of polymer silicate paint. The calculation of the paint formulation.

Keywords: an aqueous dispersion of sodium silicate, styrene acrylic dispersion, the viscosity, the concentration of pigment

Introduction

Silicate paints are widely used in the practice of painting and decorating. The aqueous dispersion of potassium silicate used for their preparation. The market well established silicate paints firm Degussa [1].

Results of the study

Given the scarcity of water dispersion of potassium silicate in the domestic market, offers colorful silicate composition based on a mixture of an aqueous dispersion of sodium silicate density of 1.15 g / cm³ and styrene acrylic dispersions. Styrene acrylic dispersions Lakroten E-21 and Nowopole 110 used to develop formulations.

Minium iron oxide, chromium oxide, ocher was used in the development of the formulation as a pigment; colored sand deposits (Penza region, Kuznetsk district) – as a filler. Characteristics filler are shown in Table 1. Acrylic dispersion Lakroten E-41 was used to control the composition viscosity
The rheological properties of the compositions were evaluated in terms of the relative viscosity, determined using a viscometer VZ-4.

Figure 1 shows the dependence of the relative viscosity of the pigment volume concentration. As can be seen from the data, when filling in the range of $0 < \phi < 0,154$ (pigment - minium iron), $0 < \phi < 0,023$ (pigment - chromium oxide), $0 < \phi < 0,044$ (pigment - ocher) viscosity increase slightly, the polymer matrix is only partially converted into a film state. A significant change in the ratio of bulk and film phases of the matrix occurs at later filling, there is a sharp increase in viscosity of the composition.

![Graph of relative viscosity vs pigment volume concentration](image)

**Table 1**

<table>
<thead>
<tr>
<th>Fraction content, % (by volume)</th>
<th>Sandy 1-0,05 mm</th>
<th>Dusty 0,05-0,005 mm</th>
<th>Clayless 0,005 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy 1-0,05 мм</td>
<td>77</td>
<td>12,33</td>
<td>10,67</td>
</tr>
</tbody>
</table>

Fig. 1. Dependence of the relative viscosity of the pigment volume concentration: 1 - minium iron, 2 - chromium oxide, 3 - ocher

Figure 2 shows the dependence of the viscosity upon the volume fraction of the pigment in coordinates $\lg \eta - C$ (where $C$ - the concentration of the pigment in the system). This relationship is a two intersecting lines. The point of intersection, projected on the $x$-axis, will be a critical pigment volume concentration (CPVC). The presence of inflection points in the curve $\lg \eta = f (C)$ indicates that the interaction of the filler in the filler interaction dominates in the filler-binder interaction.
Fig. 2. The logarithm of the relative viscosity of the bulk pigment content:
1 - minium iron, 2 - chromium oxide, 3 - ocher

The optimum content of the filler and the pigment was calculated by two methods.

In the first case, the flow of pigment (filler) was calculated by the following formula [2].

\[ V_{nan} = \frac{1}{\alpha}, \]  
\[ V_{ns} = 1 - \frac{\rho_{hac}}{\alpha \rho_{hcm}}, \]  
\[ V_{mon} + V_{ns} = 1; \]  
\[ V_{mon} = V_{nan} - V_{nan} V_{iban}, \]

where \( V_{nan} \) - the amount of the pigment particles (filler) volume units.;
\( V_{ns} \) - volume of the solution of the film former, volume units;
\( \alpha \) - coefficient move apart pigment particles (filler);
\( \rho_{hac} \) - bulk density of the pigment (filler), kg / m\(^3\);
\( \rho_{hcm} \) - true density of pigment (filler), kg / m\(^3\);
\( V_{mon} \) - the volume of monolithic pigment particles (filler) volume units.;
\( V_{iban} \) - the volume of interparticle voids pigment (filler) volume units.
Coefficient move apart pigment particles (filler) was determined by the formula:

\[ \alpha = \left( \frac{d + h}{d} \right)^3, \]  

(6)

wherein \( d \) - an average particle size of the pigment (filler), m;
\( h \) - the average thickness of the interlayer film former is 1.4 microns.

The second method of calculation based on a formula

\[ \varphi = \frac{\rho_{hac}}{\rho_{ucm}} \left( \frac{hS_{yo}\rho_{ucm}}{6} + 1 \right)^{\frac{1}{3}}, \]  

(7)

where \( S_{yo} \) - a specific surface area of pigment (filler), m\(^2\) / g.

The average particle size was determined by the formula

\[ d = \frac{6}{S_{yo}\rho_{ucm}}. \]  

(8)

Consumption pigment (filler) in both cases were the same. The main properties of the pigments and fillers, as well as the results of the theoretical calculations are shown in Table 2.

The values obtained for the pigment volume concentration (PVC) of various kinds of pigments were used in the development of future formulations colorful compositions.

Application of ink only in the formulation of colored sand, although it creates a color gamut, but these compounds are prone to sedimentation in spite of the presence of additives Lakroten E-41. In this regard, a filler in the color developing ink formulations used as replacement parts pigment. Fig. 3, 4 presents the results of experimental studies of the relative viscosity and the logarithm of the viscosity of colorful compositions from a mixture of pigment content (minium iron) and filler (sand color).
### Table 2

<table>
<thead>
<tr>
<th>Name</th>
<th>Specific surface $S_{\text{vol}}$, m$^2$/kg</th>
<th>Average particle size $d \cdot 10^{-6}$, m</th>
<th>Bulk density $\rho_{\text{bac}}$, kg/m$^3$</th>
<th>True density $\rho_{\text{vem}}$, kg/m$^3$</th>
<th>Factor move apart particles</th>
<th>The volume of the pigment particles (filler) $V_{\text{Han}}$, volume units</th>
<th>The volume of monolithic pigment particles (filler) $V_{\text{mon}}$, volume units</th>
<th>Volume of the solution of the film former $V_{\omega2}$, volume units</th>
<th>Volume content $\varphi$</th>
</tr>
</thead>
<tbody>
<tr>
<td>minimum iron</td>
<td>510,0</td>
<td>3,72</td>
<td>1265</td>
<td>3163</td>
<td>2,607</td>
<td>0,384</td>
<td>0,153</td>
<td>0,847</td>
<td>0,152</td>
</tr>
<tr>
<td>chromium oxide</td>
<td>975,9</td>
<td>1,33</td>
<td>927</td>
<td>4635</td>
<td>8,648</td>
<td>0,116</td>
<td>0,023</td>
<td>0,977</td>
<td>0,023</td>
</tr>
<tr>
<td>ochre</td>
<td>1171,6</td>
<td>1,78</td>
<td>720</td>
<td>2885</td>
<td>5,702</td>
<td>0,175</td>
<td>0,044</td>
<td>0,956</td>
<td>0,044</td>
</tr>
<tr>
<td>sand color</td>
<td>67,9</td>
<td>33,20</td>
<td>1516</td>
<td>2527</td>
<td>1,132</td>
<td>0,833</td>
<td>0,530</td>
<td>0,470</td>
<td>0,533</td>
</tr>
<tr>
<td>Sand colored ground</td>
<td>506,5</td>
<td>4,73</td>
<td>870</td>
<td>2527</td>
<td>2,177</td>
<td>0,459</td>
<td>0,164</td>
<td>0,836</td>
<td>0,162</td>
</tr>
</tbody>
</table>
Fig. 3. Dependence of the relative viscosity of the content of the mixture of pigment and filler:
1- by volume content of pigment 0.142;
2- by volume content of pigment 0.132.
The experimental results show that the replacement of the pigment filler, an increase of the critical pigment volume content (Figure 4)

Fig. 4. Dependence of the logarithm of the viscosity of the content of the mixture of pigment and filler:
1- by volume content of pigment 0.142;
2- by volume content of pigment 0.132.
Conclusion

Developed paint based on an aqueous dispersion of sodium silicate and styrene acrylic dispersion. Studies indicate that the coatings have sufficient adhesion to cement substrate constituting 1.4-1.8 MPa, bottling is 4-5 min. The compositions are used only for internal painting works. Coatings are highly decorative expressiveness. Use as a filler local material (colored sand) will expand the resource base, reduce the economic costs of production of paint.

References


Received: January 25, 2015; Published: February 25, 2015