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### DEVELOPMENT OF DEFOAMER SYSTEM FOR PLASTIC PAINTING WATER-DISPERSING PAINT

The basic types of defoamers and their applicability in different systems. Determination evaluation criteria steps defoamers. The regularities of the actions of defoamers of different chemical nature, and their mixtures in water-dispersion paint for painting of plastic. Obtained data set for defoaming action of additives of different chemical nature. The dependence of the speed of defoaming from chemical nature of defoamers and their number is studied. Found optimal concentration of defoamers and their mixtures in water dispersion system for painting of plastic products showed the presence of a synergistic effect when using a mixture of defoamers in the present systems. The mechanism of their defoaming actions was suggest.

**Introduction.** Changeover from solvent-borne to more environmental friendly water systems is considered to be the well-known world tendency in developing paints and lacquers (PLM). However, together with undeniable advantages for water-dispersing (WD) systems there are also drawbacks, in particular, intensive foaming, as the result of inevitable physicochemical interaction of surface-active materials (SAM) and water under the conditions of thorough mixing. In connection with this, the problem of defoaming is one of the most important in composing of formulae of water-dispersing paints and lacquers.

Foaming is a cause of serious trouble of production process because of loss of efficiency of dispersing equipment in connection with lowering of its effective volume and is also a cause of coating imperfection such as boils and craters.

Thus, defoaming is one of the problems of water-dispersing paints and lacquers system which is connected with specific properties of water as dispersive material.

Besides, there are no any defoaming additive agents or their systems equally effective for any water-dispersing film-forming systems.

Availability of hydrogen bonding results to intensive latent heat of evaporation. Water evaporates slowly having at this good surface tension.

Defoamers, in general, are non-solvable or, at least, partially non-water-solvable active ingredients, hydrophobic particles or their mixtures. [1].

For preparation of defoamers ingredients of varied chemical nature are used. Effectiveness of defoamer is provided by its partial incompatibility with the environment that provides defoamer drop formation in the system and as a result it does not cause coating imperfection arising at complete incompatibility. Thus, defoaming – always a compromise between effectiveness and compatibility. But at the same time, active components of defoamer should have good defoaming action.

Main active components:

- silicone oils (silicone polymers) – pure silicone oils, and also organically polysiloxane-modified. They are minor ingredients [2] due to their large incompatibility with environment;

- mineral oils. Due to their aliphatic structure, they are characterized by high hydrophobic properties and as a result by limited compatibility in PLM. They are mainly used for architectural coatings as in less filled systems they cause migration of pigment that results to glitter drop [3];

- vegetable oils. They are the most environmental friendly components. As the main chain of oil molecule - aliphatic, vegetable oils have the same drawbacks as mineral oils described above [1];

- polar oils. Compatibility of these components can be easily controlled, changing their polarity. Polar oils are often used in a complex with other active components to control compatibility;

- molecular defoamers (SAM-twins). It is a new defoamer class. They have strongly marked surface-active properties, molecules orientate on the surface of boils' walls. They are used for the materials of UV-drying, furniture and auto paints [4];

- hydrophobic particles. Frequently they are surface-modified particles of silicone dioxide, aluminic oxide, urea, waxes and polymer particles (polyamides, polypropylene). They are applicable for all sorts of WD PLM [7].

The structure of the foam is inhomogeneous. It can have absolutely different properties depending on air and liquid phase composition. Besides, the structure of the foam can be altered as time went on. As a result, there is not any universal defoamer. The selection of defoamer for each particular system is mainly based on empirical data. The important selection criteria are dispersion nature, pigment volume concentration, application method and conditions of defoamer application. Thus, developing water-dispersing paint for plastics on basis of styrene acrylic dispersion there should be an individual approach to the selection and dosage of defoaming additives.

**Main part.** WD PLM on basis of styrene acrylic dispersion of EOC EC 4120 trademark is regarded as PLM. Besides, paint and lacquers composition included:

1. Water.
2. Defoamer.
3. Coalescent Butilcarbitol.
4. Styrene acrylic dispersion.
5. Pigment paste on basis of iron-oxide black pigment.
6. Thickening agent of BYK 425 trademark.

For the research the following defoamers were used: defoamer on basis of mineral oils agent of DrewPlus L-1513 trademark, defoamer on basis of polyethersiloxane heteropolymer of Tego Foamex 1488 trademark and also defoamer on basis of defoaming polysiloxanes blend of BYK-022 trademark and their blends. Coating properties with different content of the above mentioned defoamers differ from manufacturers recommended to the lower side and also to the excessive consumption side are examined.

Macrofoam fall rate and also availability and destruction of macrofoam after composition of PLM and boils time destruction was quality index of defoaming.

Visually coating defects such as craters and layer inequalities were estimated. Besides, properties of coatings forming on polymer base such as polystyrol are measured. The following things are related to these properties: coating layer thickness, brightness, relative hardness on Koenig deferential lever, adhesion at abruption and also glitter as some components of defoamer can decrease this property.

In Table 1 there is a formula of examining paint lacquers material.

Table 1

**Basic formula of examining paint lacquers material**

Component	Number, g
Preparation of pigment paste	
Water	2.14
BYK 2010	0.214
Omiocarb	5.14
Black i/o	3.19
Butilcarbitol	0.34
Aqua ammonia	0.086
Paint composition	
Water	13.54
Butilcarditol	4.51
Dispersion	67.69
BYK 425	3.15

Examining defoamers in the following concentrations (%) were introduced into the samples of received paint lacquers material:

- Tego Foamex 1488 (0.1; 0.5; 1.0; 1.5);
- DrewPlus L-1513 (0.5; 0.8; 1.0);
- BYK-022 (0.03; 0.5; 1.0).

After composition and keeping the paint during 24 hours research on defoaming property was carried out and samples were applied onto polystyrol base.

Macrofoam settling rate while using examining defoamers can be seen in Fig. 1.

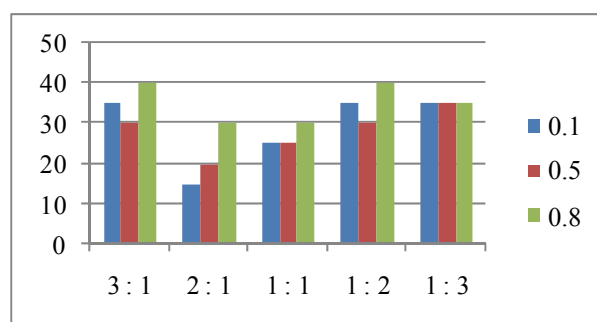


Fig. 1. Macrofoam settling rate while using examining defoamers: 1 – Tego Foamex 1488; 2 – DrewPlus L-1513; 3 – BYK-022

Destruction time of microfoam while using examining defoamers can be seen in Fig. 2.

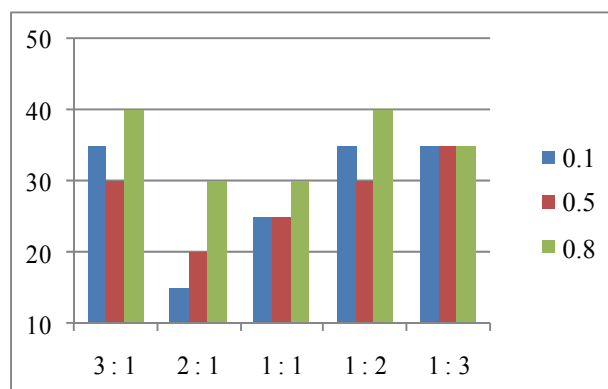


Fig. 2. Microfoam destruction time: 1 – Tego Foamex 1488; 2 – DrewPlus L-1513; 3 – BYK-022

Analyzing the received data it can be mentioned that the present defoamers eliminate macrofoam rather well but it is necessary to reduce time of microfoam destruction. The worst index of macrofoam settling time were obtained while using Tego Foamex 1488 defoamer and microfoam destruction – while using BYK-022.

Thus, BYK-022 defoamer destroys macrofoam the best and DrewPlus L-1513 defoamer influences microfoam the best in this paint lacquers system.

For further research the following blends of defoamers were used: DrewPlus L-1513 and BYK-022 in different proportions and also at different

concentrations of blends in ready-made systems: DrewPlus L-1513:BYK-022 in proportion of 3 : 1, 2 : 1, 1 : 1, 1 : 2, 1 : 3 at mixture proportion of 0.1; 0.5; 1.0% as the whole formula.

Further, properties of PLM and coating on its basis were tested. Data about macrofoam settling time microfoam destruction can be seen in figure 3 and figure 4 correspondently.

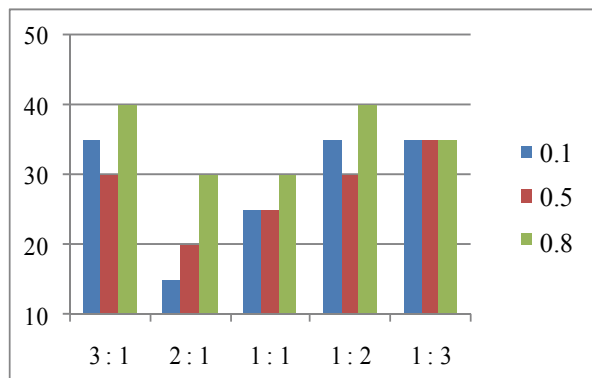


Fig. 3. Macrofoam settling time

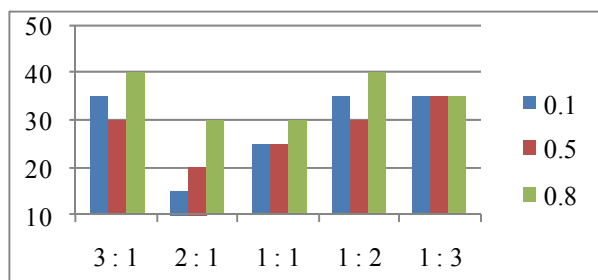


Fig. 4. Microfoam destruction time

Application of examining defoamers and their blends has not considerable influence on physical and mechanical properties of the ready-made coating, however, in some cases some flattening of coating can be observed. Properties of coating can be seen in Table 2.

Table 2

**Physical and mechanical properties of coating**

Properties	Value
Thickness, mkm	35
Brightness, %	1.4
Glitter, %	70
Adhesion at separation, MPa	1.5
Relative hardness, cond.unit	28.8

Thus, application of defoamer blends can provide not only effectiveness of defoaming but also reduce their dosage. To our point of view, this is connected with the fact that different defoamers act on different mechanisms, but in spite of this, defoamer of any type some has mechanisms than it

can realize in more or less extent with varying intensity on different kinds of foam.

Thus, mineral oils, composing defoamers, due to their chemical nature influence SAS molecules: located in space near an SAS molecule, they reorient them, removing hydrophobia parts of molecules from the air into dispersion phase, thereby, violating the balance at the interface water – air that leads to changing of electrostatic interaction between neighboring lamellae. Because of this, lamellae start gravitating, distance between them reduces and surface tension increases. This power balance of the system further slides to critical value due to hydrophobic particles which are present in a defoamer, deoriented molecules of SAS are removed from a thin layer of liquid between boils, therefore, completely destabilizing film between them. Microboils combine into larger ones that are removed from the content onto the surface forming macrofoam. This mechanism is more typical for defoamers on basis of mineral oils, to which DrewPlus L-1513 (Fig. 2) belongs to.

Destruction of macrofoam a little differs from destabilization of microfoam. The first stage of macrofoam destruction is penetration of a defoamer drop into lamella. For this defoamer should have low surface-tension [2, 3]. After penetration into lamella, defoamer drops merge together forming a “bridge” in a liquid film stabilized by SAM molecules.

Apart from low surface-tension there is one more demand to defoamer - hydrophobicity. We believe that this very property starts working at the second stage of macrofoam destruction. A defoamer drop being in lamella as a “bridge” is not being wetted by dispersion phase, i.e. contact angle is more than 90°.

**Conclusion.** Thus, the completed research allows to declare that for varnish-and-paint composition on basis of styrene acrylic dispersion EOC EC4122, application of blends of defoamers DrewPlus L-1513 and BYK-022 in the ratio of 2 : 1 allows to achieve synergetic effect of their action, that provides not only considerable improvement of defoaming index but also a sharp reduction of optimal dosage of defoaming system that decreases the price of receiving paint-and-lacquer materials. Application of this system resulted to a slight fall of glitter, though all other properties of the coating practically remained unchanged.

Thus, in energetically stable film with low surface-tension, area with also low surface-tension appears but with bigger contact angle between dispersion phase and defoamer drop that results to the destruction of lamella, air release and, as a result, to macrofoam destruction. This mechanism of macrofoam destruction can be proposed for defoamers of polysiloxanes and in this case BYK-022, that, apparently, explains more active fall of macrofoam in its presence (Fig. 1).

Requirements applicable to defoamers stipulate availability of necessary properties that provides participation in different defoaming mechanisms. But due to its chemical nature and physical characteristics of defoamers mineral oils have a big tendency to reorientation of SAM molecules in space and polysiloxane solutions have smaller surface-tension and strong hydrophobicity.

Correspondently, every type of defoamer that was used in this system fulfills its task according to its typical mechanism, thus time of destruction of macro- and microfoam reduces by 25 and 58,3% correspondently, and also dosage of agents reduces by several times (Fig. 5, 6).

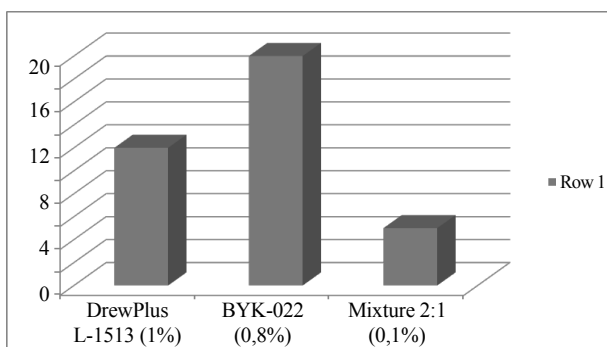


Fig. 5. Macrofoam destruction time

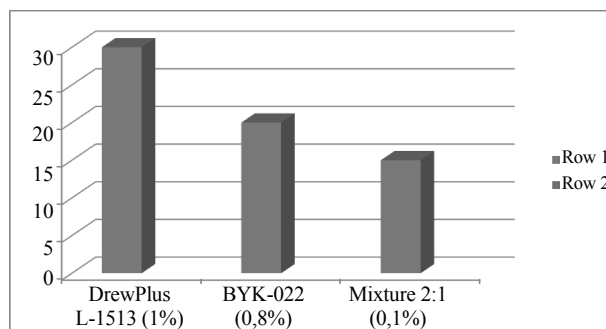


Fig. 6. Microfoam time destruction

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