УДК 621.315

ANALYSIS OF THE ACTIVATION LEVEL OF COMPOUND STRUCTURES SURFACE

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At present time the compound materials insluded organic and inorganic components differed by mechanical, chemical and electrical properties such as glass-fiber materials and its components, have a wide distribution for work in a high electric fields. An interface physical properties in that materials mostly define the quality of that goods.

In this article the adhesion buildup matters of the surface of glass fibers as a compound structure are considered after influence the electrical torch and barrier discharges..During the glass fibers production the paraffin and polyterpen lubricants are applied on their surface, that on the one hand protect them from mechanical damages and moisture influence and on other hand strongly reduce the wettability and adhesion on the border of phase division – glass fiber - binding agent [1-3].

For estimation of adhesion properties changes after the different type of treatment the method of contact moistening angle measurement based on connection between adhesion work, where solid contacts with liquid, and the equilibrium contact moistening angle was used.

In turn the adhesion work was calculated by formula of Dupre-Yung:

$$Wa = \gamma \times (1 + \cos\theta) \tag{1}$$

where γ - surface tension of the working fluid

θ - contact moistening angle

The bundle of glass fibres as a compound structure is considered, that depending of function has different number of fibres (from thousand to 10^4-.10^5). The diameter of each fibre is 12-13 μ.Therefore the soaking of that structures is very difficult and the whole soaking both a free and twisted bundle in content of glass fabric isn't solved yet. The fibres moistening by binding agent depends of surface energy value, that also depends of activation degree of glass fibres surface. For absolute analysis was considered, which process characteristics the contact moistening angle reflects. During the moistening of solids surface by liquid three physical bodies take part in this process:liquid, solid and gas. The contact moistening angle is the characteristic of the equilibrium state in system of these three bodies, i.e when the drop on the surface is on equilibrium state.According [4] the balance in liquid – solid – gas system is described by formula:

$$\lim_{\Delta A \to 0} \frac{\Delta G^S}{\Delta A_S} = 0 \tag{2}$$

where ΔAs - virtual displacement of liquid

ΔG - change of the free surface energy in system

In turn this change connects with surface tension factor - γ, seeming surface change - ΔAs and roughness factor – r. If the roughness factor is set [5] by expression:

$$r = \frac{\Delta \mathrm{A}_N}{\Delta \mathrm{A}_S} > 1 \qquad \{3\}$$

the change of the free surface energy can be written as [4] :

$$\Delta G^S = \Delta \mathrm{A}_S \times r \times (\gamma_{SL} - \gamma_{SG}) + \Delta \mathrm{A}_S \times \gamma_{LG} \times \cos(\theta_S - \Delta\theta_S) \qquad \{4\}$$

where S,L,G is refered to solid, liquid and gas; γ - surface tension factor on the border of mediums; θ_S - seeming moistening angle; $\Delta\theta_S$ - virtual change of angle.
In this case an equilibrium condition will be described by formula:

$$r \times (\gamma_{SL} - \gamma_{SG}) + \gamma_{LG} \times \cos\theta_S = 0 \qquad \{5\}$$

If to enter the specific work notion for this system like in [4]:

$$\varpi_{LSG} = \gamma_{SG} + \gamma_{LG} - \gamma_{SL} \qquad \{6\}$$

we will get the follow expression:

$$\varpi_{LSG} = \gamma_{LG} \times \left(1 + \frac{1}{2}\cos\theta_S\right) \qquad \{7\}$$

Practically this formula is the formula of Dupre-Yung {1} for the surface with roughness – r.
From comparison of formulas (7} and {1} we have got the formula:

$$\cos\theta_S = r \times \cos\theta_N \qquad \{8\}$$

For bundle of glass fibres, that aren't fluffed up these angles aren't same {fig.1}

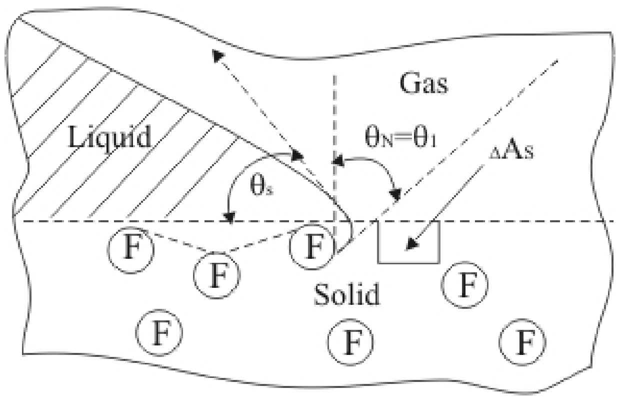

Fig1.Moistening scheme of the glass fibres compound structure.

Physically it means, that we can't measure the angle arised at the beginning of liquid wicking in slot on the surface.
If the bundle of glass fibres is presented like compound ordered structure, the roughness factor – r can express as:

$$\cos\theta_S = r \times S_1 \times \cos\theta_1 - S_2 \qquad \{9\}$$

where S_1 and S_2 – the parts of total area, that belong to each constituent of the ordered structure in projection; S_1 – the part of fibres projection; S_2 – the part of gas space between them.

From expressions {7} and {8} we can see, that roughness decreases θ_S, if $\theta_N < \frac{\pi}{2}$, i.e when liquid moistens the surface. When $\theta_N > \frac{\pi}{2}$, i.e when liquid doesn't moisten the surface, roughness increases θ_S. For the glass fibres surface layer the range of measured moistening angles is approximately 25° - 70°. If the fibre diameter is marked through R, for structure we can get approximation, that when $\theta_1 \geq 25°$, $S_1 \approx \cos\theta$ and $S_2 \approx 1-\cos\theta$

The roughness factor in this case will be:

$$r = \frac{R\times(\pi - 2\theta_1)}{2R\times\cos\theta_1} = \frac{\frac{\pi}{2}-\theta_1}{\cos\theta_1} \qquad \{10\}$$

and the seeming angle of the compound structure will be:

$$\cos\theta_S = \cos\theta_1 \times \left(1+\frac{\pi}{2}-\theta_1\right)-1 \qquad \{11\}$$

From formula (11) we can see, that the moistening angle of compound structure θ_S is changed from 30° to 110° while θ_1 is changed from 30° to 60°. Calculations have shown, that the contact moistening angle of compound structure θ_S is greatly differed from θ_1 when θ_1 is very big and is almost same with it when $\theta_1 \leq 40°$.

Physically it means, that for non-activated fibre surface liquid will cross from fibre to fibre{ dotted line on fig.1}and will leave behind the hollow occluded gas space between neighbouring fibres. When the surface is activated, i.e on small natural moistening angles liquid will fill the occluded gas and on presence of proximities between them will penetrate into glass fibre bundle.The bubbles capture phenomena is disappeared and as a result the bundles soaking is sharply improved, that is very important during the fibre glass materials production. For the glass fibres fluff up before theirs entry in bath with binding agent the opposing torch dischrges scheme [5] was applied and as a result the partial discharges were arised between the fibres inside the bundle and the activation of each fibre was increased.In turn this phenomena has increased the discharge current on presence the glass fibres bundle in gap.

Thus the calculations, that were done in this article, show the connection between the seeming moistening angle and natural moistening angle for the different types of compound structures and can estimate theirs surface activation level.

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STRUKTUR TƏŞKİLEDİCİLƏRİNİN SƏTHLƏRİNİN AKTİVLƏŞMƏ SƏVİYYƏSİNİN TƏHLİLİ

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Təqdim olunan məqalədə şüşə liflərdən təşkil olunmuş materiallarının təşkiledicilərinin səthlərinin aktivləşdirilməsi prosesslərinə baxılmışdır. Aktivləşmə dərəcəsi islanma bucagının ölçülməsi vasitəsilə təyin olunmuşdur. Təşkiledicilərə malik strukturlar üçün, səthin relyefini nəzərə alaraq, ölçülən islanma bucağının həqiqi islanma bucagından asılılığını təyin etməyə imkan verən tənlik alınmışdır. Müəyyən edilmişdir ki, kiçik həqiqi islanma bucagında, onun qiyməti ölçülən islanma bucagının qiymətinə yaxındır. Lakin böyük həqiqi islanma bucagında mayenin bir lifdən diqərinə keçməsi struktur təşkiledicilərinin səthlərinin islanmaya meyilli olmamasını təsdiq edir.

АНАЛИЗ СТЕПЕНИ АКТИВАЦИИ ПОВЕРХНОСТИ СОСТАВНЫХ СТРУКТУР

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В данной статье рассматривается процесс активации составной структуры.состоящей из стекловолокон. Степень активации определялась посредством измерения краевого угла смачивания. При помощи геометрических преобразований было получено выражение Дюпре-Юнга для составной структуры с учетом шероховатости поверхности, из которого вытекает зависимость измеряемого кажущегося угла смачивания от истинного. Показано, что при малом истинном угле смачивания его значение близко к измеряемому углу смачивания, что свидетельствует об активации поверхности каждого стекловолокна в жгуте. Напротив, при большом истинном угле смачивания жидкость переходит с волокна на волокно, что говорит о плохой смачиваемости поверхности составной структуры.