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DISTINCTIONS OF PREPARATION BATCH FOR OBTAINING WHITE GLASS COATINGS

Abstract. *Enameling technology in Ukraine pays much attention to the mechanical, physical, chemical, aesthetic and consumer properties of enameled products for various purposes, but issues of the order of charge are not given due attention. The process of preparation of batch for subsequent frit cooking is considered to be well known and standard. Such qualities of enameled products as expressive form, whiteness, enamel color, quality of decor, and pattern predetermine the competitiveness of products in the market of consumer goods. These indicators depend on monitoring the accuracy of compliance with each stage of production, including the quality of raw materials (constancy of chemical composition and purity of materials, the degree of their grinding, the sequence of introduction into the charge, the duration of mixing). The influence of the sequence of introduction of raw materials into the charge on the optical indicators of titanium glass coverings is studied. A rational technological procedure for the preparation of batch has been worked out, which consists of mixing in the first stage titanium dioxide and magnesium oxide, then sodium and potassium nitrate and sodium tripolyphosphate and only then sand and all other components. The grain composition of the materials corresponded to sieving through a 02 (912 holes/cm^2) sieve. Glass-enamel coatings with a high reflectivity of a white surface (CDR=87.1…87.2%) and good gloss of the glass layer (84–85%) were obtained. The developed glass covers are designed for application to steel products for domestic and technical purposes.*

Key words: *raw materials, order of composition of charge, glass enamel, anatase, optical characteristics, coefficient of mirror reflection (CMR), coefficient of diffuse reflection (CDR).*

INTRODUCTION

Presently due to modern technologies, wide spectrum of the enameled wares is possible made for pharmaceutical, chemical, food and other industries of industry.

Expansion of application of white opaque titanic glass-enamel coatings domain for steel in industry causes the necessity of further study and improvement of their aesthetic-consumer descriptions, namely — whiteness of glass-enamel layer. A standard in this area is a white enamel, a titania-opacified enamel with the degree of whiteness over 85%.

Experience of modern productions on release of the enameled steel products shows that most widely apply of titania-opacified enamel with high degree of opacifing to protection of internal and external surfaces [1]. This type of enamel differs in high whiteness thanks to existence a suppressing phase of dioxide of titan mainly in the form of small crystals of anatase in it.

Whiteness — the major characteristic of the enameled products which defines their competitiveness which is traditionally estimated in production of the enameled metal products on the coefficient of diffusion reflection (CDR).

The whiteness of glass-enamel coatings depends on many factors: chemical composition of raw materials, purity of raw materials, quality of mixing of batch, conditions of cooking of enamel and fiering of coverings, mill additives, etc. [2].

The leading European producers release enamel frit, having the quality surpassing the majority of domestic analogs information on structures frite “know-how” is not disclosed. So, for example, Mefrit (Czech Republic) delivers to enamel in the form of powders frite (premixes) as a ready-made product for the subsequent wet enameling [3].

The Dutch firm “Ferro” except frite delivers also batch in the form of powders semi-finished products, the so-called “nucleus” including the components which are responsible for characteristic properties of enamels. Titanic enamels of this firm differ in high rates of whiteness. The components which are responsible for an indicator of whiteness (CDR) presumably are a part of “nucleus”. Having received such “nucleus”, the customer only adds the materials which remained according to the recipe and enamel at the corresponding mode melts.

STATEMENT OF A PROBLEM

In Ukraine insufficient attention is paid to issues of studying of technology of batch mixing in anenamel industry. In this regard there was a need to receive enamels with high operational and optical characteristics by improvement of technology of batch preparation.

To study influence of sequence of raw materials introduction to composition of preparation of batch on optical indicators of glass coatings of white color, to fulfill a rational production cycle of preparation of batch and to receive enamel coatings with CDR>85% and CMR>80%.

METHODS OF RESEARCHES AND PUBLICATIONS

In work as a basis of the nonefluor-titanic enamel, containing in the chemical composition the following oxides, %: 84.4 (SiO_2 + TiO_2 + B_2O_3 + Na_2O) of 15.6 (Al_2O_3 + K_2O + MgO + P_2O_5) was used. The following materials were a part of batch of this enamel according to the calculated recipe: quartz sand (SiO_2), boric acid (H_3BO_3), dioxide of titanium (TiO_2), alumina (Al_2O_3), soda calcinated (Na_2CO_3), potassium (KNO_3) and sodium ($NaNO_3$) of saltpeter, oxide of magnesium (MgO) and tripolyphosphate of sodium ($Na_5P_3O_{10}$).

All raw materials were in advance prepared: were sifted through corresponding a sieve: (quartz sand — having sunk through a sieve 08 (83 openings/cm^2); dioxide of the titanium, boric acid and soda — having sunk through a sieve 1 (55 openings/cm^2); potassium and sodium saltpeter — having sunk through a sieve 07 (98 openings/cm^2); alumina, oxide of magnesium and tripolyphosphate of sodium — having sunk through a sieve 09 (64 openings/cm^2) [4].

In technology of batch mixing of initial enamel all raw materials were weighed serially, then at the same time were carefully mixed, pounded and sifted through a sieve 09 (64 openings/cm^2).

During the experiment preparation of batch for melting of enamels was carried out to several stages. To determine rational option of sequence of mixing of raw materials three series of experiences of sequence of introduction of materials were executed and studied: I — № 1–8; II — № 9–12; III — № 13–18 **(tab. 1–3)**. For the purpose of receiving necessary thin fraction of input products and ensuring closer contact of reagents in a solid phase in all studied options (except initial) each stage of mixing (grinding by a pestle in a porcelain mortar) was proceeded within 5 minutes (including intra phasic mixing), then batch was sifted through a sieve 02 (918 openings/cm^2). In the first series of experiences **(tab. 1)** practically in all options at the first stage of preparation of batch TiO_2 was entered (unlike initial option). For studying of influence of sequence of input products addition on batch pro-melting speed, quartz sand as the most refractory component, on I, II, III, VIII sta-

Table 1

Order of introduction of raw materials (I series)

Option of batch preparation	Sequence of introduction of raw materials							
	I	II	III	IV	V	VI	VII	VIII
Parent version	SiO_2	H_3BO_3	TiO_2	Al_2O_3	$NaNO_3$ Na_2CO_3	KNO_3	MgO	$Na_5P_3O_{10}$
1	TiO_2 $Na_5P_3O_{10}$	SiO_2	H_3BO_3	Al_2O_3	MgO	KNO_3 $NaNO_3$ Na_2CO_3	—	—
2	TiO_2 SiO_2	$Na_5P_3O_{10}$	H_3BO_3	Al_2O_3	MgO	KNO_3 $NaNO_3$	Na_2CO_3	—
3	TiO_2 H_3BO_3	$Na_5P_3O_{10}$	SiO_2	Al_2O_3	MgO	KNO_3	$NaNO_3$ Na_2CO_3	—
4	TiO_2 SiO_2	$Na_5P_3O_{10}$ Al2O3	H_3BO_3	MgO KNO_3	$NaNO_3$ Na_2CO_3	—	—	—
5	TiO_2 H_3BO_3	$Na_5P_3O_{10}$ Al2O3	SiO_2	MgO KNO_3	$NaNO_3$ Na_2CO_3	—	—	—
6	TiO_2 $Na_5P_3O_{10}$ Al2O3	SiO2	H_3BO_3	MgO KNO_3	$NaNO_3$ Na_2CO_3	—	—	—
7	MgO Al_2O_3	KNO3	$Na_5P_3O_{10}$	Na_2CO_3	$NaNO_3$	TiO_2	H_3BO_3	SiO_2
8	TiO_2 KNO_3 $NaNO_3$	$Na_5P_3O_{10}$	SiO_2	H_3BO_3	Al_2O_3	MgO	Na_2CO_3	—

Table 2

Order of introduction of raw materials (II series)

Option of batch preparation	Sequence of introduction of raw materials						
	I	II	III	IV	V	VI	VII
9	TiO_2 $NaNO_3$ KNO_3	SiO_2	$Na_5P_3O_{10}$	H_3BO_3	Al_2O_3	MgO	Na_2CO_3
10	TiO_2 $NaNO_3$ KNO_3	$Na_5P_3O_{10}$	MgO	SiO_2	H_3BO_3	Al_2O_3	Na_2CO_3
11	TiO_2 $NaNO_3$ KNO_3	H_3BO_3	$Na_5P_3O_{10}$ Al_2O_3	SiO_2	MgO	Na_2CO_3	—
12	TiO_2 $NaNO_3$ KNO_3	$Na_5P_3O_{10}$	Al_2O_3	H_3BO_3	SiO_2	MgO	Na_2CO_3

ges of batch preparation was added. For an cover of grains of silicon dioxide, the tripolyphosphate of sodium and boric acid (stages I, II, III and VII) were entered. Sodium and potassium saltpeter which creates an oxidizing environment during cooking was entered at five initial stages of batching **(tab. 1)**. The calcinated soda was added almost in all options at the last stages of preparation of batch. Because of existence in most of structures of titanic enamels of oxides of magnesium and aluminum, we studied their addition on different stages: I, II, IV, V and VI, **(tab. 2)**.

In the second series of experiences on I stages in all options $NaNO_3$ and KNO_3 mixed together with the main suppressing component — TiO_2. Tripolyphosphate of sodium ($Na_5P_3O_{10}$) was entered on II and III stages. Quartz sand along with H_3BO_3 was added at the subsequent stages preparation of batch (II, IV and V). For this series of experiences it is characteristic that Na_2CO_3 was added at the last stages of mixing. Alumina and magnesium oxide were obligatory components on different stages [5]. For the third series of experiments **(tab. 3)** influence of duration of contact of input products among themselves (var. № 17 and № 18) on optical characteristics of the received coatings (CDR and CMR) was studied.

So, for example, option No. 18 differed in the fact that all raw materials were added without mixing (from II stage), and after batch preparation

Table 3

Order of introduction of raw materials (III series)

Option of batch preparation	Sequence of introduction of raw materials						
	I	II	III	IV	V	VI	VII
13	TiO_2 SiO_2	MgO	$Na_5P_3O_{10}$	H_3BO_3	Al_2O_3	$NaNO_3$ KNO_3	Na_2CO_3
14	TiO_2 MgO	$NaNO_3$ KNO_3	$Na_5P_3O_{10}$	SiO_2	H_3BO_3	Al_2O_3	Na_2CO_3
15	TiO_2 H_3BO_3	MgO	$Na_5P_3O_{10}$ Al_2O_3	SiO_2	KNO_3	$NaNO_3$ Na_2CO_3	—
16	TiO_2 $NaNO_3$ KNO_3	MgO	$Na_5P_3O_{10}$	SiO_2	H_3BO_3	Al_2O_3	Na_2CO_3
17	TiO_2 MgO	$Na_5P_3O_{10}$	$NaNO_3$ KNO_3	SiO_2	H_3BO_3	Al_2O_3	Na_2CO_3
18	TiO_2 MgO	$Na_5P_3O_{10}$	$NaNO_3$ KNO_3	SiO_2	H_3BO_3	Al_2O_3	Na_2CO_3

mixing during 30 minutes was made. In options No. 13–16 $Na_5P_3O_{10}$ was entered on III stages, and Na_2CO_3 at the last (VI and VII) stages of batch preparation. Introduction of $NaNO_3$ and KNO_3 was obligatory (stages I, II, V and VI) and almost in all options quartz sand was added on IV stage of batch preparation. Also it was characteristic the fact that MgO was entered into composition of batch at the first or second stages.

Enamels were melted at a temperature of 1260–1280 °C (ref. — 1300 °C) during 54–55 min. (ref. — 70 min.). Frit was received in the way of wet granulation. Frits according to the uniform recipe, an h: 100.0 frit; 5.0 chasovyarsky clays; 0.1 KCl; 0.1 $NaNO_3$ and 40.0 ml of water were ground. The dried-up coatings were burned at temperatures 770; 800; 830 °C during 4 min. Optical characteristics were measured by means of the comparator of color KTs-3 and a gloss meter of FB-2. Water resistance and spreadability of frite were determined by standard techniques. For coatings chemical stability was defined by the "spots" method.

RESULTS OF RESEARCHES

For researches the titanic enamel which is earlier developed at the department of chemical technology of ceramics and glass of "Ukrainian State University of Chemical Technology" which differed from similar production titanic ESP-117 in absence as a part of toxic fluorine, lower temperatures of melting and burning of coatings was used. On water resistance initial enamel belongs to I hydrolytic class, has good spreadability (32.8 mm), coatings on its basis maintain effect of 4% acetic acid during 5 minutes without loss of gloss that conforms to requirements to integumentary enamel for economic ware. Having physical and chemical properties, almost similar with production enamel, the studied enamel is characterized by higher optical rates: $CDR_{ref.}$=85%, $CMR_{ref.}$=80%, CDR_{prod}=82.7%, CMR_{prod}=76%. On visual assessment the coating of the studied enamel has the best quality as has no yellowish shade characteristic of ESP-117.

In the studied enamels the titanium is present in two coordination states: $[TiO_4]$ and $[TiO_6]$. For receiving coatings with high whiteness it is desirable to hold in enamel titanium in a tetravalent state. Thanks to a high rate of refraction of TiO_2 (rutile = 2.76; anatase = 2.52) it is possible to receive well opacified titanic enamels with CDR to 90% [4]. Anatase provides more white opacifing, than rutile. The isometric form and the uniform small size of crystals of anatase is the reason of it. Dispersion of light from such small crystals gives a weak, but pleasant blue shade to a white covering [6; 7]. Their optical characteristics are presented in **tab. 4–6**. The quality of the received skilled titanic glass-coating was defined visually.

In the first series of experiences it was revealed that addition on the first stage of mixing of batch the titanium dioxide with boric acid or sand, and on the second sodium tripolyphosphate addition, provides high rates of whiteness (84.5–87.0%) and gloss (75–81%) of coatings **(tab. 4)**. Insignificantly below optical indicators (CDR=82.5%; CMR=76%) in a coating on option No 8 of batch preparation where the same way tripolyphosphate of sodium was entered at the second stage, but the first stage differed that TiO_2 was mixed with fusible components ($NaNO_3$ and KNO_3). Coatings by options of batch preparation No 6 and 7 do not differ in high rates of CDR and CMR **(fig. 1)**. Apparently mixing of TiO_2 initially with refractory components (Al_2O_3, SiO_2, option No 6) do not promote fast melting of batch. Enamel coatings by option of batch No 7 where TiO_2 was entered at the sixth stage differed in slightly grayish shade and decrease in gloss (74%) in comparison with a coating by initial option (80%).

On V–VII stages the soda calcinated and saltpeter ($NaNO_3$ and KNO_3) which create a neces-

Table 4

Optical characteristics of skilled coatings I series

Characteristics of coatings	Temperature of burning, °C	Numbers of coatings								
		initial	1	2	3	4	5	6	7	8
CDR, %	770	85,9	75,8	84,4	75,5	79,8	83,0	70,4	69,6	76,7
	800	85,5	76,2	85,9	84,5	85,8	87,0	79,8	76,0	82,5
	830	85,2	84,6	86,4	86,9	86,0	88,5	82,3	85,0	87,4
CMR, %	770	78	63	78	69	68	71	63	66	63
	800	80	75	81	78	79	75	76	74	76
	830	76	78	85	82	84	83	83	81	84

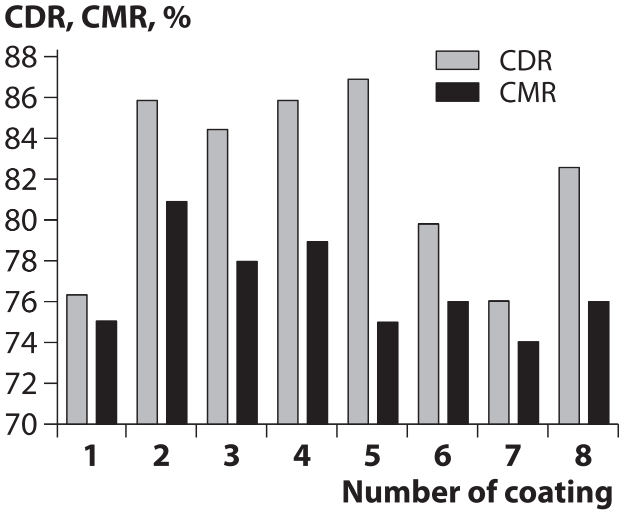

Fig. 1. Optical characteristics of coatings I series at an optimum temperature of burning (800°C)

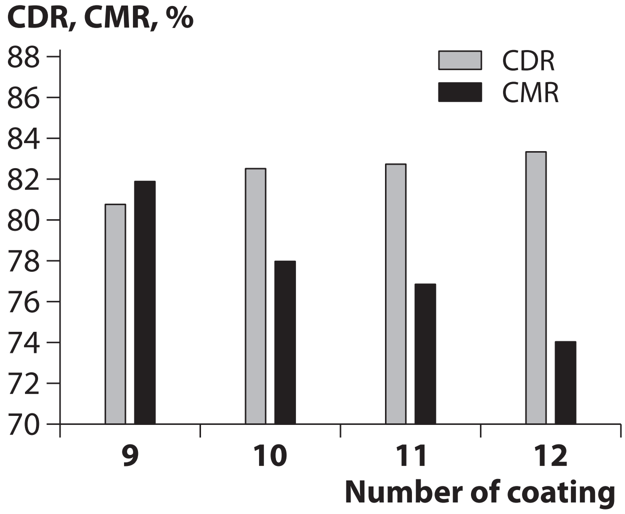

Fig. 2. Optical characteristics of coatings II series at an optimum temperature of burning (800°C)

sary oxidizing environment in enamel fusion were entered in the batch. At decomposition of these components during melting of enamel there is an allocation of gaseous products that promotes uniform pro-melting of furnace batch. The best coatings of this series are NoNo 2, 3, 4. They differ in higher values of gloss and whiteness **(tab. 4)**, good melting glass-layer.

Possibly, such combination of raw materials provides uniform distribution of the components stated above around quartz grains that accelerates process of melting of furnace charge and promotes anatase crystallization that in turn affects indicators of whiteness of coatings **(fig. 1)**. However, in a temperature interval of burning optical indicators for these coatings are unstable **(tab. 4)**.

The second series of experiences differed from previous in the fact that on the first stage dioxide of the titanium was mixed with such oxidizers as sodium and potassium saltpeter for the purpose of oxidation of organic impurity in fusion and by counteractions to coloring by sand impurity. For example, for the translation of an ion of Fe^{2+} with the bigger painting force in Fe^{3+} ion having the smaller painting force. Besides, tripolyphosphate of sodium was entered on II and III stages of batch preparation, and the calcinated soda on the last.

Enamels of this series were melted at lower temperature (1260–1270°C) and coatings differed in higher gloss (especially at the maximum temperature of burning of 81–87%, **(tab. 5, fig. 2)**.

Concerning CDR — values are a little lower (80.8–83.4%), than on coatings of the first series. Apparently introduction on the first stage of batch preparation of the most fusible components ($NaNO_3$ and KNO_3) influenced also on decrease of whiteness of coatings. We have chosen as the best of this series glass-enamel coating by option of batch preparation No 10 **(fig. 2)**.

In III series of experiences on initial stages (I and II) dioxide of the titanium and oxide of magnesium were entered. It is possible to assume that

Table 5

Optical characteristics of skilled coatings II series

Characteristics of coatings	Temperature of burning, °C	Numbers of coatings			
		9	10	11	12
CDR, %	770	74,2	81,2	79,1	83,0
	800	80,8	82,6	82,7	83,4
	830	82,1	86,9	84,0	85,2
CMR, %	770	71	70	71	65
	800	82	78	77	74
	830	87	86	85	81

Table 6

Optical characteristics of skilled coatings III series

Characteristis of coatings	Temperature of burning, °C	Numbers of coatings					
		13	14	15	16	17	18
CDR, %	770	80,6	85,9	86,2	85,4	84,6	73,0
	800	84,6	87,1	87,5	85,9	85,0	82,2
	830	86,2	87,2	87,2	86,2	86,2	84,2
CMR, %	770	57	71	70	68	72	71
	800	71	84	77	75	77	78
	830	75	85	83	83	88	89

when mixing dioxide of the titanium and oxide of magnesium on the first stages of batch preparation there is possibly a close contact and chemical interaction of these components in a solid phase. When heating batch to 850°C, there is possibly a formation of metatitanates of magnesium ($MgTiO_3$ and Mg_2TiO_4) which interfere with formation of Ti_2O_3, thus excepting interaction of TiO_2 with iron oxide therefore titanium crystallizes mainly in the form of anatase that promotes receiving white glass-layer with a bluish shade and good gloss **(tab. 6)**.

On option of batch preparation No 14 very dense and smooth coating with a bluish shade with stable high coefficients of diffusion and mirror reflection in a temperature interval of burning of glass-enamel coatings (800–830°C, **tab. 6**) was received.

When mixing of batch of this series tripolyphosphate of sodium and saltpeter ($NaNO_3$ and KNO_3) were added to quartz sand that was provided fast melting of fusion. Option No. 13 differed in addition of SiO_2 on I stage that was worsened gloss of a coating (71%). Addition of boric acid after silicon dioxide promotes increase in gloss of coverings from 75 to 84% **(fig. 3)**.

For the purpose of receiving the glass-enamel coatings possessing high rates of whiteness and gloss it is more expedient to use III a series of mixing of raw materials where in the beginning dioxide of the titanium and oxide of magnesium are mixed. After that it is more preferable to add a fusible (saltpeter and tripolyphosphate of sodium) and only then to enter quartz sand. Other components are added on the last stages of batch preparation.

Dilatometric curve **(fig. 4)** of the studied nonfluor titanic enamel which is received according to

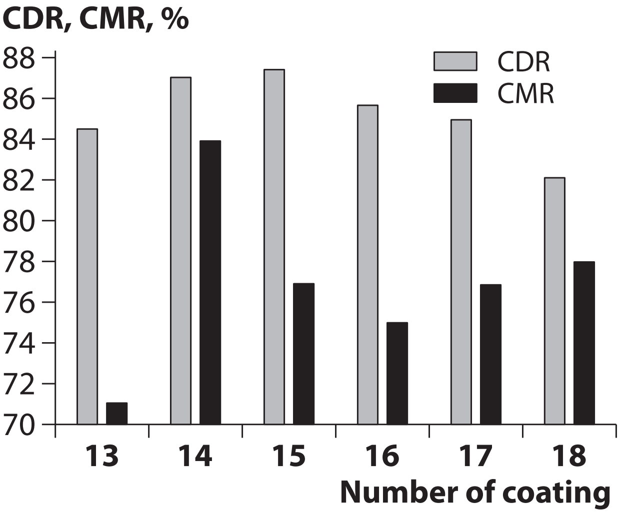

Fig. 3. Optical characteristics of coatings III series at an optimum temperature of burning (800°C)

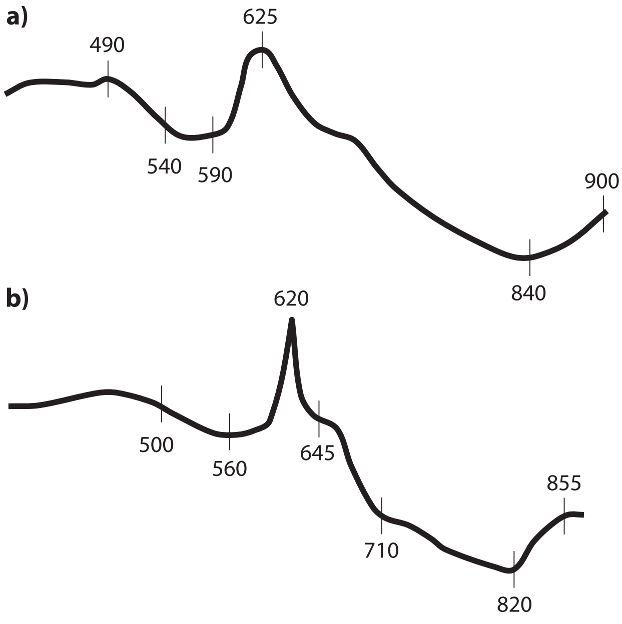

Fig. 4. Diffraction curves basic (*a*) and investigated glass-enamel coatings by the option of batch preparation No 14 (*b*)

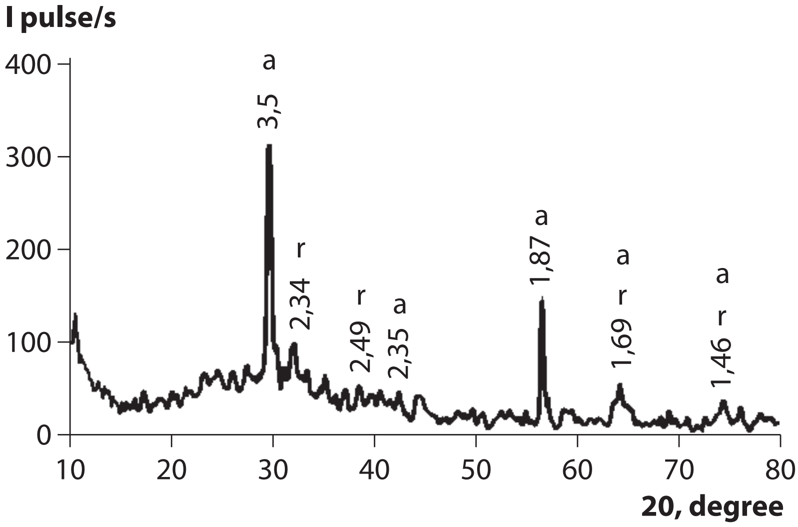

Fig. 5. X-ray phase curves a glass-enamel coating by the option of batch preparation No 14

the initial (traditional) scheme of batch preparation (a) and according to the scheme of batch preparation No. 14 (b) have similarity and distinctions. Softening of enamels happens in almost identical interval 490/500…590/600°C; exo-effect which can be connected with allocation of TiO_2 in the form of anatase is observed also at close temperatures 625/620°C. However well expressed sharp peak of enamel (b) demonstrates intensive allocation of crystals of anatase, unlike the rounded-off form of this peak of enamel (a). On the subsequent endo-effect of enamel (b) the pointed extremum form is observed at a temperature of 820°C that can demonstrate process of dissolution of initially allocated crystal phase, unlike the rounded-off form of endo-effect of enamel (a).

The received results confirm these literatures that release of anatase in the form of spheroidal crystals (0.17–0.22 microns) begins at a temperature over 600°C and becomes the most intensive in the range of temperatures 620–720°C [8; 9].

Because these enamels burning at 800°C it is possible to assume that anatase crystals which are allocated actively at 620°C **(fig. 4*b*)** in nonfluor enamel according to the option of batch preparation No 14 and grow further actively at decrease in viscosity of fusion of enamel, do not manage to be dissolved in fusion at a temperature of 820°C and it prevents transition of the emitted anatase to rutile.

The X-ray phase analysis, carried out on the DRON-3 diffractometer, existence in the studied coating on the basis of the enamel prepared according to the special option of batch preparation, more anatase, than rutile **(fig. 5)** is confirmed.

Thus, the prevailing crystal phase is anatase that provides necessary optical indicators of glass-enamel coatings of white color.

CONCLUSIONS

As a result of researches influence of sequence of introduction to batch of raw materials on receiving titanic coatings of white color with good optical characteristics is studied, the rational technological order of preparation of batch which consists in mixing on the first stage of dioxide of the titanium and oxide of magnesium, then saltpeter addition ($NaNO_3$ and KNO_3) and tripolyphosphate of sodium and only then SiO_2 and all other components is fulfilled. Dense, smooth titanic coatings are received (option No 14) with stable optical characteristics (CDR, 87.1–87.2%) and (CMR, 84–85%).

Good chemical resistance of the developed glass-enamel coatings allow to apply them to enameling of steel products of household and technical purpose.

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ОСОБЛИВОСТІ ВИГОТОВЛЕННЯ ШИХТИ ПРИ ОТРИМАННІ СКЛОПОКРИТТІВ БІЛОГО КОЛЬОРУ

Резюме. *При розгляді технології емалювання в Україні велику увагу приділяють механічним, фізичним, хімічним, естетичним і споживчим властивостям емальованих виробів різного призначення, але питанням виготовлення не надається належної уваги. Процес підготовки партії для подальшого приготування шихти вважається добре відомим і стандартним. Такі якості емальованих виробів, як виразна форма, білизна, колір емалі, якість декору зумовлюють конкурентоспроможність продукції на ринку споживчих товарів. Ці показники залежать від контролю точності кожного етапу виробництва, включаючи якість сировини (сталість хімічного складу і чистоти матеріалів, ступінь їх подрібнення, послідовність введення у шихту, тривалість перемішування). Досліджено вплив послідовності введення сировини у шихту на оптичні показники титанових скляних покриттів. Розроблено раціональну технологічну процедуру виготовлення партії, яка полягає у змішуванні на першій стадії діоксиду титану та оксиду магнію, потім натрієвої та калійної селітри та триполіфосфату натрію і лише потім піску та всіх інших компонентів. Композиція зерна матеріалів відповідала просіюванню через сито 02 (912 лунок/см²). Отримано склоемалеві покриття з високою відбивною здатністю білої поверхні (КДВ=87,1–87,2%) і хорошим блиском шару скла (КДзВ=84–85%). Розроблено скляні кришки, призначені для нанесення на сталеві вироби для побутових і технічних цілей.*

Ключові слова: *сировина, порядок формування шихти, скляна емаль, анатаз, оптичні характеристики, коефіцієнт дзеркального відбивання (КДзВ), коефіцієнт дифузного відбивання (КДВ).*

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ОСОБЕННОСТИ ПРИГОТОВЛЕНИЯ ШИХТЫ ПРИ ПОЛУЧЕНИИ СТЕКЛОПОКРЫТИЙ БЕЛОГО ЦВЕТА

Резюме. *При рассмотрении технологии эмалирования в Украине большое внимание уделяют механическим, физическим, химическим, эстетическим и потребительским свойствам эмалированных изделий различного назначения, но вопросам изготовления не уделяется надлежащего внимания. Процесс подготовки партии для дальнейшего приготовления шихты считается хорошо известным и стандартным. Такие качества эмалированных изделий, как выразительная форма, белизна, цвет эмали, качество декора обуславливают конкурентоспособность продукции на рынке потребительских товаров. Эти показатели зависят от контроля точности каждого этапа производства, включая качество сырья (постоянство химического состава и чистоты материалов, степень их измельчения, последовательность введения в шихту, продолжитель-*

ность перемешивания). Исследовано влияние последовательности ввода сырья в шихту на оптические показатели титановых стеклянных покрытий. Разработана рациональная технологическая процедура изготовления партии, которая состоит в смешивании на первой стадии диоксида титана и оксида магния, затем натриевой и калийной селитры и триполифосфата натрия и только потом песка и всех других компонентов. Композиция зерна материалов отвечала просеиванию через сито 02 (912 лунок/см²). Получено стеклоэмалиевые покрытия с высокой отражательной способностью белой поверхности (КЗО=87,1–87,2%) и хорошим блеском слоя стекла (КДО=84–85%). Разработаны стеклянные крышки, предназначенные для нанесения на стальные изделия для бытовых и технических целей.

Ключевые слова: *сырье, порядок формирования шихты, стеклянная эмаль, анатаз, оптические характеристики, коэффициент зеркальной отражения (КЗО), коэффициент диффузного отражения (КДО).*

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