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THE POSSIBILITY TO IMPROVE THE THERMAL STABILITY OF INDUSTRIAL GLASS FROM THE POSITION OF SYSTEM ANALYSIS

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The article characterizes the notions of “system” and “system analysis”. There has been developed a common approach to present the characteristics of substances and materials. We have proposed a generalized model to reveal the factors that influence the thermal stability of glass. The article presents the groups and subgroups of factors of the block entitled “parameters and properties of glass and glassware” that influence the thermal stability of industrial glassware. It also discusses the advantages of the given system approach, aimed at improving the thermal stability of industrial glassware.

Keywords: system analysis, system, factor, characteristic, thermal stability, substance, material, industrial glassware.

S-au caracterizat noţiunile „analiza de sistem” şi „sistemul”. S-a elaborat o abordare unită pentru prezentarea caracteristicilor substanţelor şi ale materialelor. S-a propus modelul generalizat pentru stabilirea factorilor, care influenţează stabilitatea termică a sticlei. S-au prezentat grupurile şi subgrupurile factorilor blocului „parametrii şi proprietăţile sticlei şi produselor din sticlă”, care influenţează stabilitatea termică a produselor industriale din sticlă. S-au discutat avantajele abordării de sistem propuse pentru îmbunătăţirea stabilităţii termice a produselor industriale din sticlă.

Cuvinte-cheie: analiza de sistem, sistemul, factor, caracteristica, stabilitatea termică, substanţa, material, produsul industrial din sticlă.

INTRODUCTION

Thermal stability is an important operational property of industrial glassware (containers, assorted and laboratory glassware, illuminating glassware, flat glass, etc.). The methods, determining the thermal stability of industrial glassware, are classified according to the temperature difference, linear thermal expansion coefficient, geometric dimensions of the samples, operating conditions, and so on [1-2]. For most types of industrial glassware thermal stability is regulated by the standard requirements.

The thermal stability of glassware is influenced by a large number of factors: the chemical composition and glass structure, the molding method and the configuration of the articles, the thickness of the glass, the state of the article edge, etc. [1-3]. In some cases, the products are partially or completely rejected due to insufficient thermal stability of the glass. It is difficult to identify the causes of the flaw, as the impact of many factors on the thermal stability of the glass is unknown. Glass plants are often unable to identify factors that reduce the thermal stability of glass.

The aim of the undertaken work was to reveal the factors that influence the thermal stability of industrial glassware from positions of system analysis.

ANALYTICAL PART

The system analysis is used in different spheres of human activity: science, engineering, cosmonautics, construction, education, economics, medicine, defense industry, etc. The notion of “system analysis” has a multidimensional aspect. Specialized literature offers several dozens of definitions of the notion of “systems analysis”.

In our opinion, the system analysis can be characterized as follows: “The system analysis is a comprehensive study of an object to obtain an integral representation about it and reveal its relationship with other objects”.

The most important principles of the system analysis are the following [4]:

1) before taking decisions one must clearly formulate the ultimate goals and the criteria to assess the expected result;

2) the problem should be considered as a whole, i.e. as an integrated system, and reveal all the consequences and the relationships of each particular solution;

3) it is necessary to identify and analyze the possible alternative ways to achieve the goals; the goals of the separate subsystems should not contradict the goals of the whole system.

According to [5], "the main and most valuable result of the system analysis is not its quantified solution to the problem, but rather an improved understanding of this problem and the essence of different ways of solution".

The basis of the system analysis is system approach in which any object considered as a system [6]. Zaitsev O. S. defines a system as follows [6]: "the system is the great number of elements in these relationships and connections with each other, which give it the integrity and unity". As elements of the system are the objects, substances, properties, features, notions, laws, etc., that is any material and abstract character objects.

The most difficult and responsible procedure in the system analysis is making a generalized model, which reflects all the factors and relations among them that may influence the decision-making process. [4]. Until present, there is no integrated approach to create such a model to represent factors characterizing the physical, chemical and technological properties of glassware.

1. The author has attempted to develop a common approach for the compilation of the characteristics of substances and materials. For this first stage, all the factors that characterize the substance and the material as the system are divided into three blocks (in other directions). Block-diagram of the preparation of the characteristics of the substances and the materials is shown in fig. 1.

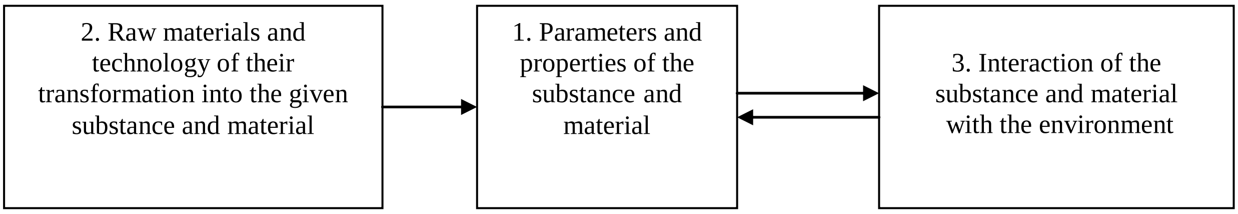

Fig.1. Block diagram of the representation of the characteristics of the substance and material from the position of system analysis

The first block includes the parameters, properties, and other information that characterize any substance (material): composition and parameters characterizing it; the type and parameters of the structure; physical, chemical, biological, and technological properties; the surface state of the glass and others. The second block contains the factors that influence the obtaining of the substance (raw materials and the technology of their transformation into the given substance etc.). The third block characterizes the interaction of the substance with the environment, otherwise said with other substances. It includes the operating conditions of the substance, the influence of the environment on the properties of the substance, and so on.

In terms of system analysis, the thermal stability of glass is a system of correlated factors. A specific model of factors for a given glass property is generated based on a generalized model of the three blocks of factors. The upper level of the factors that influence the thermal stability of industrial glassware corresponds to the block-diagram in fig. 1.

In its turn, each block includes several groups and subgroups of factors. Fig. 2 shows the groups, and Fig. 3 – the subgroups of factors of the central block "1. Parameters and properties of glass and glassware".

We similarly characterized the groups and subgroups of factors, specified in block "2. Raw materials and technology of their transformation into glass" and "3. The interaction of glass with the environment".

We shall present the groups of factors related to block "2. Raw materials and technology of their transformation into glass".

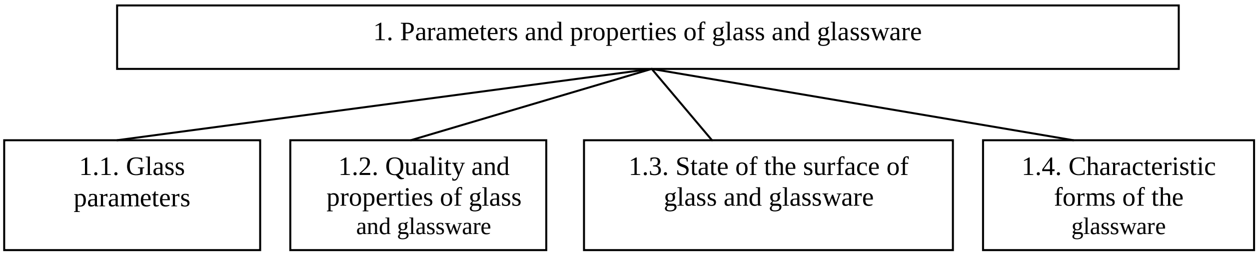

Fig. 2. Block-diagram of groups of factors related to block
"1. Parameters and properties of glass and glassware"

2.1. Raw materials and their preparation.
2.2. Preparation of batch and its characteristic.
2.3. Molten glass and conditions of its melting.
2.4. The methods and conditions of molding glassware.
2.5. Heat treatment of glassware.
2.6. Finishing operations.

Groups of factors that are included in block "3. Interaction of glass with the environment":

3.1. Glass contact with the environment (gases, liquids, solids).
3.2. Temperature.
3.3. Pressure.
3.4. Physical fields.
3.5. Radiation and others.

Then, the factors related to the individual subgroups are presented. In some cases, the subgroups of factors consist of subsubgroups of factors. For example, the subgroup "Physical properties of glass" is divided into properties subsubgroups: general, optical, thermal, mechanical, hydro-physical, electrical, magnetic, acoustic, etc. Further, each subsubgroup is subdivided into separate properties. For example, the mechanical properties of glass include mechanical strength, hardness, elasticity, and flexibility. It should be noted that usually each separate property is determined by various methods.

There are close connections between the factors of one subsubgroup (subgroup, group, block), as well as between the factors of different subsubgroups (subgroups, groups, blocks). Thus, for example, the structure of glass surface layers (subgroup of factors 1.3.3) depends on the chemical composition of glass (subgroup of factors 1.1.1), on structural and physical properties of glass (subgroup of factors 1.1.3), on the presence of all sorts of impurities in glass (subgroup of factors 1.2.4), on the production technology of glassware and on the conditions of its operation (blocks of factors 2 and 3), and others.

In the next stage, we determine the influence of each factor on the thermal stability of industrial glassware. For example, it has been experimentally found that in identical conditions the thermal resistance of glassware in equal amounts depends on its configuration.

Then, comes the most difficult and responsible stage: arranging of the factors according to the degree of their importance for the thermal stability of glassware. To this purpose, we experimentally identify the influence of each factor on the thermal stability of glassware. In cases where no experimental data is available, we take into consideration the qualitative evaluation of the influence of this factor on the thermal stability of glassware. It must be mentioned that there is not much information with reference to the influence of many factors on the thermal stability of industrial glassware.

Thus, the system analysis helps us to obtain **an integral representation** of the factors that influence the thermal stability of glassware (or another property of glass), of their relationship to each other and it enables us to arrange the factors according to the degree of their importance. This approach reveals the possibility to improve the thermal stability of industrial glassware and if necessary, to correct in due time the process of its manufacturing.

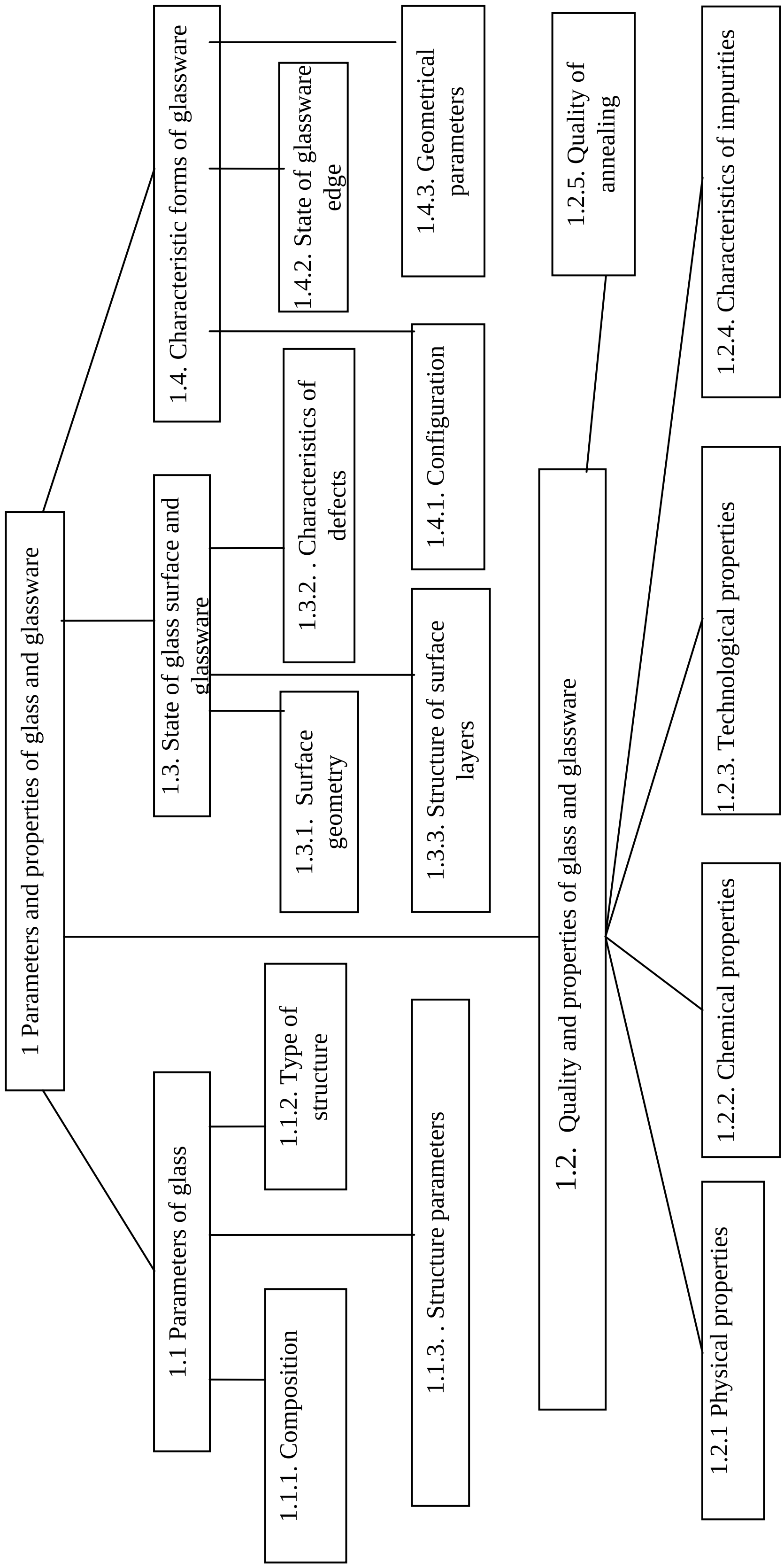

Fig. 3. Groups and subgroups of factors of block "1. Parameters and properties of glass and glassware", influencing on the thermal stability of industrial glassware

CONCLUSIONS

A generalized model to reveal the factors that influence the physical, chemical and technological properties of industrial glassware has been developed for the first time. Blocks, groups and subgroups of factors that influence the thermal stability of industrial glassware are presented as an example of such an analysis.

There have been revealed reliable connections between the factors of one subsubgroup (subgroup, group, block), as well as between the factors of different subsubgroups (subgroups, groups, blocks).

The system analysis enables us to obtain **an integral representation** of the factors that influence the thermal stability of glassware (or another property of glass), their relationship to each other and it is possible to arrange the factors according to the degree of their importance.

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