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PREPARATION AND OPTICAL PROPERTIES OF THE MODIFIED LEAD CRYSTAL GLASSES WITH THE ADITION OF FILTER DUST

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ABSTRACT: Filter dust is dangerous waste from production of lead crystal glass, which was intercepted on chimney filters. This dangerous waste must be specially located and liquidated, because it's toxic. Presented work deals with utilization of filter dust like a raw material in the production. Samples of glasses were prepared by melting of mixtures of glass fragments with the addition of filter dust (0 – 1,5 weight %). Optical properties of prepared glasses are studied, because it's very important parameter for evaluation of crystal glass quality. Crystal glass is material with high light transmittance T and high refractive index n_D. Changes of optical properties show on influence of filter dust addition on named properties. Results of this study are important for utilization of filter dust as a raw material in the crystal glass production.

KEYWORDS: glass, transmittance, index of refraction, colour

1. INTRODUCTION

Glass is a material which we commonly use in daily life and scientific studies. It is a solid an amorphous structure. It forms with the cooling of the constituting elements from liquid phase at a rate which will hinder the conversion of the elements to crystal structure [1].

The most important property of colourless (non–absorbing) glasses is their light transmittance with wavelenght from near ultraviolet through visible to infrared region. Changes of these optical characteristics by interaction of radiation with glasses show on influence of chemical composition, influence of temperature or thermal history, structural arrangement, grade of isotropy and influence of absorbing or emitting impurities can be investigated [2].

With measuring and expression of colourity of glasses deals the norm ČSN 011718, which uses the International colorimetric system CIE exclusively. This problematic is worked in next publications well–arranged [4–6]. Optical absorption in glass in the visible spectral region colours the glass, leading to applications in optics and to many decorative uses [3].

Prepared samples were exposed to research of optical properties changes, which are very important for final product, which is transported to customer – refractive index n_D, transmittance T and colourity. Samples of glasses were melted with the addition of filter dust. It's a dangerous waste, because it contains about 56.6 weight % of lead oxide. Utilization of filter dust as a raw material for glassmaking batch preparation in glass production could bring reduction of its quantity and ecologization of production. It was observed, what addition of filter dust is possible to admixture to the glassmaking batch without negative changes of final product properties.

2. EXPERIMENTAL PART

For the study of refractive index n_D, transmittance T and colourity were used samples of lead glasses, which were obtained by melting of modified glassmaking batches. Glassmaking batches were formed from lead glass fragments from the glass production with the addition of 0 – 1,5 weight % of filter dust. Samples of glasses were melted in platinum crucible in glass oven of Netzsch Gerättebau GmbH during 1,5 hours, it was used temperature range 1200 – 1500°C.

It was prepared six samples of lead glasses and one sample without addition of filter dust, this was used as a reference sample. Samples of glasses were coolled by the temperature of 520°C with holding during 2 hours and then temperature descended to the room temperature spontaneously.

Samples, which was used for measurements of refractive index n_D, were cut out to prism–shaped with parameters 20x10x10 mm. Surfaces of prisms were improved by flatting and abrasion polishing. Refractive index was measured by Abbe refractometer by temperature 20°C and wavelenght 589,3 nm, which belongs to the spectral line D, which approximately legs in the middle of visible spectrum range and it belongs to the yellow light of Natrium.

Colourity an optical transmittance of prepared samples of lead glasses were measured with the using of VARIAN 50 SCAN UV – visible Spectrophotometer in RONA, a. s ., Lednické Rovne. For each sample was obtained spectrum in the range 200 – 800 nm with the step scan 1 nm. Colourity was evaluated by system CIELAB [CIE 1976 (L*, a*, b*)]. Samples were formed to the prism–shaped with parameters 50x20x20 mm.

3. RESULTS AND DISCUSSION

Prepared samples of lead glasses with a various addition of filter dust were submitted to the research of optical properties. Measured values were compared with values of reference sample with the original composition without addition of filter dust. It was evaluated these optical properties: transmittance T, refractive index n_D and colourity of samples of lead glasses.

Refractive index was measured for each sample five times and resultant value is arithmetic average from the measured values. Values of refractive index are shown in the Tab. 1. The evaluated value of refractive index of reference sample lead glass without the content of filter dust was 1.5500. The highest evaluated value of refractive index was 1.5541, which belongs to the modified sample 6 with the highest content of filter dust (1,5 weight %). Values of refractive index of lead glasses samples were in the range 1.5500 – 1.5541. The evaluated values increase a little with the addition of filter dust in the samples of glasses. All measured values were corresponded with the required value for refractive index of lead crystal glass. On the base of increasing values of refractive index it can be said, that the content of lead oxide (PbO) in the glass samples increases with the addition of filter dust. It was confirmed by the chemical analysis of lead glass samples.

Tab.1: Values of refractive index n_D of samples of lead glasses.

Sample	n_D
Glass 0 (reference)	1,5500 ± 0,0001
Glass 1	1,5507 ± 0,0003
Glass 2	1,5510 ± 0,0002
Glass 3	1,5518 ± 0,0002
Glass 4	1,5520 ± 0,0003
Glass 5	1,5523 ± 0,0005
Glass 6	1,5541 ± 0,0004

From measured values of Absorbancy A were calculated corresponding values of Transmittance T in % per formula:

$$A = \log \frac{1}{T} \qquad (1)$$

All modified samples of lead glasses 1 – 6 with the content of filter dust were showed values of Transmittance T in the wavelength interval of 380 – 780 nm. All obtained values were comparable with the values of reference sample. Fig. 1 shows named results.

The lowest values of Transmittance were obtained for sample 1 with the content of filter dust of 0,25 weight %. The highest values, which were comparable with values of reference sample, showed the sample 4 with the content of filter dust of 1 weight %. Sample 6, which showed the highest refractive index n_D, it was showed the second worst light transmittance. It can be due impurities contained in filter dust.

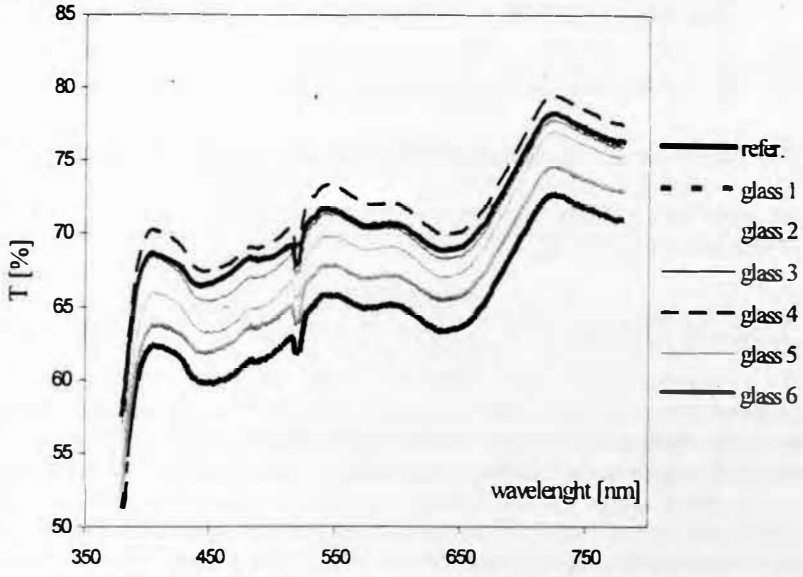

Fig. 1: Transmittance T for different samples of lead crystal glasses as a function of wavelength.

For evaluation of colourity of prepared lead glass samples were used coordinates L*, a*, b* obtained by calculation from spectrums, which were measured in the range of 380 – 780 nm. Values of chromaticity coordinates L*, a*, b* for all samples of lead glass are shown in the Tab. 2. The values of coordinates L*, a*, b* of modified lead glasses are comparable with values of coordinates of reference sample of lead crystal glass.

Tab. 2: Values of chromaticity coordinates L*, a*, b* for single sample of lead glasses.

Sample	a*	b*	L*	Content of filter dust [weight %]
Glass 0	–1,11218	2,730433	90,11867	0,00
Glass 1	–0,96270	3,650536	87,06804	0,25
Glass 2	–0,94739	3,896062	89,79132	0,50
Glass 3	–1,08425	3,236761	89,81219	0,75

Glass 4	−1,10070	2,957542	90,91836	1,00
Glass 5	−0,97083	3,836369	89,10602	1,25
Glass 6	−1,01282	3,588846	88,22277	1,50

Fig. 2 shows the graphic representation of coordinate b* as a function a* for the studied samples of lead glasses. The changes between values of reference sample of lead glass and samples 1 – 6 weren't showed any marked differences. All points of graphical dependence of coordinate b* as a function of coordinate a* were laid in the same part of chromatic–space.

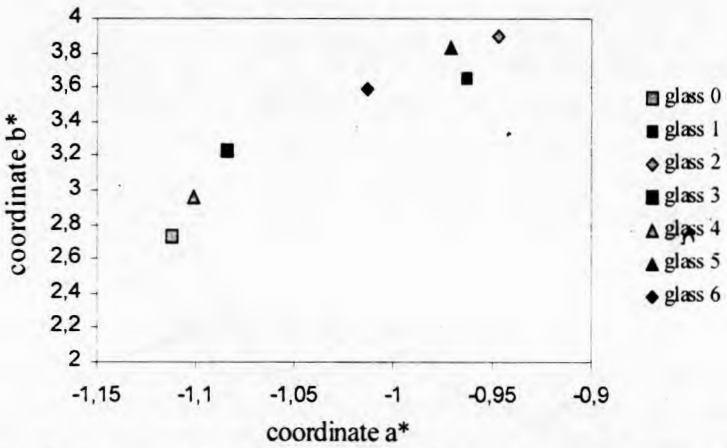

Fig. 2: Dependence of coordinate b* as a function coordinate a* for single samples of lead glasses.

Graphical interpretation of dependence of coordinates a*, b* as a function of filter dust addition (Fig. 3) shows a little differences between values of coordinates b* of lead glass samples and small values differences of coordinates a* in the comparison with the values a*, b* of reference sample of lead glass. The calculated values showed, that the colourity of modified samples of lead glasses were comparable with colourity of reference sample of lead crystal glass. All modified samples were showed out the claimed parameters of colourity of lead crystal glasses. The addition of waste's raw material – filter dust, almost weren't influenced colourity of glass samples. These results are very important for the recycling of filter dust, which is intercepted on chimney filters and it's dangerous waste, which must be special located and liquidated.

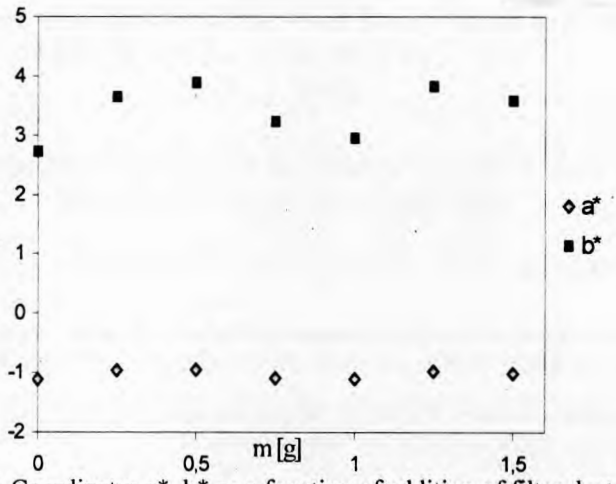

Fig. 3: Coordinates a*, b* as a function of addition of filter dust

4. CONCLUSION

Utilization of filter dust as a next raw material for the preparation of glassmaking batch could bring economical and ecological shares for this manufacturing process. These facts were the reason to solve a question, which quantity of filter dust could be possible to add to glassmaking batch without changes of properties of final product, which are very important for customers and utilization of products in daily life.

Samples were prepared by melting of mixtures of glass fragments with the addition of filter dust in the quantity of 0 – 1.5 weight %. These optical properties were evaluated: refractive index n_D, transmittance T and colourity. Modified samples of lead glasses with addition of filter dust were compared with reference sample of lead crystal glass. Modified samples showed out the claimed values of colourity and another studied optical properties. Addition of studied waste material weren't influenced colourity of samples of lead glasses. It was a positive effect of possibility to recycle this waste material.

On base of obtained results could be established the possibility of utilization of filter dust as an incoming raw material in melting process of lead crystal glass. For the utilization of this possibility of harmful waste elimination is necessary to explore the changes of another properties of glasses. For example chemical durability, which is very important for the utilization of glass in daily life. Chemical durability of glasses is very important by their contacts with different liquids or chemical substances.

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