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Investigation of the Liquid Glass Effect on the Physico-Chemical and Physical Properties of Minerals

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Abstract: ***Liquid glass is a widely used reagent in mineral raw processing and it is the subject of quite a number of studies. The paper presents the results reflecting its novelty and proves that the mechanisms of liquid glass effect and actively depressing or activatingforms are defined by the nature of the mineral and the process conditions. Thus, the authors proved that during floatation of the pulp with pH of more than 11, the depressive impact of liquid glass on fluorite is decreased due to reducing the adsorption of SiO_3^{2-} ions on the negatively charged surface of the mineral. It is proved that the liquid glass consumption intensifies the effect of disjoining pressure of fluid films resulting in the increase of the content of generated class -0.071 mm in the finely ground iron-vanadium middlings. Liquid glass reduces the coercive force intensity and substantially weakens the magnetic properties of minerals thus improving iron-vanadium concentrate quality during further recleaning.***

Keywords: liquid glass, fluorite, titanium-magnetite ore, ore dressing

1. Introduction

Liquid glass is one of the most common reagents used in mineral processing. High adsorption properties of liquid glass make it possible to use this reagent in a variety of ore pretreatment and dressing processes. In addition to valuable technological properties liquid glass is non-toxic, ecofriendly, inexpensive, widespread and available reagent.

Despite the fact that a good deal of research is devoted to the liquid glass, yet at present there is no general theorysufficiently approving which form of existence of liquid glass is the most active.Knowing that most of the authors carried out investigations studying the liquid glass effect on various minerals and in different conditions using a variety of processes, we may consider that there is no single mechanism of liquid glass effect – common to various minerals and different conditions. Perhaps the mechanism of liquid glass effect and actively depressing or activating forms will be defined by the mineral nature and the process conditions. To clarify the mechanisms of liquid glass effect we have carried out investigations and obtained some results reflecting the novelty of the work.

It is known that liquid glass is a common depressor in floating non sulfide minerals [1],[2],[3]. It is proved that mineral floatation suppression with liquid glass is caused by extensively hydrated silicate compounds:H_2SiO_3, $HSiO_3$– and SiO_3^{2-}, which concentration is defined by pH value. Professor M.A. Eigeles and other scientists found out that liquid glass in weak concentrations activates the fluorite and calcite floatation [1]. However the investigations being carried out proved that little activation of fluorite species occurs in high reagent density. According to the results obtained the liquid glassdensification from 500 to 3000 mg/dm^3 decreases the yield of fluorite species by 5-10%, calcite – 2.5% with increasing pH from 7.2 to 10.8 (Fig.1,2).

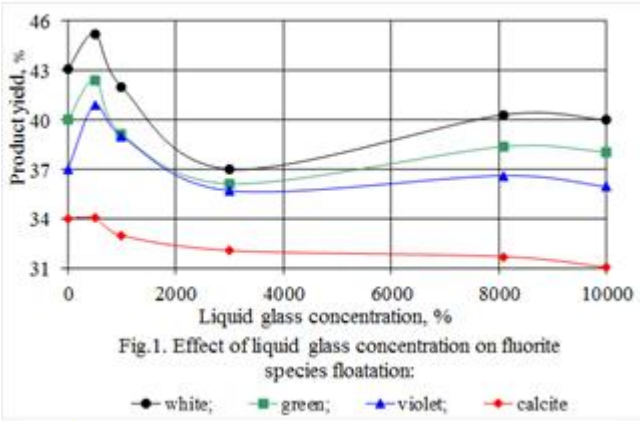

Fig.1. Effect of liquid glass concentration on fluorite species floatation:

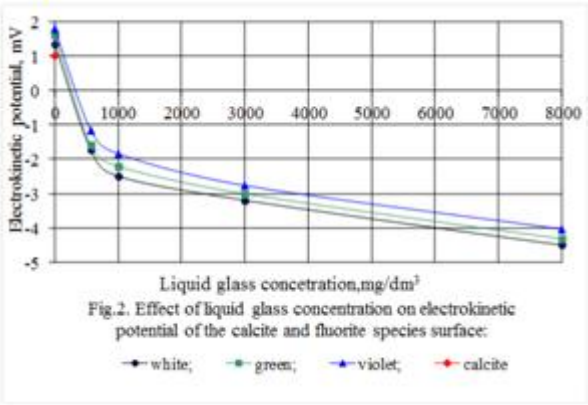

Fig.2. Effect of liquid glass concentration on electrokinetic potential of the calcite and fluorite species surface:

Further liquid glass densification to 8000 mg/dm^3 increases pH value to 11.2 while the ion adsorption of SiO_3^{2-} dropsresulting inminimization of the reagent depressive effect. The electro kinetic potential of the minerals being studied becomes negative when the density of liquid glass equals to 500 mg/dm^3 and its value increases continuously with densification of this reagent.

Thus the minimization of the liquid glass depressive effect is associated with increasing pH value resulting in densification of SiO_3^{2-}ions which adsorption on the negatively charged

surface of fluorite species is decreased. Diverse floating of fluorite species is due to the different energy state of their surfaces as evidenced by the results of electrokinetic potential measurement. Thereby the electro kinetic potential of white fluorite equals to 1.35 mV, green – 1.61 mV and violet – 1.79 mV [4]. Another important reason for different floating of fluorite species is the cubic form of crystal lattice of hexaoctahedral class exposed along definite cleavage planes. In cleaving grainsaccording to the features of cubic forms of a crystal structure, perfect cleavage in the form of octahedron is observed within white fluorite, in green and violet fluorites besides perfect cleavage in the form of octahedron appears cleavage in the form of rhombic dodecahedron and cube combined with octahedron.

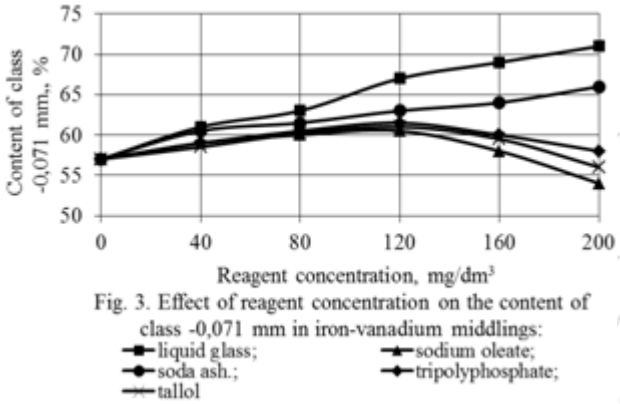

Fig. 3. Effect of reagent concentration on the content of class -0,071 mm in iron-vanadium middlings:

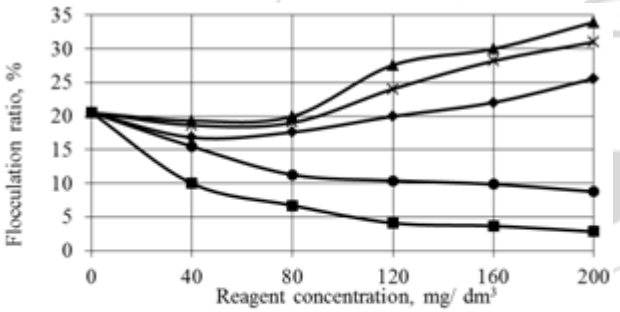

Fig. 4. Effect of reagent concentratoin on the flocculation ratio of the particles of iron-vanadium

We have also studied the liquid glass effect in order to intensify the process of grinding titanium-magnetite ore from the Kopansky field compared toother reagents: soda ash, sodium oleate, sodium tripolyphosphate and tallol [5]. The results of titanium-magnetite ore grinding for 40 minutes with adding various reagents are presentedin Fig.3. The presented data approved that the liquid glass has the greatest effect on the process of grinding titanium-magnetite oresamong all reagents beinganalyzed. If the reagent concentration is 160 mg/dm^{3}predefined classgrowth-0.071 mm equals 12%.

Intensification of the class growth -0.071 mm is explained by dispergation of the particles due to the disjoining pressure enhancement of adsorbed layers and greater mobility of the matter in the mill. Disjoining pressure is caused by molecular impact of the solids on the fluid boundary film and formation of double electric layer on the phase boundary. Disjoining pressure of plane-parallel fluid film [7], [8] located between the particles equals to the pressure P(H) at which fluid film in stable state impacts on the particles trying to separate them. When using liquid glass the electrical and molecular components of disjoining pressure are increased due to the fixed SiO_3^{2-}, $HSiO_3$ ions$^-$ and the H_2SiO_3 molecule, thereby the equilibrium thickness of the fluid layer is reduced and disjoining pressure is increased. Thus, the finely ground ferromagnetic particles can be classified according to their real size. It is known that to prevent adhesion of finely ground particles and to increase the separation efficiency of magnetic particles it is reasonable to use chemical reagents [6]. The data resulting from the study of the reagent effect on the flocculation ratio of finely ground iron-and-vanadium middlings are presented in Fig.4.

The experimental results approve that liquid glass is the most effective reagent. It is found that the particle flocculation ratio is decreased from 20.5% to 3.7 %, if the liquid glass concentration is 160 mg/dm^3. Moreover this reagent acts as a reagent-dispersant. Liquid glass when interacting withfinely ground iron-and-vanadium middlingsweakens the magnetic properties due to reducing the coercive intensity resulting in prevention of magnetic adherence of the magnetite particles with magnetite and ilmenite particles.

The results of experimental studies of liquid glass effect on characteristics of wet magnetic separation approvethat when liquid glass concentration is 160 mg/dm^3,ironweight percentage in the concentrate increases to 57.90 – 64.16%, and the iron recovery in magnetic fraction – from 86.00, to 91.48%. Weight percentage of titanium dioxide is reduced from 11.32 to 5.84%, and the titanium recovery – from 69.52 to 34.43%.

2. Conclusions

1) Floatation activity of fluorite species depends on the crystal lattice form and natural concentration balance of proper types of adsorption centers.
2) The liquid glass depressive effect on fluorite with pH of more than 11 is decreased due to reducing the adsorption of SiO_3^{2-} ions on the negatively charged surface of the mineral.
3) The liquid glass consumption intensifies the effect of disjoining pressure of fluid films resulting in the increase of the quantity of generated class -0.071 mm in the finely ground iron-vanadium middlings.
4) Liquid glass reduces the coercive force intensity and substantially weakens the magnetic properties of minerals thus improving iron-vanadium concentrate quality during following recleaning.

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