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EFFECT OF SODIUM OLEATE, GLYCERINE, GLUCOSE AND AMIDE ON COAL FLOTATION AND CTAB ON CLAY FLOTATION

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RESUMO

O comportamento dos reagentes oleato de sódio, glicerina, glicose e amido foram avaliados na flotação do carvão mineral, e do surfactante CTAB na flotação da argila. Testes de flotação realizados em Tubo de Hallimond mostraram que para o carvão todos os reagentes atuaram como depressantes, sendo que o oleato de sódio teve uma melhor atuação onde a recuperação do carvão mudou de 70% em água para 17% na concentração de 1.10^{-6} mol/L. O CTAB atuou como coletor para a argila onde a recuperação mudou de 0% em água para 100% na concentração de 5.10^{-4} mol/L. Medidas de potencial zeta mostraram que as superfícies do carvão e da argila são semelhantes e carregadas negativamente em toda faixa de pH. Esta semelhança é devido ao alto teor de cinzas no carvão mineral brasileiro e da interação da argila com o carvão. O potencial zeta da argila em presença de CTAB mudou de negativo para positivo devido a adsorção do surfactante sobre a argila e a neutralização das cargas negativas sobre sua superfície. Estes resultados serão úteis no estudo de melhores condições para flotação da mistura carvão-argila.

PALAVRAS-CHAVE: flotação, carvão mineral, argila, depressores, coletores.

ABSTRACT

The effects of sodium oleate, glycerine, glucose and amide were evaluated on coal flotaion and CTAB on clay flotation. Flotation tests realized in Hallimond tube showed that all the reagents used in coal flotation were depressants, and the oleate had the best effect where the recovery of coal changed from 70% in water to 17% in $1.\ 10^{-6}$ mol/L. CTAB was collector to clay flotation in which the recovery of clay changed from 0% in water to 100% in 5.10^{-4} mol/L. Measurements of zeta potencial showed that the coal and clay surface were very similar and were negatively charge in all pH values. This similarity is due to the high content of ash in coal and the interaction of clay with coal. The zeta potencial of clay in the presence of CTAB changed from negative to positive due the adsorption of surfactant on clay and the neutralization of negatives charges on the surface. These results will be used to choose the better conditions in clay-coal flotation.

KEY-WORDS: flotation, coal, clay, depressants, collectors.

1. INTRODUCTION

Coal can be used for the generation of electricity and steel production. The reserves of coal in Brazil are located in the states of the south. Candiota mine in the state of Rio Grande do Sul has a reserve with resources of about 12.10^9ton. Kaolinite layers were formed together with coal and are called "tonsteins" (Matos, 2000). The exploration of coal is associated with environmental damage due the content of ash (clays, quartz) and sulfur (pyrite). Flotation is the technique more used for fine coal cleaning. (Ayhan, 2005). Clean coal should contain less than 2% in ash and minimal sulfur. The effect of fine clays on coal flotation has been extensively studied and it has been concluded that flotation is difficult because of the interactions of clay with the coal. (Xu, 2003) Surfactants and polymers are reagents commonly used in mineral flotation. (Kaggwa, 2005); (Rath, 1997); (Sharma, 1996). These compounds can act as collector in hydrophilic minerals like clays or as depressants in hydrophobic minerals such as coal. (Atkin, 2003). The objective of this work was to study the effects of sodium oleate, glycerine, glucose and amide on coal flotation and CTAB on clay flotation.

2. EXPERIMENTAL

2.1 MATERIALS

Samples of coal and clay (kaolinite) were obtained from Candiota mine – Rio Grande do Sul – Brazil. Particle sizes used in flotation tests were approximately 150μm of diameter. The reagents used were sodium oleate, glycerine, glucose , amide and cetyltrimethylammonium bromide ,CTAB.

2.2 PROCEDURES

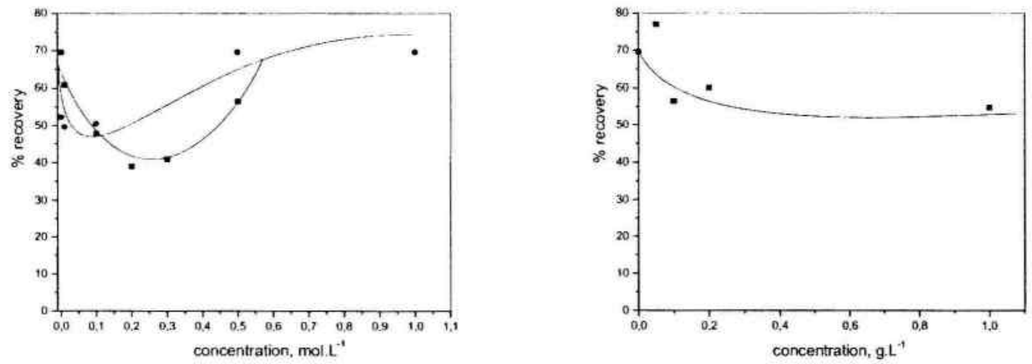
The ash content was determinated by ABNT method and was found to be 50%. Flotation tests were realized in Hallimond tube at room temperature using air as carrier gas at constant flow of 1L/min. The time was always 10 minutes. Oleate, glycerine, glucose, and amide were used in coal flotation and CTAB was used in clay flotation. Zeta potential measurements were realized on Micro-Electrophoresis Apparatus MkII of Rank Brothers Ltd.

3. RESULTS AND DISCUSSION

3.1 FLOTATION TESTS

The surface of coal is naturally hydrophobic, and in water, 70% was recovery. The effects of glycerine and glucose on coal flotation are shown in **Figure 1 (a)**. Both reagents were depressants reaching a minimum of 39% in 0.2 mol/L of glycerine and 47% in 0.1mol/L of glucose. Coal flotation using amide is shown in **Figure 1 (b)**. Amide had only a slight effect as depressant reaching a minimum of 55% in concentration of 0.4 g/L. The adsorption mechanism of glycerine on coal from flotation tests is shown in **Figure 2**. The coal surface changed from hydrophobic to hydrophilic due the glycerine adsorption by hydrophobic interaction glycerine-coal, and changed to hydrophobic again due the bilayer glycerine adsorption. The behaviour of coal flotation in the presence of sodium oleate is shown in **Figure 3**. Oleate had a better effect as depressant, reaching a minimal of 17% in dilute solutios of $1.\ 10^{-6}$mol/L. The adsorption mechanism of oleate on coal from flotation tests can be observed in **Figure 4** and is similar of glycerine on coal.

Clay flotation using CTAB is shown in **Figure 5**. Clay is naturally hydrophilic and in pure water its recovery was very poor. The surfactant was a collector of clay flotation and 100% was recovery in the concentration of 5.10^{-4} mol/l. In coal flotation, glycerine and oleate had a better effect as depressant due the adsorption on coal surface with polar group towards to aqueous solution by hydrophobic interaction. In clay flotation, the adsorption of CTAB via electrostatic interaction was efficient, with the non-polar group towards to aqueous solution, as is shown in **Figure 6**.



(a) **(b)**

Figure 1. Coal flotation , T = 20°C, pH = 6.0, in the presence of **(a)** ■ glycerine ● glucose; **(b)** ■ amide.

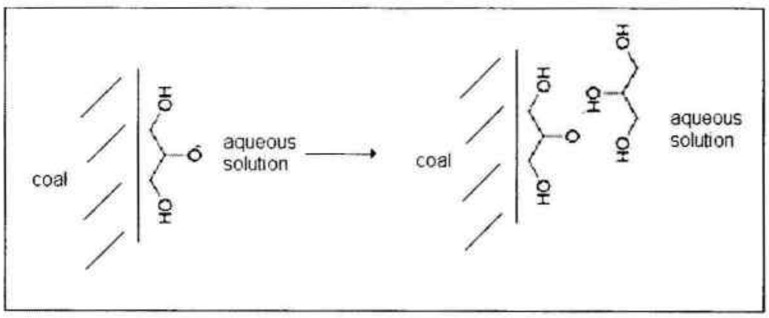


Figure 2. Adsorption mechanism of glycerine on coal.

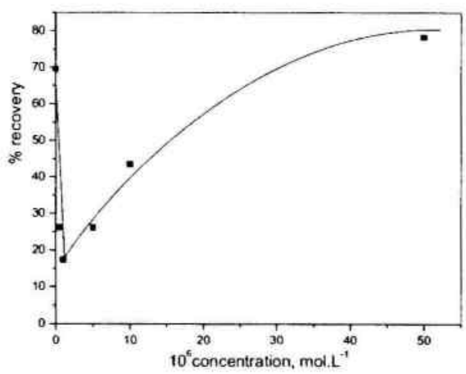


Figure 3. Coal flotation , T = 20°C, pH = 7.5 in the presence of sodium oleate.

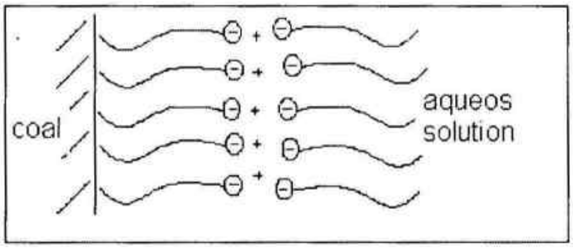


Figure 4. Adsorption mechanism of oleate on coal.

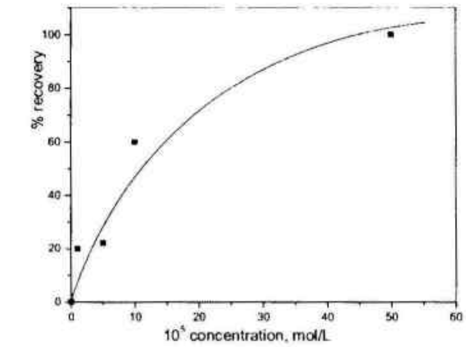


Figure 5. Clay flotation , T = 25°C, pH = 6.0 in the presence of CTAB.

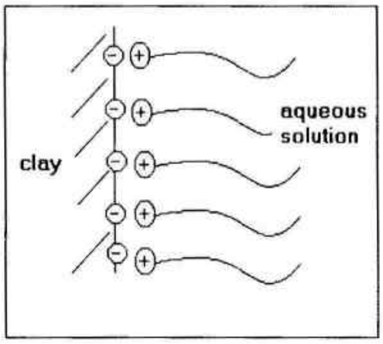


Figure 6. Adsorption mechanism of CTAB on clay.

3.2 ZETA POTENTIAL

The effect of pH on the zeta potential is shown in **Figure 7** for coal and clay. In both cases, the mineral surface has a negative charge in all values of pH. The pH profiles for coal and clay are very similar. These results can be explained by the high content of ash (clays), 50%, of Candiota coal, and shown that coal particles are coated with clay particles.

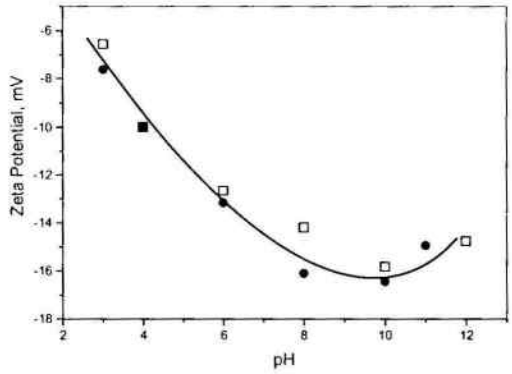


Figure 7. Effect of pH on Zeta Potential of (□) coal and (●) clay.

The effect of CTAB concentration in zeta potential of clay at pH = 6.0 is shown in **Figure 8**. As can be seen, the surface charge of clay changes from negative to positive in presence of CTAB. This is due to the adsorption of CTAB on the clay surface by electrostatic interactions of negatives sites of the clay surface with the positive part of the CTAB molecule. This result can be compared with the clay flotation recovery **(Figure 5)**, were the maximum recovery is obtained when the zeta potential is positive. The zeta potential of coal surface has no significant change in presence of oleate, glycerine, glucose and amide, probably due to the fact that its adsorption is very low.

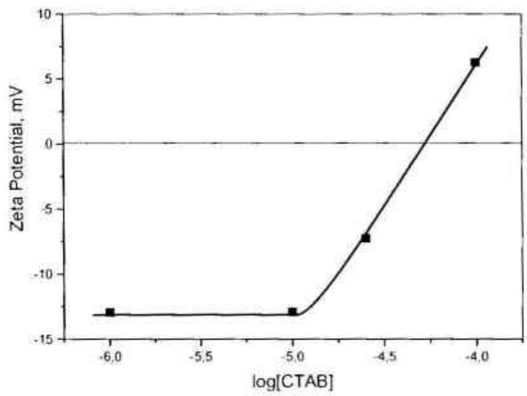


Figure 8. Effect of CTAB concentration in zeta potential of clay in pH = 6.0.

4. CONCLUSIONS

The reagents sodium oleate, glycerine, glucose and amide were depressants in coal flotation, and oleate was the best depressant, changing the recovery from 70% in water to 17% in dilute solutions of 1.10 mol/L. Zeta potential measurements of coal and clays surfaces showed that the pH profile for both minerals was very similar due to the high content of ash in the coal, and the interaction of clay with the coal. CTAB adsorption occurs on the clay surface by electrostatic attraction of cationic group with negative clay surface and zeta potential of clay change from negative to positive. Oleate, glycerine, glucose and amide have no effect in zeta potential of coal. These results will be used to choose better conditions in coal-clay flotation.

5. REFERENCES

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