

DEXTRINS AS SELECTIVE FLOTATION DEPRESSANTS FOR SULFIDE MINERALS

Jan DRZYMALA*, Piotr TOMASIK**, Beata SYCHOWSKA**, Marek SIKORA**

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Dextrins from thermal modification of potato starch under ammonia, hydrogen sulfide, and gluten were tested as flotation depressants of galena and chalcocite in a Hallimond cell with xanthate to make the sulfides hydrophobic. All dextrins, except prepared under hydrogen sulfide, depressed flotation of the sulfides. The cessation of flotation occurred at different doses of dextrins, usually between 2 and 20 kg per ton of the floated material. Dextrins from starches thermally modified under ammonia were found to be promising selective depressants in the studies with model (1:1) mixtures of galena and chalcocite but poor separation was achieved with copper ore containing lead minerals. The separation of galena from chalcocite from synthetic mixtures was also poor in the presence of gluten-modified dextrins.

Key words: flotation, galena, chalcocite, dextrin

INTRODUCTION

Starch is a common and most readily renewable plant polysaccharide. Recently, its non-nutritional applications evoked a considerable interest (Miller and Laskowski, 1983; Ye et al., 1996; Raju and Forsling, 1997; Tomasik and Schilling, 1998). Roasting of starch leads to dextrins, called the British gums, properties of which can be controlled by heating condition (Tomasik et al., 1989). Due to their origin, dextrins are environmentally friendly biodegradable products. Aqueous solutions of polymeric dextrins and starches influence the surface properties of particles in water (Gaudin, 1963; Laskowki, 1969; Lin and Budrick, 1988) leading to a modification of their flotation. It is known that dextrins depress, to a different extent flotation of a number of minerals including sulfides, which are present in the Kupferschiefer Cu-Ag ore from the Lubin region in Poland. Recently, new methods of dextrinization were

*Technical University of Wrocław (I-11), Wybrzeże Wyspińskiego 27, 50-370 Wrocław, Poland

**University of Agriculture, Mickiewicza Ave. 21, 30-120 Krakow, Poland

developed. Dextrinization carried out under ammonia (Sychowska and Tomasik, 1997), hydrogen sulfide (Sychowska et al., 1998) and with gluten (Sychowska and Tomasik, 1996) provided series of novel dextrans. Their application for flotation of galena and chalcocite, the dominant sulfide minerals in the Polish copper ore, in the presence of xanthate as the flotation collector is described in the present study.

EXPERIMENTAL

Galena originated from a deposit of sulfide minerals in Trzebieńka (Poland) and synthetic chalcocite was kindly provided by the Copper Smelting Plant in Legnica (Poland). The minerals were crushed and ground in an agate mortar shortly before flotation to avoid oxidation of sulfides. The 0.16-0.20 mm size fractions were used in the experiments. The solid particles (0.2 cm^3 that is 1.0 g of PbS or 0.7 g of Cu_2S) were suspended in 120 cm^3 of aqueous solution of depressant, then agitated for 5 minutes. The pH of the solution varied between 6.4 and 7.2. Amount of butyl xanthate subsequently added to the solution provided its final concentration of 0.0001 kmol/m^3 . After 5 min of agitation, the suspension was transferred to the Hallimond tube and floated for 15 minutes with the airflow of $0.625 \text{ cm}^3/\text{s}$. Starches and dextrans were used in the test as modifying reagents. Dextrans prepared from starch modified under ammonia (N) (Sychowska and Tomasik, 1997) hydrogen sulfide (S) (Sychowska et al., 1998), and with gluten (30% w/w) (G) (Sychowska and Tomasik, 1996) were prepared according to the methods described in the indicated sources. Roasting time and temperature used in the preparation of the dextrans tested in this study were as follows: G-9: 4h, 180°C ; N-1: 2h, 140°C ; N-8: 4h, 180°C . Also unmodified potato starch (S-O) was used in our studies.

Flotation tests involving a copper ore were also carried out in a Mechanobr laboratory flotation machine, equipped with a 500 cc cell. A sample of 150 g of ore was used in the experiment. Flotation was carried out in distilled water in the presence of 75g/Mg potassium amyl xanthate, 25g/Mg α -terpineol and 600g/Mg of dextrin. The solids were introduced to water followed by dextrin, collector and finally frother. The time of agitation with the chemicals was 5, 3, and 1 minute, respectively. The pH of flotation was 8.0. Initial flotation provided a rough concentrate and tailing. The rough concentrate was cleaned in a subsequent flotation to produce a final concentrate and a semiproduct.

The copper ore was kindly supplied by the KGHM Polska Miedz, SA, Lubin (Poland).

RESULTS AND DISCUSSION

The results of flotation of chalcocite and separately galena, both with xanthate and dextrins are presented in Figs 1-2, respectively. They show that the depression of flotation of the investigated sulfides appears at a rather high, about 20 kg/ton, admixture. When either N- or G- dextrins were added, chalcocite was more sensitive to depression than galena. S-dextrins depressed neither galena nor chalcocite.

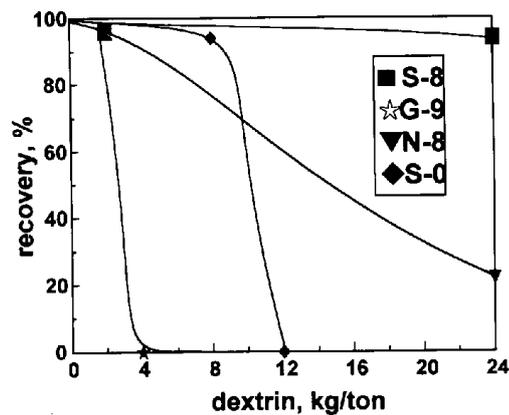


Fig. 1. Flotation of chalcocite in the presence of various dextrins (pH = 6.4-7.2)

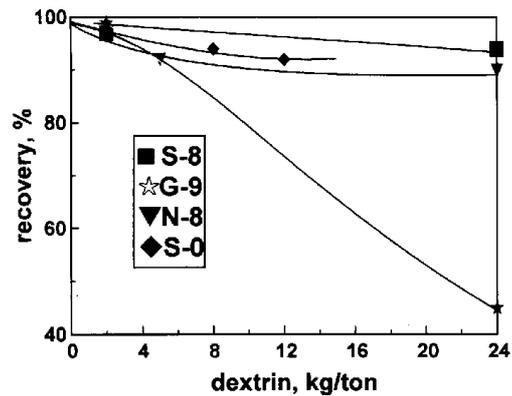


Fig. 2. Flotation of galena in the presence of various dextrins (pH = 6.4-7.2)

Dextrin G-9 and N-type dextrins were additionally tested. The results of separation of galena from chalcocite, carried out in the Hallimond tube with 1:1 (by weight) mixtures of both minerals in the presence of dextrin G-9, are shown in Figs 3. It can be seen that dextrin G-9 did not facilitate a good separation of galena and chalcocite. The difference between the recovery of chalcocite and galena never reached 100%.

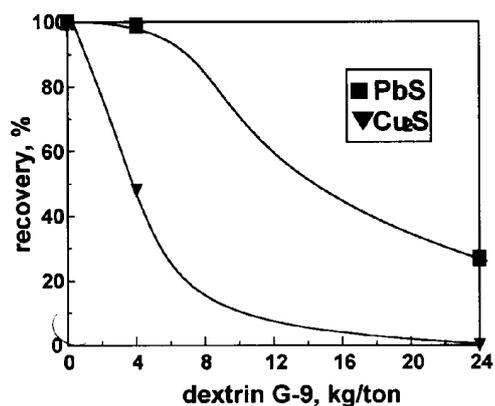


Fig. 3. Flotation of 1:1 galena - chalcocite mixtures in the presence of dextrin G-9 (pH = 7.1-7.2)

N-1 and N-8 dextrans offered promising results. The results revealed that dextrin N-8 prepared under more drastic roasting conditions provided increasing separation (Fig. 4a-b). The effect of separation of galena and chalcocite, when the 1:1 mixture of the minerals was subjected to flotation in the presence of dextrin N-8 (Fig.5), almost reached the level anticipated from the flotation tests for individual minerals.

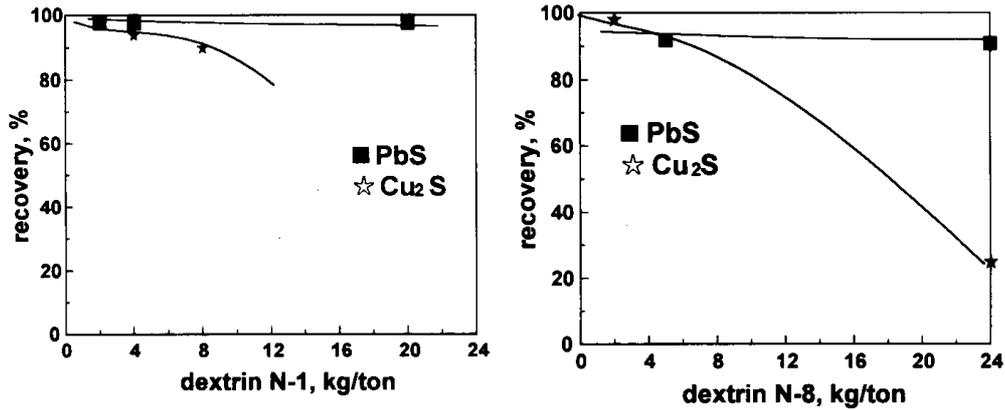


Fig. 4. Results of flotation of galena and chalcocite in the presence of dextrans N-1(a), and N-8 (b). pH = 7.1-7.2. Minerals were floated separately

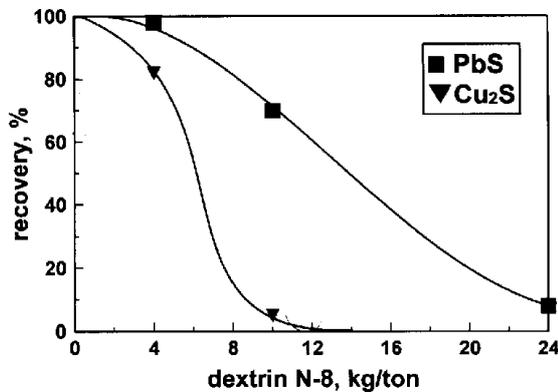


Fig. 5. Flotation of galena-chalcocite (1:1) mixture in the presence of dextrin N-8 (pH=7.1-7.2)

Dextrin N-8 was also tested with the copper ore and the results are given in Fig. 6. For comparison purpose the results of flotation of the copper ore in the presence of dextrin without modification (DBM) and flotation without any dextrin are also given in Fig. 6. It appears from Fig. 6 that the selectivity of separation of copper and lead minerals in the presence and absence of investigated dextrin is poor. Dextrin DBM does not change the selectivity of separation though it slightly depresses the flotation of sulfides in comparison to flotation without any dextrin. Dextrin N-8 has some

depressing power towards copper minerals because the reduction of flotation of copper minerals is greater than towards the lead minerals. Still greater amount of dextrin N-8 depresses flotation of sulfides in the ore almost completely.

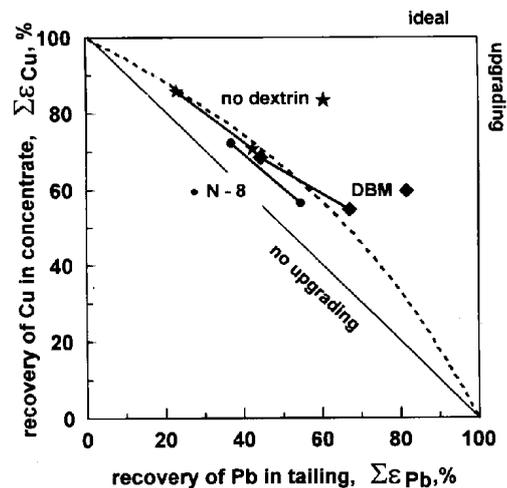


Fig.6. Result of flotation of copper and lead from copper ore in the presence of dextrin N-8 and dextrin thermolyzed in the absence of modifying chemicals (DBM). Results in the absence of dextrin are given for comparison. Dextrin concentration was 600 g/Mg, pH around 7.

According to Lekki (2002) the reason of the unequal selectivity of separation achieved for synthetic mixtures and real ore most likely results from different redox environments in the systems.

CONCLUSIONS

Ammonia, hydrogen sulfide and gluten modified dextrins are not very promising modifiers in the xanthate flotation of sulfides on a small laboratory scale experiments carried out with pure galena and chalcocite as well as with the Polish copper ore.

LITERATURE

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Drzymala J., Tomasik P., Sychowska, B., Sikora M., *Dekstryny jako selektywne depresory dla minerałów siarczkowych*, Fizykochemiczne Problemy Mineralurgii, 36, (2002), 273-278 (w jęz. ang.)

Dekstryny, otrzymane przez termiczną modyfikację skrobi ziemniaczanej w obecności amoniaku, siarczku sodu oraz glutenu, zastosowano jako depresory ksantogenianowej flotacji galeny i chalkozynu. Pomiary przeprowadzono we flotowniku Hallimonda. Badane dekstryny, z wyjątkiem tej która była modyfikowana siarkowodorem, depresowały flotację zarówno chalkozynu jak i galeny, gdy minerały te poddawano flotacji osobno. Zanik flotacji miał miejsce przy różnych stężeniach dekstryn, ale zwykle miało to miejsce przy użyciu od 2 do 20 kg na megagram flotowanego materiału. Dekstryny otrzymane przez termiczną modyfikację amoniakiem okazały się obiecującymi selektywnymi depresorami ksantogenianowej flotacji, gdy badania prowadzono z udziałem modelowych mieszanin czystych minerałów galeny i chalkozynu, ale uzyskano słabą selektywność procesu, gdy do badań użyto rudy miedzi zamierającej także minerały ołowiu. Rozdział galeny od chalkozynu zawartych w syntetycznych mieszaninach obu minerałów była słaba, gdy jako depresora użyto skrobi modyfikowanej glutenem.