

## THE VALUE AND LIMITATIONS OF ELECTROCHEMICAL MEASUREMENTS IN SULPHIDE FLOTATION

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Process chemistry is mostly dependent on the oxidation state and amount of different minerals, galvanic interactions, chemicals and dissolved ions in the process. Hydrophobicity of sulphide minerals is dependent mainly on the formation of elemental sulphur or metal-deficient sulphur layer, metal-xanthate and dixanthogen at the surface. These reactions are electrochemical in nature and therefore control of oxidation process in the flotation pulp can improve the selective flotation.

However, it has not been possible to generalize the relationship between the electrochemical variables in the pulp (such as Eh and dissolved oxygen concentration) and flotation behaviour of sulphide minerals from different deposits due to the differences in the mineralogy and electrochemical reactivity of the sulphide minerals. Mineralogy of sulphide ores from different deposits and even in the same deposit changes drastically. The contents of different minerals and degree of liberation can vary significantly between and among these ore bodies. Besides the degree of liberation, the changes in mineralogical composition of the feed to a flotation process affect the chemical, electrochemical and galvanic reactions and their kinetics in flotation pulp.

Three sulphide ores with different mineralogical character were used to investigate the value and limitations of Eh and DO measurements in sulphide mineral flotation. Çayeli complex Cu-Zn ore from Rize, Turkey, contains pyrite, chalcopyrite and sphalerite as major sulphide minerals with lesser amounts of galena and tetrahedrite. Major gangue minerals include barite, dolomite, quartz and kaolinite. The sulphide mineral content of this ore is more than 90 % (~60 % pyrite). The mineralogical composition of Küre ore (Kastamonu, Turkey) is less complex than that of Çayeli ore, the major sulphides being pyrite and chalcopyrite with minor amount of marcasite and bornite. The major gangue minerals are quartz and carbonaceous clay minerals. Sulphide mineral content of Küre ore is about 70 % (~64 % pyrite). The third ore used in this research is Merensky ore obtained from Bushveld Igneous Complex in South Africa. Mineralogy of Merensky ore is completely different from Çayeli and Küre ores. Merensky ore sample is a platinum group mineral (PGM) bearing ore. Although Merensky ore can be considered as a complex sulphide ore in terms of variety of the sulphide minerals, the total sulphide mineral content is less than 1 %. The remaining 99 % of the ore consists of non-sulphide gangue minerals, mainly feldspar and pyroxene (Table 1). The majority of PGMs are associated with the sulphide minerals. Therefore, the process is in essence a bulk sulphide float with the overall

performance comprising of the combined performance of the individual minerals and the aim is to optimize total sulphide recovery.

The flotation conditions applied to the three ores were different in terms of size distribution, type and dosages of the reagents used due to the differences in mineralogy and therefore dissemination of the sulphide mineral grains. However, the dissolved oxygen content (DO) and therefore the redox potential of the pulp (Eh) were adjusted and controlled by using air, nitrogen and their mixtures in the pre-aeration and flotation stages. DO, Eh and pH of the pulp were continuously recorded by using YSI membrane electrode, Pt-Ag/AgCl ORP electrode and glass combination electrode respectively. Moreover, oxygen demand tests were undertaken to determine the degree of electrochemical reactivity of the ore. The flotation results were evaluated to find a correlation between mineralogy of the ores-electrochemical parameters (DO and Eh)-flotation performance.

The results of oxygen demand tests revealed that Çayeli sulphide ore was more electrochemically reactive than Küre and Merensky ore. Therefore, the changes in DO oxygen concentration influenced Eh of the pulp and hence the flotation performance. In spite of its 70 % sulphide mineral content and mild steel grinding, Eh of the pulp in Küre ore was not strongly influenced by the changes in DO concentration. This was attributed to the differences in the oxidation state of the sulphide minerals (particularly pyrite) present in the two ores. However, in spite of very slight changes in Eh of the pulp, flotation behaviour of pyrite and chalcopyrite changed at different air/nitrogen gas combinations (i.e. different DO content of the pulp). Eh and flotation behaviour of the sulphide minerals in Merensky ore was not affected with the changes in DO concentration in pre-aeration stage. This was attributed to the very low sulphide mineral content of Merensky ore.

Consequently, it was revealed that not only sulphide mineral content of the ore but also the electrochemical reactivity of the sulphide minerals (particularly pyrite) determined the value and limitations of the use of Eh and DO as control parameters in sulphide mineral flotation.