HTX

ADVANCED WATER TREATMENT

HYDRUS TECHNOLOGY

MINERAL PROCESSING & ORE RECOVERY FROM TAILINGS AND WASTE

1. Introduction & Background

In over 90% of the global trade in iron ore, and increasingly with ore beneficiation and processing, most ore is of the banded iron formation (BIF) type. It consists of a mixture of hematite and magnetite with a finer component comprising the more weathered forms ferrihydrite and goethite. Goethite and ferrihydrite generally become entrained in water of most water-based ore beneficiation plants (OBPs). The very fine fraction also includes a higher proportion of undesirable components including kaolinite (and other clays), silica, and highly oxidized iron ores such as goethite. These components have very low density and cannot easily be recovered via conventional gravity separation equipment.

Many ore producers have recognized the benefits associated with ore beneficiation plants (OBPs) since it enables them to produce a high-grade concentrate. This concentrate is blended with lower grades of *run-of-mine* (ROM) ore to produce a ***blended*** ore product capable of direct shipping, (DSO). In other situations, such as Brazil, there is an increasing component of ore which is marginally below grade for direct shipping and without the benefit of recovery, is disposed to tailings.

2. Key Challenges

Ferrihydrite present in iron ore tailings, has a complex atomic structure, resisting usual structure determination methods (electron microscopy and traditional X-ray diffraction crystallographic techniques). This has made ferrihydrite's crystalline structure the subject of some controversy within the scientific community.

Several years ago, scientists working at the Argonne Advanced Photon Source in Chicago devised a model for the atomic structure of ferrihydrite as having the formula $Fe_{10}O_{14}(OH)_2$ and consisting of 20% FeO_4 tetrahedra and 80% FeO_6 octahedra. Their work has provided us with a better understanding of the relationship between the structure and magnetic properties of ferrihydrite and compositional variations associated with conventional aging in geological time.

Being anti-ferromagnetic at ambient temperature and with only a weak ferrimagnetic-like component, ferrihydrite is not normally considered useful in the tailoring of functional ferrimagnetic nanomaterials. However, Hydrus Technology has demonstrated that ferrihydrite, in the presence of selected anions, undergoes a significant magnetic enhancement corresponding to the formation of an intermediate phase preceding its transformation into maghemite (γ-Fe_2O_3) or hematite (α-Fe_2O_3).

3. Technical Solution

Hydrus Technology's role in these circumstances is to either recover a higher proportion of the valuable components present in tailings, or to offer a profound change to the tailings composition by changing a characteristic of the contained minerals using electrochemical means. This change is usually either a change to the density, by removing chemically bonded water from the crystal lattice, or magnetically, by changing existing components into magnetic forms to improve or enable their recovery.

Hydrus Technology believes that this and other transitory phases play an important role in the magnetic recovery of iron minerals from what is characteristically regarded as tailings. Specifically, Hydrus Technology has recognized that the lower than expected density of so-called 'disordered' ferrihydrite, noticeable due to cation vacancies, can be **electrochemically** filled to enable a transition from disordered ferrihydrite to ferrimagnetic ferrihydrite, which is effectively a proto-magnetite.

4. Benefits

Tailings constitute a major waste stream to the mineral sector and there are clear benefits in being able to recover even a minor percentage of those currently lost to the waste stream. As market conditions dictate the delivery of higher-grade concentrates, so there is value in relation to other tailings streams. There are similar benefits if a proportion of the waste can be marketed as a by-product, as is the case with alumina tailings. Similarly, an improvement in the magnetic susceptibility of ore minerals enables greater recovery in traditional circuits designed for magnetic recovery.

5. Conclusion

Hydrus Technology has developed the technology to recover a higher proportion of the valuable components present in tailings by changing characteristics of the contained minerals using electrochemical means. These changes are ore specific, but can include either a *change to the density* (by removing chemically bonded water from the crystal lattice) or *changes to magnetic susceptibility*, by changing oxidized non-magnetic components into paramagnetic or weakly magnetic forms.