

Magnet Enhancer Technology for Impurities Separation in Kaolin Processing

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Introduction

Magnet enhancer technology (MET) combines magnetic separation and hydroxamate flotation approaches. The result is a process that allows higher brightness (and consequently more valuable) kaolin in a more efficient way. It also improves purification enough to allow processing of previously un-economical ore bodies. This performance can be achieved using a lower intensity magnetic field which allows lower capital.

Background

The focus of sustainability of future kaolin mining heavily relies on enabling technologies that conserve water and energy while minimizing waste generation. Manifesting challenges include improving yield, reducing energy consumption, beneficiating hard to process raw materials and simplifying process flows to result in more cost effective operations.

The kaolin beneficiation process, shown in figure 1, involves dispersion, size classification, removal of colored impurities and drying or slurry preparation for the end use. Improving removal of the colored impurities leads to a higher-brightness kaolin product. Higher brightness is one of the most sought-after properties on applications such as paper coating and paint. The processes for removing such impurities include magnetic separation, froth flotation and selective flocculation.

These processes are employed independently or in combination with each other. The magnetic separa-

tions separate ferro- and para magnetic impurities from dia-magnetic kaolin with the help of high intensity cryomagnets. The flotation and selective flocculation processes exploit the physico-chemical differences between the surface properties where the impurities are selectively activated to render themselves for separation by adhering to carrier gas bubbles, as in flotation, or by attaching to a functionalized polymer. The major advantage with magnetic separation remains high yield and low reagent usage, however, limited success is achieved in the separation efficacy when finer impurities (<1 micrometer) are present in the feed. Use of stronger magnetic intensities during magnetic separation show only limited success. In addition, the diamagnetic colored impurities irrespective of size restrictions are not removed. Although both finer colored impurities and diamagnetic colored impurities are removed by flotation and selective flocculation, these processes require use and management of several chemicals. The performance of these chemical processes depends on process and feed variables, leading to quality variations. Post cleaning steps are then required that introduce cost and complexity in the process flow. In particular, poor yield from selective flocculation offers the least tolerant quality-yield tradeoff compared to other processes. There is a significant need to develop a robust process that encompasses the positive attributes of all three processes in a cost-performance effective manner.

During the past two decades, Cytec has documented through number of patents and industrial prac-

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tices that the chelating surfactants such as alkyl hydroxamate offer significant advantages over conventional anionic collectors such as sulfonate and tall oil. The benefits of chelating surfactants in flotation and selective flocculation processes include:

- improving savings through substantial reduction in the energy input to the feed at the preconditioning stage,
- increasing the quality of the product by increasing the titanium removal potential and by being very selective to the impurity phase thereby substantially reducing the surfactant contamination and the corresponding side effects to the end products in subsequent applications,
- enhancing the yield across the process by avoiding inadvertent activation of kaolin,
- simplifying process by eliminating the number of cleaning steps required,
- reducing the number of chemicals addition, control and management, and
- enabling “hard to beneficiate” raw materials ultimately providing cost savings to the manufacturer.

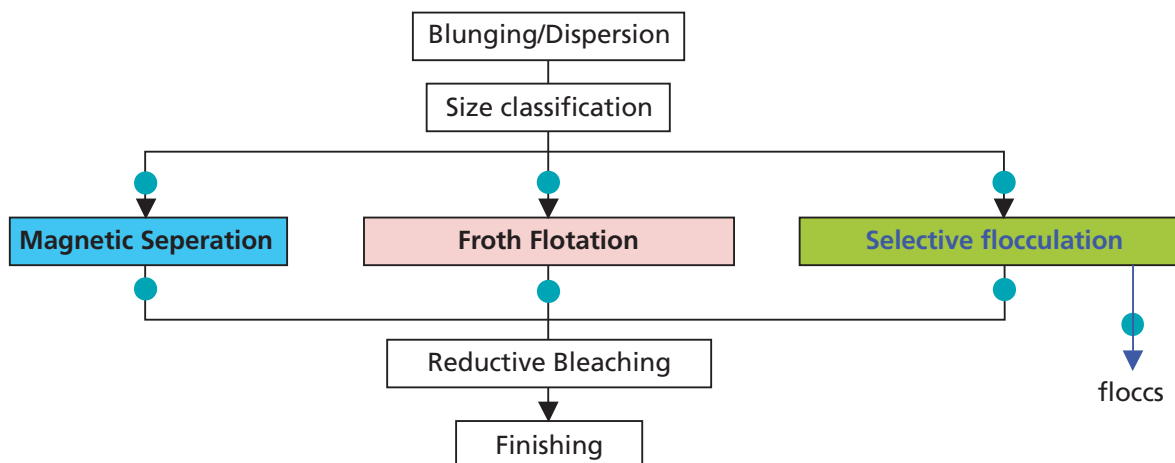
Magnetic Enhancer Technology

The magnet enhancement technology (MET) combines the best attributes of the hydroxamate chemistry in flotation and selective flocculation with magnetic separation. In the proprietary process, a tailor-made reagent is used to selectively bind to the impurities. This reagent combines magnetite for attraction to the magnet and hydroxamate (or other chemistry) for selectively attaching to the impurity targeted for removal. This system (impurity/reagent+magnetite) is separated from the kaolin when the low or high intensity magnetic field is applied.

Application

Extensive test work suggests that MET can be applied to all the feeds and products in the kaolin beneficiation processes (see green dots in figure 1). The applications include: 1) achieving the product quality with the feeds that are not amenable to conventional magnetic separation, or 2) enabling MET as a replacement for flotation or selective flocculation (for colored impurities removal) from the existing beneficiation processes.

Figure 1: Process Flow of Kaolin Beneficiation



The MET allows removing impurities at a very low magnetic field of 0.1-1 tesla providing a less capital intensive technology and thus allowing the kaolin manufacturers to save energy while improving performance of existing low intensity magnets. Figure 2 indicates excellent performance (below the solid line at 0.6%) for TiO₂ removal (the colored impurities) in the product from 0.1 to 5.0 Tesla at the same reagent dosage and conditions.

Advantages of Magnetic Enhancer Technology:

- Extension of existing magnetic separation technology
- Comparable in quality and cost effectiveness to flotation and selective flocculation
- Adaptable to existing magnets with minimum capital
- Process for removal of impurity minerals over wide size range - coarse to ultrafine kaolin
- Removes non-magnetic impurities
- High process yield
- Robust process
- Easy to use with minimal operator training

MET is a viable fine particle beneficiation process and a potential alternative to flotation and selective flocculation technology to achieve high brightness kaolin. When compared to existing technologies: magnetic separation (MS), flotation/selective flocculation (F/SF), MET emerges with synergistic advantages.

In summary, MET is a powerful technology for removing low level impurities from Kaolin. It can

also provide a basic approach for removing impurities from other mineral systems as well when combining the right combination of functionalized reagents with low-intensity magnetic separation.

Figure 2: MET: Efficient Impurity Removal With Low Intensity (Low Energy) Magnet Field.

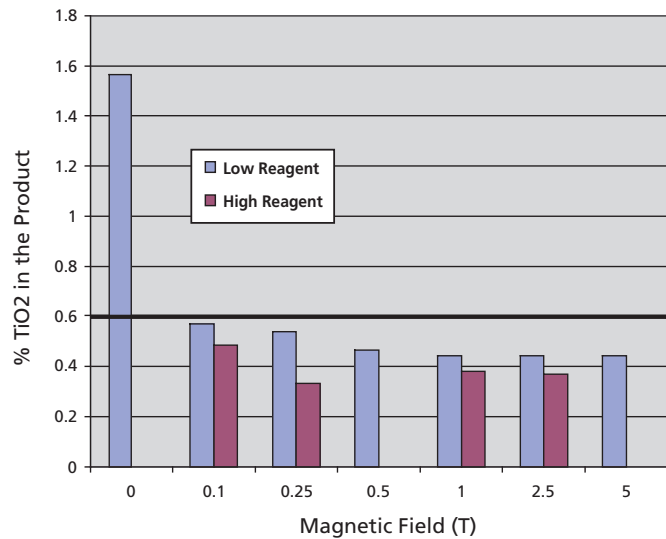


Figure 3: Comparison of Magnet Enhancer Technology

Attributes	MS	F/SF	MET
Product Cost	Green	Red	Yellow
Yield	Green	Yellow	Green
Chemical & Energy Usage	Green	Red	Yellow
Process Simplicity	Green	Red	Green
Post processing issues	Yellow	Red	Yellow
TiO ₂ rejection & Brightness Inc	Red	Green	Green
Operator Training	Green	Red	Green
Ability to Process Finer Particle	Red	Green	Green
Reserves utilization	Red	Yellow	Yellow

Green = Performs very well Yellow = Performs adequately
 Red = Performs poorly (all relative to other options)

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