FLASH ROASTING OF SULPHIDE CONCENTRATES AND LEACH RESIDUES USING A TORBED* REACTOR

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Abstract

Conventionally hydrometallurgical recovery processes from sulphide concentrates include roasting, leaching, precipitation, impurity removal and zinc electrowinning. The use of the novel (yet commercially proven in other mineral and metallurgical industries) TORBED process reactor for the flash roasting of sulphides will be proposed. The potential advantages in its application will be discussed including very fine particle processing capability, lower cost smaller roasters, waste minimization, improved leaching efficiency and overall process simplification.

INTRODUCTION

In hydrometallurgical zinc recovery processes from sulphide ores, a high grade concentrate containing typically 50 -60% zinc and 2-8% iron is roasted at 900-980°C, generally in fluid bed roasters, to produce a calcine for leaching with sulphuric acid under 'neutral leach' conditions. Zinc recovery of 85-90% is obtained at this stage. The zinc bearing leach liquor is treated for impurities removal through controlled precipitation stages and zinc metal is recovered by electrolysis.

During neutral leaching, a considerable amount of zinc is left with the residue as zinc ferrite with amounts of lead and silver. Zinc from these leach residues is generally recovered under hot acid leach conditions with dissolved iron in solution removed as iron containing jarosite, goethite or hematite precipitates. Zinc recovered under these conditions improves overall zinc recovery up to 97.5%.

The roasting temperatures are normally chosen to maximise the decomposition of zinc sulphate while avoiding excessive formation of zinc ferrite (which begins to form at ~750°C). Generally, fluid bed roasters operate at 900-960°C in bed. Operation at higher temperatures, besides encouraging additional zinc ferrite formation, can also result in clinker formation due to the presence of lead in the feed. Clinkers can reduce zinc conversion due to poor bed fluidization. In conventional fluidised bed operations, besides the mineralogy and chemical analysis of the feed, the moisture content and particle size distribution can affect the process performance significantly.

Thermodynamic analysis indicates that ferrites will become unstable and decompose above 1100 C. Hoboken[1] test work at 1000 C with a space or freeboard velocity of 2m/s for a pelletised zinc concentrate feed containing up to 8.9%Pb and 3.8%Cu showed no accretion problems. The product calcine contained less than 0.5%S as compared with

*TORBED® is a registered trade mark of Torftech Ltd approximately 2%S at normal zinc roasting temperatures.

Flash roasting using a TORBED reactor

Today, concentrates are being produced from new sources of more complex ores. These ores require finer grinding in order to achieve an acceptable concentration of zinc sulphide as a feed to a zinc roaster. These finer concentrates are more difficult to process in conventional roasters.

Experience in processing sulphides (Cu, Ni) and inorganic precipitates with the TORBED reactor suggests that there are inherent advantages for fine powder (<50 m) processing. TORBED reactor application to sulphide roasting has shown an ability to overcome eutectic molten intermediate phase transformations to obtain fine powder end products – typically with a retention time measured in milliseconds. Treatment of inorganic precipitates has also been shown to provide end products with very high pore volumes and reactivity. Translated to hydrometallurgical downstream processes, this indicates potential to improve or simplify leaching circuits.

Since close control of temperature is required to minimise ferrite formation and avoid molten eutectics, evaluation of the TORBED reactor to roast zinc sulphide concentrates at normal operating temperatures of 900-960 C is considered timely. Flash roasting of fine powders with temperatures higher than 1100 C using a TORBED reactor could also offer unique advantages. Under these conditions ferrite, even if formed, can be decomposed and clinker formation can be minimised with elimination of volatile lead compounds with downstream process advantages.

The TORBED Reactor

In order to understand how a TORBED reactor is used for the flash processing of fine particulates, an understanding of the basic principles of operation is useful.

A TORBED reactor retains a compact shallow packed bed of particles suspended above an annular ring of stationary blades or vanes (somewhat similar to a static set of turbine blades) through which a process gas stream is passed at high velocity (see Figure 1).

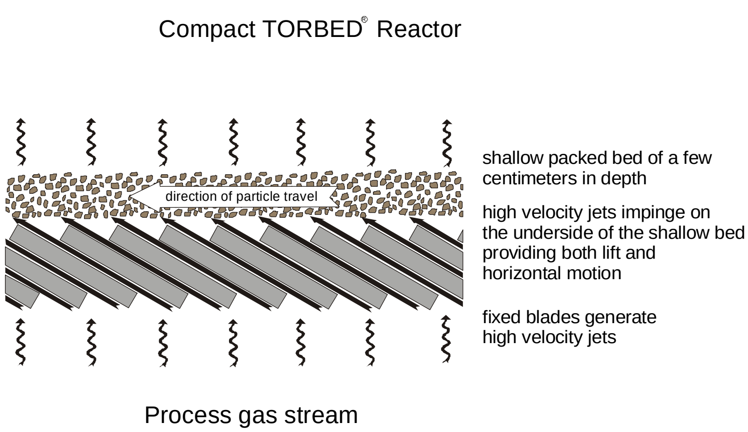

Figure 1 *Compact* TORBED Reactor Principles

The high velocity gas jets (generated in the restriction between the blades) exchange kinetic energy on impact with the particles on the underside or base layer of the bed providing both vertical lift and horizontal motion. The blades and bed are arranged in such a way that the bed mixes rapidly in a controlled fashion and circulates within an annular chamber with a toroidal mixing pattern (see Figure 2).

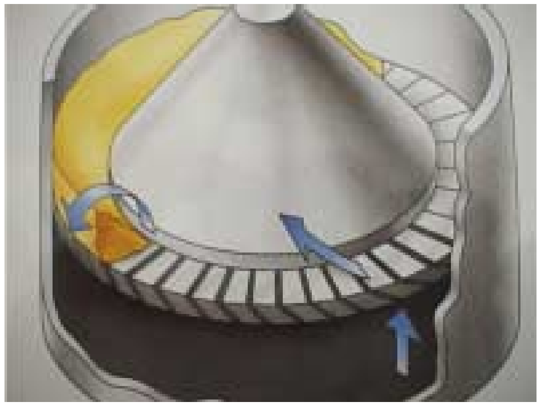

Figure 2 Cutaway section of the circulating TORoidal BED shape

Fine powder processing

It has been found that fine powders (ideally 100% <50μm diameter) can be injected into a TORBED reactor such that the powder is transported uniformly in a plug flow pattern through a resident packed bed of inert ceramic particles held in the reactor (see figure 3). By this means the fine powder can be "flash processed" with retention times of the order of 10 to 20 milliseconds. Such a processing technique allows closely controlled temperature increases of the fine powder of 1000°C or more within this short residence time. The selection of the resident bed particles (typically 2-5 mm diameter) determines the superficial velocity of the process gas stream without elutriation of the resident bed particles. Thus by utilising selected bed particles with a high density, superficial velocities in excess 10m/s are possible.

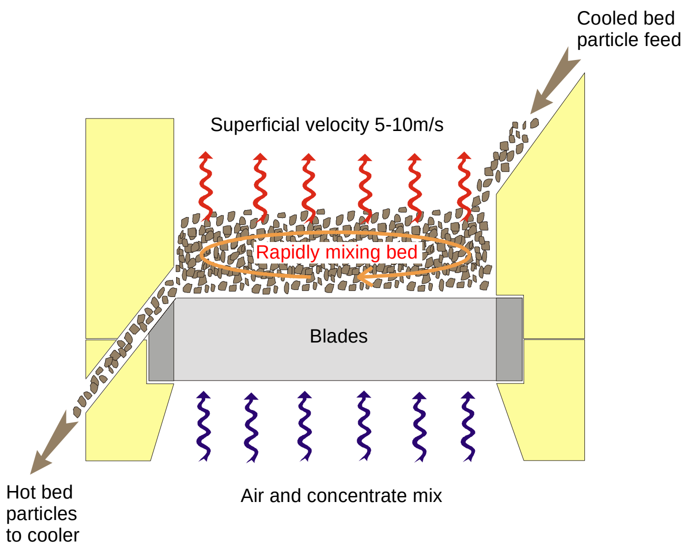

Figure 3 Principles of fine powder flash processing through a TORBED reactor

Frequently high surface area products are produced with particle morphology that has not been achieved before. This is either due to exfoliation, formation of fine fissures (caused by rapid expansion of gases), or increased porosity. This characteristic of the TORBED process has distinct advantages in situations such as the flash roasting of sulphide ores where the increased surface area allows for more effective leaching of the oxidized metal species.

The capability of the TORBED reactors to flash process fine particles enables a more compact lower cost roaster to be considered both for the roasting of concentrates and leach residues (because of the significantly higher superficial velocities).

Concentrate roasting

There is evidence that the use of a flash roast technique for zinc sulphide concentrates even at normal industry conditions at 900-950 C produces significantly reduced ferrite formation and an order of magnitude increase in particle porosity (enabling faster leach kinetics). The potential exists for the removal of a hot acid leach step. If the roast were increased to temperatures in excess of 1100 C, ferrite formation may be reduced even further. As high temperature gas filtration is becoming available, so the potential to separate undesirable volatiles may also be feasible.

The fine powder injection process requires that the concentrate feed is sufficiently free flowing to enable entrainment in the process air stream. This may require the concentrate to be dried prior to injection into the TORBED flash roaster. Although this involves an extra process step, the removal of water prior to roasting will result in a lower volume of offgas for particulate removal. The feed of an essentially dry SO_2 containing gas stream to the acid plant will have operating advantages for that unit process. Avoiding the addition of water for cooling further enhances the quality of offgas. The flow of an inert bed material through the TORBED reactor is used to remove heat and control the temperature in the reactor providing cleaner high-grade heat recovery from the bed material. The work undertaken has indicated that a TORBED flash roaster will be substantially smaller than existing roasters with attendant cost savings. The low air pressure drop across the roaster of 100-200mm WG also represents substantial savings in utility costs. A schematic flow sheet for such a roasting process is shown below as figure 4.

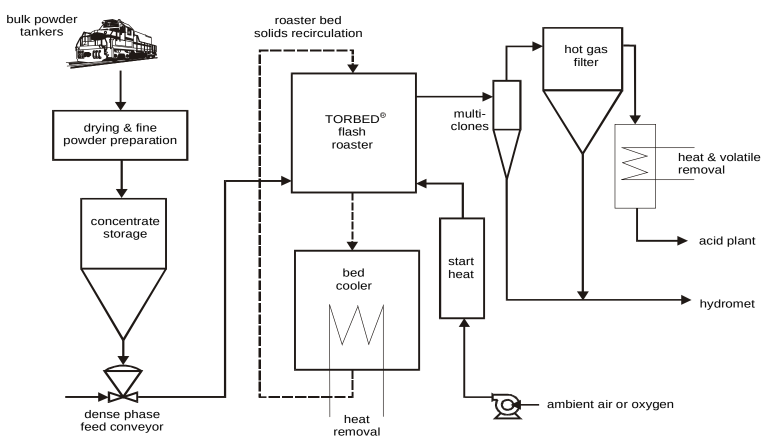

Figure 4   Schematic flow sheet for a TORBED flash roaster

High temperature calcination of leach residues

TORBED reactors are often commercially viable at low tonnage throughput rates compared with existing technologies. For existing zinc plants, the availability of small scale TORBED roasters may make it feasible to consider high temperature (>1100 C) calcination of residues from the neutral or weak acid leach step, as an alternative to the use of hot strong acid leaching to break down ferrites.

Conclusions

Flash processing through the novel TORBED reactor technology could offer opportunities to process zinc and other sulphide concentrates, whole ores and leach residues with higher specific throughput, significant downstream process compression and reduced residues and lower capital and operating costs.

[1] R. Danoison, R. Winard, H. Willerens and L. Vos. Lead Zinc 80. Eds J.M.Cigan, T.S.McKay and T.S. O'Keefe. TMS publications, Warrendale, PA., pp 69-83.