Thermogravimetric analysis of a polymetallic copper sulphide

M. Vázquez (1*), M. Rabaçal, (3), M. Costa (3), I. Moreno-Ventas (1,2)

(1) Department of Ciencias de la Tierra, University of Huelva, 21007, Huelva (España)
(2) Centro de investigación de Química Sostenible (CIQSO)Univeristy of Huelva, 21007, Huelva (España)
(3) Mechanical Engineering Department, Instituto Superior Tecnico 1049-001, Lisbon (Portugal)
* corresponding author: marta.vvazquez@hotmail.com

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INTRODUCCIÓN

Pyrometallurgical processes extract copper from concentrates between 25-45% copper obtained by flotation from materials with approximately 2% copper. (M.E. Schlesinger et al., 2011)

It is important to know the ignition temperature of the sulphides since there are autoignition phenomena that affect the operations of mining, transportation, stowage of polymetallic sulphides and copper metallurgy.
The different factors that determine the behavior of a polymetallic sulphide in an oxidative process are mainly the sulphur type, grain size, composition of the oxidizing gas and the temperature of the medium.

The oxidation of a polymeric mixture of sulphides implies a "cloud effect" that consists of a particle that goes into ignition causing a local thermal increase around it and can induce the ignition of another nearby particle of higher ignition temperature, despite that the temperature of the combustion gas being lower. The cloud effect can trigger chain ignition reactions at a lower combustion temperature than at a higher ignition temperatures of the sulphides in the mixture.

METHODOLOGY AND MATERIALS

The concentrate studied consists mainly of chalcopyrite (63.13%), chalcocite (17.75%) and pyrite (5.64%). In the granulometric curve of this concentrate a gradual variation in the diameter of the particles is observed, with a percentage in fines (<50 µm) of 69.45% and a specific surface area of 0.736 m^2 /g.

The tests were carried out heating the concentrate from 30°C to 1000°C at two different oxygen relative concentration: 21% O_2 (atmospheric) and 45% O_2 . The working gas mixtures consisted of O_2 and N_2.

The studies were carried out using methods of thermogravimetry (Pyris 1), X-ray diffraction (BRUKER D8 Advance X-ray diffractometer), and scanning electron microscopy (SEM) (FEI QUANTA 200).

Figure 1 represents a the TGA curve of a sample composed of a mixture of polymetallic sulphides..

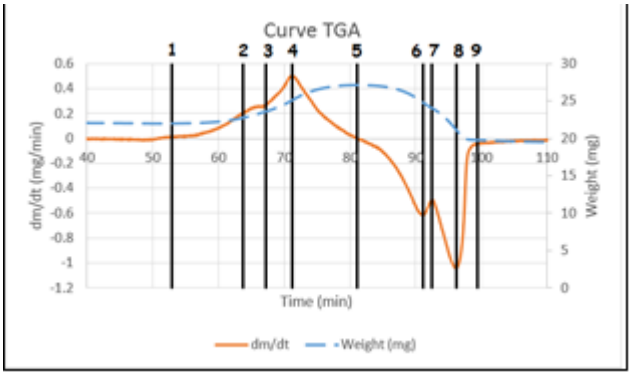

Fig 1. *TGA graph of a model concentrate representing dm/dt (main axis) and mass (secondary axis) vs. temperature.*

The blue curve (dashed line) represents the mass (mg) against time (min), while the orange curve (solid line) represents dm/dt (mg/min) versus time (min). So the orange curve is a marker of the slope variations of the blue curve.

The vertical lines indicate significant changes in the topology of the curves. The most noteworthy points are the area of mass gain between points 1 and 5 (355-635ºC), the zone of mass loss between points 5 and 9 (635-816ºC) and the start of ignition at point 4 (541ºC).

The TGA curves of monomineral sulphide samples have smoother topologies for both mass gain and loss zone (G. W. Reimers et al., 1987, S.E. Pérez-Fontes et al., 2007).

Figure 1 shows inflections corresponding to points 2 and 3 in the area of mass gain and points 6, 7 and 8 in the

zone of mass loss, due to the processes suffered by the different types of polymetallic sulphides of the mixture.

RESULTS AND DISCUSSION

Graph of TGA CO-2527 (Fig. 2) shows two curves corresponding to the variation of mass vs. temperature (dashed line) and two curves corresponding to dm/dt vs. temperature (Solid line)(Blue: 21% oxygen and red: 45% oxygen).

The points indicated as A, B and C are points where collected oxidation residues have been studied with XRD and SEM (Fig3).

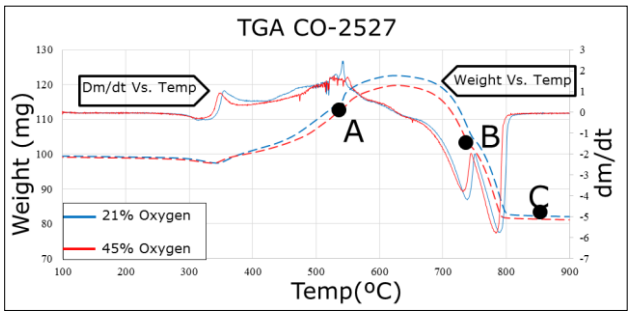

Fig 2. *TGA graph representing mass (main axis) and dm/dt (secondary axis) vs. temperature under two oxidizing conditions.*

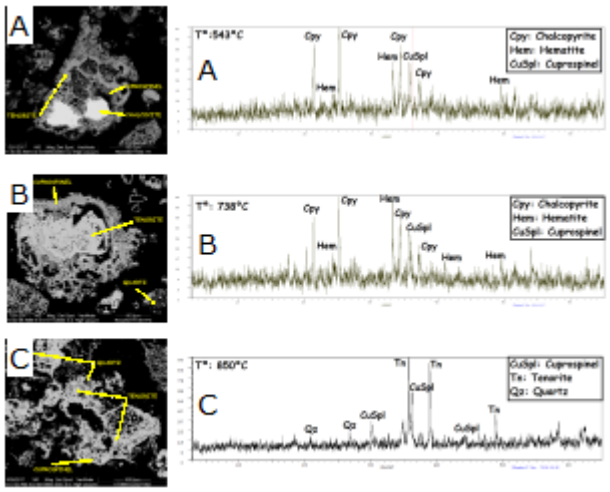

Fig 3*: BSE images (left) and diffractograms (right) of TGA residues at indicated temperatures. A and B at 45% Oxygen mixture, C at 21% O_2.*

The residues at point A (543˚C) are formed by chalcocite, cuprospinel, tenorite, hematite and quartz.

The residues at point B (738˚C) are formed by cuprospinel, tenorite, hematite, chalcopyrite and quartz.

The residues at point C (850˚C) are formed by cuprospinel, tenorite and quartz.

CONCLUSIONS

Increase mass range of the concentrate between 300-650˚C.

Mass loss range of the Cdo. between 650-800˚C
Start of the combustion of the Cdo. at 550˚C.

Combustion termination point at 800˚C.

Maximum point of mass gain at 650˚C.

The starting point of the combustion is before the point of maximum mass gain.

Range of competition between gain processes and mass loss between 550-650˚C.

The enrichment of O2 in the working gas hasn't effect on the TGA topology, that is, it doesn't affect the ignition temperatures.

THANKS

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