CREATIONS de UiTM

INTERNATIONAL MEGA INNOVATION CARNIVAL 2023

Fostering Innovation to Global Communities

LET'S CRAFT A BETTER WORLD TOMORROW!

ePROCEEDING

20th MAY 2023

UNIVERSITI TEKNOLOGI MARA
CAWANGAN SELANGOR, KAMPUS DENGKIL
MALAYSIA

ORGANISED BY:

UNIVERSITI TEKNOLOGI MARA

Pusat Asasi

30 TO 3000 MAGNETITE

***[1]Nur Asyikin Ahmad Nazri, [2]Raba'ah Syahidah Azis, [3]Hasfalina Che Man, [1]Norhafezah Kasmuri**

[1]Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil 43800 Dengkil, Selangor, Malaysia

[2]Department of Physics, Faculty of Science, Universiti Putra Malaysia, 43400 Serdang Selangor, Malaysia

[3]Department of Biological and Agricultural Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

*E-mail: asyikin2750@uitm.edu.my

ABSTRACT

This work presented the extracted magnetite from waste mill scales through an eco-friendly and low-cost approach. The extraction of the magnetite involved two magnetic separation steps which were named as magnetite separation 1, and curie temperature separation technique. The magnetite is then used in removal of copper ions from an aqeous solution. Different milling times were used to reduce the size of the raw mill scale which is 24, 48 and 72 h. The increase in the milling time resulted in the homogenous dispersion of iron oxides particles, the reduction of particle clustering, and the reduction of distances between the particles. Magnetite was characterized using XRD, SEM and particle size distribution. Solubility of the iron oxides increased as the milling time increased. The concentration of copper ions was determined by a spectrometer. As a result, 72 hours milling time had shown highest adsorptions of copper which is 95 % removal efficiency at the optimum conditions. The characterizations of the millscales waste after the process having magnetite XRD spectrum and successfully reduced the size to microparticles. To conclude this, the price of millscales waste from RM30/kg now turned to magnetite can be up to RM3000/kg.

Keywords: Waste mill scales; milling time; iron oxides; Cu ions; removal efficiency (RE)

INTRODUCTION

There have been widespread interested on mill scales as iron oxides sources. On an average, every year, one single steel processing unit produces about 6500 to 8500 tons of mill scale and almost 18-20 million metrics tons of this material is produced every year. Most of the material is dumped landfills. Waste mill scales were believed to have high potential to be explored in many application because it rich with percentages of Fe (~72%) [1]. Therefore, many trials were taken to turn these waste mill scales into valuable product. Relatively mill scale is pure oxide with little contamination. It is magnetic material with typical range 93-95% complement with good properties such porous, hard and brittle. Therefore, this project used to recycle millscales wastes into an metals ions adsorbent.

Waste mill scales was purchased from steel industries. The waste mill scales has flakes shape structure with diameter <1 mm. Copper solution was prepared from copper nitrate ($Cu(NO_3)$). The waste mill scales were conventionally ball milled using a Pascal mechanical

milling for 24, 48 and 72 h. The waste mill scales magnetic separation routes were done similar to previously reported by [2]. The magnetite (Fe_3O_4) yielded from CTST was dried in oven at 120 °C for 24 h.

The structural and phase composition of samples were analyzed from X-ray diffraction (XRD) pattern, characterized using a Philips Expert PW3040 diffractometer operating operated at 40 kV and 40 mA with CuKα radiation (λ = 0.154 nm). The microstructure, particles size and elemental analysis of the samples were observed using a NovaNano 230 field emission scanning electron microscope (FESEM) equipped with Energy-dispersive X-ray spectroscopy (EDX).

INNOVATION DEVELOPMENT

The non-chemical extraction of magnetite from the waste millscales was made possible by the magnetic separation magnetite. Our late Professor Mansor (UPM), who spent years researching mill scale waste and using it widely, served as an inspiration for this effort. The innovative aspect of this invention was the use of magnetite to remove 95% of the metal ions from an aqueous solution. Similar performance to commercial magnetite priced at RM3000/kg. The XRD spectrum as shown in Figure 2, described the behaviour of the magnetite after the magnetic separation and after milling with 3 different time (24, 48, and 72 h).

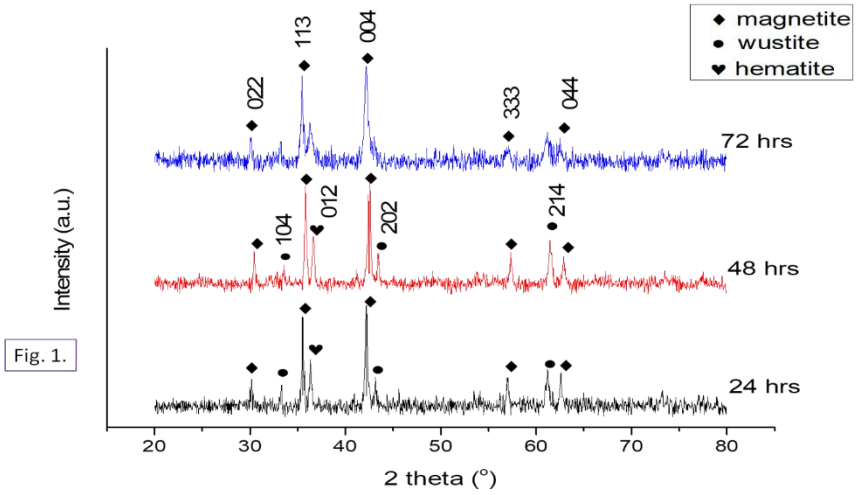

Fig. 1.

Figure 1: XRD spectrum.

The SEM images shown in Figure 2 gave the information on the size of the magnetite after milling with 3 different period. The size og the magnetite after milling for 24, 48 and 72 hours is 30 µm.

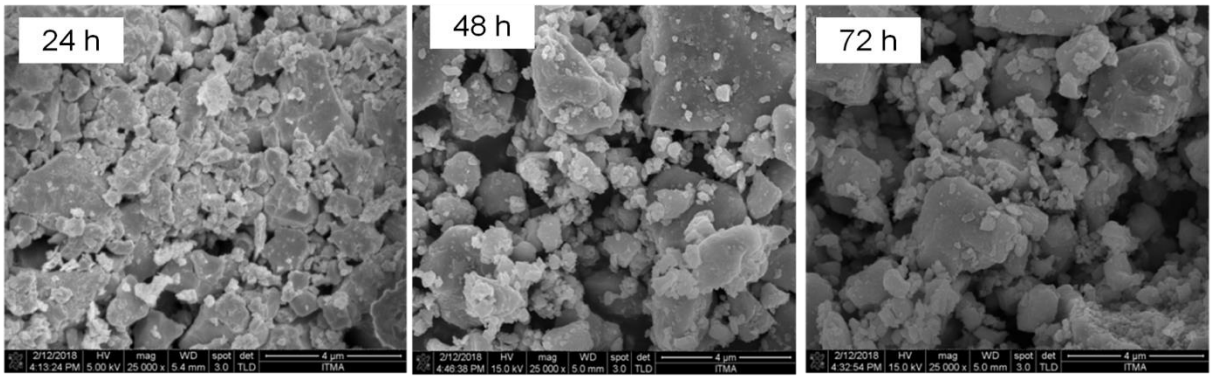

Figure 2: SEM images.

COMMERCIAL POTENTIAL

With numerous industrial uses, magnetite is a mineral that is frequently discovered in iron ore deposits. Millscale is a waste material that contains a sizable quantity of magnetite and is a byproduct of the steel-making process. As a result, magnetite from millscales may be extracted and used for commercial purposes.

The price of millscales waste is RM30.00 per kilogramme. It appears as flakes of millscale trash that contains some pollutants. Then, for 24, 48, and 72 hours, these flakes are subjected to standard milling at 600 rpm. The contaminants are then removed using magnetic separation 1 when the millscales are submerged in water and a magnetic field is applied to the area surrounding the column. The earliest separation techniques are shown in figure 3. A 1 T magnetic field is applied, drawing in the magnetic materials, while the impurities are either floating or completely submerged at the bottom.

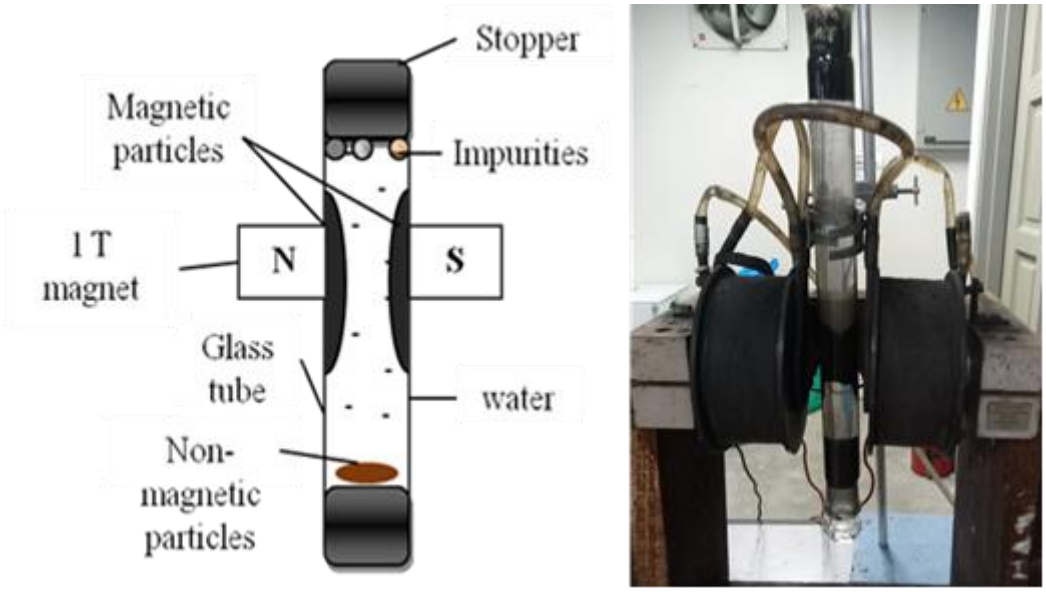

Figure 3: Magnetic separation 1.

To remove magnetite exclusively, a second magnetic separation is used. Wustite has a Curie Temperature of 780C, hence heated water was employed for this purpose in order to cause the wustite to sink to the bottom. Therefore, only magnetite and hematite will be drawn to and left

behind by the magnet's application. This second separation will take place repeatedly for a number of times in order to obtain pure magnetite. The magnetite spectrum is shown by the XRD examination as the outcome. To sum up, this straightforward, non-chemical process extracts magnetite with 99% purity.

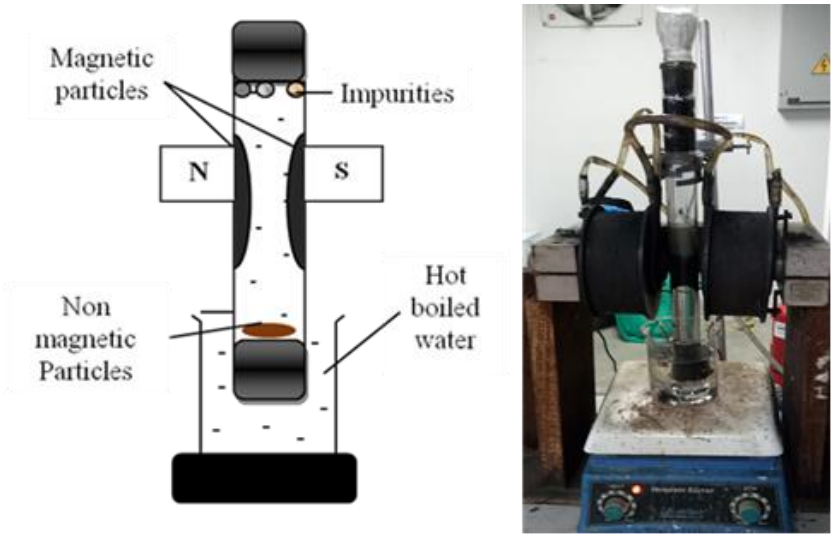

Figure 4: Second magnetic separation technique.

In order to prove that the product was similar to commercial magnetite, the magnetite used in adsorption of copper ions to see the performance. From the study, it was found that the removal percentages is similar to the commercial magnetite. In comparison with the millscales before processed to magnetite also proved when the removal is higher. This can be seen from the Figure 5.

Figure 5: The right tubes is the water samples treated with millscales, in the middle tube was treated using magnetite.

CONCLUSION

In conclusion, the magnetite extracted from waste millscales have the same abilities with the commercial magnetite in removing metals ions from the aqueous solutions. Therefore, 30 to 3000 magnetite have bigger chances to be commercialised.

ACKNOWLEDGEMENT

Thanks to Universiti Teknologi MARA (UiTM) and Universiti Putra Malaysia (UPM).

REFERENCES

[1] Wang, Z., Huang, K., Luo, Y., and Chen, Y. (2021). Utilization of Mill Scale Waste for the Production of Magnetite Nanoparticles. Journal of Environmental Management, 282, 111966. https://doi.org/10.1016/j.jenvman.2021.111966

[2] Azis, R. S., Hashim, M., Yahya, N., Saiden, N. M. (2002). A Study of Sintering Temperatures Variation on Microstructure Developments of Strontium Hexaferrite Millscale-Derived. Journal of Applied Sciences, 2(12), 1092-1095. DOI: 10.3923/jas.2002.1092.1095.