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Experimental study of the particle trajectory in a free-fall separator

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Abstract:
In order to meet the needs of the waste electrical and electronic equipment recycling industry, multiple researches have been carried out by American, Japanese, European, Canadian and Algerian laboratories on the electrostatic separation of granular plastic materials and the main charging mechanisms involved. To this end, the free-fall electrostatic separator is widely used in the sorting and purification of sub-millimetre size ores. Currently, the process is also successfully applied to the sorting of granular plastics from waste electrical and electronic equipment. In these installations, the sorting of granular materials is produced by the electrostatic force acting on particles pre-loaded in devices using the triboelectric effect. The quality of the products recovered at the exit of the electrostatic separator is strongly linked to the charge to mass ratio (Q/m) of the particles in the mixture.

Résumé :
Afin de répondre aux besoins de l'industrie du recyclage des déchets d'équipements électriques et électroniques, multiples recherches ont été réalisées par des laboratoires américains, japonais, européens, canadiens et algériens sur la séparation électrostatique des matériaux plastiques granulaires ainsi que les principaux mécanismes de charge impliqués.
A cet effet, le séparateur électrostatique à chute libre est largement utilisé dans le tri et la purification des minerais de taille sous- millimétrique. Actuellement, le processus est aussi appliqué avec succès au tri des plastiques granulaires issus des déchets d'équipements électriques et électroniques. Dans ces installations, le tri des matériaux granulaires est produit par la force électrostatique qui agit sur des particules pré-chargées dans des dispositifs utilisant l'effet triboélectrique. La qualité des produits récupérés à la sortie du séparateur électrostatique est fortement liée au ratio charge/masse (Q/m) des particules du mélange.

Mots-clés : séparation électrostatique, champ électrique, trajectoire des particules.
Keywords: electrostatic separation, electric field, particle trajectory.

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Introduction :

Aware that electronic waste is a source of pollution and danger for nature and consequently for mankind, many industrialised and less industrialised countries are gradually organising themselves to recover the materials contained in this waste. In order to meet the needs of the waste electrical and electronic equipment recycling industry, a number of research projects have been carried out by laboratories on the electrostatic separation of granular plastic materials and the main charging mechanisms involved.
The main objective of this paper is to improve free-fall electrostatic separation techniques by studying and analysing the trajectories of the particles.

Experimental Procedure

1. Electrostatic Separator

To carry out an experimental study of the behaviour of plastic particles in a free-fall separator, we used a laboratory model (Figure 1).This installation consists of the following elements:
- A closed Plexiglas tower;
- Two aluminium electrodes glued to two Plexiglas plates. The voltage of the sources used in this study varies from 0 to ± 30 kV.
- A collector with several removable cells
- A conical funnel ending in a tube receives the particles coming from the loading device in order to guide them in free fall into the electrostatic separation zone.

2. Triboelectric charger

In this study, particle loading by triboelectric effect is produced using a screw conveyor designed at the IRECOM laboratory of the University of Sidi Bel Abbés.

3. Electrical balance

The total mass of the particles is measured using a high resolution electronic balance (0.001g)

4. Charge measuring device

The charge of the product recovered in a cell is measured using a Faraday bucket and a Keithley6514 electrometer.

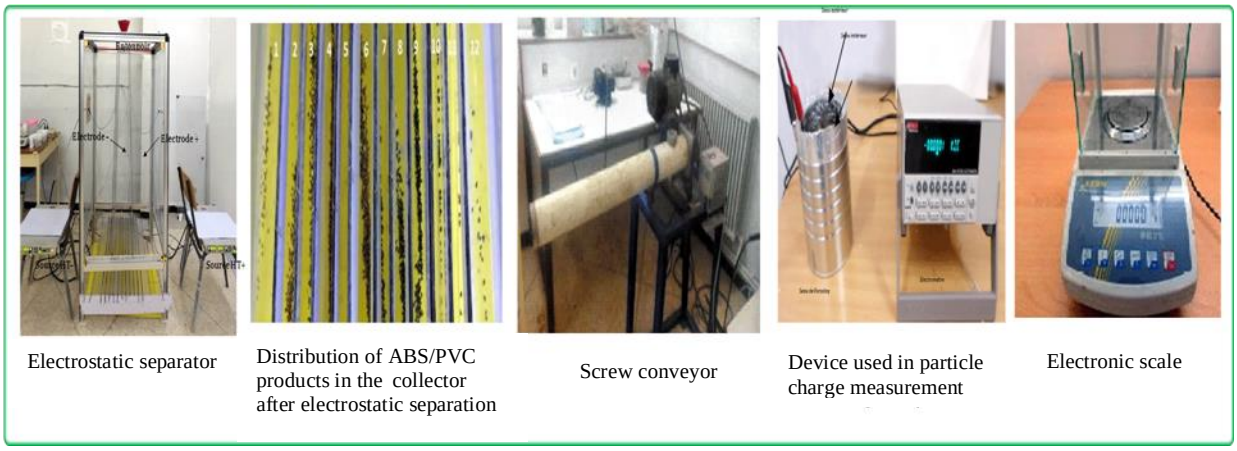

Figure 1. Materials used for electrostatic separation

In all the experiments, we used a mixture of two products consisting of 50 g of ABS and 50 g of PVC.

The distribution of the mass charge of the product recovered in the cells of the collector, we notice that the product recovered near x = 0 has a very low mass charge compared to the product recovered at the ends of the collector. On the other hand, the positively charged product recovered at the end of the collector has a higher mass charge in absolute value than the negatively charged product recovered at the other end.

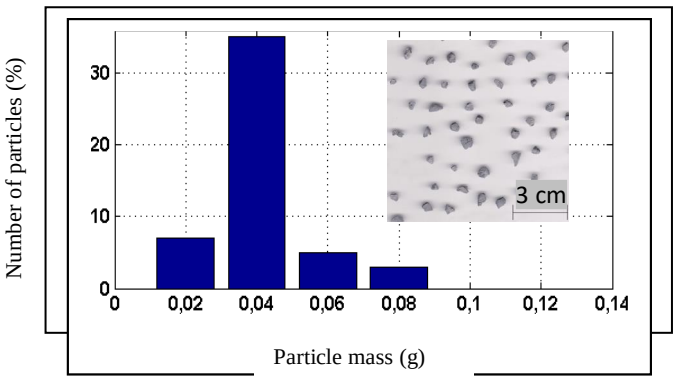

Figure 2: Number of ABS Particle Mass

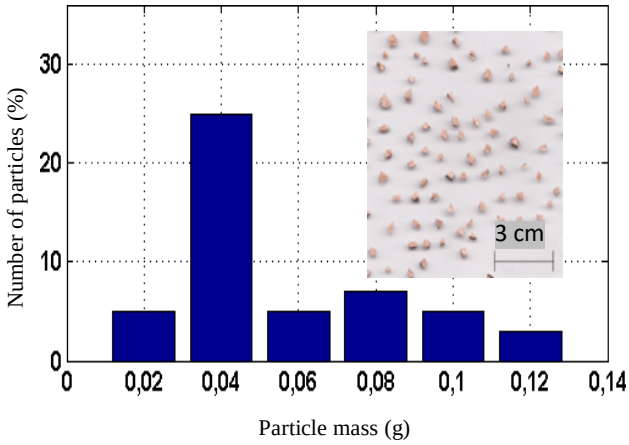

Figure 3: Mass distribution of PVC particles

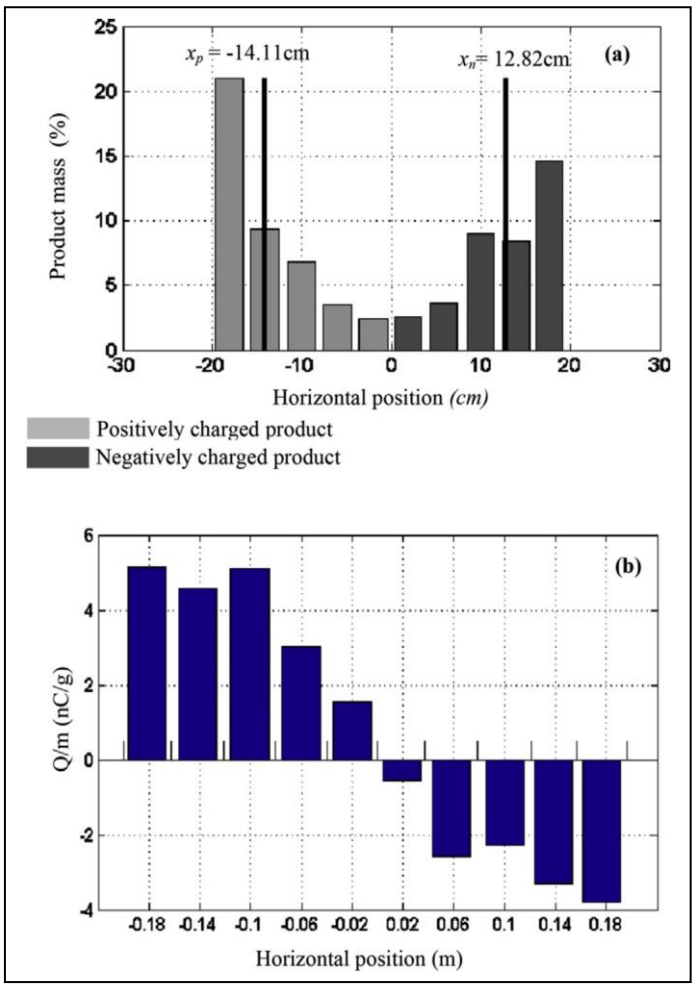

Figure 4: (a): Total weight of the product in the collector cells and (b): Charge/Mass ratio measured in each cell.

By examining the distribution of the mass charge of the product recovered in the cells of the collector, it can be seen (Figure 13) that the product recovered in the vicinity of x = 0 has a very low mass charge compared to the product recovered at the ends of the collector. On the other hand, the positively charged product recovered at the end of the collector has a higher mass charge in absolute value than the negatively charged product recovered at the other end.

Conclusion:

This study aims at the experimental analysis of the connection between the horizontal displacement of the particles with respect to the axis of symmetry of the installation, the intensity and direction of the forces acting on the particles during their movements from the starting point (i.e. the exit of the funnel) to the end point (i.e. the final position of the particle in the manifold)

References:

R. Ciccu, R. Peretti, A. Serci, M. Tamanini, A. Zucca, Experimental study on triboelectric charging of mineral particles, J. Electrostat 23 (1989) 157e168.

R. Peretti, A. Serci, A. Zucca, Electrostatic K-Feldspar/Na-Feldspar and feldspar/ quartz separation : influence of feldspar composition, Mineral Process. & Extr. Metall. Miner 33 (2012) 220e231.
I.I. Inculet, Electrostatic Mineral Separation, RSP Ltd., John Wiley, 1984.

K. Haga, Applications of the electrostatic separation technique, in: J.S. Chang,

A.J. Kelly, J.M. Crowley (Eds.), Handbook of Electrostatic Processes, Dekker, New York, 1995, pp. 365e386.
L. Dascalescu, Electrostatic separation of plastics from industrial wastes, J. Electrostat 25 (2001) 282e288.

I.I. Inculet, G.S.P. Castle, J.D. Brown, Electrostatic separation of plastics for recycling, Part. Sci. Technol. 16 (1998) 91e100.

S. Bendimerad, A. Tilmatine, M. Ziane, L. Dascalescu, Plastic wastes recovery using free-fall triboelectric separator, Int. J. Environ. Stud. 66 (2009) 529e538.

A. Tilmatine, K. Medles, S. Bendimered, F. Boukhoulda, L. Dascalescu, Elec- trostatic separators of particles. Application to plastic/metal, metal/metal and plastic/plastic mixtures, Waste Manag. 29 (2009) 228e232.

M. Zelmat, A. Tilmatine, M. Rizouga, R. Gouri, K. Medles, L. Dascalescu, Experimental analysis of a cyclone tribocharging device for free-fall tribo- electric separation of plastic particles, IEEE Trans. Diel. Elect. Insul. 20 (2013) 1584e1589.