Trial Plan - Delft University Kinetic Gravity Separator (KGS)

Trial host / location: Delft University, The Netherlands

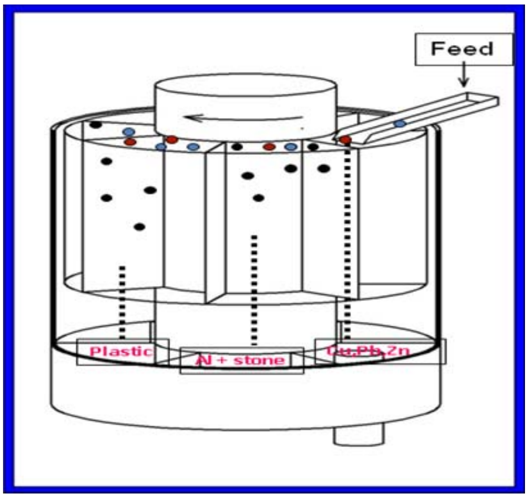
Trial date: 14th- 15th January 2009

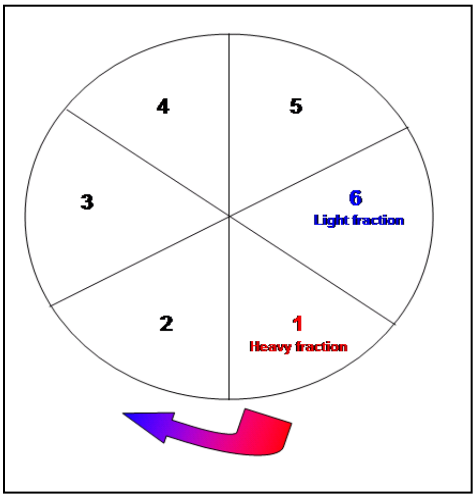
Duration: 2 days

Attendees: Nicola Myles (Axion), Roger Morton (Axion)

Trial contact: Peter Rem, P.C.Rem@tudelft.nl

Trial equipment: The kinetic gravity separator (KGS) is a machine which separates on the basis of terminal velocities in water. In simplistic terms, if there is a difference in the settling velocities of the feed particles, then a separation between them should be possible. The machine is capable of separating the feed material into more than two fractions. It has been used to separate light and heavy non-ferrous alloys in the size range 2-10mm along with various types of plastics. Material which floats in the separator is collected separately.



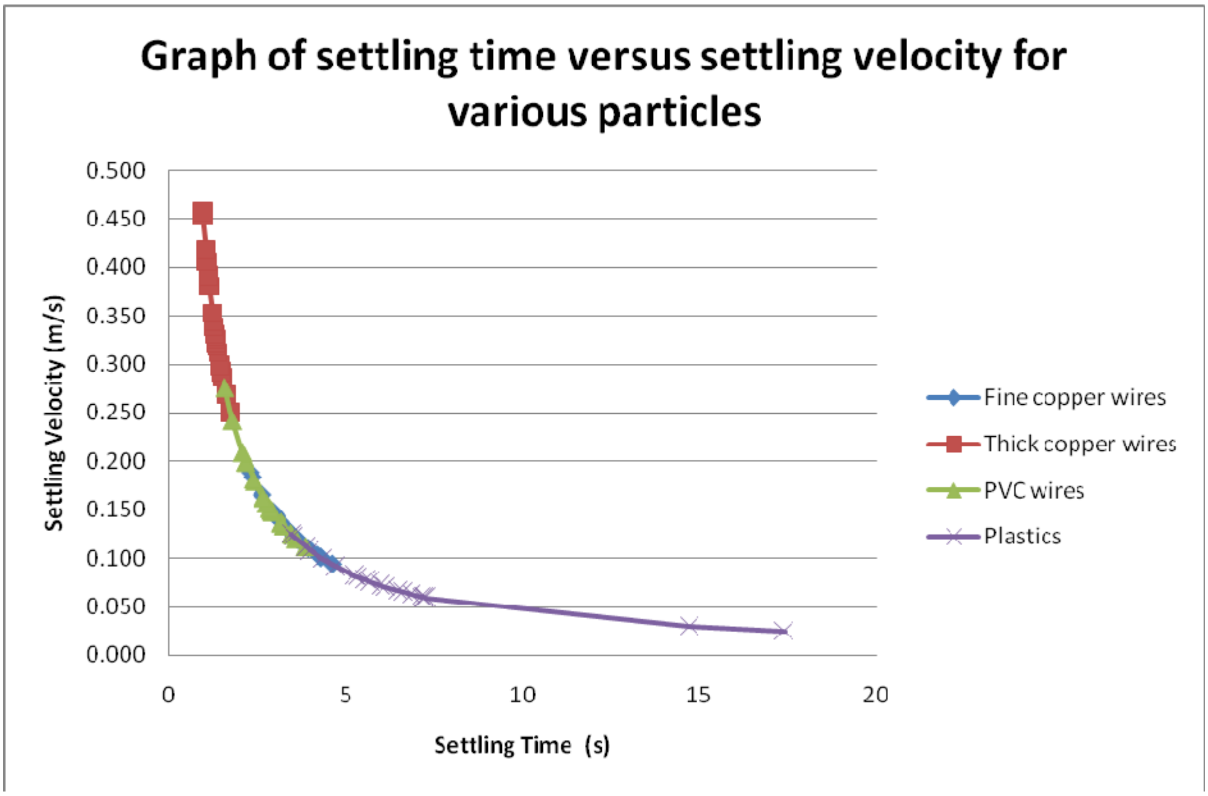


The two diagrams above describe the machine. The left figure shows a cut away side view of the machine. Material enters at the top via a chute. The feed material separates out due to the difference in the settling velocities of the individual particles. The figure on the right is an over head view of the compartments within the separator. Each compartment collects a different fraction. Compartment 1 collects the heavy metals; compartments 2 and 3 collect the heavy plastics and lighter metals whilst compartments 4, 5 and 6 collect the plastics and floaters. The separator can process 1 tonne per hour. In order for the KGS to work properly, it is necessary that materials have both a maximum and minimum particle size where by the maximum should be less than three time the minimum size. For the separation to be effective there needs to be a 10% difference in the terminal velocities of the particles.

The particles fall, from the feeding point to the collection point in the bottom of the compartments, a distance of approximately 1m. The rotation of the unit can be varied from 1 rotation per 6 seconds to 1 rotation per 30 seconds. This means the settling velocities have a range. At the fastest rate of rotation the settling velocities are as follows: 1st compartment >1 m/s, 2nd compartment 0.5-1 m/s, 3rd compartment 0.33-0.5 m/s and so on.

At the slowest rotational rate the settling velocities are as follows: 1st compartment >0.2 m/s, 2nd compartment 0.1-0.2 m/s, 3rd compartment 0.066-0.1 m/s. and so on.

Initial tests were conducted on some of the sample material at Axions laboratory in Salford. The graph below shows the settling time versus the settling velocities of various materials. The thick copper wires mainly have a settling velocity above 0.25 m/s and should be able to be separated from the other material. There is a clear overlap of the settling velocities of the fine copper wires and the PVC coated copper wires and hence separating these into two clear fractions may prove difficult. A separation at a settling velocity of around 0.08 m/s should produce a fairly pure plastic fraction.



The information on the settling velocities will prove useful when adjusting the settings of the kinetic gravity separator to obtain the most effective separation.

Trial objectives: The main objective of the trial is to use the kinetic gravity separator to test a number of separations for which currently there is no satisfactory method. The primary separation to be considered is the separation of metal from other components for various mixtures derived from mixed WEEE.

The following separations have been proposed:

a) The separation of copper wires and metal from plastic to produce a high purity copper stream which could be sold to copper smelters; and
b) The separation of stone/copper/metal from a heavies post granulator fraction. The copper in this fraction is much heavier and thicker than the copper found in the mixed plastics fraction and hence should be easier to separate.

The particle size of the material described above can vary. However, the copper wires tend to be finer than the plastic/stone/glass and can be as small as 0.5mm (diameter) x 2mm (length).

Copper smelters in Europe require a maximum of 5% combustible material in the copper fractions that they process. Non-combustible materials such as stone and glass can be present at much higher percentages

Sample material: The following samples have been chosen for the kinetic gravity separator trial and each sample corresponds to the relevant objectives above:

a) Plastic/glass/copper mixture in the size range 8-12mm, derived from small WEEE separation; and
b) A copper/stone and plastic mixture derived from larger WEEE items. This consists of copper, plastic and stone in the size range 8-15mm. The copper in this fraction is much heavier and thicker than the copper found in the plastic copper mixture and hence should be easier to separate.

Approximately 150kg of each sample is required; both are sourced from Axion's polymer plant in Salford.

Sample shipping address:

Peter Rem

Faculty CiTG, TU Delft

Stevinweg 1

2628 CN Delft

The Netherlands

Trial procedure: Previous work by Delft University with the kinetic gravity separator on similar feed streams achieved lower feed purities than is desired by Axion. Therefore when processing the material it may be necessary to re-work the output which will simulate multistage processing. The trial schedule will need to allow time for this.

a) **Copper/plastic separation:** the aim of this trial is to separate the copper/metal from the plastic. If the separation is successful the copper/metal should be found in the first few compartments whilst the plastic should be later compartments. If necessary the metal rich fraction will be reprocessed to see if the purity can be improved.

For all of the trials the material can be processed while the machine is rotating at different speeds to see what effect this has on the efficiency of the separation. It is likely that Delft will have found optimum set-ups for separation of specific material so this will be discussed with them when on site.

Sampling/results to collect during the trial:

During the trial numerous samples will be taken for later analysis at Axion in order to determine the success of the kinetic gravity separator.

It is proposed that the following samples will need to be collected along with the fraction weights assuming six fractions are produced.

Trial	Input sample and weight	Fraction 1 sample and weight	Fraction 2 sample and weight	Fraction 3 sample and weight	Fraction 4 sample and weight	Fraction 5 sample and weight	Fraction 6 sample and weight	System Set up
(a) Copper/ plastic separation								
(b) Heavy copper/plastic separation								

If trials are repeated with different system set-ups extra rows can simply be added to the table to record this.

Both input and output samples will be analysed at Axion's lab in order to determine composition of the samples.

Small samples of the product streams should be taken during the trials with the remainder of the material being returned to:

Axion Polymers,

Langley Road South,

Salford,

Manchester,

M6 6HQ

Photographs of the trial equipment and samples should be taken for use in the final report. Any important information, for example equipment parameters, which will assist with the analysis of the results, should also be recorded.

Nicola Myles, Axion Recycling, January 2009