Trial Plan - Visys Multi Frequency Laser

Trial host/location: Visys, Belgium

Trial date: 24th February 2009

Duration: 1 day

Attendees: Nicola Myles (Axion), Phil Mutsaerts (All Controls)

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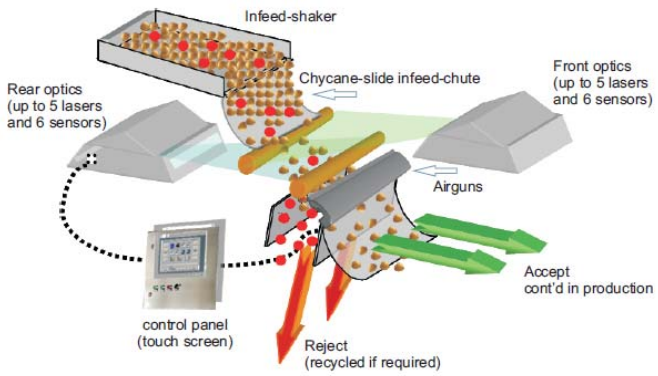
Trial equipment: Multi Frequency Laser
The Visys digital laser sorter has been trialled by Axion before. The equipment consists of up to five lasers and six laser detectors. Two specific features of the Visys system are the 'Chycane slide in-feed chute' and the fully digital operation. The fully digital operation of the system makes it more versatile and easier to use than other laser sorters as it has the ability to be programmed. A combined sort on colour, surface structure and shape can be done. The system can be configured to operate with different numbers of lasers and sensors. Items such as stone, glass, wood, metal and plastic can all be identified and ejected. The five lasers produce different wavelengths in order to identify characteristics 'signatures' for specific materials.

The sensors can detect not only the level of reflection from a particle, which can be used to sense colour, but also the amount of scattering. From this, different properties of the material can be identified. The identified material is ejected from the bulk flow of material by air jets as typical of other sensor-based sorting equipment. The feed mechanism to the system is important. It consists of a shaking feed tray which smoothly deposits the material onto a 'chycane-slide chute'. The material flows off this and passes through the lasers. The system also has the option to use front and rear optics. This means that as the material leaves the chute both sides of it can be scanned as the material is 'in flight'. The figure below shows a diagram of the unit.

Chycane-slide working principle:



Trial objectives: There are a number of trials to be run on this piece of equipment. The specific objectives are set out below:

a) **Fine wire separation:** This will be done on smaller particle sizes (12mm) but there may be an issue with the resolution of the equipment. The successful separation of WEEE plastics streams contaminated with fine copper wire is proving very difficult to achieve. Being able to recover the copper fraction would not only result in a valuable copper stream but would also cause fewer problems in downstream processes. Therefore the feasibility of removing small copper wires on the laser sorter will be tested. There are several different streams that this could be performed on ranging in particle size 2-5mm to 10-12mm.

b) **Polymer type identification:** The proposal is to set up the lasers to identify particular polymer types however this requires further discussion with Visys as they have had limited success in this area so far. During the trial we would like to explore whether it is possible to choose a combination of laser frequencies which give a characteristic frequency which allows the sorter to distinguish between some of the polymer types found in WEEE. The aim is either to demonstrate that such separations are feasible or to understand why it is not possible on the equipment. The main polymer types for identification are PS, ABS, PP, PE, PC and Nylon. The most useful separations would be to remove PP, PE, PC and nylon from ABS and HIPS or to separate HIPS from ABS. The possibility also exists to look at using a specific frequency laser to try and identify different polymer fillers for example Glass or Talc. The sample material for this test is 12mm granulated particles after pre-separation to produce a styrene-rich polymer mixture in Axion's WEEE recycling plant at Salford.

c) **Rubber separation:** The equipment can identify hard and soft surface types. Tests on both 30mm shred particles and 12mm granulated particles after separation will be conducted. Because "elastomer" type polymers generally have a matt surface finish and styrenic polymers have a glossy finish, the proposal is to try using the laser sorter to exploit this difference as a basis for separation. It seems Visys have had some success on this separation on a mixture of black rubber and black rigid polymers but the suggestion is to test this separation on a mixed colour stream containing many different polymer types. The target polymers would essentially be all elastomeric polymers as these often pose problems when compounding recycled polymers and so it is beneficial to remove these before compounding. Questions over the feasibility of this test exist and the possibility exists that the mixed colour stream will interfere with the separation.

d) **Circuit board identification:** This trial will be conducted using shred particles of 30mm size. A previous trial of PCB separation from shredded electronic scrap has been performed by Axion on the Visys unit with pleasing results. For this reason, a full throughput rate trial on this separation is going to be performed along with a more controlled test sample.

Sample material:

Based on initial discussions with Visys pre-trial samples have been shipped to them for assessment and use in training the lasers to identify the specified material.

The pre-trial samples are as follows:

a) 3kg of copper rich PVC;
b) 3kg of PS11 for polymer type identification with samples of FTIR identified polymers included to help train the machines - these included ABS, PS, PP and PE;
c) 3kg of rubber waste from rubber sorter with handpicked samples of 'foamy/soft' rubber and 'solids/hard' rubber to help train the machine to identify these; and
d) 3kg of ECS throws from WEEE processing for PCB separation (Note: this material was not available to send for pre-trial analysis but may still be considered for the full scale trial if it becomes available).

The results from the pre-trial testing indicated that removal of rubber, polymer type separation and copper wire removal were all beyond the scope of the machine in its current form. Visys is conducting research at the moment to deal with these separations but it would not be possible to trial the unit with these materials. Therefore the trial plan was adjusted and only PCB removal will be addressed.

The following samples were sent:

1. Shredded WEEE from SWEEP 'as it is';

2. The magnetic fraction from the SWEEP WEEE being passed over a rare earth magnet;

3. The non-ferrous fraction for the SWEEP WEEE being passed over an eddy current system; and

4. A specially mixed sample of WEEE plastic with a high concentration of PCB's. The idea behind this sample is that the SWEEP WEEE had already been processed and had some of the circuit boards removed, so this test will see how good the machine is at removing PCB's from shredded WEEE which has not being processed with any other equipment.

Sample shipping address:
Visys NV Clean Tec Sorting

TAO Pieter Willems

Kiewitstrat 242

3500 Hasselt

Belgium

Trial procedure:

The material was sent to Visys prior to the trial so they should have been able to tune the lasers to remove the circuit boards.

Each of the fractions will be processed in turn to remove the circuit boards.

If there is enough material various machine settings could be tested.

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 multi frequency laser.

It is proposed that the following samples will need to be collected along with the weights.

Trial	Input Material	Reject Fraction	Accept Fraction	Input Weight	Reject Weight	Accept Weight
(a) PCB separation						

The samples both input and output will undergo analysis at Axion's lab in order to determine the composition of the samples.

The product samples will be hand sorted to determine the compositions.

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

During the trial photographs of the equipment and samples should be taken for use in the final report. Any important information which may assist with the analysis of the results should also be recorded.

Other information:

Nicola Myles, Axion Recycling, January 2009