Trial plan - RTT NIR

Trial host/location: RTT, Zittau, Germany

Trial date: 3rd February 2009

Duration: 1 day

Attendees: Nicola Myles (Axion), Mike Bennett (Axion), Helen Whitehead (WRAP), Lucy Keal (WRAP)

Trial contact: Ernie Beker, beker@unisort.com , +49 6104 6657 61, Gerd Brinckmann, Brinckmann@rtt-zittau.de +49 3583 54084-0

Trial equipment: The RTT equipment is a near infrared (NIR) separator for plastic sorting of granulate or flakes of particle size 5-20mm. The sensors within the equipment detect the characteristic infrared spectrum of light reflected by an illuminated object. The NIR spectrum of each material is unique and hence the detectors can identify specific materials and separate them from the bulk flow of material. The machine can be programmed for different sorting criteria. The machine requires a vibratory feeder. The material is delivered to the NIR detection area via a sorting chute. As they pass down the sorting chute the unwanted particles are identified. When a material which needs to be removed is detected, air jets are activated at the correct time and location to eject the unwanted material from the product stream once it has reached the end of the chute.

Trial objectives:

There are several specific objectives for the trial:

a) Investigate the effect of particle size distribution on the efficiency of the sort. The aim of this is to determine and quantify how well the machine performs on different size fractions. Ideally this trial should be kept fairly straight forward to ensure that it is the size distribution which is being assessed and not, for example, material colour. From the results of the trial it should be possible to determine whether screening the material before passing it through the NIR yields a better separation along with the minimum size limit for efficient identification

b) Test the limits of darkness of particles before the NIR stops identifying them for a range of different polymer types.

c) Identification and ejection by polymer type from a mixture. This is to test if a separation such as PS from ABS would be possible. May try the separation of filled PP, which is classified as a contaminant, from the mixture. Filled PP may have a detrimental effect on the final polymers physical properties when it is extruded hence being able to remove it would be beneficial. Post separation analysis of the results will be conducted at Axion's lab to assess the success of the separation.

d) Identification and ejection of minor impurities which includes nylon, silicone rubber, polycarbonate and PMMA.

Sample material: A number of different samples for the trial are required in order to test the various objectives listed above.

The following samples have been chosen:

a) 3 x 30kg samples (all white material)
    1) Sub 6mm 90% PS / 10% PE
    2) 6-12mm 90% PS / 10% PE
    3) Unscreened 90% PS / 10% PE

Note of how samples (a) were produced:

Firstly white fridge material (PS01) was granulated and sieved at 6mm.

White PE (virgin material) was then granulated. This was then spiked into the PS01 sub 6mm and over 6mm fraction to give a 10% fraction of PE in the samples, (a1) and (a2).

A sample of unscreened PS material was spiked with 10% PE, (a3).

b) 9 x black sample plaques of PS and PP prepared by Axion's lab - samples were prepared by the addition of 0.5% to 5% black master batch to virgin PS and PP in 0.5% increments.

c) 250kg of PS11 (for PS/ABS separation after contaminant polymer removal).

d) 250kg of PS07 (for contaminant polymer removal).

Sample shipping address:

RTT Systemtechnik GmbH

Mr Gerd Brinckmann

Hirschfelder Ring 9

D-02763 Zittau

Germany

Trial procedure: With agreement of RTT two initial samples will be sent over, these are 20kg of PS11 and 20kg of PS07. The sample material has a particle size range of 4-12mm and is mostly mixed chips of HIPS and ABS with impurities of nylon, PMMA, silicone rubber etc. RTT will evaluate the material and run some initial tests on these samples to give Axion feedback on whether or not a full trial should be arranged. Based on successful analysis and feedback suggesting a full scale trial should go ahead the trial plan is as follows.

a) **Size distribution:** To investigate the effect of particle size distribution on the sort efficiency samples with particles at various sizes were required. Specific samples have been made up for this part of the trial as explained above. The intention is to run all three samples (a1, a2, a3) through the NIR machine which has been set up to positively eject the PE from the binary PS/PE mixture.

b) **Black PP and PS**: The investigation of the limits of detection of black material before the NIR stops identifying the material is quite a simple test. A range of different polymer plaques have been made up which includes numerous black

samples of PS and PP to show the scale of blackness. All of the plaques will be placed in front of the NIR sensor to see if it can detect them.

c) **PS11**: The trial to test the identification and ejection by polymer type relates to sample (c). If time allows the sample will be run through the system to remove contaminants, such as nylon, silicone rubber, polycarbonates, PMMA and filled PP. The material will then be passed through again to separate the ABS and PS. If time is tight the contaminant removal step will be skipped and the PS/ABS separation performed on the sample as it is as this is the priority for this part of the trial. May also consider investigating a colour separation where the machines ejects all colours and not black or white. This is based around the idea all colours are ABS but some ABS is black so the success of this separation is doubtful and is also time dependent.

d) **PS07**: The final part of the trial will be to identify and eject minor impurities. Sample (d) is PS07 which contains impurities such as nylon, silicone rubber, polycarbonate and PMMA. The sample will be run through the machine with the objective being to remove all of the contaminants.

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 NIR technique.

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
a1 (Size Distribution)						
a2 (Size Distribution)						
a3 (Size Distribution)						
B (blackness level)						
c (PS11 PS/ABS separation)						
d (PS07 contaminant removal)						

Both the input and output samples will be analysed at Axion's lab.

The size distribution of sample (a) is known as this material was specifically created for this trial. Analysis will need to be done on the reject and accept fraction to determine the

composition of PE and PS in each fraction along with measurement of the size distribution of the product.

For trial (b) the level of blackness of the plaques is required. A standard scale of blackness will be purchased for the trial. In this trial the detection limit of the machine will be correlated to the level of blackness of the samples.

For samples (c) and (d) the composition of the PS11 and PS07 feed material must be analysed in detail. This will be done by using the FTIR machine at Axion's lab. Approximately 400 chips from each sample are required to give a guide to the ABS/PS ratio. According to statistical analysis by Axion this ratio can be stated with confidence limits of 95% at an expected ABS content of 25% and an error of +/- 3.8% for PS11. For PS07 the ABS content is expected to be approximately 30% so with a confidence limit of 95% the error is +/- 4%. The percentage of black particles within the PS11 and PS07 samples will also be determined by a hand sort. This data will be added when it becomes available.

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, November 2008