Modification of a Packaging Sorting Line - concerns and difficulties

CONTACTS

- Dinis de Sousa, Director, Valorsul, Lisbon, Portugal, dinis.sousa@valorsul.pt, phone: 00351 21 953 59 44, Fax: 00351 21 953 59 69
- Hugo Firmino, Head of Department, Waste Sorting Plant and Drop off Site, Lisbon, Portugal, hugo.firmino@valorsul.pt, phone: 00351 21 754 22 51, Fax: 00351 21 754 22 59

EXECUTIVE SUMMARY

Valorsul is the company responsible for receiving and processing the municipal solid waste produced and collected in five municipalities, in the North Lisbon area. This area has 1 168 650 inhabitants and occupies of 596 km2.

In 2000-2002, it was designed and constructed the packaging sorting line of Valorsul, with a processing capacity of 1,8 ton/hour, allowing the separation of the selective collected dry waste by materials and the guiding by type, in compliance with the technical specifications demanded by the Green Dot system.

Considering the increments verified in previous years, and the estimates of growth of the collected and received materials in the sorting line, dedicated to the flux of plastic and metal packaging, higher than capacity initially installed, it was prepared a tender for the modification of the line to increase the nominal capacity to 4, 5 to 6 ton/h.

The modification of the line was concluded on 2002, and is from that time running in industrial mode, with a capacity of 4,5 ton/h, with satisfactory efficiency and quality.

Considering the existence of other similar installations for selection of packaging waste, that cannot guarantee the capacity of processing of all the waste received, and reaches the saturation of their capacity, the aim of this presentation is to share the process of modification including the automatization of sorting, enhancing the problems that will have to be identified in projects of resizing of sorting lines.

The main project assumptions to be considered, of course depends on the characteristics/composition of the incoming material, in the sorting line, which may change significantly the type of equipment and the flowchart. There are basic principles, which should be taken in account in a preliminary draft stage, namely the followings:

- Analysis of the incoming materials (composition, density and quantity), technical specifications establish by the green dot system, and life expectance of the project;
- Provide the adequate reception and storage area;
- Analysis of a solution to the adequate initial sorting, compatible with the voluminous existing in the received material;
- Scaling the inefficiencies associated to the equipments, that can be higher than indicated by manufacturers;
- Provide for the implementation of sorting cabins, in accordance with the appropriate conditions of security, ergonomic conditions, hygiene and comfort, including noise evaluation;
• Ensure possible need of over sorting of materials, especially for plastic film flow. Solutions in this case may pass through a automatic sorting with optical separation or a manual option with a large number of sorters;
• Ensure the proper sizing of suction tubing system, suited to the diameter of materials to suck plastic film with appreciate dimensions, with compatible curves and inspection/cleaning windows;
• Provide a efficient sorting of the non-ferrous metal separator, avoiding contamination of flow;
• Provide accesses to allow security in maintenance works;
• Make a plan for a experimental service period, including the evaluation of efficiency of the implemented solutions (including characterizations and mass balances of part of the process), and perform improvements where needed;
• Definition of adequate legislation to the improvement;

We believe that the automated sorting systems, compared with predominantly manuals solutions, are options that bring productivity increases that can reach an increase of the nominal capacity on 250%, but cannot avoid manual sorting, to overcome the inefficiencies associated to the automatic equipments and guarantee the compliance with the quality of materials to be sent for recycling.

INTRODUCTION

Investment in automation of the packaging sorting line in Valorsul, SA was completed in late 2007, and appeared to be crucial, in order to meet the purposes and goals of the multi-municipal recycling system. The automation of the previous packaging line, highly manual, was a challenge shared by the contractor and Valorsul, from the design till the installation. The fact that Valorsul was once again a pioneer in Portugal in the installation and operation of facilities incorporating new technology in the treatment of solid waste, motivates us to summarize some of the lessons learned from this line modification, to contribute to an optimization of solutions, which are or will be taken by other sorting plant operators for packages flow.

Valorsul is a multi-municipal system created for the treatment and recovery of municipal waste, which serves the North metropolitan area of Lisbon, using an integrated system of processing plants, which treats annually around 700.000 tons of waste. The activity of Valorsul gives priority to environmental education and awareness of residents in areas served by the system, in coordination with local municipality’s services, preventing the production of solid waste and ensuring the proper delivery, to guarantee its recovery.

The treatment processes includes the use of a sorting center (dedicated to the separation of paper/cardboard, plastics, metals and glass), an anaerobic digestion plant (for organic waste, selectively collected within large producers), an energy recovery incineration plant (which receives the in commingled waste) complemented with a bottom ash valorization plant, and finally a supporting landfill for the containment of waste not recoverable.

The collection of all waste flows is provided by municipal services, except for the organic waste which is collected by a service provider, hired by Valorsul.

The packaging material, which is the main focus of this communication, is collected in drop off points, and there is recently a strong increase of door to door collection.
The delivery of materials for recovery in drop off points, or "yellow" points, allows the delivery of plastic packages, carton drinks and aluminum and steel cans. The characterization of the flow shows that the concept of packaging is not assumed by all residents, and there is a contamination, mainly consisting of paper, cardboard, non packaging plastic and organic waste.

MODIFICATION OF A PACKAGING SORTING LINE

The collection of packages started in the early eighties and there were significant increases in quantities from the end of the nineties. Valorsul completed in 2002, the construction of its sorting plant located in Lumiar Lisbon, costing about 9 million Euros, consisting of a pavilion with (120x70) m², an drop off site, a utility building for technical support and an office and social buildings. All these infrastructures are included in an area of 3 hectares, with wooded framework. As shown in the figure 1, half of the pavilion was dedicated to "packaging". The sorting line was initially highly manual, it was used for sorting materials collected by municipalities from the containers available to residents in the multi-municipal intervention area.

![Figure 1 - sorting pavilion](image)

The following diagram (Figure 2) summarizes the sequence of activities carried out to process about 1.8 tons/hour (or in the limit 2.1 tons/hour with lower efficiency of separation of recoverable products) of packaging.

![Figure 2 - diagram of old packages sorting line of Valorsul](image)
It should be noted that the low capacity for initial sorting of the line it was due to its inappropriate design, which not guarantee the processing of the amounts projected, made worse with the poor quality of materials collected.

On the last two years of operation (2005-2007) the manual sorting line was operated in two shifts, with great use of extra work, with the maximum sorters distributed in the line, and also conditioning the preventive and corrective maintenance.

The strong growth rate of the materials collected, the intention to recover waste primarily through recycling, and the need to meet targets indexed to the area of intervention of Valorsul, forced to promote an international tender for the design/construction of the modification/alteration to the packaging sorting line.

The design and delivery of the modification to the packaging sorting line was limited in the following aspects: the area used for the initial packaging sorting (half of the area of the pavilion); the equipment and sorting cabs was to be reuse (if technical and economically advantageous). The tender established as subject a sorting capacity of 4.5 to 6 ton/hour of collected materials with a predefined composition and density. The proposals should also take into account the conditions of operation (air climate cabs, ergonomics job conditions, luminance and noise levels and adequate air quality), the existence deployment of water networks (potable, service and fire) and the restrictions imposed by the civil infrastructure of the constructed building.

The constraints of location, capacity and quality requirements and the penalties provided for failure of the subject of the supply may be among the reasons which have led to only two proposals have been submitted to the international tender, offered by groups not very specialized in this particular field, including constructors/suppliers of equipment designed for the scope of intervention, but both without experience in the exploitation of the sorting facilities.

The award criteria defined before the tender were prioritized according to their weighting:

- Operation cost for the life project - 35%
  (labor, electrical consumption and mobile equipment)
- Processing capacity and efficiency of recovery - 25%
  (evaluation of mass balance; nominal capacity of equipment, technical resources dedicated to quality control)
- technical quality of construction - 10%
  (lay-out, sorting cabin comfort, accessibility for maintenance, design and lay-out of electrical installation, supervision and control, anti-corrosive protection, and processing capacity of equipment namely: ballistic separator, open bags, optical sorters and transporters)
- Execution time - 5%
  (extension of period of execution, and stoppage of the line)

Before signing the contract, it was necessary to redesign parts of the projected plant and find solutions involving the supplier and Valorsul, in order to ensure a more reliable operation.

The modification of the packaging sorting line was designed for a nominal capacity of 4.5 ton/hour, on the area of deployment of the previous line, and included the reuse of the following equipments:
- trommel (with changes to the mesh size of 180x180 mm);
- tow sorting cabs and boxes;
- Electromagnetic separator for ferrous;
- Eddy current separator for non-ferrous;
- Metal press;
- Packages press;
- Conveyors;
- Command and control systems;
- Electrical grid (part) and lighting;
- Drainage network;
- Water and fire network.

The new packaging sorting line implemented over the old line, as previously identified, incorporated the following main equipments:

- 1 bag opener;
- 1 ballistic separator;
- 2 optical separators with double track;
- 1 optical separators with simple track;
- 2 automatic film aspiration systems;
- 1 semi automatic film aspiration systems;
- 1 compressor
- 2 bag filters

Figure 4 –final layout ( new equipment identify with colors )

The final layout and process can be summarized as stated in the next paragraphs:

The packages received in sorting center are stored in an area of about 15x25 m² and a wheel loader feeds the carrier's conveyor, which has a variable speed.

The material reaches the rotary sieve, allowing the separation of all materials in two fractions:
• Small fraction: the part that passes through the rotary sieve (180x180mm), and is directly routed to the ballistic separator;

• Large fraction: which goes over the screen and is sent to the cabin for manual pre-sorting of plastic film, paper and cardboard and bulky products;

In the cabin of the pre-sorting, the large fraction is subjected to a process of manual sorting, where is sort the film-plastic, the paper/cardboard, and bulky products.

The remaining large materials (including bags with packaging materials inside) is conveyed to a bag opener (figure 6) and then to a ballistic separator (figure 7). With the pendulum movement of this equipment the products are separated into three fractions:

• Fine fraction: selected by a mesh of 60mm and sent to containers as refuge;

• Light and plain fraction: sent to the upper part of the ballistic separator and then to a sequence of two automatic film aspiration systems, and then the rest to the line dedicated to paper/cardboard;

• Rolling and heavy fraction: routed to the separator of ferrous metals and then to two optical separators with double valve.
The first optical separator, sorts three types of packaging material:

- drink carton, which is sent directly to the boxes of storage;
- Plastic packages (PET + HDPE), which are sent to the 2nd optical separator;
- Remaining material is sent to the cabin of over-sorting;

The second optical separator (figure 8), segregate the flow into three fractions:

- PET fraction, sent to the cab of sub-sorting;
- HDPE fraction, sent to the cabin of sub-sorting;
- MIX fraction, sent to the boxes of storage directly through fall.

From both fractions, of PET and HDPE, are removed the contaminants by manual over sorting. The PET-OIL packages not recognized by the optical separator as different of other PET material, may be also, manually removed. Others plastic packaging present in those initial fractions is hand sorted to the correspondent conveyer as Mixed Plastics.
The material obtain from the negative sorting in the first optical separator and the contaminants manually removed from the fluxes of PET and HPDE consisting of mixed plastics, non-ferrous metals and other recoverable as PET, HDPE, ECAL, are submitted to another two points of manual sorting where 2 operators choose the recoverable. The material that follows to an Eddy current separator, where non-ferrous metal are automatically separated and sent to the press. The result is sent to a storage box for Mixed Plastics.

The conveyor with all the materials sucked by two automatic film aspiration systems reaches the cabin for positive manual over sorting of plastic film.

Finally in the baller feeding line one optical separator with simple track, does an automatic over sorting of all materials (except film, due to their low density and difficulties in sorting the material), and resend the contaminants, which are recoverable belonging to other fluxes.

MASS BALANCE MAIN DIFFICULTIES

The flowchart described, which can be followed in figure 9, with an input of 4.5ton/hour, and considering the composition arriving the reception in Valorsul, the mass balance obtained, shows the following distribution:

Trommel (mesh of 180mm) – Mesh fall - 60.2%; Pre Sorting Cabin - 39.8%

Pre Sorting Cabin: Bulky material + paper / cardboard - 8.2%; ballistic separator - 91.8% inclines

Ballistic separator with slope of 13º (nominal capacity - 120m3/h): plans and light fraction - 15.7%; rejects - 17.6%; packages - 66.7%

1st Optical separator (infra red system with DUOLINE® scanning technology – width of 1400mm): Fraction mixed plastics + non-ferrous metals - 25.3%; fraction to the 2nd optic separator - 57.7%; Carton drinks fraction - 17%

2nd Optical separator (infra red system with DUOLINE® scanning technology – width of 1000mm): PET fraction - 34.9%; HDPE fraction - 24.5%, mixed plastics fraction - 40.6%
During the start up of the modified line some difficulties has been solved or mitigated and the most relevant are listed bellow:

- **Difficulties in sorting of paper and cardboard**, due to their high presence in the packaging fraction (between 12 to 15%). We have awareness sections to guarantee that the material is deposited on the container dedicated to the Paper and Cardboard;
- **Difficulties in sorting**, in the pre sorting cabin with the semi automatic film aspiration system caused by the film size and closed curves on sucking pipe elements. The film with bigger dimension is putted directly in a container. We also change the curves and are installed inspection points.
- **High presence of carton drinks in the flow of plans and light**, selected in the ballistic separator. Made an adjustment in the slope of the equipment;
- **Strong contamination of the fraction of film aspiration with automatic systems**, with paper and board. We have awareness sections to guarantee that the material is deposited on the container dedicated to the Paper and Cardboard;
- **Contamination of fraction of non-ferrous metals**, with ECAL. Adjustment of the optical separator and manual over sorting. Difficulties not exceeded in full;
- **Clogging of various materials with high dimensions** (blinds, pipes, etc.). Awareness sections. Installed intermediate points, in the fall to guarantee the separation;
- **Efficiency of the optical separator below the projected**. Flow adjustment. Ensure dispersion of the materials in the equipment. Ensure the crushing of packages, problem not resolved yet.
- **Increase of occupational noise**. Cover the equipment.
- **Difficulty of access for maintenance of some equipment**. For the critical points was installed maintenance access and acquisition of loading platform;
- **No plan for characterization of materials** (outputs and intermediate points) complementary to the start, and after the changes that have to be making;
CONCLUSIONS

The main project assumptions to be considered, of course depends on the characteristics/composition of the incoming material, in the sorting line, which may change significantly the layout. There is however principles, which form the basis of any work to develop, should be examined in a preliminary draft stage, namely the followings:

- Analysis of the incoming materials composition, quantity, technical specifications establish by the green dot system, and life expectance of the project;
- Provide the adequate reception and storage area;
- Analysis of a solution to the adequate initial sorting, compatible with the voluminous existing in the received material;
- Scaling the inefficiencies associated to the equipments, that may be higher than indicated by manufacturers;
- Provide for the implementation of sorting cabins, in accordance with the appropriate conditions of security, ergonomic conditions, hygiene and comfort, including noise evaluation;
- Ensure possible necessity of over sorting of materials, especially for plastic film flow. Solutions may pass through a solution manual or automatic screening with optical separation;
- Ensure the proper sizing of suction tubing system, suited to the diameter of materials to aspire dimension and also compatible curves;
- Provide for the efficient sorting of the non-ferrous metal separator, avoiding contamination of flow;
- Provide access to equipment maintenance;
- Make a plan for a experimental service period including the evaluation of efficiency and to perform improvements;
- Definition of appropriate legislation to the improvement;

The principles listed below, may affect the concept and should be adequately pondered according to the composition e quantity of material that we think will income to the line and not forgetting the amount planned to invest.

In conclusion, we believe that the automated sorting systems, compared with predominantly manuals solutions, are options that bring obviously productivity increases that can reach 250%, but which cannot dispense manual sorting to overcome the inefficiencies associated to the automatic equipments and guarantee the compliance with the quality of material sent for recycling.