AN ECONOMICAL & ENVIRONMETAL SOLUTION FOR INCREASING THE RECYCLER'S PROFITS FOR RECLAIMING R-PET FROM DIRTY POST-CONSUMER PET BOTTLES

Presented by: Anthony S. Georges, Vice President,
AMUT, North America.
55 Regalcrest Court, Woodbridge, On. Cda.
905 652 9034

INTRODUCTION

Ladies and Gentlemen I want to take this opportunity to thank the GPEC conference team for the opportunity to discuss with you one of the most environmentally friendly recycling plants that is also one of the least expensive to operate to produce R-PET flakes in the World. It is so unique that just last fall the USA patent office awarded AMUT S.p.A. patents for our wonderful recycling technology. It is a great honor to be recognized by the American Officials for our achievements and to have the pleasure to review the operations of one of our Europe client's with you today.

Today we will be examining the operations of the MONTELLO PET RECYCLING PLANT, located in Bergamo, Italy. AMUT built the R-PET washing plant in the year 2000 and has been in fully operation since 2001. We will have the opportunity to view a short video of the complete operation, and examine the flow of the recycled PET materials, from when they arrive to the factory and to the final storage of the clean PET flakes. We will also review the cost of operating a production plant producing 2,500 Kilograms of clean PET flakes per hour.

Before beginning the video a quick overview of AMUT S.p.A., which was founded in 1958 manufacturing plastic extrusion machinery in the town of Novara, located in Northern Italy. AMUT's success in single and twin extrusion technology was a natural lead in to the recycling industries as plastic materials can easily be recycled. With the recycling sector strongly developing in the 1980's AMUT was a leader in many plastic-recycling processes building its first PET washing plant in the 1980's. With many PET plants constructed around the world and the newest PET recycling plant to be operational in the next few months in Colmar, France for Freudenberg, our recycling technology continues to be accepted as the world leader. AMUT designs, manufactures and sets up the whole recycling plant for PET and have developed the complete patented recycling technology.

AMUT has three large fabricating plants in Novara and has recently opened its new office and support facility in North America. The annual turn over of AMUT is approximately $70,000,000 US. We manufacture not only recycling plants, but single and twin extruders, for sheet, profile, pipe and even shotgun shells at both Remington/Olin and Winchester in the USA. In 2000, we developed our thermoforming technology and now can supply complete in-line systems for up to 9-layer sheet extrusion and thermoforming to produce packaging with R-PET flake. We have approximately 1,000 extrusion lines operating in North America.

1. DESCRIPTION OF THE PET RECYCLING SYSTEM TECH NOLOGICAL FLOW AND OVERVIEW

The dirty PET bottles, which supply the AMUT patented washing plant, are from urban and industrial collection sites that are pre-sorted, but still have other Non-PET containers, such as PVC, HDPE and PP bottles. They are transported in compressed bales.

In the first stage of the process, requires that the bales of bottles be conveyed into a storing tank. The bottles and the pieces of bales are conveyed into the "Pre-Wash Unit" screened cylinder (AMUT patent) where the dirty bottles are subjected to a hot water wash. This stage breaks up the bottles from each other, frees smaller particles of dirt, glass pieces, waste material, will be detach and be removed with most of the bottle labels. These waste materials or pollutants, are collected, along with other impurities, and are automatically conveyed to a discharge system for waste removal to the exterior of the building.

With a pneumatic transport system, that also removes excess water from the bottles' surface, the bottles are transported through a metals separator and then, to a belt conveyor for the visual control. The bottles are then stored in the "Constant Feeder" which ensures continuous & constant feeding of the bottles to the to downstream stages.

The "Constant Feeder" is equipped with a special extraction belt that has electronic loading sensors whose function is to supply through a weighing system the bottles stream by adjusting the feeding capacity to the detection section, a constant and consistent flow of bottles.

From the constant feeder, the bottles flow continuously towards two NIR electronic control stations in series to sort out other contaminant polymers which double checks the bottle stream and removing all Non-PET bottles. The NIR detector has the possibility to separate not only PVC but also other unwanted polymers bottles. Both the detectors, through a pneumatic ejection system reject the materials identified as PVC or Non-PET.

After these two detectors there is also installed a metal detector which automatically separates the ferrous and not ferrous metals. The inspected and selected bottles are then conveyed to the wet grinder able to produce flakes.

A trap system placed under the grinder removes the all particles heavier than the PET flakes, while the PET flakes are pumped to a flake and paper separation system. The paper is dragged out with the water and separated through a filter.

The flakes are then conveyed to the pre-floatation step to separate and remove the majority of the Polyolefin particles, the residual paper labels and the floating pollutants, before reaching the final PET flake washing stage.

Through-out the pre-flotation it is particularly important to avoid dissolving some substances such as inks etc., with the aim to keep the PET FLAKE and wash water as clean as possible for the next critical stages. The perfect cleaning of the PET flakes from the remaining pollutants is therefore essentially concentrated on the removal of various impurities that are still stuck to the flakes. The system must therefore remove any remaining labels, various impurities, by detaching them from the flake and removing the glue while preventing their re-distribution on the cleaned PET flakes.

All these important functions are perfectly performed by a single machine, the FRICTION WASHER (AMUT patent). This Friction Washer machine also has notable savings towards installation and operating costs, focusing on reducing fresh water consumption, limiting the amount of chemical used for washing the PET flakes and recuperating the heat energy of the wash water.

In the Friction Washer the heating of the wash water is indirectly made by steam, and the flakes are subjected, at very high temperatures, to a strong but

non-destructive friction action, which causes the reduction to pulp of the labels and the removal of the glue. Utilizing a strong stream inlet of hot water at the required temperature, the Friction Washer, removes these impurities while preventing the glue redistribution on the clean PET flakes. For the complete cleaning process to succeed it is therefore necessary that the temperature requirements in each machine section be precise while being able to adjust the friction intensity, and the duration time that the flakes remain in the Friction Washer. All these operations are accomplished continuously and automatically through the computer control system.

Another floatation tank removes any impurities lighter than water, as the clean PET flakes exit the Friction Washer, such as, the PE caps and labels. The flakes then pass through the final fresh water centrifugation rinsing system, which eliminates caustic soda residue.

A final hot air drying system removes the humidity. A final sieve selects the material at the required size, while any oversized flakes are transported to the final grinder to meet the specifications. A de-dusting system removes the fine particles, while a metal detector placed after this unit identifies any metal traces. The flakes are then transferred and stored in silos, before the final packing or further processing.

A Waste Water Treatment (WWT) system for the processing of the dirty water (AMUT patent) is strictly linked to our recycling technology. The WWT system allows the re-use of the process water within the limits of salinity, pH, COD and BOD and to ensure a good operation of the plant, with the aim to minimize the consumption of fresh water and reduce the amount of wastewater to be treated.

The key to minimizing the water consumption is to have the fresh water only introduced into the system at the final Flake rinse stage in the centrifuge. The wash water flows back through the different washing stages and is loaded by the impurities that are dissolved or brought in suspension. A series of ‘Closed-Looped Filters’ installed throughout the line at each washing stage eliminates the suspended bodies and allows for water recycling.

In particular one of the ‘Closed-Looped Filters’ allows the re-use of the water containing the glue that has been detached by the temperature and friction action in the Friction Washer. The structure of the filtering material

and the special filtration system retains the glue, recycles the wash water while minimizing the heat losses.
This gives a reduction of the operational costs for the plant management while obtaining the best quality material. The heating of the water, if necessary, is made by low-pressure steam, always in an indirect way, and allows for the recovery through condensation.

This process focuses on the careful recovery of the thermal energy through heat exchanger systems, further reducing operating costs, energy savings and consumption of water.

To minimize the amount of direct labor involved in the complete washing process, no manpower is required for handling any waste materials collected from the different process stages as they are automatically managed. Waste materials from the various filters are automatically collected through a screw conveyor and discharged in a wet form into stationary or movable bins. The PVC bottles rejected by the detectors are conveyed to the belt for the manual control in order to recover the PET bottles that have been rejected together with PVC bottles.

The plant is put in operation and controlled from the control room by means of a computerized system interfaced with the PLC of the plant power cabinet. Electronic synoptic PC, on the Siemens control program, displays the Layouts, the functioning conditions of each component of the plant (machines, solenoid valves, limit switches, thermo-controls, weighing systems etc.), alarms page with data storage, lubrication page, page of the technological parameters that can be changed from keyboard, recording (clear or protected) of temperatures, amps absorption, productions, & chemicals. Possibility of direct phone-assistance by modem with dedicated telephone line.

The complete washing plant to produce 3,000 kilograms of clean PET FLAKES per hour and covers a total area of about 30 yards x 50 yards.

2) DETAILED DESCRIPTION OF THE DIFFERENT SECTIONS

PRE-WASHING SECTION

FEEDING AND OPENING OF BALES
Section A

The feeding of the washing plant begins by cutting the bindings of the dirty, sorted PET bottle bales which will be fed on to the first loading belt which can be located on the factory floor, in a pit, or a different position, according to the Customer's requirement. (The video presentation will examine the "PIT" version.)

This feeding system to the Pre-Wash unit, is as automated as possible by means of an automatic measuring device that determines the weight loss and automatically supplies the complete system with the required flow capacity avoiding any over-or underfeeding. This automatic measuring system is installed on the "Constant Feeder" loading belt, and is controlled by, the filling level of the "Constant Feeder" which is located downstream from the Pre-Wash unit.

From the first loading conveyor belt with steel cleats, the dirty sorted PET bottles are loosened from the compressed bales and hoisted by a second belt onto the hot water de-baling screened drum that will open the bales completely, including any compressed blocks of bottles that may still exist, and assist in the removal of labels from the bottles.

The drum feeding is in two parts, which ensures better de-baling as the compressed bottles pass from one part to the next section of the drum.

ROTARY PREWASHING SCREENED DRUM
Section B

The bottles are conveyed to a screened rotary drum, which loosen, by hot water showers the compressed bottles, removing most of the labels and eliminating most of the small crushed parts and waste matter. The removed labels and the small impurities are extracted together with the washing water. The dirty Pre-Wash Water flows through its own special 'Closed-Looped' filtering system for continuous separation of the suspended

particles and then the filtered water is recycled after it has again reached the pre-set washing process temperature.

The extraction holes in the screen located in the first part of the 'Pre-Wash' unit are designed to prevent the passage of the bottles even if they are badly crushed or the small, but allow the detached parts and small waste matter to pass through. Furthermore the opening shape is designed to facilitate the extraction of the detached labels. The bottles then pass over a second screen in the second part of the 'Pre-Wash' drum.

The whole drum is perforated and the bottles are never immersed in the water, therefore the dirty bottles are only an externally washed. The washing is made by hot water with an indirect steam inlet to avoid water consumption. The washing water is not held in the system, but on the contrary, the pre-wash system provides a fast flowing with an immediate outlet to the 'closed-looped' filter.

MANUAL INSPECTION STATION
Section C

The exterior washed bottles move from the rotary 'Pre-Wash' drum by a pneumatic transport system, which removes the excess water on the bottles' surface. The bottles are transported through a metals separator and then, to the manual control belt, where one or two workers will remove the foreign items that could be still present in the bottle stream. (The second visual inspectors might be necessary depending on the quality of the sorted PET Bales.)

Bottles that have been rejected by any of the downstream automatic Detectors are sent back to this dedicated portion of the manual control belt. In this way the visual operator can recover any of the PET bottles that have been removed with the bottles identified as PVC or NON-PET containers, to minimize the loss of good quality PET bottles.

BOTTLES STORAGE AND DOSING SECTION
Section D

STORAGE IN THE "CONSTANT FEEDER"

The exterior washed inspected bottles will fall into the storage and dosing container, the “Constant Feeder”, consisting of a conveying and extraction belt with high side panels, having the following functions:
- Accumulation of the bottles to allow the occasional interruption of the feeding from the de-baling and pre-washing screen or from the control belt. To prevent any loss in the throughput of the automatic sorting and washing equipment;
-Supplying the correct quantity of bottles to the automatic detection line.

The flow of bottles is controlled by the extraction belt speed. The speed is determined by, the automatic weighing system installed on the belt, which also automatically controls the first feeding belt to the de-baling drum by means of the load sensors system that detects the weight of bottles feedstock in the “Constant Feeder” and establishes the stop and start operation. This automatic control system ensures a smooth, well regulated and automatic feeding throughout the detection and all washing stages.

METERED FEEDING TO THE AUTOMATIC SORTING SYSTEM

From the "Constant Feeder" the belt extracts the bottles at a pre-set throughput rate. The extraction belt’s speed is adjusted by monitoring the weight of extracted bottles, performed by a control system placed on the same extracting belt. The extraction belt from the ‘Constant Feeder’ will supply a continuous flow of the bottles to the automatic Detection systems.

DETECTION SYSTEMS
Section E

POLYMERS NIR Detection

The electronic control system is performed by two NIR detectors placed in series and will separate all kinds of polymers, which are not PET (PVC included).

The bottles are exposed to the near Infrared light and consequently selected (PET or not PET) according to the specific characteristics of the thermoplastic. The PVC and non- PET identified bodies will be sorted out

by both detectors through a pneumatic ejection system that is focused on the target bottle to minimize the number of PET bottles that might be ejected.

All the ejected bottles are transferred back by conveyor belt to the manual inspection station to eliminate the PVC and non-PET bottles. As an alternative to the manual inspection, a NIR polymer detector can be used.

METAL DETECTOR

In series with the above detector systems, a metal detector has been installed. The metal detectors can identify the presence of small metallic parts (also aluminum) and remove them by utilizing the ejection system.
Both the ejected bottles with metallic parts inside and any good bottles are transferred back by the conveyor belt to the manual inspection station, for the recuperation of any good PET bottles.

Sometimes small metal parts cannot be seen or removed by the manual inspection, and a second metal detector is placed on this belt to eliminate the metal polluted bottles only.

PRODUCING THE PET FLAKES CLEANING SECTION
Section F

GRINDING
The cleaned exterior sorted PET bottles are now automatically conveyed to a special grinder used to reduce the bottles to flakes about 20 millimeters in size. This grinding operation is down underwater. In this stage there is a first efficacious cleaning of the Flake material, thanks to the natural action of the wet grinder and the presence of the water.

The grinding stage consists of two ‘Wet Grinders’, each wet grinder is capable to grind up to 2,500 Kilograms of bottles per hour input, that works out to approximately 2,000 Kilograms of Flakes per hour for each wet grinder of final washed flakes. Therefore for our washing system, both wet grinders are working in parallel to produce flakes, grinding about 3,600 Kilograms of bottles per hour and consequently they are working at 75 percent capacity level.

We recommend over sizing the wet grinding section because our experience has demonstrated that the knives of the two wet grinders shall require sharpening every 8 days. The knives maintenance of one wet grinder for the sharpening is approximately six hours. During this six-hour period, the second grinder will operate at maximum capacity level to produce approximately 2,000 kilograms of flakes per hour.

In this example, the net production loss is approximately 1,000 Kilograms of cleaned high quality PET Flakes for 12 hours, instead of 3,000 Kilograms of cleaned high quality flakes for 6 hours. The total gain of Flake production with two wet grinders is approximately 6,000 Kilograms for every time the knives substitution (the difference between 18,000 Kilos loss with one large wet grinder and 12,000 kilos loss with two smaller and less expensive wet grinders).

The knives substitutions will occur approximately 45 times every year and therefore the theoretical production gain is 270 metric tons per year.

This recommended wet grinding system, based on our clients' production experience, can be adjusted to suit other client's requirements or specific needs.

FLAKES CLEANING
Section G
Flake grinding and water separation
From the two wet grinders the PET flakes are taken along with the water stream and are pumped to a screw separator, which separates the flakes from water. At this stage most of the waste substances have been reduced to pulp by the grinder and are separated from the PET flakes together with the water.

Utilizing its own 'Closed-Looped' filter system these impurities are placed on the waste conveying system and exit the building along with all other waste material. The filter system allows the water to be recycled.

Flakes pre-wash and first floatation separation
Before conveying all the flakes to the intensive washing, the PET Flakes are separated from the Polyolefin (PO) Cap Flake fraction, the remaining paper and any others floating substances.

This operation will take place in a pre-washing trough. The substances removed during the pre-floatation are pumped into another 'Closed-Looped' filter system for their separation, and set aside as wet material which can be further cleaned by its own PO Flake wash system (optional) or stored and sold as dirty PO material.

The filtered water is then recycled.

Glue separation and frictional washing
"FRICTION WASHER" AMUT Patented technology
At this point we have removed almost all, PVC, PO, labels, dirt and other waste matter, and are left with PET Flake. To obtain the perfect final cleaning of the flakes it requires that essentially the removal of any residue of labels, along with the hot separation and removal of the remaining glue together with the separation and removal of other impurities that are still stuck on the flakes.

The FRICTION WASHER performs all the above functions in one unique flake washing machine, while saving operation costs, by reducing the amount of water, chemicals and heat lost needed for the full treatment.
In the Friction Washer, the flakes are subjected to an intense but non-destructive friction action at high temperature and by monitoring the exact percentages of the cleaning chemicals, through our computer program system this washing process reduces any remaining labels to pulp and the hot water removes any glue on the PET Flake by melting.

It is possible also to adjust both the friction action power, and the residence time of the flakes during the treatment.

The whole washing process is continuous and automatic. The strong flow of hot water removes any remaining pollutants. The hot water temperature is always kept constant therefore the glue is held in suspension in the hot water flow and is eliminated before any possible chance of adhering to other cleaned PET flakes.

The dirty wash water exits the Friction Washer containing the impurities, especially the glue, and is cleaned through its own special 'Closed-Looped' filter system and the filtered water will be recycled after its re-heated in the

heat exchangers to counterbalance the thermal losses. This unique filter system removes the glue from the wash water.

The glue sediments is captured on the filter which is at a moderate temperature, as heat exchangers ensures the cooling of the dirty wash water coming from the friction washer, while heating up the filtered water of the Rotary Pre-Wash Screened Drum at the first stage of the bottle washing plant.

Water-steam exchangers installed in the plant heat the wash water (see water treatment section) and reduce the amount of energy costs required to heat the water.

Rinsing

To avoid that glue sticks again on the flakes coming from the Friction Washer, an intensive rinsing system with hot water has been adopted. This system is obtained by allowing the material coming from the extraction screw of the Friction Washer pass in to a second screw - in a very hot water bath - in continuous renewal.

The rinsing action also takes place in the extraction screw of the Friction Washer where water, coming from the rinsing unit against the current of the material, flows out. These hot rinsing operations besides avoiding the glue from reattaching again, removes most of the caustic soda off the cleaned PET flakes, reducing drastically the flakes' pH.

The PET flakes' pH value will further decrease in the floating and rinsing trough, as well as in the final centrifuge rinse.

Floatation

The flakes are then sent to the final floatation stage, where any part lighter than water is removed from the cleaned PET flakes since the PET flake will sink.

The lighter materials, such as the PE and the remaining paper labels reduced to pulp, are separated from the surface of the troughs and pumped to a suitable "Closed-looped" filter to retain these impurities (set aside as wet material) and the filtered water is recycled.

Centrifuge
The cleaned PET flakes are then conveyed to the centrifuge for the mechanical elimination from most of the water. An adequate flow of fresh water ensures the rinsing during the operation.

This fresh water represents the only fresh water fed in to the system and with a series of devices it is recycled in counter-flow to the flakes and the dirty bottles.

Drying
The flakes are then sent to the final grinding by means of a pneumatic system with a hot air stream to dry the flakes to a humidity level of 0.7%.

The dried flakes are conveyed in a constant quantity to the next phase.

FINAL SIEVING AND GRINDING SYSTEM
The flakes are sieved in a three-stage sieve. Only those flakes with a larger dimension than specified by the client, are conveyed to the final grinder to achieve the optimal dimension for the PET flakes. The cleaned sized flakes are then sent directly to the storing system, passing through a pneumatic classifier, which eliminates not only the fines particles, but also the light ones, such as paper fibers and thin films.

The percentage of the flakes to be grind is approximately 10 % of the total flakes. The third stage of the sieve eliminates the fine PET particles, which are conveyed by a screw into a separate storage system, to be than recycled and sold as clean R-PET.

ELIMINATION OF THE METALLIC PARTICLES
An additional safety device, which is located before the sieving system, detects and sorts out any accidental small parts of the ferrous and non-ferrous metals.

STORAGE OF THE CLEANED DRIED PET FLAKES
Section H
The material handling system for the cleaned dried PET flakes to the holding silos, the transfer system of the flake to final container within the plant, along with the construction of the silos are manufactured by the company ARIOSTEA.

ARIOSTEA has more than 50 years experience in the design and building of complete material handling plants for plastics and chemical industries. They have supplied numerous complete material handling plants in North America, for recycling, compounding and the plastic manufacturing industries for a wide range plastic materials and chemicals.

The newest material handling system for a PET recycling plant will be done in co-operation with AMUT PET WASHING PLANT for the Freudenberg plant in Colmar, France. The new plant is to be operational in the spring of 2005 with a capacity of 3,000 kilograms of clean PET flakes per hour.

WATER TREATMENT
Section I
The patented Recycling and filtration of the process water
The system adopted (and patented) by AMUT focuses on water conservation and particularly the technology of water flow that is necessary to wash the dirty bottles and the clean the PET flakes. The impurities found in the washing dirty PET Bottles post-consumer and post-industrial consisting of:
All types of foreign materials, labels and glue that must be cleaned by water conditioned with alkaline, surface-active agents and antifoaming agents.

To fully remove the glue it is necessary to use hot water. This patented wash system imposes: That the water recycling system, also reduces the energy consumption for the heating the quantity of the water involved and consequently to limit the quantity of chemicals.

The solution: Economical and Environmental
For each washing section of the plant an adequate "Closed-Looped" water filtration system installed within the water circuit. This way the AMUT solution is able to retain the insoluble substances and remove them from the flakes (or from the bottles). The wash water can be re-used even if it is hot.

Being recycle the water will load with the dissolved substances and therefore the salinity (as well as COD and BOD) will rise, but the dissolved chemicals remain active (caustic soda, surface-active agents, antifoaming agents), as they have not been consumed because the pollutants entered together with the dirty bottles, which is the Pre-wash using the dirtiest recycled wash water.

One of the filters is specifically used to eliminate the glue removed in the "Friction Washer" by melting at high temperature and that is emulsified in the treatment water. The unique operation of the filter is based on sucking the water through a panel of filtering material on which it is possible to detain the glue as well other fine particles. The filtering panel is continuously cleaned by a slow driven motion blade, which always gives a clean filtering surface. The retained substances are set aside as wet material sent by automatic conveyor out of the building.

The panel is renewed periodically even without stopping the filtration process. It is therefore necessary to keep separate the water in each of the different plant sections, to have the ability to continuously to eliminate the glue. This allows the water recycling monitoring salinity concentration without the need of a massive renewal of fresh water, which would badly influence the energy consumption and the quantity of conditioning chemicals. Fresh water is therefore introduced only at the end of the plant, i.e. in the centrifuge (the last rinsing operation of the clean PET flake) and will then flow upstream to the Rotary Pre-Washing Screened Drum where is used to wash the dirty bottles at the start of the whole process.

The washing process is further advanced thanks to the careful design of the water circulation system, which allows the complete process to perform with a low water quantity for the different rinsing operations that are sufficient to ensure the full elimination of the chemicals from the final clean flakes.

The perfect performance of the adopted system is certified by the excellent data of the "Delta Color b" test and "Residual pH" test, whose indexes are respectively influenced by the presence of the residual glue and chemicals.

The drastic reduction in water consumption by this patented system reduces the final amount of dirty wastewater sent to water treatment plant (if this plant should be necessary).

AUTOMATIC BY-PRODUCTS RECOVERY
Section J

WASTE MATERIAL
The AMUT washing plant performs the cleaning of the PET bottles and the PET flakes all other substances are considered as pollutants and therefore are considered as by-products. Some of these by-products have a good

commercial value. The washing plant is designed to retain these pollutants on the filters installed on the water circuit and set aside as wet material.

To limit the handling of these materials and to automates the plant, the design of the plant allows only one screw-conveyor and one belt can automatically convey outside into wheeled bins all waste materials from the filters to the exterior of the building.

POLYOLEFINS RECOVERY FROM WASTE CAPS AND LABELS (OPTIONAL)

On request it is possible to supply the machinery necessary to recover the PO flakes, which are only separated in the first pre-floating and rinsing trough. The PO fraction that corresponds to approximately 180 kilograms per hour for a plant with 3,000 kilogram of cleaned PET flakes per hour output. PE flakes coming from the first floating trough are conveyed by means of a screw to a Floating-Decantation trough and into this trough they are pushed under water level by a screw.

Since polyolefin float these are easily separated from the other heavy pollutants that fall on the bottom of the trough. The heavy parts are extracted by a screw and conveyed on the belt for the elimination of the scraps. A water stream generated by a pump, on the trough surface, extracts the PO flakes that are sent to its own centrifuge by means of a drainage screw. Besides drying, the centrifuge allows the extraction of any paper fiber and small and thin dirty parts.

In order to eliminate the superficial moisture, the material is put into thermo-controlled hot air dryer. The evaporated water that is extracted by the centrifuge is put again in the trough directly by the net and the estimated consumption is approximately 30 to 50 liters per hour.

By means of a pneumatic conveyor system the cleaned PO flakes are sent to a filling station equipped with an automatic valve controlled by the level. The Management Control system is done with a proper electric cabinet and the controlled by the supervisor of the general plant, where the relative synoptic is pointed out.

ALTERNATIVE TO THE PO WASHING PLANT

In order to separate only the PO flakes without removing the paper and other foreign matter a conveyor screws can take the PO flakes to loading station

that will be installed instead of the PO flake washing and drying systems. These PO flakes could then be sold at a lower value than the cleaned and dried PO flakes.

AUTOMATIC SEPARATION OF PVC AND NOT PET FROM THE FLOW OF PET BOTTLES

NIR DETECTORS ON THE MANUAL INSPECTION CONVEYOR (OPTIONAL)

The separation of PVC and NON-PET bottles from the main flow of PET bottles often means the accidental removal of some good PET bottles from the main stream of PET Bottles prior to the wet grinder.

To avoid the loss of good bottles, the flow of the ejected bottles is conveyed back to the manual inspection control conveyor. In order to facilitate the task of the operator, it is possible to automate the selection process by introducing a second NIR detector on this conveyor belt, so as to eliminate one of the two control operators do the bottle inspection.

ESTIMATED OPERATING PARAMETERS FOR COST ANALYSIS

For the Cost Analysis (in PowerPoint Presentation only, but available on request) we list the various operating parameters for the adopted engineering system, to point out the necessary components to the economic calculation of the cost of the PET bottles reclaiming plant.

The described aspects are the following and are broken down in their own sub-heading below:
-Material rejected by the process
-Electrical utility
-Water – wastewater
-Compressed Air Requirements
-Chemical products
-Treatment products
-Heat consumption
-Manpower per shift

MATERIALS REJECTED BY THE PROCESS

PET eliminated during the washing process is approximately 2 to 3 %.
The percentage of materials, such as PO, paper, humidity, broken parts, and other inert waste materials is approximately 15%.

As such, to achieve a desired production of 3,000 Kilograms of Cleaned PET flakes; the estimated input of the Dirty Bottles should be approximately 3,600 kilograms per hour.

ELECTRICAL UTILIY

The total installed electrical consumption of the line including all the ancillary equipment is estimated to be 1,200 KW, with about 900 KW being absorbed. This electrical consumption is approximately 0.3 KW/ Kg of cleaned PET Flake.

WATER

All the water involved in the process is continuously treated and recycled so as to minimize the consumption of fresh water of the energy and of the chemicals to treat it. The total washing process consequently includes the filtration system of all the waters through a series of screen and plate filters as well a specifically designed filter with fossil meal panel. Substances that are suspended in the water are easy removed as mud and can be easily eliminate without consumption of water for cleaning the filters. The system is based on the continuous elimination of the insoluble substances carried in the plant by the dirty bottles to be recycled, or those created in the process itself. Thanks to the filtration system even microscopic pollution are deducted.

The water circulating in the system can therefore be continuously re-used because it is kept clean from the suspended substances, while the consequent concentration of soluble substances carry in by the bottles or then added as conditioning chemicals can reach high levels without influencing the washing capacity of the system.

The water consumption of the plant feed by pre-sorted bottles is approximately: 1.1 Liters/kilogram of washed product.

The water consumption is determinate by humidity from the waste, water evaporation in the different treatment stages and then as sewage water to the sewerage system after chemical-physical or biological treatment depending on the characteristics admitted by the sewerage regulation of region. The medium quantity to be destined to the sewerage is therefore approximately 85% of the fresh water usage. The dimensioning of an eventual treatment plant of the sewage water must be larger taking into the consideration the

peaks due to temporarily non-standard feeding or in the event of operation errors.

TREATMENT OF THE SEWAGE DISCHARGE

For Wastewater Treatment, it is necessary to install a suitable plant should the local standards not permit the direct discharge into the sewerage system.

Indicative characteristics of the sewage BEFORE THE TREATMENT:

COD	15,000 milligrams/liter
Bod	7,000 milligrams/liter
S.S. (suspended solids) in the sewage	30 grams/liter
Mineral oil in the sewage	Present
Sewage pH	11 (<0.2% soda)

COMPRESSED AIR REQUIREMENTS

The estimated consumption of compressed air will be:
300 Nm3/h
Which takes into account the required air needed to make the air ejection from the NIR detectors.

The specific estimated air consumption per product washed would be:
0.1 Nm3/Kg (washed flake).

CONSUMPTION MATERIALS

Chemicals in the wash process

The percentages of chemicals required for an efficient wash process are very important and must be monitored precisely throughout the process. The consumption of chemicals is therefore depending on the following parameters:

- The type of contaminants (carry in by the bottles) to be removed;
- The percentage of discharge water required to maintain the acceptable level of salinity, and suspended solids;
- Efficiency of the washing machines.

As our recycling system is designed for very intensive water recycling, the result is very low quantity of discharged water and therefore the consumption of chemicals is optimized. Thanks to the high efficiency of our " **FRICTION WASHER "** the use of chemicals is also very low.

The consumption of chemicals is estimated to be less than 0.012 kg/kg of washed product. This rate of consumption can be affected by the possible variations on the quality and the source of the input material.

Fossil Meal for the water treatment plant
Water filtration has an important function and the consumption of fossil meal for the filter of the process water is about, 0.012 kg/kg of washed product, again this may vary depending on the quality of the input material.

HEAT CONSUMPTION
The energy consumption for water heating, necessary in different parts of the plant, is reduced thanks to the careful flow diagram, water treatment and the engineering precautions, which avoid the losses of heat in the water. In this system, the water is recycled different times in different points of the plant.

Generally in the worst conditions the heat to be reintegrated in an hour is approximately:
1,500,000 Kcal/h/3,000 kg RPET

The steam consumption relative to the different utilities is approximately:
0.93 kg steam / kg RPET

Since the water involved in the system, in case the washing plant stops, must be reset at the exercise temperature, it is advisable to install a 3,500 kg/h steam generator to allow for a faster re-start.

TREATMENT GUARANTEE
The guarantees are governed by the quality of the input material and contaminants. The PET bottles to be reclaimed may come from the different collections processes (for example; Municipal Post-Consumer Collection) and have been manually or automatically pre-sorted. They can be in bales, with the following max dimensions:
1,200 X 1,100 X 1300 mm.; with a maximum density of 450 kilogram per cubic meter.

In case of density higher than 200 kilograms per cubic meter density, the bales have to be pre-broken in small parts through a proper action of the loading forklift truck. (This is demonstrated in the video presentation.)

To avoid that the bottles moving on the belt during the sorting operation automatic detector systems, it is important that they arrive crushed form and not in the original form where they may roll and avoid the ejector.
Therefore the baled bottles have a level of foreign items, parts, caps, and labels as follows:

Legend:

PVC/B	= PVC from bottles
PVC/P	= PVC from packaging
PO	= polyolefin
ALUT	= aluminum from caps
ALUL	= aluminum from cans
Fe	= iron from cans
In	= inert not metallic
C	= paper labels
N.C.	= Not Considered

Initial Contaminants:

PVC/B	PVC/P	ALUT/ALUL	PO
0.5%	N.C.	0,02 %	7%

Glue	C	In	Fe
1%	3%	0.5%	0.01%

EXPECTED SPECIFIC PRODUCTION PARAMETERS

1. RESIDUAL CONTAMINANTS ON R-PET FLAKES

a. PVC Bottles, with double detectors	40 ppm
b. Polyolefin	20 ppm
c. Paper	10 ppm
d. Glue	10 ppm
e. Metals (average value)	10 ppm
f. Residual pH	<10
g. Humidity	0.7%
h. Filterability	100bar/h/cm2 (ref. UNI)

2. EXPECTED CONSUMPTIONS

a. Absorbed electric power	0.3 kW/kg RPET
b. Water	1.1 l/kg RPET
c. Air for x-rays detector	0.1 Nmc/kg RPET
d. Filtering material for main filter (diatom)	0.012 kg/kg RPET
e. Steam	0.93 kg/kg RPET
f. Conditioning products	0.012 kg/kg RPET

MANPOWER PER SHIFT
(Minimum requirement)

	1st Shift	2nd Shift	3rd Shift
General Manager}			
Managing Director}			
Production Director}			
Shift Supervisor	1	1	1
Visual control	2/3	2/3	2/3
Material Movers	2	1	1
Cleaner	1	-	-
Control, Preparation, Shipment	1	-	-

TOTAL UNITS OF LABOR 15-18 (5 days per week 24 hours per day).

ELECTRIC CONTROL SYSTEM (QELAV/PET)
One of the key fundamental elements in reducing the operational costs, labor, and chemical consumption is having a computer system that takes into account the complete operation. The operation is controlled in the Supervisors office adjacent the washing plant. From this location the PC Supervisor Control station (based on SIEMENS Supervisor program), the supervisor can adjustment and control all aspects of the operations.
Supervisor program consists of:
Electronic synoptic board, composed of 10 pages with numbered drawings of all plant components, stating:
Normal and anomalous machine condition; amperage absorption of the technologically important motors; speed of the motors controlled by inverter; flow rate of chemicals and inlet water; temperature values page of alarms with date and hour recording of the occurred anomaly; of the identification by the operator's side; and of the ended anomaly; readable on 3 levels that can be set and possibility of graphic analysis of the anomalies.

Page for allowing the settable technological operation parameters, which has the minimum and maximum control for each value with adjustment protected by password.
There is also with remote control switches to start the main and auxiliary motors, valves and protection fuses, timers, voltmeters, ammeters, etc.
PLC for automatic control, sequences, thermo-regulators, ammeter Thresholds, weighing systems.
Individual pages are set up in order to examination the operation, for example; programmed maintenance, where for each intervention it is visualized the number of hours programmed for the intervention (protected by password), the actual value of operation hours, a reset push-button after the execution of the maintenance work (protected by password).
Other pages include:
The count of the total operation hours is also readable in other pages.
Page of general controls with plant start-stop, selection manual/automatic, restart of the sequences after anomalies and conditions control before the automatic start page of the automatic sequences with description and condition of all relevant motors recapitulate page of the chemicals dosing pumps with their condition and the value of the instantaneous flow rate automatic management of the report print to be attached to the packed material, with indication of the number of the produced lot, number of the sack pertinent to the lot, with possibility to set a series of general data hourly/weekly storage on files, Excel/Access format, of the production data, amperometric absorptions of the main motors, chemicals consumption, temperature, settable parameters and alarms;
Page of alarms with historical recording;
Page of lubrication;
Page of the technological parameters that can be set through keyboard
Display and historical recording of the main parameters as listed here below: Water temperature of the pre-washing section; Temperature of the water entering the “Friction Washer”; Temperature of the water at the outlet from the “Friction Washer”; Temperature of the water entering the drier; Temperature of the water at the outlet from the drier; Amps absorption of the wet grinder; Amps absorption of the final grinder; Amps absorption of the “Friction Washer”; Amps absorption of the centrifuge; Amps absorption of the washing drum; Drier low operation monitoring; Process water inlet flow Chemicals feed; Hourly output of produced R-PET.
The computer system also allows for the linking through a modem and or telephone line dedicated to the assistance and remote diagnosis with our technical team.

In closing, recycling of plastic materials can be done by putting the Environment first, while increasing the profit margins for the Recycling Company.

From the MONTELLO case study presented today we see that in Europe, where Energy costs are high, Fresh Water & Land are limited, Direct Labor expensive, etc. and we are supplying new recycling plants as well as upgrading old plants to make both, environmental friendly and profitable operations.

If you would like to receive the PowerPoint Presentation, and/or Video Presentation of the Montello Recycling Plant, please contact me directly at:
905 652 9034 or ageorges@royalgrouptech.com