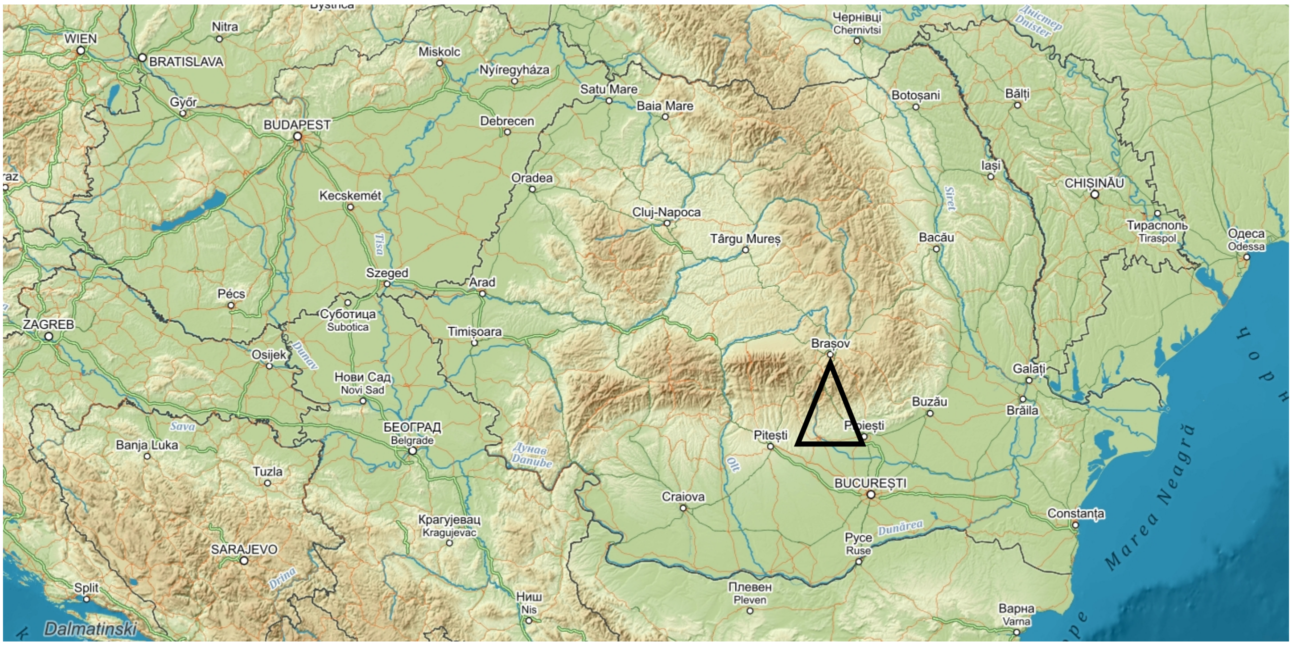
Regional Waste Treatment Center BRASOV

Technological study



BROMECO INDUSTRY S.R.L.

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Commercial Galleries, Room 5

Brasov, ROMANIA

SYSTEM OF MUNICIPAL WASTE TREATMENT

Part PS1-1

Bulk Handling Systems has decades of experience around the world developing waste processing systems of all types and scale. Our integrated recovery process allows cities to maximize usage from landfill by the recycling of commodities and extracting organics for the production of biogas to fuel clean vehicles. The solution proposed for project Brasov operates with proven technology in a patented process that will deliver unrivaledresults.

Process is based on our approach with the following assumptions:

- High processing rates are required. The line will provide 20 *tons per hour of capacity*.
- High recovery rates of recyclables are required. Our system will recover *90% or more* of the available recyclables from the wastestream.

A processing system has only value if it is rugged, robust, and easy to keep operational. Our clients are not successful when their equipment is not running, so we design and build our systems to run at greater than 90% operational efficiency:

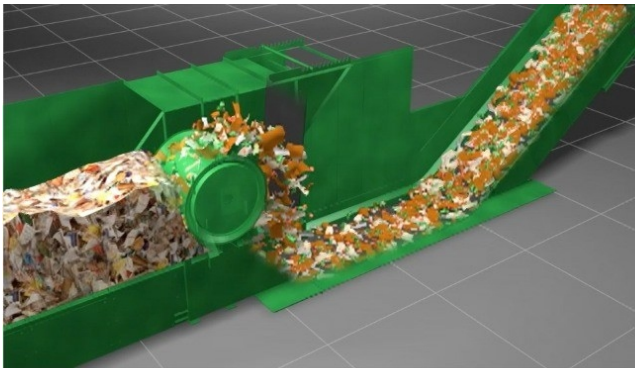
- Meticulous engineering design, ensuring every piece of equipment is properly sized and integrated into the rest of the system.
- Best -in-class manufacturing systems, ensuring every component has quality fit and finish, and is rugged and reliable enough to withstand for years of service in the harshest operating environments.
- Robust quality control mechanisms, ensuring that every part of the system has been checked for proper build and operation prior to shipment.
- Dedicated project management, training, and ongoing support to ensure that the system is organized and wellrun.

The Mixed Waste Materials Recovery Facility will separate the waste stream into the following products:

- Large Rigid Plastics
- Large Film Plastic
- Scrap Metals
- Large Cardboard (OCC)
- Film Plastic
- PET (#1) Containers
- HDPE (#2)Containers
- Mixed Plastic (#3-#7)Containers
- FerrousMetals
- Aluminum Beverage Cans(Non-Ferrous)
- Organic rich material for AnaerobicDigestion
- Combustible fuel feedstock(RDF)
- Residue

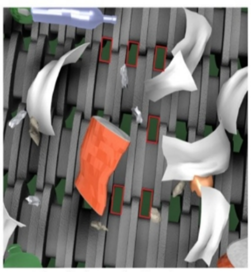
The Mixed Waste is comprised of one line operating at 30-35 tons per hour.

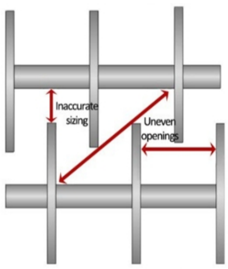
An efficient processing system requires an even, steady flow material has to be given to the sorting equipment. For this task we use the Metering Bin, which is a combination of a variable speed conveyor and a metering wheel to control the rate and depth of the material flow.



The operator removes any Over Sized Bulky Material on the tipping floor and then feeds the material to be processed into the Metering Bin with a front end loader. The Metering Bin transfers this material to the infeed chain belt conveyor, which feeds the by pass gradient to the Pre-Sort.

After the stream has been reduced to a controlled size range, we begin separating the material by size. Accurate sorting of the various commodities starts with precise sizing of the fractions. This is the flagship technology for this application in this industry.

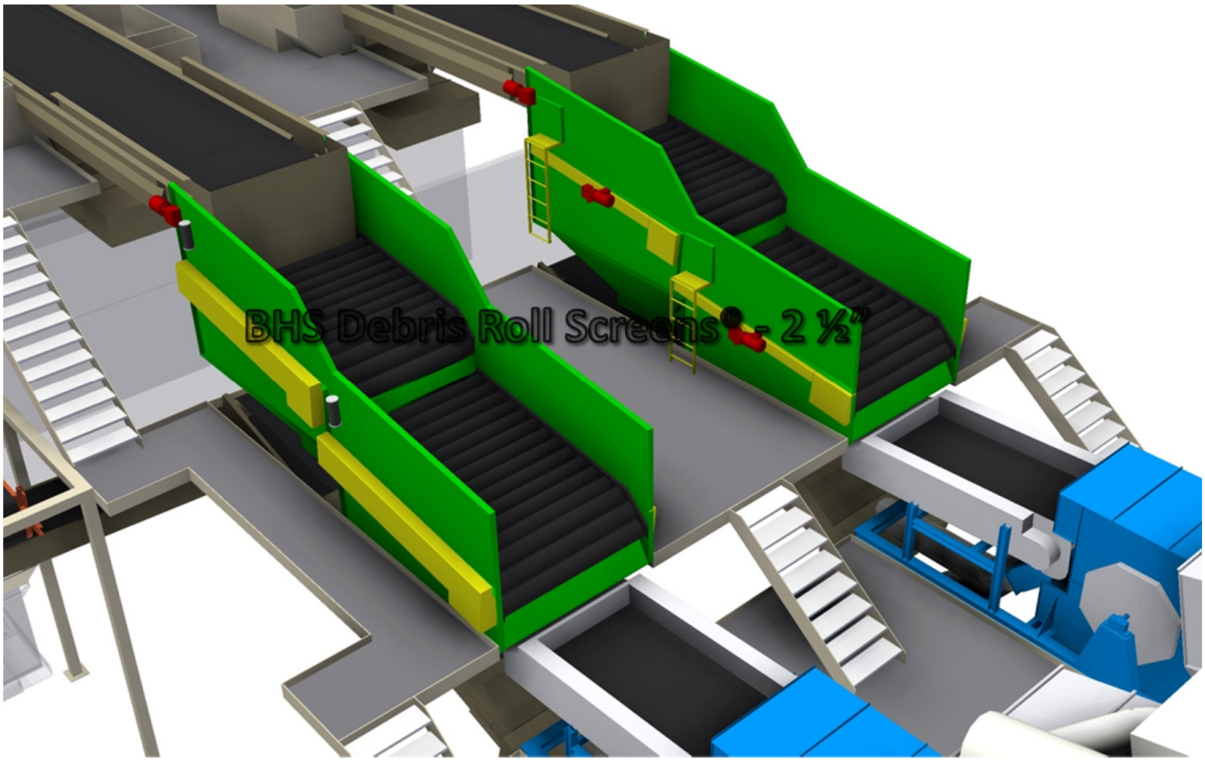




All Tri-Disc sieves utilize our patennted inline tri-shaped, compound disc design. This disc configuration was developed in response to an obvious need in the market for a better performing and demanding applications such as Mixed Waste. The benefits of this configuration are exceptional material mixture, extremely accurate sizing, minimal wrapping, and virtually no commodity loss. This type of performance is simply not possible with other types sieves.

The first sieve in the process is the large fraction of scalping sieve. This is a specialized Tri-Disc sieve that is mounted on a gradient. The largest items in the stream bounce over the sieve deck where they are presented to a manual QC station. Sorters positively pick any recoverable products such as OCC, mixed rigid plastics, and scrap metals. In addition to providing a mechanical means of recovering OCC from mixed waste, this step also begins the conditioning of the material stream that allows the final recovery equipment to operate at peak levels. The large Tri-Discs create significant mixture of the material, releasing smaller items so that they fall through the sieve and move further into the sorting process.

The overs from the scalping sieve are transferred through a *post-sort*, which is discussed under Step 3 of this process.



Once material passes through the scalping sieve, it is transferred to a roll sieve for further classification by size. The sieve targets a nominal 2½" size range, creating an overs fraction that is 2½-12". The unders will go out as organic fraction. A key differentiator between the DRS and other sieves in this application is our ability to make accurate and precise size of the material without loss of valuable commodities. The Interface Opening (IFO) of the 2 ½" sieve is specifically designed to provide maximum removal of fines without allowing crushed aluminum or PET containers to fall through. Other equipment manufacturers are forced to oversize the opening in their fines sieve to get adequate fines removal, leading to the loss of valuace commodities.

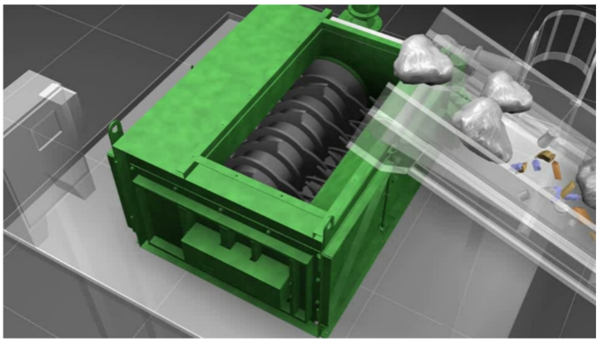
The material falling through the 2 ½" DRS is mostly organics, small compostable paper and inerts. Removal of this material early in the process is critical towards ensuring high quality recovered commodities. This 0-2 ½" stream is rich in organics, and is suitable for waste to energy conversion.

To minimize the burden on the pre-sort staff, we are offering a new approach to conditioning the material before it gets to the sorting platform. To accomplish this, we are utilizing a declined roll sieve that is specifically designed to prevent wrapping and to remove the appropriately sized material that does not need to be pre-sorted. This will give the pre-sort staff a much better opportunity to manage removing the large stringy material at the front of the system as there will be a significantly lower burden on this belt.

Only the over fraction bigger than 250 mm will go to the Post-sort, so less danger for the sorters as they do not have to stick their hands in the waste and can get injured by needles, glass, or any other material

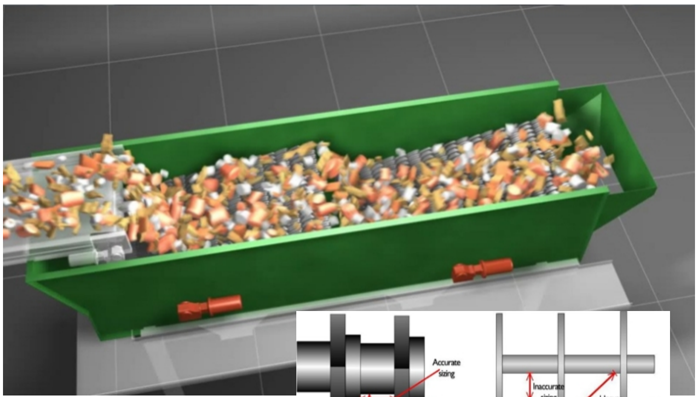
Sorters are positioned on the pre-sort platform so that they can remove any large trash and other items that may damage the downstream technology. The over fraction can be fed to a shredder

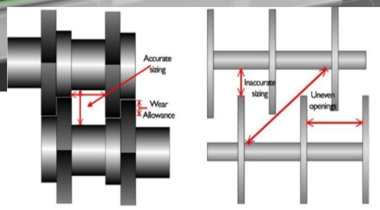
Bagged material removed at the presort station is transferred to the bag breaker. The bag breaker tears open the bags and releases the contents without damaging the materials inside. This frees up the material for downstream sorting and recovery. This machine is specifically designed to open bags without shredding the material inside. The patented anti-jamming mechanism keeps material from backing up.



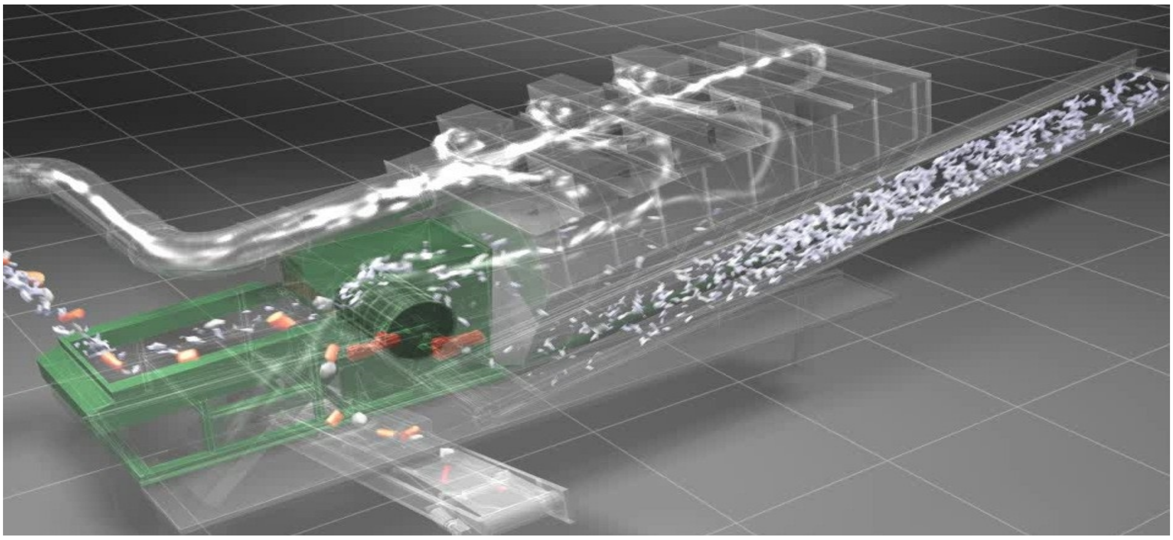
After bulky items are removed and all of the bags are opened, we begin breaking down the material by size. Sizing is a critical step in processing MSW as it begins the conditioning necessary for final sorting. The DRS is the best technology in the industry for sieving material to size.

The DRS uses tri- shaped, compound disc design. This disc configuration was made from an obvious need in the market for a better performing screen in demanding applications such as MSW. The benefits of this configuration are exceptional material mixture, extremely accurate sizing, minimal wrapping, and virtually no commodity loss. This type of performance is simply not possible with other types of sieves.



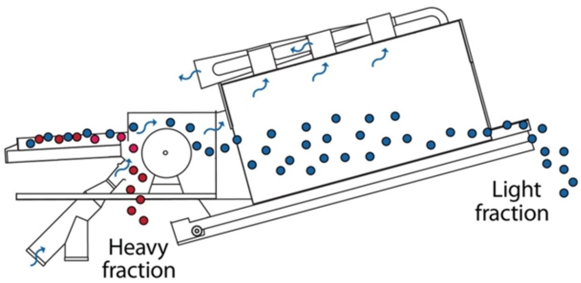


A DRS with hardened steel discs is utilized after presort to remove the <2" size fraction. This fraction is mostly organic (such as food waste), broken glass, and other inert materials. The 2"(-) fines are segregated with other organics for Anaerobic Digestion and composting.



After the smallest and largest fractions have been removed from the stream, the material is ready to be conditioned for recovery via density separation.

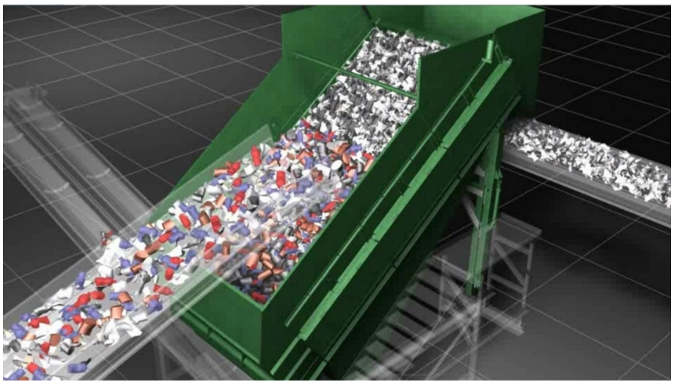
The lighter, low-density material contains the vast majority of the recoverable commodities. This fraction includes the paper, plastics, aluminum, and tin cans. The heavier material contains less recoverable commodities, and is mostly made up of organics, inert materials such as rocks, soiled paper, textiles, and other non-recyclable materials.



In order to release the recyclables for recovery utilizes is used a Single Drum Separator (SDS). The SDS is a robust, efficient technology that is currently used in hundrets of waste processing installations around the world. This machine uses highvolume air to push/pull light materials away from the heavy materials. A high speed conveyor accelerates the materials into the air stream, where they are propelled against a rotating drum. As the material hits the drum, air lifts the light materials up and over into the expansion chamber, where they settle onto a take away conveyor.The heavy materials bounce off of thedrum and down, where they are collected on a conveyor.

The heavy fraction is transferred to a manual post-sort, where full containers, OCC, Wood, and Rigid Plastics can be picked by sorters before the material is combined with the system residue stream.

The light fraction moves ahead in the process for further processing. The light material recovered by the Single Drum Separator now looks very similar to traditional Single Stream Recycling material.

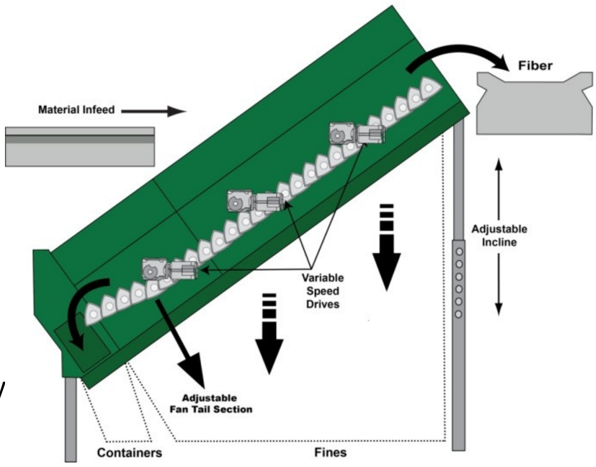


This is possible due to the processing steps applied to the waste stream throughout the process to this point. The next step is to break the material down into flat (2D), round (3D), and fine fractions.

- The 2-Dimensional , flat fraction is mostly paper and plasticfilm
- The 3-Dimensional, round fraction is mostly plastic, aluminum, and ferrouscontainers
- The fines (<2”) are residue

These fractions are separated to allow maximum efficiency of final sorting. We utilize the patented Polishing Screen, which is a specialized, angled disc sieve. Due to the unique compound configuration of the discs, this sieve will not wrap up with plastic bags like other disc sieves do. Plastic film simply travels up the screen along with the paper, without wrapping up and clogging the sieve. The Polishing sieve stands alone in its ability to separate high volumes of commodities into sortable fractions.

- The 2-Dimensional fraction climbs up the Polishing Sieve and drops over the top.
- The 3-Dimensional materials roll down the Polishing Screen.
- The Fines (<2”) fall through the openings between discs



The 2D and 3D fractions are now suitably conditioned for final commodity sorting.

The 2-Dimensional fraction from the Polishing Sieve is now ready for final purification. At this step, we applie the *Fiber Pure System*, a pending process that delivers high quality marketable mixed paper and

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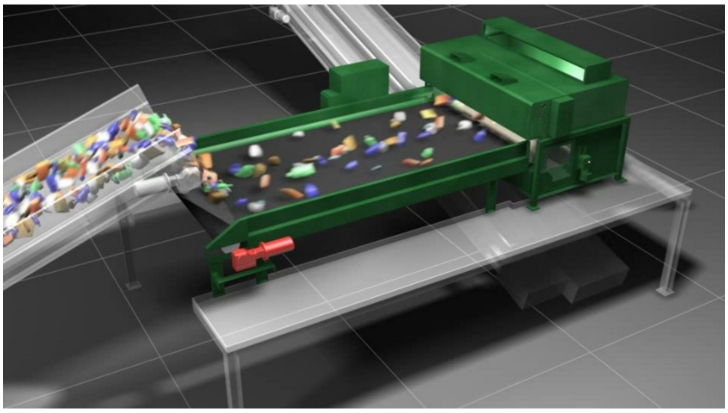
film products from conditioned municipal waste.

The 2D material passes through the optical sorter, where targeted plastics are identified and ejected upwards with a blast of compressed air. Once ejected, the material enters a negative pressure zone where the light-weight (clean) film plastic is evacuated pneumatically and separated from the non-marketable film and contaminants. This film plastic is deposited onto a QC belt with a *Rotary Air Separator (RAS)* for final quality control before storage.

The default stream from this optical sorter is transferred to the fiber post-sort line, where sorters remove any contamination. The finished Mixed Paper is stored in a walking floor bunker before being automatically fed into the system baler.

The 3D (container) fraction also requires further sorting and purification before it is ready to bale. At the core of the container sorting process are *Optical Sorters*.



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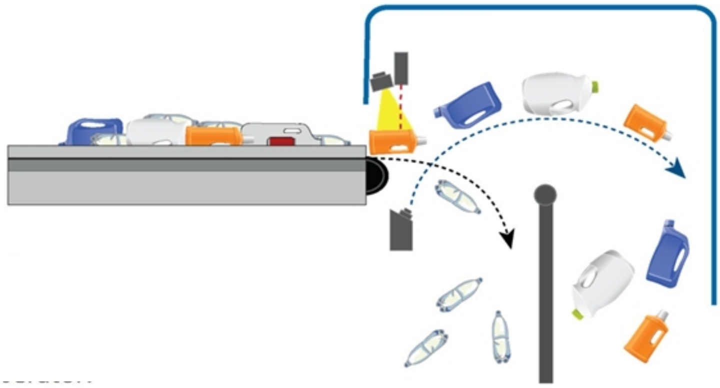
Like other optical sorters in the market, our units use Near Infrared light and high speed sensors to identify materials by their polymer type. When a targeted product is detected, a high pressure blast of air ejects the item onto a collection conveyor. Where we differ from other optical technology is in the design and application of this concept. The net result is higher recovery and purity rates of final products.

Three fundamental characteristics differentiate the Manufacture from the others.

1. *In-Flight Sorting*. Our units detect and eject items after they leave the belt, while in-flight. Other brands detect over the belt and then eject the material as it passes ejection nozzles a significant distance away.



This delivers multiple benefits to the plant operator:

- Reduction in the amount commodity loss caused by bottles rolling or otherwise moving between the points of detection and ejection.
- Increased ejection accuracy due to a more certain flight. The material is already in flight so its aerodynamics and path of flight are already known. When others detect 12” before the end of the belt, future aerodynamics is uncertain and this results in degraded performance.
- By detecting off the belt, we are able to use transmitted light for clear bottles which provide a stronger signal in the near infrared range of light.

2. The Spectrometers – units include an array of Spectrometers that are placed across the entire width of the belt. Other units utilize a mirror (either rotating or oscillating) that sends a reflected light wave to a single Spectrometer. Since our units avoid the use of a mirror, any error or delayed response from the mirror is avoided.
3. This means that the units are fully integrated into the design and the function of the processing system in a comprehensive manner. Since integration of technologies is critical to the success of any MRF, this relationship eliminates the ability of one party blaming the other if are any issues. The bottom line is that we have full responsibility for all aspects of the facility.

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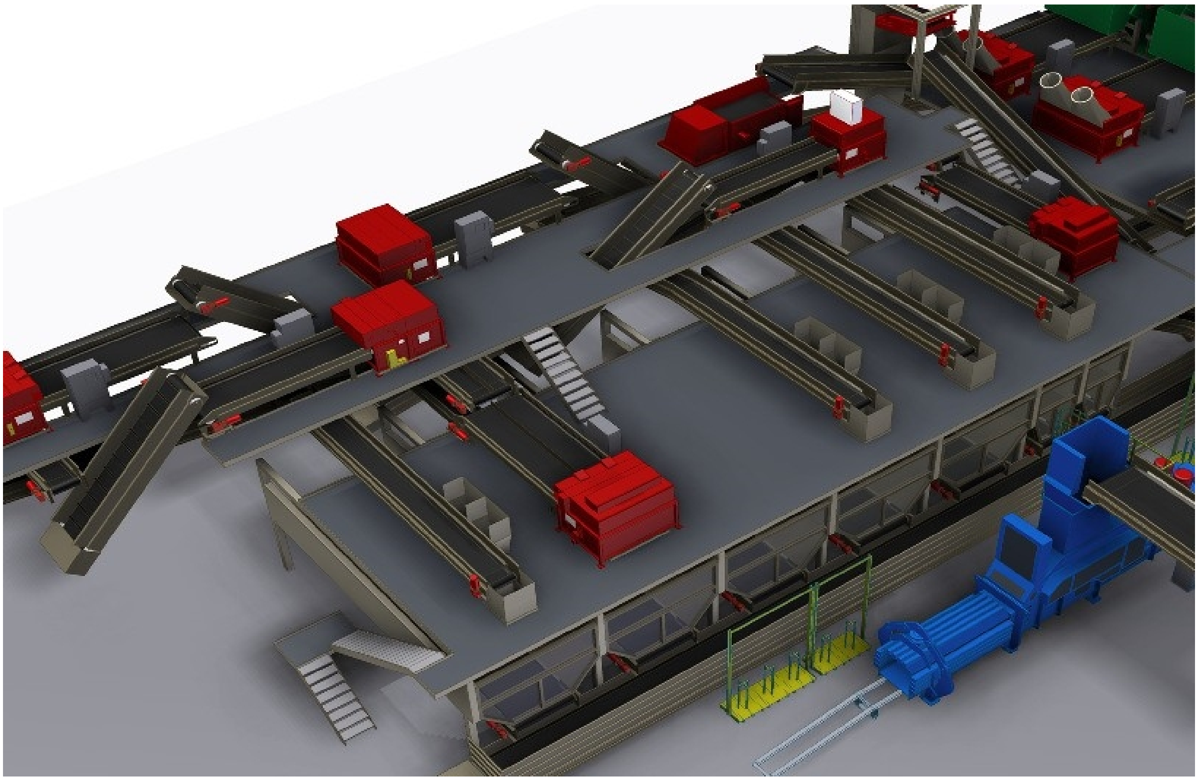

The container stream is passed through a combination of Optical Sorters and magnetic separators that recover various commodity types.

- Ferrous metals are removed with an over-bandmagnet
- HDPE is recovered with an *SpydIR*
- PET is recovered with an *SpydIR*
- Aluminum is recovered by an Eddy CurrentSeparator
- Mixed Plastics are recovered by an *SpydIR*

Finally, each container stream is passed by a quality control station for removal of any contaminates. Quality control for PET and Mixed Plastics is accomplished with an additional optical unit to ensure purity even at high volumes. The finished products are stored in bunkers and are ready for baling.

In order to guarantee maximum purity of the recovered commodities, quality control stations are provided throughout the plant. These stations allow a final opportunity for human intervention. If an item is found where it shouldn't be, the sorters can remove it and place it in a chute that will transfer it to the proper location in the system.

Materials RDF removed at the pre-sort stations are stored in bunkers below and prepared for further processing for pelletization or for energy use.

The high-volume recyclables (Paper, PET, HDPE, Mixed Plastics, Aluminum Cans, and Tin Cans) are stored in large bunkers with walking floor bottoms. These bunkers are automated and are unloaded to the baler when full.

Film plastic is continuously fed to a small auto-tie baler.

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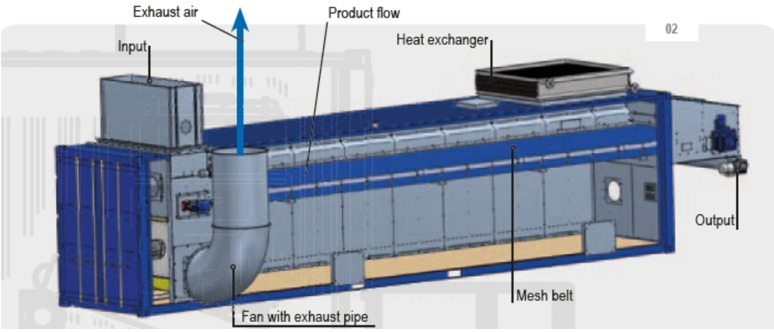
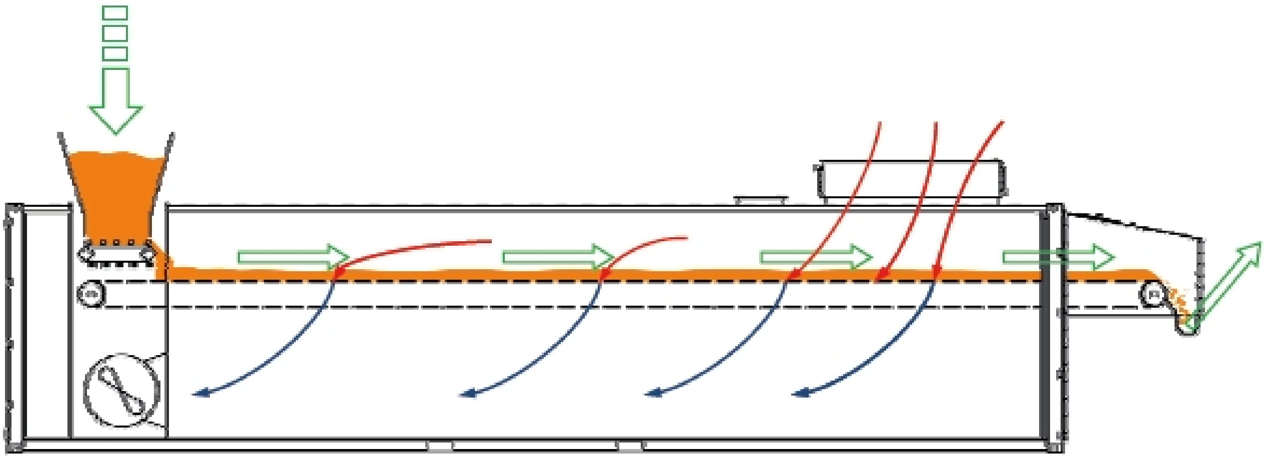
RDF drying and pelleting system

Part PS1-2

The Belt Dryer is a compact belt dryer constructed into standard shipping container. The container not only provides an external weather protection cover, it is also the supporting structure.



With the special polyester textile belt the airflow routing can be turned around. In other words, fresh air flows through the heat exchanger and is sucked into the drier. The product is pressed onto the textile belt by the pressure of the airflow. The air can only flow narrowly by the drying product thereby absorbing more moisture, like container drying for instance.



Densification of waste materials is an important step in many recycling processes. Waste products often come as a mix of various materials with a low bulk density. The handling of the waste product therefore provides in many cases the necessary challenges. The pelleted waste material is uniform in shape and has a much higher bulk density then the incoming material. The pelleting process has therefore been an important step in a number of waste recycling installations for many years.

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The pelleting lines for Brasov will be the same design:

- conveyor from the store of separated material RDF,
- the buffer bin 200 m^3, the special design for RDF,
- the two feeder transporters from buffer bin, whose will fill in the two pellet mills,
- the two pellet mills with accessories,
- the output conveyer for the pellets below the pellet mills,
- the two dispatching bins for filling of the two transport containers,
- the air-conditioning for the pelleting and dispatching line,
- the wiring and control system of pellet line,
- the fire safety equipment of pellet line including the sensors and distributing systems and applicators of fire water

First we buffer the waste material flow into a specially designed Life bin. The advantage of buffering the waste material is that the pellet mills connected to the buffer bin can run continuously and independently from the often intermittent material input feed. Subject product flow comes for example from bale shredders. Our specially designed Life bin provides the means to feed up to 4 pelleting lines from a single waste material flow. Our waste material extraction screw is specially designed to convey even the most difficult materials; this makes it possible to control the pelleting capacity accurately even if there is a large variation in particle size within the waste material. The vibratory feeder is an essential element in the waste material pelleting line. It transports the waste material from the dosing screw into the pellet mill. During this transportation time, the waste material is shaken apart which results in a very regular product flow to the pellet mill. This regular product flow results into a very stable pelleting process.

The flow characteristic of waste materials often requires positive transportation up to the pellet mill. The forced feeding screw ensures an optimum feeding of the ring type die. Long waste material particles are unforgiving and wrap easily around any obstructing part, so inside the ring die, normal deflectors and directing parts can not be used. To help feed distribution the feeding screw has the same diameter as the ring type die. A pellet mill main motor overload can be corrected quickly by operating the by-pass function of the feeding screw. The by-pass function is achieved by sliding the complete feeding screw away; this provides excellent means to clear the die area rapidly.

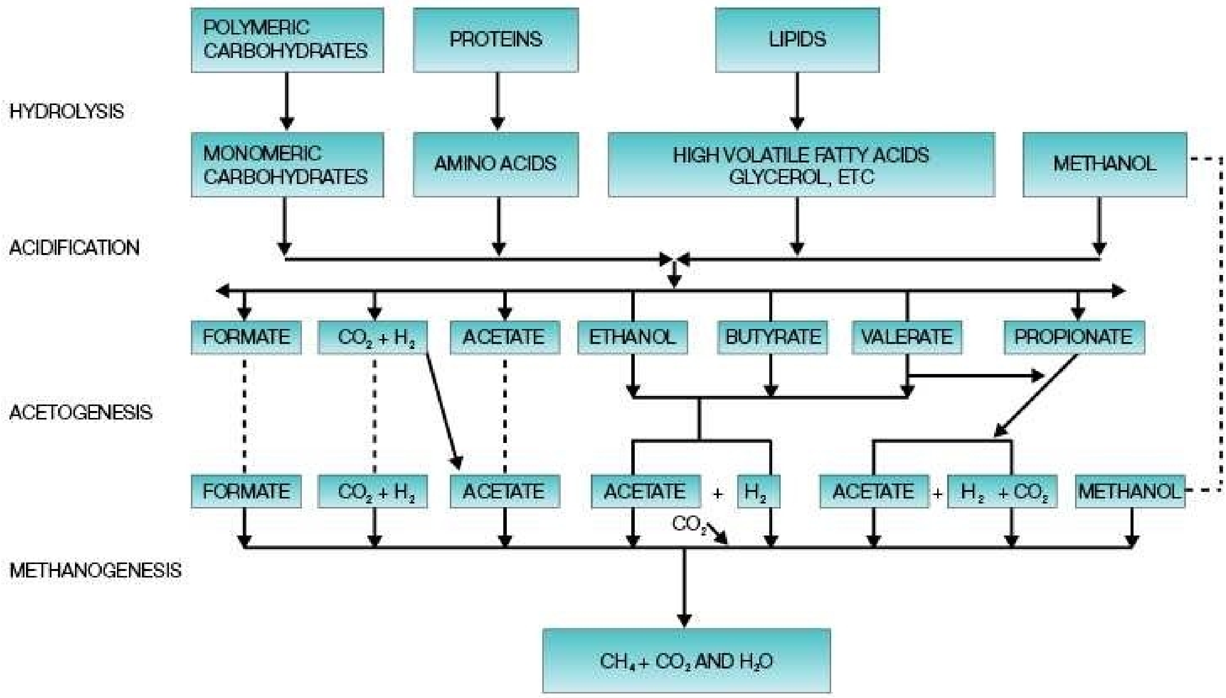
The automated press roller adjustment remote is the most desirable tool in the waste pelleting process. The lineator makes it possible to retract the press rollers automatically from the die surface without having to open the pellet mill door.

System of energy using of RDF in biogas power plant

Part PS1-3

The heart of the biogas plant is it's digestion process which can be divided into four separatesteps:

- Hydrolysis
- acidification,
- acetogenesis
- methanogenesis



Anaerobic digestion(AD)is the natural process that breaks down organic matter in the absence of oxygen to release a gas known as biogas, leaving an organic residue called digestate. Biogas is a mixture of methane, carbon dioxide and water and can be used to produce electricity and heat or used as a natural gas substitute.

A separate liquid intake pump pumps the liquid intake directly from the stables to the mixing tank.

The solids are fed to the intake hopper on the vertical mixer by the system installed on site. From here, a screw conveyor transfers the material into the mixing tank.

The input substances, which are transported by screw conveyors and substrate pumps, are homogenised in the central mixing tank by the centrally positioned agitator. The mixing tank is designed as a sealed, non- pressurised tank with an inspection opening. The agitation time, feeding intervals and respective daily volumes of the input substances can be entered into the PC and amended as required. Once the agitation process is complete, the substrate pump (which is upstream of the solids shredder) pumps the substrate into the fermenter. The pumping process is controlled by a weighing system, which is located beneath the mixing tank.

An useable volume of the fermenter will be adjusted to a data derived from the Feasibility study. An expected daily supply of substrate may result in a substrate residence time of approx. 65 days. The fermenter is equipped with the Flexo roof with integrated gas membrane, specially developed by the manufacturer. The biogas is stored in the fermenter. If there is a volume of 120t/day then we will need approx. 15,000 m³ fermerter or two of 7,500m³.

The heating system, comprising stainless steel pipes, is mounted to the inside tank walls of the fermenter. The immersed, height-adjustable agitators ensure that the substrate and heat are evenly distributed in the fermenter. In order to remove the sulphur from the biogas, atmospheric oxygen is fed into the fermenter with a compressor. Two inspection windows allow to look inside the fermenter.

A recirculation shaft is attached to the fermenter. The recirculating matter is transferred from the fermenter into the shaft by an overflow pipe. From here, the substrate pump pumps it into the mixing tank for dry substance control.

As per the overflow principle, the fermented substrate is fed from the fermenter into the residue rack tank. From here a pump transfer the material to the residue storage tank supplied by the customer in the direct vicinity of the fermenter. A hold-back time of 180 days together with the predefined input volumes will result in a total residue volume of approx. 58,020 m³ requiring storage.In the proposal, a residue storage volume of 78m³will be included. Furthe rstorage volume in the direct vicinity of the fermenter has to be provided by the customer.

The biogas which is produced in the fermenter is fed from the gas storage to the combined heat and power plant (CHP), which is installed in a plant building that must be provided by the customer. Additionally, a noise protection cabin is installed by the manufacturer in order to ensure compliance with the noise regulations. Prior to entering the CHP, the biogas is dehydrated. The condensate produced here runs off into the condensate shaft. The CHP has an upstream frequency regulated gas compressor. Excess gas in the fermenter gas membrane is flared off via a stationary gas flare.

The biogas is burned in the CHP, converted into power with the aid of the generator and fed into the public electricity network. Heat which occurs during the combustion process is used to heat the fermenter. Any additional heat available can be connected for heating purposes. If no heat is required by external consumers then this is automatically transported over a plate-type cooler.

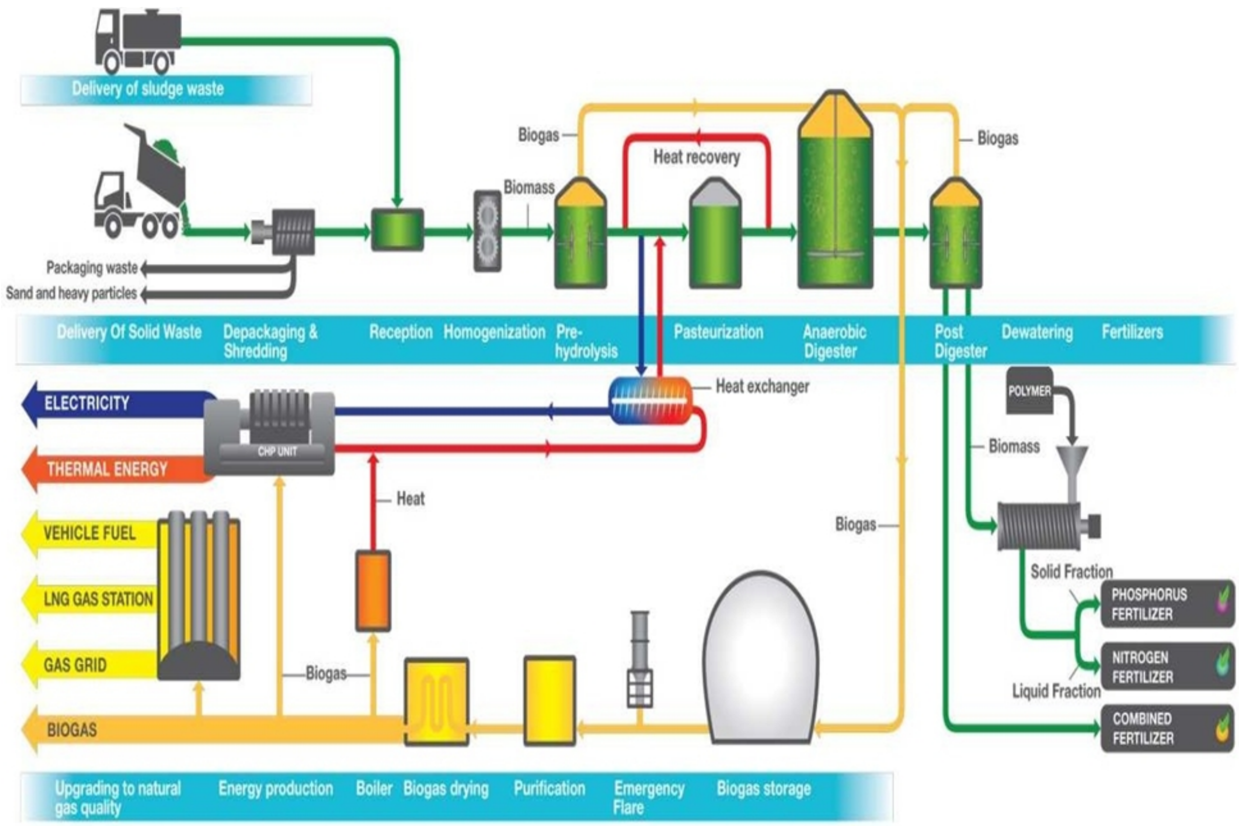
Prior to starting up, the fermenter is first filled with liquid intake. If no liquid intake is available, the input substance must be inoculated to initiate the biological process.

If the biological process is influenced by an inadequate supply of trace elements and nutrients or lacking buffer capacities then the operator must add the required additives accordingly.

The offer comprises the supply and installation of a biogas plant with the following essential components:

- Vertical mixer with approx. 2x95 m³ storagecapacity
- Liquid intake intakepump
- Mixing tank for 2x15 m³ contents with agitator
- Substrate pump and solids shredder

- Fermenter with 15,060 m³ net volume incl. roof, gas store, heating and agitatorsystem
- Desulphurisation unit
- Recirculation shaft
- Condensate shaft with submersible pump
- Residue rack tank with 2x27 m³ net volume made of PE
- Residue rack tankpump
- Combined heat and power plant with 999 kWel including controller
- Gascompressor
- Emergency flare system
- Gas analysis system
- Gas flowmetering
- Instrumentation, control and safetytechnology
- Pipes

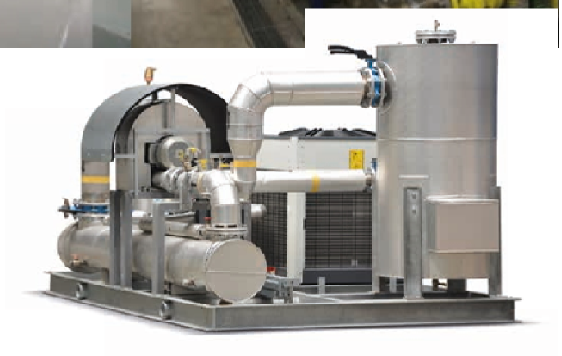


The combined production of heat and power, or cogeneration, is the method of electric power generation during which the heat created during the manufacturing process is utilized efficiently.This results in a very high efficiency when the energy in the fuel is being used.The small-sized and medium-sized CHP units are mostly designed on the basis of gas-combustion engines. The engine rotates and drives the generator.

The heat from engine cooling and from exhaust gases are, used for heating, hot water preparation, and other purposes.The power produced in CHP unit can either be exploited for internal needs or supplied to the power grid. In certain cases, CHP unit can also have a role as a backup source of power in case of power outage. The new communication technologies available today enable to monitor the CHP units for operation 24 hours a day from anywhere in the world and to control their operation remotely from computer or cellular phone. With this level of interaction, we can easily see any deviation from the normal CHP unit operation and we can draw the operator's attention to the necessary correction,if it is required.

In addition, the remote monitoring reduces the repair time in case of failure, because the service technician sets out to the installation site already aware of the failure cause. Most frequently, more consultation regards to the CHP unit settings by phone is sufficient.

Gas treatment equipment is mainly intended to reduce the moisture content in biogas, landfill gas or coal mine gas to a level convenient for applicationin of CHPunit. The entire equipment is placed on the base frame. Individual parts of the assembly that come into contact with gas and all gas/fluid pipes are equipped with heat insulation with mechanica lprotection.



Flares are used for the burning of waste gases or gases redundant within the shut-down of combined units. Burning in flares is guaranted by automatic overpressure gas burners of the series APH-M, which can burn lowpressure and medium-pressure natural gas, propane, propane-butane, biogas, sewage and degasation gas. Burners comply with technical requirements EN 676, EN 267; consequently, they can be used for broad spectrum of burning and technological equipment. Emission values do not exceed limits specified by the government decree no. 352/2002 Coll. In relation to the requirement of the law no. 22/1997 Coll.,

the independent authorized body (AO 202) evaluated the compliance with selected standards and technical instructions, and declaration of conformity was issued for them. Flare operation is fully automatic, not demanding any permanent attendance, only temporary supervision. Continuous control of heat output and low air excess in burning guarantee high economy of the operation. From design point of view, the burners are designed as complex unit, i.e. - fan supplying the combustion air is contained directly in the body of the burner. Cooling of combustion chamber is solved by the air blown by the fan into the spiral header around the casing of combustion space. The whole cycle from starting over burner control to shutdown is automatically controlled by modern microprocessor. These automatics are equipped with communication channel RS-485 that allows connection to remote control or master control system (PC).

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System of energy using of RDF in depolymerization units

Part PS1-3

Energy Conversion Processor System (ECPS) has been designed to generate energy from all hydrocarbon based bio-degradable or synthetic waste. These units will operate continuously while producing a high quality of gaseous and liquid fuels.

ECPS pyrolysis systems works with a variety of sources of wastes, generating gaseous and/or liquid fuels from waste. The efficiency of the ECPS systems are entirely dependent on the purity and the energy content of the waste. These systems consist of the following subsystems:

Comprised of an internally insulated box which contains the waste to energy stainless steel retorts. The retorts are completely isolated from the furnace environment therefore no gases are allowed to leak from box to the retorts or the retorts to the box. A burner and a combustion furnace are installed under the Reactor to supply the necessary heat to increase the temperature of the material in the retorts. This burner can be ordered with the capability of operating on duel fuels, either two gases or gas and liquid fuel. The heat from the burner travels through three passes to efficiently heat the retorts.

The retorts are the reactors for the entire ECPS system. Retorts are installed within the internally insulated box having an inlet and an outlet outside of this box. Processing material such as waste rubber, MSW, plastic or any other organic or synthetic material are fed into the upper retort from outside via two air locked valves. These valves are important because they minimize the passage of air into the retort. The material first goes through the first air locked valve.

Once the material fills the cavity of the space between the top and the bottom air lock valves, the top air locked valve closes. The bottom feed air lock valve opens allowing the material to fall into the retort. The feed system can be synchronized with the opening of the feed valves through the system program. The retort is designed to operate under a vacuum, and the pressure is also controlled to make sure the system does not get over pressured. A pressure transducer is installed on the retort and monitors the fluctuations of pressure in the system. This transducer will adjust the speed of the blowers that pull the gas from the retorts to maintain a constant pressure in the retorts. It is recommended to keep the retort pressures slightly below zero inches of water column.The upper retort is the fast pyrolysis system. Most of the volatiles evaporate in the upper retort. The lower retort is at higher temperature and breaks down the more difficult and higher temperature material. Once the material is completely processed and completed its cycle it exits the bottom retort through two airlock valves in the same manner as the feeding process.Each retort is equipped with a high temperature stainless steel auger which moves the material from the inlet, on the top auger, through the retorts, and finally to the discharge point. These augers travel at a pre-set speed determined by the manufacturer. However, the speed of the augers can be changed at the Operator Control Panel to suit the material processed.

As mentioned above, the furnace is equipped with a single or dual fuel burner that is normally fueled with natural gas, propane gas, waste gas or two fuels at the same time. The burner is supplied with a flame safeguard control and can be manually modulated to a higher firing rate on demand. The Reactor temperature control commands the burner to start and modulate to higher firing rates or lower firing rates according to the status of the retort temperature. The only other control that restricts the burner operation is the insulated box temperature.Prior to placing the system on line the burner furnace refractory must be cured.

The processed gas is piped from the cyclone to the inlet of the Twin Scrubber Tanks, which are redundant on the system for maintenance and continued operation. The installing contractor will again be required to provide for the thermal growth of the piping between the cyclone and the scrubber tanks. The gas entering the scrubber tanks will be cooled and cleaned in the twin venture vessels attached to the scrubber tanks. These vessels are equipped with spray nozzles to perform the cleaning and cooling. The gas is pulled down through the demister screen in the tanks and the up through the collection vessel on the opposite end on the tank. The tank is supplied with a sight glass, level controls and make up valve to maintain the desired level of coolant in the system and allow the gas to pass freely. The washing and cooling will be accomplished with water or light oil depending on the materials being pyrolsised. Rubber or plastic will require a light oil as they may produce a wax. With manure, bio sludge, MSW, coal or wood you would use water. Both systems will require cooling towers and heat exchangers to maintain the cooling mediums temperature. The system has twin Wash pumps that circulate the cooling medium through the heat exchangers and to the wash nozzles in the Venturi tanks of the scrubbers. The scrubbers are supplied with level controls to maintain a level below the demister screen, which will allow the gas to freely pass through the Scrubbers.

This portion of the system is again a tank with a heat exchanger and vertical demister mounted on it top. As the gas is pulled from the scrubber tanks it enters the top of the condenser's shell and tube heat exchanger. This exchanger is again being cooled by the system cooling tower, the gas is cooled and condensed as it travels down the heat exchanger to the tank and will be pulled up through the demister, which will strip the remaining condensable gases and water from the non-condensable gases as it travels to the inlet of the Tuthill Blowers. This tank is equipped with a sight glass and level controls to also maintain the required gas path.

The system is again supplied with twin vacuum gas blowers, for redundancy.

They are a Root type positive displacement blowers that maintain a slight negative pressure within the system while pulling the pyro gases from the retort to the blowers. The blowers are controlled through the use of a pressure

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transducer which is installed on the top retort. The transducer senses the pressure changes in the retort as the rate of the gasification process changes. As the gas flow changes the retort pressure changes. The transducer sends a signal to the VFD on the blower speed control and it compensates to maintain the slightly negative pressure in the system at the preset levels. This insures the quality and uniformity of the by- products.

The blowers send the gas to the intermediate storage tank which acts only as an accumulator. The gas must not be collected here as it will create back pressure on the system. Your installation contractor will connect to this vessel for the final transport of the product.

The system will be supplied with a cooling tower and three shell and tube heat exchangers. Twin 16” vertical and a 10” on the condenser tank. This equipment will be used to maintain the desired cooling water temperatures needed for the Scrubber tank venturi wash systems and the Condenser heat exchanger. We will have a cooling water circulating pump and twin process pumps to circulate the spray water or oil used in the Scrubber system.A cooling tower is supplied to cool and re-circulate cooling water to the condenser.

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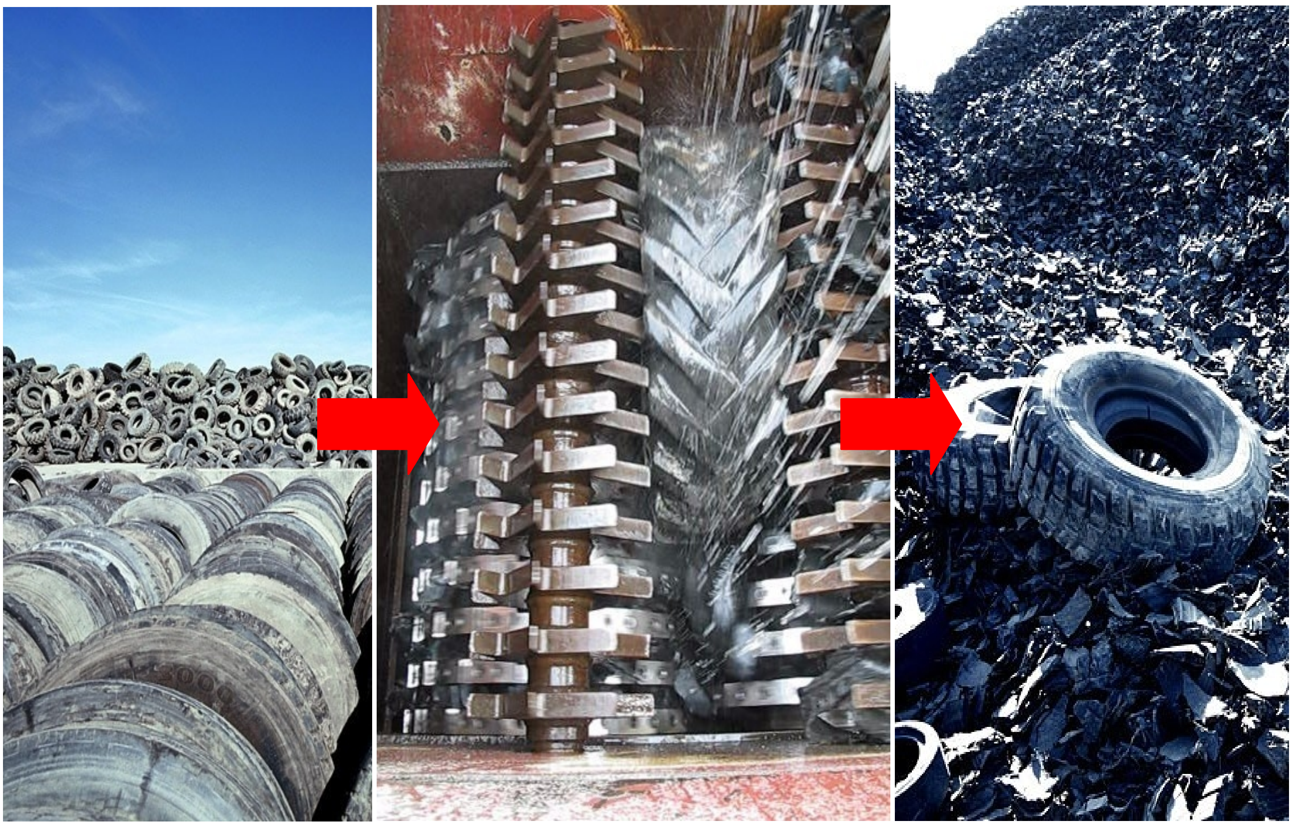
Waste tire treatment system

Part PS3-1

Rubber is, used in various industrial branches for the production of many technical products, comodity and consumer goods. For almost any type of processing it is necessary that the bales are size reduced into granules or powder. For the economical size reduction of natural and synthetic rubber of any kind, in form of bales, sheets or chips, vulcanized or un-vulcanized, with or without textile reinforcement, offers Ultra-Granulators.

We can supply powerful , low rpm, high torque shredder. Rotor and grinding room are completely wear protected. All wear parts are bolted and thus welding is unnecessary. Two star rollers inside the feeding chute position the tires between the two rotors.



The rotor knives are form-fit with the rotor disc, cutting forces are directly passed to the rotor. All wear parts are bolt-on design. The rotors discs are mounted fix with the rotor shaft. The housing is sheeded against wear by exchangeable wear plates. The rotor knives are available in a width of 50, 75, 100 and 150 mm.

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Part PS3-2

The single shaft shredder is, used in recycling operations for the production of valuable secondary raw materials. The feed material should be in pieces in order to be metered into the machine. Whereby, it does not make any difference to the shredder whether or not it is fed with old tire chips.

The single shaft shredder, size reduces all cuttable material to a particle size smaller than 20 mm or when necessary coarser. Material is normally fed by means of a conveyor belt or vibratory feeder across the entire width of the machine. Massive, serrated rotor tearing elements work with the material between the stator serrations. The tearing elements do not require re-sharpening, due to the regular reversing action of the rotor they are self sharpening. Exact working gap settings are not required in order to achieve good results and only the stators must be adjusted at specific intervals. A well dimensioned screen is installed in the lower part of the housing, which retains the material in the cutting chamber until it is discharged through the screen holes. The material is then discharged straight down out of the machine into a mechanical conveying system. The installation of an auxiliary exhaust system is recommended.

Part PS3-3

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A technical description is provided in RDF processing section – page .

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Building waste treatment system

Part PS4-1

Cutting through the massive, mixed clutter of Construction and Demolition (C&D) waste requires ingenuity that's always mindful of the bottom line. Efficient recovery of these materials could mean the difference between red and black ink.

A significant percentage of the C&D material stream is made up of small pieces, and hand sorting these materials is inefficient and produces low recovery. Only automation will keep these materials out of the landfill. We can make your transition to automation fast and painless. Our Nihot air technology is unsurpassed as it delivers accurate separation of rock, wood and light material.

For the C&D line, we need to define what should be recovered out of the incoming waste.

Normally the process starts with a shredder, after shredder you need to size it and remove the fine fraction.

The middle stream will go to Nihot SDS to remove the heavy fraction from the light fraction.

On the heavy fraction you can add manual sorting to recover the wood from the stones.

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The light fraction can be used as a RDF fraction or can be separated into different commodities either manually or with optical sorters.

Waste gas collecting system

Part PS5-1

GCCS Design Overall GCCS design is based on expected LFG collection, the type and depth of the waste, SWD site conditions and operating status (open or closed), and the overall goals of the LFG project. During the construction phase, use of proper techniques and quality assurance procedures is needed to ensure proper system operation and reliability. Finally, operation of these systems determines the success of the LFG project. Periodic monitoring and adjustments must be made to the GCCS as SWD site conditions constantly change. Changing SWD site conditions are caused by waste filling at open sites, degradation of organic material, settlement of the waste mass and weather conditions.

Extraction Wells Gas collection begins in the extraction wells, where LFG is extracted from the waste mass and enters the GCCS. Extraction wells are typically composed of slotted plastic pipe, surrounded by stone or other aggregate material, that are installed in borings in the waste mass below the surface of the SWD site. Above the surface of the waste mass, the extraction well typically has a wellhead to allow for vacuum adjustment and sampling of the LFG. The orientation of these wells can either be vertical or horizontal, and the decision to use vertical and or horizontal wells will depend on site-specific factors and goals of the LFG project.

Vertical wells are usually installed in areas where the site has stopped receiving waste or where waste filling will not occur for a year or more. However, they can be installed and operated in areas with continued waste placement, but placement will result in increased operation and maintenance requirements. The components of a vertical well include the well piping with perforations or slots at the bottom portion of the pipe, clean gravel backfill, soil backfill, a bentonite plug and a wellhead. Polyvinyl chloride Training Opportunities Skilled and appropriately trained personnel are needed to operate a GCCS. GMI offers training opportunities on operations of landfills and LFG systems. Visit their website to learn about upcoming training opportunities. International Best Practices Guide for LFGE Projects 22 3. Design, Construction and Operation of Landfill Gas Collection and Control Systems (PVC) piping for vertical well construction is sometimes used, because PVC resists collapsing caused by heat and pressure in deep waste better than high density polyethylene (HDPE) pipes. However, PVC pipe can become brittle over time and crack and collapse. For this reason, HDPE pipe may be preferred and also has been used successfully in vertical wells. A bentonite plug is, used to prevent infiltration of air from the surface through the well annulus into the well. Bentonite is a family of clay compounds that expands when wet to serve as an effective seal.1 The use of a plastic seal around the well at the waste mass interface with the cover soil can also be used to inhibit air infiltration. The amount of vacuum that can be applied to a well (and the overall performance of the GCCS) can be limited by the effectiveness of the seal between the perforated portion of the pipe and the surface of the waste mass and cover soil. The depth of the well depends on the depth of waste and will typically terminate at 3 to 5 meters above the base of the waste mass. In some situations, vertical wells can be constructed as the SWD site is filled with waste. In these cases, it is common for concrete or steel piping to be stacked vertically and act as a barrier between the waste and the gravel as the waste is applied around the well. This concrete or steel barrier can be perforated or removed to allow LFG to be extracted from the well at a future date. Vertical well boreholes range from 20 to 90 cm in diameter and include 5 to 15 cm diameter pipe. A minimum borehole diameter of 30 cm and pipe diameter of 10 cm are recommended. Larger-diameter boreholes and pipe typically increase LFG collection as a result of the increased surface area. The placement and spacing of vertical wells in a SWD site depend on various site-specific parameters.

Horizontal extraction wells can be installed while an SWD site is still receiving waste and may be used if LFG collection is desired in an area before closure. Horizontal extraction wells are placed in a trench within the refuse. The trench is backfilled with gravel (or other aggregate such as tire chips or broken glass), and the perforated pipe is installed in the center of the trench.

Vertical Extraction Well International Best Practices Guide for LFGE Projects 3. Design, Construction and Operation of Landfill Gas Collection and Control Systems 23 the trench to reduce clogging of the aggregate by the backfill or trash above. Common spacing of horizontal wells is 30 to 40 meters apart. The perforated pipe within the trench is typically 10 to 20 cm in diameter. The overall goals of the LFG project also should be considered when the placement of extraction wells is planned.

For the case of meeting regulatory requirements or significant environmental mitigation issues, a GCCS designer may include additional components to achieve greater emissions control (as an example) even though these collectors may not be cost effective for energy use purposes. However, if an LFG project is being implemented for economic reasons, such as a GHG emission reduction project or for energy use, the extent of well coverage on the SWD site may be prioritized based on economic considerations. Landfill operations and the overall goals for the GCCS will determine whether vertical or horizontal wells, or both, will be used.

Wellheads are typically found on the extraction wells above the surface to allow for vacuum adjustment and sampling of the LFG. There are several components of a LFG wellhead: a vacuum control valve; monitoring ports; and an option for flow measurement. The vacuum control valve allows an LFG technician to adjust the vacuum applied at each individual wellhead. The wellhead is often designed with one or two monitoring ports so an LFG technician can measure the temperature, pressure, and composition of the LFG. These ports allow an LFG technician to record the impacts of well adjustments and to identify potential problems and troubleshoot errors that may occur in the GCCS. Frequent wellhead monitoring promotes optimal system operation and allows for effective system maintenance. In addition, wellheads can include a flow measurement device (for example, an orifice plate or pitot tube) to measure the differential pressure of the LFG and use those figures to calculate the LFG flow. The top of the wellhead should include a removable cap to access the well for internal inspection and measure and remove liquids as necessary. High levels of liquid (leachate) in a well can reduce LFG collection, especially if the liquid level is above the perforated pipe section of the well, preventing the gas from moving into the well.

Lateral and header piping are installed to transport LFG from the individual wells to the blower and flare system. LFG piping should be designed to accommodate the necessary volume of LFG, minimize vacuum loss and provide consistent vacuum to the individual wells. Lateral pipes connect each well to larger header pipes. Header pipes aggregate the LFG collected and transported in the lateral pipes. The lateral and header piping system should be designed to accommodate the maximum expected LFG flow rates to minimize future upgrades if LFG collection continues to increase. Pipe sizing should also consider vacuum loss caused by friction and the avoidance of pipe blockage by allowing LFG flow to continue despite moderate condensate build up that results from sagging and in areas where waste can settle. LFG piping may be installed above the surface or below the surface.

Condensate refers to the moisture or liquid that is formed when extracted LFG cools. There are many factors that affect the quantity of condensate generated in a GCCS, including the LFG temperature and volume. In addition, the climate conditions at the site also can influence the amount of moisture formed in the LFG. As LFG is collected from the waste mass, it cools and has a reduced ability to hold moisture in a vapor form. The condensation that forms can restrict or completely block the flow of LFG in the piping system. The GCCS must be carefully designed to consider condensate management issues to prevent negative impacts on LFG collection. The lateral and header systems should be designed to facilitate condensate drainage to low points, where it can be removed from the system by vacuum-sealed sump pumps or allowed to drain back into the waste mass. Typically, a minimum slope of 3 to 5 percent will facilitate condensate drainage even if pipe settlement occurs. If drained back into the waste mass, the condensate low point must include a vacuum trap to prevent air from being drawn into the header. The trap must provide a sufficient vacuum break to match the maximum expected applied vacuum on the system (plus a safety factor). Once the LFG is collected from the waste mass, it is necessary to treat it to remove moisture and particulates. The removal of moisture and particulates is necessary to reduce the abrasive and corrosive nature of the raw LFG to protect the blower and ensure the LFG will burn effectively in a flare or other combustion device. Particulates are typically removed through the use of filtration. The most common device for moisture control is a moisture separator (sometimes referred to as a knock-out pot), which is a large cylindrical vessel that reduces the velocity of the LFG to allow entrained moisture to fall out of the LFG. A mist eliminator is often used to further remove moisture and other particulates in the LFG. A mist eliminator can be a wire-mesh or plastic-mesh screen through which the LFG passes and collects droplets of water that were too small to be collected by the moisture separator. The wire-mesh sieve is subject to potential corrosion. This system also screens out other particulates that the LFG may contain. Typical condensate management systems will pump the liquids collected by sumps to one or more storage tanks to house the condensate until it can be treated, reused or disposed of. Collected condensate is typically combined with leachate for treatment or disposal.

The blower and flare skid is a critical part of the GCCS. The blower provides the vacuum used to collect LFG from the waste mass. It also provides the necessary pressure to push the LFG to the flare or to an energy use device. A flare system is, used to combust the LFG and in many cases is required to control odors or mitigate other environmental or health concerns. If possible, the blower and flare system should be centrally located near the LFG collection system or near the energy use device. The flare systems should be installed away from any trees, power lines, or other objects that could be ignited by the flame or damaged by heat. Once the LFG has been treated, it then flows to the blower where the vacuum at the inlet is adjusted to meet the requirements of the GCCS and the outlet pressure of the gas is adjusted to conform to the requirements of the flare or energy use device.

System for the disposal of old landfills

PartPS5-2

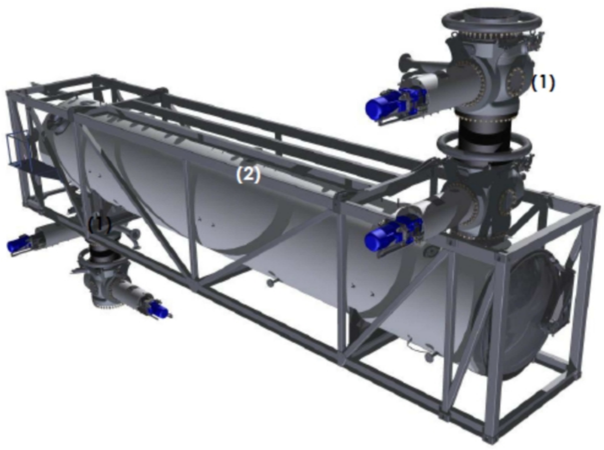
We can process involves subjecting MSW to a non- combustion, high-temperature and high-pressure concentrated steam environment. What results is a heterogeneous mixture of clean, sterilised and odour-free material that can be easily separated, reclaimed and recovered, and sorted into four different fractions: organic fibre, plastic, metal and rejected material.

Organic fibre is the main fraction obtained from the active hygienization process and results from the treatment of organic material, paper and cardboard. This fraction, defined by Ambiensys as material that is less than 10 mm in size, has excellent recovery potential.

Active hygienization treatment system essentially comprises the following modules:

- First modul is for feeding and dosing the waste before it enters the system. Waste that is deposited in the plant's reception area, after being shredded to control maximum size, is transported on belt conveyors and fed into the inlet hopper. This modul can handle continuous adjustable batches of approximately 85 kg/min[1], depending on the density of the material.

- Second modul come in pairs and are attached to the inlet and outlet systems. They ensure correct pressurisation prior to the entry of waste into the treatment system and depressurisation prior to the extraction of treated material.



- Third module is a high-pressure autoclave, in which the waste is subjected to uniform high-temperature and high-pressure steam treatment for 15 to 30 minutes. The duration of the process is determined by the time it takes the waste to travel from one end of the module to the other

After the process has finished and the appropriate sorting has been carried out, the following fractions are obtained:

- Organic fibre: this is the result of treating organic matter, paper and cardboard.
- refuse-derived fuel (RDF): this stream consists of a mixture of thermally-recoverable materials with high calorific value, including non-recyclable plastics, textiles, pieces of wood, rubber and leather.
- Metals: metals are obtained without labels, paint or liquids. The separation plant enables ferrous metal and aluminium streams to be obtained.
- Recyclable plastics: this consists of plastic fractions with recycling market

value, such as PET, HDPE, PP and others.

- Rejected material: this consists of glass, rubble and any elements that have not been mechanically separated. Organic fibre elements that are larger than 10 mm in size are also rejected.

Reception and collection system has to be isolated from the rest of the plant and have an air extraction system to prevent the accumulation of gases that are harmful to the health of the operators and the environment. The area also features certain security measures to prevent accidental access to the pit. A system is installed to ensure that the lorry access gate opens and closes properly to prevent accidents.

From the pit, the waste is loaded in varying amounts of up to 1 mt by means of an articulated hydraulic grabber and overhead travelling crane.

In this area, the MSW is shredded to a particle size of 100 mm by means of a twin-shaft, twelve-blade primary shredder.

In case of need scrubber equipment installation can be added for the plant air treatment.

The main treatment of MSW is carried out in an area of about 1.200 m^2 adjacent to the reception area and separated off by a brick wall.

The belt conveyors that carry the material are enclosed to prevent bad odours escaping.

The waste passes through the pressurisation and feeding system, which comprises one of the two modules. When inside the machine, it is subjected to a steam-saturated atmosphere under the desired temperature and pressure conditions and passes along the internal transport system towards the exit area, while undergoing thermal/mechanical treatment technology. Prior to exiting, the treated waste passes through the second module where depressurisation takes place.

Our system's supply of steam is provided by a steam fuel feeder or boiler with a nominal capacity of 2,000 kg/h of steam and an operating pressure of 7 bar as backup of the Biomass steam boiler.

As well as steam, the area is also supplied with compressed air and electrical power to ensure that the system works properly.