

Integra Plastics: The 40 million Euro plastic recycling plant

HERBOLD latest washing line technology for high quality flakes



Figure 1: Herbold Washing Line

Introduction:

The recycling rate in Bulgaria is approx. 61%. This makes the country to the top performer considering the average EU recycling rate of approx. 40%. The current situation of plastics with increasing amount into the market, China ban, increasing recycling targets, etc. demonstrates the necessity of more and better recycling of plastic. The new plant of INTEGRA in the outskirts of Sofia is build up on an entire area of approx. 35.000 m² (approx.. 12.000 m² for production and approx. 5.000 m² for warehouses) and designed for handling of 40.000 tons film and 90.000 tons rigid plastics each year. INTEGRA is able to recycle post-consumer film from household sources with any kind of mixed color film materials and upgrade into 5 different qualities. INTEGRA will employ in this new factory 85 highly qualified stuff in the warehouse, production, laboratory, etc. The startup of the plant will be beginning of Q3 / 2019.

The plant represents a milestone in plastics recycling and is in the constellation the first of its kind in Europe.

Target:

There are lots of recycling facilities where mixed waste materials get processed and plastic recycled. These plants are mostly designed to produce at the end low priced products as the design of the recycling plant does not allow producing high quality product. Furthermore the quality of the recycled material is not always constant which makes the following processes become more unsteady. The target from INTEGRA was to close the loop and generate from pre-sorted waste again granules which are comparable to virgin material. Only "perfect" recycled material can be again used for producing of high-grade plastic product. The process steps which are described under *Figure 2* are close to this target and an important step of circular economy.

Process:

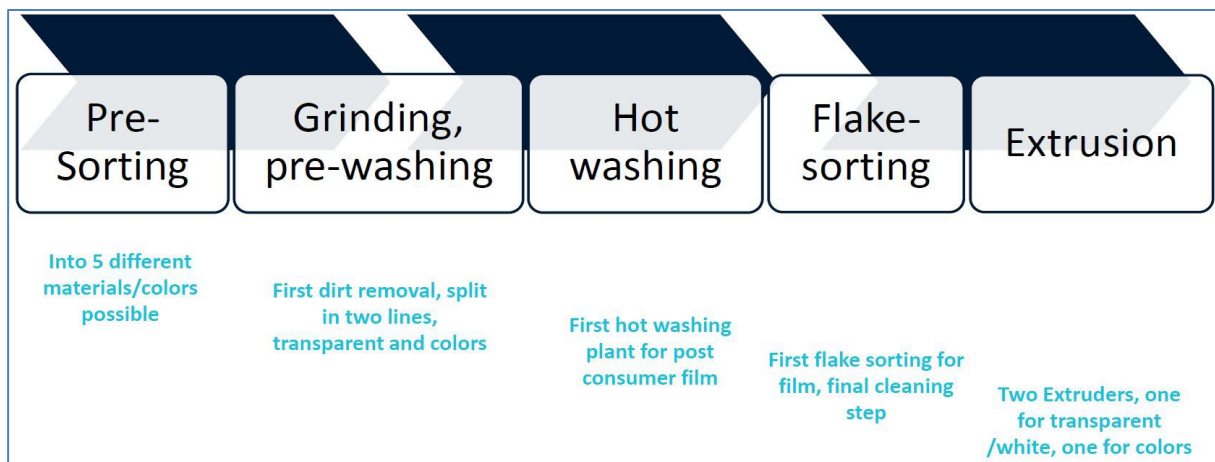


Figure 2: Concept with special features

Pre-Sorting:



Figure 3: Pre-Sorting step

Pre-sorted waste pressed in bales coming from DSD 310 sources gets forwarded to the De-wiring unit. This is first step of the plant where the wires of the bales will be removed. The dismantled material is now forwarded to the first size-reduction step in a shredder. The task is to generate sizes like DIN-A4-sheets in order that the detection of the NIR sorter works well.

The material is moving then on conveyor belts of more than 1km length where ballistic separator, NIR optical sorter and other mechanical instruments take over the cleaning process in order to receive material free of metal, glass, stones, paper, wood, etc. During this process the film material is sorted into transparent LDPE, blue LDPE, green HDPE, white HDPE and others. The different fractions get pressed into new bales for further processing in the washing line.

Washing Line & Flake-Sorting & Extrusion:



Figure 4: Herbold Washing Line

Pre-Shredding:



Figure 5: Shredder EWS 60/210



Figure 6: De-Wiring unit

As the washing line receives again baled and wired material it is necessary to de-wire the bales. Therefore the process starts again with a de-wiring unit.

The washing process is splitted into two lines with each approx. 1,85 t/h input capacity.

It starts with the new **HERBOLD Shredder EWS 60/210** for pre-sizing of the material which can be used in dry as well as wet design. In the INTEGRA plant the machine is operating in wet design. The machine is designed to be very robust and durable and is convincing with the ease of maintenance. Due to the worldwide increasing amount of plastic waste and as a result the high recycling rates, which are required to the industry, the input capacities of such washing lines are also increasing. HERBOLD Meckesheim has added the new shredder EWS 60/210 to its product portfolio to handle such requests.

Pre-Washing unit VWE 700:



Figure 7: Pre-Washing unit VWE 700 with material feeding

An important component in the washing line is the **multistage prewashing unit**, which captures coarse foreign bodies and reduces the mineral fraction, both to protect the subsequent machines. The remainder is also gently prewashed. The type of prewashing developed by HERBOLD Meckesheim has been a proven technology for a long time already that has convinced our customers. We have now optimized this process step even further by increasing the throughput performance for films, optimizing the flow of water, and integrating a baffle plate thickener into the unit to clean the process water. We therefore remove contaminants directly on the unit.

Wet Granulation and Friction washer:



Figure 8: Wet Granulator SMS 80/160

The material is size reduced and washed at the same time in the **wet granulator SMS 80/160**. Friction during the cutting process is used to obtain an excellent washing of the flakes. Most of the dirt is washed off at this step. HERBOLD heavy duty granulators from the SMS series are designed for tough applications and maximum outputs. The energy efficient working granulator with double cross cutting action is one of the key design features which ensure a real scissors cut with less generation of heat.

Furthermore the machine is protected against wear with complete exchangeable wear protection package for granulator's housing and rotor.

Since the flakes are discharged from the granulator with water, it is necessary to install a friction washer which separates the dirty water and further contaminations. The **friction washer** separates the flakes from dirty water and is equipped with a rinsing device for automatic cleaning of the screen and of the inner housing. Furthermore it is optimal protected against corrosion by the use of galvanized parts.

Hot-Wash Step:



Hot-washed flakes

Figure 9: Hot-Wash Step

Increasing quality requirements in the plastic recycling industry also require optimized cleaning stages. An important step in plastic recycling is the **hot washing step**, which has been a major step in the PET bottle recycling process. HERBOLD Meckesheim has advanced this step of the process for PO films and can offer optimized temperatures and appropriate dwell times, and can provide optimal cleaning results and end material quality through the use of suitable additives.

The end result of the clean flakes speaks for itself: Fatty impurities from remnants are dissolved and washed away, as are residues from labels and their adhesives. This clean flake material has reduced odour, is clear and does not yellow. This step is absolutely necessary and an important part to close the loop in order to produce at the end a high quality product which is comparable with the quality of a virgin product.

The hot-wash step is equipped with its own **hot-water treatment** in order to reduce the operation costs and keep the loss of heat to a minimum. The hot-water treatment contains a decanter where solids are separated from water by high speed rotation. The NaOH lye is transported to the heat exchanging unit in which the needed temperature of the lye is generated. The loop is closed by pumping the hot washing lye back to the hot-wash step.

The hot-wash step for film material is one of the key points what INTEGRA appreciates on the HERBOLD concept.

Hydrocyclone density separation:



Figure 10: Hydrocyclone density separation



Figure 11: Hydrocyclone unit

HERBOLD relies on **density separation with the hydrocyclone** and we have established this type of mechanical separation in the field of plastics recycling.

In our opinion, density separation in a separation tank with simple weight force is a thing of the past, as the use of centrifugal forces in a hydrocyclone significantly improves the separation result and also creates a washing effect due to the generated friction. The acceleration used for separation is 11x higher, which is an impressive number! With combining the hydrocyclone with the hot wash, the end result in the subsequent steps, i.e. regranulation is clearly noticeable. The lifetime of the tools from re-granulation is much higher. Due to intensive washing and high separation efficiency it is possible to generate better final product quality which is a good argument for premium price!

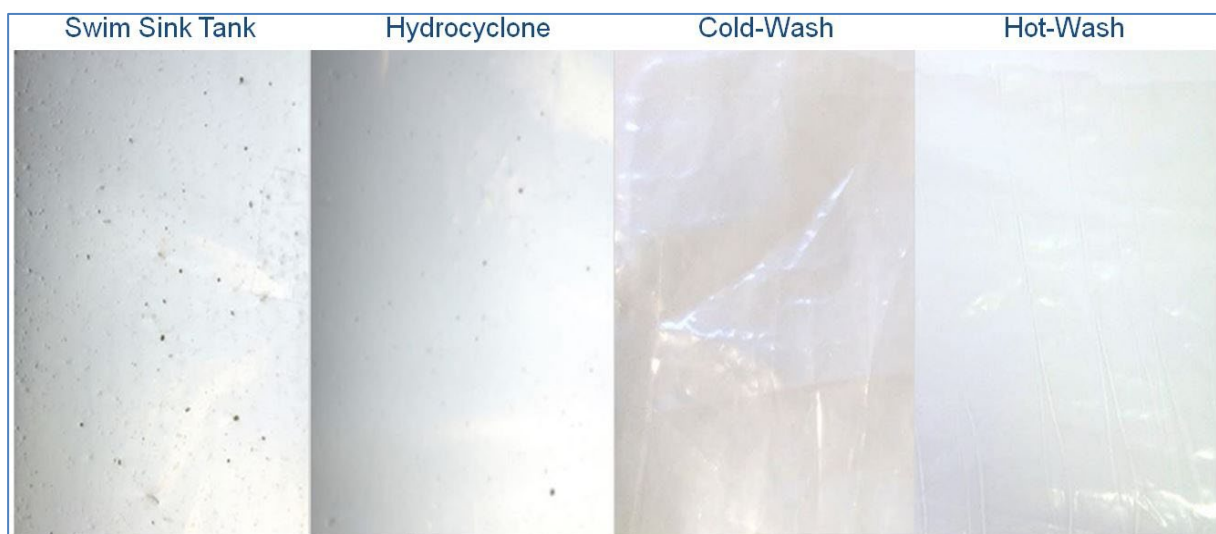


Figure 12: Quality improvement with Hydrocyclone and Hot-Wash

Drying & Sorting & Intermediate storage & Extrusion:



Figure 13: Mechanical dryer T2015S and thermal dryer

The installed **mechanical dryer T2015S** is suited for high product output rates. The material is received after the friction washer from the hydrocyclone step for first drying with mechanical forces. At the same time contaminations such as paper labels are removed from the fraction by the high impact energy.

The dryers from HERBOLD Meckesheim already meet the highest quality standards for increased drying efficiency and performance, better accessibility, wear-resistant parts or automatic cleaning systems. In addition, **thermal drying** has now been optimized, which is used primarily in film recycling to achieve low residual moisture in order to process the material further in an energy-saving. The flow through the coils was optimized and the heating temperature was improved in terms of energy consumption. With the thermal dryer it is no longer a problem to receive for low density film material moisture levels <5% for further processing in an extruder.

The material is afterwards pneumatically forwarded to the **HERBOLD flake silo** which is especially suited for badly flowing materials as film flakes. With the continuous working agitator arm and discharge screws we are able to avoid any bridging of the material and allow a trouble free discharge to the next unit.

A special feature of this INTEGRA washing line is that one of the two lines includes a NIR-flake sorting unit after the thermal drying step. This is the first of its kind for such kind of material. This equipment is intended to sort with cameras and sensors different colored film-flakes than transparent one. The target is to receive high quality end product whose quality is close to that of virgin material in order to replace this one day. This would be a real circular economy and the loop would be closed!



Figure 14: NIR Flake sorting unit for film flakes

The process is closed with two extrusion units at the end. The produced granules out of the flakes can now be used for producing new material, i.e. blowing of new film for different applications. An energy-saving and with high capacity working extruder requires always an efficient washing process which is definitely fulfilled with the components of HERBOLD.

Agglomerating with Plastcompactor:



Figure 15: Herbold HV Plastcompactor for ejected plastics

The target should be always to utilize each fraction, also the fraction which is ejected, especially in this case from the NIR-flake-sorting unit. As the input capacity of the INTEGRA plant is very high, the amount of ejected material (i.e. different coloured film flakes) is also enough which makes the recycling of this fraction also useful. With the **plastcompactor** a gentle treatment of the flakes is possible and at the end the customer receives agglomerate with high bulk density and improved flow characteristics which makes further processing of the material much easier. This material can be used for producing low quality products where no great demands are necessary.

Water Treatment:



Figure 16: Extended Water Treatment

One of the most important process steps in a washing line is the water treatment, which is often forgotten. It would be related with high costs if just fresh water is used to keep the process running. The water treatment at INTEGRA plant is consisting of three steps: The first step is designed as **mechanical purification** of larger particles ($> 500 \mu\text{m}$). This is done by means of two screening machines. To keep the fresh water consumption to a minimum and increase the life time of the machines and parts it is necessary that some of waste water is discharged to the next **chemical treatment step with flotation**.

This allows minimizing the dissolved and sedimentable solids in the waste water. By adding flocculants into the system it is possible to separate solids down to a size of approx. 40µm. Furthermore it is possible to influence the waste water discharge parameters by dosing chemical substances into the system.

The water is then further treated in the **biological water treatment** by Moving-Bed-Biofilm-Reactor (MBBR). For this the discharged water from the clear water tank of the flotation process is pumped into the MBBR-process. The process consists of an aeration tank with special plastic carriers that provide a surface where a biofilm can grow due to oxygenation and contained waste particles in the water. The remaining waste particles in the water serve as food for the microorganisms of the biofilm and as result the BOD-amount of the water is reduced. Further splitting agents are improving the flocculation and therefore increasing the COD-reduction. The water coming out at the end from the sand filter is now cleaned waste water and can be forwarded into the canal.

Electrical Control Unit:

The automatic plant control is done by Siemens PLC S7-1500. Furthermore the complete plant control is combined and monitored in a separate control station. The challenge was to install here a dynamic process control in order that settings can be adjusted automatically as well as to have a well communication or signal exchange between the different installed systems on site to allow a smooth operation.

Summary / Benefit:

HERBOLD is proud to be part of this project, which is the next generation of mixed film recycling. With our experience of more than 40 years in engineering and manufacturing of machines for recycling of plastics we have supported INTEGRA and designed a system which is state of the art! The current situation with plastics (i.e. China ban, new design of packaging material, demand of use recycled plastic material, plastic recycling rates, recycling targets, etc.) will contribute that more recycling plants like INTEGRA will follow in the near future in order to get a truly circular economy!

HERBOLD washing line system includes components which presents the latest technology for such kind of process. The **benefits** are obvious:

- New **shredder EWS 60/210** in dry and wet applications for high applications and in maintenance-friendly design.
- The new design of the **pre-washing unit VWE** for protection of the downstream equipment:
 - Internal water treatment reduces the water consumption which results in a release of the general water treatment
 - Lower wear and maintenance costs for downstream equipment
- The critical machine parts are designed with **replaceable wear parts** which can be easily exchanged:
 - Reducing of down time periods to a minimum
 - Long years of operation is possible
- HERBOLD machines are famous for its **sturdiness and reliable design**. Especially our Granulator from the SMS series is the best example for this.
- **HERBOLD Hot-Wash Step** guarantees on the basis of its special design excellent cleaning results due to optimum temperatures, suitable dwell time and optimum use of additives.
- The **Hydrocyclone density separation** which is integrated by HERBOLD in the field of plastic recycling has a significant better separation effect than swim-sink technology and additionally intensive washing of the material due to centrifugal forces:
 - Better final product quality → Product can be sold for premium price
 - Lifetime of tools from the following process is higher (i.e. re-granulation process) which results in saving of costs and time for changing.

- Optimized **thermal drying** step with higher drying effect, higher energy efficiency and better temperature setting.
- Three step **water treatment** with combining of mechanical, chemical and biological process steps in order to minimize the fresh water consumption, increasing the life time of the machines and parts as well as improving the quality of the waste water for discharging into rivers.
- HERBOLD is always in a close cooperation and support (i.e. service and spare parts) with its customers which helps first of all to improve our technology with the received feedback and present always the best solution to our customers.

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About HERBOLD:

The HERBOLD Meckesheim GmbH is a leading specialist for the plastic and recycling industry. The systems help reduce and recycle plastic waste all over the globe. Systems from HERBOLD are used worldwide. They are used to treat the “clean” waste produced in the plastic processing industry as well as used, mixed, and contaminated plastic waste. The machines are used for fine grinding plastic granulates and waste as well as in numerous other applications in waste treatment, raw material recovery, and material preparation in various industrial processes. Today, HERBOLD is managed by the fourth generation, Karlheinz and Werner HERBOLD, and develops and tests the systems in its own technical department. Over 160 employees in Meckesheim and the employees of our international representatives provide support for the custom machines manufactured according to customer requirements, from the planning and commissioning phases to the end of their service lives.