

ValueFlex

Basic Engineering I

Process description washing lines and extrusion



Washing line

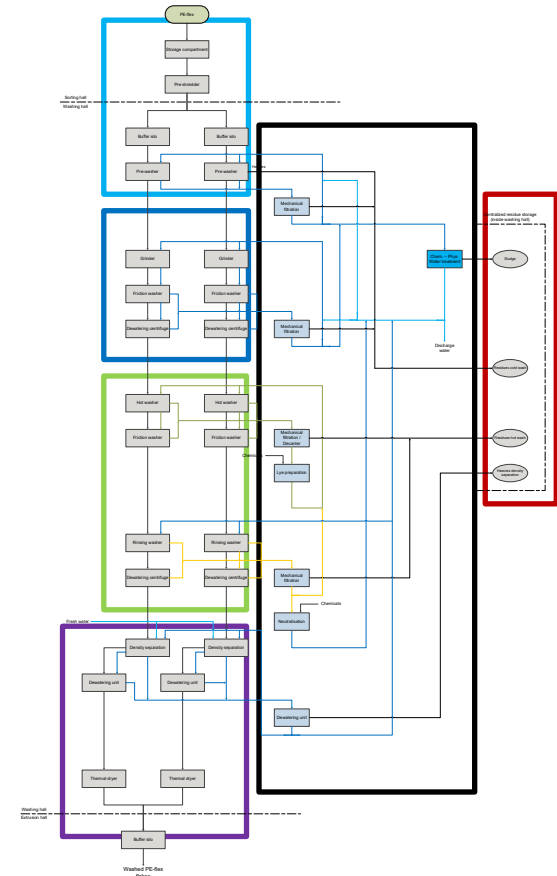
As mentioned in the beginning of this chapter, the washing part consists of three technically identical washing lines.

Each washing line consists of six main functional areas, highlighted on the right side of this slide.

For the following detailed description of the process, the sectional depictions of a single line washing line will be regarded.

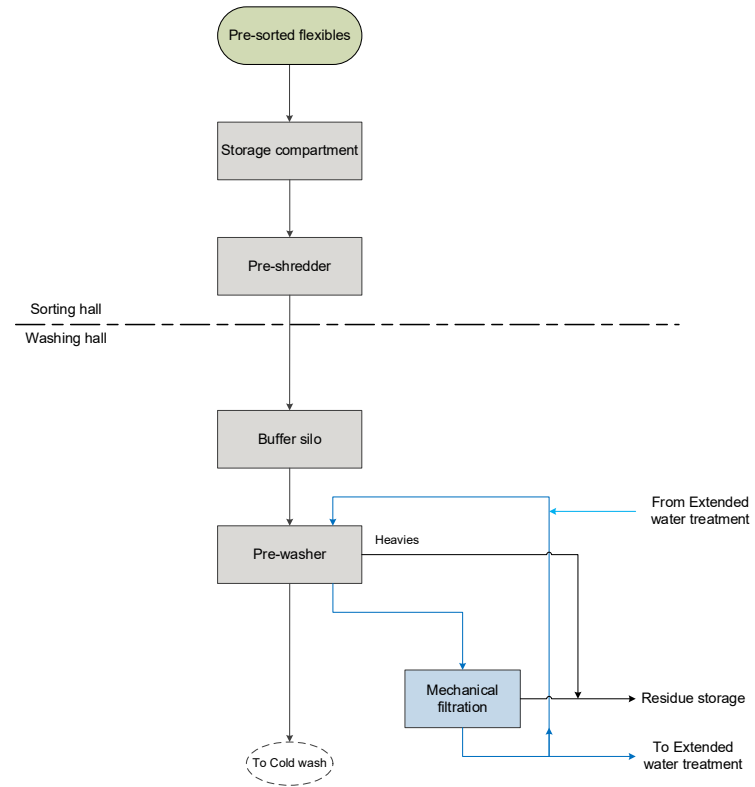
Functional areas

- Infeed & Pre-Wash
- Cold Wash
- Hot wash and Rinsing
- Density separation and dewatering
- Process water concept
- Residue collection



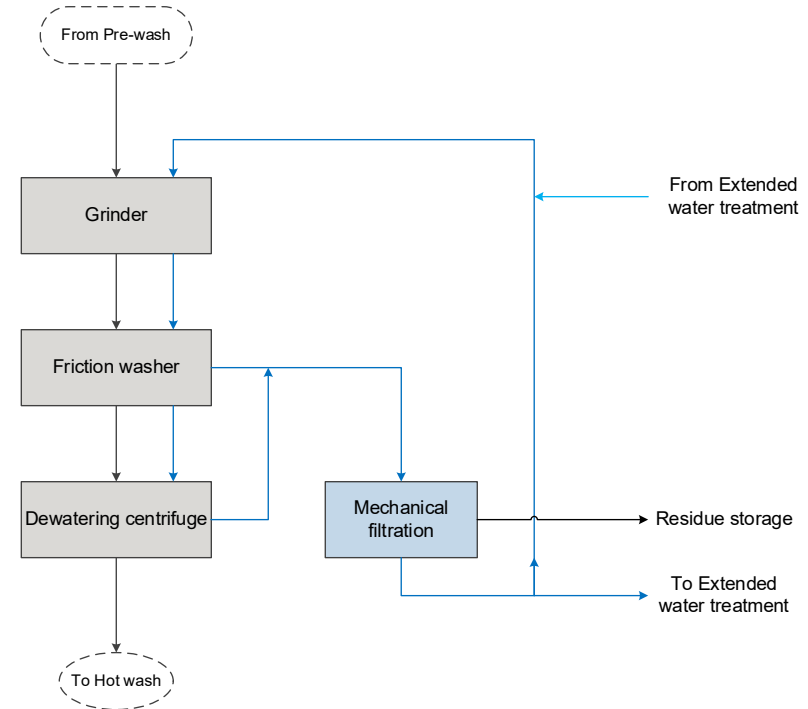
Infeed & Pre-Wash

- The Input of the washing line is pre-compacted film from the storage compartments.
- The film is fed to a pre-shredder for size reduction / increasing bulk density. The grain size after pre-shredding lays between 60-80 mm.
- A Buffer silo upfront machinery washing line to ensure a continuous material flow by levelling out the difference in capacity between the pre-shredder and the washing line. Due to this, downtimes caused by clogging can be prevented.
- A Pre-washing units heavy materials that sink in water (e.g. stones) to decrease wear in the subsequent grinding step. Additionally, coarse contaminants are cleaned from the film surfaces.
- Process water is continuously taken out of the Pre-washer and cleaned by mechanical filtration.



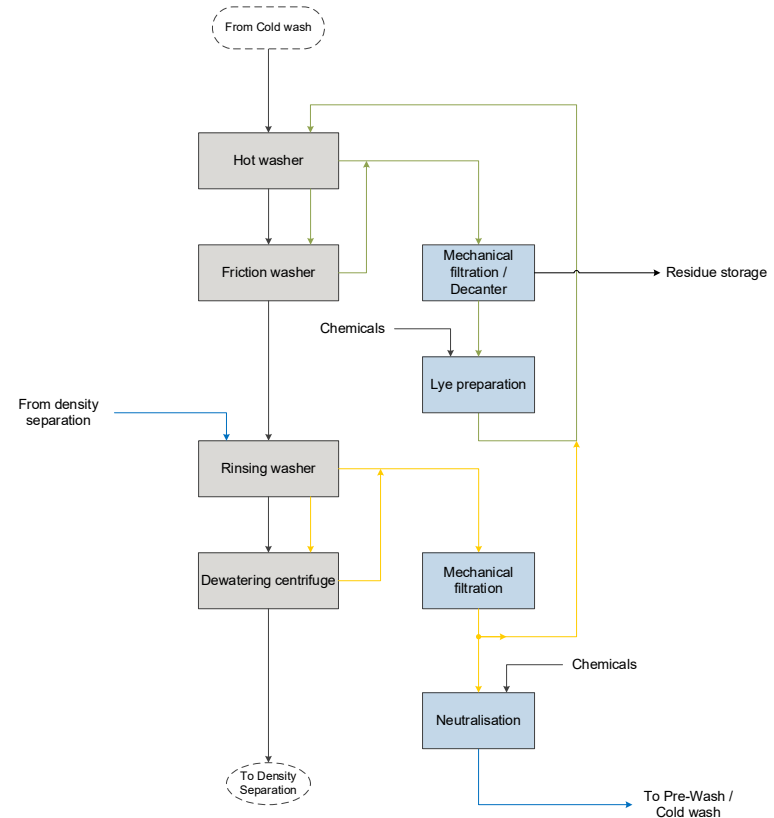
Cold wash

- Grinding of the pre-shredded film flakes for size reduction and separation of impurities into the process water.
- In the friction washer, paper, fibres and surface contaminants are further separated from the film flakes and removed by a screen with the process water. A first dewatering is done by gravity during the transport through the friction washer.
- The film flakes are mechanically dewatered by a dewatering centrifuge, so process water that gets transported to the next washing stage is minimized.



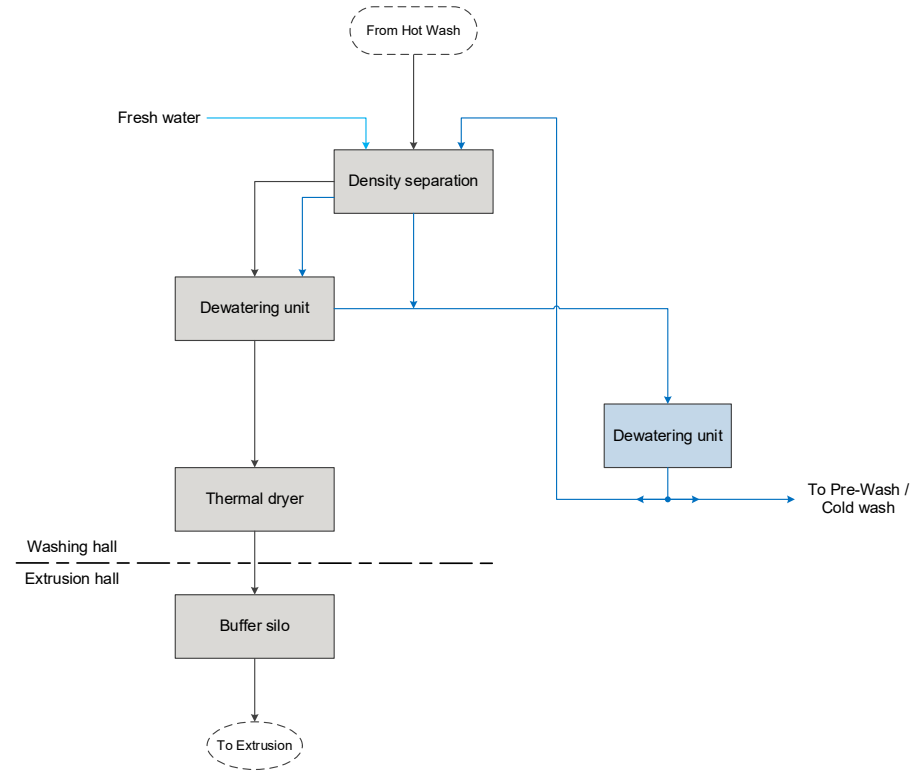
Hot wash and rinsing

- Intense washing of the cold washed film flakes by:
 - Utilisation of chemicals (e.g. caustic soda)
 - Batch or continuous design
 - Retention time ~ 10 - 15 min
 - Temperature ~ 80 – 90 °C
- Oily-pasty (e.g. glue) impurities are separated into the washing lye.
- The contaminants are then removed by a friction washer and a mechanical filtration unit. For filtration, a screen or a decanter can be foreseen.
- To separate the lye, the hot washed film flakes are rinsed in a rinsing washer by utilising process water from the subsequent washing stage of density separation.
- The film flakes are mechanically dewatered by a dewatering centrifuge, so process water that gets transported to the next washing stage is minimized.



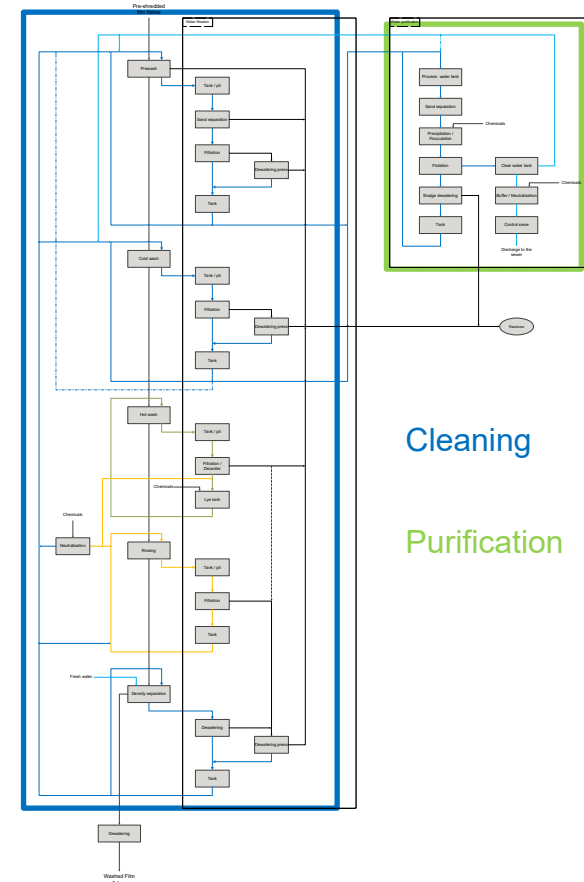
Density separation and dewatering

- In the separating medium water, contaminants with a density of $> 1 \text{ g/cm}^3$ (especially polymers) are removed from the film flakes.
- Floating material is mechanically dewatered (e.g. screen / centrifuge).
- The mechanically dewatered flakes are thermally dried to reduce the residual moisture to a minimum.
- The washed and dried film flakes are pneumatically transported into a buffer silo which is positioned in the Extrusion hall.



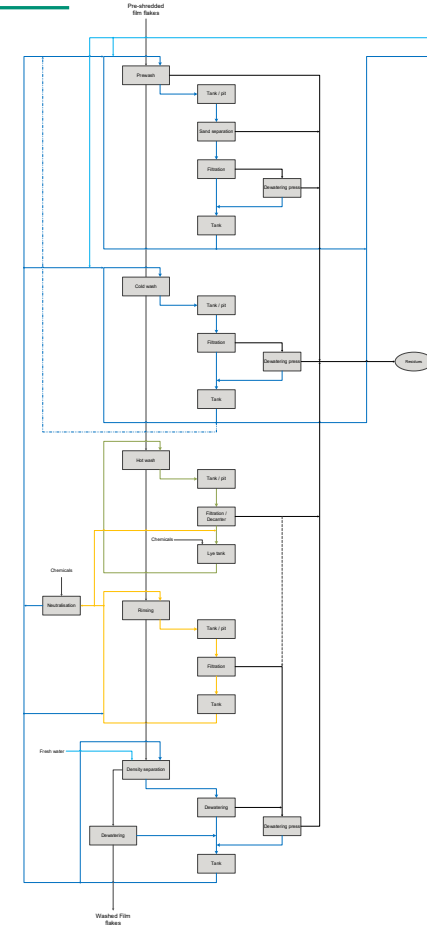
Process water concept

- The process water concept is designed based on a counterflow principle with recirculation of process water to minimize the discharging of process water and the usage of fresh water.
- Fresh water is utilized only in the last stage of the washing process (density separation), where the input material to the density separation is already cold and hot washed. The residual impurities (e.g. organic, paper), except sinking parts as for example other plastics, are reduced to a minimum due to the previous washing processes.
- The process water treatment can be divided into two treatment steps:
 - **CLEANING**
 - Process water from the washing steps is cleaned by mechanical filtration and (partly) recirculated to the respective washing step.
 - **PURIFICATION**
 - Partly, the process water from the pre-wash and cold wash step is purified in a chemical-physical water treatment process (flotation). Purified water from the water treatment is partly recirculated to the pre-wash and cold wash step and partly discharged as waste water.



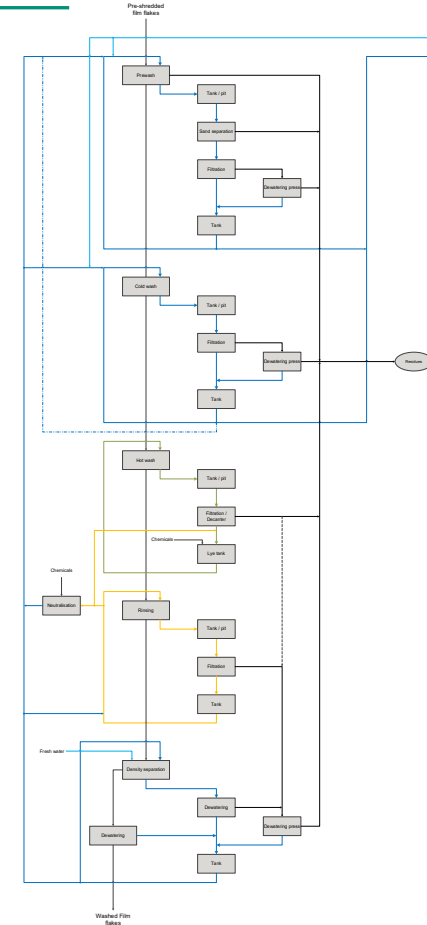
Process water concept - Cleaning

- Pre-wash
 - Process water from the pre-wash unit is treated by a sand separator and a filtration unit. The residues from the filtration unit are dewatered by a dewatering press. The cleaned process water is recirculated to the pre-washer and partly transported to the purification.
- Cold wash
 - Process water from the cold wash units is treated by a filtration unit. The residues from the filtration unit are dewatered by a dewatering press. The cleaned process water is recirculated to the cold wash and partly transported to the purification. One part of the process water can alternatively be recirculated to the pre-wash unit.
- Hot wash
 - Process water from the hot wash unit is treated by a filtration unit or optionally a decanter. The residues can optionally be dewatered by a dewatering press. The cleaned lye is stored in a lye tank for conditioning and reheating and is recirculated into the hot wash unit.
 - The hot wash circuit functions as a closed loop. Only water that evaporates or is taken out as residual moisture with the material will be replenished from the subsequent rinsing step.



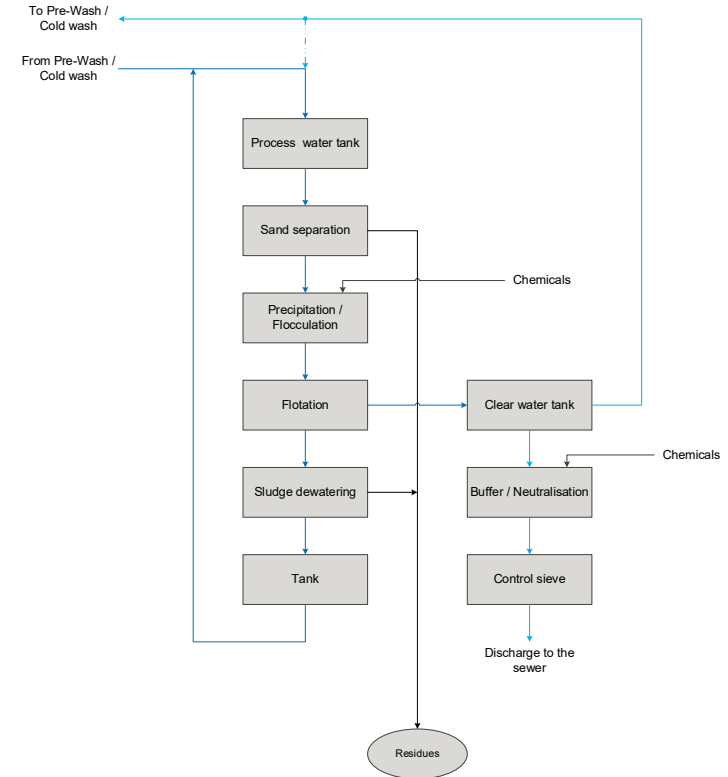
Process water concept - Cleaning

- Rinsing
 - Process water, that is pumped to the rinsing washer from the density separation is used to wash off remaining lye from the film flakes.
 - Separated water from the rinsing step is treated by a filtration unit. The residues from the filtration unit are dewatered by a dewatering press together with the sinking parts from the density separation. The cleaned process water is recirculated partly to the rinsing step and partly to the pre-wash and cold wash step after adjusting the pH-Value (Neutralisation).
 - One part of the process water is used to replenish the hot wash circuit.
- Density separation
 - Fresh water is fed to the water circuit of the density separation. As the density separation is the last washing stage, the film flakes are the cleanest at this point of the process. By adding fresh water, the quality of the flakes is improved further. Water which is discharged out of the overall washing circuit in the purification step is replenished by fresh water at this stage and circulated to upstream washing stages.
 - Process water, which is separated from the floating and sinking material by dewatering units is recirculated to the density separation unit. Excess process water, which is generated by adding fresh water, is used for rinsing and is partly fed back to the pre-wash and cold wash.



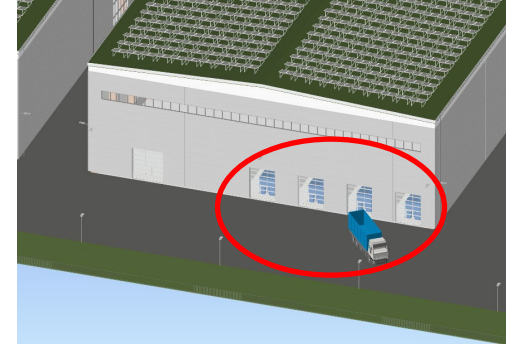
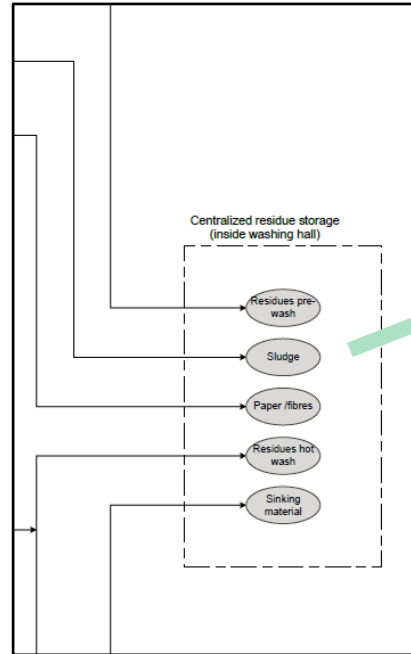
Process water concept – Purification

- A part of the process water from the water circuits of pre-wash and cold wash is transported to an extended water treatment stage (Purification). The water is stored in a process water tank.
- Settleable solids (e.g. sand) are separated by a sand separator and transported to the residue storage.
- The process water is mixed with flocculants and, if necessary, flocculation aids to precipitate colloiddally dispersed particles from the water and create flocs.
- In a subsequent flotation unit the flocs are separated through air bubbles, that attach to the surface of the flocs and are removed by means of a clearing device (e.g. paddles on top of the flotation tank). The sludge is then dewatered by e.g. a decanter and is transported to the residue storage. Process water, which is separated from the sludge is stored in a buffer tank and recirculated to the process water tank.
- Clear water, which is freed from the precipitated particles, flows into a clear water tank. A partial flow is pumped back to the pre-wash and cold wash units. A smaller partial flow is pumped to a buffer / neutralisation tank. If necessary, the pH-Value of the clear water is adjusted by using chemicals to acceptable criteria for discharge into a municipal sewer system.
- The neutralised wastewater is pumped onto a control sieve before discharge in order to avoid the carry-over of films or other impurities.
- To avoid the sedimentation of particles in pipelines and machines when the main washing line is not running, a by-pass is foreseen. The clear water from the clear water tank then circulates to the process water tank instead of being fed back to the pre-wash and cold wash.



Residue collection

- Residues (e.g. paper/fibres, sludge, sinking parts) are dewatered by dewatering presses and then collected in a centralized residue storage area in containers.
- The water filtration and dewatering units will be positioned on a platform on top of the storage containers.
- Residues, which are discharged next to key machinery, are collected together and transported to the centralized storage area.

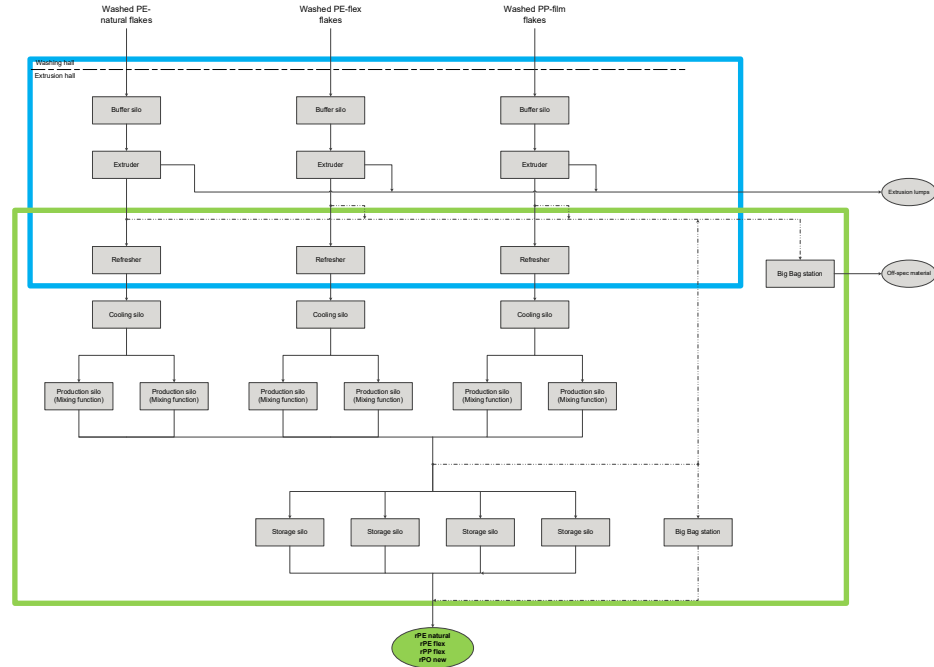


Extrusion

- For each washing line, a dedicated extrusion line is designed based on the throughput.
- Upfront the extrusion lines, a material buffer unit with 100 m³ each is foreseen for decoupling of the washing line and the extrusion line.

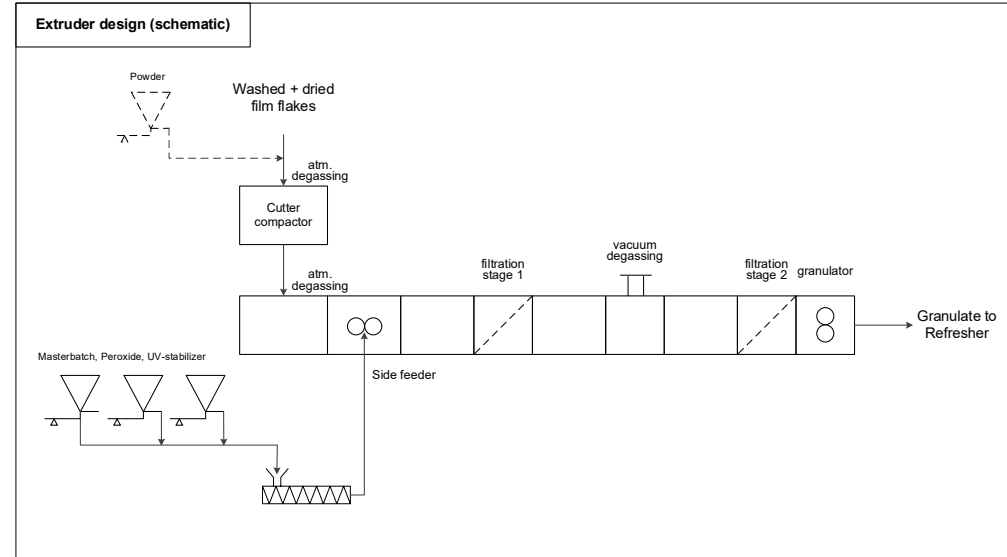
Extrusion and decontamination

Material handling



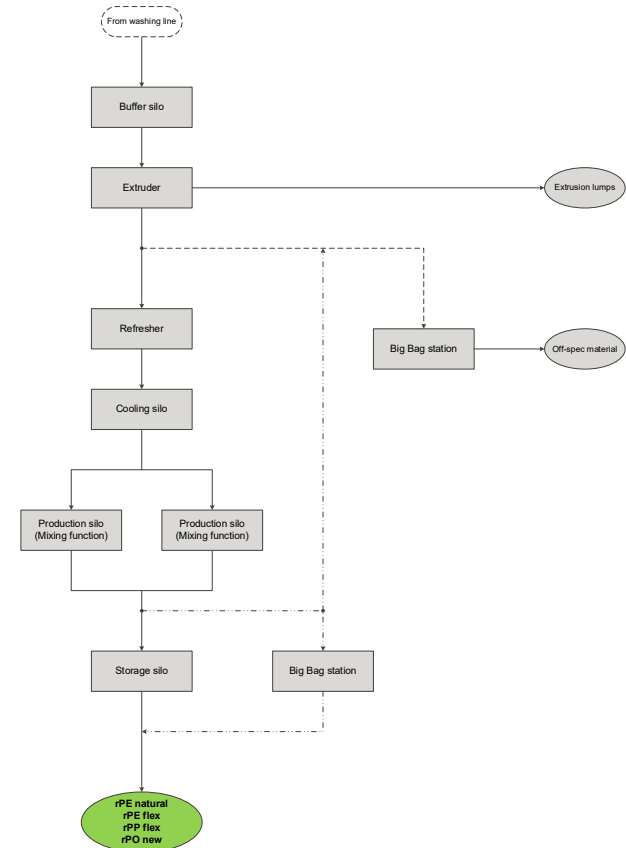
Extrusion

- Pre-compacting of washed film flakes to increase bulk density.
 - Integrated in Extruder as Cutter compactor unit.
- Producing of granulates by a single-screw extruder.
 - Additives can be mixed to the melt by a side feeder
 - Masterbatch, Peroxide, UV-stabilizer.
 - Atmospheric and vacuum degassing stages.
 - Two filtration stages.
- Granulation of the melt and transport to a downstream online decontamination (Refresher).
 - The refreshing process is a quasi-continuous treatment process, which simulates a certain residence time by the flow of material from the top to the bottom of a cylindrical silo body.
 - By flushing the granulates with hot air from the bottom to the top of the silo body, remaining volatile substances are expelled and transported out of the refresher. By this method, the odour and quality of the granulate is increased.



Material handling and quality control

- When the quality does not fulfil the requirements (checked by analysing devices integrated in the extruder), the granulate can directly be transported into a Big Bag station before refreshing.
- After refreshing, the granulate is transported into a cooling silo.
- The cooled down granulate is filled in one of two production silos with mixing function for homogenisation.
 - After filling one of the two mixing silos, it is blocked for quality analysis. Only after confirming the quality by laboratory, the silo will be emptied and transported to the subsequent storage and loading equipment.
- Three ways of further transportation and loading are possible:
 - Big Bag station in case of insufficient quality (Off-spec material).
 - Big Bag station in case of fulfilled quality requirements but the customer demands the product shipped in BigBags.
 - Storage silos for loading into silo trucks .



Dust filter

- Collecting of dry air flows:
 - Pneumatic transport
 - Area extraction (e.g. pre-shredder)
- Separation and collection of dust from the air flows
- Clean air is discharged to the environment

Odor filter

- Collecting of odorous air flows:
 - Area extraction (e.g. Water treatment)
 - Extrusion
- Active carbon filter to neutralize odor / air pollutants
- Clean air is discharged to the environment

Cooler / Chiller

- Cooling capacity needed:
 - Granulate cooling
 - Extruder (Drive)



Compressor unit

- Production of compressed air:
 - NIR sorting
 - Instrumentation air
 - Maintenance

Heat recovery will be foreseen:

- Limit energy consumption due to cooling
- Preheating of water / air (e.g. Hot wash, Thermal drying)
- Heating of buildings