Plastic recycling machines

A catalogue on machinery for recycling of plastic waste

Realised by: Sethupathy Azhaganandam / Verele de Vreede
WASTE, Netherlands
Developed for the EJOM project in Mali
Version: August 2019

Copyrights

This publication is realised under the EJOM project funded by the EU.

The publication is also available in French

More information on the publication and related publications can be found on www.waste.nl.

Realised by WASTE Foundation:

Verele de Vreede

Sethupathy Azhaganandam

Sophie van den Berg

Contents

Introduction

This catalogue shows a selected number of machines suitable for the valorisation of plastics into products which can be used as secondary material for the plastics industry.

The first chapter gives a short explanation on plastics, the types and how they can be recycled or valorised. Then the various valorisation processes are shown in diagrams with a reference to the machines that can be used during the various valorisation steps.

The second part of this catalogue lists a selection of different machines mentioned in the diagrams. It has an image and if available a technical drawing. Furthermore an explication on the machine:

1. Type of machine and the possibility to build it in Mali
2. Production capacity either in weight / hour or weight per time of usage
3. An estimation of the costs (EURO) (based on the prices in 2019 and excluding the costs of transport from India to Dakar which would be 4,000 – 6,000 Euro per container
4. Electricity usage of the machine either in HP (horsepower) or KW (kilo watts)
5. Options for maintenance and availability spare parts and other remarks.

The described machines in this part are:

- Agglomerator
- Shredder / Grinder
- Manual / semi-automatic washing units
- Automatic washing unit
- Extruder machine towards producing crumbs
- Extruder machine towards producing granules in two stages
- Machine to make tiles
- Reversed Osmosis (RO) waste water treatment
- Mixer machine
- Hydraulic press for products using bigger moulds
- Manual injection moulding machines

Annex 1 gives some recommendations on health and regulation when working with these machines, and in plastic value chain.

Annex 2 gives recommendations on good maintenance of the machinery, to ensure high productivity and safe handling.

Information from this catalogue is based on the expert input from Sethupathy Azhaganandam, engineer and working at WASTE as adviser on machinery and Sophie van den Berg, solid waste adviser at WASTE, specialised in plastic valorisation and businesses.

For the annex on safety and health requirements we have made use of the publication ***Guide technique sur le recyclage des déchets plastiques dans les pays en développement***: realised by, Ingénieurs Assistance Internationale – Ingénieurs sans Frontières (http://www.isf-iai.be)

Types of plastics

There are thousands of different types of plastics, each with its own composition and characteristics. 6 types of plastics can be identified which can be easily recycled. The plastics industry has developed a coding system that makes recycling easier. Table 1 below shows the 6 types of plastics with their codes, their general characteristics and usual usage.

Identification code	Normal usage	General characteristics	Examples
	PET (Polyethylene terephthalate) • Mineral water bottles • Coca Cola, Pepsi bottles • Bottles with other contents eg oil	• Transparent • Hard • Strong/tough • Impermeable for water and gas • Heat resistant • Grease and oil resistant	
	HDPE (High-density polyethylene) • Bottles and flasks for soap • Buckets and other containers • Film • Crates • Milk packaging	• Impermeable for water • Resistant against chemical products • Hard or semi-hard • Strong • Surface is soft and waxy • Cheap • Permeable to gas • Natural milky white colour	
	PVC (Polyvinyl chloride) • Floor tiles • Isolation of electric cables, pipes for irrigation • Soft materials like raincoats • Shoe soles	• Transparent • Hard, rigid (flexible if plasticized with additives) • Good resistance against chemical products • Stable in the long term • Insulation against electricity • Low gas permeability	

Identification code	Normal usage	General characteristics	Examples
	LDPE (Low-density polyethylene) • Thin shopping bags • Plastic bags • film	• strong/tough • Flexible • Waxy surface • Soft- scratches easily • Can be transparent • Melts at a low temperature • Stable electrical properties • Barrier for water	
	PP (Polypropylene) • If soft uses for bags of chips • If hard used for drinking cups • Yoghurt containers	• Excellent resistance against chemical materials. • Melts at high temperature • Hard but flexible • Waxy surface • Half transparent • Strong	
	PS (Polystyrene) • Cups for coffee or tea • Packing material • Disposable cutlery	• Clear and opaque • Glassy surface • Rigid / Hard • Brittle • High clarity • Affected by grease and solvents	
	Other types of plastics, Plastics mixed with other plastics or other materials.		Currently not interesting to recycle.

When working in plastic recycling, you have to take into account the following:

- For most valorisation and recycling activities it is important to separate the different types of plastics.
- You need to avoid the littering of plastics into nature, rivers and the sea
- The recycling of plastic saves on petrol and energy

Despite that the production process is more or less the same for all types of plastics, it is good to know that a business generally should choose one type only to valorise or recycle and that each type of plastic requires its own machines with a customised set of knives, temperature regulation or pre-paring phase.

The following figure shows how the general production line is set up. But the entrepreneur can decide on some variation and only decide to work on part of this valorisation chain. The whole chain

can absorb a lot of employees, especially in the collection and sorting (both not included in this figure). Other steps in the process such as washing and drying can be done by hand or automatically. There are even machines that automate the whole production line. It should be clear that every automation comes with a price tag and extra investment and maintenance costs.

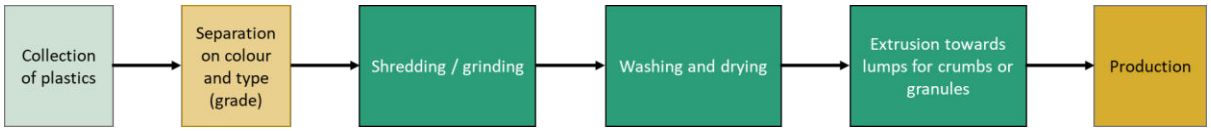


Figure 1. General production line

In the next chapter several possible variations in the production line are shown. Every production line asks for another business plan. The products will be different and with that the potential clients vary as well. In most of the production lines the end-product is a secondary raw material (crumbs, flakes, lumps and granules) and is meant for producers of (recycled) plastic products, in that case we put as end of the line transformation. In the case that the end of the product line is a product directly for the market it is called final product.

Secondary raw materials

This catalogue of machines is mainly focussing on production lines in which the plastic waste is turned into a secondary raw material to be used for the production of actual new products. These secondary raw materials are:

- Agglomerates or crumbs
- Flakes
- Lumps
- Granulates

Various transformations	
	
Lumps phase before extrusion white	*Coloured lumps*

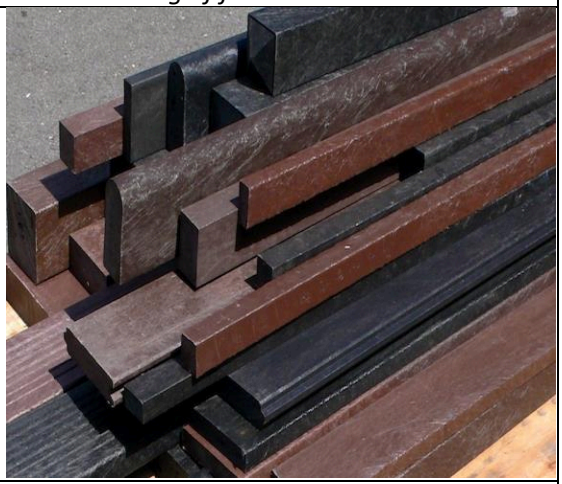
Various transformations	
	
Mixed agglomerates or crumbs	*Crumbs from colour sorted plastics*
	
Mixed flakes	*One coloured flakes*
	
Black granules or pellets	*Blue granules or pellets*

Exceptions in this catalogue are the machines suitable for making tiles or plastic lumber as the primary material can be plastic waste that only needs to be washed and agglomerated.

Also some small scale recycling moulding presses are shown, that use secondary plastic raw material.

Other examples of machines that use recycled plastics making products ready for the market are:

- Extrusion (Pipes)
- Injection moulding (containers)
- Blow moulding (bottles etc.)
- Blow moulding films (bags, sheets)
- Make tiles directly (mix with sand or other components)

Examples of various products made from recycled waste material	
	
Extrusion : Pipes	*Injection moulding: Buckets*
	
Blow moulding: Bottles	*Blow moulding of film : sacks*
	
Moulding with pressure: Paves with sand	*Extrusion: Plastic lumber*

Rules for proper reuse of plastics

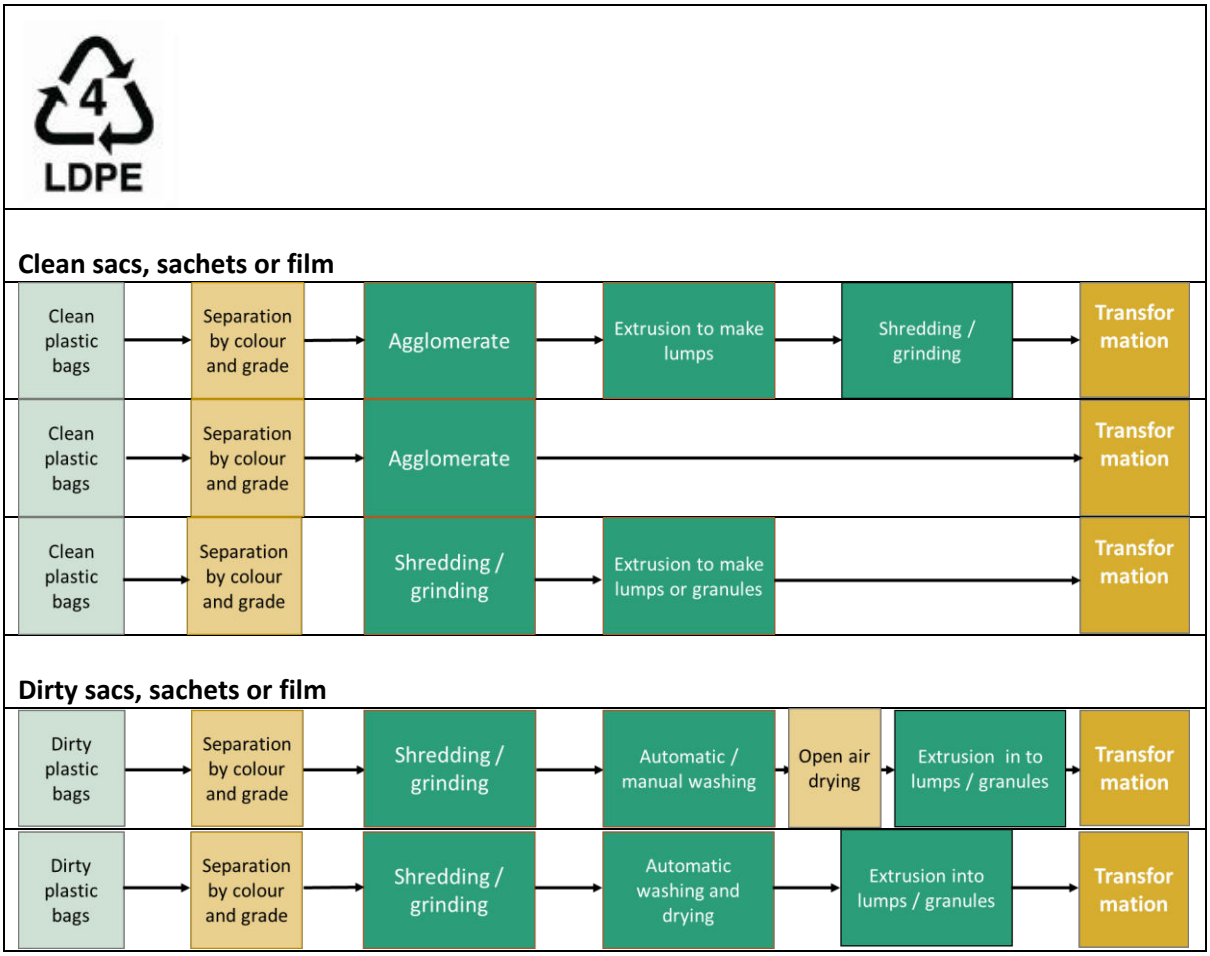
It is important to realise that there are international rules regarding the reuse of plastics. For instance, it is not allowed to use recycled plastics in containers for food or drinks. Additionally, electric copper thread cannot be isolated using recycled plastics. On the other hand the plastic tube around the copper thread already isolated with primary plastics can be made from recycled plastics.

For each country it is advised to check which rules are set up by the government.

Various production lines to make secondary raw plastics

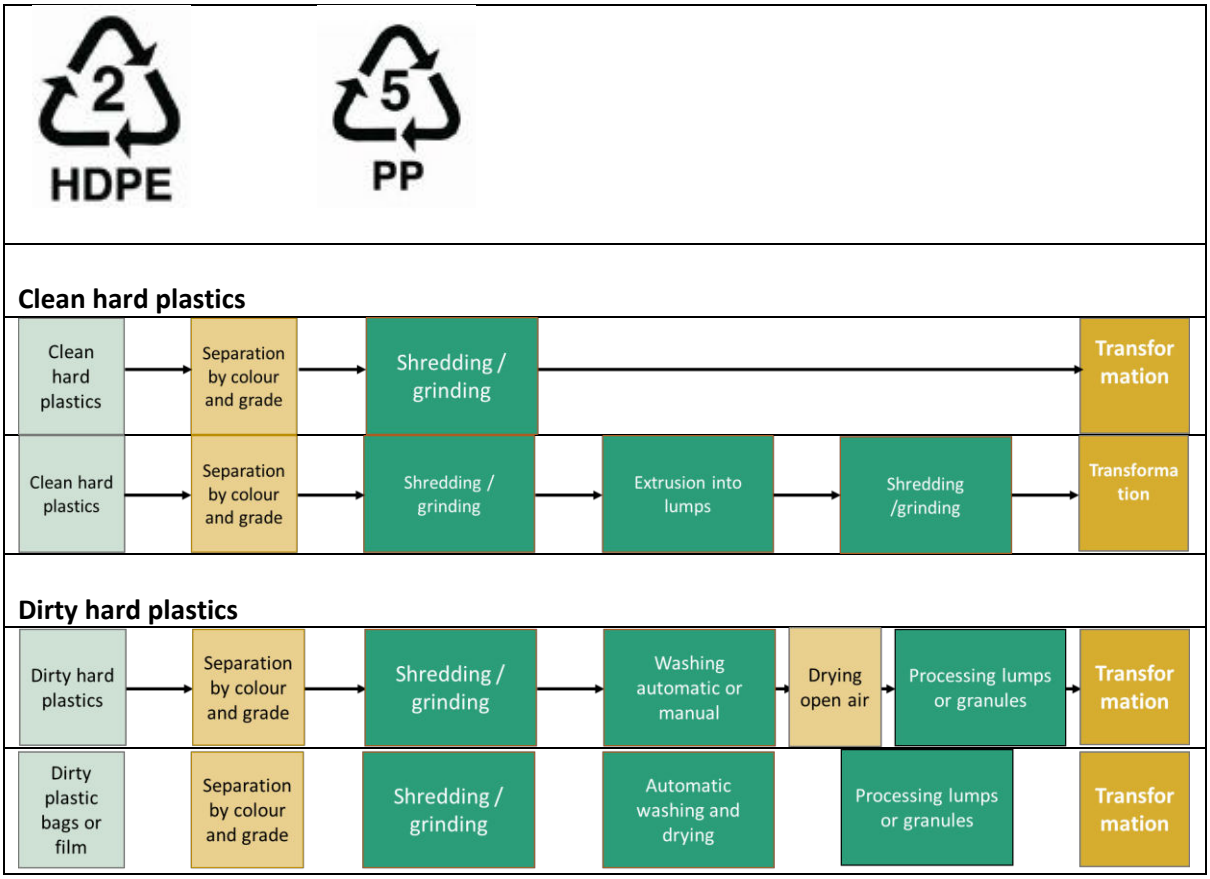
In this part of the document various production lines are shown, which can be applied in a business. It is divided per type of plastic and at the end of the page a list of machines relevant for the various stages is given plus the page where you can find a more extensive description of the machines.

Plastic film and sacks



List of machines suitable for these production lines:

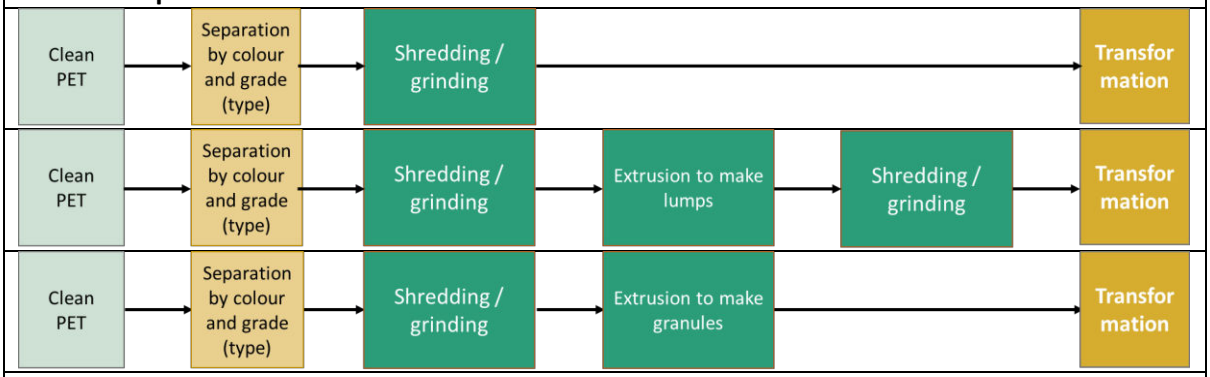
Hard plastics



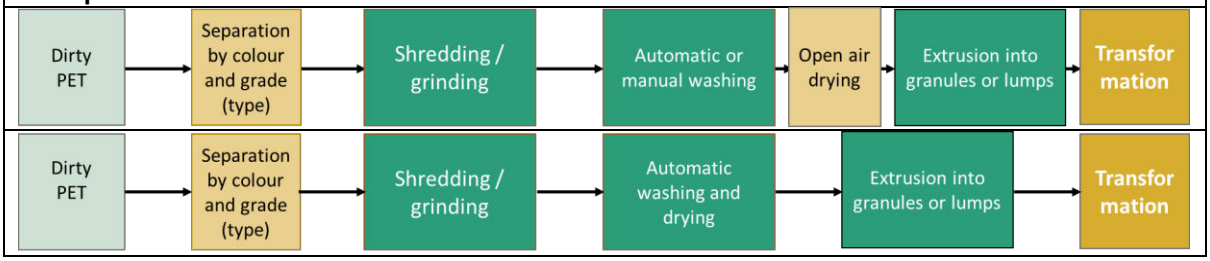
List of machines suitable for these production lines:

PET plastics

Clean hard plastics



Hard plastics sales

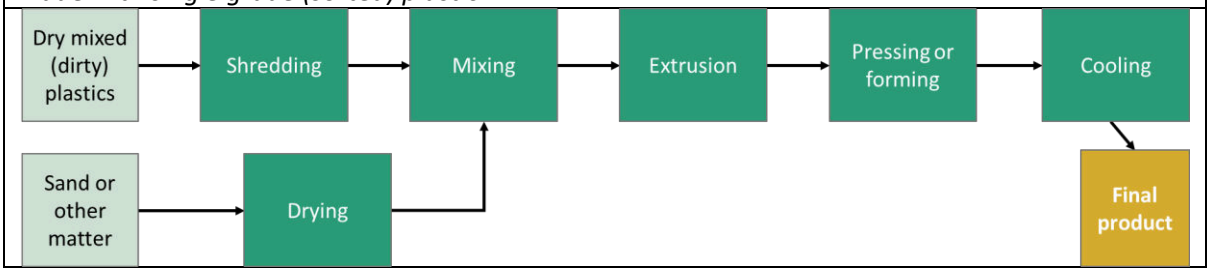


List of machines suitable for these production lines:

Plastic tiles / Plastic lumber

All types of plastics can be used

Depending on the product you choose what type or types of plastic you can use. The end product defines the types of plastic suitable. Sand tiles can accept all types. Plastic lumber is preferably made with single grade (sorted) plastic



List of machines suitable for these production lines:

Plastic recycling machines

The following pages describe and explain machines that play a role in the process from plastic waste to secondary raw material (crumbs, lumps, flakes or granules) or a new final product.

The costs of the machines are based on the prices of such machinery in India in 2019. India and China produce machines cheaper than Europe and in addition the machines often have a more simple technology, which makes them easily to maintain.

It is important to realise that currently there are no suppliers of these type of machines in Mali or surrounding countries (Ghana, Senegal).

During the EJOM project, an expert assists potential buyers and is asked to contact the EJOM coordination office.

The transport of a machine ordered in India takes 4 weeks from India to Dakar and you have to add the shipping cost is 4,000 - 6,000 Euro per container. (costs can be shared with others join filling the container). This means that the costs for transport from Dakar to Mali are not included, as that is cheaper to be arranged from Mali itself.

Depending on the type and size of the order the transport takes 2 months or more. Transport costs are often shared with others filling a container. However it might be necessary to fill a container yourself. The machines described below are examples. Often they are adapted to a certain type of plastic. Because the type of plastic influences the shape and size of the blades or filters, the machines need to be adapted. To decide on the correct blades it is desirable to consult an expert.

Also included in the catalogue are some examples of moulding machines, machines for making recycled products using moulds.

The machines described are:

N.B.

When working with plastics please make sure you use the necessary safety equipment, do a regular maintenance check, and ensure safe usage and safe handling of the machines. A more extensive list with tips can be found in annex 1 and 2 of this document.

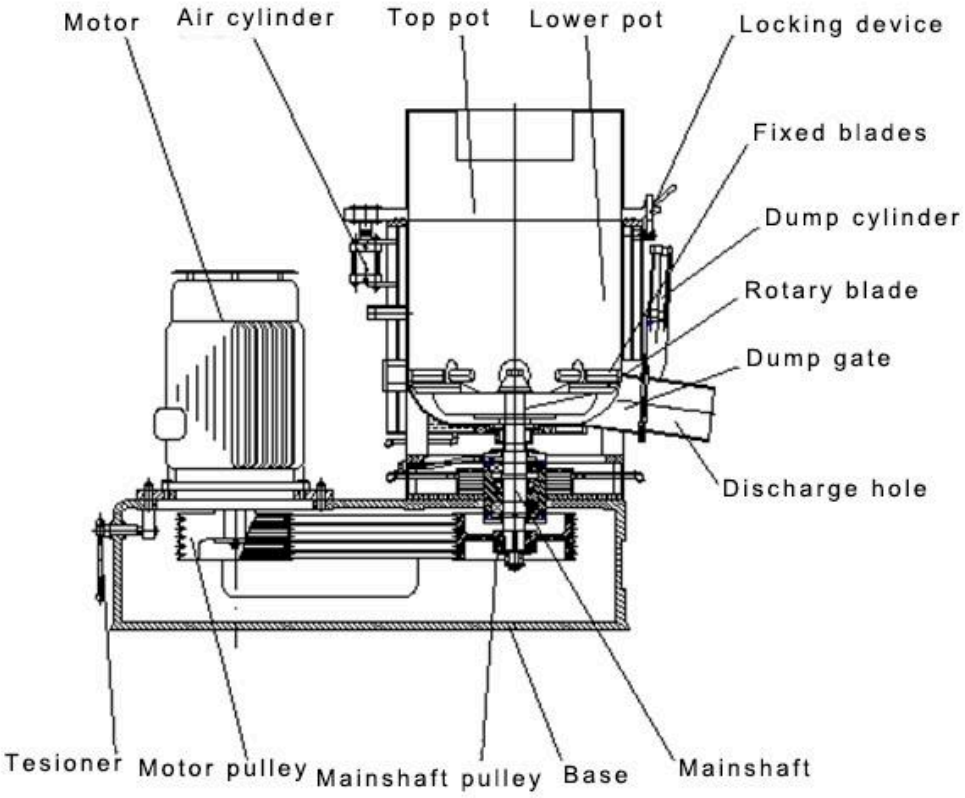
Agglomerator

Function	Melts the plastics and forms crumbs. This machine can be used as stand-alone
Types of plastics	  
Plastic bags and film material, preferably clean Dirty bags will have less value and the machine will be less productive. The various types of plastics have to be treated separately and each type of plastic needs a different type of blades.	
	
1. Manufacturing	Partially possible in Mali Main pieces and high quality elements have to be imported (eg. knives and main shaft pulley)
2. Production capacity	10 kg to 200 kg/h
3. Costs	2,000 to 15,000 Euro
4. Mechanical power	3.5KW to 60KW
5. Divers	Different models and accessories available Type of blades are based on type of plastic processed

Technical characteristics of some typical machines				
Motor	5 HP /3.7 KW	30 HP / 22.2 KW	40 HP /29.6 KW	80 HP / 60 KW
Circular blade	4	4	6	8
Fixed blade	4	4	6	8
Productivity	8 to 12kg/h	50 to 70 kg/h	85 to 100kg/h	175 to 200 kg/h

Input Products	Results	Results
		
Sachets	Crumbs	Coloured crumbs

Technical drawing of an agglomerator

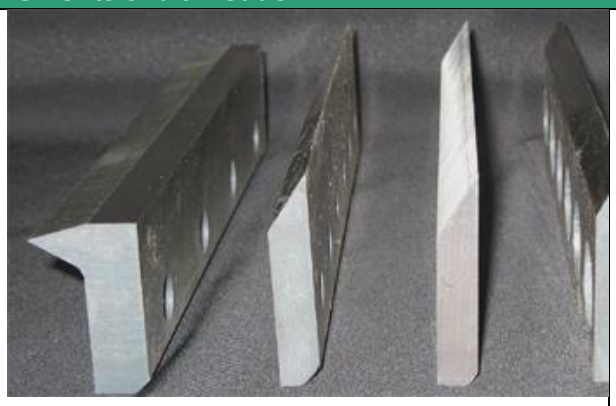


Shredder / Grinder

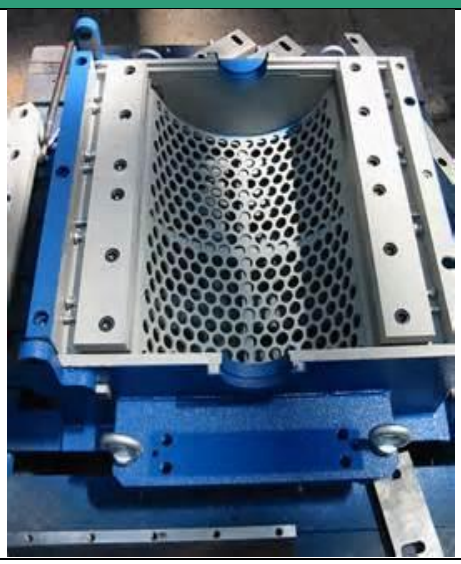
Function	Shredding of plastics
Types of plastic Bags	
Hard plastics	 
The shredder / grinder can be used stand-alone and the produced flakes can be sold directly to the plastic industry. For further valorisation the shredder /grinder must be followed by a washing unit and extruder	
	
1. Manufacturing	Possible in Mali. Main parts and special quality materials must be imported: • Crankshaft, rotor shaft • Pulley of the main shaft, fly wheel and pulley for the rotor • Blades
2. Production capacity	50 to 350 kg/h
3. Costs	1,000 to 5,000 Euros
4. Mechanical power	5.6KW to 22.4KW
5. Various	• Stones and metal objects can damage the blades and the machine. • Proper maintenance and sharpening of the blades can increase the speed of production. • Spare blades are available. • Depending on the type of plastic material the hopper, filter and blades vary.

Technical characteristics of various shredders						
Motor	7.5 HP / 5.6KW	10 HP / 7.4KW	15 HP / 11.2KW	20 HP / 14.8KW	25 HP / 18.6KW	30 HP / 22.4KW
Blades	8	10	13	13	13	13
Productivity	50 – 80 kg/h	75 – 100 kg/h	100 -150 kg/h	150 -250 kg/h	300 - 500 kg/h	350 -500 kg/h

Elements of a shredder

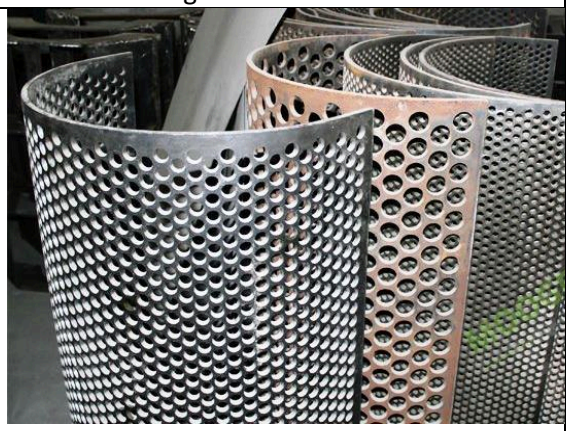


Blades



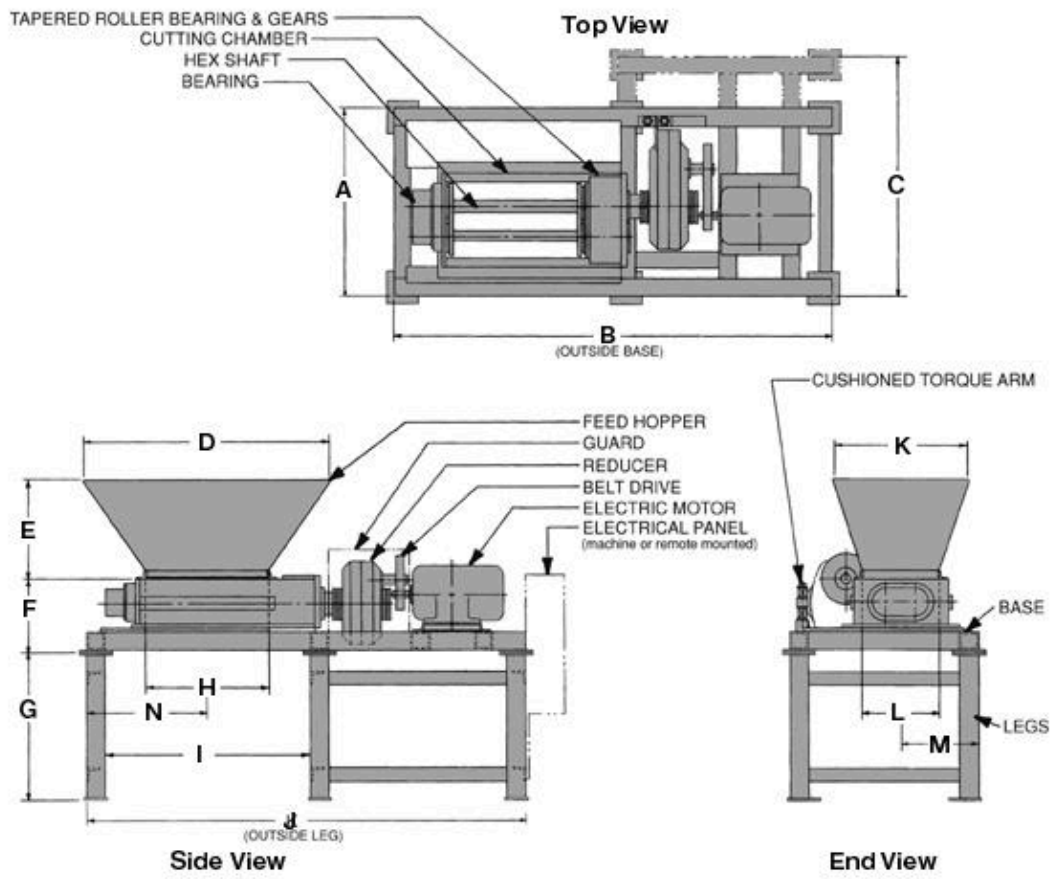
Bottom housing

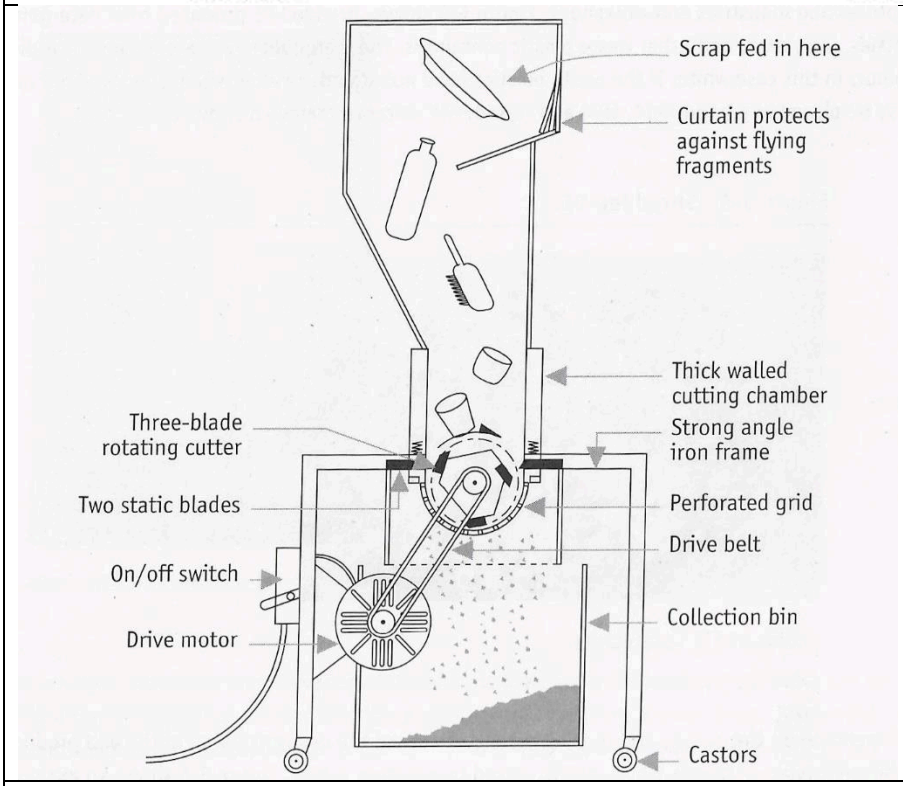
Rotor shaft



Filters

Technical design of a shredder





N.B. Depending on the type of plastic, hopper, filter and blades vary.

Manual washing units

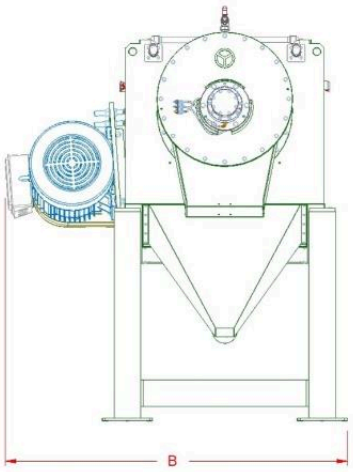
Function	**Wash already shredded plastics**
Types of plastics Sacs, bags and film	
Hard plastics	 

- This washing process is after grinding.
- This cannot be done after agglomeration.
- The machine can be used independently, or in a production line
- Film material washing capacity is about 50 kg / h
- Hard plastic washing capacity is about 200 kg / h

1. Manufacturing	Can be manufactured in Mali (manual, semi-automatic or automatic machine). Washing tank included.
2. Production capacity	25 kg/h to 200 kg/h
3. Costs	600 to 15,000 Euros
4. Mechanical power	5.6KW to 22.4KW
5. Divers	Different models and accessories available

Technical characteristics of the manual washing unit			
Motor	15 HP	25 HP	30 HP
Drum dimension	24inch / 61cm	34inch / 86.3cm	36inch / 91.4cm
Productivity	25 kg/lot	50 kg/lot	50 – 80 kg/lot

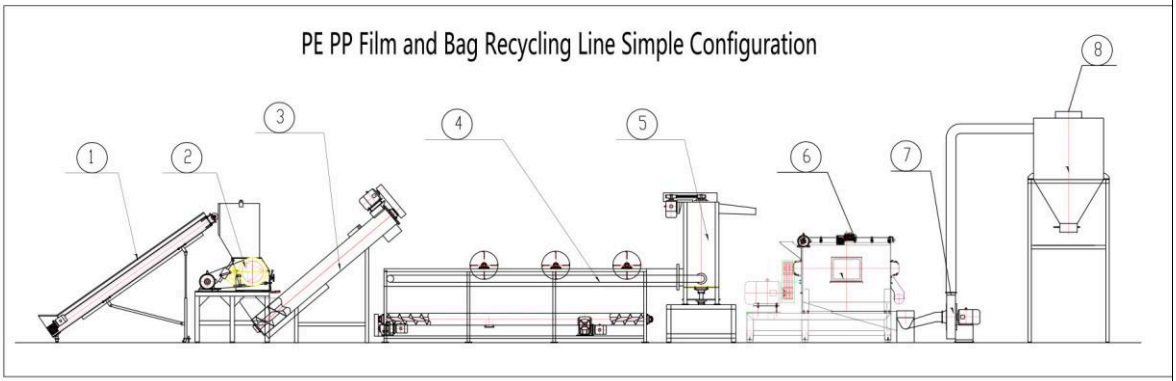
Technical drawing of a manual washing unit



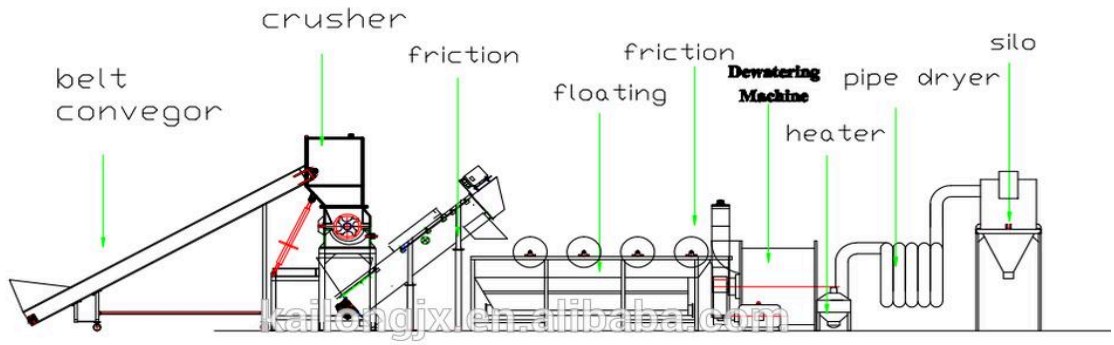
Automatic washing unit (including drying)

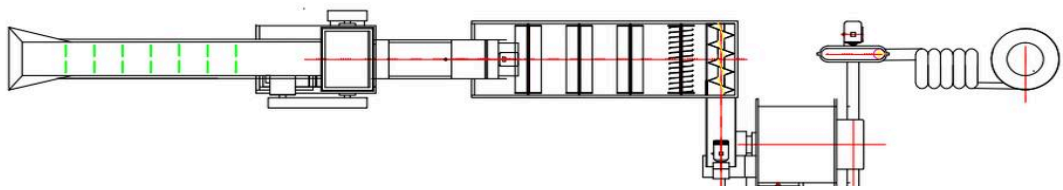
Function	Wash automatically already shredded plastics
Types of plastics Grinded Bags / films	
Hard plastics (flakes)	 
• Washing of hard plastics can be more than 200 kg per hour • Washing of soft plastics is less efficient as it is more difficult to clean than hard plastics	
	
1. Manufacturing	• Can be manufactured in Mali (manual, semi-automatic or automatic machine). • Washing tank included. • The OR water unit (Osmoses Reversed) must be imported (for cleaning the waste water)
2. Production capacity	25 kg/h to 350 kg/h
3. Costs	600 to 15,000 Euros
4. Mechanical power	5.6KW to 22.4KW
5. Various	Different models and accessories available If the product is very dirty and mixed, you must have 2 to 3 wash tanks.

Technical drawing automatic washing (included drying)



1) **Conveyor belt**
2) **Granulator/Shredder**
   A wet grinding machine equipped with a V-cutting technology rotor and flame-treated hardened knives cuts and washes the material.
3) **Screw feeder**
   Bringing the material to the next element
4) **Sink-floating tank**
   A tank separates different materials by their density. Light material is discharged from the end of the tank while heavy material is discharged by bottom and side screws.
5) **Spiral washer**
   Material is washed again in order to achieve high cleanliness
6) **Mechanical dryer**
   Water is removed by high speed centrifuge.
7) **Thermal dryer**
   This second dryer has electrical heat to further dry the material using high temperature
8) **Silo**



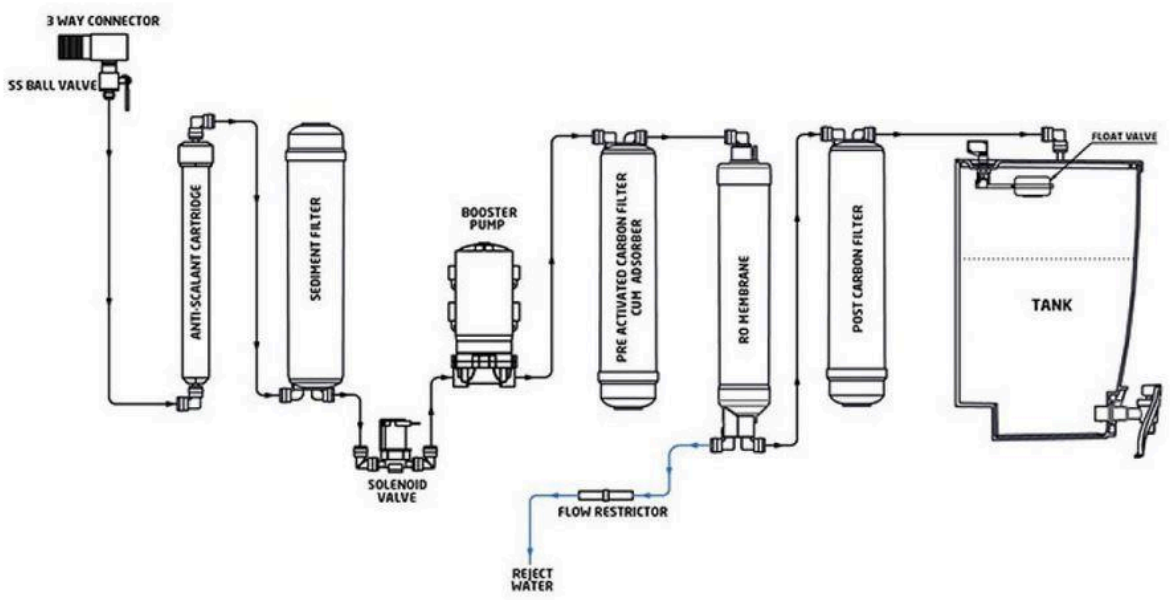


Reverse Osmosis (RO) waste water treatment

Function	Waste water treatment (a simple waste water treatment with a sink basin and sand filter can used too)
The machine is always in combination with a washing or tiling machine	
	
1. Manufacturing	Has to be imported, building is not possible in Mali.
2. Production capacity	200 l/h – 3,000 l/h
3. Costs	1,000 to 5,000 Eur.
4. Mechanical power	0.7 – 5.5 kW
5. Various	Filters need intensive maintenance

Technical characteristics				
Operation	Automatic	Automatic	Automatic	Automatic
Capacity	200 l/h	500 l/h	1.000 l/h	3.000 l/h
Machine power	1 HP	3 HP	5 HP	7.5 HP
Water feed	320 ppm	800 ppm	1.600 ppm	4.800 ppm
No of Filters	2	2	2	3
Recuperation	50 – 55%	50 – 55%	50 – 55%	50 – 55%

Technical desigh of the RO filter

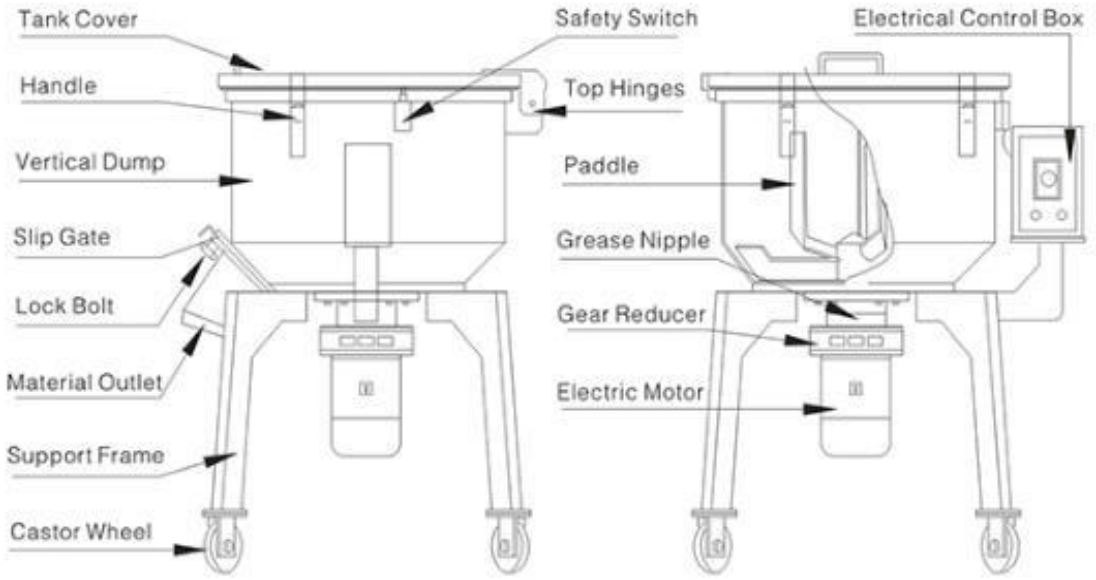


Mixer

Function	Mixing and preheating of plastics with colours before the valorisation treatment.
The mixer can mix all types of plastic, additives and dyes. (master mix, secondary materials) It preheats the materials so that the plastics becomes soft that results in a faster production in the extrusion machine and is used before the extruder	
	
Manufacturing	Can be built in Mali
Production capacity	60 kg/h – 500 kg/h
Costs	750 to 4.000 Euro
Mechanical power	5 HP – 15 HP
Various	If the mixer precedes a recycling machine, the process in the second machine happens faster, because the plastic is already preheated and a little soft. It is not advised to use a cement mixer as the speed is too slow to preheat resulting in unproper mixing of components.

Technical characteristics					
Motor	5 HP	7.5 HP	10 HP	12.5 HP	15 HP
Production	60 kg/h	120 kg/h	250 kg/h	400 kg/h	500 kg/h
Reheating	1.5 kw	2.5 kw	3 kw	4 kw	5kw

Technical design mixer



Single–stage recycling and extruder

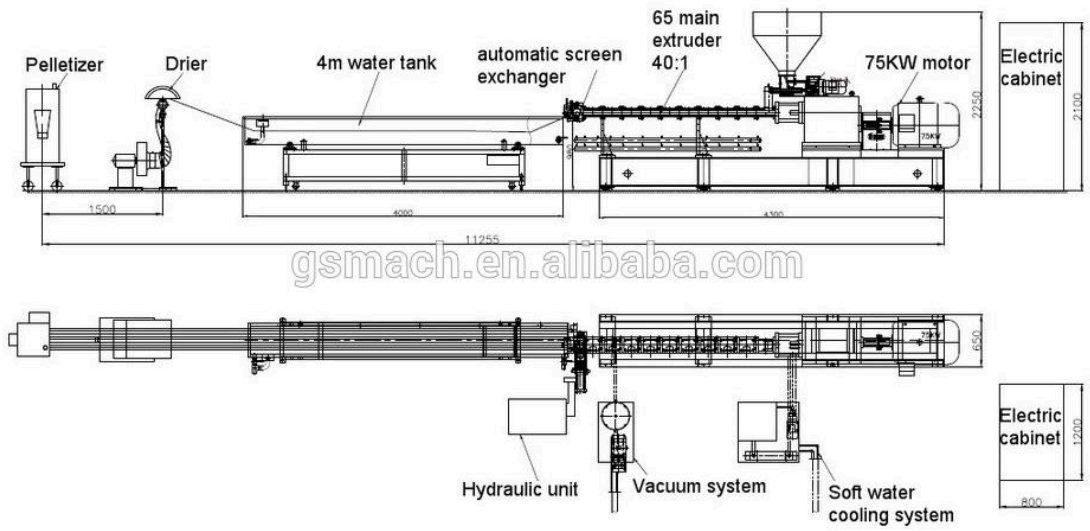
Function	Extrusion for processing plastic waste into granules
Types of plastics/ input material Sacs / bags / film • Already agglomerated • Non agglomerated	
Hard plastics (flakes or pellets)	 

- If the machine is to be used for lumps only, it can be used as a standalone
- To run this machine at full productivity for granules, an additional cooling tower or cooling unit, compressor and mixer machine is needed.
- Processing non-agglomerated bags and film lowers the efficiency

1. Manufacturing	The extruder cannot be manufactured in Mali. Assembly of imported elements is possible in Mali The cooling tank can be manufactured in Mali
2. Production capacity	50 kg/h to 350 kg/h
3. Costs	Machine : 4,500 to 25,000 Euros Cooling tank : 1,000 to 3,000 Euros
4. Mechanical power	Machine : 30 HP to 155 HP Cooling tank : 5HP to 30HP
5. Various	• If plastic is mixed with sand, the production capacity reduces. • Blades vary with the type of plastic processed • 4 replacement blades for the pelletizer are needed to ensure continuous work

Technical characteristics of the recycling and extrusion machine for processing plastic crumbs							
Diameter of screw	50mm	65mm	75mm	90mm	100mm	120mm	140mm
Main motor	12.5 HP	15 HP - 20 HP	20 HP	25 HP	30 HP	50 HP	75 HP
Heating capacity	10kw	12kw	20kw	25kw	30kw	32kw	36kw
Productivity	25 – 30kg	50-60kg	60-80kg	90-120kg	100-150kg	200-250kg	300-350kg

Technical drawing of the recycling and extrusion machine for processing plastic crumbs

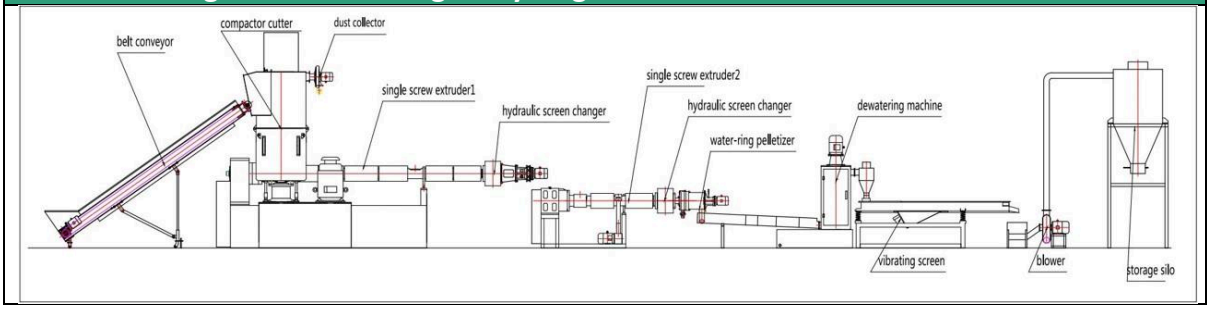


Two-stage recycling machine

Function	Extrusion in 2 steps First stage is mainly for materials melting and compounding; Second stage is low speed single screw extruder, for pressure building-up and extruding. Mainly used for film waste material.
Types of plastics (input material): Agglomerated sacs / bags / Films (crumbs) film flakes/ big sacs	
Hard plastics (flakes/granules)	 
• Clean plastic bags are preferred, dirty bags reduce the life of the machine • The machine must be preceded by a grinder and if possible by a mixer, which at the same time mixes (plastics and possibly dyes) and preheats the material. • To achieve higher productivity with this machine, an additional cooling tower or cooling unit, a compressor have to be added in the chain.	
	
	
1. Manufacturing	The recycling machine cannot be built in Mali. Only the cooling tank can be manufactured in Mali
2. Production capacity	50 kg/h to350 kg/h
3. Costs	• Recycling machine : 4,500 to25,000 Euros • Cooling tank: 1,000 to 3,000 Euros
4. Mechanical power	• Recycling machine : 29 HP to 155 HP • Cooling tank: 5 HP to 30 HP
5. Various	• Plastic mixed with sand will reduce the flow of production- • 4 replacement blades in the pelletizer are advised to ensure continuous work.

Technical characteristics of a two-stage recycling machine							
Diameter of screw	50mm	65 mm	75mm	90mm	100mm	120mm	140mm
Main motor	7.5 HP X 7.5 HP	7.5 HP X 7.5 HP	10 HP x 10 HP	15 HP X 15 HP	20 HP X 20 HP	30 HP X 30 HP	50 HP X 50 HP
No. holes in extrusion head	5	7	9	11	18	24	30
Heating capacity	10kw	12kw	20kw	25kw	30kw	32kw	36kw
Size Pelletizer / granulation	6”(inch)	6”	8”	8”	8”	10”	10”
Motor Pelletizer / granulation	1 HP	1 HP	2 HP	2 HP	2 HP	3 HP	5 HP
Productivity	40-50kg	50-60kg	60-80kg	90-120kg	100-150kg	200-250kg	300-350kg

Technical design of the two-stage recycling machine



Tile production machine

Function	Mix and melt plastics to recycle with sand or saw dust
Types of plastics Already agglomerated plastic bags (crumbs)	
Hard plastics and bottles (flakes)	 
Product	Tiles

- This machine must be preceded by an agglomerator / grinder
- Secondary materials like sand can also be added
- **To mix well a mixer needs to be added to the production line**
- If you add sand you need a sand dryer
- HDPE & LPDE must be flaked
- Bags must be agglomerated
- To achieve higher productivity with this machine, an additional cooling tower or cooling unit, a compressor and mixer machine have to be added in the chain.

1. Manufacturing	Manufacturing can be done in Mali. Main parts and special quality materials must be imported.
2. Production capacity	50 kg/h to 500 kg/h
3. Costs	600 to 5,000 Euro
4. Mechanical power	7.5 HP to 30 HP
5. Various	• Use magnets to take out metals in the waste

Technical characteristics of tile production machine					
Diameter of screw	65mm, 90mm & 65mm	90mm, 130mm & 90mm	100mm, 150mm & 100mm	120mm, 160mm & 120mm	140mm, 200mm & 140mm
Main motor	7,5 HP x5 HP x7,5 HP	15 HP x 7,5 HP x 15 HP	20 HP x 10 HP x 20 HP	30 HP x 15 HP x 30 HP	50 HP x 25 HP X 50 HP
Heating capacity	20kw	25kw	30kw	32kw	36kw
Productivity	50-60kg/h	70-80kg/h	100-120k/hg	150-200kg/h	250-300kg/h

Technical drawing of tile production machine
Not yet available, the machine has recently been developed

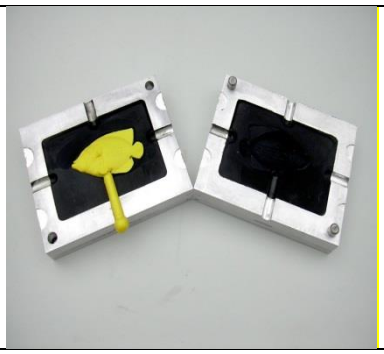
Hydraulic press for moulds

Hydraulic presses are used to press the melted plastic waste material in a mould. Examples are boards, roofing tiles, bricks etc.

Function	Apply pressure on the filled moulds	
		
Hydraulic pressure - double pillars M / c	Hydraulic pressure M / c - single pillar	Manual Pressure M / c
Capacity 100 tonnes	60 tonnes	manual 3-10 tonnes
5 HP	3 HP	Non applicable
Costs	400 -1,500 Euros	

Manual injection moulding machines

The manual injection moulding machine can be used to produce recycled products on a small scale. The input material is crumbs, flakes or pellets. Examples of products are screw driver handles, small toys, key rings and the like. These moulding machines are suitable for products up to 120 grams

function	Apply pressure on small moulds
  	
	
Examples of moulds	
	

Technical characteristics				
Strength	**250w**	**400w**	**700w**	**900w**
Weight	**30kg**	**50kg**	**80kg**	**100kg**
Yield	**0–20gm**	**0-50gm**	**0-80gm**	**0-120gm**

ANNEX 1 Health & environmental regulations

Working with plastic is working with chemical matter. Working with machines means you have to take safety precautions and that you have to take measures to safeguard the workers. And working with machines and plastic waste that are rarely clean, ask a toll of your machine and you need to pay special attention to maintenance.

This annex gives an overview of dangers for the workers and tips to ensure safe production

Chemical dangers and precautions.

Plastics in itself are not dangerous but you have to take into account

- Plastics are inflammable.
- The plastics can be mixed with dangerous chemicals (colourings, phthalates)
- Degradation of plastics in the light and or heat can break them down into toxic monomers
- Collected plastics can be polluted with all kinds of dangerous substance

Tips:

- Store plastics in a dry and dark place
- Keep the plastics away from uncontrolled heat
- Make sure that the machines are working at the correct temperature
- Wash and dry the plastics before further sorting and or treatment.

Safety precautions for persons handling plastics and machines

All machines handling plastics, work with blades, heat, screws and the like. This means that hands can get wounded, plastic shreds can fly around, heat causing access water explode and molten plastics can cause serious burns.

Tips:

- Make sure the persons handling the machines know how the machine works and use the necessary safety equipment:
    - gloves, waterproof for washing
    - safety glasses (grinding)
    - work overalls
    - ear plugs or headphones for grinding
    - a dust mask (grinding and sorting)
- Take regular breaks for strenuous work such as washing, sorting, cutting, ...
- Work in well ventilated rooms. Indeed, in addition to the related problems to air quality, recycling machines give off a lot of heat.
- Make sure plastics are dry before putting them into the machine

Safety equipment	
	
Gloves, waterproof for washing	Working gloves
	
Safety glasses (grinding)	Safety shield
	
Work overalls	Safety clothes

Safety equipment	
	
Ear protectors for grinding	Ear plugs
	
A dust mask (grinding and sorting)	Reusable dust mask

ANNEX 2 Maintenance and safety around the machines.

Most machines need regular maintenances, working with waste plastic actually demands more attention as there is a big chance that the plastics are polluted with sand and metal objects. Both are harmful for the blades or turning elements of a machine. The water on plastics can cause sudden explosions in the hot machines. Therefore it is important to make sure that the plastics are as clean and dry as possible. Metals can be taken out by adding a good magnet in the production line.

Tips:

- Thoroughly wash and dry the plastics you will be using
- Add a magnet to fish out metal particles
- Check your machine after each production day and clean it regularly
- Make sure you have an emergency button to be able to cut down the electricity in one go.
- Have at least one fire extinguisher suitable for fires from plastics & electricity
- Make daily project reports on production & functioning of the machine
- Clean the machine and their surroundings daily
- Turn off the machine, while repairing / maintenance

Essential accessories to safeguard the workplace