



**PLANT PRESENTATION OF A RECYCLED POLYMERS
- CRUM RUBBER GRANULES**

- September 2022 -

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About the Company

Produces recycled polymers - crumb rubber granules since 2000 from end- of-life tyres.

The installed technology employs the cryogenic process. This technology rare in Europe on an industrial scale, provides superior cryogenic rubber granules for both raw material and end product applications.

Cryogenic granules have as their main applications:

- Infill for football pitches and golf courses in synthetic turf;
- Ecological road pavements of high resistance and durability (crumb rubber modified bitumen);
- Shock-absorbing and anti-compacting floors for horse riding rings and arenas;
- Raw material for the polymer manufacturing industry (rubber and plastic).

This factory is currently the most notorious European producer offering cryogenic rubber granules. It exports its production to countries ranging from the USA to Russia, through countries in the Middle East and Africa, accounting for over 70% of sales.

Is responsible for the valorization of about 40% of used tyres generated in Portugal, assuming itself as one of the earliest agents in the circular economy.



Products

The purpose of tyre recycling is the separation of the tyre into its three main components: rubber, steel and textile fiber. The valorization of rubber as the main constituent of the tyre (about 60%) is the focus of the activity. Once transformed into granules it is assumed as a secondary raw material in the recycled polymers market.

CRYOGENIC RUBBER GRANULES

Exclusively employs the cryogenic technology in its production.

This process (very cold, very fast, and under an inert atmosphere) gives rubber polymers a consistency similar to that of glass. The granulation of this "rubber glass" occurs by shattering the rubber under the effect of powerful and instantaneous impacts. As the granulation occurs in a fraction of a second and under very low temperature, it does not generate friction, cutting forces or abrasion in the material.

Thus, the molecular chains of the resulting rubber polymers:

- Do not degrade either chemically or thermally;
- Its elastic properties (shock absorption and elastic recovery) remain unchanged and intact over time;
- Protective agents in rubber (antioxidants, UV stabilizers and others) remain effective, resulting in high resistance to atmospheric ageing.

For this reason cryogenic granules show distinctive characteristics:

- Rubber odor null or very slight;
- Does not release carbon black (does not stain skin or clothing);
- Resistant to UV radiation;
- No impact on the climate;
- Abrasion resistant;
- Resistant to compaction and friction;
- Non-floating or highly reduced buoyancy;
- Physically and temporally stable on the long term;
- Very good elastic response per unit mass;
- Excels PAH testing (safety/toxicology);
- Complies with DIN V 18035-7 concerning the emission of heavy metal leachate and organic pollutants;
- Harmless to health - According to OSHA OMB No. 1218-0072.

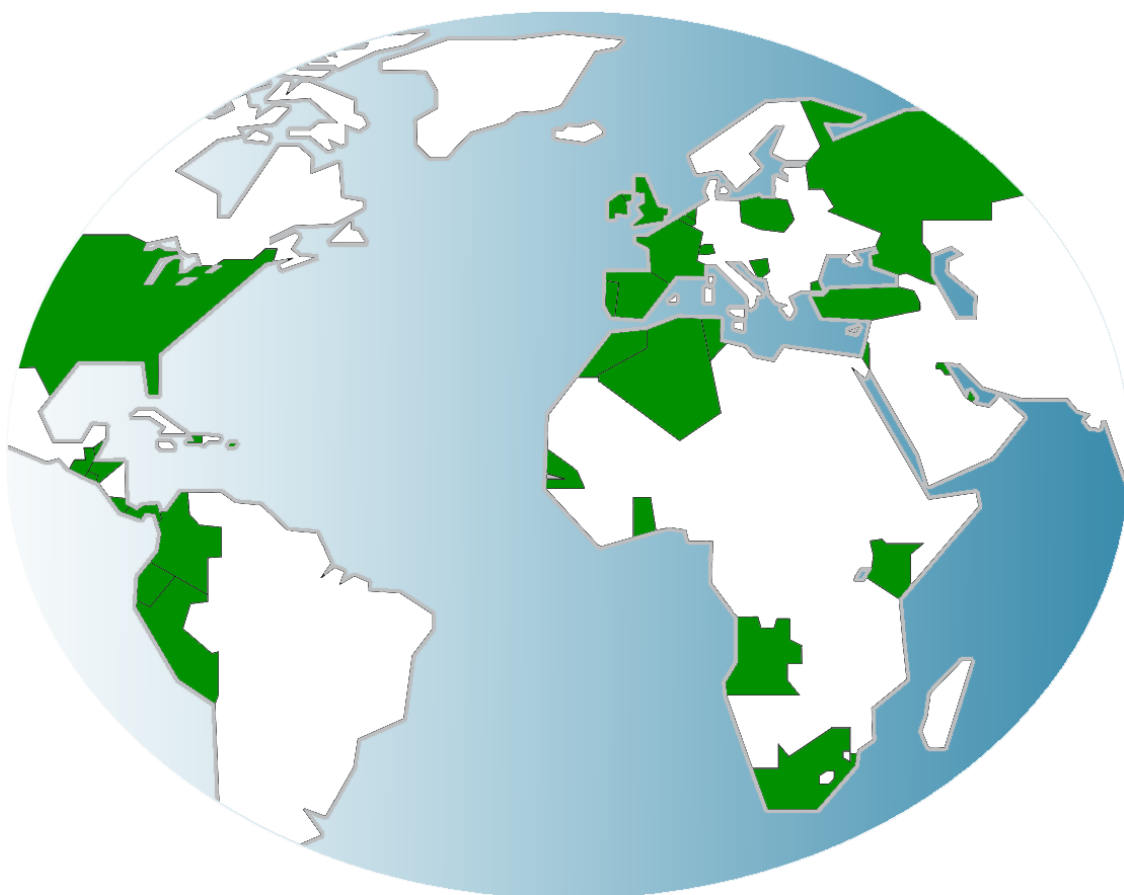
Reference Granules

CRYOFLEX®

CRYOFLEX® is a cryogenic rubber granule developed by the company to serve as the infill of high performance synthetic turf pitches. Tested against other

elastomers, CRYOFLEX® has shown excellent mechanical performance, improved ageing response and great interactivity with athletes¹.

Several football pitches across the world (main or training) incorporate CRYOFLEX®, as shown in the map below. Such examples are the stadiums of Manchester Utd., Chelsea FC and Liverpool FC in the **United Kingdom**, CSKA in **Russia**, Shakter in **Ukraine**, Académica and Vitória de Guimarães in **Portugal**, among several others (including in these countries).



FLEXYGRAN®

The company has developed a specific product for use on the surface of horse riding rings, arenas and other horse-riding facilities.

By applying an approximately 5cm-thick layer of FLEXYGRAN® on a sandy floor, spread manually or by mechanical action and then mixed by the horses themselves, excellent results are obtained both in terms of elasticity and the damping and anti-compacting effects of the floor. Comfort increases and the risk of injury to horses decreases.

¹ All tests were developed by independent and accredited entities in accordance with the standards set by FIFA and UEFA.

The specific characteristics of cryogenic granules are all kept intact in FLEXYGRAN®, namely the absence of smells, which makes this product recommended for use in covered arenas.

FLEXYGRAN® incorporates moisture absorbing textile fibers, the effect of which is to reduce dust as well as the frequency of watering by about 30%.

With FLEXYGRAN® the elasticity of the floor improves, the risk of injury decreases, sand does not compact and the drainage capacity increases.

Tests conducted by COUDELARIA DO ALTER, in Alter do Chão, showed excellent results.



CRYOFLEX® applied in Golf courses

In February 2007, the first synthetic golf course incorporating cryogenic granules was inaugurated in Madrid. It is a nine-hole golf course, built in central Madrid, on a public water deposit active in the city water supply - the EL CANAL DE ISABEL II deposit. The deposit is part of a sports complex, with a surface area of 53,000 m², integrating two synthetic turf football pitches, in which the cryogenic granule was also the elastomer of choice.

This project is part of the water network operator's policy of reinvestment of profits, the urban requalification of the areas where the water deposits are located which converts them into green spaces of high quality, at the service of the welfare of the population.

Crumb Rubber Modified Bitumen (CRMB) for ecological road pavements

The company has developed a specific cryogenic granule for mixing with bitumen for application in road paving. The resulting mixtures were called Crumb Rubber Modified Bitumen (CRMB).

CRMBs are the result of pioneering techniques developed in the USA which have strong economic and environmental advantages, approved and certified by several national and international organizations:

- Great resistance to ageing that increases the durability of the floor;
 - Decreases operating and maintenance costs and extends floor life;
- During paving works, CRMBs maintain the homogeneity of bitumen viscosity, enhancing the efficiency and quality of the work;
- Increased grip between tyre and road which increases safety;
- Reduction of traffic noise resulting in:
 - Best comfort for road users and residents;
 - Suppression of acoustic barriers;
- Low steel content in granules obtained by cryogenic technology allows for:
 - Greater durability of equipment and lower maintenance cost.

The company has been supplying cryogenic granules for incorporation into CRMB-built roadways in the following countries: Portugal, Spain, Italy and Argentina.

The photo below illustrates a BMB application under the harshest conditions of use.



OTHER PRODUCTS

Steel

The company produces steel from tyre recycling, offering two types of products to the steel market:

- Steel sections obtained from cryogenic grinding - 0.5 to 5 cm;
- Whole steel rims extracted from the sidewalls of heavy duty tyres.

Fibre

The factory obtains textile fibers resulting from the cryogenic grinding of the tyres. It is an energy-recoverable material with high calorific value, the highest of which is in the order of 7200 Kcal/kg. However, the entire product is sold as a secondary raw material to the steel industry.

Chips

These are tyre parts that result from tyre crunching. Available in different dimensions, they are intended for applications such as:

- Raw material for rubber granules;
- Substitute inert material for soil preparation in construction works;
- Slope stabilizer;
- Elastomer in expansion joints at anchor points in construction works.

MADRE® - Tyre Derived Aggregate Material

MADRE® is a product for use in Civil Engineering works, replacing inert materials and finite natural aggregates, whose extraction negatively impacts the environment. These materials, derived from chips, stand as a technically and economically viable alternative to traditional gravel.

The incorporation of MADRE®, produced by the company, in Public Works, is an opportunity for its promoters to join the Green Economy, by promoting the national recycling industry and the preservation of the environment by replacing natural resources with recycled products which show technical and economic advantages.

Technology

The company has successfully installed and perfected the Cryogenic Technology. Its industrial process is developed in three phases:

1. Fragmentation of the raw material;
2. Cryogenic Processing;
3. Bagging and storage.

1. Fragmentation of the Raw-material

This phase consists of the fragmentation of light and heavy duty tyres into small parts of homogeneous section through a blade cutting process, thus obtaining the product called chip.

2. Cryogenic Processing

This process performs complete and individualized separation of rubber, steel and textiles without waste or discernible material loss. It is a continuous process, automatically controlled, and performed under an inert atmosphere. It can be divided into three phases:

2.1.1 - Cryogenic cooling

The chips are launched into a nitrogen-cooled tunnel to -196°C , where an exchange of cold occurs between the chips at ambient temperature and the liquid nitrogen. By cooling the chips to a temperature of -96°C , the glass transition point (T_g) is reached, that is, the "rubber" attains a glass-like behavior.

2.1.2 - Cryogenic grinding

Under an inert and very cold atmosphere, chips frozen at -96°C are subjected to very strong impacts on special hammer mills, which shatter them instantly into small granules of different sizes.

2.1.3 - Segregation

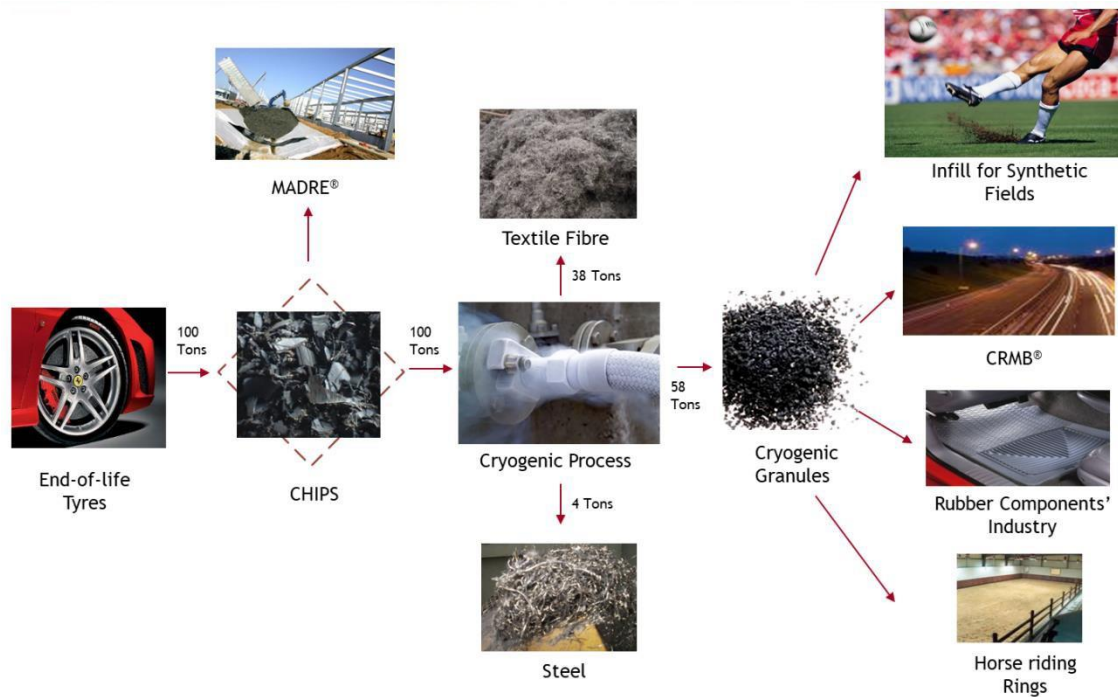
It consists of the separation of the different materials, drying, classification and purification of the final product, through the following operations:

- Densimetric separation of textiles;
- Magnetic separation of steel;
- Drying of granulated rubber;
- Size grading of rubber granules into standard dimensions;
- Elimination of dust and other waste.

3. Bagging and Storage

The obtained granulates then transit to several silos, from where they are bagged in synthetic raffia Big Bags, with a capacity of about 1.2 tons. The packaged product is then stored until shipment.

Illustration of the industrial process



Equipment

The inventory of all factory equipment is listed below. The following item types are excluded from this inventory:

- Software, data, publications, files, books, artwork, drawings, bibliographic backgrounds, CDs, cassettes, toys, monographs, etc.;
- Equipment under long-term lease or which belongs to third parties;
- Intangible or soon-to-be intangible assets;
- Tools and utensils;
- Administrative and/or laboratory equipment;
- Containers.

Ref.	Designation	Description and/or technical data	Components
#01	Debeader	Removes bead wire before shredding	Motor: General Electric Model: SK 404 J C2147 A 100HP 1480 Rpm 50HZ 400V 133A
#03	Tyre conveyor	Belt conveyor 1200mm. Feeds tyres to the shredder #07	Motor: NORD Model: SK 100L/4; 2,2KW; 1420/30 Rpm gear motor: NORD Model: 3262 AZ-100/L4; 3HP;
#07	Tyre shredder	Heavyduty shredder, dual shaft and knives.	2 Motors: WEG Model: 444/STDZ; 100HP; 380V; 1500Rpm
#09A	Tyre Chips' vibrating Screen	Chips' size sorter after shredder #07 1"1/8 rpm 454 serial n° 1599-1	Motor: Premium Efficiency
#09B	Tyre conveyor	Belt conveyor 600m. From #09A to #07	Gear motor: SEW; Model: FA47/G DT L4; 1,5KW; 1410/72rpm
#10	Hopper	Hopper fed by a Redler chain conveyor.	Gear motor: SEW; Model: R97 DT S4; 1,1KW; 1410/7,5rpm
#11	Metal Detector	-	-
#12	Chips' conveyor	Belt conveyor 600mm. From #09A to #10	Gear motor: SEW; Model: FA67/G Dt 100LS4; 1400/51rpm
#13	Chips' conveyor	Belt conveyor 600mm, from #10 to #18	Gear motor: SEW; Model: FA67/G Dt 100LS4; 1400/51rpm
#18B	Cryogenic Tunnel	Cryogenic chamber and gear motor.	Gear motor: SEW; Model: R 87 DV 132S4; 7,5HP; 62rpm
#18A	Inlet valve	Rotary valve	Gear motor: SEW; Model: FAF 77DT100LS4; 3HP; 26rpm
#18C	Air Exhaust	Gas extractor	Motor: WEG; Model: 182T 0999; 2HP; 1500rpm
#20	Vibrating feeder	Hammer Mill #21 feeder	Motor: Kinery corp; Model: 30BC02UPP; 30A; 860rpm; 230/460V; 0,5 cv
#21A	Hammer Mill A	Milling unit nr.1	Motor: WEG; Model: 280 S/M 05/00 AV77031; 90Kw; 1480rpm
#21B	Hammer Mill B	Milling unit nr.2	Motor: WEG; Model: 280 S/M 05/00 AV77031; 90Kw; 1480rpm
#21C	Hammer Mill C	Milling unit nr.3	Motor: WEG; Model: 280 S/M 05/00 AV77031; 90Kw; 1480rpm
#28	Screw conveyor	Screw conveyor for milled materials	Gear motor: SEW; Model: KAF77 DV 100L4; 3Kw
#29	Bucket conveyor	Bucket conveyor after hammer mills	Gear motor: SEW; FA77 DT 100LS4; 2,2Kw; 1400/21rpm
#32	Primary vibrating screen	Sorting unit for fluff, steel and rubber.	Motor: WEG; Model:132S 1099; 1500rpm; 5,5Kw; 190/380V; 18,8/9,42A
#35	Magnetic separator	Steel separator	Gear motor: SEW; FA37/DT80N4; 1,0Kw; 1400/128rpm
#36	Screw conveyor	Crumb rubber conveyor	Motor: WEG; Model: 90L 032000; 1,5HP; 1500rpm Gearbox: DODGE; Size: SCXT 115; 7,13HP; Ratio:15,35
#37	Screw conveyor	Screw conveyor before reprocessing	Motor: WEG; Model: 90L 032000; 1,5HP; 1500rpm Gearbox: DODGE; Size: SCXT 115; 7,13HP;
#38A	Fluff Conveyor	Belt conveyor from #32 for fluff	Gear motor: SEW; Model: FA47/G

Ref.	Designation	Description and/or technical data	Components
#38B	Conveyor	Belt conveyor 600mm	DT 90 L4; 1,5Kw; 1410/49rpm Gear motor: SEW; Model: FA47/G DT 100 LS4; 2,2Kw; 1410/86rpm
#38C	Conveyor	Designed and manufactured by RECIPNEU.	Gear motor: NORD Model: SK 100L/4; 2,2KW; 1440/60rpm
#41	Conveyor	Belt conveyor 600mm for steel	Gear motor: SEW; Model: FA47/G DT 90 L4; 1,5Kw; 1410/49rpm
#44	Rotary dryer	Crumb rubber dryer	Motor: LAFERT; Model: HE112ME4; 3,7Kw; 1755rpm
#45	Vibrating sorter	Crumb rubber Oversize separation	Motor: Kinergy corp; Model: 30BC02UPP; 30A; 860rpm; 230/460V; 0,5 cv
#52	Secondary magnetic separator	Steel cleaning	Gear motor: SEW Eurodrive; Model: R32 DT 80 K4; S/N°: 80,19,35770,0/1; 0,756HP; 107rpm; 230/400V
#55	Secondary screen	Crumb rubber separation by size	Motor WEG; Model: F56H0400; 1,5Hp; 1500rpm; 50Hz; 190/380V; 5,6/2,84A;
#55A	Cleaning screen (DC 0814/ DC 1014)	Fiber decontamination	-
#58A	Bucket conveyor	Dryer feeder	Motor: WEG; Model: F56 H 0400; 1,5HP; 1500rpm Gearbox: DODGE; Size: TXT 115T; 7,13HP; Ratio:15,35
#58B	Bucket conveyor	Cleaning screen feeder	Motor: WEG; Model: F56 H 0400; 1,5HP; 1500rpm Gearbox: DODGE; Size: TXT 115T; 7,13HP; Ratio:15,35
#58C	Oversize's bucket conveyor	Reject sizes returning to cryogenic tunnel	Motor: WEG; Model: F56 H 0400; 1,5HP; 1500rpm Gearbox: DODGE; Size: TXT 115T; 7,13HP; Ratio:15,35
#58D	Bucket conveyor	Secondary screen feeder	Motor: WEG; Model: F56 H 0400; 1,5HP; 1500rpm Gearbox: DODGE; Size: TXT 115T; 7,13HP; Ratio:15,35
#58E	Inlet Bucket conveyor to storage silo 5	Bucket conveyor - 7.80m	Motor: SEW; Model: R37DT90S4; 1,1Kw; 1400/210rpm
#58F	Inlet Bucket conveyor to storage silo 4	Bucket conveyor - 7.80m	Motor: SEW; Model: R37DT90S4; 1,1Kw; 1400/210rpm
#58G	Inlet Bucket conveyor to storage silo 3	Bucket conveyor - 7.80m	Motor: SEW; Model: R37DT90S4; 1,1Kw; 1400/210rpm
#58H	Inlet Bucket conveyor to storage silo 2	Bucket conveyor - 7.80m	Motor: SEW; Model: R37DT90S4; 1,1Kw; 1400/210rpm
#58I	Inlet Bucket conveyor to storage silo 1	Bucket conveyor - 7.80m	Motor: SEW; Model: R37DT90S4; 1,1Kw; 1400/210rpm
#58J	Outlet Bucket conveyor from silo 5	Bucket conveyor - 7.00m	Motor: SEW; Model: R37DT90S4; 1,1Kw; 1400/210rpm
#58K	Outlet Bucket conveyor from silo 4	Bucket conveyor - 7.00m	Motor: SEW; Model: R37DT90S4; 1,1Kw; 1400/210rpm
#58L	Outlet Bucket conveyor from silo 3	Bucket conveyor - 7.00m	Motor: SEW; Model: R37DT90S4; 1,1Kw; 1400/210rpm
#58M	Outlet Bucket conveyor from silo 2	Bucket conveyor - 7.00m	Motor: SEW; Model: R37DT90S4; 1,1Kw; 1400/210rpm
#58N	Outlet Bucket conveyor from silo 1	Bucket conveyor - 7.00m	Motor: SEW; Model: R37DT90S4; 1,1Kw; 1400/210rpm
#58O	Outlet Bucket conveyor from silo 6	Bucket conveyor - 7.00m	Motor: SEW; Model: R37DT90S4; 1,1Kw; 1400/210rpm
#58P	Outlet Bucket conveyor from Rotor Mill	-	Motor: SEW; Model: R37DT90S4; 1,1Kw; 1400/210rpm
#64A	Outlet Bucket conveyor from cryogenic tunnel	Bucket conveyor	Motor: VP Motors; Serial N°: B20013ACJ; 2HP; 1500rpm
#64B	Screw conveyor. Inlet into secondary screen.	Screw conveyor	Motor: VP Motors; Serial N°: B20013ACJ; 2HP; 1500rpm
#64C	Screw conveyor. Inlet into silo 1	Screw conveyor 4.980m	Gear motor: SEW; Model: R27 DT90 S4; 1400/172rpm; 1,1Kw
#64D	Screw conveyor. Packing silos 1, 2 e 3	Screw conveyor 13.350m	Gear motor: SEW; Model: R27 DT90 S4; 1400/172rpm; 1,1Kw
#64E	Screw conveyor. Outlet from silos 4 and 5 to the rotor mill	Screw conveyor 8.800m	Gear motor: SEW; Model: R27 DT90 S4; 1400/172rpm; 1,1Kw

Ref.	Designation	Description and/or technical data	Components
#64F	Screw conveyor. Outlet from rotor mill - inlet into silo 6	Screw conveyor 4.980m	Gear motor: SEW; Model: R27 DT90 S4; 1400/172rpm; 1,1Kw
#64G	Screw conveyor outlet from silo 6	Screw conveyor 2,990m	Gear motor: SEW; Model: R57 DT90 L4; 1410/38rpm; 1,5Kw
#64H	Screw conveyor. Outlet from silo 5	Screw conveyor 2.990m	Gear motor: SEW; Model: R57 DT90 L4; 1410/38rpm; 1,5Kw
#64I	Screw conveyor Outlet from silo 4	Screw conveyor 2.990m	Gear motor: SEW; Model: R57 DT90 L4; 1410/38rpm; 1,5Kw
#64J	Screw conveyor. Outlet from silo 3	Screw conveyor 2.990m	Gear motor: SEW; Model: R57 DT90 L4; 1410/38rpm; 1,5Kw
#64K	Screw conveyor. Outlet from silo 2	Screw conveyor 2.990m	Gear motor: SEW; Model: R57 DT90 L4; 1410/38rpm; 1,5Kw
#64L	Screw conveyor do fundo do silo 1	Screw conveyor 2.990m	Gear motor: SEW; Model: R57 DT90 L4; 1410/38rpm; 1,5Kw
#64M	Screw conveyor. Packing	Screw conveyor 2.490m	Gear motor: SEW; Model R27 DT90 S4; 1400/172rpm; 1,1Kw
#72A	Blower	Air filter system	Motor: WEG VDE 0530; Model: 225 S/M-4 05/00 AV83584; 45Kw; 1475rpm
#72B	Wet cyclone	Fibre cleaning	Motor: Ifimoto Iberica; Model: JL90S-4; 230/400V; 50HZ; 1390rpm; 1,5HP; 4,7/2,7A
#72C	Dry cyclone	Fibre cleaning	Motor: WEG; Model: 90S-4 05/00 FL40571; 50HZ; 1440rpm 1,1Kw
#73A	Control Panel	-	-
#73B	Motor Control Panel	-	-
#76	Storage Bins	-	-
#79A	Single Package Station	DC0814 Package	Motor: WEG; Model: B 56 C042000; 0,25HP; 1500rpm; 19/380V; 1,7/0,85A
#79B	Twin Package Station	DC1430 and RA1435 package	Motor: WEG; Model: B 56 C042000; 0,25HP; 1500rpm; 19/380V; 1,7/0,85A
#79C	Single Package Station	Package DC3080 and DC8000	Motor: WEG; Model: B 56 C042000; 0,25HP; 1500rpm; 19/380V; 1,7/0,85A
RM01	Rotor mill K62	Rotor mill Konings Type RM1000 Mach.nr 004	Motor: Siemens; Model; 10A8 317-6A1368-Z315
RMCR	Rotary screen	Rotary screen into the rotor mill	Motor: Siemens; Model: EK681 4741 01; 50HZ; 750rpm; 1,5Kw K64
RMSF	Screw conveyor rotor mill K63		Motor: NORD; Model: SK 90 L/ 4 TF FF; 1,5Kw; 230/400V; 1385rpm; 6,42/3,71A; 50HZ
RMVR	Rotary valve	Rotor mill's rotary valve	Motor NORD; Model: SK 71L/4; 50HZ; 0,37KW; 136rpm; 23/400V
RMCI	K65 rotary screen		Motor ASEA; 50HZ; 1420rpm; 1,5Kw; 6,4A
RMCS F	K66 rotary scteen		Motor: WEG VDE 0530; Model: 225 S/M-4 05/00 AV83584; 45Kw; 1475rpm
	Weighbridge	60 Ton Weighbridge Cachapuz	
Atlas	Air Compressor	Air compressor Atlas Copco	
Inger	Air Compressor	Ingersoll Rand Air Compressor	
#80	Rotary ultra fine separator	Ultra fine grades	
#91A	Screw conveyor DC 0308	Screw conveyor input DC 0308	
#91B	Screw conveyor DC OVs	Screw conveyor DC OVs	
#91C	Cyclone and pipes		
#91.1 D	Screw conveyor for packaging fine grades		
#91.2 D	Screw conveyor for packaging coarse grades		
#92	Densimetric column		
#93	Granulator PRZ 356	Granulator PRZ 356	
#94	Detextilator	Detextilator	
#95	Coanda + Cyclone	Coanda + cyclone	
#96	Crumb rubber Final		

Ref.	Designation	Description and/or technical data	Components
	screen		
#97	Granulator's cooler		
#98A	Suction system and filters		
#98B	Suction system and filters		
#98C	Suction system and filters		
#100	Suction system center		