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Waste glass bottle recycling plant

LB-O2

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Waste-Glass Recycling Plant

Waste glass is not just waste, but a new resource. Supersoil is an artificial light porous foamed material that is made by crushing, milling, baking and foaming waste glass. The Waste-Glass Recycling Plant is a plant for recycling waste glass produced in the local community into Supersoil.

You just need to place waste glass bottles into the hopper. The Waste-Glass Recycling Plant automatically crushes them and performs milling, sorting and baking to produce Supersoil.

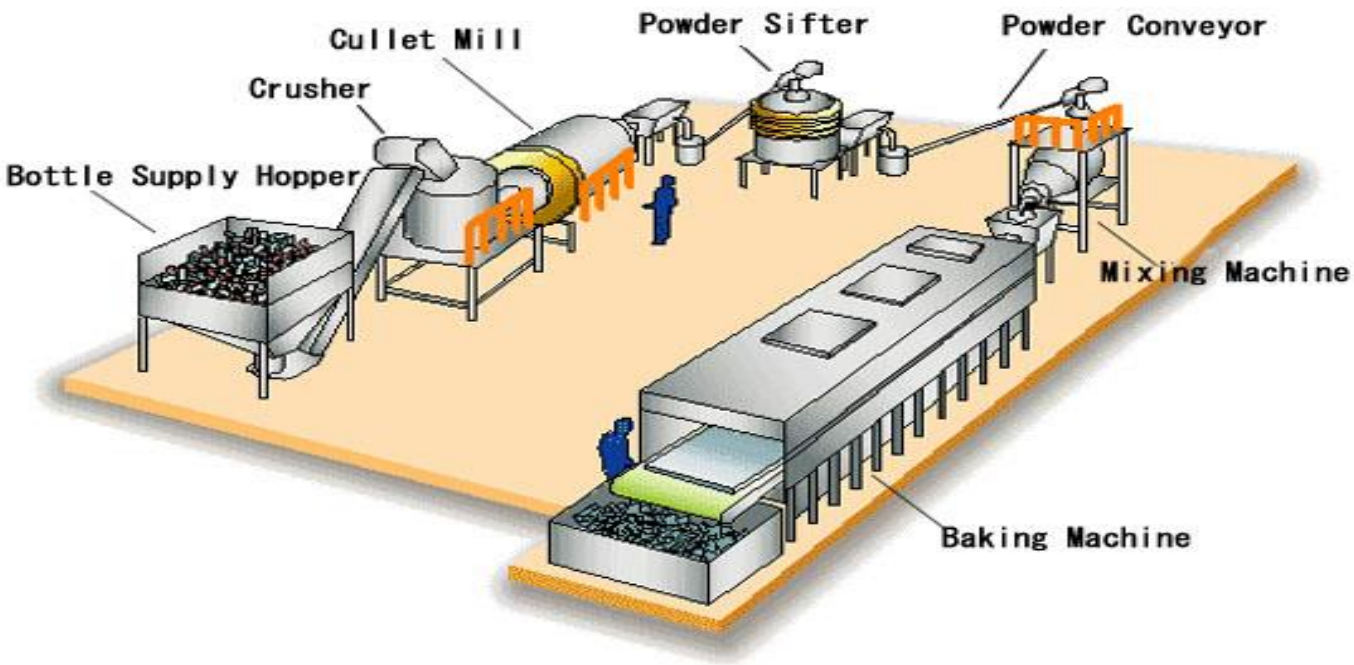
Outline

The Waste-Glass Recycling Plant is a set of machines to produce Supersoil, a pumice-like light porous foamed material, from waste glass produced in the local community as 99% of its basic materials.

The Waste-Glass Recycling Plant consists of 9 machine units, a bottle supply hopper, a bottle conveyor, a crusher, a cullet mill, powder conveyors, a powder sifter, a mixing machine, a baking machine and a Supersoil sizer; and automatic control panels. The bottle supply hopper can hold about 4.5 m^3 of waste glass, which is crushed into cullet of less than 6 mm in size by the crusher. The cullet is then milled into glass powder with a median grain diameter of 35 μm by the cullet mill. The glass powder is sent to the powder sifter, which removes foreign objects and powder grains that are not of a specified size. The mixing machine mixes glass powder and add-in materials, and continuously sends the resulting powder mixture to the baking machine. There the powder mixture is preheated, softened, baked and foamed in the temperature range of 700 ~ 920 degrees centigrade. The layer of glass powder mixture having an initial thickness of 15 mm is converted into a light porous slab having a thickness of about 60 mm. More than 70% of these machines have originally been developed by Trim.

Most conventional glass recycling machines crushes glass only into cullet. The resulting cullet is used for making glass again if it is transparent or brown, and other cullet is mixed in secondary concrete products, asphalt paving and blocks. The cullet, however, is low-value-added products, and its use in business is limited. On the other hand, Supersoil, produced by the Waste-Glass Recycling Plant, has a wide range of application, such as a light embanking material in civil engineering, a culture medium or an inorganic soil amendment in horticulture and agriculture, a purification material in water purification and an insulator in architecture. It is now used in various areas for various purposes.

Production Stages and Machine Units



Bottle Supply Hopper

The bottle supply hopper can hold about 4.5 m^3 (3.5 t) of waste glass bottles, and the vivratory feeder attached to the hopper bottom supplies glass bottles stably to the conveyor.

Crusher

Waste glass bottles carried in by the conveyor are crushed in a single process into cullet less than 6 mm in size (the specified grain size of the crusher) by a compact crusher having a diameter of 1,600 mm.

Glass bottles are compressed and crushed by rollers, which is based on the mechanism of the mill. To improve the wear resistance of the machine, special steel is used for the inner parts, and removable couplings are used for the inner structure. As a result, our crusher has better wear resistance and durability than ordinary glass crushers. (Patented)

Cullet Mill

Glass cullet of less than 6 mm in size produced by the glass crusher is further milled to produce galss powder. Our cullet mill is a tube mill modified for glass cullet. Its inlet can easily take in glass pieces of different sizes and shapes, and its outlet discharges glass powder in the order of smaller specific gravities. The produced glass powder is separated from paper, such as bottle labels, by a rotary sieve within the two-layer hopper. The cullet mill contains many alumina balls, which collide with each other to mill cullet. The machine requires no maintenance for about 2 years. The full-automatic operation of the cullet mill synchronized with the glass crusher enables a continuous production of glass powder, and has achieved a stable glass powder production of the specified grain size and a higher production efficiency (more than 97%).

Powder Sifter

Glass powder produced by the cullet mill is sorted according to grain sizes, and powder of the specified grain size is taken out.

Connection with a powder conveyor allows the continuous sorting of powder. In addition, because of its closed system, no powder is released into the surrounding environment.

Powder Conveyors

Powder conveyors transfer glass powder from the cullet mill, the powder sifter, and the mixing machine.

These are spinflow conveyors based on the principle of whirlpools. They allow full-automatic, stable powder transfer, while powder transfer was considered difficult before. Furthermore, since they do not use air flow, the generation of static electricity is low, and no dust is released into the work environment.

Mixing Machine

Glass powder sorted out by the powder sifter and two types of patent protected chemicals are automatically measured and mixed. These materials. which are different in quantity, specific gavity and shape, are thus uniformly mixed.

The mixing machine is of sequential batch type and can produce 350 kg of powder mixture in a batch process. In addition, the whole process of feeding, measuring and adding the two types of foaming materials is fully automated, allowing the stable production of glass powder mixture in uniform quality.

Baking Machine

Powder mixture produced by the mixing machine is baked to make a light porous foamed material, or Super soil. The baking machine consists of a baking section and an annealing section, each of which has a light, insulating and fireproof sructure. The machine also has a wire-mesh belt conveyor to allow continuous baking.

Furthermore, the baking machine is equipped with 16 burners to carry out the processes of preheating, softening, baking and foaming.

Supersol Sizer

Produced Super soil blocks are broken and sorted into specified sizes.

The breaker has breaking blades whose shape and material have been specifically designed for Super soil production, allowing efficient breaking and sorting.

Characteristics

Earth-Friendly (returnable to the soil)

Super soil is perfectly recyclable, from the soil and back to the soil.

High Water Permeability and Retentivity

Even when Super soil is compacted, it retains good water drainage. Its high water permeability, water retentivity and air permeability promote plant growth.

Fire-Resistant (inorganic mineral)

Super soil is an inorganic mineral and fire-resistant.

Lightweight (can be made to have a different specific gravity)

Super soil can be made to have different specific gravities depending on its use.

Type	Specific Gravity (oven-dry)	Water Absorption	Characteristics	Use
L1	0.3 - 0.6	≥ 30%	Continuous-cavity type ultralight material with high water retentivity	Greening: Light soil Farming: Soil amendment
L2	0.4 - 0.5	≤ 30%	Independent-cavity type ultralight material	Civil engineering: Light subgrade material Architecture: Light material
L3	0.5 - 1.0	≤ 10%	Independent-cavity type light material with mostly closed pores	Civil engineering:Light subgrade material Architecture: Light material
L4	1.0 - 1.6	≤ 5%	Independent-cavity type light material that is slightly heavier than water	Civil engineering: Light subgrade material Architecture: Light material Water purification: Purifying material

It is possible to produce Supersol having different characteristics by changing the types of add-in materials, milling conditions and baking conditions.

High Workability (adaptable to various conditions)

Supersoil is adaptable to various application conditions, such as a place of complex topography or where there are underground pipes. It is easy to handle, and can be handled even in the rain.

- * Very light
- * Easy to handle as a banking material and can be applied in ordinary procedures.
- * Does not need curing.
- * Since Supersoil is made from glass, no harmful substance is dissociated from it. Thus, it is very safe to the environment.
- * Since Supersoil is an inorganic mineral, it is chemically stable and does not corrode.

How It Was Developed

Supersoil production technology was developed by the Kishimoto International Technology Institute under the "Research and Development Business Cooperation Contract" signed in February 1997 with the Clean Japan Center" (CJC) as a project to which a supplementary budget was granted in 1996 by the Ministry of International Trade and Industry (currently the Ministry of Economy, Trade and Industry) and which was entrusted to CJC by the New Energy and Industrial Technology Development Organization (NEDO) as a verification test of glass cullet recycling.

Based on the result of this project, Trim Co., Ltd. developed a Supersoil production system (plant) for practical use. Today, Trim has built the plants arround Japan and is promoting community vitalization through recycling.

Constituents and Data

Constituents

SiO_2	70.37%
Al_2O_3	2.22%
Na_2O	12.92%
CaO	10.91%
K_2O	1.02%

Tested by the Industrial Technology Center of Okinawa Prefecture

Date requested: April 23, 2002

Test type: Quantitative analysis (SiO_2, Al_2O_3, Na_2O, CaO, K_2O)

Physical characteristics

Single	Specific gravity (dry)	0.4 - 0.5
	Grain size range	2 - 75 mm
	Water content	0%
	Uniaxial compressive strength	30 - 40 kgf/cm^2
	Toxic substances	None
Compacted	Density	0.3 - 0.4 t/m^3
	Triaxial compressive strength	$\phi \geq 30^\circ$
	CBR	17.70%
	Coefficient of permeability	3×10^{-2} - 1×10^{0}cm/s

Designed physical constants

Dry Density (t/m^3)	Designed Constants				Number of Rolling for a Spreading Depth of 30 cm (/layer)	
	Wet Density (t/m^3)	Adhesion (kN/m^2)	Internal Friction Angle (degrees)	Allowable Bearing Power (kN/m^2)	10-t swamp bulldozer	1-t vibratory roller
0.25	0.40	0	25	39	0	0
0.30	0.45		30	98	2	4
0.35	0.55			137	4	8
0.40	0.60			176	8	-

Table of light banking materials

Types		Light Banking Material	Wet Density (t/m^3)	Characteristics
Light Materials	Artificial materials	EPS	0.01-0.03	Ultralight, self-standing
		Urethane foam	≈ 0.03	Ultralight, flowable
	Recycled materials	Granulated slag	1.2 - 1.35	A by-product at ironworks
		Coal ash	1.1 - 1.5	A by-product at thermal power plants
		Supersol	0.4 - 0.6	Made from glass bottles
		Volcanic ashes deposit	1.2 - 1.4	Low cost
Weight-reduced Soils	Foam composite light soil	FCB, etc.	0.5 - 1.2	Flowable, density controllable
	Foamed beads composite light soil	SLS, etc.	0.9 - 1.3	Density controllable, characteristics similar to soil

Wet density of light banking materials

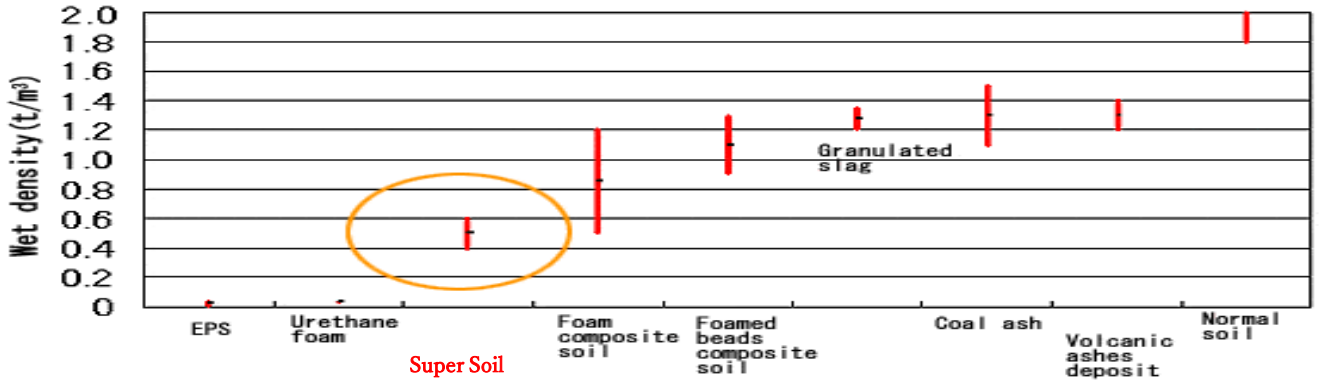


Table of Ingredients. Results of Elution Test

Table 1　Ingredients of SUPERSOL

Ingredient		Content percentage
SiO_2	silicone dioxide	73.5%
CaO	calcium oxide	12.1%
Na_2O	sodium oxide	10.5%
Al_2O_3	aluminum oxide	1.6%
MgO	magnesium oxide	0.4%
K_2O	potassium oxide	1.0%

Results of analysis by testing institution

Table 2　Results of elution test

Item	Elution test value	Environmental limit
cadmium	Under 0.001 mg/ℓ	0.01 mg/ℓ or less
total cyanide	Not detected.	Not detected.
organic phosphorus	Not detected.	Not detected.
lead	Under 0.005 mg/ℓ	0.01 mg/ℓ or less
hexavalent chromium	Under 0.005 mg/ℓ	0.05 mg/ℓ or less
arsenic	Under 0.005 mg/ℓ	0.01 mg/ℓ or less
total mercury	Under 0.0005mg/ℓ	0.0005 mg/ℓ or less
alkyl mercury	Not detected.	Not detected.
PCB	Not detected.	Not detected.
copper	Under 0.5 mg/kg	125 mg/kg or less
dichloromethane	Not detected.	0.02 mg/ℓ or less
carbon tetrachloride	Not detected.	0.002 mg/ℓ or less
1,2-dichloroethane	Not detected.	0.004 mg/ℓ or less
1,1-dichloroethene	Not detected.	0.02 mg/ℓ or less
cis-1,2-dichloroethene	Not detected.	0.04 mg/ℓ or less
1,1,1-trichloroethane	Not detected.	1 mg/ℓ or less
1,1,2-trichloroethane	Not detected.	0.006 mg/ℓ or less
trichloroethylene	Not detected.	0.03 mg/ℓ or less
tetrachloroethylene	Not detected.	0.01 mg/ℓ or less
1,3-dichloropropylene	Not detected.	0.002 mg/ℓ or less
thiuram	Not detected.	0.006 mg/ℓ or less
simazine	Not detected.	0.003 mg/ℓ or less
thiobencarb	Not detected.	0.02 mg/ℓ or less
benzene	Not detected.	0.01 mg/ℓ or less
selenium	Under 0.001 mg/ℓ	0.01 mg/ℓ or less
fluorine	0.1 mg/ℓ	0.8 mg/ℓ or less
boron	0.16 mg/ℓ	1 mg/ℓ or less
dioxins	<10 pg-TEQ/g-dry	1,000 pg-TEQ/g or less

Results of analysis by testing institution

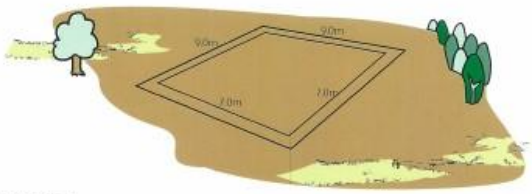
Rainwater retention tank construction example

PREPARATION

1. Determining the Spot

1) Make sure to select the spot suitable for the rainwater reservoir

2) Clear the spot and determine the excavation area.

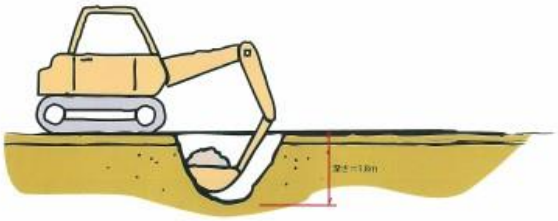


2 Excavation

1) Excavate using backhoe or any other method.

2) Excavate 30cm depth x 1m to 1.5m square on outer perimeter of the above 2)

3) Size of the hole may have some allowance and it can be adjusted by sand/soil upon laying the liner sheet.



3 Laying Liner Sheet

1) The excavated side and bottom must be compacted.

2) Make sure that the excavated side and bottom be completely smooth.

3) Lay the liner sheet.

4) Adjustment may be made as per above 2. 4)