

SOLIDIFICATION

IMMOBILIZATION AND ENCAPSULATION OF WASTE AND CONTAMINANTS

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PUBLICATION SOLIDIFICATION

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➔ 01 | SOLIDIFICATION-Plant

01 | Summary:

The SOLIDIFICATION, also known under the terms STABILIZATION, IMMOBILIZATION or CONDITIONING, encapsulates contaminants non-leachably and permanently and minimizes the risk of environmental hazards.

The SOLIDIFICATION is specifically qualified to treat inorganic waste and contaminants, specifically heavy metals, but also organic waste and radioactive waste.

Typical types of waste, which are qualified to be treated by SOLIDIFICATION are:

- ➔ Inorganic waste / solids, e.g. spent catalysts from petrochemical and chemical industry, fly ash and fine slag from incineration plants, specifically municipal waste and hazardous waste incineration plants
- ➔ Inorganic sludge, e.g. heavy metal containing sludge from galvanizing and leather industry
- ➔ Radioactive sludge
- ➔ Municipal and industrial sewage sludge
- ➔ Contaminated soil

The SOLIDIFICATION process is based on the physical encapsulation of the contaminants and the chemical fixation of the contaminants in the solid matrix of the new generated product.

Normally cement, limestone or fly ash is used as additives in combination with water. The chemical fixation is caused by additives like sulfides, iron salts, sodium silicate, clay, zeolite etc.

Depending on the specification of the waste to be treated and the specification of the final product, the final product of the SOLIDIFICATION will be reintegrated at site, disposed and integrated at approved landfills or used for construction e.g. base layer of roads or core of dykes and banks.

Furthermore the final product of SOLIDIFICATION can be casted to molds. The hardened molds can be reused or integrated into a landfill.

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Further information
about Solidification:

<http://bit.ly/1wBObkx>

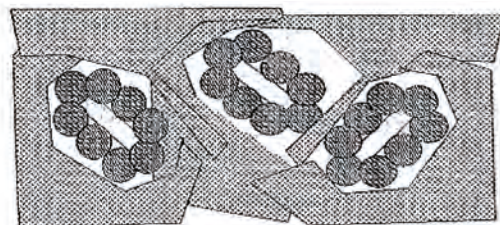
**02 | Process Description
SOLIDIFICATION:**

The **SOLIDIFICATION** process is based on the physical encapsulation of the contaminants and the chemical fixation of the contaminants in the solid matrix of the new generated product.

The input material / waste is mixed in continuous or batch wise operated mixers with additives like cement, limestone, gypsum, fly ash or blast furnace slag (scoria) and water intensively. In this process the waste and the contaminants of the waste are encapsulated and fixed.

In case of the physical encapsulation, the input material will be encapsulated by the binding material and the additives. Thereby it shall be differentiated between micro encapsulation (encapsulation of single particles) and macro encapsulation (encapsulation of agglomerates of particles or the whole waste matter). In case of the physical encapsulation the porosity will be reduced substantially and the connecting paths to the surface will be blocked and a water infiltration is not possible. The leaching process is limited to the surface or fracture surface of the final solidified product.

In case of the chemical fixation of the contam-



➤ 02 | Physical Encapsulation

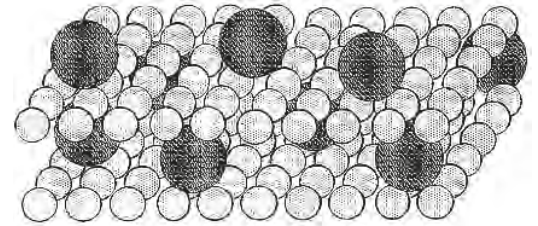
inants, the contaminants will be integrated into the crystal lattice or the solid matrix of the final solidified product.

In case of the treatment of heavy metal containing input material frequently precipitation processes are used to transfer the heavy metals to a non leachable form and to fix the heavy metals in the final solidified product. The alkalinity of cement causes in presence of certain heavy metals the generation of non leachable hydroxides and carbonates. To some extent special precipitation chemicals like sulfides or organic sulfur components (e.g. TMT 15) are used to immobilize heavy metals.

Furthermore chemical sorption and physical sorption processes are used for the fixation and immobilization of contaminants. In case

of the sorption processes heavy metals and also organic molecules are bonded to electrically charged surfaces of special substances like clay materials. For sorption of heavy metals clays like bentonite or vermiculite or ion exchange resins are used.

Depending on the specification of the waste to be treated and the specification of the final



➤ 03 | Chemical Fixation

product, the final product of the **SOLIDIFICATION** will be reintegrated at site, disposed and integrated at approved landfills or used for construction e.g. base layer of roads or core of dykes and banks.

Furthermore the final product of **SOLIDIFICATION** can be casted to molds. The hardened molds can be reused or integrated into a landfill.

➤ 04 | Solidified Mold (Concrete Block)



03 | Applications SOLIDIFICATION:

Typical input material/type of waste for SOLIDIFICATION are:

- Inorganic waste / solids, e.g. spent catalysts from petrochemical and chemical industry, fly ash and fine slag from incineration plants, specifically municipal waste and hazardous waste incineration plants
- Inorganic sludge, e.g. heavy metal containing sludge from galvanizing and leather industry
- Radioactive sludge
- Municipal and industrial sewage sludge
- Contaminated soil

Typical clients for the SOLIDIFICATION are:

- Waste treatment facilities
- Landfill facilities, specifically hazardous waste landfill facilities
- Hazardous waste incineration facilities
- Incineration facilities: Municipal waste and hazardous waste incineration plants, power plants
- Waste treatment operation companies, also soil treatment companies
- Chemical industry
- Petrochemical industry
- Metal processing industry, like galvanizing industry
- Nuclear power industry and disposal facilities for radioactive waste



➤ 05 | Various Input Material (inorganic solids, heavy metal containing sludge, sewage sludge)



04 | Equipment **SOLIDIFICATION:**

SOLIDIFICATION Units consist of the following parts:

- Feed hopper for the waste (including grid for the protection of the downstream equipment)
- Conveyor for the waste, e.g. drag chain conveyor, screw conveyor, sludge and slurry pumps etc.
- Silo plant(s) for the additives
- Conveyors for the additives, e.g. screw conveyors, pneumatic conveyors etc.
- Dosing units for the waste and the additives (gravimetric or volumetric)
- Process water tank and process water system
- Feeding and dosing units for the additive chemicals
- Mixer (continuous or batch operated)
- Conveyors and loading facilities for the final solidified product
- **Alternative:**
Casting facilities for the production, compaction and transport of molds

According to the applications the **SOLIDIFICATION** units are equipped with required accessories like air extraction and filter units.

Feed hoppers are designed for the filling via wheel loader. Special design for the filling via truck and skip truck are available also.

The design of the feed hopper avoids bridging, even during handling of very difficult input material, like inorganic sludge or sewage sludge. For the protection of the downstream equipment and the retention of bigger particles like stones the feed hopper can be equipped with a grid.

The discharge of the material from the feed hopper is carried out via a double screw conveyor. The throughput will be adjusted via a manual adjustable gear box or a frequency inverter in accordance with the required throughput and the specification of the input material.



➤ 06 | Feed Hopper

Preferably drag chain conveyors are used for the transportation of the input material / waste. In accordance to the specification of the waste and the layout of the **SOLIDIFICATION** unit, specifically the distance between feed hopper and mixer, also screw conveyors, belt conveyors or sludge or slurry pumps are used.

Drag chain conveyors ensure the highest flexibility and robustness for the conveying of various input materials considering discrepancies in the specification of the input material and the layout of the **SOLIDIFICATION** plant. Drag chain conveyors transport reliably either solids / bulk materials or also sludge with a dry substance content more than 15 %. Drag chain conveyors cause only a low mechanical load on the transported material and therefore drag chain conveyors work with low abrasion.

The drag chain conveyor consists of a robust steel frame construction with renewable abrasion protection panels at the bottom. The flanged conveying elements are connected via flexible fasteners. The one or two string ground chain consists of C45 steel or 42CrMo4 steel. The ground chain is routed via gears made from low abrasion manganese steel. The design of the conveying paddles is adjusted to the specification of the input material / waste.



➤ 07 | Drag chain conveyor (inside and outside)

The silo plants for the additives are filled pneumatically. A pneumatic pinch valve which is controlled via a level switch protects the silo against over filling.

Silo Plants are equipped with automatic pneumatic silo top filters which are activated during the filling process of the silo. The automatic cleaning process is controlled either by time or by differential pressure.

The silo plants are in accordance to the application either equipped with level switches or continuous level monitoring systems.

To avoid bridging in the silo the conical bottom segment is equipped with pneumatic bulking systems, mechanical knocking systems or special vibration bottoms to avoid bridging in the conical bottom segment of the silo.

The transition to the conveyor is designed as sliding valve and/or star feeder system depending on the specification of the additives. Star feeders are variable speed controlled.

In general the additives are transported via screw conveyors to the SOLIDIFICATION unit. According to the application and the specification of the additives screw conveyors with shaft or spiral conveyors without shaft are used.

The screw conveyors are designed either as trough screw conveyors or tube screw conveyors and throughput controlled via manual gear boxes or frequency inverters.

Based on the material selection and the special design, specifically the low rotation speed, screw conveyors work with very low abrasion. For high-

ly abrasive additives the screw conveyors are equipped with abrasion protection panels.



Input material / waste and additives are dosed via volumetric dosing units or gravimetric weighing drums into the mixer. The selection whether volumetric or gravimetric dosing units are used is based specifically on the required quality of the final solidified product and the selection of the mixer type (continuous or batch wise operated).

Volumetric dosing units consist of a feed hopper and a dosing screw. The type of the dosing screw is adjusted to the specification of the dosing material. The throughput is controlled either via manual gear boxes or variable speed control via frequency inverter. According to the specification of the dosing material bulking agitators and feeding improvers are installed in the feed hopper to ensure a continuous and homogeneous filling of the dosing screw and an exact dosing of the material.

In general the gravimetric dosing takes place batch wise via weighing drums, which are located on weighing cells. Continuous weighing systems are used in special applications only, if the specification of the dosing material enables the use of a continuous weighing system. Specifically for the input material / waste the use of continuous weighing systems is limited because of the specification of the waste and the variation of the specification of the waste materials.



➤ 08 | Volumetric dosing unit

The process water system consist of a process water tank (break tank), which ensures the independence from the local water supply, the pressure generation and maintenance system, the flow control system and the required dosing valves.

The chemical additives are dosed via qualified dosing pumps to the process water. Static mixers ensure the required mixing and homogenization with the process water.

In accordance to the application and the required specifications of the final solidified product various mixing devices are used

- Continuous operated double shaft mixers with paddles
- Continuous operated plough share mixers
- Batch plough share mixers

The mixers are the core equipment of the SOLIDIFICATION unit and ensure a proper mixing of the input material/waste with the additives, the process water and the chemical additives and ensure the required specification of the final solidified product.

The mixing devices are equipped with manual adjustable gear boxes or variable speed drive via frequency inverter and changeable, adjustable mixing tools. The qualified material selection for the shell of the mixer and the mixing tools ensures low abrasion. For abrasive applications renewable abrasion protection panels are applied to the mixer shell.

The required mixing and the required retention time is controlled via the size of the mixer or the filling level of the mixer, the rotation speed of the mixer shaft(s) and the adjustment of the mixing tools.



➤ 09 | Double shaft mixer in operation



➤ 10 | Double shaft mixer (inside, new)



➤ 11 | Plough share mixer (Batch mixer)

The transport and the loading of the final solidified product are executed via belt conveyors in general. For the homogeneous and complete filling of skips various types of PURATEK belt conveyors are available:

- Belt conveyors and cascades of belt conveyors
- Slidable belt conveyors (also available with reverse transport)
- Swivel-mounted belt conveyors
- Telescopic belt conveyors (also available swivel-mounted)

The skip handling is designed as a skip shifting system or skip carrousel systems.

For the skip shifting systems skip trolleys for single or multiple skips, which are moved on rails, are used. Via special turn tables the filled skips are provided for the loading to special skip trucks.

Skip Carrousel provide a comfortable skip handling, specifically a smooth dropping of the empty skips and smooth pick-up of the filled skips and provide also a possibility for intermediate storage for several skips.



➤ 12 | Loading belt conveyors in operation



➤ 13 | Skip carousel

The final product of SOLIDIFICATION can also be casted into forms, compacted and get hardened to molds. The molds can be removed from the form/shattering after short period already, but the final strength will be achieved after approximately 30 days only. The hardened molds have a very low porosity. A water infiltration is not possible further on. Leaching is limited to the surface of the concrete block.

For the production of molds batch mixers are used. The content of the mixer is adjusted to the size of the molds to be produced. The content of the mixer is emptied after the mixing process into the form/shattering completely.

Therefore an empty form/shattering is transported via a roller conveyor system under the mixer. A vibration and compaction unit, which ensures the required compaction of the final solidified product and the final strength of the molds, is located under the mixer.

The filled forms/shattering are transported via a roller conveyor system out of the SOLIDIFICATION unit. At the end of the roller conveyor system the filled forms are picked up by a fork lift and transported to the hardening area.



➤ 14 | Roller conveyor system for handling of forms/shattering (automatically operated)

05 | Handling of the Final Solidified Product:



➤ 15 | Mould (treated waste) after removal of the form/shattering

Depending on the specification of the waste to be treated and the specification of the final product, the final product of the SOLIDIFICATION will be re-integrated at site, disposed and integrated at approved landfills or used for construction e.g. base layer of roads or core of dykes and banks.

The re-integration or the integration of the final solidified product in landfills takes place in layers with qualified compaction. The result is a monolithic block of final solidified product.

Furthermore the final product of SOLIDIFICATION can be casted to molds. The hardened molds can be reused or integrated into a landfill.



➤ 16 | Integrated final solidified product (monolithic block))



Further information
about Solidification:

<http://bit.ly/1wB0bkx>



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