Sandvik Rotoform® process
New performance standards in premium pastillation
The Sandvik Rotoform process combines the Rotoformer drop depositor with a steel belt cooler to create a system capable of producing pastilles of highly uniform shape, stability and quality, in an environmentally friendly manner.

**The characteristics of the Rotoform process**

- Pastilles are solidified directly from the melt, eliminating the energy and equipment costs associated with subsequent grinding, crushing or other breaking processes.
- Pastilles are of a highly uniform shape and stability, with practically no dust produced.
- Pastilles are free flowing and ideal for handling, blending, storage and further processing.
- Higher bulk density and better packing properties than bulky flakes.
- Environmentally friendly production as cooling media (water) and product are kept apart, ensuring no possibility of contamination either way. The excellent thermal conductivity of the steel belt means cooling time is short, so very little vapor or gas can get into the atmosphere and little oxygen can penetrate the product.
- Melts with widely varying properties can be handled with special Rotoform models: viscosities from 1 to 50,000 mPas, temperatures up to 320°C.
- Pastilles can be produced with diameters from 1-30 mm.

**Typical Rotoform plant**

![Diagram of the Rotoform process](image)

Free flowing pastilles of a uniform size and shape.
The principle of the Rotoformer

A pump transports the molten product from a vessel, pit or supply pipe system into the Rotoformer system.

The Rotoformer consists of a heated cylindrical stator – which is supplied with liquid product – and a perforated rotating shell that turns concentrically around the stator, depositing drops of the product across the whole operating width of the steel belt.

A system of baffles and internal nozzles built into the cylindrical stator provides a uniform pressure across the whole width, providing an evenly flow through all holes of the perforated outer shell. This ensures that every pastille is of a uniform size, from one edge of the belt to the other.

The circumferential speed of the Rotoformer is synchronised with the speed of the belt: drops are therefore deposited without deformation. Heat released during solidification and cooling is transferred by the stainless steel belt to the cooling water sprayed underneath. This water is collected in tanks and returned to the waterchilling system; at no stage does it come into contact with the product.

After the droplet has been deposited onto the steel belt, some product will remain around the holes of the outer shell. A special heated refeed bar forces this product into an internal gap in the Rotoformer from where it is mixed with new product and re-fed onto the steel belt.

The design of an effective Rotoformer system takes into consideration a number of factors. For instance, the minimum diameter of a pastille depends on the diameter of the holes in the rotating shell, the density and viscosity of the product itself, the surface tension and the mechanical acceleration applied to the droplet.

Furthermore, the drops need to be of a certain weight and volume in order to be deposited onto the steel belt, and the distance between the outer shell of the Rotoformer and the steel belt will also need to be determined from case to case.

All these parameters have to be finalised before choosing the appropriate Rotoformer component configurations. Such determinations are chosen on specially developed computer programs and/or test runs using the particular product to be processed.

[Image of Rotoformer assembled on steel belt cooler]

[Image of Rotoform feeding onto steel belt cooler]

[Image of Rotoform principle]
The experience we have gained in steel belt based granulation has enabled us to adapt, develop and improve upon the Rotoform concept, building solutions to a range of new chemical processing applications.

The basic principle remains unchanged – the efficient processing of a melt into solid pastilles – but an entire Rotoform family has now been developed to allow the production of pastilles from virtually any meltable chemical and a wide range of food products.

The development of this comprehensive product range has not only led to faster and more efficient pastillation, it has also opened up new opportunities for chemical processing. In the past, certain melts have proved impossible to process. Some need an extremely high melt temperature of up to 320°C; some demonstrate abrasive, sedimenting or corrosive properties; and still others fall into the category of supercooling melts.

With the right Rotoformer configuration it is now possible to produce pastilles out of chemical melts with any of these extreme and demanding requirements.

The Rotoform family

<table>
<thead>
<tr>
<th>Product</th>
<th>Temperature °C (max.)</th>
<th>Viscosity mPas (max.)</th>
<th>Pastille size mm (max.)</th>
<th>Capacity t/h (max.)</th>
<th>Typical products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotoform® 3000</td>
<td>270</td>
<td>50,000</td>
<td>30</td>
<td>6</td>
<td>Hot melt adhesives, Resins, Sulphur, Waxes</td>
</tr>
<tr>
<td>Rotoform® HS</td>
<td>270</td>
<td>100</td>
<td>15</td>
<td>12.5</td>
<td>Sulphur, Urea</td>
</tr>
<tr>
<td>Rotoform® HT</td>
<td>320</td>
<td>50,000</td>
<td>30</td>
<td>5</td>
<td>Bitumen, High temp resin, PET, Pitch</td>
</tr>
<tr>
<td>Rotoform® FD</td>
<td>200</td>
<td>50,000</td>
<td>30</td>
<td>3</td>
<td>Chocolate, Cheese, Chewing gum base, Emulsifier, Fat, Soup concentrate</td>
</tr>
<tr>
<td>Rotoform® AS</td>
<td>270</td>
<td>50,000</td>
<td>30</td>
<td>5</td>
<td>Catalyst, Stearate, Sulphur bentonite, Other suspensions</td>
</tr>
<tr>
<td>Rotoform® SC</td>
<td>200</td>
<td>20,000</td>
<td>15</td>
<td>2</td>
<td>Agrochemicals, Photochemicals, Plastic additives, Rubber chemicals, Stabilizer</td>
</tr>
<tr>
<td>Rotoform® CR</td>
<td>270</td>
<td>50,000</td>
<td>30</td>
<td>6</td>
<td>Aluminium sulphate, Calcium nitrate, Sodium sulphide</td>
</tr>
<tr>
<td>Rotoform® MC</td>
<td>270</td>
<td>1,000</td>
<td>2</td>
<td>0.5</td>
<td>Additives, UV stabilizer, Waxes</td>
</tr>
<tr>
<td>Rotoform® MI</td>
<td>220</td>
<td>5,000</td>
<td>15</td>
<td>0.02</td>
<td>Laboratory use, Small scale production</td>
</tr>
</tbody>
</table>

Typical products:
- Hot melt adhesives
- Resins
- Sulphur
- Waxes
- Urea
- Bitumen
- High temp resin
- PET
- Pitch
- Chocolate
- Cheese
- Chewing gum base
- Emulsifier
- Fat
- Soup concentrate
- Catalyst
- Stearate
- Sulphur bentonite
- Other suspensions
- Agrochemicals
- Photochemicals
- Plastic additives
- Rubber chemicals
- Stabilizer
- Aluminium sulphate
- Calcium nitrate
- Sodium sulphide
- Additives
- UV stabilizer
- Waxes
- Laboratory use
- Small scale production
The Rotoform HS (High Speed) has been specially developed for high capacity pastille production. The major difference between this and the Rotoform 3000 is the size of the outer shell – a diameter of 250 mm makes it more than 3x bigger than the 80 mm outer shell of the Rotoform 3000.

This increase in size means the (negative) influence of centrifugal force on the droplet is reduced, as a result, the system can operate at a higher circumferential speed and, consequently, a higher belt speed.

The increased diameter of the outer shell also means there is more space for the inner body and pre-distribution of the chemical product across the belt width.

**Key advantages of the Rotoform HS:**
- Increased capacity
- Utilisation of the experience of the Rotoform 3000
- Fewer parts (i.e. seals) for lower spares and service costs

**High pastillation speed – reduced centrifugal forces due to increased diameter**

$F_1, F_2 = \text{centripetal force}$

$r_1, r_2 = \text{depositor radius}$

$s_1, s_2 = \text{circumferential speed}$

$V_1, V_2 = \text{belt speed}$
Rotoform FD – for the food industry

The Rotoform FD has been specifically developed for use in food processing plants, where the need to meet stringent standards in terms of hygiene and reliability is imperative.

- All parts that come into contact with the product are made of stainless steel or other materials appropriate to food industry standards.
- The Rotoformer can be completely dismantled within 10-15 minutes for cleaning or maintenance.
- The volume of product contained in the Rotoformer is only 2-2.5 litres, ensuring minimal loss when cleaning or changing over to a different product.
- By using a cleaning cycle (agent, water) in a closed loop, the Rotoformer can be cleaned without dismantling.
- All parts can be reached from floor level, allowing easy access for operation, maintenance and cleaning.

Combined with the ideal qualities of the steel belt (smooth surface, ease of cleaning, ease of product removal, excellent thermal conductivity for good control of solidification process), the Rotoform FD provides the ideal solution for the pastillation of a wide range of food products, including:

- Cheese
- Chewing gum base
- Chocolate
- Emulsifier
- Fat
- Soup concentrate
The Rotoform AS has been specially developed for the pastillation of abrasive and sedimenting melts, typically those containing solids – in form of a powder or ground material – of a severely abrasive nature.

The inherent advantages of the Rotoform, combined with additional purpose-designed equipment, make the Rotoform AS the ideal solution to the challenge of pastillating abrasive and sedimenting products.

A number of special design features have been incorporated to ensure successful handling of these product types:

- Low volume processing means fewer solids in the system at any one time, reducing the possibility of separation from the basic melt.
- High velocity product flow through the Rotoform reduces the time available for separation to take place.
- Interior workings designed to eliminate the possibility of ‘dead corners’ where sediments might separate.
- Throughout, the system has been designed with very few moving parts, reducing friction to a minimum.

With the Rotoform AS, materials which at one time were impossible to pastillate can now be processed, including:

- sulphur bentonite (a suspension of elemental sulphur and up to 10% bentonite, a special form of clay)
- Stearate
- Suspensions of wax and solids
- Catalysts (nickel catalyst which contains up to 30% sharp edged nickel powder)
Some product melts will not solidify simply through cooling, requiring instead a controlled precrystallization process before pastillation. These products, known as subcooling melts, can be solidified using a specially developed supercooling system – the Rotoform SC – which combines a precrystallizer with the Rotoformer and a steel belt cooler.

The experience gained through more than 50 supercooling installations has resulted in continuing process improvement and the development of systems tailored to specific product or process requirements.

Such is the proven performance and reliability of our supercooling process that it is now accepted as the standard solution for continuous and controlled pastillation of subcooling melts. Indeed, for some melts, this process has proved to be the only method available for producing solid pastilles.

Applications for the Sandvik supercooling process include the pastillation of:
- Agrochemicals
- Photochemicals
- Plastic additives
- Rubber chemicals
- Stabilizer

Typical supercooling plant

![Diagram of a typical supercooling plant]
The Rotoform MC (Micropastillation) has been specially developed to enable the production of pastilles as small as 1 mm diameter directly from the melt, avoiding the need to grind or crush larger granules. Pastilles of this size, known as micropastilles, have the advantage of being easier to dissolve, mix or dose in subsequent reprocessing.

In this system, the distance between the surface of the outer shell of the Rotoformer and the steel belt is so small that the pastille does not fall by gravity but is taken onto the steel belt through simple adhesion. The gap between the outer shell and the steel belt is therefore critical to the successful operation of this process, and the Rotoform MC incorporates special devices for the easy and accurate adjustment of its position in relation to the surface of the steel belt.

This process is suitable for any type of product that is already being formed into pastilles, granules or pellets, including hot melt adhesives, waxes, resins, detergents, emulsifiers, pharmaceuticals, antioxidants and many others.

This system also provides outstanding flexibility, offering quick and easy changeover to the production of normal pastilles (from 3-8 mm diameter).
Delivering all the benefits of our standard Rotoform system but on a smaller scale, the Rotoform MI is ideally suited to use in laboratory testing operations and within existing plants to define quality, production rates and other key parameters of products in the development stage.

System capacity depends on the products being processed and can be up to 20 kg/h. Maximum melt temperature is 220°C and products with viscosities from 10 to 5,000 mPas can be handled successfully. The key advantages of this system are:

- Maximum versatility – strips and pastille forming
- Premium quality Rotoform pastilles
- Simple operation and accurate system control

The Rotoform MI granulation system is based on a small scale steel belt cooler and matching Rotoform feeding device, consisting of a stator, metering bar, rotating shell, refeed bar and the drive.

The melt is brought via compressed air or inert gas to the Rotoform MI system where a needle valve guarantees exact dosing onto the belt. As with all Rotoform systems, the feed and steel belt cooler are perfectly synchronised. Cooling is carried out by means of cold water sprayed onto the underside of the steel belt.

**Typical Rotoform MI plant**
Design data

Standard dimensions for
RF 3000, RF HT, RF FD, RF AS, RF SC, RF CR

<table>
<thead>
<tr>
<th>mm</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>400</td>
<td>565</td>
<td>566</td>
<td>1160</td>
<td>380</td>
<td>730</td>
<td>1000</td>
</tr>
<tr>
<td>600</td>
<td>600</td>
<td>665</td>
<td>666</td>
<td>1160</td>
<td>380</td>
<td>730</td>
<td>1300</td>
</tr>
<tr>
<td>800</td>
<td>800</td>
<td>765</td>
<td>766</td>
<td>1160</td>
<td>380</td>
<td>730</td>
<td>1600</td>
</tr>
<tr>
<td>1000</td>
<td>1000</td>
<td>865</td>
<td>866</td>
<td>1160</td>
<td>380</td>
<td>730</td>
<td>1900</td>
</tr>
<tr>
<td>1200</td>
<td>1200</td>
<td>965</td>
<td>966</td>
<td>1160</td>
<td>380</td>
<td>730</td>
<td>2200</td>
</tr>
<tr>
<td>1500</td>
<td>1500</td>
<td>1115</td>
<td>1116</td>
<td>1160</td>
<td>380</td>
<td>730</td>
<td>2650</td>
</tr>
</tbody>
</table>

Dimensions for drum diameter 800/1000 mm

Rotoform outer shells – different hole patterns are designed for different applications
Since the introduction of the first Rotoform system and the development of the full product range, it has been possible to pastillate many different chemical products, from bulky mass products such as sulphur or fertilizer, all the way through to fine chemicals such as those used in the cosmetic and pharmaceutical industries, plus a wide range of plastic and food products.

The only preconditions for Rotoform pastille production are that the melting point of the product must be below 300°C, and that solidification takes place only by extraction of heat (with the support of a precrystallizer if required).

The list here shows some of the chemical products now commonly processed using the Rotoform system. Hundreds more have been successfully tested.

Different products from A-Z:

Additives
- Alkane sulphonate
- Ammonium nitrate
- Ammonium phosphate
- Antioxidants
- Antiozonants
- Anthracene
- Asphalt
- Benzoic acid
- Bisphenol A
- Bis-hydroxyethyl-terephthalate (BHET)
- Bitumen
- Calcium chloride
- Calcium nitrate
- Calcium stearate
- Caprolactam
- Carbazol
- Catalysts
- Cobalt napthenate
- Cobalt stearate
- Crotonic acid
-
Detergents
- Diaminodiphenylmethane (DMA)
- Emulsifier

Fat chemicals
- Fatty acid
- Fatty alcohol
- Fatty amide
- Fatty ester
- Fatty stearate
- Food products
- Cacao mass
- Cheese
- Chocolate
- Edible fats
- Gelatine
- Gum base
- Sauces
- Soup concentrates
- Fungicides
- Herbicides
- Hot melt adhesives
  - Based on ethylene vinylacetate,
  - polyurethane, polyamide,
  - polyester
  - Reactive hot melt
- Insecticides
- Lactam 12
- Magnesium chloride
- Magnesium nitrate
- Maleic anhydride
- Master batch
- Monochloracetic acid
- Naphthalene
- Neopentylglycol (NPG)
- Nickel catalyst
- Paradichlorbenzol
- Pesticides
- Photo gelatine
- Phthalic acid
- Polyethylene glycol
- Polyeleleneterephthalate (PET)
- Polystyrene
- Polyvinylacetate
- Potassium hydroxide
- Potassium nitrate
- Potassium polyphosphate
- Powder paints
- PVC additive
- PVC stabilizers
- Resins
  - Acrylic
  - Colophonium
  - Epoxy
  - Hydrocarbon
  - Phenolic
  - Polyamide
  - Polyester
  - Silicon
  - Tall oil
- Rubber chemicals
- Sodium acetate
- Sodium hydroxide
- Sodium nitrate
- Sodium sulphide
- Sorbitol
- Stabilizers
- Stearic acid
- Subcooling melts
- Sulphur
- Sulphur + Bentonite
- Surfactants
- Synthetic soap
- Tar pitch
- Tensides
- Toluene-diisocyanate (TDI)
- Triazole (BTA, TTA)
- Trimellitic anhydride (TMA)
- Triphenyl phosphate (TPP)
- Urea
- UV-stabilizers
- Waxes
  - Paraffin
  - AKD
  - Microcrystalline
  - PE-wax
  - PP-wax
  - Bee-wax
  - Filled wax
  - Flavoured wax
  - Wax colours
  - Montan wax
  - Coating wax
- Zinc nitrate
- Zinc stearate
Steel belt coolers with Rotoformers in action worldwide
Sulphur, whether derived from natural sources or as a by-product of oil, gas or chemical processing, is produced in liquid form at a temperature of between 125-145°C. A molten product of this nature can be difficult – and expensive – to transport, handle and store, so it is commonly formed into a more manageable solid product.

The Sandvik Rotoform principle has, for many years, been recognised as setting the worldwide standard in premium quality pastillised sulphur production. Among its key benefits are:

- Low friability and excellent resistance to impact abrasion (low visual dust generation). Formed sulphur is moved an average of 15 times between production and re-use (various stages of handling, transport & storage), so low dust generation is particularly important.
- Good flow characteristics with high angle of repose.
- Easy remelt (no agglomeration).

While the quality of end product has been central to the success of the Rotoform principle, its suitability to the particular requirements of the oil and gas industries has been a key factor behind the 200+ sulphur solidification installations now in operation around the world.

- The capacity of a Rotoformer is ideally suited to the requirements of a typical refinery.
- High flexibility – ability to install several machines to create a modular system in which one or more units can be shut down and restarted at short notice.
- Operation is efficient, environmentally friendly and – critical to the oil and gas industries – extremely safe.
Our responsibility for turnkey solutions

At Sandvik, we can design, supply and install complete pastillation plants appropriate to your particular product and process requirements, encompassing everything from the feeding of the melt to downstream handling & packing systems and complete process control.

Our work starts with feasibility and pilot tests in one of our three test centers – Fellbach/Germany, Totowa/USA or Nishinomiya/Japan.

If it is impractical for a test to be carried out at the test center, a mobile unit can be delivered and installed at your own laboratory or manufacturing site.

These facilities can be made available for tests on – and pilot production of – your own products, enabling our process specialists to assist you in planning the most efficient and commercial systems.

During the execution of a contract, our engineers will provide as much support as is required, including the detailed specification of any equipment or utilities to be supplied by third parties. This level of involvement can of course extend to full responsibility and guarantee of entire turnkey plants, including:

- Engineering
- Manufacturing and supply of goods
- Erection and commissioning
- Start-up
- Training of your personnel
- Aftersales service and spare parts supply.

In terms of ongoing support, our global presence means we are able to offer our service, spare parts or any other assistance at very short notice, ensuring reliable operation and minimum downtime throughout the working life of any installation.
The solution for pastillation

Sandvik Group
The Sandvik Group is a global high technology enterprise with around 300 subsidiary companies, 37,000 employees and activities in more than 130 countries. Sandvik’s operations are concentrated on its three core businesses of Tooling, Mining and Construction, and Materials Technology — areas in which the group holds leading global positions in selected niches.

Sandvik Materials Technology
Sandvik Materials Technology is a world-leading supplier of products with extensive added value in advanced stainless steels, special alloys, metallic and ceramic resistance materials as well as process plants based on steel belts, and sorting systems.

Sandvik Process Systems is a product area within Sandvik Materials Technology and a world force in the design and manufacture of steel belts, press plates and steel belt-based industrial processing systems. Markets served include food, chemicals and pressing equipment for wood and other materials.