THE SULPHUR COMPANY - A WORLD LEADER IN SULPHUR PROCESSING & HANDLING
EXPERTISE BASED ON LONG-TERM PARTNERSHIP WITH THE WORLD’S SULPHUR INDUSTRY
THE SANDVIK NAME HAS BEEN SYNONYMOUS WITH INNOVATION IN ENGINEERING SINCE THE MID-1800S AND WE HAVE BEEN ACTIVELY INVOLVED WITH THE SULPHUR INDUSTRY SINCE 1951 WHEN WE INSTALLED A STEEL BELT COOLER FOR SULPHUR SLATING AT A REFINERY IN MEXICO.

So successful was this first installation that another 125 systems were subsequently installed worldwide, all based on the same principle of solidifying liquid sulphur in the form of slates.

This early experience of meeting the needs of customers eventually led to the development in 1979 of a rotary drop former technology that would go on to become the world’s most widely used system for the solidification of sulphur: the Sandvik Rotoform.

Today, more than 600 Rotoform systems are in use across the sulphur industry and our expertise extends far beyond the solidification stage, encompassing everything from the receipt of molten sulphur from the SRU to a complete range of downstream handling processes.

WELCOME TO SANDVIK, THE SULPHUR COMPANY
Choose to work with Sandvik and you open the door to a wealth of expertise covering every aspect of sulphur processing and handling.

We can design, integrate and commission equipment for every stage of the process, from upstream preparation, degassing and filtering of molten sulphur through a range of different solidification options, to downstream conveying, storage, reclamation and bagging or bulk loading.

Our experts can also help you maximize productivity and achieve a faster ROI through operator training and planned maintenance programs.

PROCESS SYSTEM EXPERTISE
Our sulphur processing systems are employed around the world – often in remote locations or challenging conditions – and we support them all through a global service network. So wherever you’re based, you get the support you need.

Our engineering, consulting and project management teams have the expertise to undertake end-to-end project management from feasibility studies and front end engineering design (FEED) through to complete engineering procurement construction (EPC) packages. This includes installations where considerations such as the potential risk of earthquakes or specific local weather conditions need to be taken into account.

And by assuming total responsibility for a project, we not only ensure full system optimization but can also deliver cost savings through significant project efficiencies.

STRENGTH AND STABILITY OF A GLOBAL ENGINEERING GROUP
Choose Sandvik and you benefit not only from our technical expertise but also from the reassurance of working with one of the world’s foremost engineering groups.

Sandvik is a high-technology engineering business with advanced products and world-leading positions within selected areas. Overall, the Sandvik Group employs approximately 49,000 people across more than 130 countries.

As part of this group, we’re able to offer the specialist skills and responsiveness of a medium-sized company, underpinned by the strength and stability of a group with annual sales in excess of US$ 15 billion.

REAP THE BENEFITS OF SINGLE SOURCE SUPPLY BY WORKING WITH ‘THE SULPHUR COMPANY’
A combination of factors has resulted in sulphur being extracted from crude oil and gas in greater volumes than ever before:

- a growing world population means increased demand for energy;
- the world’s remaining hydrocarbon reserves contain higher levels of sulphur than previous fields;
- changes in environmental legislation have led to a continuing reduction in the amount of sulphur permissible in fuel, resulting in sulphur recovery efficiency levels as high as 99.9%.

Global output is now in the region of 60 million tons p.a. (of which approx. 95% is recovered from oil and gas sources). By definition, recovered sulphur is produced in the greatest quantities in those areas where oil and gas is refined: North America, Russia, China and the Middle East.

In terms of demand, huge amounts of sulphur are now required for the production of agricultural chemicals and fertilizers; this is due to a combination of ever more intensive farming methods and the removal of sulphur from fossil fuels, resulting in a reduction in the amount of ‘free’ sulphur that was once deposited from the atmosphere.

As a result, more than 50% of world’s sulphur output is traded internationally, and therefore has to be stored and transported in a form that is safe, clean and commercially viable.

**PREMIUM QUALITY FORMING**

Where processing takes place close to a refinery, sulphur can usually remain in its molten form. But when greater distances are involved – and certainly when elemental sulphur is to be shipped from one continent to another – it needs to be solidified.

It was in order to establish standards for formed sulphur – and its suitability for transportation (i.e. export) – that, in the late 1970s, SUDIC (Sulphur Development Institute of Canada) set about defining what has now become globally recognised as a ‘premium’ quality product.

In determining this quality, SUDIC looked at friability and fines content, both critical to efficient, clean and environmentally safe production and handling. The other major factor was moisture content; excess moisture not only adds weight, leading to unnecessary transportation and remelting costs, but also results in increased acidity, causing corrosion in conveyors, silos, trucks, rails cars and ship holds. A ‘wetter’ product is also more susceptible to freezing into lumps during cold weather, a significant factor in North America and Russia.

Together, these factors determine not only the quality of the formed sulphur but also the ease with which it can be handled and the potential impact on the environment during storage and transportation (formed sulphur can be handled as many as 15 times between solidification and subsequent reprocessing).

We have therefore focused the design and development of all Sandvik sulphur forming products – as well as our complete array of downstream handling equipment – on ensuring that SUDIC premium quality sulphur reaches the end user.
MORE THAN 50% OF THE WORLD’S SULPHUR OUTPUT IS TRADED INTERNATIONALLY AND THEREFORE HAS TO BE STORED AND TRANSPORTED IN A FORM THAT IS SAFE, CLEAN AND COMMERCIALLY VIALBLE

<table>
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<th>SPECIFICATIONS</th>
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<td>According to the SUDIC definition, premium quality sulphur will meet the following specifications 21 days after forming:</td>
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<td>Mean size:</td>
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<td>Size distribution:</td>
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<td>Moisture:</td>
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Sandvik forming equipment meets or exceeds these specifications.
LIQUID SULPHUR DEGASSING

The Sandvik Brimrock DG Series sulphur degasser provides an economical means of reducing poisonous hydrogen sulfide in liquid sulphur.

Its high degassing capability – $\text{H}_2\text{S}$ is reduced to less than 10 ppm – minimizes the potential for downstream regulatory safety violations, and its robust design and ease of operation ensures low operating and maintenance costs.

Self contained, compact and portable, this skid mounted unit is supplied with all necessary wiring and pipework and is extremely easy to use.

- Maximum degassing capability to below 10 ppm $\text{H}_2\text{S}$
- Superior environmental performance
- Continuous operation under negative pressure in a fully contained system

LOW COST, HIGH CAPACITY SULPHUR DEGASSING, BLOCK POURING AND REMELTING
Limited manual labor or exposure to potential hazards.
Low operating and maintenance cost
Efficient use of energy

RELIABLE AND EFFICIENT REDUCTION OF HYDROGEN SULFIDE

Molten sulphur is pumped through the degassing reactor where billions of tiny air bubbles transfer the H₂S gas from the molten liquid to the headspace of the sealed reactor tank.

A carefully defined volume of catalysts is then introduced, quickly reducing the hydrogen polysulphide molecules to gaseous H₂S, resulting in the degassing of both H₂S and H₂SX within the molten sulphur.

H₂S rich airflow exits the degassing reactor and is transferred via ducting to an appropriate effluent treatment system, while the degassed molten sulphur is transferred to downstream systems.

A PRACTICAL AND ECONOMICAL SOLUTION TO THE STORAGE OF LARGE VOLUMES OF SULPHUR

The Sandvik Brimrock SR800™ is a versatile and compact unit offering predictable, high capacity throughput. Nominal capacity is 35 metric tonnes per hour (mtph) with feed sulphur moisture content of less than 5% and minimum contaminate levels. For sulphur with higher contaminate levels (up to 5%), we offer the Sandvik Brimrock CSR575™.

Solid sulphur is melted in a settling tank while heated liquid sulphur is recirculated through the tank, aiding in the melting process. The heavier contaminates settle out of the molten sulphur and are continuously removed via a sludge extraction conveyor.

- Predictable, maximum throughput rates
- Efficient use of energy
- Reduced sulphur concentration in recovered contaminates
- Low operating cost; low maintenance
- Environmentally friendly

IN-DEPTH EXPERTISE IN LARGE SCALE BLOCK POURING SOLUTIONS

Block pouring offers a practical and economically viable solution to this, and our sulphur forming experts have extensive experience in the design of such systems.

As well as supplying all necessary equipment – pouring towers, forms etc. – we can also provide a full consultancy service covering every aspect of the block pouring site, from safety and environmental compliance to pouring techniques and future remelting considerations.

HIGH PERFORMANCE, LOW MAINTENANCE SULPHUR REMELTERS

We offer a choice of two remelting systems, both skid-mounted for easy transportation by truck, sea or rail.

BLOCK POURING AND REMELTING

Fluctuations in global sulphur output and projections of future supply outstripping demand mean that sulphur producers face an increasing challenge of medium to long term storage of large volumes of sulphur.
Our flagship Rotoform system – the only dry solidification process on the market – offers unrivalled product uniformity, direct-from-the-melt pastillation and environmentally friendly operation. These, and a whole range of other qualities, have combined to make the Sandvik Rotoform the world’s favourite premium solidification process – more than 600 Rotoform units have been supplied for sulphur forming operations.

Recent years have seen the expansion of the Rotoform family, with the introduction of specialised models for medium capacity applications and, most recently, the Rotoform S8, specifically developed for low cost sulphur pastillation. However, all Rotoform units operate on the same proven principle as our first sulphur dropformer developed back in 1979.

**FROM MELT TO SOLID IN A SINGLE STEP**

The Rotoform consists of a heated, cylindrical stator and a perforated rotating shell that turns concentrically around the stator, depositing sulphur drops across the whole operating width of a continuously running steel belt. The circumferential speed of the Rotoform is synchronised with the speed of the belt, ensuring that drops are deposited accurately, consistently and without deformation.

The belt is cooled by water sprayed on the underside and the resulting heat transfer results in rapid solidification of the product.

The sulphur droplets are then discharged as solid, hemispherically-shaped pastilles at the end of the cooling system. To eliminate the possibility of damage to the pastilles during discharge, a thin film of silicon-based release agent is sprayed onto the steel belt.

**PASTILLES TO SUIC PREMIUM PRODUCT SPECIFICATION**

The efficiency of this single step, liquid-to-solid process results in a product quality classified as ‘premium’ as defined by the Sulphur Development Institute of Canada (SUIC) specifications (see page 7).

The uniform shape and size of Rotoform pastilles make it free-flowing for easy handling and its predictable high bulk density is a major advantage in terms of storage and transportation.

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**PREMIUM ROTOFORM SOLIDIFICATION FOR SMALL TO MEDIUM CAPACITY REQUIREMENTS**
UNRIVALLED PRODUCT UNIFORMITY, DIRECT-FROM-THE-MELT PASTILLATION AND ENVIRONMENTALLY FRIENDLY OPERATION HAVE MADE THE SANDVIK ROTOFORM THE WORLD’S FAVOURITE PREMIUM SOLIDIFICATION PROCESS.

The Rotoform process also offers a number of environmental advantages:

- As the cooling water never comes into direct contact with the sulphur, there is no risk of cross contamination.
- Solidification takes less than 10 seconds so there is little time for H₂S to escape, resulting in very low emission values.
- Low levels of sulphur dust levels mean no need for exhaust air treatment.

BENEFITS INCLUDE

- Low friability, which minimizes product degradation and dust
- High angle of repose, good flow characteristics
- High purity and consistent quality
- Low residual H₂S (<10ppm)
- Low moisture content (the Sandvik Rotoform® process does not increase the moisture content).
- Unrivalled uniformity
The Sandvik Brimrock RS1500™ is a fully automated sulphur granulation process based on rotating drum technology. With a nominal throughput rate to 65 mtph, this is the highest capacity granulation unit available, and produces formed sulphur to SUDIC specifications (see page 7).

Seed or nuclei particles of solid sulphur are generated externally by freezing sprays of liquid sulphur in a water bath at controlled pressures to form the desired size range. These particles are then augured into a slowly rotating drum with appropriately placed flights attached to its inner surface. The flights create curtains of particles inside the drum as well as gently moving them towards the discharge end.

As the nuclei particles travel along the drum, they are progressively enlarged to the required size by means of sulphur sprayed from a bank of nozzles running the length of the drum.

The temperature in the drum is moderated by the evaporation of water from spray nozzles located inside the drum.
LOW CAPEX AND OPEX FOR HIGH CAPACITY SULPHUR FORMING

The Sandvik Brimrock RS1500™ is supplied prefabricated for fast delivery and rapid installation, and its simple design, low maintenance requirements and continuous operation combine to deliver exceptional ROI.

- Highest capacity granulation unit available in the industry
- Uniform end product - external seed generation enables controlled variation of size distribution during operation

- Small footprint (60% less than other granulators)
- Minimal rotating equipment
- Fast delivery, quick installation, low shipping costs
- No sulphur ‘pre-conditioning’ required
- Continuous operation – no need for routine shut down
- No solid waste streams or liquid effluents
- Low maintenance – horizontal 0° drum reduces stress

A FULLY AUTOMATED SULPHUR GRANULATION PROCESS WITH A NOMINAL THROUGHPUT RATE OF 65 MTPH - THE HIGHEST CAPACITY GRANULATION UNIT AVAILABLE

PREMIUM GRANULAR PRODUCT TO SUDIC SPECIFICATION

The spherical product meets the shape criteria and Stress Level I and II friability parameters of the SUDIC premium product specification.

The completely spherical shape – along with the repeated spraying and cooling of thin layers of molten sulphur on the surface of the granules as they pass through the granulator – accommodates the natural shrinkage of the product as it completes the transition from melt to solid, without weakening the product.
From our small/mid-size capacity Rotoform pastillation system to the high capacity Sandvik Brimrock drum granulator, we have the systems to meet any sulphur granulation requirement, enabling the production of premium quality product suitable for subsequent handling. But refineries need more than this: once the sulphur has been formed, it has to be conveyed, stored and then bagged or bulk loaded.

And just as our name has become pre-eminent in solidification, so we are also able to provide complete bulk material handling systems.

Our capabilities encompass everything from the supply of transfer conveyors and bucket elevators to bulk storage and loading systems.

Sulphur handling also requires the use of appropriate materials: if it comes into contact with water it will create sulphuric acid, leading to serious corrosion of conveyors, buildings, trucks, trains and ship holds. Our facility design and consultancy services will ensure that this risk is mitigated and your investment is protected.

We also ensure maximum productivity through proven equipment and process design, delivering handling systems with operational reliability in excess of 8,000 hours/year.

SAFETY & DUST GENERATION
One of the most important challenges when handling sulphur in a solid form is managing the risk of dust explosion. Solidification to SUDIC premium standard is an essential part of this as low friability means a significantly lower risk of dust generation, but equally important is the need for safety management to be designed into every stage of downstream handling.

Conveyor belts are protected against the build-up of static electricity and dust suppressants are applied at final transfer points. Bucket elevators are enclosed in dust-tight casings and provided with upward-facing explosion vents. The buckets themselves will be antistatic with rubber-coated steel carrying wires.

In terms of storage, closed silos or hoppers are supplied with roof venting and equipped with bursting discs. When sulphur pastilles are stacked and reclaimed indoors, metal supports in the building will be grounded and good natural or mechanical ventilation provided.

The same need for safety applies to loading processes, so the risk of dust formation is minimised at truck, rail and ship-loading facilities through the use of telescopic chutes with level sensors.

COMPLETE, INTEGRATED ENGINEERING SOLUTIONS
Ever increasing levels of production mean that refineries will not only have to process more sulphur but also find safe and efficient ways of storing, handling and loading the solidified material. Our experience across both areas means we are in a unique position to be able to design, construct, install and commission complete, integrated engineering solutions.

RELIABLE AND SAFE DOWNSTREAM SULPHUR HANDLING SYSTEMS
OUR CAPABILITIES ENCOMPASS EVERYTHING FROM THE SUPPLY OF TRANSFER CONVEYORS AND BUCKET ELEVATORS TO BULK STORAGE AND LOADING SYSTEMS
With handling equipment encompassing everything from conveyor components to rectangular/circular stackers and reclaimers, and a comprehensive range of bagging and loading solutions, we can deliver downstream solid sulphur handling plant for any requirement.

**COVERED/OPEN STOCKPILES**
Our custom-built stacking and reclaiming systems can be used to deliver stockpile solutions for any capacity or location. These can be circular or rectangular, indoor or outdoor, and the high angle of repose of sulphur pastilles (typically 28°) allows the development of high capacity stockpile solutions.

The use of luffable stacker booms keeps the boom tip as close to the stockpile as possible, minimising the drop height to reduce the risk of damaging the formed sulphur.

- Open or closed storage
- Portal and semi-portal reclaimers
- Simple hoppers and belt feeders, front end loaders

**OPEN SILOS**
We can also design, manufacture and install storage silos with top loading/bottom reclamation equipment.

- Closed silos for small to medium capacity storage
- Large capacity, concrete storage silos
- Gentle handling of formed sulphur
- Designed to highest safety standards

**CONVEYING**
We can provide a full range of conveying and elevator solutions to suit all requirements and environments, and can design systems with the minimum number of transfer points for clean and efficient operation.

- Wide belts to enable reduced velocity
- Static-conductive conveyor belting
- Dust-tight conveyor design with transfer skirts and enclosed transfer points

FROM STACKING AND RECLAIMING TO BAGGING AND LOADING
WITH A RANGE OF HANDLING EQUIPMENT AND COMPREHENSIVE BAGGING AND LOADING SOLUTIONS, WE DELIVER DOWNSTREAM SOLID SULPHUR HANDLING PLANT FOR ANY REQUIREMENT

CHUTES
All loading systems are equipped with chutes designed to deposit materials with the minimum amount of dust generation.

- Cascade chutes slow down material drop to minimise dust
- Level sensors reduce drop distance
- Dust skirts beneath chutes contain any remaining dust

TRUCK LOADING
Our bulk materials handling team can design, manufacture and install truck-loading equipment to meet any requirement.

- Telescopic loader with level sensors to reduce drop distance
- Continuous truck loading
- Single or multiple loading bays

RAIL LOADING
Rail loading systems can be designed to meet any requirement, with solutions for continuous or stationary loading.

- Telescopic loaders with level sensors
- Loading up to four rail cars at once
- Continuous loading via pivotal arm

SHIP LOADING
We offer four types of systems for ship-loading: stationary, linear travelling, radial quadrant and mobile units.

- Telescopic loaders with level sensors
- Telescoping, luffing, slewing and shuttling
- Remote control units

BAGGING
We can supply complete bagging systems suitable for 50 kg bags or big bags (500 / 1000 kg).

- Pre-weighers
- Open mouth bagging, automatic closing
- Metal detection
As a company operating in every corner of the world, from the frozen Canadian north to the deserts of the Gulf states, from the tropical heat of South America and the Indian subcontinent to the remotest regions of Asia, we are able to provide customer support on a global basis.

We have invested heavily in an infrastructure that enables us to deliver service when and where it’s needed, through local technicians backed up by a dedicated engineering team. We can also provide in-depth skills training for your in-house teams, ensuring optimum system productivity, a high quality end product and maximum return on investment.

And a network of regional offices and production centers means that Sandvik expertise, advice and spare parts are never more than a phone call away.

We can work with your people to support planned maintenance programmes that will minimize the risk of costly downtime, and we can work with them to develop and implement best practices that ensure maximum plant efficiency and full compliance with all relevant health & safety and environmental requirements.

In short we will provide a complete package of support services to ensure that your Sandvik systems achieve maximum productivity at all times.

When you choose Sandvik as your supplier, you’re not only investing in precision engineered, sulphur processing and handling solutions. You’re also entering into what we hope will become a long term partnership, one that we will support through many decades’ experience in meeting the needs of the world’s oil and gas refineries.

- Global capability
- Trained, equipped and qualified engineers
- Full system optimisation
- Fast, cost effective commissioning
- Transfer of know-how to in-house personnel
- Tested under production conditions
- Full technical service

GLOBAL AFTER SALES SUPPORT TO PROTECT YOUR INVESTMENT
As a company operating in every corner of the world, we are able to provide customer support on a truly global basis.