IPCO's Rotoform granulation system forms the heart of an end-to-end sulphur solidification and handling plant installed at Hellenic Petroleum's Elefsis refinery near Athens, Greece.

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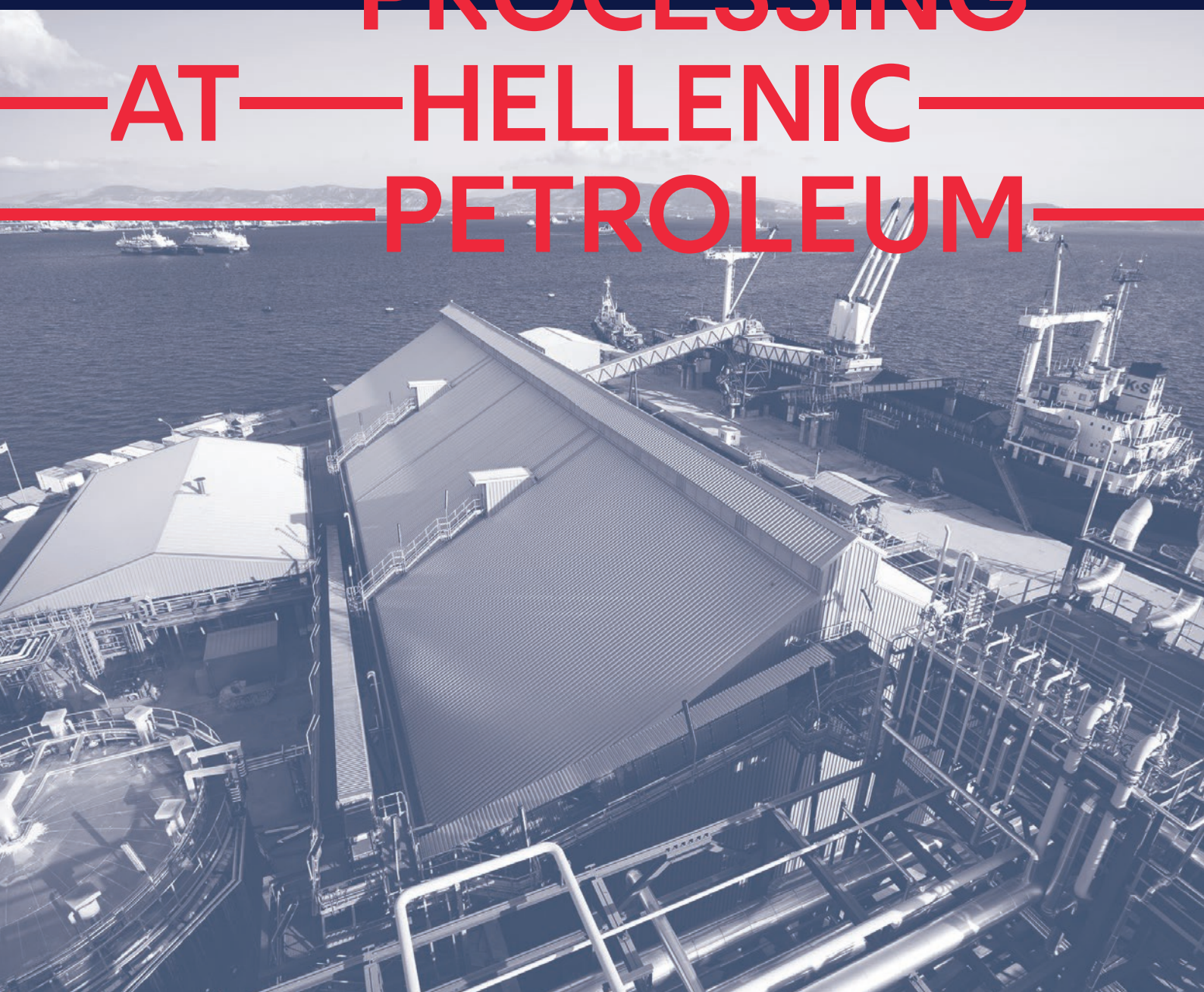
CASE STUDY: SULPHUR PROCESSING AT HELLENIC PETROLEUM



FROM LIQUID SULPHUR TO SHIP-LOADING

IPCO and ROXON deliver end-to-end sulphur granulation and handling solution for Elefsis refinery upgrade.

Hellenic Petroleum has installed a sulphur granulation and handling plant at its Elefsis refinery, south of Athens, Greece, as part of a €1.2 billion upgrade designed to improve production capabilities while at the same time reducing emissions.

The project has enabled the production of ultra low sulphur fuels and given Hellenic the ability to handle different kinds of crude. Other objectives of the upgrade included a significant reduction in emissions together with efficiency enhancements and improved safety conditions.

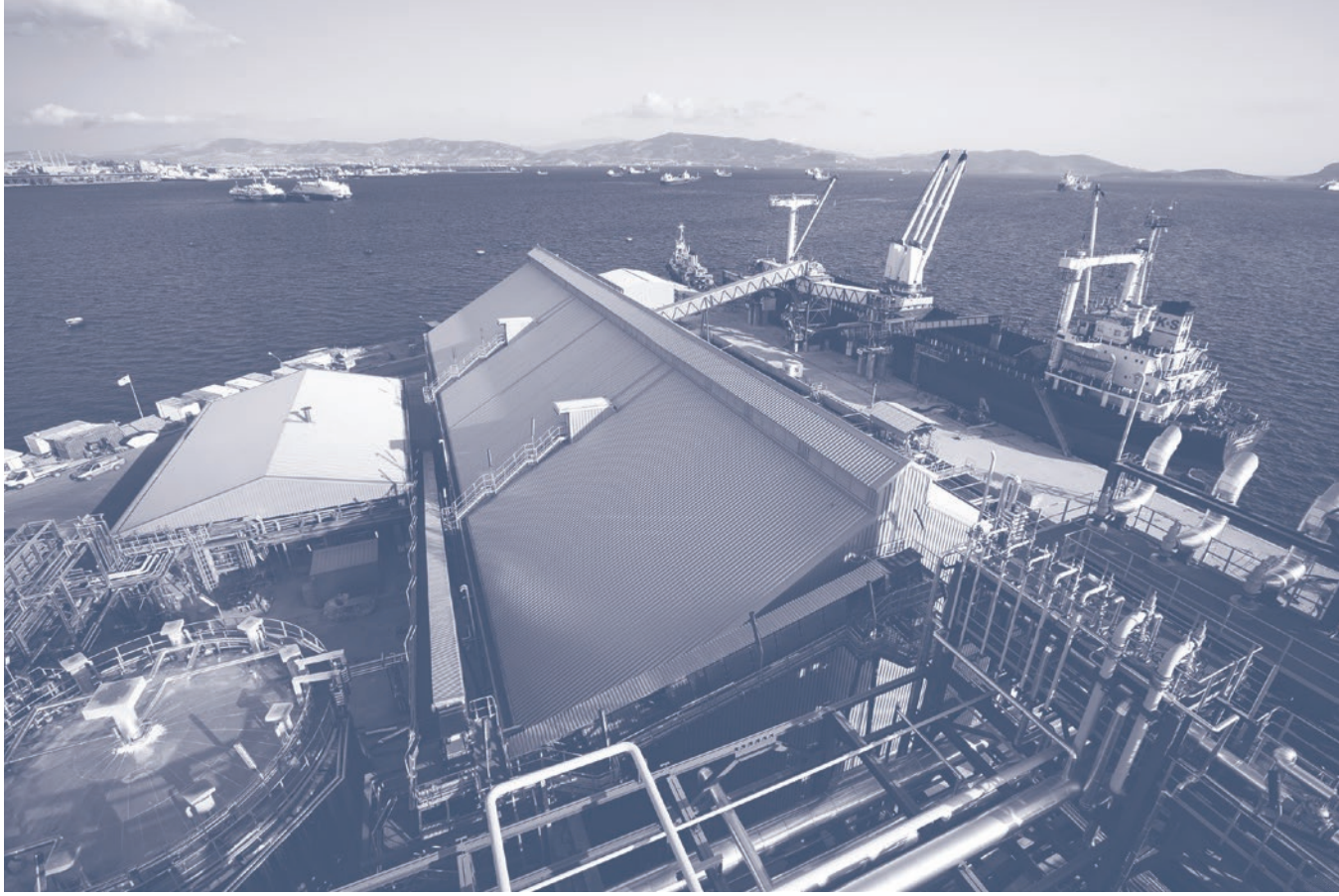
Front end engineering design (FEED) for the Elefsis refinery upgrading project was carried out by Foster Wheeler Italiana, and the engineering, procurement and construction management (EPCM) and project management contractor (PMC) roles were undertaken by Tecnicas Reunidas in Madrid.

Achieving a reduction in emissions was particularly important to Hellenic Petroleum, with environmental protection having been an integral part of its activities for many decades.

And it was this commitment to environmental protection that was a deciding factor in the awarding of the sulphur solidification contract to IPCO.

Germany-based IPCO delivered a solidification solution based on four of its Rotoform® granulation systems, each with a capacity of approx. 300 t/day. Bulk materials handling OEM supplier ROXON – with whom IPCO has cooperated on other projects to deliver the streamlined service and synergies of a single supplier – installed the solid sulphur handling facilities, including stacking, storage, reclaiming and ship-loading equipment.

This order sees the continuation of a relationship that extends back to the mid-1980s when IPCO first installed sulphur granulation lines at Hellenic Petroleum's Aspropyrgos refinery.



Environmentally-friendly sulphur solidification

IPCO's Rotoform system offers a number of process benefits, but for Hellenic it was the inherent cleanliness of the process that proved to be its key advantage over other technologies.

The Rotoform process uses indirect heat transfer for solidification; the fact that there is no contact between the molten sulphur and the cooling water means there is no risk of cross contamination and the water can be recycled within the system, again and again.

Cooling time on the Rotoform line is short, so very little vapour or gas can get into the atmosphere. As a result, minimal air extraction is required and that which does pass through the exhaust comes within legal emission limits for both H_2S and SO_2, so there is no need for treatment such as scrubbing or incineration.

Another environmental quality is that the system is in itself a process with low energy consumption and low compressed air requirements.

From melt to solid in a single step

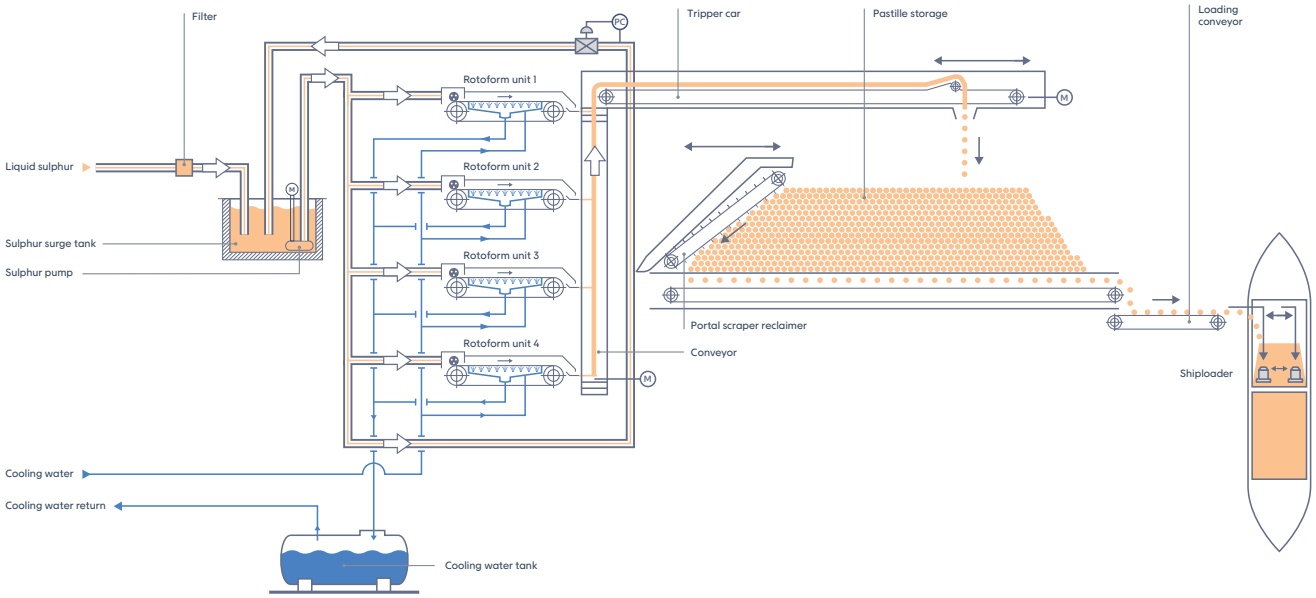
Solidification of the sulphur extracted at the Elefsis refinery begins with the molten product being pumped from sulphur recovery units to a liquid sulphur storage tank. From here it is pumped – via a heated pipeline and through a double filter – to a precooling system.

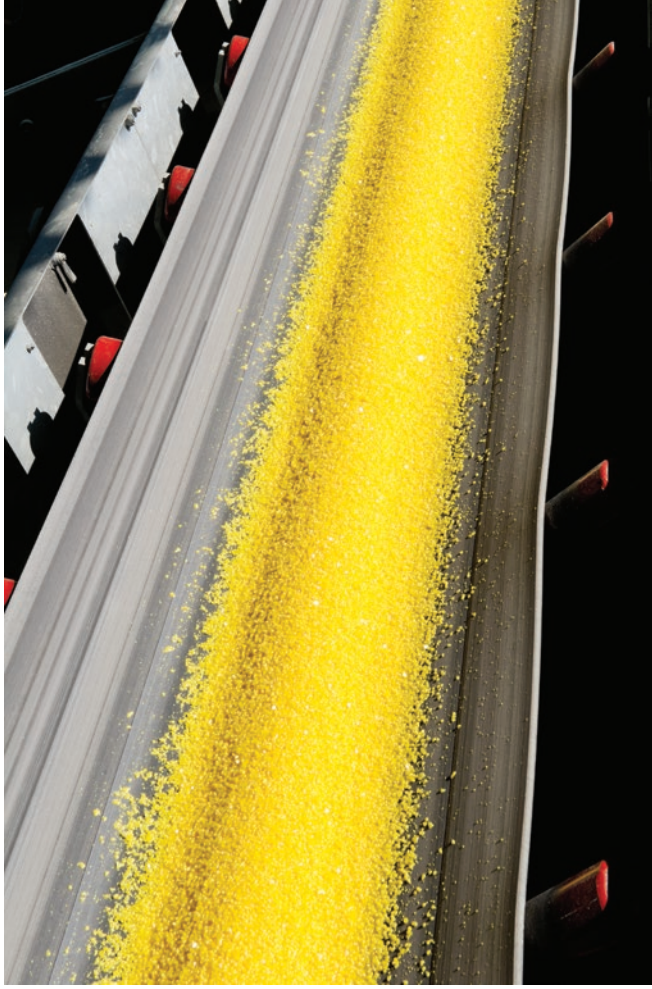
The precooler can accept the liquid sulphur at up to 150 °C, and then cools it down to 125 °C. This ensures a constant feeding temperature to the Rotoform pastillation units, irrespective of the temperature of the liquid sulphur held in the storage tank.

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, hemispherical 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 applied to the steel belt.





As the pastilles are taken off the end of the Rotoform line, they are conveyed outside the solidification building to the covered stockpile area.

The installation of four separate Rotoform units gives Hellenic Petroleum a high degree of flexibility. Each line can be operated individually, and shut down/restarted at short notice. The ability to reduce the capacity of individual units from 100% to 75% via a few switches on the control board – and ramp back up to full production just as easily – delivers another level of flexibility. Higher capacities can be achieved in the future by installing additional units and grouping them with the existing systems.

Premium quality solidification to SUDIC specifications

As well as delivering the required levels of capacity and flexibility required, the installation at Hellenic Petroleum's refinery also satisfies all key requirements for formed sulphur in terms of quality: good flow characteristics; consistent quality and stable properties; and a product that is easily remeltable with no agglomeration.

More specifically, the pastilles fall within the standards required of a 'premium product', as defined by the Sulphur Development Institute of Canada (SUDIC) specifications in 1978. These state that a product must satisfy the following standards after being formed:

Specifications	
Mean size	between 2 and 5 mm
Size distribution	less than 5% bigger than 4.75 mm minimum 75% between 4.4 and 2.4 mm less than 2% smaller than 1.18 mm less than 0.1% smaller than 0.3 mm
Moisture	less than 0.5% by weight
Friability	less than 1% fines (< 0.3 mm) under stress level I less than 2% fines (< 0.3 mm) under stress level II
Bulk density	1 040 kg/m³ loose, 1 200 kg/m³ agitated
Angle of repose	not less than 25°
Compaction	below 0.2% fines (< 0.3 mm) by weight under static load below 0.5% fines (< 0.3 mm) by weight under dynamic load

The qualities of low friability, good impact abrasion resistance, good flow characteristics, high bulk density and high angle of repose are all important, given that the solidified sulphur can be moved several times between production at the refinery and subsequent re-use (i.e. the various stages of handling, storage, shipping etc.).

This combination of flexibility, minimal environmental impact and premium product quality has resulted in over 2 000 successfully completed Rotoform installations across the oil & gas, chemical and food industries.

Complete solid sulphur handling system

IPCO has been a leading supplier of granulation systems to the oil and gas industries for many years, while Finland-based ROXON is a world force in bulk materials handling. In bringing together their particular know how and technical expertise, the two companies have been able to provide Hellenic with an end-to-end solution.

Once the sulphur has been solidified, it has to be stored in preparation for shipping. As the refinery is located close to a densely populated area, these facilities had to be designed to take all possible precautions to minimise any impact on the environment.

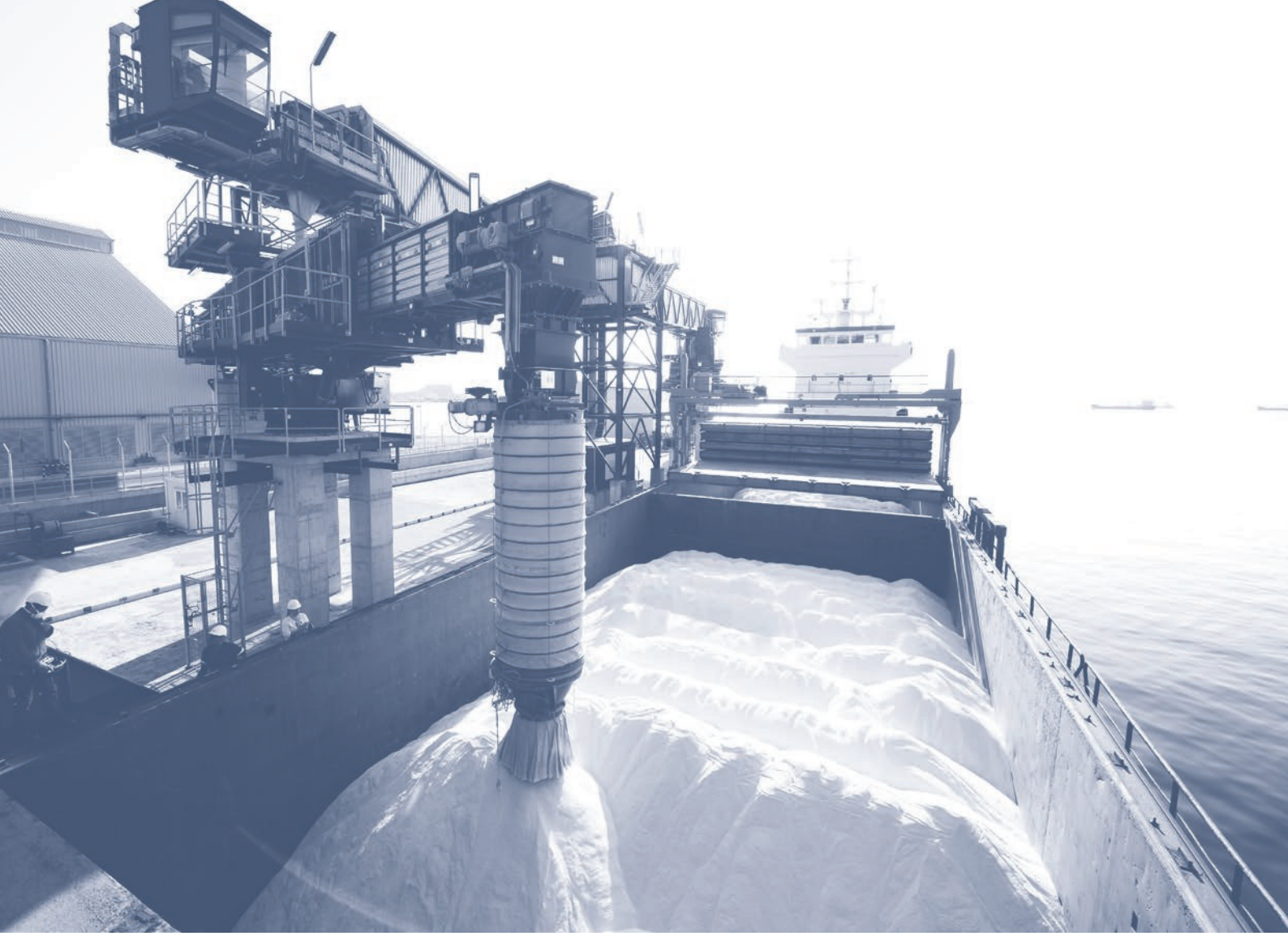
ROXON's expertise in materials handling systems enabled the design and supply of a highly efficient downstream storage and reclamation solution, as well as bulk loading for truck, rail and ships to support fast, reliable delivery of the solidified sulphur to export markets. The system includes belt conveyors, stockpile feeding tripper conveyor, advanced scraper reclaimer, dust suppression at loading points and the use of telescopic chutes in shiploaders.

The stockpile feeding system uses a belt conveyor with a capacity of 33.5 tph to feed a distribution system at a height of approximately 20 m. From here, a rail-mounted conveyor discharges the solid sulphur pastilles along the full length of the covered stockpile by means of a tripper car.

This area has the capacity to house around a month's sulphur production, approximately 10 300 metric tons.

Sulphur is reclaimed by means of a portal scraper that travels the full length of the pile, on one side only, discharging the pastilles onto a conveyor belt running along the stockpile.

Two ship-loaders have been installed, each fed by a 70 m transfer belt and delivering a combined maximum loading capacity of 70 tph. A remote control unit enables loading to be managed from outside the operator's cabin if this offers better visibility of the cargo hold. A combination of telescoping, luffing, slewing and shuttling travel means the ship-loaders are able to feed all hatches on every type of vessel used to ship sulphur from this port.



A world leader in sulphur solidification and handling plants

IPCO's expertise in sulphur solidification and handling has been established over many decades. Today, the company manufactures equipment for sulphur degassing, molten loading for truck and rail, block pouring, remelting and a full range of sulphur solidification technologies.

The Rotoform system, designed for small to mid-size capacity requirements, is the most widely used process for the production of premium quality pastilles, having been installed in most of the world's major refineries. Where higher capacity is required, IPCO's sulphur granulator drum system is a fully automated, once through process based on rotating drum technology.

IPCO's sulphur processing systems are in operation around the world – often in remote locations or challenging conditions – and are supported by the company's global service network.

Engineering, consulting and project management teams are able to undertake end-to-end project management and, by assuming total responsibility, not only ensure full system optimization but also deliver cost savings through project efficiencies.

At the time of this case study, IPCO was operating as Sandvik Process Systems and ROXON was operating as Sandvik Mining and Construction.

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