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Danieli's QSP-DUE®: unlimited freedom for green HRC production

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QSP-DUE direct casting and rolling technology allows three production modes: coil-to-coil, semi-endless, and full endless. These modes enable the production of various steel grades and strip formats, meeting end-user needs. The maturity of the technology is evidenced by concrete applications.
The process offers a wide product mix, catering to various market needs, with perspective towards automotive exposed sector with dedicated features and production strategies. At the same time the commitment to sustainability is evident through the electrification efforts, setting new standards for high-quality, sustainable steel production, driving innovation, and meeting diverse market demands.

KEYWORDS: QSP-DUE; SLAB; ROLLING; STRIP THICKNESS; AUTOMOTIVE EXPOSED;

INTRODUCTION

The QSP-DUE process developed by Danieli represents a significant advancement in high-quality hot-rolled coil production. This direct slab casting and rolling process is rapidly gaining market share due to its competitiveness and ability to meet diverse market requirements. Over the past 30 years, Danieli has continuously innovated the Quality Strip Production (QSP) family, developing the Danieli Universal Endless (DUE) layout.

QSP-DUE offers three production modes: coil-to-coil, semi-endless, and full endless. Full endless mode allows direct rolling of cast products without division into slabs, making it ideal for ultra-thin commercial grades. Coil-to-coil mode provides flexibility, with slabs cut by the pendulum shear and processed individually. Semi-endless mode balances efficiency and customization, with jumbo slabs cut and rolled, then separated into coils by a high-speed shear. These modes enable the production of various steel grades, thicknesses, and widths to meet diverse end-user needs.

BENEFITS

Global references confirm the success of the Danieli Universal Endless layout

Thanks to its proven performance and flexibility, QSP-DUE technology has been successfully implemented

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by leading steelmakers worldwide. These installations demonstrate the reliability, productivity, and versatility of the Danieli Universal Endless layout across different production targets and operating conditions.

The following references highlight the real-world achievements and technological excellence of QSP-DUE in various regions.

Fig.1 - Induction heating system between roughing and finishing mill stands.

Hoa Phat Dung Quat Steel Joint Stock Company / Vietnam

The Dung Quat QSP plant, operated by Hoa Phat Dung Quat Steel Joint Stock Company, has a design capacity of up to 3.9 million tons of steel per year, and it is one of the most productive plants operating in the world. To date, the QSP has produced over 13 million tons of hot-rolled coils, maintaining high quality. Operational efficiency allowed the achievement of 6 m/min casting speed and a sequence length of over 28 hours. The caster processed 50 heats without interruption, covering a total length of 7,342 meters, and achieved a production output of 13,040 tons in one day, with an average throughput of more than 470 tons/hour.

Class 1 quality hot-rolled coils maintain a stable rating of 97.5%, showing excellent strip surface quality and coil shape. QSP operations are consistently stable and reliable, even for thin gauges as low as 1.2 mm. New, high-value products developed include the weather-resistant grade SPAH with a strip thickness of 1.6 mm, which meets the required quality and mechanical properties for container-making applications.

Yukun Iron and Steel Group Co., Ltd. / P.R. China

Yukun Iron & Steel Group Co., Ltd. (Yukun) started up a new DUE plant in 2024 to produce up to 4.6 Mtpy of hot-rolled coils, setting a new world record for Danieli's in-line casting and rolling technology. The DUE line produces strip thicknesses from 0.80 to 25.4 mm and widths between 900- and 1,500-mm. Casting records have been set on the Danieli-patented DySen caster: 145-mm-thick slabs have been regularly produced, using a 152-mm mould. 165-mm-thick slab rolling was also tested.

Endless rolling has been established, reaching the mini-

mum design thickness of 0.8 mm thick strip within the first seven campaigns from the beginning of the endless production. Coils showed excellent surface quality, precise geometric dimensions, and uniform microstructure and properties.

This followed the production of thicknesses of 25 mm in the same line, something unique in the world.
Within 10 days of the DUE plant start, Yukun marketed and sold premium-quality HRC products.

Fig.2 - Rolling mill split design.

Shougang Jingtang United Iron & Steel Co. Ltd. / P.R. China

Shougang Jingtang United Iron & Steel Co. Ltd. (SGJT) confirmed its trust in Danieli's technology by ordering the world's first Danieli Universal Endless (DUE®) plant, which has been operating at full capacity since 2019, exceeding the nominal capacity of 2.1 Mtpy. The caster reached a speed of 6 m/min for low-carbon grades, with stable casting conditions. Up to 37 heats were cast in 24 hours, equivalent to around 7,800 tons, with casting sequences exceeding 16 hours of continuous operation.
Endless production represents up to 97% of each casting and rolling sequence, with steady-state rolling conditions enabling thin-gauge production. Over 90% of QSP-DUE output is less than 2.0 mm thick, with over 50% ranging from 1.5 mm down to the recent plant record of 0.70 mm.

Fig.3 - Coil with a strip thickness of 0.70 mm produced at SGJT.

A wider product mix

The QSP-DUE process allows a wider product mix to respond to various market needs, especially in the automotive sector. Today, QSP-DUE operators can produce and deliver grades with superior mechanical properties and surface quality. The focus is on automotive applications, particularly for exposed panels. These grades are used in complex components, adding value, and yielding higher profit margins. Advanced high-strength steels (AHSS) are increasingly in demand, projected to exceed 85% of the automotive market in the future. AHSS grades include crack-sensitive types like peritectic, Dual Phase, Complex Phase, Martensitic, and TRIP steels.

Several innovations developed by Danieli in recent years have been available to ensure the widest possible product mix. The funnel-shaped mould normally used in thin-slab casters deforms the shell during solidification, making it unsuitable for high surface-quality grades. Danieli has designed a flat mould for high-speed casting, improving fluid dynamics and eliminating chemistry limitations. Last year this mould was tested at high casting speed on a thin slab caster, showing excellent results in terms of surface quality and sequence duration.

Exposed grades are generally prone to clogging, which is counteracted by argon injection into the mould and the use of a quick-change submerged entry nozzle (SEN). These practices are now possible in the QSP-DUE process, thanks to increased mould thickness, a slim SEN design, and robotic operations that ensure high repeatability and safety.

Additionally, the argon-loaded flow in the mould is controlled by the MM-EMB+S, which combines two different technologies: an AC brake/accelerator, widely used in conventional slab casters, and the DC device, adopted in thin slab casting for a long time. The MM-EMB+S enables a wide variety of operating modes, including mould stirring, particularly useful for several reasons: temperature homogenization, inclusion floatation, prevention of inclusion entrapment and reduction of gas bubble entrapment.

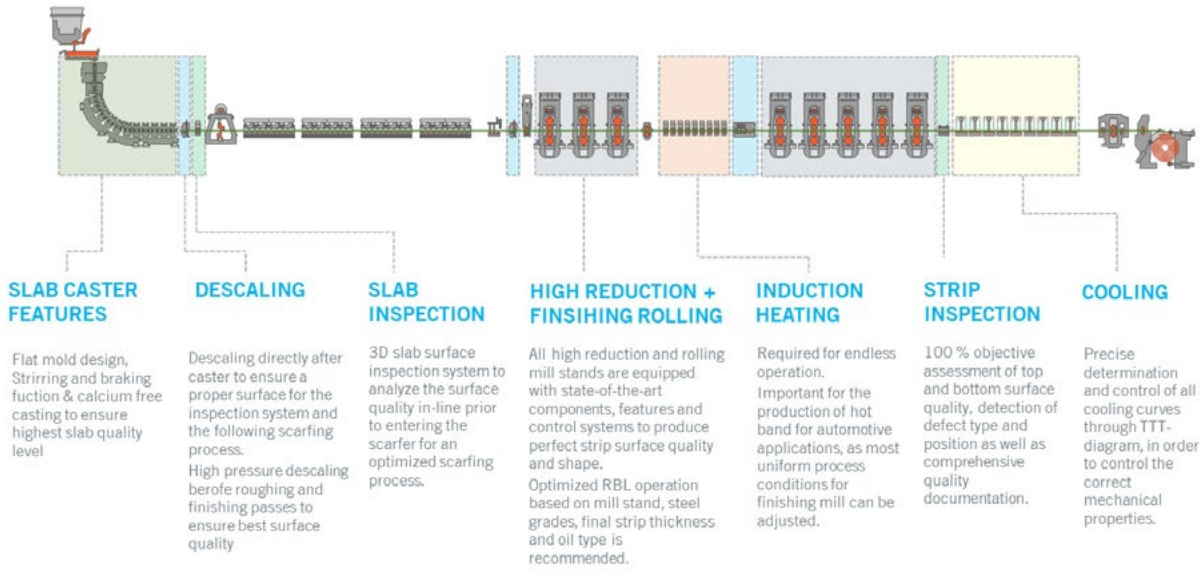

Fig.4 - Equipment specifically designed for automotive-exposed quality requirements.

QSP-DUE features three descaling points: the first at the caster exit, the second just before the first roughing stand, and the last right before the first finishing mill stand. The combination of the three devices ensures coils are free from defects related to scale imprinting. Two surface inspection systems are foreseen, one at the caster exit and the second prior to the downcoiler area, providing immediate feedback on strip-surface quality and its compliance for auto-exposed applications.

To achieve the highest standards of surface quality and

optimize the production of exposed panels, scarfing might be required. The scarfing process is performed using oxygen-fueled linear torches to remove a thin layer of material along with surface defects, such as cracks, non-metallic inclusions, or surface irregularities that can compromise the hot-strip surface quality. The precision of this process is vital to minimizing material loss while achieving a defect-free surface. The scarfer is integrated into the production process, conditioning slabs while hot to maintain the energy-saving approach of the QSP-DUE. The scarfer operates at the same productivity as the casting machine and hot strip mill, ensuring that all the slabs produced in a sequence are surface conditioned.

Fossil-free steel

Compared to the conventional route, the DUE process reduces energy consumption by 70%, leading to a 90% reduction in CO_2 emissions. While QSP-DUE is already an environmentally friendly technology, further electrification of processes that currently rely on fossil fuels—such as tundish and SEN preheating, and the gas-fired tunnel furnace—can reduce direct CO_2 emissions to zero. The primary source of direct emissions in the DUE process is the tunnel furnace, which allows coil-to-coil and semi-endless production modes, in addition to the full endless production mode, significantly broadening the product mix. Additionally, the tunnel furnace serves as a buffer during work roll changes in the rolling stands, enabling longer production sequences with consistent surface quality. A clear advantage from an OpEx perspective.

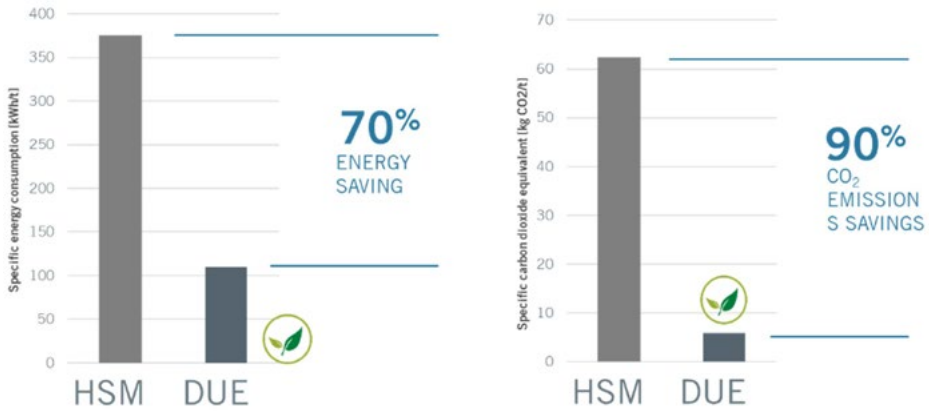

Fig.5 - Energy saving and CO_2 emissions reduction: comparison between conventional HSM and DUE.

Reducing emissions requires enhancing efficiency and rethinking the heating process. One effective strategy is to minimize heat losses by replacing the currently used water-cooled rolls with dry rolls, which can yield energy savings of approximately 25 to 30%. Transitioning the tunnel furnace toward full electrification necessitates a comprehensive overhaul of its components. Given the slab thickness, longitudinal flux induction heaters have been selected to maximize electrical heating efficiency. The layout of the electric tunnel furnace includes a combination of sections with induction heaters and sections equipped with electrical resistance.

CONCLUSION

QSP-DUE is a mature technology that has demonstrated advantages over the conventional route in terms of energy efficiency and its ability to cover an extremely wide product mix, as proven by actual results. As the industry evolves, QSP-DUE sets new standards for high-quality, sustainable steel production, driving innovation and meeting diverse market demands.