



ECOSTAR – A NEW GENERATION OF COST-SAVING AND LONG-LIFE ROLLERS¹

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Abstract

Strand guide rollers are permanently exposed to vapors, acids and heat and are expected to withstand enormous forces without deformation. Under such conditions, rollers are normally subject to wear, leakage and even breakage. In order to stay competitive, operators must analyze roller-related fixed costs and to take advantage of the improvement potential that exists in advanced roller designs. The new EcoStar strand guide roller system from Siemens VAI features advanced, reliable and quality-enhancing solutions, and are ideal for virtually all strand-support applications. Replacing an old-type roller with a modular EcoStar roller does not involve any modifications to the existing caster segments. The use of identical roller modules minimizes delivery periods, and industrial scale manufacturing makes prices highly attractive.

Key words: Continuous casting; Strand guide rollers; Dry-casting; Long-life lubrication; Maintenance-cost savings.

ECOSTAR – UMA NOVA GERAÇÃO DE ROLOS PARA REDUÇÃO DE CUSTOS E VIDA LONGA

Resumo

Os Rolos dos Segmentos de Veio estão permanentemente expostos a vapores, ácidos e calor e são demandados a suportar enormes forças sem sofrer deformações. Sob tais condições, os rolos são normalmente sujeitos a desgaste, vazamentos e até mesmo a quebra. A fim de manterem-se competitivas, as Siderúrgicas devem analisar os custos fixos relacionados aos rolos e aproveitar o potencial de melhoria existente nos projetos avançados dos mesmos. A nova vertente EcoStar - Sistema de rolos de Segmentos de Veio da Siemens VAI caracteriza-se por soluções avançadas, confiáveis e voltadas para a melhoria da qualidade, e são ideais para praticamente todas as aplicações de suporte do veio. A substituição de um rolo de modelo antigo por um rolo modular EcoStar não envolve quaisquer modificações nos segmentos de lingotamento existentes. O uso de módulos de rolos idênticos minimiza os prazos de entrega, e sua fabricação em escala industrial faz com que os preços sejam altamente atrativos.

Palavras-chave: Lingotamento contínuo; Rolos de segmentos de veio; Lingotamento seco; Lubrificação de longa duração; Redução dos custos de manutenção.

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1 INTRODUCTION

Optimized design of the caster rollers is a decisive factor for ideal slab support, slab quality and high caster productivity. Siemens VAI, a leading supplier of continuous casting technology, has recently introduced a new roller type known as EcoStar.⁽¹⁾ Featuring the use of modular and proven design elements in combination with special manufacturing techniques, a superior roller solution has been developed that offers a number of significant benefits for steel producers. This article outlines the main design features of this new caster roller type, solution variants, and aspects of maintenance and refurbishing. Examples of industrial applications are presented.

2 DEVELOPMENT OF A MODULAR ROLLER SYSTEM

The roller body of conventional slab caster rollers is typically designed as a single element machined from a round blank consisting of quenched and tempered steel (Figure 1a). As a consequence of additionally required machining of the roller ends, the steel strength in the high-load end-sections of the roller body is less than along the roller barrel. This may lead to the formation of irreparable cracks, requiring costly roller-body replacements. To counteract this problem, Siemens VAI developed a patented modular roller system that is characterized by the insertion of roller stubs into the end sections of the roller body (Figure 1b). A shrink-fitting technique is then applied on the roller stubs to create a highly compact, rigid and backlash-free roller body module. This solution generates additional advantages such as reduced stress concentration in the high-load areas of the roller body end sections; the possibility to select the ideal material for the axle stubs; and a fully sealed, water-tight system. Furthermore, the entire unit can be easily refurbished at relatively low costs.

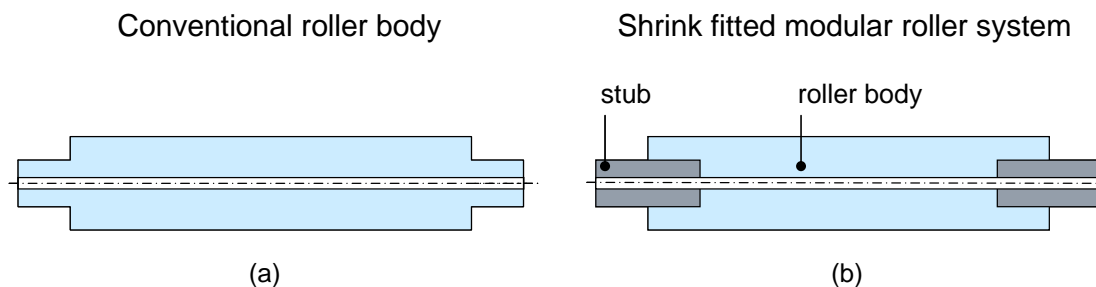


Figure 1. Comparison of conventional roller body with modular roller system.

3 INTRODUCTION OF THE ECOSTAR ROLLER

On the basis of the successful and positive experience obtained with the stub-fitted roller bodies, Siemens VAI applied this design concept to replace existing rollers of any make without the need for modifying the existing segment structure. This solution was also implemented in Siemens VAI I-Star rollers (intermediately supported trans-axle rollers) to decisively reduce roller life-cycle costs. This new roller type is referred to as EcoStar. Each roller unit typically consists of three or more roller bodies and the associated bearings blocks mounted on rigid prefabricated roller stubs (Figure 2). This design of the intermediate support structures and their positioning allows an optimum load-carrying



capacity to be achieved. Particularly high-strength and ductile rollers are produced using special manufacturing techniques. Single-pass overlay welding is applied using highly durable martensitic stainless steel. The application of a single, highly resistant overlay welding layer facilitates the heat transfer from the roller surface to the internal cooling zone of the roller. The bearing blocks are sealed against water and dirt. The driven and non-driven rollers are, in principle, of identical design. The driven rollers are outfitted with a longer stub onto which the coupling flange of the drive system is shrink-fitted (Figure 3).

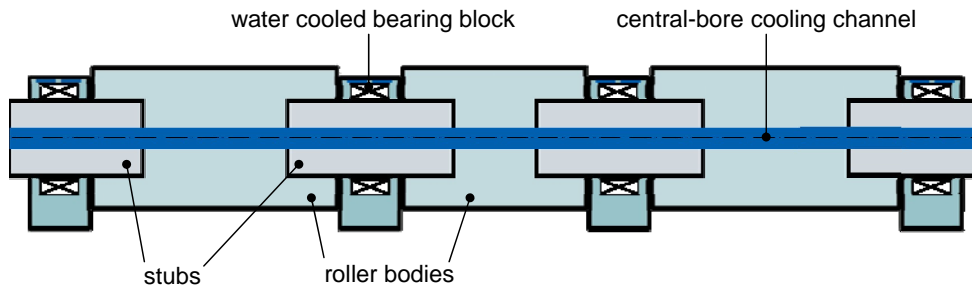
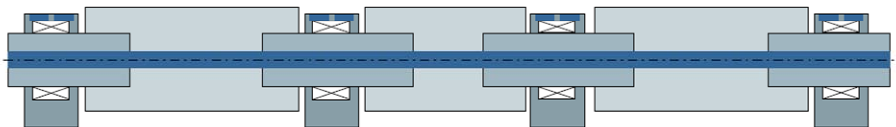


Figure 2. EcoStar roller body with two intermediate supporting elements.

EcoStar idle roller



EcoStar driven roller

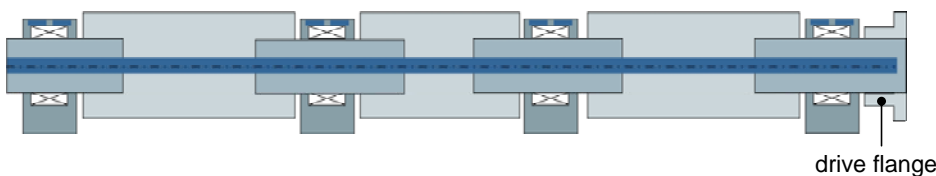


Figure 3. Comparison of EcoStar idle roller with EcoStar driven roller.

4 ECOSTAR ROLLER VARIANTS

EcoStar rollers can be individually adapted for installation throughout the strand-guide system. Depending on the operational, cooling and lubrication requirements, customized EcoStar rollers are available. Outdated rollers from other suppliers can be easily substituted with this new roller solution. A wide selection of bearings are offered, including spherical, toroidal, self-aligning cylindrical (three-ring type) and Eich roller bearings with spring bushings (Figure 4).

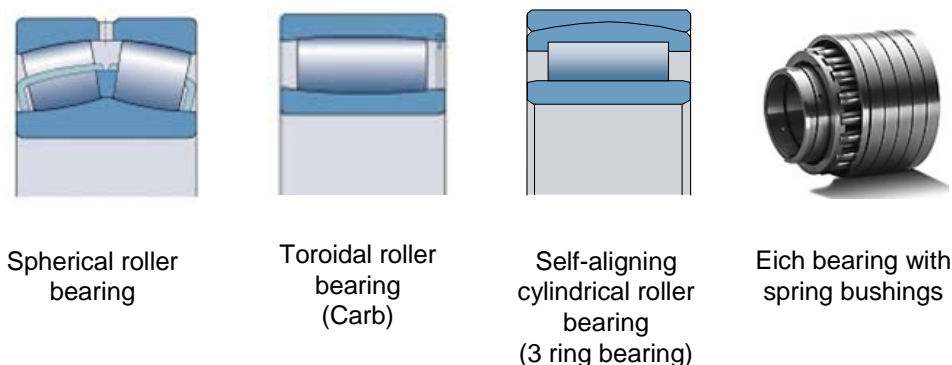


Figure 4. Available bearings for EcoStar rollers.

In the standard basis variant, internal roller cooling is carried out by means of a single, central-bore cooling channel. When external roller cooling is to be avoided, internal peripheral cooling of the roller bodies enables “dry casting” conditions in certain sections of the strand-guide system. The internal water circuit does not require elastomeric seals and welds for proper sealing. This is an important factor for improved system reliability. Dry roller-cooling solutions are particularly ideal when casting crack-sensitive steel grades or ultra-thick slabs that require super-soft cooling conditions.

Two internal peripheral cooling design variants are available depending on the roller diameter: The EcoStar Spiral roller system is ideal for roller diameters up to 300 mm and more (Figure 5). By means of spirally arranged passageways, the cooling water flows in close proximity to the roller surface. The advantage of this system is that a high flow velocity is possible, which promotes a good heat transfer and also prevents clogging of the cooling channels (Figure 6). Roller body machining can be carried out easily, efficiently and economically. Maintenance requirements can be kept to a minimum.

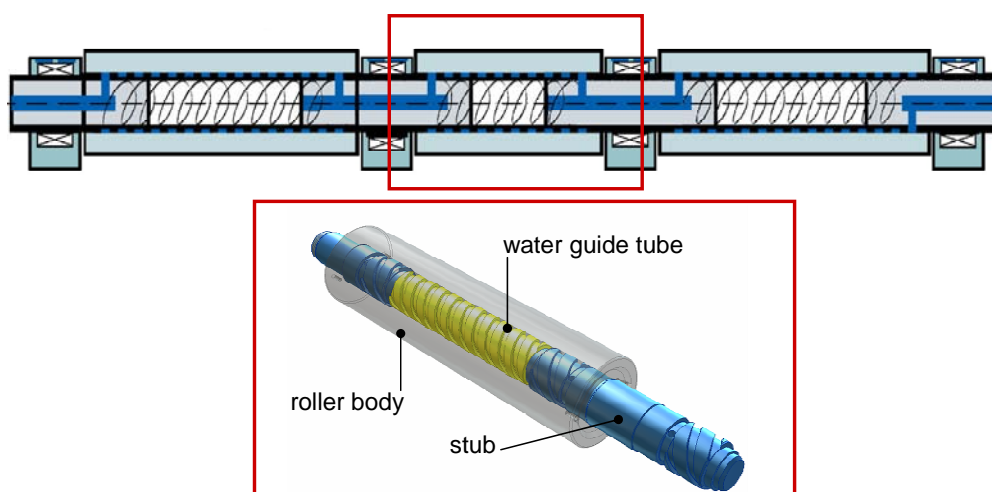


Figure 5. Principle diagram of EcoStar Spiral roller (left) and 3D model of roller body (right).

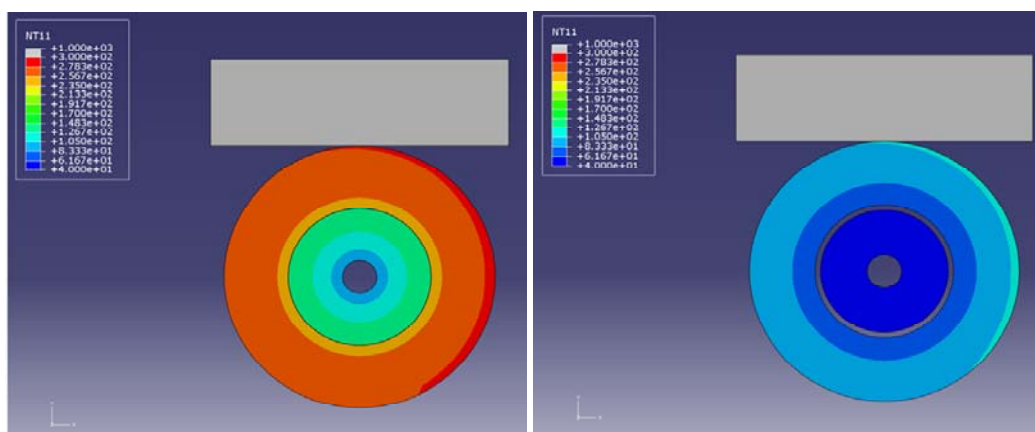


Figure 6. Comparison of calculated temperature cross section of conventional and spirally cooled roller bodies under dry-casting conditions.

For roller body diameters exceeding 300 mm and more, the EcoStar Revolver roller system is preferred, particularly for full-face roller bodies that were typically used in older casting machines (Figure 7). This roller type is characterized by the flow of the cooling water through longitudinally arranged cooling channels, which are bored through the roller body parallel and close to the roller surface. Similar to the EcoStar Spiral roller design, no sealings or seal weldings are necessary. Thanks to the efficient cooling of the roller body peripheral zone, weldable high-temperature steel grades are not required for the manufacture of this type of roller body, thus significantly reducing costs and delivery times.

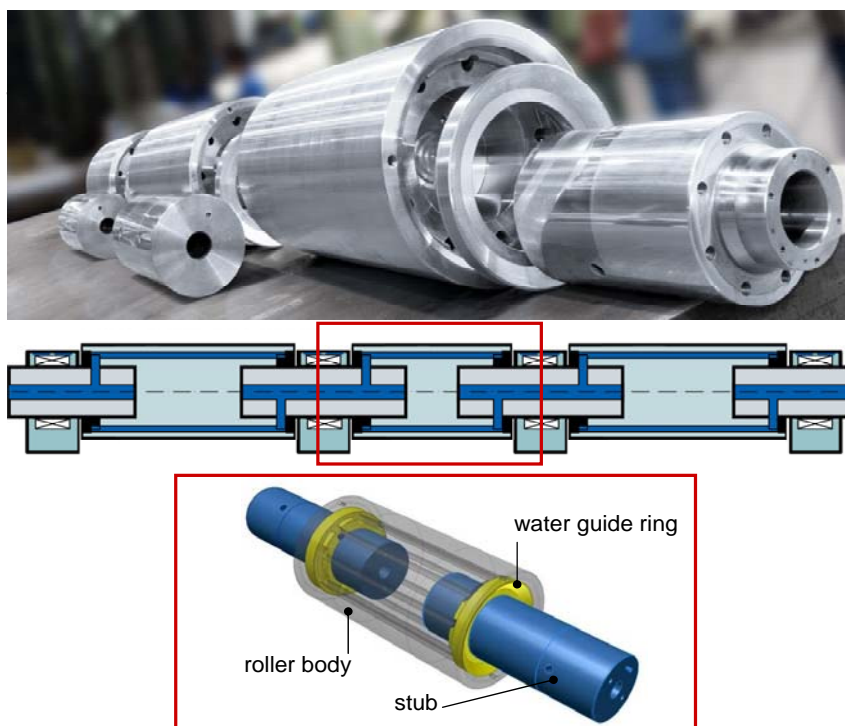


Figure 7. Design of EcoStar Revolver roller.



In addition to standard roller-lubrication systems employing grease or oil/air, a long-life lubrication system featuring the use of a special long-life grease and new seal types is also available. Lubrication is applied only during the assembly of the rollers and is no longer needed during roller operation. Reliable lubrication is ensured in this way and no contamination of the spray cooling water occurs.

5 MAINTENANCE ASPECTS

After the completion of the first roller campaign, the surface of the EcoStar roller is lathed (Figure 8). Only the external bearings are dismantled. A functionality check of the internal bearings is performed after which the rollers are reinstalled in the caster. After the second roller campaign, the roller is completely refurbished. The central stubs are sawed in half and the central and outer bearing blocks are dismantled. Rewelding of the roller surface followed by machining to the required roller diameter is then carried out. The remnant stubs are removed and replaced with new stubs. All roller components that are in good condition are reused, and worn parts are replaced by OEM (original equipment manufacturer) components. Following reassembly, the refurbished roller is almost as good as new. Thanks to the high reusability of all components, considerable maintenance-cost savings are achieved.

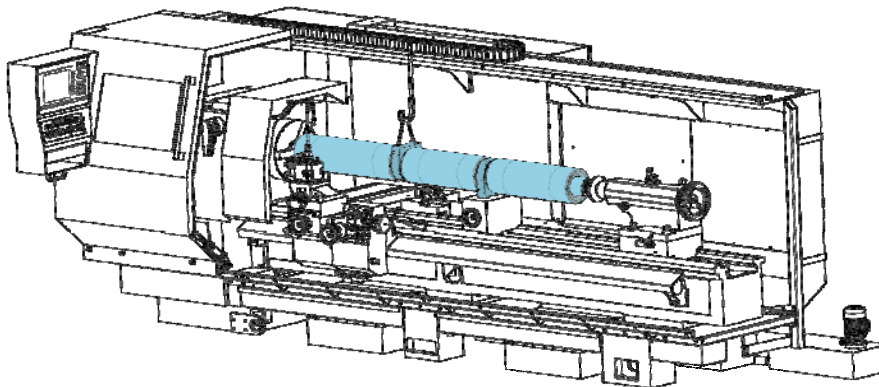


Figure 8. Machining of EcoStar roller for reuse.



6 INDUSTRIAL APPLICATION EXAMPLES

In 2004, Siemens VAI was requested by the Cremona-based Italian steel producer Acciaieria Arvedi Spa to replace the existing slab caster rollers with EcoStar rollers. The previous rollers, with a single intermediate support and split-bearing roller design, had a lifetime of only about 400 heats. This meant lost production and high roller-replacement costs. The company goal was to have a new roller system installed that would be capable of withstanding at least 2,000 heats. Roller replacement was carried out in two steps: In the first step, the original split-bearing rollers were substituted with so-called toroidal roller bearings (Carb). This increased the roller lifetime to about 1,000 heats. In a second step, self-aligning cylindrical roller bearings (SACRB) from the German company Eich were used for the intermediate support of the EcoStar rollers. This combination allowed more than 2,000 heats to be cast before roller refurbishment was necessary.

Since that time, hundreds of EcoStar rollers of different design types have been installed in numerous slab casters of different steel producers, including voestalpine Stahl (Linz, Austria) – standard EcoStar rollers; Essar Steel Algoma (Sault Ste. Marie, Canada) – installation of lifetime-lubrication rollers; Ruukki Oyj (Raahe, Finland) – EcoStar Revolver roller type; OJSC Novolipetsk Steel (Lipetsk, Russia) – EcoStar Spiral roller type; North American Stainless (East Ghent, Kentucky, U.S.A.) – installation of EcoStar stubs in existing rollers; ThyssenKrupp Steel AG (Duisburg - Beeckerwerth, Germany) – installation of EcoStar rollers for industrial testing; ArcelorMittal CST (Vitoria, Brazil) – existing driven rollers replaced with three-fold intermediately supported EcoStar rollers; and Companhia Siderúrgica Nacional (CSN) in Volta Redonda, Brazil – replacement of full-face, 420 mm diameter rollers with EcoStar Revolver rollers.

7 BENEFITS

The patented EcoStar rollers provide ideal strand support across the entire slab width with minimum strand bulging. This is an important factor for the production of highest-quality slabs. Thanks to the unique and modular design features of EcoStar rollers, producers profit from a number of operational and production cost benefits. The long lifetime of the robust and highly reliable rollers minimizes unscheduled downtimes, and thus contributes to increased caster productivity. Internal roller cooling ensures a longer bearing lifetime in addition to increased safety aspects. A number of roller variants are available depending on customer preferences, including design solutions for dry-casting, and roller bearing lifetime lubrication. Maintenance costs are also significantly reduced due to the easy machining of the roller surfaces and high reusability of all components. Finally, the use of prefabricated and standardized roller components is the basis for short delivery times.

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