



WHITE PAPER:

Efficient energy supply systems for cranes in steel plants

A comparison between polymer e-chains[®] and festoons

iglus[®]

The problem

Modern steel production takes place in steel plants with increasingly high levels of integration. Blast furnaces, coke plants, the actual steel plants, the foundry and the mill all form a single production entity, in which the complexity and importance of safe and energy-efficient material flows are ever increasing. By combining primary and secondary metallurgy, as well as bar stock production in a single plant, transport routes and equipment requirements can be reduced, thus leading to major energy and cost savings. However, the increasing horizontal integration in the smelting works also poses a technical challenge for all transport and material handling systems – not least for the cranes in steel plants. The creation of an operationally reliable, yet also rational, energy supply system is a key factor in not only being able to make full use of the potential for cost reduction, but also in finding suitable technological solutions for each application. Users can essentially choose between two types of solution: festoons or e-chains®. Both systems have their advantages and disadvantages. A comparison of these should therefore act as a reliable guide for choosing the right solution for each application.

Energy supply system for cranes in steel plants

When it comes to material handling in steel plants, good reliability and low maintenance requirements are of central importance. Material or machine damage, that can lead to downtime for the entire plant, can mean costly production outages. As a result, when designing cranes for steel plants, the service life and operating period of both the cranes in their entirety and their individual components must generally be as long as possible, their maintenance periods as short as possible, and their minimum susceptibility as low as possible. These conditions apply despite the tough ambient conditions, such as high levels of dust and heat, and the strict requirements with regard to travel distances, moving speeds and precision when positioning the loads. After all, in steel production, demanding break bulk cargo comes together with the latest automation and control technology. This means that in addition to the general challenges posed for all crane manufacturers (as established in the European standard DIN

EN 13001), designers of cranes for steel plants also have to overcome several other industry-specific challenges.

A large number of cranes are used in the steel industry. These range from rolling ingot, slab, ladle and loading cranes through to special cranes for handling rails, sheet metal or coils. All of these are heavy-duty and high-performance cranes, which require high levels of energy to hoist and transport the materials. Travel distances of over 100 meters and loads of well over 100 tons are no rarity.



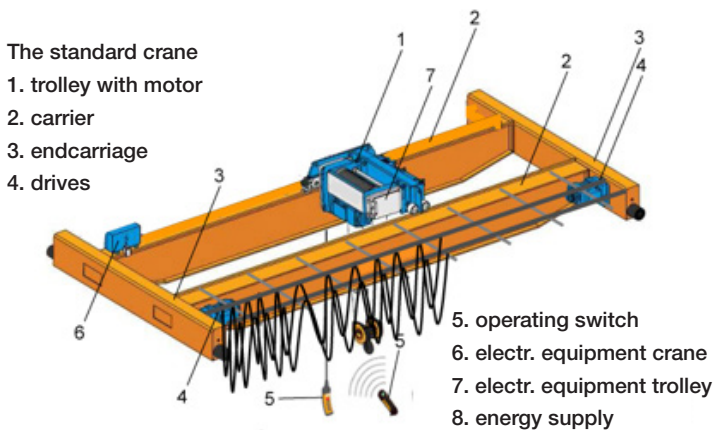
Mechanical claw on a slab crane directly above a furnace

Source: igus® GmbH

One particular requirement that all components of cranes in steel plants have to meet is that they are resistant against radiant heat from the product. Slabs and rolling ingots can be heated to temperatures of up to 1000°C (1832°F). Ladle and loading cranes are even used to transport molten metal. Even the radiant heat can therefore exceed 100°C (212°F). Flames and hot flashes can also occur. Temperature-resistant energy supply systems and cables are therefore a must.

Festoons: the traditional solution

Every steel plant is different. As such, customized solutions are needed for applications. The right energy supply system solution must be found for each crane. The main solution to date has been festoons, i.e. towing or guide chains (the term “festoon” generally means garland and relates to the appearance of the chains).



Schematic diagram of a standard crane with a festoon energy supply

Source: igus® GmbH

Festoons comprise free-span supply lines with integrated steel cables for strain relief. The cables generally hang freely and without protection on the (stainless) steel girder and are dynamically moved (retracted and extended) by additional drives. This free design is usually suitable for indoor cranes, which are not directly subjected to the effects of the wind and weather. However, this is not the case for cranes in steel plants. In this harsh environment with intensive levels of heat and dust, festoons have to be specially protected and are therefore enclosed in protective cladding. However, this ‘armor’ increases the total weight of the system, as well as the steel structures required to bear the large cable lengths and the cable junction.

A major disadvantage of festoons is that they can get caught and entangled during operation, leading to downtime. The use of cable loops gives rise to a need for huge lengths of cable. The cable has to be more than twice the length of the travel distance to cover this. As these loops also require a certain system height, festoons take up a great deal of space, as well as needing lots of protective cladding where applicable. The necessary cable lengths and travel distances also increase the cable’s mechanical stress.

In the past, festoons have proven to be relatively reliable energy supply systems for cranes in steel plants. In some areas of smelting works, they are most likely still indispensable. For example, guide systems that pass over hot slabs or are used for foundry cranes require festoons with protective steel cladding due to the high levels of heat and radiant heat. However, festoons have their limits with regard to energy efficiency and service life. They are relatively heavy and need high levels of drive power, i.e. a high energy input, due to their long travel distances. Furthermore, their wear behavior is not optimal, increasing the need for maintenance and potentially causing system downtime in the long term. This makes it sensible to look for alternatives for areas in which festoons do not necessarily have to be used.



Energy supply via open hanging festoons on a two-girder crane.

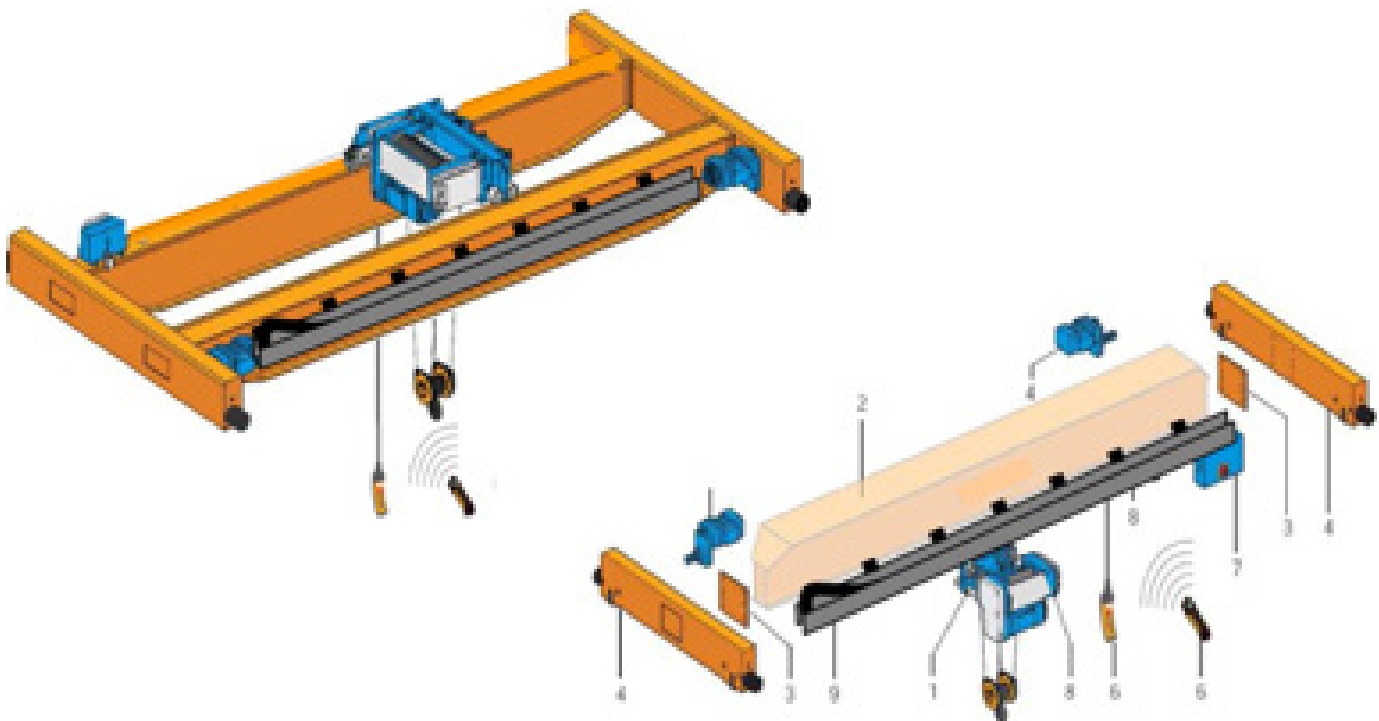
Source: igus® GmbH

Plastic e-chains®: the innovative solution

Compared to simple protective hoses, there is no doubt that e-chains® are a more complex and thus more expensive solution. Every meter of the chains comprises approx. 30 to 100 individual components or links, usually made of polyamide (PA) (with or without fiberglass reinforcement) or the thermoplastic polymer polyoxymethylene (POM). The modular structure enables the chains to be flexibly adapted to the application. This means that the chains can be easily extended or shortened and are simple to assemble and maintain. Most systems can be accessed from the outside, thus speeding up the initial installation process and any necessary repair activities. In particular, when using pre-assembled cables, cables with large connectors or hoses with press-on fixtures — which can only generally be inserted from the outside — the assembly, replacement and downtime periods can be significantly reduced.

e-chains® made of high-performance plastics have already been successfully used in many heavy-duty areas for many years and are increasingly seen in the crane manufacturing industry as well. The general requirements in this sector are swiftly rising. Travel distances,

speeds and loads are constantly increased. This naturally leads to greater cable loads, which have to be supported, guided and moved by all energy supply systems. e-chains® made of tribologically optimized polymers not only master these requirements outstandingly, but also have several further unique selling points that predestine them for use in heavy-duty applications such as cranes for steel plants. First and foremost, they weigh far less than solutions made of metal or other materials, while still offering excellent stability with regard to tractive, thrust and torsional forces. They are also non-corrosive and dry-running as well as media resistant. As such, they are characterized by good durability, environmental friendliness and a maintenance-free nature. Last but not least, they cost less than comparable systems made of non-plastics.



Schematic diagram of a standard crane with an e-chain®

Source: igus® GmbH

Standard cranes with e-chain®

On a crane with e-chains® made of tribopolymers, the cables are protected in two ways – by the chain itself and by the guide trough. In the case of long travel distances and high speeds in particular, the trough guides the chain securely and quietly. The chain in turn runs evenly and smoothly (i.e. also conserving energy) along the guide trough. For weight reasons, the best trough material is aluminum, although it can also be made of galvanized or stainless steel. A look at the two schematic diagrams above immediately reveals a huge difference in the requirements with regard to cable length. When using plastic e-chains®, the cable length is reduced by almost 50%. The shorter cable lengths reduce the energy usage, the mechanical stress, the weight and thus the need for complex steel support structures and protective steel cladding. This even makes it possible to relieve the strain on the entire system while also increasing the crane's hoist load.

e-chains® also vastly reduce the space requirement. As the images show, their compact design means that they need far less space both heightwise and widthwise. The reduced cable length and the obsolete nature of



The same two-girder crane as above but after it has been modernized with a plastic e-chain® in an aluminum guide trough.

Source: igus® GmbH

the cable junction create extra space that can be used to install additional cybernetic and sensor systems. This makes it possible to attach switch cabinets to the crane trolleys and integrate more powerful units,

such as air conditioning units, if necessary. Furthermore, the entire girder length can be used for the trolley travel. This makes all areas of the hall accessible to the crane. As no festoons hang down from the crane, the full area below the crane girder can also be used. This potential is in no way small or negligible if you consider that with some festoons, the cable loops are longer than the height of the crane girder. A predefined e-chain® bending radius ensures that the ability to save space does not cause problems with the cable guidance, i.e. cable damage similar to the entanglement of festoons, due to the design not reaching hazardous minimum angles. This prevents the cables from bending, even in continuous operation. High-quality e-chains® also help to protect the cables by offering high torsion stability and a smooth, wide load-bearing area made of solid polymer.

As plastic e-chains® comprise standardized chain links, the length can be variably adjusted to the respective crane. This makes installation quick and easy – both in the case of the initial installation and when retrofitting heavy-duty cranes previously equipped with festoons. In the event of a repair, the chain and cables can be quickly accessed as defective links are easy to open and replace, as are defective cables. The modular structure of the e-chain® therefore offers a great deal of flexibility during installation and great ease of assembly and maintenance. In principle, however, the low wear properties of the chains, which are made from tribologically optimized polymers, and their outstanding cable protection ensure a high service life and minimize maintenance requirements and downtime. This guarantee can also be enjoyed by smelting work operators, who can put the special plastic chains to versatile use as this material withstands long-term temperatures of up to 120°C (248°F) and even short-term temperatures of up to 200°C (392°F). In summary, plastic e-chains® therefore act as a high-tech, low-cost and durable solution for cranes in steel plants.

Future technologies: roller e-chains®

Development in the field of plastic e-chains® is far from standing still. Their potential and that of tribopolymers for energy supply systems in general are far from exhausted. Among the many new product innovations in this area are roller e-chains®. These use the principle of 'rolling instead of gliding' and are an optimum solution especially for long travel distances (with roller chains, travel distances of up to 800 meters and speeds of up to 10 m/s are possible). By using the roller chains, the necessary tractive and thrust forces can be reduced by approx. 75 percent and the friction factor from 0.3 to 0.1 in comparison to gliding applications. This gives rise to a potential drive power reduction of up to 37 percent. igus® GmbH has been using this technology for several years and already implemented it in more than 1,000 crane systems worldwide. The roller chains come in variable widths and can be fitted with several types of rollers for different conditions. The ball bearings are made of highly robust stainless steel. Thanks to special extension links, these e-chains® can withstand even higher fill weights, making extremely long cable lengths possible. They are also functionally reliable in extremely dirty conditions and are an optimum solution for high additional loads.



The roller e-chain® system with roller extension links for even higher additional loads.

Source: igus® GmbH

Summary

The technical and financial superiority of e-chains® made of tribopolymers compared to festoons is particularly clear in three areas: energy savings, reductions in cable length and reliability. Plastic chains reduce the costs and increase the system's service life. They guarantee an efficient, permanent and operationally reliable energy supply for all cranes in steel plants. Plastic chains bring you a huge step closer to the aim of completely avoiding downtime. Smelting work operators can maximize their throughput — while also lowering their operating costs. Plastic e-chains® should therefore be used to both equip new systems and modernize existing ones. The retrofitting costs will be quickly amortized by the operational savings, meaning that investments in the technical innovation of the plastic e-chain® certainly pay off in the medium and long term.