Damage mitigation up to 160,000 Nm

When downtime can cost millions

Modern steel plants around the world are producing myriad steel variations and alloys to keep pace with the enormous global demand for this metal. Raw or recycled materials in charges as large as 100 tons are melted down in electric arc furnaces. Downstream processing of the steel by continuous casting systems into blooms or billets must take place immediately after smelting. After a cooling-off period that can last for hours, the final processing step in modern steel production is carried out in the plant‘s rolling mill. This part of production shapes the steel into rods (natural gas heated walking beam furnace) or reinforcing steel (natural gas heated pusher furnace) on different mill lines. Generally these large systems comprised of heavy machinery are, or must be, operated around the clock in 3 shifts 7 days a week. Shutting off or shutting down the system for scheduled maintenance of individual components, e.g. motors, gearboxes or couplings, is generally avoided because a so-called „freeze-up“ condition of the system (e.g. slag bath) must be prevented. Therefore maintenance free components are used to the extent that it is possible. For the most part, the system is safe in normal operation. But what happens beyond the scope of normal operation?

What happens when an individual component breaks due to previously undetected material fatigue?

What happens when a bloom jams in the continuous casting system?

What happens in the mill line when the wrong pressure or an incorrect stroke path is set?

In these cases it is the profitability of the entire system which is at stake. Such large systems made up of heavy machines must be put back into operation as quickly as possible. This is where a mechanical safety coupling from R+W Antriebselemente GmbH offers maximum protection against destruction of components in the drive train. The specification for such a safety coupling is sized for a factor of 1.3 - 2.0, for example, over the motor‘s pull-out torque or pull-up torque. Should a crash occur during normal operation, the instantaneous torque in the drive train increases overproportionately. The coupling is able to disengage the crash side from the side still intact within a matter of milliseconds, thus

Millisekundenbereich die Crashseite von der noch ipreventing a complete outage of all components. Because of the safety coupling‘s rapid separation, the maintenance crew will most likely only have to make a single replacement or, better yet, simply clear the jam. The coupling‘s maintenance free design, above all in combination with its re-engaging function, makes the system‘s return to normal operation possible in a remarkably small amount of time.

Mechanical safety coupling in comparison to other coupling systems

This topic has been the subject of discussion in heavy equipment engineering for decades. For such crash situations, the engineer has a choice between shear pin couplings or hydraulic couplings. Their disadvantages in comparison to mechanical safety couplings from R+W are distinct. A shear pin coupling is indeed less expensive to purchase but it also requires a great deal more time to put back into operation. The pins (and usually their bushings too) must be completely removed. Afterwards the coupling must be adjusted again before new pins and bushings can be inserted, all at the expense of enormous maintenance overhead. The advantageous price has played itself out no later than when this coupling disengages for the first time. This type of coupling also requires very experienced maintenance personnel because an incorrectly performed repair will cause the coupling to disengage at incorrect torque levels in the future. These difficulties add up to extreme costs in the event of a stoppage. An overload coupling operating on a hydraulic principle has the advantage of an extremely compact design. If the coupling disengages due to an overload, multiple safety valves will be blown out of the coupling by oil under pressures of up to 1000 bar. The contamination of machine components in the vicinity of the coupling is considerable. After the system is at a standstill, these individual valves must be replaced and then the coupling must be refilled with oil injected by a special pump, precisely controlling oil pressure to determine the proper disengagement torque. Such hydraulic safety couplings do indeed separate the drive and driven components at the rated torque in the event of an overload, but attached components are able to free-wheel only after a certain delay, occasionally leading to additional component damage. Under circumstances this delay can lead to additional component damage. In the design of the R+W mechanical safety coupling, all of these disadvantages were examined and addressed. The R+W functional principle, utilizing disc springs, puts the torque limiter back into operation immediately. There is no need to replace any expendable parts like pins or valves. Furthermore a disengagement event does not spray hydraulic oil onto adjacent components. But the most important factor is, maintenance personnel and the system‘s operating authority have 100 % assurance the coupling will again disengage the next time a problem arises, and at exactly the same torque, and without the possibility of putting the coupling back into service incorrectly.

Technical data for the ST safety coupling

R+W engineers and designers were able to draw on almost 20 years of company experience during the development of the ST safety coupling. Disc spring curves, surface hardness ratings, tooth mesh depths and angles, to name a few areas of expertise, were all optimized for this latest adaptation of R+W’s existing SK series torque limiters. The extensive positive feedback following the coupling‘s initial premier at the Hannover Exhibition 2009 gave our designers confirmation they had

developed just the right coupling for today‘s market. In comparison to other mechanical safety couplings, this coupling is up to 23 % more compact with respect to outer diameter at a given torque rating. The difference in overall coupling weight in the most extreme case is 1 ton. Consequentially, for a given coupling size, considerably greater circumferential speed is permissible, meaning overall, that the newly developed ST safety coupling represents an improvement in physical size, weight and maximum permissible operating speed. These individual improvements, especially the size factor, make it easier to install the coupling, and make the entire drive train lighter such that it may be possible to preassemble. Finally, the lower overall weight also reduces mass moment of inertia as a consequence of lower flywheel mass. Aside from shortening acceleration and braking processes, the system achieves greater dynamics which, in the end, translates into higher productivity for the end customer.

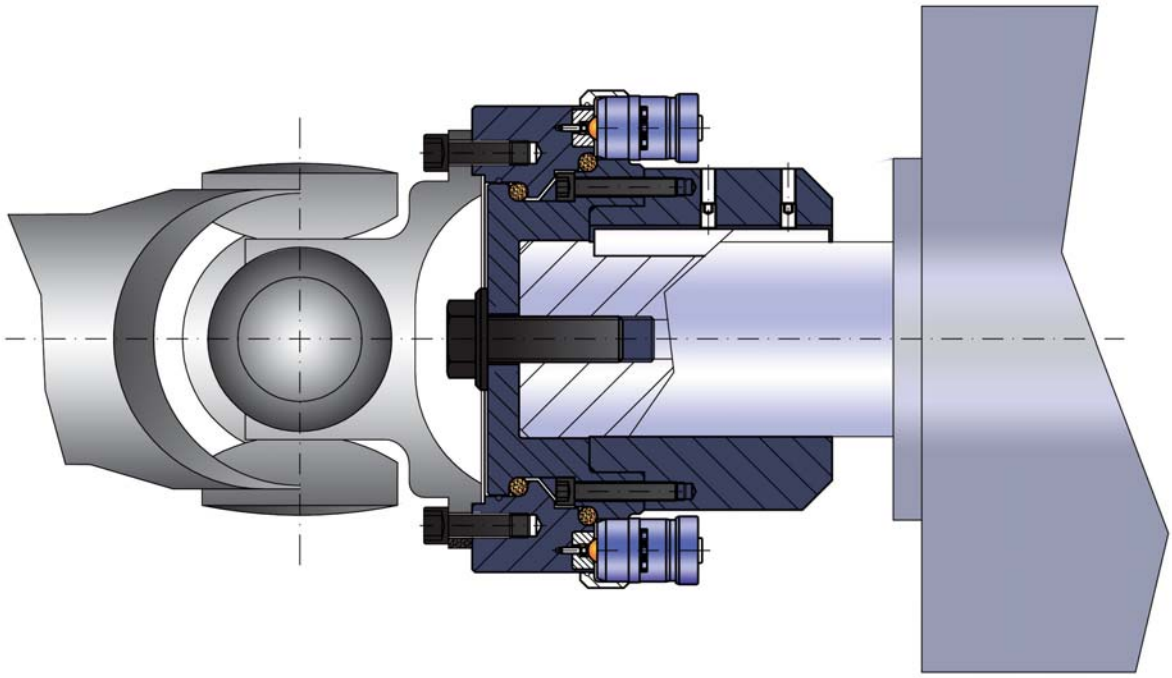
Structure and functional principle of the ST safety coupling

Die Sicherheitskupplung besteht aus zwei FlanThis safety coupling consists of two flanges connected by means of so called actuation elements. The actuator elements are mounted onto flange 1 at a predefined radius. Balls seated at the head are forced by disc springs at a defined value against oppositely positioned detent segments. The coupling‘s disengagement torque can be set according to the physical relationship: force x lever arm = torque. Each actuation element can be adjusted within a predetermined force range. In contrast to currently available actuation segments, those employed as standard equipment by R+W have the range clearly marked on a scale. Sophisticated measurements of plunger depth and conclusions about disengagement torque made on the basis of graphs and diagrams are eliminated, saving significant amounts of time. Each actuation element also has a fixed limit for the adjustment nut, precluding gross maladjustment which might otherwise jam the mechanism. ST series safety couplings are available now with short lead times, and can be ordered for disengagement torque ratings of up to 160,000 Nm. Couplings are completely functional as delivered and require no further maintenance or lubrication.

Depending on disengagement torque, 3, 6 or 9 actuation elements are distributed around a given radius, though all three configurations have 9 receptacles, making it possible for the customer to retrofit individual actuation elements at any time. In extreme cases (very little available space combined with a high torque requirement) the number of actuation elements can be increased from 9 to 12, or the number of disc springs can be increased to produce greater force. Such measures can increase performance by as much as 25 % for the entire coupling unit. R+W was also able to present improvements in re-engagement functionality at the Hannover exhibition. A peripheral groove provides a leverage point for better, simpler re-engagement of individual plungers, reducing the downtime before a system can be returned to normal operation.

ST series

The ST series of safety couplings was initially developed for indirect drives (model series ST1). Technical parameters, such as radial transverse forces produced by chain sprockets or belt pulleys, are compensated by special shoulder bearings. These bearings also permit an almost unlimited time to brake individual flywheel masses to a standstill. ST1 series couplings are also ideal for cardan shafts in heavy machinery. These connecting elements are most frequently used for power transfer in heavy machine construction. Due to the coupling‘s compact design, the increase in outside diameter of the cardan shaft is minimal, and a simple adapter flange is made available for easy mounting.
Two additional models are available for direct drives. In addition to the safety segment, the ST2 series also includes an elastic compensation element. The plastic employed, made of natural or synthetic rubber, compensates for incurred misalignment in axial, lateral and angular directions. This also has the effect of filtering torque fluctuations. The second series for direct drives (model ST3) is configured as a torsion resistant coupling characterized by exact torque transmission, great durability and compensation for all three types of misalignment with very small restoring forces.



Summary

The ST series safety couplings presented are available for rated torques of 1,000 – 160,000 Nm in four different body sizes, and shaft diameters from 40 to 290 mm. These couplings are absolutely backlash and maintenance free and are offered in a comprehensive delivery package including the coupling, torque adjustment wrench, and a special tool allowing for re-engagement by screws (if desired) as well as easy manual disengagement to facilitate easier adjustment.

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