INFORMER

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CREATIVE BY DESIGN A new lease of life for the B80D LRV

SPOTLIGHT

CONSERVING RESOURCES Bridging the transition to efficient hybrid trains

CUSTOMERS + PARTNERS

CYBERSECURITY The Knorr-Bremse Center of Competence

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KNORR-BREMSE



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INNOVATIVE TECHNOLOGIES AND SYSTEMS COMPETENCE FROM A SINGLE SOURCE

Knorr-Bremse Rail Vehicle Systems offers an impressive variety of customized solutions for braking and onboard systems.



BRAKE SYSTEMS



SYSTEMS



SYSTEMS



TCMS











WIPER- / WASH SYSTEMS



ASSISTANCE







SIGNALLING SYSTEMS





Dr. Peter Radina Member of the Management Board of Knorr-Bremse Systeme für Schienenfahrzeuge GmbH

INFORMATION FOR KNORR-BREMSE'S CUSTOMERS AND BUSINESS PARTNERS

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Dear reader,

Can you guess how much time a typical car driver in Rome wastes sitting in traffic congestion? According to a study conducted by Inrix last year, the answer is 166 hours a year. That's a huge number. But it's no longer an exception in Europe: The study found eight of the world's ten most congested cities there.

A shift of people and freight from road to rail is the order of the day. However, conventional methods reach their limits when faced with the need for additional transportation capacity. We at Knorr-Bremse are working towards the goal of stretching these limits: We are making tangible contributions to noticeably improving network infrastructure utilization by means of highly innovative solutions. This issue of informer features some of the approaches we have taken.

Our Reproducible Braking Distance (RBD) project, for example, brings together a combination of coordinated functions such as deceleration control, wheel slide protection and sanding that will bring tomorrow's trains to a halt reliably and precisely – even in adverse conditions. Thanks to reduced braking distance variation, train headways can be shortened and frequencies increased. Particularly in view of such megatrends as mobility and urbanization, more efficient utilization of existing rail infrastructure capacity is imperative.

But, of course, our striving for greater reliability, vehicle availability, and transportation capacity does not end with braking systems. Our windshield wiper and wash systems are equally essential. The same goes for our new EP2002 3.0 brake control system, or cyber-security. By integrating innovative security architecture into our sub-systems, we are providing convincing solutions here, too.

On top of all that, we're very serious about the transformation towards completely environment-friendly mobility – another of the topics featured in this issue. By converting diesel trains to hybrid vehicles, we are not only reducing energy consumption and emission quantities on a large scale. Our engineers have at the same time developed an immediately available technology to bridge the gap to the climate-neutral train.

As you can see, we at Knorr-Bremse remain true to our goals: providing solutions that meet our customers' and partners' needs; making an effective and positive contribution to society; and keeping our eyes firmly fixed on the future of our planet – each and every day.

In recent months, though, so much has changed in our lives. The Covid-19 pandemic has impacted the economic situation – and has had repercussions for Knorr-Bremse, too. But let me assure you of one thing: All parts of our Company are proactively and flexibly adapting their activities to the current situation. But at the same time we put great emphasis on balancing the interests of the Company, our customers, and our employees, with a view to ensuring that we all emerge united and strengthened from this crisis.

Stay healthy!

Yours sincerely, Induis

Dr. Peter Radina

news

FULL AUTHORIZATION GRANTED TO COM-MISSION MODERNIZED DESIRO CLASSICS

Desiro Classic (VT642) vehicles that have been upgraded with the ESRA Evo brake control system can now be used for passenger services in Germany without being subjected to temporary authorization restrictions.

The German Federal Railway Authority has lifted the last remaining subsidiary condition for obtaining commissioning authorization – a maximum of one year's operation with shorter wheelset axle inspection intervals. This means that VT642 Desiros that have been upgraded with the ESRA Evo brake control system can now immediately operate in Germany under the same conditions as before the upgrade. Although the wheelsets are not modified during the upgrade, ratification of the interface certification was still pending – until now.

Obtaining this certificate was an important milestone for Knorr-Bremse. It is unusual for a systems supplier to obtain commissioning authorization, and this particular case is a first for the industry. This approach can provide a model for future modernization project certification.

The responsible RailServices engineers report that the upgraded systems are also proving to be a big hit amongst operators. "The drivers of upgraded vehicles are particularly impressed by the significantly enhanced wheel slide protection performance compared to the old MRP control system."

The modernization of further Desiro Classics is continuing apace. A framework contract has already been signed with Deutsche Bahn (DB) to upgrade 155 vehicles, accounting for more than half of the current DB Desiro fleet.



More than half the current DB Desiro fleet will receive an ESRA Evo brake upgrade



KNORR-BREMSE AT "MASS-TRANS" IN JAPAN

Knorr-Bremse may not have its own rail manufacturing operation in Japan, but the principle of "think global, act local" still applies: With its local employees at the Sakado Service Center (SSC), the Company ensures that products and systems marketed in Japan can be serviced throughout their entire life cycle. In this context, Knorr-Bremse attended its third "Mass-Trans Innovation Japan" trade fair in Tokyo at the end of November.

As well as presenting the new EP2002 3.0 brake control unit, with its longer maintenance intervals that improve life cycle efficiency for fleet operators, Knorr-Bremse also introduced its new iASU (intelligent Air Supply Unit). It also took the opportunity to highlight its core competence of supplying complete braking systems: In Japan there is a tradition of inviting tenders for vehicle sub-systems right down to the level of individual components. By offering complete, customized braking systems with carefully matched components, Knorr-Bremse can significantly reduce the complexity of the vehicle design process.



news

NEW LIFE

The Cologne mass transit authority is carrying out a major modernization project to give 33 B80D LRVs a new lease of life. The first vehicle has already been successfully upgraded from an MRP brake control system to an ESRA system. The technical supervisory authority (TAB) in North Rhine-Westphalia is currently processing extension of the existing commissioning authorization.

In modernization projects like the ESRA upgrade in Cologne, little things can sometimes turn into major challenges. The optical speed sensor mounted on the rotor housing of the B80D LRVs is a case in point. Inside the housing, a slotted disc connected to the axle is scanned by an optical sensor in the rev counter, with 110 pulses generated for each wheel revolution. The braking and traction drive control unit calculates the speed of the vehicle in kilometers per hour based on the wheel diameter and the number of pulses recorded per second.

When Duewag built the first B80Ds back in the late 1980s, this was the standard method of measuring a vehicle's speed. However, modern speed sensors use a completely different technology that is not affected by any build-up of dirt. Making use of the physical Hall effect, the pulses are generated by the changes in the magnetic field of a rotating magnet wheel. The problem is that the magnet wheel cannot be easily mounted on the slotted disc.

Creative solutions needed

RailServices devised a solution involving a new, prefabricated rotor housing designed to accommodate the magnet wheel. This means that state-of-the art sensor technology can now be deployed in an appropriate installation space – a classic plug-and-play solution.

As is so often the case with such modernization projects, the B80D vehicles required a number of other creative solutions. For instance, the fact that some sub-systems were decades old meant that not all of the technical documentation was still available. Fortunately, Kiepe Electric, which was one of the original B80D project partners, is now part of the Knorr-Bremse Group, and Kiepe engineers were able to ensure the best possible compliance with today's requirements. Another example was the extremely highprecision work required to achieve the necessary installation space in the vehicle chassis.

A familiar sight in Cologne: The B80D LRV operated by Kölner Verkehrs-Betriebe AG

Combining the old and the new

The B80D vehicles also threw up one further specific challenge. As usual at the time when they were built, the negative poles of the wheel slide protection system were simply attached to terminal strips at different points throughout the vehicle. This outdated cabling arrangement does not provide the robust protection against external electromagnetic interference that is required in a modern environment. To improve the electromagnetic tolerance, Kiepe's engineers had to use shielded multicore cables for the wheel slide protection system cabling.

In this instance, Kiepe Electric recognized the need for a pragmatic solution and was able to implement it as efficiently as possible.



PUTTING SERVICE QUALITY TO THE TEST

The RailServices customer satisfaction survey only takes around five minutes to complete, but is an invaluable aid to help Knorr-Bremse respond more closely to customer expectations. Participation will also benefit a good cause.

Service excellence is all about being responsive to customers' individual needs. But how easy is it to contact the staff at RailServices? What impression do they make, and how good are their specialist skills? How satisfied are fleet operators, for example, with the interval between ordering a spare part and the delivery date offered?

"We like to put our service quality to the test at regular intervals," says RailServices Vice President Mario-Bernd Beinert. "We expect this customer satisfaction survey to deliver important insights into how we can maintain and improve the quality of the services we offer. We are determined to work on any areas where there is room for improvement, so that we can meet customer expectations more closely." It only takes about five minutes to fill in the



questionnaire – and it goes without saying that the information will be treated with strict confidentiality by RailServices and not passed on to third parties or used for any other purpose than the survey.

For every questionnaire completed, RailServices will donate five euros to charity. At the end of the survey, customers can decide for themselves which project Knorr-Bremse should make the donation to: a therapeutic center for disabled children in Ukraine, or a school for disadvantaged children in Cambodia. Both projects are supported by the charitable organization Knorr-Bremse Global Care.

> https://www.netigate.se/a/s. aspx?s=842424X210651242X68605



DB CARGO OPTS FOR RAILSERVICES CT² TRAINING

The Knorr-Bremse CT² (Computerized Train Console for Training) Demonstrator, which was introduced only last November, has already attracted a major customer: DB Cargo. The freight company recently concluded a framework agreement with RailServices for the professional development of employees from Germany, France, Poland, and Bulgaria.

Located in Berlin, the CT² Demonstrator enables hands-on demonstration and visualization of rail vehicle braking systems' complex functionality. A locomotive driver's console, with visible connections to the compressed air system and brakes, is used to provide a clear and comprehensible explanation of all brakerelated processes. This means training can take place without the need to make any locomotives available – and the same goes for using the demonstrator for ESRA/ST03A training. As both theoretical and practical training take place at the same location, the length of the course can also be reduced from nine to seven-anda-half days.



Dr. Peter Berger at the presentation of the CT² Demonstrator in Berlin

spotlight

HYBRID BRIDGE

Knorr-Bremse company Kiepe Electric has developed an immediately available technological solution to help pave the way for climate-neutral rail transportation, by equipping diesel trains with batteries – a key to significant energy and emissions savings.

There is no question that diesel trains have two compelling advantages for rail operations. Firstly, they are relatively cheap. And secondly, they can be used universally. But in the context of the climate crisis, these advantages are no longer enough, and acceptance of diesel is dwindling among passengers and policymakers alike.

On the other hand, though, electrification of a railroad is an expensive infrastructure project involving significant investment in terms of time and money.

In addition, it does nothing to solve the problem of what to do with the diesel-powered trains already in service. How can these vehicles be made fit for the future? Kiepe Electric has come up with a convincing solution: converting diesel trains into full hybrids.



Hybrid vehicles for universal use

The first step is to fit the multiple unit with an electric powertrain. To create space for an electric energy storage system, one of the two diesel units is removed, and the vehicle is then equipped with an optimized energy management system that enables it to run on electrified sections of routes, drawing power from overhead lines. On non-electrified routes, the control unit switches to the traction battery, with the other diesel engine remaining on board as a fallback option.

Leaving aside restrictions in mixed operation, the range on nonelectrified sections of a route can be as much as 40 kilometers using electric traction alone. When combined, the three energy sources – overhead lines, traction battery and diesel engine – represent an enormous energy saving, depending on the different levels of efficiency. The most efficient method for rail operation, with over 80 percent efficiency, is electrical traction using the overhead line. For battery-powered trains, the figure is marginally lower at around 73 percent. Conventional diesel trains, on the other hand, are only around 35 percent efficient.

Conversion financed by reduced energy consumption

Whereas a pure diesel train consumes 550 kWh for a given round trip, with the new concept consumption is cut to 415 kWh – a reduction of around 24 percent. This example is based on the

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E-HYBRIDS

These combine a classic electric drive with an additional battery drive for operations without overhead lines.

DUAL-MODE VEHICLES

These combine diesel and electric traction technologies and represent a first step towards a full hybrid system.

H,-FUEL CELL DRIVE

10Hm

This is a newcomer in the rail world – a drive system that combines a battery with full EMU management system that uses a fuel cell as its energy source.

SYNTHETIC FUELS

A conventional diesel engine can run on synthetic fuel produced regeneratively using the power-to-liquids process. current-generation DMUs due for a major inspection in the next few years. The exact figure depends on the route profile and the proportion of the distance driven using electric power, but generally speaking the saving is in the order of 20 to 25 percent.

Since there is also a corresponding reduction in operating costs, it makes sense to convert trains with a remaining service life of 10 to 15 years. On some routes where operators previously used diesel exclusively, they have now switched entirely to electrical power or have at least reduced the diesel share to just 20 percent or less.

Integrated system know-how including control technology

Thanks not least to its decades of experience in the electric bus segment, Kiepe Electric is ideally placed to undertake such conversion work.

"With our modular design we are able to offer customers specific solutions that are individually tailored and immediately available," says Dr. Thomas Münch, Head of Project Planning and Technical Services at Kiepe Electric. This is true for converting both diesel to hybrid and hybrid to fully electric traction.

Modular design means that various elements are available to expand or supplement diesel drive systems, including batteries, In Motion Charging (IMC), or braking energy recuperation. Kiepe Electric differs significantly in this respect from other suppliers, since it is able to offer integrated system know-how including the control technology, rather than just stand-alone electric solutions.

"The battery cell technology is the same as for buses. The difference lies in the system size: 15 to 150 kWh is sufficient for buses," explains Münch. For trains, 150 kWh is just the start." With batteries in the 300-kWh power class range, it is possible to upgrade to full-hybrid trains, with diesel traction and a transformer for use with overhead lines. "But it is also possible to convert hybrid-capable trains with diesel traction to what are known as partial hybrids," says Münch.

Full CO, neutrality with power-to-liquids

The next step is to switch our focus to attaining full $\rm CO_2$ neutrality. This could be achieved if the power used for electric operation were generated from renewable sources, with the latter also being used to produce synthetic fuel (power-to-liquids) for diesel traction. Fueling with biodiesel would be an alternative option.

TRANSFORMING DIESEL

Today's diesel trains will in future be:

- energy-efficient vehicles with significantly improved efficiency levels and a free choice of potentially even CO₂-neutral traction
- comfortable and available vehicles equipped with triedand-tested technologies that provide operational reliability even in unscheduled operating circumstances and situations
- cost-effective vehicles in terms of operation and maintenance, without the need for any new or special infrastructure
- universally deployable vehicles for both electrified and non-electrified routes



PRECISION IN ALL CONDITIONS

Due to the unpredictability of stopping accuracy, braking curves for train control systems have to be very conservative. But what if braking distance variation could somehow be reduced thanks to innovative interaction of braking technologies? Knorr-Bremse has created an important foundation for this in the form of its Reproducible Braking Distance (RBD).



More reliable braking distances enable better utilization of rail infrastructure

Only those with time on their hands choose to travel across Rome by car. The Italian capital tested its drivers' nerves more than any other city in Europe in 2019, with 166 hours lost to congestion. Only in Bogotá and Rio de Janeiro are commuters worse off internationally. As illustrated by the "Global Traffic Scorecard" – an Inrix study published in March – the impact of congested city streets is a global problem. The figures are part of the flipside of the megatrend of urbanization. And if nothing changes, the situation will worsen significantly in the foreseeable future. A key part of the solution to this problem is to increase rail passenger transportation capacities. One option – clearly a costly one – is to build new infrastructure. The other is to increase the capacity utilization of existing rail networks. The latter is the approach that Knorr-Bremse Rail Vehicle Systems aims to facilitate with its Reproducible Braking Distance (RBD) concept.



Reducing braking distance variation

Michael Kohl, Braking System Portfolio Manager, explains the initial premise: "A train must always be able to stop safely within a fixed distance however adverse the conditions." On the one hand, the prevailing current environmental conditions determine the available wheel-rail adhesion. "In other words, whether the tracks are clean and dry, dirty and wet, or covered in leaves." On the other hand, variations in braking distance are accounted for by differing wheel diameters, load measuring tolerances, and brake pad friction coefficients.

So, to a certain extent, the limits of infrastructure capacity utilization are currently determined by the continuing unpredictability of stopping accuracy. "The relatively conservative braking curves used in train control systems for safety reasons extend the distance between two trains and therefore result in inefficient utilization of infrastructure capacity," explains Kohl. The purpose of RBD is to significantly reduce braking distance variation – and in turn to establish the basis for a significant increase in utilization of rail infrastructure. At the same time, precise braking is one of the basic prerequisites for more comprehensive automatic train operation (ATO) – a key factor in optimizing interaction within the rail network system.

A holistic concept combining deceleration control, wheel slide protection and sanding

The RBD concept integrates three braking technologies: the innovative deceleration control system (DCC), significantly improved wheel slide protection (MGS3), and the sanding system.

The deceleration control system aligns the actual braking of the train in real time with the actual effect of the braking power used. By applying the brakes according to the required degree of deceleration and taking into account current speed, outside conditions, track gradient, vehicle and car parameters, and the performance of the friction material, the DCC system to a large extent decouples actual deceleration from the variability of vehicle operating conditions and tolerances.

The new version of wheel slide protection goes beyond UIC requirements and achieves improved deceleration even with extremely poor adhesion coefficients. In addition, for the first time



the specific impact of the sanding system was examined over the entire train. This in turn made it possible to apply sanding systems in a dynamic and situation-dependent manner to improve poor adhesion values.

Reduction of train headways by up to 20 percent

Knorr-Bremse looked at the specific potential of the combined optimizations as part of a joint research project with the Berlinbased IFB Institut für Bahntechnik GmbH. The objective was to achieve clarity on the conditions under which an appropriately improved rail vehicle braking system could contribute to a significant increase in infrastructure utilization. Actual subway, urban, regional and high-speed lines were recreated in the OpenTrack railway simulation tool in order to calculate the impact of optimized braking systems for each network on potentially achievable train headways.

Depending on train type, signaling, and distance between stops, calculations showed a reduction in headways of between five and 20 percent. Surprisingly, the simulation resulted in this latter figure for high-speed rail lines using relatively short block intervals. However, the greatest potential in terms of impact on traffic flows was with subways and urban and suburban trains – in other words, on the very lines that bear the brunt of increasing urbanization.



Braking distance distribution

Braking distance distribution with RBD optimization



Customers + partners LAYER BY LAYER

The attractive, smart transportation solutions enabled by digitalization require a whole new level of product security. Knorr-Bremse Rail Vehicle Systems has responded to this challenge by establishing its own Center of Competence for Cybersecurity to deliver robust solutions that also cater to specific customer requirements.

A fake firmware update allowed two security experts to hack into the Jeep Grand Cherokee's CAN bus via its entertainment system's Internet connection. From there, they were able to take over all the vehicle's electronically controlled components via the mobile data network and perform stunts such as forcing it into an emergency stop in the middle of the highway.

According to Paolo Fanuli, Head of the Knorr-Bremse Rail division's Cybersecurity Center of Competence: "When this happened back in 2015, it was a real shock, a wake-up call for the entire automotive and rail vehicle industry. It showed that remote attacks on vehicles are possible in practice as well as in theory."

Mitigating future risks and enhancing security for vulnerable standard solutions

Advances in digitalization play a particularly important role in enabling attractive, smart transportation solutions, predictive maintenance, and assistance systems for automatic train operation. At the same time, Fanuli also expects inexpensive standard technologies to be deployed more widely.

At an organizational level, his Center of Competence is attached to Knorr-Bremse's Selectron business in Switzerland, which focuses mainly on the development and production of Train Control & Management Systems (TCMS). Nowadays, the TCMS controls almost all the vehicle sub-systems, from braking to sanitary systems. "We started developing our next-generation TCMS in 2018, paying particular attention to security by design." It is no longer enough just to protect a network's external perimeter – security must be built into the design of the equipment itself.

Maximizing cybersecurity with the defense-in-depth concept

Accordingly, the Company has adopted an approach based on the defense-in-depth concept, which involves multiple security layers. If hackers penetrate one layer, they encounter another layer that em-



ploys a different method. "The combination of these different layers provides the best possible overall protection," explains Fanuli.

Endpoint protection is an additional option. This uses integrated computer chips to encrypt important data and detect malware. The identity and integrity of software are verified using a kind of digital fingerprint. In the not-too-distant future, all vulnerable Knorr-Bremse equipment will receive a forgery-proof "identity card". Knorr-Bremse is currently creating a Public Key Infrastructure (PKI) to enable secure, automatic management of these security certificates via a cloud service.

"We obviously have to plan these measures very early on, at the system design stage," explains Fanuli. The fact that the product life cycle in the rail vehicle industry can be several decades long must also be taken into account. "Once a vehicle has been homologated, it is virtually impossible to modify its systems. Consequently, we are developing concepts and solutions that enable us to enhance cybersecurity without affecting safety so that we can avoid having to reapply for homologation."

The security strategy can also include a form of data communication pattern-matching during operation. If something looks odd, an alarm is triggered, creating a kind of early warning system. The background to this approach is that serious attacks always build up over a longer period of time. Continuous threat monitoring can stop them in their tracks before they really get going.

A comprehensive risk analysis is carried out to determine the most suitable architecture for a given application. By constantly monitoring the threat landscape, developing new, secure architectures and integrating them into its systems, Knorr-Bremse ensures that it always delivers robust solutions – especially for specific customer requirements. As Fanuli explains, "By ensuring that the measures we take are proportionate to the risks, we are able to add maximum value for our customers."

SIGNIFICANT REDUCTION IN ENERGY CONSUMPTION: MERAK UPGRADES HVAC SYSTEMS OF NEDTRAIN'S VIRMM2/3 FLEET

They are yellow and blue, and the double-decker version is one of the most iconic trains on the Dutch railway network. Knorr-Bremse's subsidiary Merak is now fitting 45 VIRM regional trains operated by Nederlandse Spoorwegen (NS) with new HVAC systems.



Knorr-Bremse has replaced 484 units installed in the 1990s with energy-efficient HVAC systems

Back in the 1990s, Dutch National Railways, Nederlandse Spoorwegen (NS), put the first of a new series of double-decker EMUs into service. Shortly afterwards, these were followed by the VIRM-2 and VIRM-3 series, which offered improved passenger capacity. Now, 45 four- and six-section versions form the backbone of the Dutch regional and intercity fleet, and their striking yellow and blue livery is a familiar sight throughout the length and breadth of the country.

In 2016, Nederlandse Spoorwegen launched a comprehensive overhaul program project for the Series 1 trains, and in April of the following year an upgrade of the later VIRM-2 and VIRM-3 models was put out to European tender. It was recently confirmed that Knorr-Bremse's Spanish subsidiary, Merak, is to be extensively involved in the process, contributing 484 state-of-the-art HVAC systems to replace units installed by another manufacturer during the 1990s.

New generation of control electronics

Integrating the units into the existing trains posed various technical challenges, including the need to reproduce the electrical and mechanical interfaces on the existing units and install new control electronics. At the same time, the new systems had to include easily accessible covers to facilitate maintenance. Compared with their predecessors they offer improved reliability combined with a drastic reduction in complexity, weight and energy consumption.

The cut in energy requirements is partly due to their modern design but also to the new generation of control electronics that they contain. Using a sensor that continuously monitors interior CO_2 levels, the system calculates passenger density and precisely adjusts the cool or warm air supply accordingly.

At the start of the year, Knorr-Bremse's Merak plant in Getafe, Spain delivered the first "pre-tryout" systems to the Netherlands. This means that when volume delivery starts next September, the design will have been thoroughly field-tested. Delivery of the last of the 484 HVAC systems is scheduled to take place a good two years later.





Even under difficult conditions and with 300,000 cycles per year, windscreen wash/wipe systems only require maintenance approximately every ten years

CLEAR VIEW AHEAD

Windscreen wiper and wash systems for rail vehicles seldom inspire the interest they deserve. But such systems are crucial if transportation capacity is to be expanded. LRV drivers have a hard enough job at the best of times in streets crowded with automobiles, trucks and cyclists: They have to keep a wary eye on block signals – and particularly as they approach a stop, pedestrians often run across the tracks at the last minute. High levels of concentration are called for if it starts to rain at dusk, and the city lights begin to reflect off the wet road surface.

"In these conditions, the situation can become positively dangerous if your windscreen is obscured because of an inadequate wiper and wash system," says Florian Hösch, Account Manager at the Knorr-Bremse "Sanding & Wiper" Center of Competence. And of course if the system fails completely, you are in real trouble. "It may seem to be small technical fault, but it has serious implications, as it means the entire LRV has to be taken out of circulation for repair." That is why it is so important for a windscreen wiper and wash system to offer maximum availability and reliability.





From tramcars to high-speed trains

This is quite a challenge, given the design of vehicle front ends with their curved windscreens. Wiping angles of 80 degrees are now the norm – with wiper blades of at least a meter in length. "This means the torque required and the load on the wiper drive system are considerable," explains Hösch. Traditional electric wiper systems originally developed for the automotive industry are simply not up to the job.

Knorr-Bremse has been quick to respond to changing requirements and, especially at its site in Mödling, Austria, has rapidly gained extensive expertise in developing systems suitable for rail vehicles. All over the world, operators now benefit from the Company's achievements in this field. Thousands of electrical and electro-pneumatic systems have been installed in vehicles ranging from local LRVs to high-speed trains – either as original equipment or as upgrades of existing systems.

Ten years without maintenance – at up to 300,000 cycles per year

They are available in versions with segmental, parallel or overlapping wipe areas, and with electronically synchronized wiper units – even with rain sensors, if required. To minimize installation costs for the vehicle manufacturers, the systems are usually supplied with pre-mounted drive units. Their durability never fails to impress: They require no maintenance for around ten years, even at 300,000 operation cycles per year.

products + services

SOPHISTICATED AIR SUPPLY

Next year sees Knorr-Bremse launch volume production of the new intelligent Air Supply Unit (iASU) – a multifunctional air supply platform specially designed for varying operational modes and equipped with a completely new energy and noise emission management system.

▲ The secret of the iASU is the iAC converter that serves as the "central brain" of the air supply system

The list of central train functions for which the air supply unit provides energy is a long one: It includes, for example, the braking and brake control system, as well as the pneumatic suspension, air horn, sanding system and toilets. But the list of variables affecting compressed air requirements at any particular moment is also a long one: In park mode, air is required for train preparation and leakage compensation. Then there is the air consumption during actual train operation, which varies according to vehicle load, speed, braking, and route topography. In the past, a very simple control logic was available to cope with these often rapidly changing requirements: The compressor was either "off" or generating air under full load.

"The current, inflexible control systems automatically switch the compressor on, for example when the pressure drops below 8.5 bar, and off again when it reaches 10 bar," explains Michael Winkler, Team Leader Product Management Air Supply at Knorr-Bremse RVS. Such frequent starting and stopping puts a strain on the motor and the supply system as a whole. Moreover, short running times increase wear and corrosion. In order to adhere to crucial filling schedules and meet maximum projected air requirements at all times, compressors are usually designed for maximum, rather than average, output. But constant operation in this mode, even when air requirements are low, generates high levels of noise.

Flexible speed control and software-retrofittable functionalities

"The new iASU represents a paradigm change for a system that has remained unchanged for decades," says Winkler. "A sophisticated, flexible speed control system matches supply to air requirements depending on the current operational situation – resulting in less wear and lower life cycle costs." The system is also quieter, smaller and lighter, and is designed to be future-proof: Functions that are still at the development stage can be incorporated via a software retrofit update. The system already offers fully flexible speed variation, system monitoring, and condition monitoring.

The secret of the iSAU is the fact that the converter (iAC) – which is uniquely designed for rail-standard compressors – is not only used to convert the power supply to a particular voltage and frequency, but also serves as the "central brain" of the air supply system. The range of flexible speeds available can be used, for example, to produce air at a lower running speed and therefore much more quietly. Operating in such a "silent mode" helps operators to meet increasingly strict noise regulations for trains in stations and residential areas at night.

The system can also respond to particularly high demand for air by switching to "boost" mode, for example when large numbers of passengers alight at a central transfer station and the pneu-

INTELLIGENT

matic suspension has to adjust itself accordingly. By supplying larger volumes of compressed air, a situation can be avoided where traction power is temporarily blocked and the train cannot leave the station.

In the future the system could even be used preventatively: Company'st could identify the train's position on the approach to a station and fill the compressed air system in advance, enabling the compressors to switch off on arrival. "Such complete avoidance of noise emissions would represent an important milestone in terms of passenger comfort," says Winkler. By taking into account this enhanced performance in "boost" mode, a smaller compressor could be fitted – with advantages in terms of weight and life cycle costs.

Elimination of auxiliary compressor, and connectivity/monitoring of all system components

Such a demand-based approach offers another advantage: If a train goes into service with an empty compressed air tank, a small auxiliary compressor is currently used to raise the pantograph. The new iASU removes the need for such an auxiliary compressor by drawing power directly from the vehicle battery to raise the power collector in "pantograph mode." Prior to this, the iASU converter reduces the starting current sufficiently to prevent battery overload. "The need for the train to carry an auxiliary compressor

is therefore a thing of the past," explains Winkler. In other words, the manufacturer saves an entire unit and its installation – and the operator saves weight and life cycle costs.

Connectivity, system component monitoring and condition monitoring are part and parcel of the package. The iASU uses algorithms to convert monitoring data into signals that are sent to the operator, keeping him informed of the condition of the components and considerably reducing the risk of system failure. This, again, impacts positively on life cycle costs.

SIGNIFICANTLY IMPROVED ADHESION

For its Reproducible Braking Distance (RBD) concept, Knorr-Bremse has made further improvements to two key elements of the braking system: The new MGS3 wheel slide protection system now features an additional mode for extremely low wheel-rail adhesion. The new Adhesion Management (ADM) for the first time quantifies the sanding effect throughout the entire train.



The problem of dirty, wet rails is truly a vexed issue. But one that needs addressing nonetheless. Leaves on the lines in the fall are as regular an occurrence as the season itself, with fog and moisture simply adding to the problem. The treacherous slippery film consisting of pollen, industrial dust and oil residues is now the rule rather than the exception in cities with overground rail transportation. The consequences are all too familiar: a growing risk of signal and platform overshoots. Increasing the safety distance between trains has an adverse knock-on effect on infrastructure capacity - although the latter is precisely what needs to be increased, given current megatrends such as mobility and urbanization.

Knorr-Bremse's integrated approach to a Reproducible Braking Distance (RBD, see page 12) is a key factor here: Enabling trains to brake reliably within a fixed distance under all conditions meets a key requirement for reducing the safety distance between trains. The wheel slide protection and adhesion management (ADM) systems are the two central pillars of RBD.

Improved braking force transmission with MGS3

Conventional wheel slide protection controllers are optimized in line with the UIC control range of 10 to 20 percent slippage, i.e. the range within which vehicle speed exceeds wheel speed by this value. However, experience in recent years has shown that leaves and oil produce track conditions where maximum values lie within a narrower slippage range. For this reason, conventional wheel slide protection no longer achieves any improvement in adhesion.

This is where the wheel slide protection algorithm (WSPA3) of the MGS3 wheel slide protection system comes into play: If the achieved braking power falls below a minimum value, the algorithm switches to a control range that has now been additionally implemented for low and extremely low adhesion. In this way, WSPA3 enables the transmission of braking power even under track conditions where until now virtually no braking power

transmission was achievable. In other words, the system gets the best possible results in even the most challenging situations

And it does not require additional sensors to be integrated either. The WSPA3 determines the braking power using the existing pressure sensors in the wheel slide protection control circuit of the MGS3 system. The new concept is already available in UIC-approved passenger coaches equipped with ESRA Classic electronics. The series is also planned for use with the EP2002 3.0 and EP Compact 3.0 control systems.

Maintaining braking distances even in adverse conditions

The new ADM also contributes to improved adhesion. The reason for this is that until now the standard practice has been to have just one sanded axle per vehicle and direction. This has been shown to have only a very limited effect on deceleration. As part of the ADM project, Knorr-Bremse developed a calculation tool to quantify the sanding effect over the entire train

The objective was to come up with a project-specific design for a sanding system distributed over several axles taking account of dirt on the tracks, insulation resistance, sand consumption, installation volume, and life cycle costs. The new system design generally involves the need for additional sanding units. In the Melbourne metro, for example, where the concept is already in use, five axles are sanded on a seven-car train. On the other hand, the system makes it possible to reliably maintain the average adhesion level required - and with it the braking distances - even in adverse conditions.



SINGLE SANDING WITH STANDARD SANDING RATES

MULTIPLE SANDING WITH HIGH SANDING RATES

higher achieved average adhesion with ADM

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Clever by design

Although the new KEf valve covers a wider "adjustment range" than its predecessors, the number of different versions has been reduced to just 50. The KRf relay valve that makes this possible illustrates the potential offered by a carefully conceived common parts strategy. Already in use since 2018, the KEf valves are a completely redesigned valve generation that reduces the 500-plus different versions of the KE valve which had accumulated over several decades to just 50. This is possible thanks to the new generation of built-in, TSI WAG-certified KRf relay valves. Whereas in previous generations, every individual setting of the characteristic curve required separate versions and components, each with a different design, large parts of the characteristic map are now covered by an adjustable, modular solution.

Until now, there was no alternative to designing and producing what to all intents and purposes was a unique relay valve with its own part number for each individual specification. Thanks to the new concept, this is no longer the case. The new valve generation's part numbers now cover characteristic maps and enable a wide range of project-specific pressure settings that are easy to adjust mechanically during the production process.









Enabling an almost limitless number of project-specific applications

The new concept is based on a standardized relay valve technology with a systematically modular design. Right up to Type E, all the valve types use the same main housing. In addition to the connection points for the power supply, brake cylinder and pilot pressure, an extra connection point is available for additional functions. The inlet and outlet valve parts for filling and venting the brake cylinder inside the units are also identical for all the different versions.

The modular design means that additional functions such as a second pilot piston can be added relatively easily. Seven equipment variants enable an almost limitless number of project-specific applications.

A universal design for short project planning and delivery times

In typical applications in the field, 90% of characteristic curves are in the 0.6-1.5 slope range. By focusing on these, the modular system covers the characteristic curves most commonly required in practice. Even though there will still be exceptions in 10% of cases, this makes it possible to reduce the number of T springs to just ten without any restrictions on operators' ability to cover the typical freight car characteristic map. The characteristic curve slope is set by selecting one of the ten T springs and setting its pre-tensioning force using a simple, external mechanical adjustment procedure during the final inspection.

This flexible, universal design is suitable for all vehicle types and enables short project planning and delivery times. Moreover, the reduced number of spare parts delivers cost benefits, since the number of different product codes that need to be stored in the maintenance warehouse is significantly lower.



The KEf freight car valve has been in use since 2018. At its heart is the KRf relay valve generation

