Used for far more than braking

Supplying rail vehicles with compressed air

Frank Hilbrink

All rail and road vehicles – from locomotives, carriages and regional trains to trams, buses and HGVs – need a reliable braking system. Such systems generally use compressed air, which is produced by screw compressors, or in rare cases, by piston compressors. These compressed air generators have to be developed specifically for the very special applications and installation conditions in these vehicles.

As one of Germany's leading manufacturers of screw and piston compressors, ALMiG supplies individual solutions that use screw compressors from the proven Track-Air series to reliably supply braking systems in vehicles with compressed air. Stadler Winterthur AG installs these Track-Air systems in a range of shunting and freight locomotives. The company carefully compared the solutions the market had to offer and concluded that the sophisticated concept of these screw compressors was perfect for its requirements.

Stadler Winterthur AG, formerly Winpro AG and a subsidiary of the Stadler Rail Group since 2005, can draw on 130 years of know-how as a manufacturer of rail vehicles since it is a successor of part of the Swiss Locomotive and Machine Works. Building on the SLMW's history, Stadler's Winterthur site manufactures around 800 bogies a year, mainly for use in the Stadler Group, and develops, designs and constructs special vehicles such as construction vehicles, complete electric compact locomotives and hybrid locomotives with both electric and diesel drives. Stadler Winterthur AG is a subsidiary of the Stadler Rail Group, which, over the last 20 years, has gone from modest beginnings to a system supplier of customised solutions in rail vehicle construction with an annual turnover of around €750 million. It has a total of ten sites in Switzerland, Germany, Hungary, Poland, the Czech Republic, Algeria and Italy and employs around 3000 members of staff.

Screw compressors for compressed air production

Compressed air is a simple medium used for brake actuation in rail vehicles the world over. The compressed air is produced in the locomotive and transported to the carriages via a piping system with hose connections. But compressed air is used for far more than just the braking system; compartment doors, external doors and WC systems use compressed air too. What's more, compressed air can be released into the atmosphere without having a negative impact on the environment. "We use a piston compressor or oil-injected screw compressor to produce the compressed air we need. We prefer screw compressors, as they are quiet, reliable and have a greater capacity as well as a particularly space-saving, compact design," explains Alberto Cortesi, a qualified engineer who is Head of Engineering at Stadler in Winterthur. "We also use

Author: *Qualified engineer Frank Hilbrink is the Key Account Manager at ALMiG Kompressoren in Köngen*

screw compressors to produce the compressed air required in shunting locomotives too, as they often have to move and decelerate very long trains. In contrast, we mainly use piston compressors for low compressed air requirements, such as in regional trains." The compressor supplies the main air receiver(s) in the locomotive with a maximum overpressure of 8 to 10 bar, while the actual braking system operates at 5 bar. The compressed air is dried before being supplied to the network,

- to effectively prevent condensation from forming anywhere in the braking system and therefore to protect all applications from freezing in sub-zero temperatures in winter, and
- to ensure maximum functional reliability of all pneumatic components.

Stadler opts for Track-Air screw compressors

At the end of 2007, Stadler Winterthur AG was looking for a supplier of compressed air generation solutions for a newly developed range of 750 and 1500 kW electric shunting and freight locomotives. The volume flow of the compressed air supply, 2400 l/min, was consciously specified at a rate normally reserved for large locomotives, such that the compressed air system of a longer train could be filled within the shortest time possible. The individual carriages are also equipped with separate auxiliary air receivers with a volume of e.g. 200 l. When a train has been parked for a long period of time, the entire line and receiver system has to be filled as quickly as possible before the start of a journey. This is an application that requires a considerable amount of compressed air, which is why Stadler asked several screw compressor manufacturers for a quotation for the following performance parameters:

- Volume flow: 2400 l/min,
- Operating pressure: 10 bar,
- Voltage supply: 400 V (50 Hz),
- Ambient temperatures: -25 to +50 °C,
- Drying compressed air in a two-chamber adsorption dryer,
- Compact design, simple installation, low noise level, already tested in rail vehicles and certified.

The solution

"After carefully analysing all of the quotations we received and comparing in detail all the prices and performance levels offered, we opted for the Track-Air screw compressors offered by ALMiG. The compact design in particular influenced our decision. Because we ordered ALMiG's complete package with a drive, dryer, controls, condensate receiver etc., they became the general supplier for providing our Ee 922 locomotive with compressed air," explains Cortesi. Fully in line with Stadler's specifications, ALMiG very quickly developed an extremely compact compressor module using proven ALMiG standard components. An initial sample system was first tested by ALMiG at -20 °C in a climate chamber, and then tested and approved by Stadler to ensure that it complied with the overall concept and installation dimensions specified. A very short and compact, electrically driven, directly coupled screw compressor with oil-injection cooling formed the basis of this module. For this project, ALMiG was able to draw on its extensive experience gained from other completed rail projects.

The compressor system is intermittently moved by the pressure measured in the reserve receivers depending on its level (switch-on pressure 8 bar, switch-off pressure 10 bar). The fresh air drawn into the locomotive is firstly cleaned of leaves and large particles of dirt in a pre-filter. As it is installed in a permanently clean and dry location, the compressor can be equipped with a standard intake filter. The oil used in the screw compressor for lubrication, internal sealing of the compression stage and transmitting the heat generated during compression releases the heat produced into the atmosphere via an air-cooled cooler. Any condensate produced is collected in a receiver (volume 70 l), which, thanks to the elasticity of the plastic used, is capable of withstanding water expanding when frozen in winter. A level prove sends a signal to the control centre when the receiver is 80 % full, such that the condensate containing residual oil can be drained at the depot and disposed of in accordance with regulations.

At an ambient summer temperature of +30 °C, ambient pressure of 1 bar, relative humidity of 70 % and pressure of 10 bar, a screw compressor in continuous operation produces just 0.04 kg/h (around 40 cm³/h) of condensate, despite the extreme situation. After 24 hours of continuous operation, just 1.008 l of condensate would therefore be produced. But because the screw compressor is used intermittently and not in 24-hour continuous operation, the amount of condensate produced is actually much lower. The condensate receiver therefore only needs emptying every two months at the earliest, even when subjected to such extreme conditions and 24-hour continuous operation. As a result of low air temperatures in winter and the associated greatly reduced humidity content of the compressed air, the amount of condensate produced might even be just 10 % of the figure specified above. It is therefore theoretically possible that the receiver would not need to be emptied during the winter months, even during continuous operation, and certainly not at Stadler's specified operation of 2 hours a day maximum. The receiver should however be emptied before winter starts.

The Track-Air screw compressors are supplied as a complete package with a drive, dryer, controls, condensate receiver etc.

The adsorption dryer in the solution implemented for Stadler is installed horizontally

Dry compressed air

The mixture of oil and air produced during the compression stage is mechanically separated into the oil and air components in the oil separator receiver. An additional wash plate in the oil receiver prevents the oil from building up when the locomotive is moving and guarantees a constant oil level. Vaporous oil components are held back in a downstream fine separator. A two-part oil air cooler (combi cooler) cools both the compressed air and the oil separated in the oil separator receiver. This cooler lies horizontally below the compressor unit. The ventilator mounted on the cooler intakes the clean cool air from the compressor chamber and pushes it through the cooler and the floor of the locomotive box into the atmosphere from above. The cooler continually blows the cooling air outside and therefore effectively prevents dirt particles from entering the cooler from the track bed below.

Photos: ALMiG Kompressoren GmbH, 73257 Köngen, Germany

Any condensate produced is collected in a 70 l receiver

After passing through another cyclone separator and a two-stage pre-filter, the compressed air, which has a residual oil content of just 0.1 to 0.4 mg/m³, is dried in a cold-regenerative two-chamber adsorption dryer. Unlike standard industrial practices, this dryer does not operate at a constant pressure dew point, but a variable one, which results in a so-called dew point reduction of 20 to 25 °C below the corresponding ambient temperature. Within entire compressed air network, this system prevents free humidity from escaping inside the locomotive, carriages and the entire pipe system. The variable dew point also permits particularly small sizing compared with an adsorption dryer with a pressure dew point that is constant all year round. The adsorption dryer is regenerated in a fully automatic manner over a pre-defined period using a low partial flow of compressed air that has already been dried. The drying agent has a service life of around 3 to 4 years. Unlike a vertical adsorption dryer used in industry, in which the regenerative air flows from the bottom up, the dryer was installed horizontally in the solution implemented for Stadler. A supporting screen prevents the drying agent from being destroyed as a result of internal friction caused by motion and vibrations when the locomotive is on the move. The small number of drying agent particles that do however get through the screen are effectively removed from the compressed air by an after-filter.

When designing the module, ALMiG attached a great deal of importance to using as few interfaces as possible to minimise installation work at Stadler and to eliminate as many sources of error as possible during installation. This is why ALMiG mounted all the necessary components, including the control cabinet and compressed air dryer, on the compressor module in advance. The overall concept was designed to be very maintenance-friendly too. The vehicle's control device provides information about all the important units on board. This system also records the screw compressor's operating hours. All the control and monitoring functions (switch-on and switch-off procedures, loaded/idle mode control, over-run times, temperatures etc.) were designed by the control departments at both Stadler and ALMiG working closely together. Faults are generated in the locomotive's control unit and reported to the driver. The compression stage should initially be changed after eight years of operation, but this forecasted period may have to be adjusted later on depending on the main components' actual operating hours.

"ALMiG is a very competent partner and provides us with excellent technical support."

Qualified engineer Alberto Cortesi, Head of Engineering at Stadler in Winterthur

The construction tolerances and the materials used in the overall design mean that the Track-Air compressor can run smoothly at supply air temperatures down to -30 °C. Additional heating systems make for faultless operation of the compressor, even when temperatures are very low outside. A fast-acting electric auxiliary heater in the oil receiver guarantees an oil temperature of -10 to -5 °C and therefore that the oil is sufficiently viscous before the compressor is started after the locomotive has been stationary for a long time, even during extreme winter temperatures. A safety circuit prevents the compressor from starting prematurely.

Certificate for safety and reliability

With the Track-Air series, ALMiG offers a turnkey system solution for generating compressed air in harsh environments on trams, underground and railway trains, buses and HGVs. ALMiG is certified in accordance with the International Railway Industry Standard (IRIS: reg. no. 1211320642). All Track-Air systems satisfy the acceptance conditions laid down in ISO 1217-3 annex C – 1996, Det Norske Veritas, Germanischer Lloyd, Bureau Veritas, Lloyd's Register of Shipping and more. They also comply with CE guidelines. The oil-injected Track-Air screw compressors, which feature a modular design, can be specifically adapted to satisfy special customer requirements, and thanks to their compact design are perfect for installation in tight spaces. The systems are manufactured in accordance with IRIS, ISO 9001 and ISO 14001. They can be supplied as both a free-standing unit or in a framework construction made from steel or aluminium, which is designed for underfloor and roof installation. As an option, the systems can be equipped with all the components required to prepare compressed air (e.g. filter and drying systems) and to control the system. Depending on the model, the customer can opt for a direct drive, a gear, universal shaft or V-belt drive, hydro drive or speed-controlled drive. The Track-Air range includes modules with

- input powers from 4 to 40 kW,
- volume flows from 0.5 to 5.0 m³/min and
- pressure levels from 5 to 13 bar.

The screw compressor systems in the modular Track-Air series demonstrate high reliability and a long service life, thanks to the use of tried and tested components, in addition to their impressively low maintenance costs, long service intervals, low weight and low-vibration and quiet design. Because the patented compression stages used by ALMiG in the Track-Air series can be equipped for any drive technology required by the customer, these screw compressors always provide tailored solutions.

The ideal partner

"We have worked with other manufacturers of compressed air generating systems in the past. Unlike our previous experiences, our collaboration with ALMiG ran very smoothly despite deadlines sometimes being tight. ALMiG is a very competent partner and provides us with excellent technical support. This also holds true for the Engineering sector, which is of prime importance. The product supplied by ALMiG is tailored precisely to our requirements and satisfies our specifications in every respect. The confidence we placed in this partner certainly hasn't wavered," sums up Cortesi.

ALMIG
21178760

WWW
www.vfv1.de/#21178760