Geared for the future

Adam L. Tietyen, Rexnord Industries LLC, US, introduces a new drive for extreme environments, including underground coal mines.

A century ago in the US, narrow-gauge railroad tracks ran throughout coal mines, and railcars were used to transport men into the mine and coal out. In smaller mines, mules were the source of power for those railcars and were so essential to the process that many mines maintained mule barns deep underground to remove the time it would otherwise take to move the mules in and out of the mine each day.

Larger mines used other methods to move the railcars. The Rochester & Pittsburgh Coal Co. mine in Pennsylvania was famous for its double track rope-haulage system, which was powered by two large steam engines. Other mines used small locomotives run by electricity from trolley wires suspended from the roof.

A big turning point came in 1924, when an anthracite mine in central Pennsylvania successfully used a conveyor belt to move coal from inside the mine to rail cars at the mine entrance. As mine owners everywhere soon discovered that conveyor belts driven by gear drives improved production time, they began to convert in greater numbers. Gradually, mules were put out to pasture and steam engines and electric locomotive systems were replaced with more efficient, drive-powered conveyor belt systems. By the 1960s, the majority of mines had replaced their railcar systems with drive-powered conveyor belting.

While the conversion to conveyors was a huge step forward in haulage, the hostile environment of coal mines soon made it clear that conveyors were only as good as the drives that powered them. Gear drives had to be able to withstand extreme temperatures and conditions, high vibration and punishing shock loads. Strength, durability and reliability were the qualities most in demand; unfortunately, they were not delivered as often as most would like.

Researching the coal industry's needs

Rexnord Industries, a leader in the gear drive industry for more than 100 years, and the manufacturer of Falk® gear drives and couplings, decided to address the troublesome issues that had surfaced in the drive industry over the years. After initiating industry studies, conducting extensive customer research and seeking input from coal handling professionals, the company was able to pinpoint what the industry wanted in a gear drive: more torque, improved thermals, longer life and easier installation and service.

Responding to this, and after more than 100,000 engineering hours, Rexnord introduced the Falk V-Class™ drive. Designed to provide maximum dependability, this drive is covered by a three year warranty – the industry's longest standard warranty.

Designed for durability

The Falk V-Class is designed with more torque capacity so that it can handle the heaviest loads. The housing is constructed of heavy-duty ductile iron, which enhances its ability to withstand shock loads. Ductile iron not only responds to stress as steel does, but has twice the tensile strength of grey or cast-iron typically used for drive housings. Cast iron tends to be brittle and fail under high loads.

Gears in the new drive are case-hardened and ground to provide greater strength and minimise wear. Other improvements to the gearing include:

- Tooth size and form have been optimised for maximum performance under load.
- Teeth have been peened through a proprietary process that provides greater strength and durability.
- A 25° nominal pressure angle tooth form is used, making teeth stronger and more able to absorb shock loads.

Dependable lubrication

The Falk Magnum seals protect against leaks using a drainback passage to keep oil in, while a contact seal and grease-purgable cavity keep contaminants out. Radial and axial bush seals also help eliminate oil leaks and prevent contact between surfaces. The drive uses longer lasting, heat-resistant Viton® and nitrile lip seals.

The drive uses larger, stronger, spherical and taper roller bearings to handle heavier loads and greater torque. Cast-in oil dams protect against dry start-ups, ensure bearings remain lubricated and cool, and that the optimum oil level is maintained at any speed.

Runs cooler for a longer life

The Falk V-Class includes a number of cooling options that have been built into the drive to ensure a longer operating life in the harshest conditions. These include:

- A split-shaft fan.
- An electric fan.
- Air-to-oil cooling.
- Water-to-oil cooling.
- The Falk DuraPlate™ system (patent-pending).

Although its power-dense housing size offers less surface area to dissipate heat, the drive maintains a lower operating temperature than drives with conventional housings. This is because its computational fluid dynamics (CFD) designed housing and cooling fins, as well as proprietary oil feed passages in the housing, optimise the unit's air and oil flow system and reduce oil temperature.

The sloped design of the housing ensures that cooling air is constantly flowing against the housing surface and removing heat. Cooling fins, which are

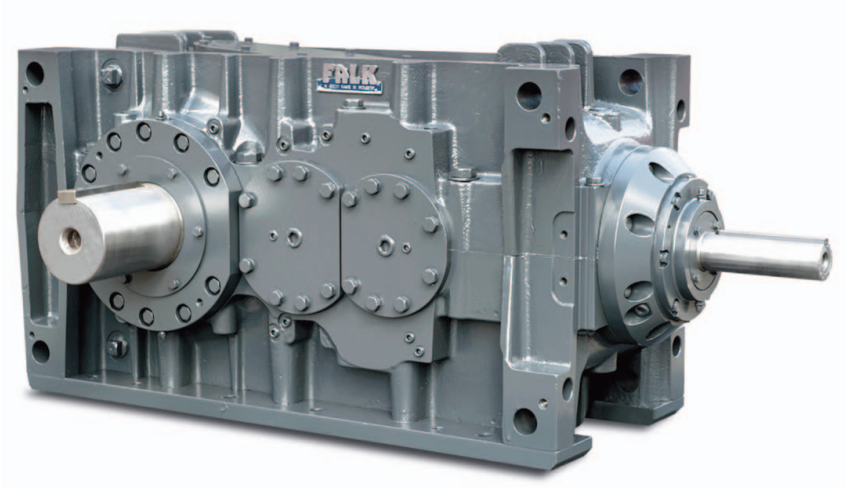

Figure 1. The Falk V-Class drive.

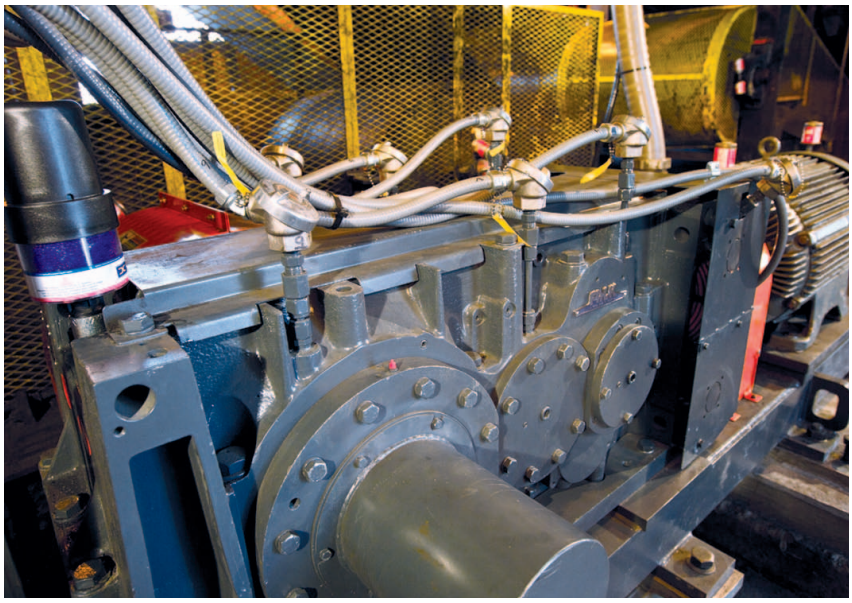

Figure 2. The 324 hp. Falk V-Class with split shaft fan and condition monitoring package.

located on the top and bottom of the unit, enhance the drive's thermal capacity well beyond that of a standard drive.

Cooling is further boosted by the DuraPlate system, which controls oil temperature in the most hostile conditions without requiring water or electricity. This system uses a set of laser-welded stainless steel plates bonded to form pocketed interior passageways through which the drive's oil is circulated. A pump driven by the intermediate shaft draws oil from the drives's low speed end and circulates it through the DuraPlate system.
A shaft-driven fan circulates cooling air across DuraPlates, which provides greater surface area to cool the oil.
The cooled oil is then circulated into the high-speed end of the drive, where temperatures are higher. Multiple plates can be mounted side-by-side to provide more extensive cooling.

Because thermal advancements help the Falk V-Class maintain a significantly lower operating temperature, fewer oil changes are required. The drive is designed with thermal options based on a lubricant sump temperature of 180˚F (82˚C), which is 20˚F (11˚C) cooler than the AGMA standard. By keeping the oil cooler, this new drive doubles the oil's service life. Cooler running oil is also more viscous, providing better lubrication of gear and bearing components, thereby extending their life.

Easy installation and serviceability

The Falk V-Class base and cover are identical, and the unit has removable feet. This allows it to be easily adapted to replace existing drives with different shaft centerline heights. Large inspection covers are built into both the top and bottom of the drive so that flipping the unit never impedes visual inspection. Further, no matter what position the drive is in, multiple oil ports mean that changing oil is never a problem.

Unlike drives with monoblock housings, the Falk V-Class is built with a horizontal split housing that enables the drive to be easily disassembled in the field for service of bearings and gears. Steel shims eliminate gasket creep and ensure bearing settings are maintained, while lip seals can be simply replaced without seal cage removal.

Quiet running

Lowering sound helps to enhance workplace safety. With this in mind, engineers designed the Falk V-Class to be significantly quieter than comparable gear drives. The geometry modifications designed into the gear teeth greatly reduce transmission error and, consequently, reduce noise. Testing of the drive has consistently met a specification of 85 dB at 1 m (compared to 90+ dBA for a typical drive), making the drive especially valuable for noise-sensitive areas.

Coal conveyor performance

A power plant in Indiana recently replaced the obsolete gear and chain drive on its coal conveyor with a Falk V-Class. The new drive is installed on a 42 in. wide troughed belt conveyor that is rated at 750 tph. The belt receives coal from a rotary rail car dumper and transports it to a distribution system, which routes the coal either to the plant or a storage facility. In the process, the belt is elevated approximately 50 ft.

The previous drive consisted of a motor, gearbox and chain and sprocket that was installed during a 1974 system upgrade that increased the belt capacity from 500 to 750 tph. The belt is powered by a drive pulley located in the middle of the belt on the return side. The new drive that replaces it connects directly to the mid-belt pulley and eliminates the sprocket and chain.

As is typical with most coal operations, the environment is dusty and has varying ambient temperatures. For this reason, the plant chose to install a split shaft fan cooling system, which improves performance and longevity under the most extreme conditions.

Installation of the drive went smoothly, with one adaptation for a new base plate to accommodate the change from chain and sprocket to direct drive. The new drive passed all inspections and is operating efficiently and coolly in this application. The power plant reports that the operating temperature at the sump was in the 150˚F (65˚C) range in an ambient temperature below 80˚F (27˚C).

Haulage evolution

Innovation helped the coal haulage industry evolve, from railcars pulled by mules to steam engines, electrical trolley wires and gear drives. Now, innovation has taken gear drives used in the coal industry to a new level, increasing uptime and raising productivity levels. The new Falk V-Class drive is a powerful new breed of drive, engineered for punishing environments and demanding applications.