Jon Brown, Quaker Chemical Corporation, USA, describes the evolution of hydraulic fluids for longwall mining systems.

In today’s world, longwall mining faces considerable challenges. The difference between a productive operation and an inefficient one often boils down to the right combination of people and products. It is important for fluid manufacturers to work closely with the longwall mine to understand their challenges, and to then employ advances in chemistry to help reach improved product performance levels for their specific applications. It is this collaboration between mining companies and their suppliers to develop tests and implement new ideas that helps mines maintain and, in some cases, even surpass productivity goals.

This partnership is well documented between Quaker Chemical Corporation and the longwall mines that they supply. For over 30 years, Quaker Chemical has continued to challenge the status quo for fire-resistant fluids used in some of the largest hydraulic cylinders in the world: longwall mining machinery.

Some of the most important functions of a hydraulic fluid occur in the longwall system where it provides pressure to the hydraulic cylinders responsible for advancing the shield over the mining equipment, pushing the face conveyor forward to the next cut, and controlling roof and floor movements. The longwall hydraulic fluid must provide lubrication of the hydraulic cylinders; maintain a consistency that allows effective filtering to remove contaminant particles and dirt; and prohibit the growth of bacteria and fungi in the working fluid.

In the first modern longwall systems, standard mineral oil-based hydraulic fluids were used to power hydraulic functions. While mineral oil has the definitive advantage of a
good cost-performance ratio, it is a distillate from crude oil and is not always the safest choice due to its tendency to catch fire easily.

As longwall systems have evolved, so too have longwall fluids, borrowing technology, namely oil in water emulsion, HFA fire-resistant hydraulic fluid, the only hydraulic fluid that is incapable of catching fire. This product is referred to as ‘95:5’ fluid for the high content of water mixed with the low percentage of oil emulsion. HFA fluids have high biodegradability, good cooling properties and are extremely cost-effective due to the high content of water that is mixed with the product. Though the use of HFA fire-resistant hydraulic fluid emulsions has brought several advantages, the high water content sourced from the mine has presented new challenges for longwall miners. Due to the varying qualities of the mix water available, the following issues arose:

- Bacteria, fungus and corrosion.
- High mineral oil content emulsions were inherently unstable and could fluctuate with temperatures and water quality, leaving split emulsions that did not function as intended or protect the equipment.

**Second generation: micro-emulsion technology**

Quaker Chemical received its first opportunity with HFA fire-resistant hydraulic fluids in Australia in 1964 following an invitation from BHP Billiton Ltd (BHP) to supply quality critical lubricants in its Australian steel mills. It was only in 1985 that Quaker Chemical was able to transfer its existing technology to the BHP longwall coal mines in the form of an HFA micro-emulsion, QUINTOLUBRIC® 814-02. A micro-emulsion differs from a standard emulsion by way of oil particle size; it has much smaller oil particles that are suspended in water through emulsifiers. The smaller size significantly increases the stability of the emulsion which, in turn, allows mine operators to use a much wider tolerance in water quality.

Lowering the mineral oil content in the fluid reduced the food source for bacteria and fungus, increased biodegradability and reduced the ability for mineral oil to form deposits in longwall machinery.

**Case study one**

Quaker Chemical introduced its QUINTOLUBRIC 814-02, HFA micro-emulsion to a major longwall mine in the US. The conversion to QUINTOLUBRIC 814-02 resulted in the following positive effects:

- Improved hydraulic systems solenoid valve cleanliness – a significant reduction in bacteria, fungi, scum build-up and deposits in longwall fluid system.
- A better working environment.
- An 80% reduction in solenoid consumption and lower filter consumption.
- Increased longwall operation, production and increased mine profitability.

This innovation is the backbone for the majority of fluids used in present day longwall mining equipment. However, various updates have been made to lower workable concentrations from 5% to 2%, to improve safety and to counteract the inherent problems faced with an emulsion. More recent iterations have proven to be stable in water hardness over 500 ppm. Though the potential for hydraulic issues significantly decreased, there were still intrinsic issues with emulsion technology that spurred Quaker Chemical to develop a new solution.

**Third generation: full synthetic technology**

In 2006, the company introduced QUINTOLUBRIC 818-02, the first fully synthetic HFA longwall fluid that would contain no mineral oil and be stable in all water types. This new technology reduced the potential to develop bacteria and fungi contamination, improved cleanliness, lowered environmental impact and increased corrosion protection.

The impetus for the product’s development was a problem with the premature failure of solenoid valves in the roof supports of a major equipment supplier. Over a two year period, the equipment supplier and Quaker Chemical partnered to research the cause. The pair discovered that certain oil-based emulsion fluids were contributing to the valves sticking by corroding the internal surface of the valve and forming corrosion, which restricted its free movement.

The fully synthetic HFA fluid was determined to be highly protective of solenoids and provide a simple chemical solution to the problem. Removing the mineral oil also removed the food source for bacteria and fungi. Bacteria can live in longwall hydraulic fluid, consuming portions of the longwall fluid in their growth, which lowers product performance. Bacteria feed on the emulsifiers used in semi-synthetic and soluble oil type fluids, which destabilise the emulsion resulting in emulsion bleed or oil split. Split longwall emulsions reduce fluid lubricity. Separated or split fluids can also cause other problems, including component corrosion and solenoid valve malfunction.

Quaker Chemical’s fully synthetic hydraulic fluids protect longwall equipment by blocking the growth of damaging bacteria, thereby increasing production time and reducing maintenance.

Operationally, the fully synthetic fluid proved to provide higher corrosion protection, lubricity and stability in extreme conditions.
water hardness (1000 ppm). The fluid mechanics led to increased pumping efficiencies, filter life and extended the life of seals.

**Case study two**

A large underground coal mine located in Australia was having issues with their longwall fluid due to the local water supply they were using to mix with the product.

Due to flooding events, there was a sediment build-up in the local water supply. The raw water filter system being used by the mine at the time was not adequate enough to keep up with this increased sediment. The local water supply was used to mix with the longwall fluid, and the increased sediment not only caused the fluid to split, but also had negative effects on filtration and all longwall components.

To help mitigate the effects of the local water supply, Quaker recommended the mine convert to QUINTOLUBRIC 818-02, a fully synthetic longwall fluid that can withstand the spikes in water hardness. Additionally, Quaker Chemical installed a new mixing station to filter the sediment from the water more effectively, and provide tighter controls on the longwall fluid concentration. With the conversion to QUINTOLUBRIC 818-02 and the new mixing tank, the mine was able to achieve the following:

- A reduction in fluid consumption – from 4% to 2%.
- A reduction in the amount of filters used – using a fully synthetic longwall fluid allowed for increased contamination capacity and longer fluid lifetime.
- An improved pump station and solenoid valve performance – a decrease in fluid contamination resulted in a longer component life, lower maintenance costs and reduced maintenance downtime.
- A reduction in maintenance downtime and monitoring needed for the mixing tank.

**Fourth generation: fully synthetic and biocide-free technology**

This year, Quaker Chemical plans to introduce a fourth generation of longwall fluids that will be completely biocide-free. Due to the high water content in HFA fluids, biocides are heavily relied upon to prevent or eradicate the formation of fungus and bacteria in the fluid. Utilising Quaker Chemical’s current synthetic technology, the new formulas were created with increased microbiological resistance to be able to eliminate the addition of biocides. Removing these chemicals from the longwall fluid creates a safer product for workers and the environment, while also reducing the cost to the customer.

**Conclusion**

By implementing a collaborative approach with its customers, Quaker Chemical aims to deliver improved technologies and solutions to issues seen in the field. This partnership is key to discovering new innovations for improving longwall productivity. The company strives to be a solutions provider rather than only a supplier.