HOW DATA FROM AN INDY 500 RACECAR TEAM WILL HELP BEARINGS PERFORM BETTER IN EVERYTHING FROM HEAVY EQUIPMENT TO ROLLING MILLS.

By Joel Garrett

Some people may believe that using a seven million dollar racecar as a test “lab” to develop a better grease is a bit of a crazy idea. Nonetheless, Joel Garrett, head of Quaker Chemical Corporation’s specialty grease business Summit Lubricant’s Inc., thought it was a perfect idea and, after working in conjunction with Sarah Fisher Hartman Racing (“SFHR”), it turned out he was right.

Here’s why: Racecars operate under extreme conditions that widely vary from track to track, creating a perfect “real-world” test situation. Further, race engineers exactingly monitor every detail of stress placed on the vehicle—including time, speed, load, and temperatures. They even measure the temperature on the inside of the bearing case. Precise measurements and proper material choices are imperative because, in the sport of auto racing, the deterioration of a single metric can be the difference between winning and losing a race. In trying to make their team’s racecar the fastest on the track, one material these race engineers analyze is grease.

The quest for a better specialty grease. In 2010, Quaker Chemical formed a partnership with the Sarah Fisher Hartman Racing (SFHR) team to see if, together, they could develop new greases that would reduce mechanical loss of energy and to extend the life of the bearings. SFHR racing team was hoping for a subtle but crucial fraction-of-a-second advantage—enough to, in a close race, mean the difference between a first and third place finish. Quaker, on the other hand, was hoping to leverage the SFHR team’s data and advance their understanding of grease under extreme stress conditions to gain market advantage in a wide range of industries.

A systematic approach to bearing grease. Typically, for wheel bearing greases, a team’s engineers choose from a selection of existing products. The team’s engineers routinely keep log books demonstrating how different grease performed on any given day. With many variables—such as the type of track, the temperature and the weather conditions—that the selection process can be more trial and error than science. Therefore, the SFHR team and Quaker decided there had to be a more systematic, scientific approach to finding a better more reliable lubricant for wheel bearings.

To develop requirements for the grease, Quaker’s chemists leveraged the data from the SFHR logs—data on every course/event based on the team’s “standard” off-the-shelf product. Engineers logged the car’s housing temperatures, brake temperatures, speeds, the levels of down force at the end of a straightaway from this they formulated a criteria for the “ideal” grease. What the racers wanted was a grease that would provide the same temperature capabilities as the standard products, but with a lower drag. To SFHR racers, a grease with a lower drag would be one of several tiny-but-crucial tweaks that Aaron Marney, one of SFHR team engineers, could help them achieve.
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In their R&D lab, Quaker ran the team’s standard grease through a battery of tests to establish a benchmark. Next, they created several grease prototypes uniquely suited to the team’s requirements for temperature, speed and load. To test the prototypes, Quaker designed and built a test rig to simulate the forces of a NASCAR race. This step was vital to the development process as actual track time is so crucial to the race and so limited. Then, the grease was tested in a real racecar on a real track and eventually, the Quaker grease was packed into the wheel bearing case on race day. To date, SFHR has run with the new grease at Indy, Milwaukee, and Pocono races. “It holds up well and gives us an advantage over the lubricants that we typically use,” says Marney about the Quaker grease.

The anatomy of an auto racing grease. A race team needs to have a range of greases on hand because different types of courses and conditions require different properties. For each race, engineers have to look at different scenarios:

» Viscosity/Temperature—Grease needs to be thick enough to lubricate even at high temperatures, but not so thick so as to soak up energy and slow the car down on a long straightaway. Temperatures on an oval course can be from about 140 to 176 degrees Fahrenheit (60 to 80 degrees Celsius; hot, but nothing a thin grease can’t handle. But on a road course, or a short oval course, where a car will be breaking frequently to navigate corners and sharp turns, temperatures of the housing that encases the wheels bearings can reach temperatures of over 212 degrees Fahrenheit (100 degrees Celsius). These courses require thicker, more viscose greases that can withstand very high temperatures.

» Load—during the race there is significant pressure on the wheel bearings. The grease needs to be able to withstand weight of the car pushing down, and the force that is applied when the car navigates turns. In addition, on a long straightaway, there is a significant amount of down force.

Leveraging the results on the track. The SFHR engineers found that the new greases provided a 10% gain on power consumption over the standard grease that they used. Further, the new greases allowed Marney and his team to use 55% less grease than the usual, prescribed, amount of grease. With the Quaker formulated product Marney explained, “we’re running with less than half of what we would feel comfortable running with other materials.” Moreover, when drivers tested the set-up on the racetrack, the reduction in the amount of grease provided them with an extra 4% gain on power consumption. “That [advantage] is huge,” says Marney. Ultimately, reducing mechanical loss with Quaker’s custom grease resulted in an improved race time of 0.5 to 200ths of a second over the standard greases. “It’s a gain that we see in the race data,” says Marney.
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Quaker's Greases vs. the Leading Competitors Greases

The test data demonstrates that the Quaker grease, on the red axis, requires less force (Pa) to strain the material when compared to the competitor's grease. In addition, Quaker's grease has a lower stress value on the x axis where the two curves (red and blue) cross over, demonstrating that it requires less force to have equal liquid- and solid-like characteristics in the grease. These values translate into less energy required to move the bearing and reduced friction when the bearing is in motion.

SFHR has gained an edge using grease developed by Quaker on their wheel bearings. Now they are ready to tackle other mechanical facets. “Now we are talking about, using lubricants and greases on other mechanical parts” says Marney.

The graph below shows the results of a strain sweep test, a rheological test of a material's liquid- and solid-like behavior. This test is especially applicable to a complex system like lubricating grease.

- The red axis and curve show the solid-like (elastic modulus) behavior
- The blue axis and curve show the liquid-like (viscous modulus) behavior
- The point at which the two curves intersect the product has equal liquid- and solid-like properties

The graph shows the strain sweep at room temperature. The data points indicate that Quaker's grease has a lower stress value compared to the competitor's grease. The graphs help illustrate the performance benefits of Quaker's grease.
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Leverage the results in industry. “The technical development we did with SFHR team, was a rare opportunity”, says Joel Garret, head of Quaker’s subsidiary Summit Specialty Grease. “The deep, real-time data we were able to collect, will help us in the evolution of our high-performance greases.”

The understanding Quaker gained from this project is directly transferable into the many industries Quaker serves. “In most applications where bearings are used—such as for steel rolling or in heavy equipment, it’s nearly impossible to get the metrics we need on grease performance”, says Garret.

So what is next? Having completed the development of a wheel bearing grease, SFHR and Quaker are ready to tackle lubricants for other mechanical parts of the SFHR racecars and will begin to apply their newly gained knowledge to create a new generation of greases that will help their industrial customers further extend the life of their tools and equipment.

About Quaker Chemical Corporation. Quaker Chemical Corporation is a leading global provider of process fluids, chemical specialties, and technical expertise to a wide range of industries, including steel, aluminum, automotive, mining, aerospace, tube and pipe, cans, and others. For nearly 100 years, Quaker has helped customers around the world achieve production efficiency, improve product quality, and lower costs through a combination of innovative technology, process knowledge, and customized services. Headquartered in Conshohocken, Pennsylvania, USA, Quaker serves businesses worldwide with a network of dedicated and experienced professionals whose mission is to make a difference. Visit www.quakerchem.com to learn more.

About Sarah Fisher Hartman Racing. Sarah Fisher Hartman Racing (SFHR) was established in 2008 and is owned by former driver Sarah Fisher, the youngest woman ever to compete in the Indianapolis 500 and the first woman to run a full IndyCar Series schedule, and businessman Wink Hartman. SFHR has competed in the IndyCar Series since 2008, earning its first victory in 2011 at Kentucky Speedway.