BY D. S. NAG

FORMULATING WATER-RESISTANT GREASE

Water in lubricating greases has been a concern for the industry for more than a century. Water can adversely affect grease lubricity and corrode the lubricated parts. Recent research shows that calcium sulfonate greases can be an answer to water issues when used in a variety of industrial and food machinery applications, an industry official said.

Formulators can use a number of options to develop calcium sulfonate greases that function well in the presence of water, said Nilesh Kadu, product manager industrial lubricants at Lubrizol India Private Ltd. He noted that calcium sulfonate provides excellent water resistance and has become the fastest growing grease thickener type. "Calcium sulfonate grease volumes are growing continuously. People are moving to these greases for steel mill applications and the food industry," Kadu said at the annual meeting of the India Chapter of the National Lubricating Grease Institute in February.

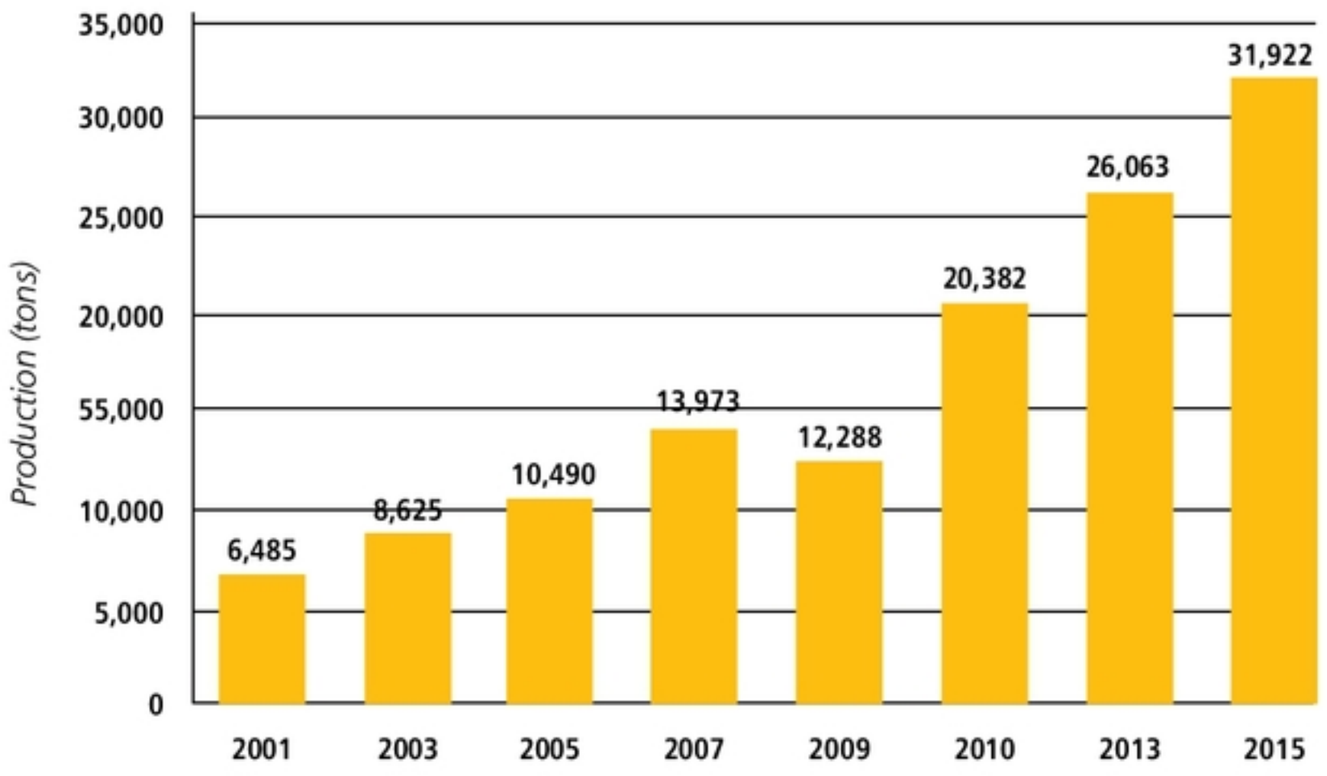
Usage Growing

Global calcium sulfonate grease production has grown steadily in recent years, with volumes rising to 32,000 metric tons in 2015 from around 6,500 tons in 2001, Kadu stated, citing data from NLGI's Grease Production Survey Report. These greases are being used in high-temperature, wet and heavily load conditions such as mining, steel mills, motor-operated valves, power plants, railroads, paper mills, marine and underwater applications, food-grade and off-highway machinery.

He noted that calcium sulfonate greases are preferred in these applications because of their high dropping point, good mechanical stability, strong extreme pressure/antiwear performance and excellent rust protection without the use of additives. "Also, the performance of calcium sulfonate greases can be enhanced with additives," said Kadu, who presented the paper written by Lubrizol Corp.'s Strategic Technology Manager Gareth Fish.

Kadu stated that while alternatives like lithium complex, aluminum complex and polyurea greases are available, they all have disadvantages compared to calcium sulfonate greases. For example, raw material costs for lithium complex greases are rising due to a scarcity of lithium. These greases also require performance enhancing additives. Aluminum complex grease has lower oxidation

Global Calcium Sulfonate Grease Production



Source: NLGI

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Comparing High Temperature Greases

Thickener	Lithium Complex	Aluminum Complex	Polyurea	Calcium Sulfonate
Advantages	• Multipurpose • Good pumpability • Readily available	• Multipurpose • Water resistance	• Ashless • Excellent oxidation resistance • Low noise • Sealed for life	• Inherent EP/AW • Good mechanical stability • Good corrosion resistance
Disadvantages	• Additives needed for performance • Rising raw material cost • Not food grade	• Poorer oxidation resistance	• Manufacturing issues • Poorer mechanical stability • Additives needed for rust, EP and corrosion	• Poorer low temperature pumpability • Availability

Source: Lubrizol Corp.

resistance. Polyurea grease has lower mechanical stability, and its toxicity causes manufacturing issues.

The main drawbacks of calcium sulfonate grease are poorer low temperature performance and pumpability issues. However, these properties can be improved with additives.

Calcium sulfonate greases were developed in the 1960s when overbased calcium sulfonate was prepared from neutral natural sodium sulfonates. Overbased calcium sulfonate was treated with acid and alcohol, and the mixture was heated until it gelled into grease. Since then, the basic process for making gelled calcium sulfonate grease has remained largely unchanged, Kadu said.

Calcium sulfonate greases are classified as natural and synthetic. The gelled thickener consists of calcite, which is crystalline calcium carbonate and calcium sulfonate. In calcium sulfonate complex grease, the thickener consists of gelled calcite, calcium sulfonate and anhydrous calcium or calcium complex soaps. It may also include calcium phosphate or calcium borate.

Kadu said each type of calcium sulfonate grease provides different advantages and disadvantages. But all

Comparing Calcium Sulfonate Greases

Thickener	Natural Calcium Sulfonate	Synthetic Calcium Sulfonate	Calcium Sulfonate Complex
Advantages	• Easiest to gel • Good yields • Good mechanical stability • Good corrosion resistance	• No issues with supply • Excellent water resistance	• Lowest cost • Slight oil bleeding helps with lubrication
Disadvantages	• Rising raw material costs • Increasing supply shortages • Poorer water resistance	• Poorer yields	• Longer gel times • Complex manufacturing processes • Poorer thermal stability • Poorer pumpability

Source: Lubrizol Corp.

types provide high dropping points and excellent extreme pressure and antiwear properties.

Water Resistance

To understand how calcium sulfonate grease functions in the presence of water, Lubrizol conducted tests to evaluate the water washout (ISO 11009) and water spray-off (ASTM D4049) of a synthetic grease without additives. The grease had a total base number of 400, and showed water washout of less than 2 percent and water spray-off of 15 percent.

Kadu said another experiment was conducted to determine if the grease could meet the requirements of steel mills, where the typical base oil viscosity is ISO VG 460. The grease was formulated using a 400 TBN sulfonate premix with 70 percent polyisobutylene having a molecular weight of 3,000. Dropping point was above 316 degrees C, and penetration was 250 without strokes. The base grease was cut to NLGI 2 grade with an ISO VG 460 oil blend and treated with rust inhibitor, antioxidant, polysulfide and copper passivator. Thereafter, it was thoroughly mixed, deaerated and tested against typical steel mill requirements.

Tests showed a water spray-off of less than 10 percent, compared to the required less than 25 percent. Water washout was 1.40 percent vs. the specified 2.75 percent. In addition, roll stability testing with added water (ASTM D8022) showed no impact on penetration. Some steel industry requirements specify water spray-off to be less than 5 percent, so some additives need to be added to improve this property, Kadu said.

The addition of 0.5 percent functionalized olefin copolymer improved spray-off to about 1 percent, but the grease was rubbery. However, adding 2.0 percent styrene-isoprene polymer improved water spray-off to 2.8 percent, without making the grease rubbery.

To meet the requirements for off-highway heavy machinery, Lubrizol formulated a grease using a 400 TBN sulfonate premix, with 66 percent 4,000 molecular weight PIB. Dropping point was above 316 degrees C, and penetration was 241 without strokes. The stiff NLGI 2 grade had a viscosity of ISO VG 320 and was treated with 5 percent technical fine molybdenum disulfide, rust inhibitor, antioxidant, polysulfide and copper passivator.

Tests showed significant improvement in water spray-off, which was close to 1.3 percent, compared to the typical requirement of less than 10 percent, Kadu said. Water washout was 1.1 percent, compared to the required less than 2 percent.

Food machinery requirements, however, are vastly different. Some applications require thermally stable greases that resist both water spray-off and water washout. Other machines require greases that can be readily removed by water for cleaning and sanitizing to avoid food contamination.

Lubrizol made two base greases using HX-1 registered 400 TBN sulfonates containing white oil and PAO as well as food grade PIB. No additional additives were included, but food grade antioxidants could be included. The grease was tested in a meat processor, and while it lubricated the equipment well when cutting meat, the PIB prevented it from being washed out for sanitizing. In contrast, PAO-based grease without PIB lubricated satisfactorily and was readily removed in the washing and sanitizing step.

Kadu concluded, saying that the technology is available today to make water-resistant calcium sulfonate greases for use in steel mills and off-highway equipment. He added that water resistance can be tailored to suit the needs of food processing equipment. □