Where did my Grease Go? Why Water Resistance can be Very Important

By John Sander, K.P. Lijesh

It is common for grease lubricated components/equipment to operate in wet environments thereby exposed to water contamination. In such applications, a grease providing higher resistance to water is recommended. In fact, the new NLGI High-Performance Multiuse (HPM) Grease specification, as well as the existing NLGI Wheel Bearing (WR) and General Chassis Grease specifications include water resistance requirements, that must be met before a product can be certified and approved for applications operating in water contaminated environment. In fact, the HPM specification allows certification to a tag HPM + WR that is specific to elevated water resistance properties beyond those of the baseline HPM specification.

Traditionally, the water resistance properties have been evaluated via physical tests, such as ASTM D1264 commonly called the water washout test or ASTM D4049 commonly called the water spray off test. In essence, these tests evaluate the grease adherence capacity to either a metal plate or a bearing surface when exposed to running or pressurized water. Recently, research members from Center for Rotating Machinery (CeRoM) (Prof. M. M. Khonsari and Dr. Lijesh), Louisiana State University, along with NLGI member Dr. Raj Shah from Koehler instruments, published a paper with MDPI Journals titled “The Standard for Water Resistance Properties of Lubricating Grease to Water.” In this paper the team used a novel approach of employing the contact angle value of a water droplet on grease surface to evaluate greases with different formulation. Then they compared the contact angle values to several traditional tests, such as the water washout and water spray off tests. Their conclusion was that this new test might be an even better indicator of grease water resistance. What makes the test used in this paper novel is that it uses chemical polar attractions as an indicator of water resistance instead of kinetic contact with moving water.

For testing the water resistance properties of the grease, the researchers developed a device that is capable of measuring the contact angle of a water drop on grease surface. Figure 1 shows the inner workings of the test device and how the configuration of the grease to the water droplet during testing.

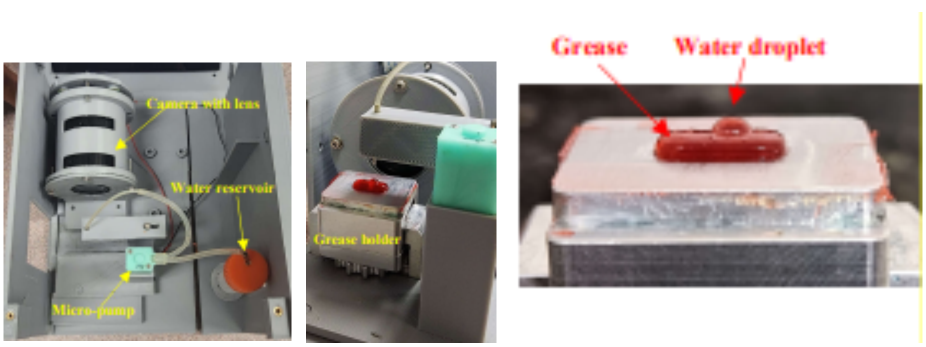


Figure 1

A camera in the device captures a video image of the water droplet on the surface of the grease. A graphical user interface (GUI) developed using Python software was used to process the images and determine the contact angles, as shown in Figure 2.

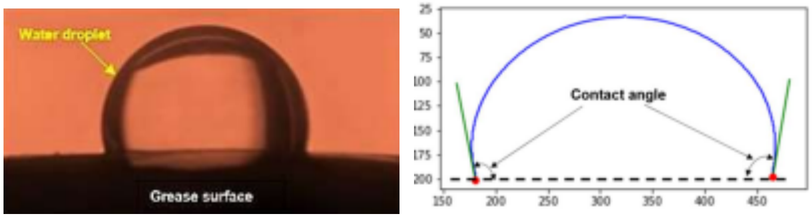


Figure 2

The team tested 16 greases of various base fluid types, base fluid viscosity, thickener type, and NLGI penetration grade. They also collected available data published by the manufacturers for various physical test parameters, including water washout and water spray off to use for correlation purposes. Unfortunately, data was not available for all samples, but based upon the ones that were available, their data correlated quite well. Also, they ran multiple runs on each sample to allow them to develop statistical comfort with their data.

Once all data was compiled, the team proposed a standardized 1-5 numerical grading system for water resistance of greases based upon the contact angle values; with grade 1 being grease with very poor water resistance up to grade 5 being grease with excellent water resistance. Table 1 provides their proposed grade ranges, contact angles associated with them and correlative water spray off and water washout data.

Table 1

Grades	Contact angle (°)	Water-resistance characterization
1	< 60°	Very Poor
2	60° – 70°	Poor
3	70° – 80°	Average
4	80° – 90°	Good
5	> 90°	Excellent

The group concluded that there could be various benefits of using this test as a replacement to ASTM D1264 and ASTM D4049. It provided additional benefits such as the smaller sample size needed, very good repeatability, less time to run a test, and a proposed quantitative grading range. Per Dr. Shah, Koehler instruments will be actively working with ASTM, ISO, and other standards organizations to evaluate it as a new standardized method in the future. Who knows, perhaps the NLGI grease certification specifications might include this test in the future. The paper can be read in its entirety using the following LINK (https://www.mdpi.com/2075-4442/11/10/440/html) to the MPDI website [1]. For additional exploration of the contact angle method applied to grease, you can refer to [2, 3].

Reference:

[1] Lijesh, Koottaparambil, Roger A. Miller, Raj Shah, Khosro Shirvani, and Michael M. Khonsari. "The Standard for Assessing Water Resistance Properties of Lubricating Grease Using Contact Angle Measurements." Lubricants 11, no. 10 (2023): 440. https://www.mdpi.com/2075-4442/11/10/440/html.

[2] Lijesh, K. P.; Khonsari, M. M.; Roger A. M. Assessment of water contamination on grease using the contact angle approach. Tribology Letters 2020, 68 (4), 1-12.

[3] Khonsari, M. M.; Lijesh, K. P.; Roger A. M.; Raj, S. Evaluating Grease Degradation through Contact Angle Approach. Lubricants 2021, 9(1), 11.

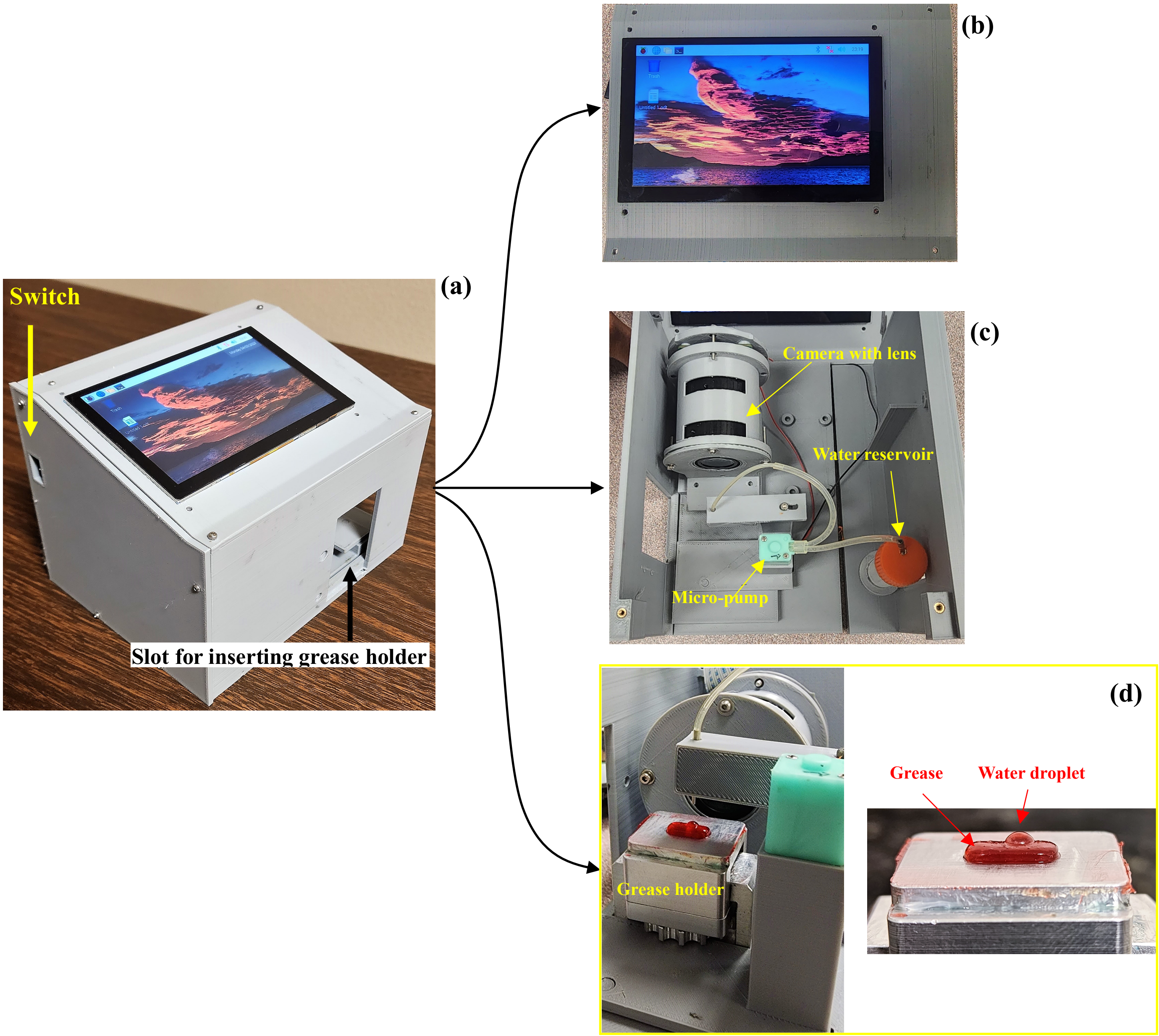
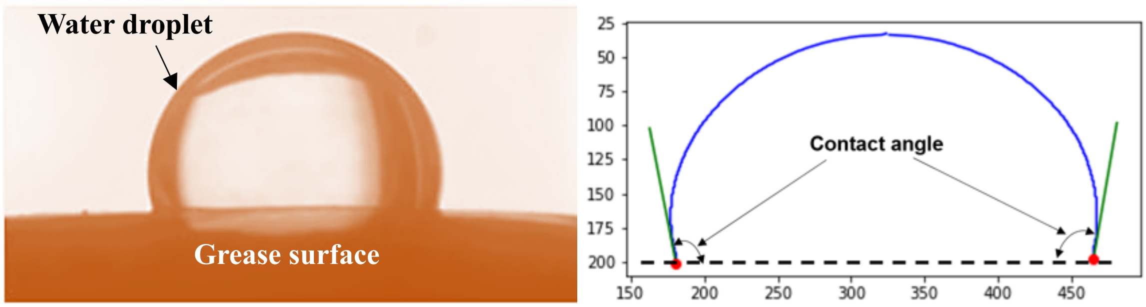


Figure 1. Custom-designed contact angle setup with their components. (a) isometric view of the contact angle setup, (b) display and microcontroller, (c) top view of the setup showing the camera and lens, micropump, and water reservoir, (d) grease holder with grease and water droplet



(**a**) (**b**)

Figure 2. Image processing of the water droplet to determine the contact angle. (**a**) image at 300 frames, (**b**) shape of droplet for analysis.