LUBRICATION TESTS

OVERVIEW

One of the challenges when investigating a lubricant application has to do with determining how much lubrication is needed. There are many different laboratory tests that can be run to evaluate the lubrication provided by a product. Some tests are simulative and others are more direct in providing data. However, none of these laboratory tests assess all the properties required of a product in an actual metalworking application.

New formulations are always compared to standard products that are known to provide sufficient lubrication at customer’s locations. The standard product defines the expected level of performance when testing a new technology.

DEFINITIONS

Lubrication tests are used to evaluate machining, grinding, drawing and stamping products. Lubrication plays a major role in their functions as far as providing enough lubrication to machine the part or stamp the part. While there are other characteristics, the level of lubrication has to be determined. Some tests focus on boundary lubrication while others provide information on extreme pressure lubrication.

TEST METHODS

CNC Machine Tools
Quaker uses several CNCs (computer numerically controlled) machine centers. They cover different types of testing. There are different capabilities with the machine tools. They have differences in the following areas:

» Axes of rotation
» Capabilities (automated vs. manual)
» Controllers
» Horse power
» Pressures
» Speeds
» Spindle capabilities
» Volume of lubricant

From this testing data, the lubrication can be compared from one product to another. The Development Laboratory has the capability of measuring different surfaces with profilometers. This data can tell the operator about surface finish and forces (drilling, reaming, etc.) with different products. There is also a computer program to determine wear on the tooling. One machine center has a dynamometer to measure downward force.

Sometimes a fresh lubricant can be compared to a used lubricant to determine how things have changed with time. This helps solve problems when a customer is having a specific lubrication problem. In some cases the CNC operator can use the customer’s tools in Quaker’s CNC. The customer’s part can be used on the CNC for the machining application. Using the customer’s part and tooling lets the customer see how the operation works outside of their operations. One unit contains an instrument that measures acoustic emissions. The acoustic emissions provide information on chatter of the tooling and some instability.
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Drawbead Simulator
This device measures the coefficient of friction and the bending deformation for the given lubricant and metal in a die cavity situation. This simulator lets you compare different products under the same loads. There is fixed compression force (load) between the test sample and the die. The test is the stretch-draw forming on large panels. Different types of metal can be run in the testing. The testing can also be set up to cause the lubrication to break down.

Falex Block on Ring Test Machine
This Falex test is called the Block on Ring Test Machine. This device measures the friction and wear characteristics of different lubricants. Like the Pin & V-Block, this method is tied to several ASTM methods (D2714, D2981, D3704, D2509 and G77). A block is put in place and a metallic ring spins on top of the block. There is variable load between the block and ring. The level of wear on the block is determined based on the scar. Again the scars for different lubricants are compared.

Falex Four-Ball Tester
The Falex Four Ball Tester can measure wear and extreme pressure lubrication. The Four Ball can run at different speeds. Three balls are brought together in a clamped fashion. The fourth ball sits on top of the three balls and rotates for a fixed period of time. The load on the 4th ball can be varied. The purpose of this testing is to compare lubrication by measuring the scar on the fourth ball. Measuring the scar on the fourth ball determines if the lubrication is higher or lower compared to other lubricants. ASTM methods D2266, D2783, D2596, D4172 and D5183 apply to this tester.

Falex Pin & V-Block
One of the standard tests is the Falex Pin & V-Block method. This method provides wear, average friction forces (measured in pounds) and extreme pressure properties of lubricants. This method is tied to many different ASTM methods (D2670, D2625, D3233 and D5620) as well as Chrysler (461-C-84-01, 461-C-84-02 and 461-C-84-03) and Ford methods (FMC-BJ1-1).

The unit is relatively easy to operate and collect data. This method lets the user compare one product to another. A steel journal is locked in place with a brass pin. Two V-blocks surround the journal while it rotates. The blocks apply increased pressure over time. The wear on the blocks can be measured to determine how much of the block was worn away.

There is also testing that is more specific for the extreme pressure testing (ASTM D3233). This test has two different methods to examine low, medium and high levels of extreme pressure testing.

Most metalworking fluids fall into the boundary lubrication. Most metalworking fluids utilize the standard 1137 steel journals and steel blocks. Other blocks and journals are available. Blocks can be weighed before and after to see how much of the block was removed. This is one way to compare fluids.
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Reciprocating Friction and Wear Test (RCP Tester)
The RCP lubrication test method measures sliding friction (boundary lubrication) and average coefficient of friction (COF) forces under stress at a certain speed. Depending upon the material being tested, the average roughness can be detected from the surfaces. The testing is conducted with a 52100 steel ball under pressure on the flat surface with a small measured amount of lubricant.

Different temperatures can be employed with the lubricants to simulate customer conditions under different loads.

Twist Compression Test
The Twist Compression Test (TCT) simulates lubricant starvation conditions in a metal forming operation. It is designed to test boundary and extreme pressure lubrication regimes. It provides information on the coefficient of friction and the conditions under which the lubrication breaks down. The unit tests lubricants under different pressures. This test measures the coefficient of friction as a rotating cylinder applies torque under pressure onto a lubricated surface. The testing is best for comparative evaluations. There are several types of wear that this unit can produce. The wear can be adhesive (cold welding), abrasive (hard surfaces), fatigue (spalling), chemical (reaction products) and mixed (any combination of the other types).

THIRD PARTY LABORATORIES
Quaker uses third party laboratories to determine specific parameters that Quaker is not permitted to do on their own. For example, the standard VOC Test Method (EPA Method 24) is determined by a third party laboratory. Some customers require specific tests for elements/compounds like mercury or phenol.

For example, aerospace customers utilize specific tests and certified test sites to run the tests to evaluate the supplier’s product. The testing tells the supplier that their product meets the aerospace specifications.

Automotive customers request suppliers to provide information on the oil content and source, the microbiological resistance, types of amines and other data specific to each product. They can also use other labs to compare different products to one another. The third party laboratory keeps the bias out of the decision making. Most automotive companies prefer to examine the CNC data.
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UNIVERSITIES
Quaker also works with different universities that have specific equipment in their machine shops as part of their curriculum. The testing is generally done with undergraduate and graduate students who are pursuing a study in these fields.

Specific parts are used with the lubricants. The universities have the capabilities to measure test pieces. The measurements are important to compare the different lubricants. Most students capture all of the information as part of their curriculum and make a final presentation to Quaker.

CONCLUSION
At some point the new product has to leave the laboratory and be tested in a customer’s application. Laboratory data is very helpful in choosing the correct product for these applications. Many times the chemist is on site to watch the performance of the new product and collect data.

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