

## TechTopics No. 99

### Special tests – type SDV7 distribution circuit breaker gearbox lubrication

This issue of TechTopics discusses the results of follow-on tests and studies performed on the type SDV7 distribution circuit breaker with stored-energy operating mechanism subsequent to the issuance of TechTopics No. 80 in 2011.

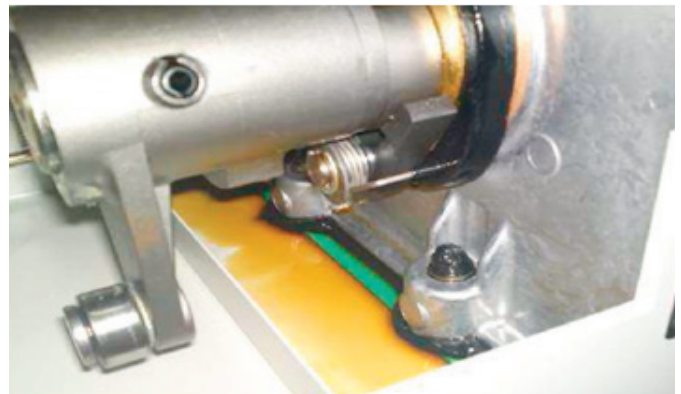
TechTopics No. 80 mentioned that a small amount of lubricant visible outside the gearbox is normal and not detrimental to the operation or the life expectancy of the type SDV7 circuit breaker. The circuit breaker incorporates a small “drip pan” to contain any lubricant that is released.

Subsequent to the original studies, reports of a few type SDV7 circuit breakers with stored-energy operating mechanism releasing more lubricant than the original tests revealed were received. This led to further investigations to validate the original view that the amount of lubricant released was not detrimental.

The photo below shows the gearbox in the type SDV7 circuit breaker stored-energy operator, and also shows the drip pan along with a portion of the gasketing system used on the bottom of the gearbox.



In the few cases that have been reported with more than a minimum amount of lubricant in the drip pan, the appearance of the unit is similar to that in the photo below.



Investigations of this leakage included tests by our lubricant supplier in an independent laboratory, as well as tests in our circuit breaker design global center of competence in Berlin, Germany, and in our design laboratories in Wendell, NC. Among the tests conducted were tests to determine how much oil might separate from the lubricant and be released, and to establish whether the release continues over time or stabilizes.

The tests conducted by the lubricant supplier were conducted in accordance with DIN 51817 (a German national standard), “Determination of Oil Separation from lubricating grease under static conditions”. This is somewhat similar to ASTM D1742 for oil separation in storage, but the DIN test is conducted with the lubricant under modest pressure instead of a simple storage condition.

The procedure is to cover the lubricant in a container with a tight-fitting "top" (actually a very fine metallic filter) such that any oil released from the lubricant can pass through the filter, allowing the amount of oil released to be measured.

One of the tests was conducted at a temperature of 70 °C with the test continuing for several weeks. A temperature of 70 °C is higher than the highest temperature expected to be experienced in the area of the operating mechanism of an outdoor circuit breaker even under the worst solar radiation conditions. Also, since the gearbox incorporates a means for equalizing pressure both inside and external to the gearbox, the lubricant is not exposed (during normal use) to the excessive pressure demonstrated during this test.

The chart below from this test shows that even under these extreme conditions (pressure and temperature), separation of oil from the lubricant stabilized at eight percent of the lubricant. The curve of oil separation over time became asymptotic at about one week, and changed very little after that. The supplier indicates that typical experience in automotive applications (the primary market for such lubricants) is in the area of two to seven percent.

The gearbox contains about 800 ml (about 1.7 pints) of lubricant. If the maximum separation of oil shown in the tests (eight percent) were experienced in a circuit breaker in service, this would be  $800 \text{ ml} \times 0.08 = 64 \text{ ml}$ . The open volume in the drip pan is about 200 ml, so even if the maximum amount of oil were to separate, it would be far less than the volume of the oil pan, and thus would not overflow.

In addition to the tests on the lubricant itself, circuit breaker operators with the maximum amount of oil that can separate from the gearbox already removed were subjected to tests under extreme conditions. These tests included endurance tests of over 30,000 operations (three times the published endurance of the operator, and fifteen times the ANSI/IEEE C37.06-2009 endurance requirement of 2,000 operations), with operational tests at temperatures ranging from +70 °C (158 °F) to -20 °C (-4 °F) and tests with contaminants added to the oil already in the drip pan. In every case, the gearbox and operating mechanism performed as normal.

The investigations have confirmed that the amount of oil that can separate from lubricant in the gearbox does not affect either the expected life of the mechanism or its operability. Therefore, we have confirmed that the maximum amount of oil that can separate is not a reason for concern.

