Combating Corrosion in Hydraulic System with Vappro VBCI 852 Hydraulic Oil Additive

Nelson Cheng[1] PhD (Honoris Causa), Patrick Moe[1] BSc, Grad Dip, MSc
[1]Magna International Pte Ltd
Singapore

Dr Benjamin Valdez Salas[2], Dr Michael Schorr[2]
[2]Autonomous University of Baja California

Abstract

Hydraulic fluid can be the most vital component of a hydraulic system. The demands placed on hydraulic systems constantly change as the industry requires greater efficiency and speed at higher operating temperatures and pressures. Maintaining the quality hydraulic fluids or hydraulic systems against corrosion and maintaining in its optimum operating conditions especially during mothballing or storage of the equipment are of paramount importance. Hydraulic reservoirs in mobile equipment, rigs, ships and military vehicles can be prone to corrosion when humid air is drawn in when the oil level drops. Once moist air gets into the reservoir, water can condense on the interior walls when causing it to oxidize and ultimately forming acids [1,2]. The said problems are more prone in tropical countries where relative humidity can reach a saturation point at times and the fluctuation of temperatures between day and night. Moisture contamination in hydraulic oils is conceivably one of the most detrimental forms of hydraulic system corrosion second only to particle contamination [3]. Water contamination in hydraulic oil can be classified into three forms of water; free, emulsified, and dissolved. All forms of water contamination not only have direct effect on the hydraulic oil, but indirect as well. Direct effects include changes in pH and viscosity which can be precarious in themselves [3]. Two potential corrosion problems must be considered: system rusting and acidic chemical corrosion. System rusting occurs when water carried by the fluid attacks ferrous metal parts. Most hydraulic fluids

contain contact rust inhibitors to protect against system rusting. However, in actual operations, the said inhibitors are not able to protect the hydraulic systems against corrosion especially in the event of leakages from the damaged seals. Vapor Corrosion Inhibitors (VCIs) need to be added into the hydraulic systems to remedy the said problem. In view of the above, Vappro VBCI 852 [12] Hydraulic Oil Additive was developed to combat corrosion in hydraulic systems. Hence a reliable test method is essential to ensure the functionality of the said additive. The German TL 8135-002 test method [4,5] has been adopted to ascertain the vapour inhibition corrosion properties of Vappro VBCI 852 [12] hydraulic oil additive and the details of the test is herein described in the test procedure of the journal.

Keywords:

Vappro 852 [12], Hydraulic Oil**,** VCI Hydraulic Oil Additive**,** Vapor Inhibition Ability, Corrosion Inhibition.

Introduction

Hydraulic and Transmission oil systems are susceptible to corrosion caused by condensation of humid air. The said problem is more prevalent in countries located in the tropical region, immobilizing machines, military equipment and vehicles.

Hydraulic supporting equipment used in many industries, such as, marine, offshore, shipping, oil and gas industries. Its reliability and life directly affect the quality of supporting underground. The level of chloride ion and moisture content in the transmission medium of electro-hydraulic controlling system is an important factor causing fault of hydraulic support. This article discusses the usage of Vappro VBCI 852 [12] Hydraulic oil additive to combat corrosion in hydraulic system.

A core component of a hydraulic system is the hydraulic fluid (mostly oil), which when degraded by heat, water or a chemical reaction leads to corrosion of some metals. Hydraulic reservoirs in offshore, military and mobile equipment are prone to corrosion due to humid air drawn in when the oil level drops. Once the air and moisture get into the reservoir, water can condense on the interior walls when the ambient temperature drops. The presence of air bubbles in the fluid can lead to excessive oxidation, cavitation, the reduction of lubricating properties of the oil and hydraulic system failure.

The condensate, ultimately, will enter the hydraulic system and pose several problems. The condensate will also adhere to the interior surfaces of the reservoir, which could lead to rust deposits that can also enter the hydraulic system. These deposits can cause problems of their own, including premature wear to components, clogging of filters and orifices, and valve malfunctions. In general, moisture is harmful to hydraulic

systems, with the exception of aqueous-type hydraulic fluids and the systems designed to utilize them.

Moisture enters waterproof containers through "breathing," which occurs when a container is exposed to wide temperature ranges. Hydraulic system needs corrosion prevention just like other systems [1] or even more so because they are driven by a fluid-compression technology through which systems transfer energy to one system to another with the exertion of force.

To combat corrosion in hydraulic system, anti-corrosion additives must be added. The said additives must also exhibit good stability in the presence of water (hydrolytic stability) to prevent break down and acidic attack on system metals. Over time, fluids oxidize and form acids, sludge, and varnish. Acids can attack system parts, particularly soft metals. Extended high-temperature operation and thermal cycling also encourage the formation of fluid decomposition products. The system should be designed to minimize these thermal problems, and the fluid should have additives that exhibit good thermal stability, inhibit oxidation, and neutralize acids as they form.

Vappro 852 [12] VBCI Hydraulic oil additive was developed to combat this major problem. It's an excellent product for protecting hydraulic and transmission systems against corrosion during long-term storage and thus enhancing the operational readiness of the military equipment and commercial equipment.

Vappro 852 [12] VBCI hydraulic oil additive is a free-flowing liquid specially developed to protect hydraulic and transmission systems from corrosion. Its proprietary amine compound offers excellent corrosion control for both ferrous and non-ferrous metals. Vappro 852 [12] VBCI hydraulic oil additive performs effectively even under adverse conditions of very high relative humidity and in the presence of chlorides and sulfur compounds. It contains no hazardous chromates, nitrites or phosphates. When added to hydraulic or transmission fluids, it enhances the corrosion inhibition characteristics, and does not cause any adverse effects on hydraulic hoses, seals and rubber components.

Vappro 852 [12] VBCI hydraulic oil additive is a type of vapor corrosion inhibitor that prevents the corrosion of metal substrates when combined with a gas or a liquid. The gas or liquid containing the said additive is applied to the material to reduce or eliminate the corrosive effects the material might otherwise have been subjected to.

Vappro 852 [12] VBCI hydraulic oil additive is applied to hydraulic system either to neutralize their corrosive abilities or to prevent a corrosive environment from reaching the material. Another function of Vappro VBCI 852 [12] is used to prevent fluid breakdown and the acid formation that causes corrosion. It possesses excellent hydrolytic stability in the presence of water.

Corrosion contributes an assortment of contamination and wear. Chemical reaction between iron and oxygen will result in rust, it occurs on account of the presence of moisture-carrying oxygen. Corrosion on the other hand is a chemical reaction between a metal and acid. Corrosion and rust tend to corrode away the hydraulic component material, causing malfunctioning and excessive leakage [6].

In view of the above, an international approved and reliable test method is essential to ensure the functionality of the Vappro 852 [12] VBCI hydraulic oil additive. The German TL 8135-002 test method [4,5] has been adopted to ascertain the vapour inhibition corrosion properties of Vappro VBCI 852 hydraulic oil additive and the details of the test are herein described below.

The German VIA Test method TL 8135-002. [7][8][9][10][11]

This method is used to determine the corrosion protection effect of VCI oil additives when added into mineral based hydraulic fluids on a defined test object of constructional steel.

A test sample with a high degree of sensitivity to corrosion through condensation water is packed together with a Vappro 852 VBCI Hydraulic Oil Additive in a vessel, which is then tightly closed. Condensation is then forced on the surface of the test sample. By means of a blank trial that is, a trial structure of the same type, but without VCI oil additive – it is determined whether the conditions of the trial are sufficient to cause corrosion to appear on the unprotected test sample.

Purpose
To evaluate the corrosion protection and Vapor Inhibition Ability properties of the Vappro VBCI 852 [12] Hydraulic Oil Additive.

Test Method Used
German test method TL 8135-002. This method is used to determine the corrosion protection effect of VCI auxiliary packing materials such as VCI emitter, VCI powder, VCI papers, VCI oil and VCI films on a defined test object of constructional steel.

Test object
4 pieces of unalloyed, solid construction steel.

Test Sample
50 ml of Hydraulic oil which contained 5% of Vappro 852 VBCI Hydraulic Oil Additive.

Test solution
10 ml freshly prepared glycerine/water mixture with a density of 1.076 g/cm^3 at (23±2) °C, which is intended to produce approximately 90% Relative Humidity in the jar.

Test Equipment and Material

For each test, 4 test sets are necessary. A test set consists of the following parts

(1) Test Jars, 1 L, wide-necked

(2) Rubber stopper, 54 mm Æ, with longitudinal through hole

(3) unalloyed, solid construction steel test objects

(4) 50 ml of Hydraulic oil with 5% Vappro 852 VBCI Hydraulic Oil Additive

(4) 10 millilitres freshly prepared glycerin/water mixture with a density of 1.076 g/cm^3 at (23± 2)°C (glycerin/water mass ratio about 1:2)

(5) Ethanol

Procedure of the test

Four test objects were polished with 320 grit abrasive paper to remove all the grit and rust. Rinsed with ethanol and dried them.

Polished test object was inserted into the rubber stopper. Please see below picture figure A.

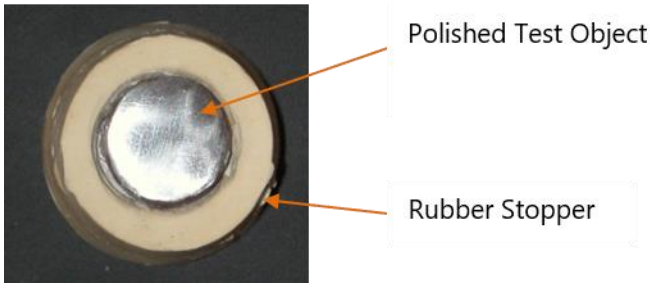


Figure A

Then rubber stopper was inserted to the test jar cover. A bottle of 50 ml Hydraulic oil with 5% Vappro 852 VBCI Hydraulic Oil Additive was placed in the jar. Then the test jar was closed with jar cover. Please see below picture figure B.

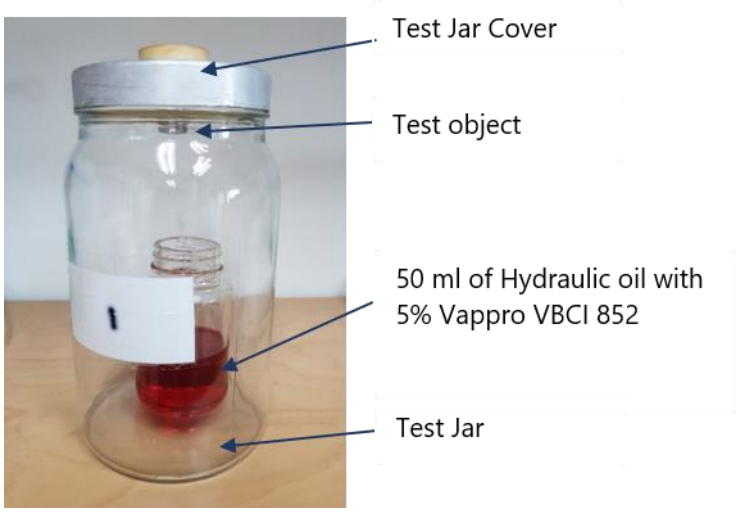


Figure B

For the blank sample, test jar was sealed without inserting the Hydraulic oil with 5% Vappro 852 VBCI Hydraulic Oil Additive. It had no VCI chemicals and it is only used as a control/ yardstick for the experiment. Please see below picture figure C.

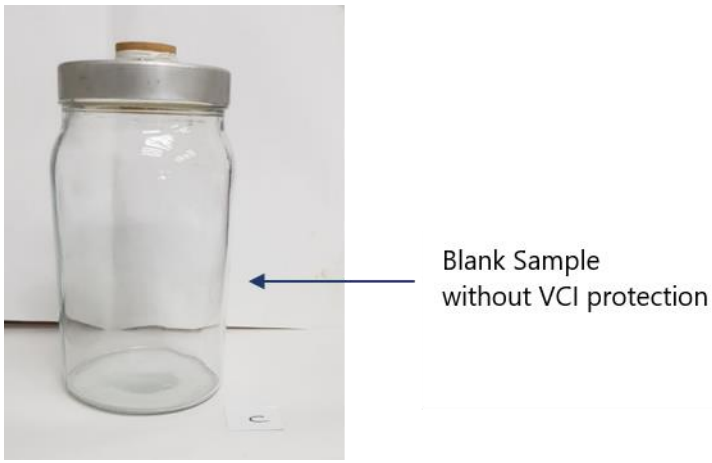


Figure C

The four test sets were stored for a period of (20±0.5) hours at a room temperature. At the end of the storage period, the jar covers were removed from the test jars, the freshly prepared 10 ml of the test solution, glycerine/water mixture, was poured into each jar immediately after opening, and the jars were immediately closed again. Please see below picture figure D.

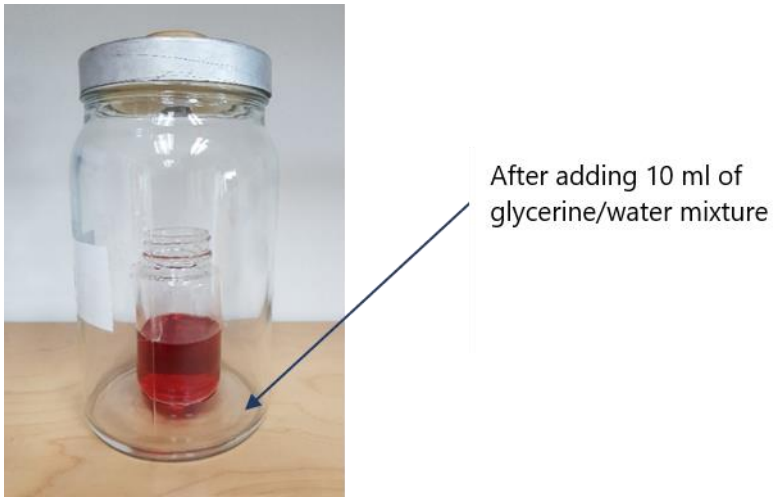


Figure D

After an additional 2 hours ± 10 minutes, the test jars were stored for a period of 2 hours ± 10 minutes in the heating chamber at temperature 40°C to create 90% Relative Humidity in test jars.
On conclusion of storage in the heating chamber, the test objects were disassembled from test jars and dried with warm air. Then inspected for any sign of corrosion on the sanded surface of the test objects from the four jars.

Test Result

The sanded surface of the test object from the blank sample was badly rusted. Please see below picture figure E.

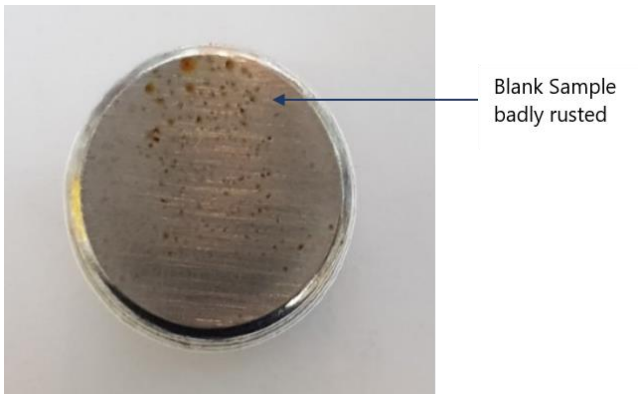


Figure E

No sign of corrosion was found on three test objects protected with Hydraulic oil with 5% Vappro 852 VBCI Hydraulic Oil Additive. Please see below picture figure F.

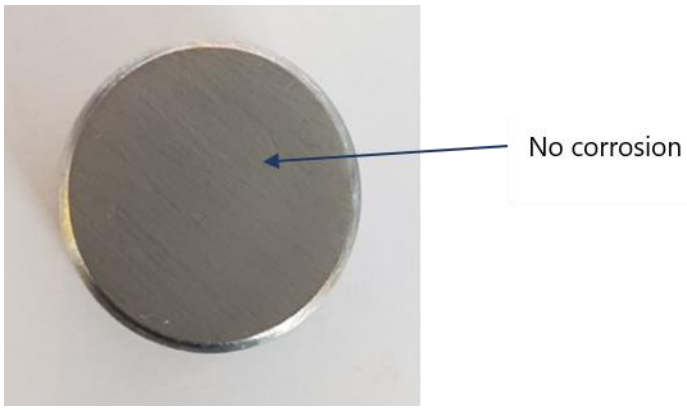
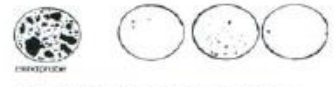


Figure F

The Requirement of TL 8135-0002 for the corrosion protection effect:

Evaluation of the test objects	Corrosion protection effect	
 Keine korrosionsschützende Wirkung	**None**	(Grade 0)
 Geringe korrosionsschützende Wirkung	**Slight**	(Grade 1)
 Mittlere korrosionsschützende Wirkung	**Middle**	(Grade 2)
 Gute korrosionsschützende Wirkung	**Good**	(Grade 3)

Blank Sample (Without VCI Film)	**Protected samples with Hydraulic oil which contained 5% Vappro 852 VBCI Hydraulic Oil Additive.**
	
Badly Rusted	**No visible corrosion was found on all three test objects**

Conclusion:

Based on the above the test result, Hydraulic oil with 5% Vappro 852 VBCI Hydraulic Oil Additive passed the Grade 3 German test method TL 8135-0002.

References:

[1] Rust and Corrosion Prevention Hydraulic Fluid | Engineers Edge ...
https://www.engineersedge.com/.../rust_corrosion_prevention_hydraulic_fluids.htm

[2] Causes of Corrosion in Hydraulic Systems | Mobile Hydraulic Specialties
mobilehydraulics.com.au/causes-of-corrosion-in-hydraulic-system

[3] Moisture in Oils: The Three-Headed Beast – AMETEK Arizona ...
https://www.azic.com/moisture-in-oils-the-three-headedbeast/

[4] https://wenku.baidu.com/view/218bb0cf0508763231121238.html

http://www.controlox.eu/wp-content/uploads/2017/05/BFSV-Test-Report-2430-17_kar_VCIfilm-Englisch_corrosion-protection-effect-TL-8135-0043_170412.pdf

[5] German Test Method TL 8135-002 DF] Appendix A German test method TL 8135-002 Testing of- E-ZAK VOP https://verejnezakazky.vop.cz/.../12759a42f0ee6e44-priloha-c-4- german-test-method-tl-

[6] Common causes for hydraulic system breakdownModern Industrial ...
www.modernhydraulics.net/common-hydraulic-system-breakdown.html

[7] German Test Method TL 8135-002 DF] Appendix A German test method TL 8135-002 Testing of- E-ZAK VOP https://verejnezakazky.vop.cz/.../12759a42f0ee6e44-priloha-c-4- german-test-method-tl-

[8] Paper 04418 - Cortec Corporation
https://www.cortecvci.com/Publications/Papers/VCIFundamentals/04418.pdf by AY Furman - 2004 - Cited by 4 - Related articles. The paper presents the example of such a program and the data of this study. Corrosion protection provided by VCI vs. distance from its source was evaluated by corrosion monitoring, utilizing metal coupons and Corrosometer with special probs. Keywords: Vapor corrosion inhibitor, corrosion tests, corrosion rate, corrosion ...

[9] Testing of VCI-papers in accordance with the Technical Terms of agris.fao.org/agris-search/search.do?recordID=DE19800582733 by A Duensing – 1980 Testing of VCI-papers in accordance with the Technical Terms of Delivery TL 8135-002 of the German Federal Armed Forces [packages for foods]. [1980]. Duensing A. Access the full text:

[10] TL 8135-002_百度文库
https://wenku.baidu.com/view/218bb0cf0508763231121238.html
Translate this page
Jul 1, 2017 - Appendix A German test method TL 8135-002 Testing of Anti-Corrosive Effect of VCI Auxiliary Packaging Materials A.1 Purpose and Area of Application A high humidity level in the air and/or condensation can lead to corrosion even in airtight materials, thereby rendering the materials unusable.

[11] German test method TL 8135-002 – GREENVCi:Anti Rust Plastic Bags ...
www.ถุงพลาสติกกันสนิม.com/.../german-test-method-tl-8135-0...
Translate this page Sep 28, 2015 สำหรับบรรจุภัณฑ์ป้องกันสนิมหรือ VCi Packaging ซง_ีในทน_ีจ!ีะกล่าวรวมทัง!พลาสติกกันสนิม(VCiFilm)และกระดาษ(VCIPaper)โดยในวันนท!ีาง ทีมงานENDUPAKขอนำเสนอขบวนการทดสอบความสามารถในการป้องกันสนิมของบรรจุภัณฑ์ป้องกันสนิม (Anti-Corrosion Packaging) ตามมาตรฐานของGerman test method TL 8135-002

[12] VAPPRO 852 - Vappro Corrosion Control Australia
https://www.vapprocorrosioncontrol.com.au/index.php/products/vci.../205-vappro-85...