Vappro VBCI MBR 1000 Masterbatch Polyethylene Resin for Extruding Anti-Corrosion PE Film, Shrink Film and Stretch Film.

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Abstract

Normal Polyethylene (PE) Film, Shrink Film and Stretch Film are used widely for packaging for both domestic and industrial applications. They are extensively used in conjunction with anti-corrosion oils and anti-corrosion coatings for packaging different types of machinery, auto-parts, pumps, metallic components and etc against atmospheric corrosive elements and moisture. Hence, industrial solvents, cleaners and degreasers need to be employed to remove the said anti-corrosion products resulting in generation of industrial waste, costly waste-disposable, and emitting of unnecessary volatile organic compound (VOC). The current method used of PE Film with anti-corrosion oils and coatings is not an environmentally friendly approach as it increases carbon footprint.

In view of Global warming, there is an urgent need to replace the current method of the usage of PE film for industrial packaging by eliminating the usage of anti-corrosion oils, coatings, industrial solvents, cleaners and degreasers.

Hence, Vappro VBCI MBR 1000 Resin was developed to solve the said problems with the environment in mind. This article entails the details of the usage of Vappro VBCI MBR 1000, its formulation and dosages for extruding it into Vappro VBCI 826 PE Film, Vappro 826S Shrink Film, Vappro VBCI 825 Stretch Film, and the German Test Method TL 81305-002 used to evaluate the Vapor Inhibition Ability of the extruded films.

Keywords

PE Film, Shrink Film, Stretch Film, VOC, Global Warming, Anti-Corrosion, Masterbatch resins.

Introduction

Global warming is the current increase in temperature of the Earth's surface (both land and water) as well as it's atmosphere [1]. Average temperatures around the world have risen by 0.75°C (1.4°F) over the last 100 years about two thirds of this increase has occurred since 1975 [2,3]. In the past, when the Earth experienced increases in temperature it was the result of natural causes but today it is being caused by the accumulation of greenhouse gases in the atmosphere produced by human activities [4].

The natural greenhouse effect maintains the Earth's temperature at a safe level making it possible for humans and many other lifeforms to exist [5]. However, since the Industrial Revolution human activities have significantly enhanced the greenhouse effect causing the Earth's average temperature to rise by almost 1°C. This is creating the global warming we see today. To put this increase in perspective it is important to understand that during the last ice age, a period of massive climate change, the average temperature change around the globe was only about 5°C [6,7].

A long series of scientific research and international studies has shown, with more than 90% certainty, that this increase in overall temperatures is due to the greenhouse gases produced by humans [8]. Activities such as deforestation and the burning of fossil fuels are the main sources of these emissions. These findings are recognized by the national science academies of all the major industrialized countries [9].

Global warming is affecting many places around the world. It is accelerating the melting of ice sheets, permafrost and glaciers which is causing average sea levels to rise [10,11] It is also changing precipitation and weather patterns in many different places, making some places dryer, with more intense periods of drought and at the same time making other places wetter, with stronger storms and increased flooding [12,13] These changes have affected both nature as well as human society and will continue to have increasingly worse effects if greenhouse gas emissions continue to grow at the same pace as today.

In view of Global warming, there is a need to reduce the said emissions, and an urgent need to offer an alternative to normal PE film and its hydrocarbon-based ant-corrosion

oils and coatings. Vappro VBCI MBR 1000 PE Resin was birthed as a result to replace current conventional PE Film.

What is Vappro VBCI 1000 MBR Resins

Vappro VBCI-MBR1000 [14,15] is a low-density polyethylene VBCI additive resin. It contains a proprietary multi-metal corrosion protection chemical compound and is used as a masterbatch additive for the production of VapproVBCI-826 V.C.I. Film, Vappro VBCI 826 S Shrink Film and Vappro VBCI 825 Stretch Film. Vappro VBCI-MBR1000 masterbatch additive when formulated with LDPE resin, will enhance constant corrosion protection for both ferrous and non-ferrous metals. It is currently being used for the production of VBCI and VCI polyethylene films, bags and sheets. Packaging film extruded from Vappro VBCI MBR 1000 Resin is widely used for packaging large and irregular shaped equipment, components, engine parts against corrosion for both the commercial and military sectors.

Depending on the plastic carrier used, it is also used for the production of VBCI Corrugated Plastic Containers, VBCI Injection Molded Parts and etc. It has almost endless formulation applications. With the introduction of VapproVBCI-MBR1000, VBCI Film can be produced at a very competitive price anywhere in the world.

The standard masterbatch of VapproVBCI-MBR1000 [14,15]is supplied in colorless pellet form or a long with blue and green pigment. The pellets are added to a film formulation at 3% - 5% by weight ratios. The final VBCI Film extruded will provide long term corrosion inhibiting properties, meeting and satisfying all industrial standards.

By extrusion either with a single or twin-screw extrusion machine. The mixing ratios is 3% - 5% by weight depending of the thickness of the extruded film. By means of a rotating mixer, mix VapproVBCI-MBR1000 masterbatch resin with the normal PE plastic resin for about 15 minutes. Once it is thoroughly mixed, put the said mixture into the hopper of the extruder for extrusion into film. We would like to recommend that virgin P.E. resin should be used for trial production and if necessary, modifications are made to provide for any additional properties needed.

Vappro VBCI MBR 1000 Resin is listed in the NATO MCRL (Master Cross Reference List) with assigned NATO STOCK NUMBER: 6850-32-076-9483. A NATO Stock Number, or National Stock Number (NSN) as it is known in the US, is a 13-digit numeric code, identifying all the 'standardized material items of supply' as they have been recognized by all NATO countries including United States Department of Defence [16,17,18].

Vappro VBCI MBR 1000 Resin Extruded into Vappro VBCI 826 Film

Vappro VBCI 826 PE 3 mils thick film [19,20] is extruded from VBCI MBR 1000 at a letdown rate of 4% by weight and 95% of normal LDPE resin by weight.
Vappro VBCI 826 is a significant breakthrough in protective packaging technology. It offers a new concept in product protection without the need for rust preventative coatings [19,20]. Vappro VBCI 826 offers protection for aluminum alloys and copper while providing excellent protection for ferrous metals, steel, and stainless steel. Vappro 826 does not change critical electrical or mechanical properties of electronic or electrical components.

It is heat sealable with standard equipment. However, bags or sheets can be tied, folded, taped or stapled for protection equivalent to a heat sealable enclosure.
Does not have to be in contact with metal to protect, the vapors travel to all portions of the enclosure. Eliminates the need for expensive and messy greasing procedures.

The film is transparent. Protected product is visible at all times. It has no coating of chemicals to flake off, stick to or otherwise damage or soil products. Protects when used in conjunction with acid bearing packaging materials, e.g. corrugated board, chipboard, wood, etc. Rough handling does not impair chemical effectiveness. Inhibitors will not affect any electrical or mechanical properties of a packaged item. No special handling is required. Available from stock in popular bag, sheeting and tubing sizes. Has a long life. Can be supplied in special sizes and forms to meet specific needs [19,20]

Vappro 826 protects ferrous and non-ferrous metals by placing the metal in a bag or by wrapping the metal with sheeting and then condenses on all metal surfaces, reaching every part of the metal surface, including recessed areas [19,20]. Method of application-
Insert product in bag or pouch and close securely to prevent entry of moisture or air. When using VCI sheeting, product should be completely wrapped or shrouded to prevent entry of moisture or air [19,20].

Vappro VBCI MBR 1000 Resin Extruded into Vappro 826S Heat Shrink Film

Vappro VBCI MBR 1000 Resin can be used for the extrusion of Vappro VBCI 826S heat shrink film. The letdown rate of 3% by weight of VBCI MBR 1000 Resin should be sufficient for 6 mils thick VBCI shrink Film. The said extruded shrink film emits VCI Vapor corrosion inhibitors into the surrounding enclosure. The released vapor deposits on the metal surface and forms a protective mono-ionic layer which provides protection to the packaged parts from corrosion. It thus enables effective and long-term protection of

ferrous and non-ferrous metals against corrosion /oxidation and tarnishing under adverse conditions including contaminants in air such as hydrogen sulphide, sulphur dioxide, ammonia or acid rain. Vappro VCI vapors easily migrate to hard to reach areas like drilled holes, crevices etc. and give effective protection [20].

Vappro VBCI MBR 1000 Resin Extruded into Vappro 825 VBCI Stretch Film

Vappro VBCI MBR 1000 Resin can be used to extrude into Vappro 825 VBCI Stretch Film [21,22]. The let downrate of Vappro VBCI MBR 1000 Resin is 5% by weight for 1 mil thick of Vappro VBCI 825 Stretch Film. Vappro 825 VBCI Stretch Film is specially developed for Corrosion Protection of ferrous and non-ferrous metals. It protects metals through vapor action and contact corrosion inhibitors. The VCI vaporizes and then deposits on all metal surfaces, reaching every part of the package, including recessed areas. Sealing your product in Vappro 825 VCI Stretch Film protects metal parts from all types of corrosion including rust, tarnish, stains, water spots, white rust and oxidation. You can now eliminate expensive rust preventatives, processing equipment, and labor cost. Vappro 825 VCI Stretch Film replaces conventional rust preventatives and desiccants. You save even more because Vappro 825 VBC Stretch Film packaging eliminates all the degreasing or coating removal required in the past. It is environmentally acceptable for use and improves health safety, compared with traditional corrosion inhibitors [21,22].

Chemical Compounds Used in Conventional VCIs Masterbatch Resin.

Ammonia was used as a VCI compound to protect immersed and exposed parts of steam boiler circuits at the beginning of the 20th century. By the 1940s, less odorous, safer and more effective substances were used for protection. Chemicals such as dicyclohexyl ammonium nitrite (DCHN) and cyclohexylamine carbonate (CHC) are just some examples.

The Vappro VBCI MBR 1000 Resin developed by Magna International uses amine carboxylate as the inhibitor. It is a salt synthesized by neutralizing carboxylic acid with a blend of amines.

Method for Ascertaining Corrosion Inhibition Properties of Vappro 826 VCI Film using German TL 8135-002 Test Method

After Vappro VBCI MBR 1000 Resin has been extruded into VBCI PE Film, Shrink Film and Stretch Film, the said films will be subject to German Test Method TL 8135-002

[23,24,25] to ascertain their Vapor Inhibition Ability Properties. It is of paramount importance for VBCI/VCI Film products to pass the said test.

Volatile corrosion inhibitor (VCI) provides protection for metal surfaces. VCI Ions attach themselves to metal. The usage of VBCI/ VCI PE film, Shrink Film and Stretch Film to protect equipment and metallic parts from corrosion during storage or shipping has been globally accepted now than ever before. Corrosion is a multi-billion dollars problem globally, as such, ascertaining the vapor corrosion inhibition properties of VCI film is of paramount importance to all manufacturers.

In view of the above, a reliable test method is of paramount importance. The German TL 8135-002 test method has been adopted to ascertain the vapor inhibition corrosion properties of 3mils thick Vappro 826 VCI Film.

Corrosion refers to the degradation or deterioration of materials on the metal surface. It has always been problematic to metal constructs and tools as degradation or rusting of metals can lead to a weakening of mechanical properties, thereby weakening them. Replacing them outright is expensive and, with resources on Earth becoming more limited, problematic in the long run.

Thus, protecting metallic constructs from corrosion is desirable as it is cheaper than replacing the part entirely and prolongs the working life of the product in the field, with many methods to do so currently available such as galvanization and sacrificial metals. One of the most common methods is using volatile corrosion inhibitors (VCIs), which is what this study is about.

They are a class of corrosion inhibiting compounds with a finite vapor pressure where the inhibitors are transported to the target metal through space to condense on the metal surface to form a protective film, lowering the corrosion rate of the metal itself. Factors that determine the efficiency of VCIs are the concentration of VCI compounds, the period of exposure and vapor pressure.

The main advantages are that it is easy to use and apply VCI onto the metal product and it is able to reach crevices, blind holes and other ‘difficult to reach areas. Limitations include being temporary films as they can be removed easily, are used at fairly low concentrations and a higher concentration is needed for the self-healing effect which could increase the cost of using it and corrosion protection may not be the only requirement, with others such as color limitation and film hardness needed. It is due to these factors that they are largely ignored in industrial maintenance coatings. However, alongside corrosion-resistant materials and corrosion protection coatings, corrosion

inhibitors are still researched and developed to further lower corrosion rates and to reduce the costs of corrosion.

Purpose of Using German Test Method TL8135-002

To evaluate the corrosion protection properties of the Vappro VBCI 826 film extruded from

Test Method Used

German test method TL 8135-002. This method is used to determine the corrosion protection effect of VCI papers and films on a defined test object of constructional steel.

Principle of the test method

A test sample with a high degree of sensitivity to corrosion through condensation water is packed together with a VCI auxiliary packing material 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 auxiliary packing material – it is determined whether the conditions of the trial are sufficient to cause corrosion to appear on the unprotected test sample.

Test object

4 pieces of unalloyed, solid construction steel.

Test Sample

Vappro 826 VCI film was cut into 6 strips of 2.5 cm x 15 cm of VCI film.

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 Jar, 1 L, wide-necked.

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

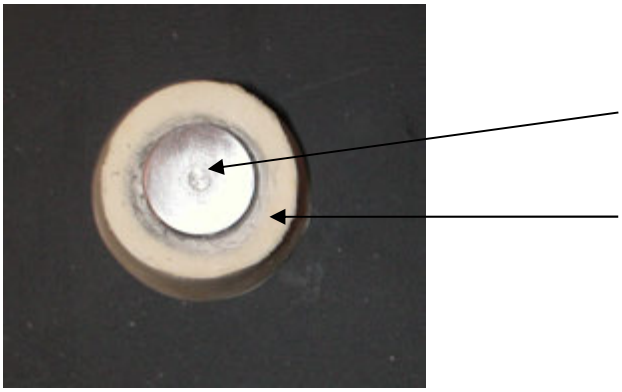
(3) Test sample of unalloyed, solid construction steel

(4) 10 millilitres freshly prepared glycerin/water mixture with a density of 1.076 g/cm3 at (23± 2) °C (glycerin/water mass ratio about 1:2)
(5) Ethanol

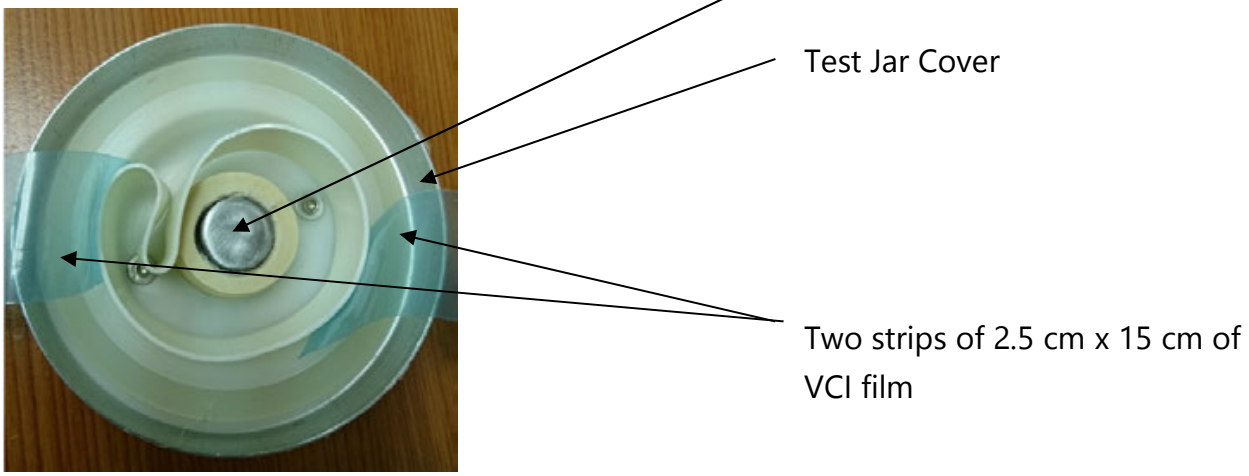
Procedure of the test

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

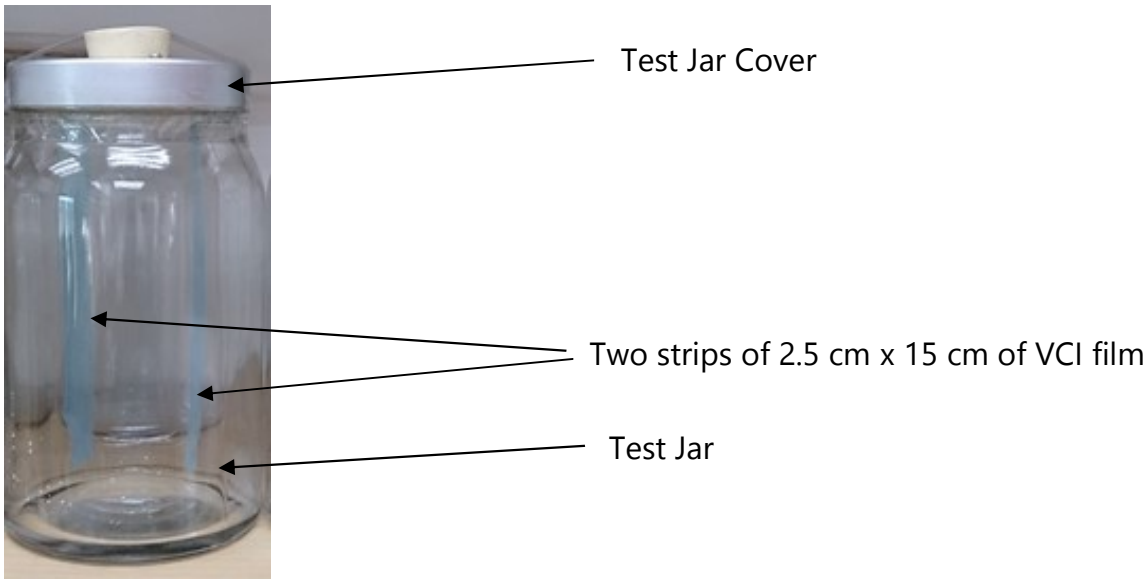
Polished test object was inserted in the rubber stopper. Please see below picture.



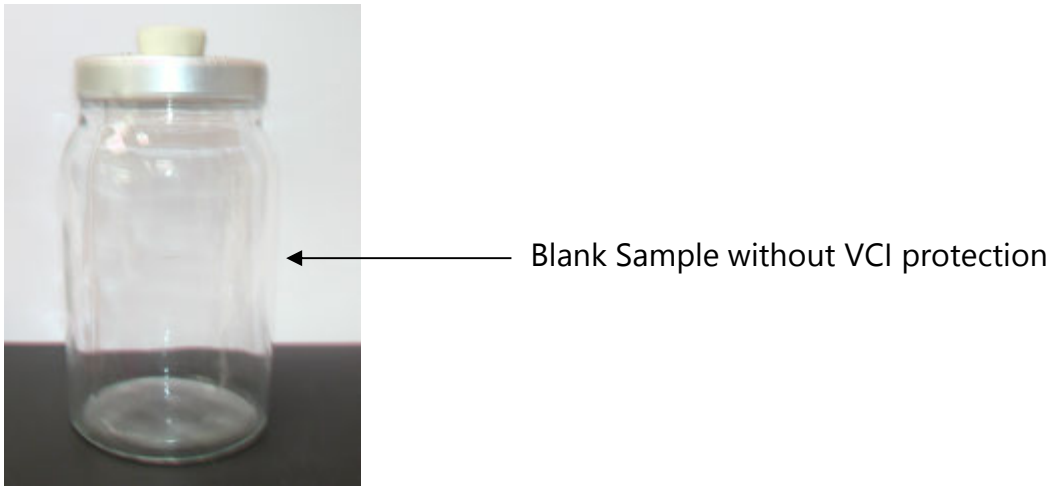
Then rubber stopper was inserted to the test jar cover. Two strips of 2.5 cm x 15 cm of test samples were attached with test jar cover. Please see below picture.



The test jar was closed with jar cover. Please see below picture.



For blank sample, test jar was sealed without inserting two strips of test samples. It had no VCI chemicals and it is only used as a control/ yardstick for the experiment. Please see below picture.

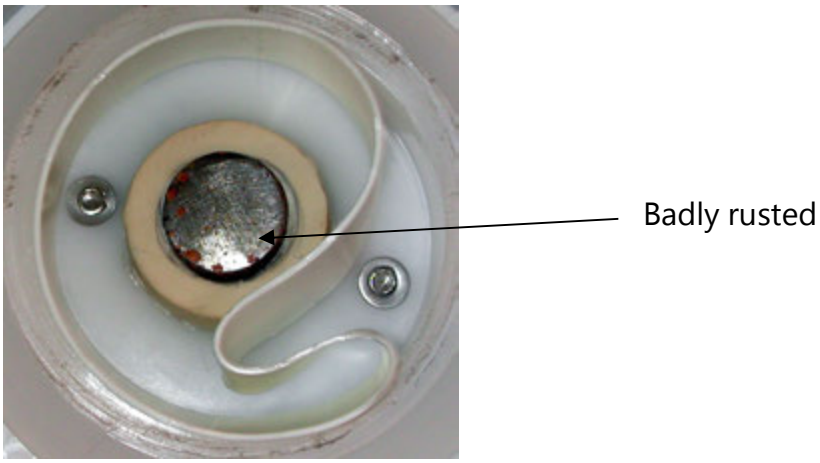


The four test sets were stored for a period of (20±0.5) hours at a room temperature. At the end of the storage period, the jar covers were removed from the test jars, the freshly

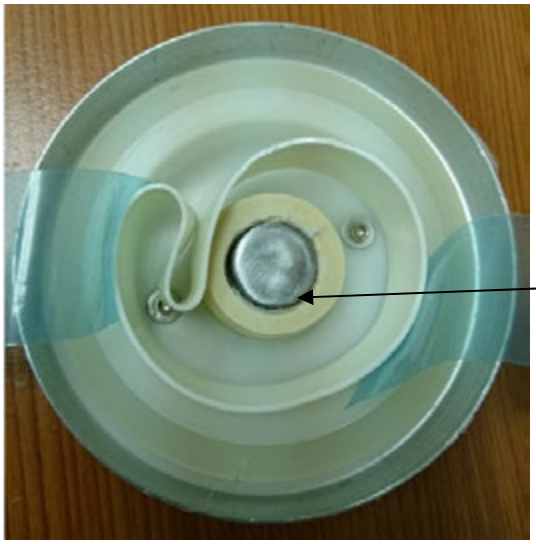
prepared 10 ml of test solution, glycerine/water mixture, was poured into each jar immediately after opening, and the jars were immediately closed again
After an additional 2 hours ± 10 minutes, the test jars were stored for a period of 2 hours ± 10 minutes in the heating chamber at temperature 40°C to create 90% Relative Humidity in the both 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 any sign of corrosion on the sanded surface of the test objects from the four jars.

Test Result

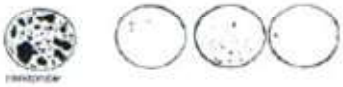
Sanded surface of the test object from blank sample was badly rusted. Please see below picture.



No sign of corrosion was found on three test objects protected with Vappro 826 VCI film. Please see below picture.



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)

Conclusion:

Blank Sample (Without VCI Film)	Protected samples with Vappro 826 VBCI film extruded from Vappro VBCI MBR 1000 Resin.
	
Badly Rusted	No visible corrosion was found on all three test objects

Based on above the test result, Vappro VBCI 826 Film extruded from Vappro VBCI MBR 1000 Resin passed the Grade 3 German test method TL 8135-0002.

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