

Pioneering **CLEAN** solutions
from our planet, for our planet.



FerroShield™ HC

*A New Product that Brings to you Superior Corrosion
Inhibition and Peace of Mind for MWF*

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VP, Global Sales and Marketing
May 23, 2017



Agenda

- Introduction
- Verdezyne Company and Technology Overview
- Product Development Journey
 - Metalworking fluid industry gap
- Product Quality
 - Customer feedback
- Summary
- Q & A

Verdezyne Company and Technology Overview



Verdezyne Story

A synthetic biotechnology company



Investors



2010

- POC for Adipic Acid & DDDA



2014

- Site selected for 1st DDDA plant



Founded in 2008

- Biotech
- Private
- 71 employees
- Carlsbad, CA



2012

- World's first biobased N6,6 fiber
- Pilot scale; ADA and DDDA
- Sold cellulosic ethanol technology to DuPont



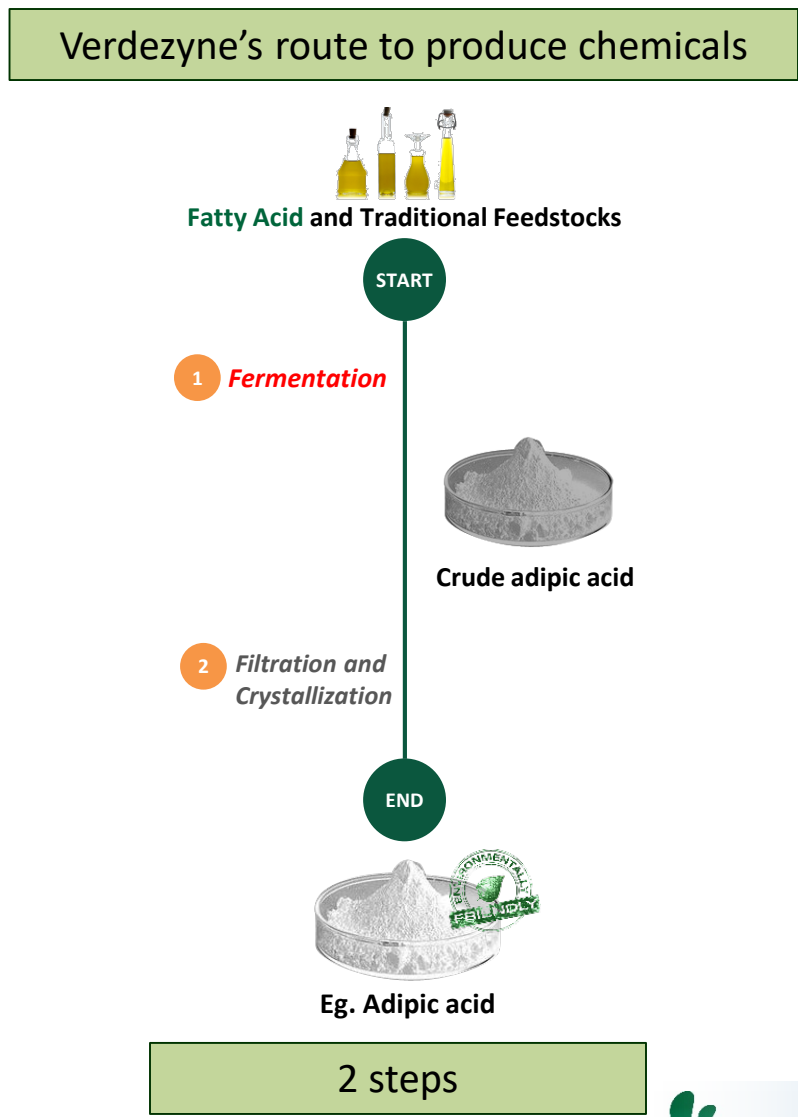
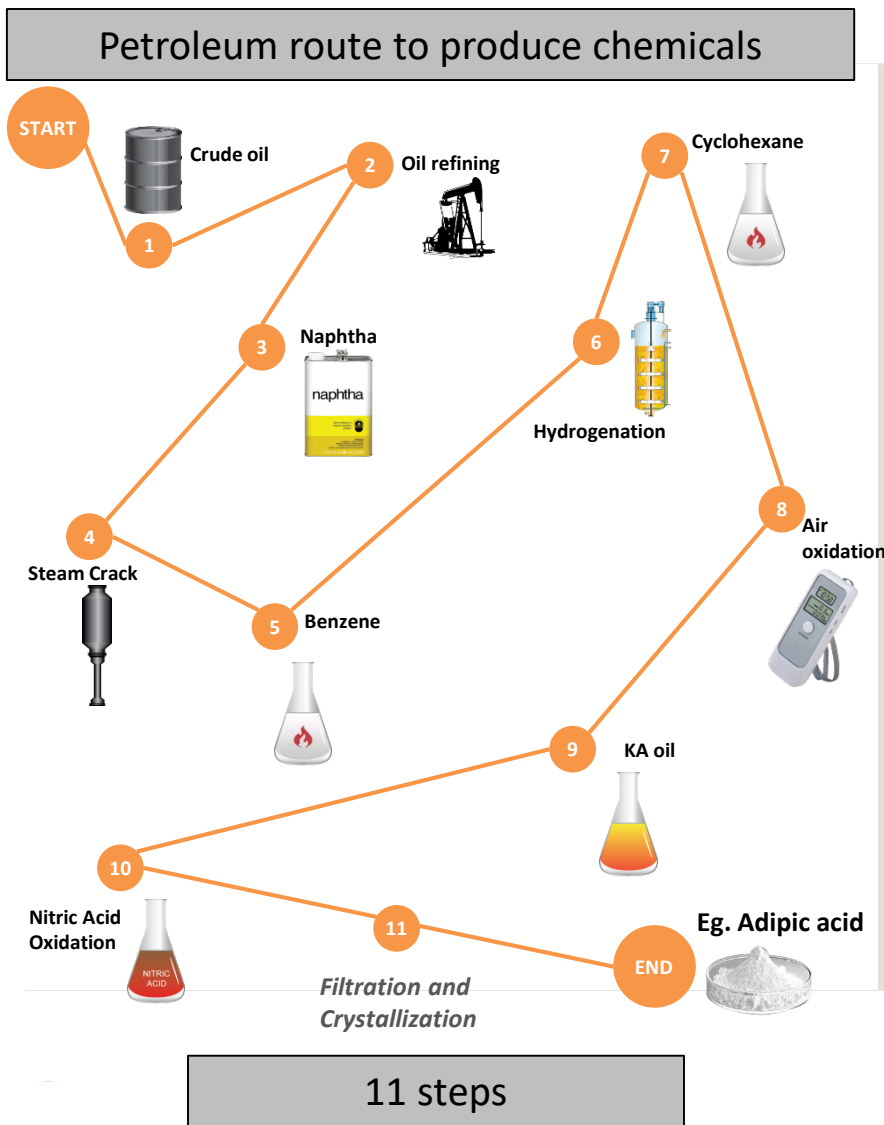
2017

- Launched FerroShield HC
- DDDA Groundbreaking



What We Do: Simplify the Chemical Production Process

The **Verdezyne way**: fewer steps, lower volume to reach economies of scale, simplified supply chain

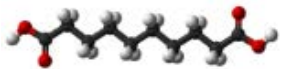


Providing Markets with Eco-Friendly Alternatives

Bio-Adipic acid



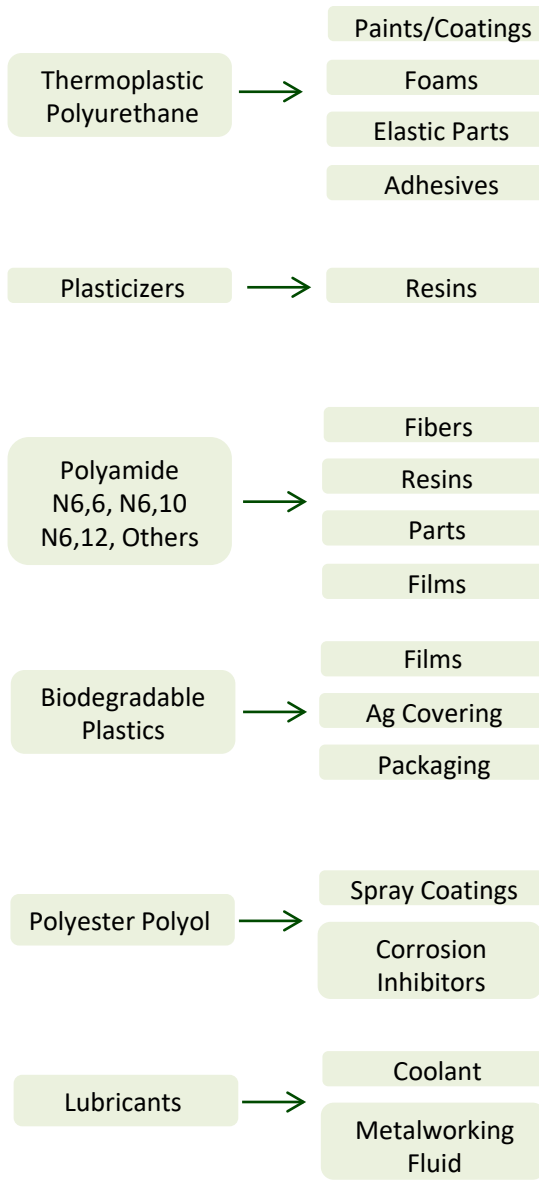
Bio-Sebacic acid



Bio-Dodecanedioic acid

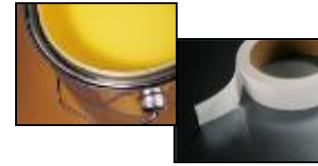


Mixed diacids



Industrial

- commercial carpet
- paints
- coatings
- adhesives
- lubricants



Automotive

- Seats and dashboards
- Tire cord
- lubricants
- belts and hoses



Home

- carpets
- upholstery
- furniture



Recreation

- footwear
- apparel
- camping gear



Personal

- packaging
- cosmetics
- fragrance
- flavorings



Verdezyne's Proprietary Platform

Engineering Organisms & Processes for Cost-effective Renewable Chemicals

Feedstock Strategy



- Non-food plant oils
- Soap stocks, distillates, and fatty acids
- Other oil co-products (i.e. PKO, PFAD)

Can use fatty acid and traditional feedstocks to produce chemicals

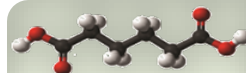
Proprietary Technology



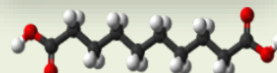
- Organisms engineered for yield and selectivity
- Fermentation-based production
- Highest quality products

Robust yeast platform using industrial fermentation methods

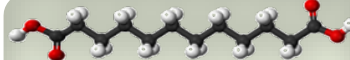
Chemical Intermediates



Bio-Adipic Acid



Bio-Sebacic Acid



Bio-Dodecanedioic Acid

- Diacids used in fibers, polymers and coatings
- Diamines and diols from diacids
- Acrylic intermediates

Total \$70B+ Market

End-Products



- Nylon and polyesters
- Fibers
- Polyurethanes
- Engineered plastics
- Resins
- Lubricants
- Coatings
- Adhesives
- Corrosion inhibitors
- Transparent Thermoplastics

Total \$1.5T+ Market

Unique Conversion Technologies – flexible feedstocks

Multiple Sources



- Canola
- Soybean
- Jatropha
- Palm
- Corn
- Coconut
- Tallow
- Peanut
- Biodiesel
- Tall Oil
- Petroleum
- Waste water

Feedstocks Tested

- Oleic Acid
- Canola Acidulated Soap Stock
- Canola Soap stock
- VOP Residue
- Residue-P003
- Soap Stock
- Acidulated Soap Stock
- Mixed Fatty Acid
- Soy Fatty Acid
- Corn Oil
- Soy Methyl Ester
- Canola Methyl Ester
- Tallow
- Yellow Grease
- Jatropha Oil
- Acidulated Soy Soap Stock
- Peanut Oil Distillate
- Trap Oil
- Brown Grease
- Fatty Acid Methyl Ester
- PKO
- C16/C18 Fatty Acid Methyl Ester
- Methylated PFAD
- Ethylated PFAD
- Propylated PFAD
- Crude Palm Oil
- Sludge Condensate Oil
- Esterified residue P and E
- Ethyl stearate
- Tall Oil Fatty Acid
- Methyl Laurate
- Ethyl Laurate
- Lauric Acid
- Methyl Myristate
- Decane
- Dodecane
- Tridecane
- Tetradecane
- Ethyl Decanoate
- Methyl Decanoate
- Waste Sludge Oil
- Corn Oil
- Bleaching Clay Oil
- CNO
- Decanoic acid
- Sludge palm oil
- Linoleic acid
- Fatty acid residue A
- Methyl Pentadecanoate
- PKOFAD

Conversion Technologies

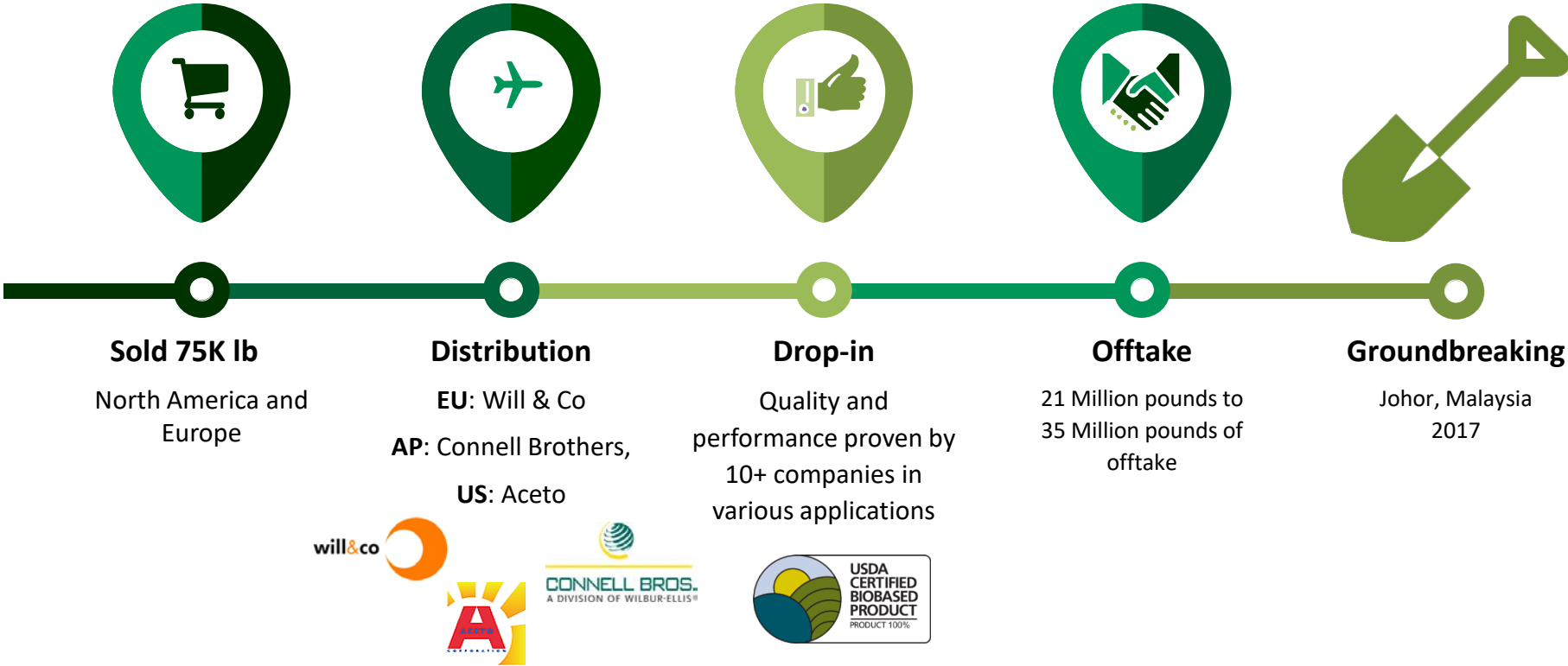


Eco-Friendly Chemicals Produced

- Dodecanedioic Acid**
- Adipic Acid
- Suberic Acid
- Sebacic Acid
- C14 diacid
- C18 diacid
- Mixed diacid

DDDA Commercial Program

Offtake Visibility



FerroShield™ HC Product Development



What started the development program?

- Jan 2016 – Announcement of possible shutdown by Invista, the largest mixed diacids supplier of corrosion inhibitor for the Metal Working Fluid (MWF) market
- Feb 2016 – Product and Market Development Programs commenced at Verdezyne
- Mar 2016 – INVISTA shutdown their DDDA and Corfree M1 plant

Market was urgently seeking alternatives for Corfree M1 replacement.

Voice of Customers

- 1:1 replacement at same cost and performance
- Continuity with existing product lines
- Long-term supply plan
- Desired properties:
 - Lubricity
 - Corrosion protection
 - Hard Water Stability
 - Compatibility with other components
- Other tests; acid value, total alkalinity, and pH

**Customers evaluation time -
as short as 24 hours to less than a month!**

FerroShield Product Development

- DOE methodology was used to accelerate development
- Determined optimal formula that delivers high corrosion inhibition and minimizes hard water precipitation
- Built in-house protocols for corrosion inhibition and precipitation testing
- Formula validated by independent laboratories and market development partners

Testing Parameters

Metal Working Fluid (MWF) solution:

- Stock solution;
 - FerroShield HC at 30%
 - Amine (Triethanol Amine) 50%
 - DI water 20%
- Diluted with 400 to 1000 PPM synthetic hard water (3:1 Ca:Mg) to 2, 2.5 and 3% concentration
- MWF Solution heated to 50°C to expedite the dissolution - optional
- Mix by shaking
- pH was not adjusted

Corrosion Inhibition

Testing

ASTM D4627 - Standard Test Method for Iron Chip Corrosion for Water–Miscible Metalworking Fluids

- FerroShield MWF stock solution diluted to: 2%, 2.5% and 3%

Results

- FerroShield HC performs better or equal to “Competitor” even at 2%
- Results confirmed by Market Development Partners (MDPs)

FerroShield HC Competitor

2% MWF

2.5% MWF

3% MWF



Hard water stability - Precipitation

Testing

- MWF made with ~400 PPM synthetic hard water (3:1 Ca:Mg)
- Used higher concentration of 5% stock solution

Results

- FerroShield HC – no precipitation
- Competitor – slight precipitation
- Results confirmed by MDP

Precipitate



FerroShield™ HC Product Quality



Product Quality Feedback

- Market Development Partner I for MWF – Dec 14, 2016
 - Results are promising with improved hard water stability at 400 ppm
 - Comparable ferrous corrosion protection to PureMix II per ASTM D4627 (CIC Test)**“Verdezyne approved as vendor as alternate source”**
- Market Development Partner II for MWF and Coolant – Dec 20, 2016
 - Results passed DIN 51360-2, testing of cooling lubricants, compared to DDDA, AC12 (Additive Chemie Luers GmbH) and Triazinetricarboxylic Acid (TC 50)**“FerroShield is excellent as a corrosion inhibitor” and approved for use**
- Market Development Partner III for Acoustic Coupler – Dec 12, 2016
“Comparable” to Corfree M1
- Market Development Partner IV for Coolant – Dec 16, 2016
 - At 3, 5, and 10% concentration, FerroShield passed CIC testing**Hard Water stable and clear solution and “FerroShield HC has passed all test criteria”**
- Market Development Partner V for CI Fluid and MWF – Dec 23, 2016
 - 3, 5, and 10% concentrations passed ASTM D4627 and hard water stable (clear solution)**Corrosion testing is equal to a “slight advantage over PureMix II”**
- Market Development Partner VI for CI Engine Coolants – April 13, 2017
 - ASTM D4340 Corrosion of Cast Aluminum Alloys in Engine Coolants Under Heat-Rejecting Conditions and D1384 Corrosion Test for Engine Coolants in Glassware: **“Passed Easily”**

Product Features and Benefits

- **White**; high purity
- **Flake**; no dust nuisance
- **Flake thickness**; less breakage with fast solubility
- **Effective at low concentration**; peace of mind; robust formula with less usage
- **Passes test**; DIN 51360-2, ASTM D4627, D4340, D1384 and others
- **Quality control**; ISO 9001 certified with CoA verified at HQ
- **Short lead time**; produced in the US



Summary

FerroShield™ HC Project Summary and Status

- Feb 2016 - Product and Market Development started
- Apr 2016 - Tested and approved by Partners
 - Corrosion inhibition; equal to or better than competition
 - Hard Water Stability; better than competition
 - Secondary Concerns Addressed; eg. flake form, color, odor
- Nov 2016 - Launched FerroShield™ HC
- Dec 2016 - Commenced with 11,000lbs production
- 2017 - Commercial production of 4.4MM lbs per year

Samples available for qualifications

Commercial Timeline - Announcements



Verdezyne Signs Agreement with Major European Chemicals Distributor Will & Co

June 9, 2015

Exclusive Agreement to Drive European Adoption of Verdezyne's First Product, BIOLON™ DDDA from its Commercial-Scale Production Facility

Verdezyne Earns USDA Certified Biobased Product Certification and Label

June 24, 2015



CONNELL BROS.
A DIVISION OF WILBUR-ELLIS®

Verdezyne Signs Agreement with Connell Bros. Co.

March 8, 2016

Exclusive Agreement with Largest Marketer and Distributor of Specialty Chemicals in Asia-Pacific to Power Sales of Verdezyne's BIOLON™ DDDA



Verdezyne Signs Distribution Agreement with Aceto Corporation

October 4, 2016

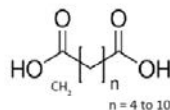
Exclusive Agreement with Leading Distributor of Specialty Chemicals in the US to Power Regional Sales of Verdezyne's BIOLON™ DDDA

FerroShield™ HC Technical Data Sheet



FerroShield™ HC Dibasic Acid Mixture

Technical Information



Composition/Ingredient Information

Typical Component	Concentration
Sebacic Acid	
CAS No. 131-20-6	20 - 40%
EC No. 209-845-5	
Undecanedioic Acid	
CAS No. 1852-04-6	25 - 50%
EC No. 217-440-6	
Dodecanedioic Acid	
CAS No. 693-23-2	20 - 50%
EC No. 211-746-3	

Product Information

Verdezyne's FerroShield HC is a nitrate-free dibasic acid mixture. It exhibits exceptional ferrous corrosion inhibition properties and can be used in a number of corrosion inhibitor applications including:

- Metalworking fluids
- Engine coolants
- Metal cleaners
- Die cast release agents
- Aqueous hydraulic fluids

Appearance

Flake	White/Off-White
Water Content	< 0.5%

Packaging

Poly Bags	20 kg net
Flexible Intermediate Bulk Container (FIBC)*	500 kg net
*FIBCs may be reused and recycled.	

Shipping Information

DOT Shipping Information	Dibasic Acid Mixture
DOT Hazard Classification	Not Regulated
Freight Classification	Acids, N.O.I.B.N., dry

For Samples and Information

760.707.5200

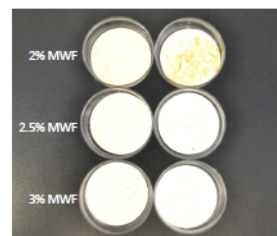
sales@verdezyne.com

or visit

www.verdezyne.com



CORROSION



FerroShield HC Competitor

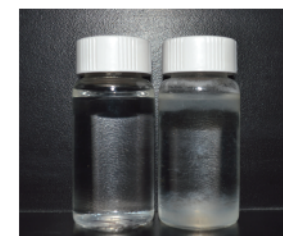
Corrosion Testing

Verdezyne's FerroShield HC is an effective corrosion inhibitor when tested using the ASTM D4627, Standard Test Method for Iron Chip Corrosion for Water-Miscible Metalworking Fluids (MWF).

A stock solution of FerroShield HC is prepared and diluted to 2%, 2.5% and 3% solutions for testing as a MWF.

Results indicate that corrosion resistance is equal to or better than the competitor. These results were confirmed by independent laboratories.

HARD WATER STABILITY



FerroShield HC Competitor

Hard Water Stability Testing

Verdezyne's FerroShield HC is formulated into a MWF and then diluted with a 400 and a 1000 ppm synthetic hard water solution.

Verdezyne recommends diluting FerroShield HC with deionized water to prevent any precipitation, but testing indicates that hard water stability is as good or better than the competitor in most formulas.

The above image shows that FerroShield HC remains clear in this 400 ppm hard water solution. Whereas the competitor has a slight cloud of precipitation at both the bottom and floating at the top of the vial.

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Thank You!



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