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

- Founded in 2008
  - Biotech
  - Private
  - 71 employees
  - Carlsbad, CA

2010
- POC for Adipic Acid & DDDA

2012
- World’s first biobased N6,6 fiber
- Pilot scale; ADA and DDDA
- Sold cellulosic ethanol technology to DuPont

2014
- Site selected for 1st DDDA plant

2017
- Launched FerroShield HC
- DDDA Groundbreaking

Investors
What We Do: Simplify the Chemical Production Process

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

Petroleum route to produce chemicals

1. Crude oil
2. Oil refining
3. Naphtha
4. Steam Crack
5. Benzene
6. Hydrogenation
7. Cyclohexane
8. Air oxidation
9. KA oil
10. Nitric Acid Oxidation
11. Filtration and Crystallization

Verdezyne’s route to produce chemicals

1. Fermentation
2. Filtration and Crystallization

Fatty Acid and Traditional Feedstocks

11 steps

2 steps
Providing Markets with Eco-Friendly Alternatives

- **Bio-Adipic acid**
- **Bio-Sebacic acid**
- **Bio-Dodecanedioic acid**
- **Mixed diacids**

**Thermoplastic Polyurethane**
- Paints/Coatings
  - Foams
  - Elastic Parts
  - Adhesives

**Plasticizers**
- Resins

**Polyamide N6,6, N6,10 N6,12, Others**
- Fibers
  - Resins
  - Parts
  - Films
  - Films

**Biodegradable Plastics**
- Ag Covering
  - Packaging

**Polyester Polyol**
- Spray Coatings
  - Corrosion Inhibitors

**Lubricants**
- Coolant
  - Metalworking Fluid

**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

- **Metalworking Fluid**
- **Coolant**
- **Spray Coatings**
- **Corrosion Inhibitors**
- **Ag Covering**
- **Packaging**
- **Fibers**
  - **Resins**
  - **Parts**
  - **Films**
  - **Films**

- **Plastics**
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- **Industrial**
  - **commercial carpet**
  - **paints**
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- **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)

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

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

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

- Total $70B+ Market
- 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 Methy Ester
- Canola Methy Ester
- Tallow
- Yellow Grease
- Jatropha Oil
- Acidulated Soy Soap Stock
- Peanut Oil Distillate
- Trap Oil
- Brown Grease
- Fatty Acid Methy Ester
- PKO
- C16/C18 Fatty Acid Methy Ester
- Methylated PFAD
- Ethylated PFAD
- Propylated PFAD
- Crude Palm Oil
- Sludge Condensate Oil
- Esterified residue P and E
- Ethyl stearate
- Tallow Fatty Acid
- Methyl Laurate
- Ethyl Laurate
- Lauric Acid
- Methyl Myristate
- Decane
- Dodecanedioic Acid
- 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
- Adipic Acid
- Suberic Acid
- Sebacic Acid
- C14 diacid
- C18 diacid
- Mixed diacid

Eco-Friendly Chemicals Produced
DDDA Commercial Program

Offtake Visibility

Sold 75K lb
North America and Europe

Distribution
EU: Will & Co
AP: Connell Brothers,
US: Aceto

Drop-in
Quality and performance proven by 10+ companies in various applications

Offtake
21 Million pounds to 35 Million pounds of offtake

Groundbreaking
Johor, Malaysia 2017
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
FerroShield HC Testing Parameters

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

- 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)

<table>
<thead>
<tr>
<th>FerroShield HC</th>
<th>Competitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2% MWF</td>
<td></td>
</tr>
<tr>
<td>2.5% MWF</td>
<td></td>
</tr>
<tr>
<td>3% MWF</td>
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</tr>
</tbody>
</table>
**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
FerroShield™ HC
Product Quality
• 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 Triazintricarboxylic 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
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
Verdezyne Earns USDA Certified Biobased Product Certification and Label

June 24, 2015

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 BIOLO™ DDDA

Verdezyne Signs Agreement with Major European Chemicals Distributor Will & Co.

June 9, 2015

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

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 BIOLO™ DDDA
FerroShield™ HC Technical Data Sheet

**FerroShield™ HC Dibasic Acid Mixture**

**Technical Information**

<table>
<thead>
<tr>
<th>Composition/ingredient Information</th>
<th></th>
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<tbody>
<tr>
<td>Typical Component</td>
<td>Concentration</td>
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<tr>
<td>Succinic Acid</td>
<td>20 - 40%</td>
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<tr>
<td>CAS No. 552-19-5</td>
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<tr>
<td>FT#: 3374065</td>
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<tr>
<td>Undecenoic Acid</td>
<td>25 - 50%</td>
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<td>CAS No. 2552-64-6</td>
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<td>FT#: 5117464</td>
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<tr>
<td>Decenoic Acid</td>
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<td>CAS No. 690-23-2</td>
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<tr>
<td>FT#: 3237464</td>
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</tbody>
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**Product Information**

Verdezyne’s FerroShield HC is a stable, new dibasic acid mixture. It exhibits exceptional ferrous corrosion inhibition properties and can be utilized in a number of corrosion inhibitor applications including:

- Anti-Wicking Fluids
- Engine coolants
- Metal cleaners
- Aviation hydraulic fluids

**Appearance**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Color</td>
<td>White/Off-White</td>
</tr>
<tr>
<td>Water Content</td>
<td>&lt; 0.2%</td>
</tr>
</tbody>
</table>

**Packaging**

<table>
<thead>
<tr>
<th>Type</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poly Bag</td>
<td>75 liters</td>
</tr>
</tbody>
</table>

**Shipping Information**

- ERT Shipping Information: Dibasic Acid Mixture
- ERT Hazard Classification: Not Regulated
- Freight Classifications: Acid, N.O.O.B., Dry

For Samples and Information

760.707.5200

sales@verdezyne.com

or visit

www.verdezyne.com

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**CORROSION**

FerroShield HC vs. Competitor

2% MW: FerroShield HC provides better corrosion protection.

2.5% MW: FerroShield HC provides significantly better corrosion protection.

3% MW: FerroShield HC provides the best corrosion protection.

**HARD WATER STABILITY**

FerroShield HC vs. Competitor

FerroShield HC with hard water shows no signs of precipitation, whereas the competitor has a heavy coat of precipitation at the bottom and floating at the top of the solution.

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FerroShield HC is formulated into a MWF and then diluted with a 50/50 blend of synthetic hard water solution.

Verdezyne recommends using FerroShield HC with dosed water to prevent any precipitation, but testing indicates that hard water stability is at least better than the competitor.

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

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The FerroShield Data Sheet includes information which may relate to trademarks or registered trademarks of various manufacturers of materials. Verdezyne cannot warrant or certify the accuracy of this data. The information contained herein is intended for use as a guide only and is based on laboratory tests conducted by Verdezyne. We recommend that users should conduct their own tests and investigations to properly determine the suitability of the materials for their specific applications. Verdezyne strives for accuracy in our data sheets, but we cannot guarantee the accuracy of all information presented. If you require additional information or have any questions, please contact us.
Thank You!

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