Corrosion and Frictional Comparison of Magni 565 & 567 Using Gardobond Z3100 Phosphate & Phosfan Phosphate as Pretreatments

By: Stephen Rascoe
Peter Pelloski
Date: 06/6/2016
Objective
To benchmark the corrosion performance using the Phosfan pretreatment process for Magni 565 Duplex coating system against the current Gardobond Z3100 pretreatment used at Depor Industries Inc. in Troy Michigan.

Background
A controlled lot of M10 hex head bolts were purchased by Wilson Garner and approved bolt manufacturer for friction control. Half the bolts were sent to Phosfan in Israel for the Phosfan project the other half were sent to Depor for the Gardobond Z3100 process. Following the Gardobond phosphating process from Depor, parts were sealed in plastic bags with desiccant and held until the balance of the parts were returned from Phosfan. Upon receipt of the Phosfan parts all parts were coated with the same base coat primer B06J_500 and B18 top coat per the Magni 565 and 567 coating systems.
Background-cont.
Parts from each of the two systems were then friction tested to see if the candidate pretreatment would meet the current ISO16047 specification used by General Motors like the Gardobond Z3100 does.

An additional amount of parts from each system were then subjected to a 32” bowl feeder test (10 minutes/maximum frequency) to simulate sorting operations which all automotive bolts are subjected to. In addition, parts were also subjected to 5 torque run downs which are conducted to simulate the OEM’s service life requirements for any coating.

Bolts from each system following each type of pre testing stress were then placed into two laboratory accelerated corrosion tests. A neutral salt spray test (N.S.S.) per ASTM B-117 and a life cycle test using the Toyota CCT-A exposure.

One group of bolts with no pretesting stress was used as a control for each respective corrosion test. Pictures were taken at the beginning of testing and then at various levels throughout testing.
Methods and Materials

- M10 Hex Head Wilson Garner bolts
- B06J mixed lots
- B18 Lot #30191
- Gardobond Z3100 pretreatment stream
- Phosfan phosphate pretreatment stream
- Dispatch electric oven for curing
- ISO16047 Friction Standard
- Toyota CCT-A
- Neutral Salt Spray per ASTM B117
- 32” Vibratory Bowel
- Schatz Torque and Tension Machine
- Ronci Dip and Spin machine
### Processing Information

**2771 Hammond Street Detroit, Michigan 48209-1239**

| Project   | 15484:10617
|-----------|--------------
| Date      | 1/28/2016    
| Applicator| Lorenzo Rascoe

<table>
<thead>
<tr>
<th>Sample #</th>
<th>Coating Description</th>
<th>Viscosity (in seconds) @ Temperature T</th>
<th>Substrate and Pretreatment</th>
<th>Centrifuge/Rotor/Tail Unit Spin Characteristics</th>
<th>Zone Oven Temperature</th>
<th>Total Oven Time</th>
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CCT A - Method
(Toyota Cycle Corrosion Test)

Neutral Salt Spray

CCT A-method (Toyota Cycle)

50°C × 5% NaCl (17hr)

Hot-air drying (70°C × 3hr)

Salt water immersion (50°C × 5%NaCl, 2hr)

Outside-air blowing ((20°C) × 2hr)

Our cycle equals 1 day
ISO16047 Testing Using a Schatz Unit for Torque and Tension
### Gardobond Z3100

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<th>J&lt;sub&gt;x&lt;/sub&gt;(28.3 kN)</th>
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### Phosfan 1x 565

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Legend:
- Red: 1x Magni 565
- Green: Phosfan 1x 565

### Test Parameters

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<tr>
<th>Test standard</th>
<th>Project</th>
<th>Operator</th>
<th>Department</th>
<th>Test title</th>
<th>Test Bolt</th>
<th>Topcoat/DTF</th>
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<th>Washer Type &amp; Finish</th>
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<td>Research</td>
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Friction Comparisons of Gardobond and Phosfan Pretreatments Under Magni 567

### Gardobond Z3100

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### Phosfan

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Test performance analysis and comparison tables are shown, detailing friction measurements and other relevant data for both Gardobond Z3100 and Phosfan pretreatments under the Magni 567 apparatus. The data includes various tests conducted on different materials and conditions, indicating superior performance metrics for Gardobond Z3100 compared to Phosfan under certain test parameters.
32” Bowel Feeder Exposure to Simulate Sorting and Assembly
Coated Parts Before N.S.S. Testing

Depor Phosphate (Controls)

Magni 565

Magni 567

Phosfan Phosphate (Controls)

Magni 565

Magni 567
Coated Parts Before N.S.S. Testing

Depor Phosphate (5x Torque)

Phosfan Phosphate (5x Torque)

Magni 565
Magni 567
Magni 565
Magni 567
240 Hours of N.S.S. Testing

Depor Phosphate (Controls)

Magni 565  Magni 567

Phosfan Phosphate (controls)

Magni 565  Magni 567
240 Hours of N.S.S. Testing

Depor Phosphate (5x Torque)
Magni 565
Magni 567

Phosfan Phosphate (5x Torque)
Magni 565
Magni 567
480 Hours of N.S.S. Testing

Depor Phosphate (Controls)

Phosfan Phosphate (Controls)

Magni 565
Magni 567
Magni 565
Magni 567
480 Hours of N.S.S. Testing

Depor Phosphate (5x Torque)

Magni 565
Magni 567

Phosfan Phosphate (5x Torque)

Magni 565
Magni 567
720 Hours of N.S.S. Testing

Depor Phosphate (Controls)

Phosfan Phosphate (Controls)

Magni 565  Magni 567  Magni 565  Magni 567
720 hours of N.S.S. Testing

Depor Phosphate (5x Torque)

Magni 565  Magni 567

Phosfan Phosphate (5x Torque)

Magni 565  Magni 567
1,000 Hours of N.S.S. Testing

Depor Phosphate (Controls)
Magni 565  Magni 567

Phosfan Phosphate (Controls)
Magni 565  Magni 567
1,000 Hours of N.S.S. Testing

Depor Phosphate (5x Torque)

Magni 565  Magni 567

Phosfan Phosphate (5x Torque)

Magni 565  Magni 567
1,500 Hours of N.S.S. Testing

Depor Phosphate (Controls)

Magni 565
Magni 567

Phosfan Phosphate (Controls)

Magni 565
Magni 567
1,500 hours of N.S.S. Testing

Depor Phosphate (5x Torque)

Phosfan Phosphate (5x Torque)
2,000 hours of N.S.S. Testing

Depor Phosphate (Controls)

Phosfan Phosphate (Controls)

Magni 565  Magni 567

Magni 565  Magni 567
2,000 hours of N.S.S. Testing

Depor Phosphate (5x Torque)

Magni 565  Magni 567

Phosfan Phosphate (5x Torque)

Magni 565  Magni 567
Coated Parts before CCT-A Testing

Depor Phosphate (Controls)
- Magni 565
- Magni 567

Phosfan Phosphate (Controls)
- Magni 565
- Magni 565
Coated Parts Before CCT-A Testing

Depor Phosphate (Bowl feeder damage)  Phosfan Phosphate (Bowl feeder damage)

Magni 565  Magni 567  Magni 565  Magni 565
20 Cycles of CCT-A Testing

Depor Phosphate (Controls)

Magni 565
Magni 567

Phosfan Phosphate (Controls)

Magni 565
Magni 567
20 Cycles of CCT-A Testing

Depor Phosphate (Bowl feeder damage)  Phosfan Phosphate (Bowl feeder damage)
30 Cycles of CCT-A Testing

Depor Phosphate (Controls)

![Image of Depor Phosphate Controls]

Phosfan Phosphate (Controls)

![Image of Phosfan Phosphate Controls]
30 Cycles of CCT-A Testing

Depor Phosphate (Bowl feeder damage) Phosfan Phosphate (Bowl feeder damage)
ISO16047 Friction Results

<table>
<thead>
<tr>
<th>Pretreatment Combination</th>
<th>Mean $\mu$</th>
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<tr>
<td>Magni 565 with Phosfan</td>
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<td>Magni 567 with Gardobond</td>
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<tr>
<td>Magni 567 with Phosfan</td>
<td>0.132</td>
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</table>

The frictions between the two pretreatments and Magni systems are very close with values similar for the Magni 565 and values a little lower for the Phosfan for Magni 567. Typically we would run a 30 piece sample to get a statistical valid representation.
Neutral Salt Spray Results

- The Magni 565/567 control samples using the Gardobond pretreatment showed no red rust after 2,000 hours.

- The Magni 565 control with Phosfan treated bolts showed red rust on one bolt (<1%) at the 2,000 hour mark.

- The Magni 567 with Phosfan treated bolts showed no red rust for the full 2,000 hours of testing.

- The Magni 565 5X torqued bolts with the Phosfan pretreatment showed red rust under the head at 1,500 hours while the Gardobond 5X torqued samples showed no red rust at 1,500 hours.
Toyota CCT-A Results

• The Magni 565/567 controls for both pretreatments showed no red rust at 20 cycles.

• The Magni 567 Phosfan control samples had less red rust after 30 cycles then the Magni 567 Gardobond Z3100 pretreated samples and much less white corrosion products were evident.

• The stressed bowl feeder red rust development for the Magni 565 were equal for both pretreatments at the 30 cycle mark.

• The Magni 567 bowl feeder results using the Phosfan pretreatment showed significantly less red rust then the Magni 567 bowl feeder samples using the Gardobond Z3100 pretreatment after 30 cycles of testing.
Based on these initial findings, it appears that the Phosfan pretreatment is equal to the Gardobond Z3100 for the Magni Magni 565 system and significantly better than the current Gardobond Z3100 pretreatment especially after the second primer application for the Magni 567 system when subjecting the fasteners to film damage (5X tightening and/or bowl feeder exposure). Why the first red rust corrosion products appears under the head on the Phosfan bolts versus the threads needs to be quantified.

The corrosion improvement in the Magni 567 system when stressed seems to also result in reduced white corrosion development which may result from a better adherence/hardness value of the Phosfan film.
Summary-cont.

The other reported benefits of the Phosfan system such as processing footprint, low sludge generation, water consumption, lower energy costs and efficiencies cannot be addressed in this study and would need to be discussed with Magni upper management and applicator base. Moving forward we would recommend a larger amount of material (100-200 pounds) to be processed to be more representative of real world application volumes.
Thank you!