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Evaluating Packaging and Corrosion Prevention Options for Components

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For: Customer

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Project #: 16-274-1825.bis

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Background:

Customer is currently experiencing corrosion problems with several parts and is looking to overhaul their packaging systems. Customer is currently using Zerust ExCorr MultiMetal VCI paper and Compound RP-99S as a liquid rust preventative. Based on the parts being packaged, Cortec is recommending VpCI-126 film and VpCI-146 paper as a superior packaging system for the parts in question. In addition, BioCorr is offered as a liquid rust preventative for treatment of parts as necessary.

Sample Received:

Five different types of parts were shipped for testing:

1. Large Locking Gear
2. Small Locking Gear
3. Side Gear
4. Locking Side Gear
5. Pinion

Each part shipped contained three different sets of treatments/surface finishes:

1. Turned
2. Turned & blasted
3. Turned, blasted & rust preventative

Note that Pinions are not blasted, therefore only two different treatments were presented: turned, and turned with rust preventative. In total, 42 parts were presented to Cortec. Parts were shipped in Zerust ExCorr MultiMetal VCI Paper; parts protected with a rust preventative were treated with Compound RP-99S from Madison Chemical. All parts were in good condition with no visible rust. The paper received was in good condition, with no visible tears or other imperfections. Plastic packaging dunnage was also shipped to Cortec to be used for holding parts during testing.

Method: Humidity Chamber Testing (ASTM D-1735 Conditions)

Materials:

1. VpCI-126 bags (Batch # 510230)
2. VpCI-146 paper
3. BioCorr (Batch # 216516)

Procedure:

Parts were unpacked and inspected for signs of corrosion prior to testing. Parts were then organized and treated based on the metal finish of the part. “Turned” parts and “Turned & Blasted” parts were given one of three treatments below:

1. Control (no additional treatment or packaging)
2. Competitor Packaging Material (ZeRust ExCorr MultiMetal Paper)
3. Cortec Recommended Packaging Method (wrapped in VpCI-146, inside VpCI-126 bag)

Parts labeled “Turned, Blasted, & RP” were given one of three treatments below:

1. Competitor RP Only (Compound RP-99S, Madison Chemical)
2. BioCorr Rust Preventative
3. BioCorr Rust Preventative, VpCI-146 paper wrap, VpCI-126 bag

Parts coated with BioCorr were cleaned with methanol; other parts were not cleaned prior to packaging and testing. Parts were placed inside the humidity chamber and tested until failure.

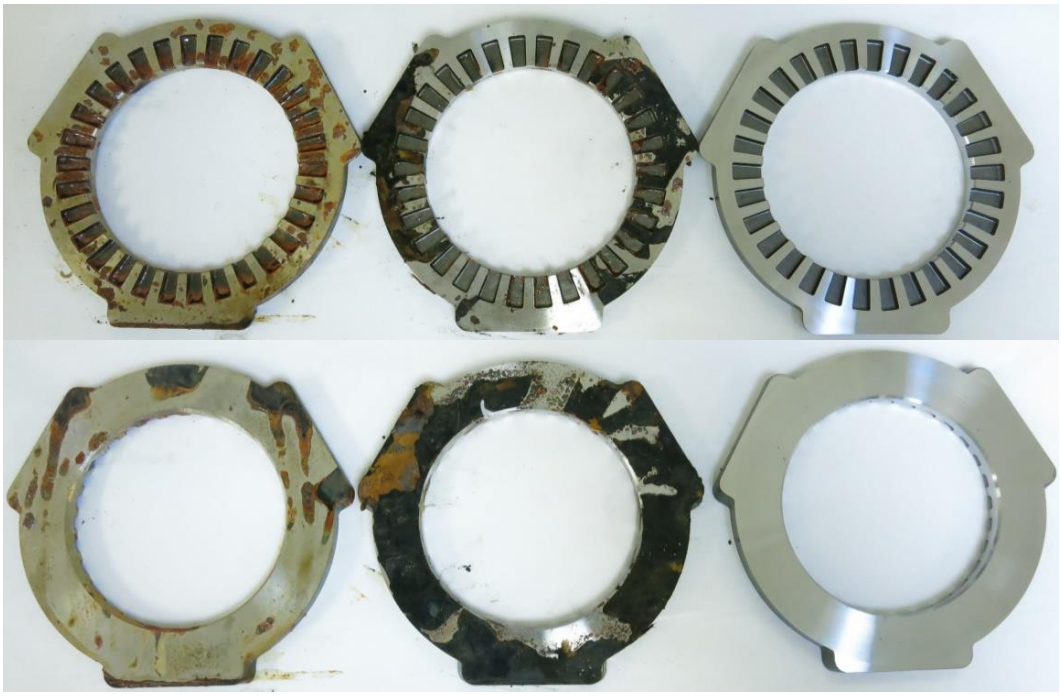
The condition upon failure was rated by the following criteria:

- **Light**: Small sports or areas of corrosion, <10% of the total surface area
- **Moderate**: Moderate patches of corrosion, 10-50% of the total surface area
- **Heavy**: Significant corrosion, >50% of the total surface area

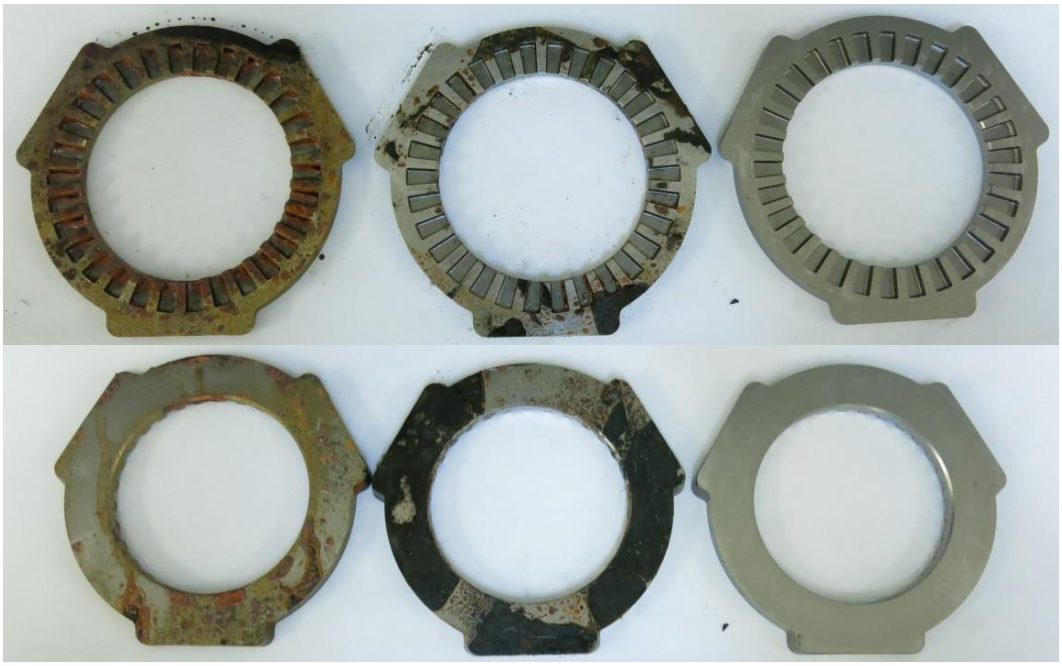
Table 1: Relevant Test Dates & Times

Part	Processing	Treatment	Failure Date	Condition Upon Failure*	Run Time [hours]
Locking Side Gear	Turned	1	1/27/17 @ 8 am	Moderate	15
		2	2/1/17 @ 8 am	Moderate	135
		3	--	--	427
	Turned & Blasted	1	1/27/17 @ 8 am	Moderate	15
		2	2/1/17 @ 8 am	Moderate	135
		3	--	--	427
	Turned, Blasted & Rust Preventative	1	1/30/17 @ 7 am	Light	87
		2	2/16/17 @ 12 pm	Moderate	427
		3	--	--	427
Small Locking Plate	Turned	1	1/27/17 @ 8 am	Moderate	15
		2	2/1/17 @ 8 am	Moderate	135
		3	--	--	427
	Turned & Blasted	1	1/27/17 @ 8 am	Moderate	15
		2	2/1/17 @ 8 am	Moderate	135
		3	--	--	427
	Turned, Blasted & Rust Preventative	1	1/27/17 @ 8 am	Moderate	15
		2	2/7/17 @ 8 am	Moderate	279
		3	2/13/17 @ 12 pm	Light	427
Side Gear	Turned	1	1/27/17 @ 8 am	Light	15
		2	1/31/17 @ 8 am	Moderate	111
		3	--	--	427
	Turned & Blasted	1	1/27/17 @ 8 am	Heavy	15
		2	1/31/17 @ 8 am	Light	111
		3	--	--	427
	Turned, Blasted & Rust Preventative	1	1/30/17 @ 7 am	Light	87
		2	2/1/17 @ 8 am	Light	135
		3	--	--	427
Locking Side Gear	Turned	1	1/27/17 @ 8 am	Moderate	15
		2	1/31/17 @ 8 am	Light	111
		3	--	--	427
	Turned & Blasted	1	1/27/17 @ 8 am	Heavy	15
		2	1/31/17 @ 8 am	Light	111
		3	--	--	427
	Turned, Blasted & Rust Preventative	1	1/30/17 @ 7 am	Light	87
		2	2/1/17 @ 8 am	Light	135
		3	2/13/17 @ 12 pm	Light	427
Pinion	Turned	1	1/27/17 @ 8 am	Moderate	15
		2	2/13/17 @ 12 pm	Heavy	427
		3	--	--	427
	Turned & Rust Preventative	1	1/30/17 @ 7 am	Light	87
		2	2/13/17 @ 12 pm	Moderate	427
		3	--	--	427
Test Start Time: 1/26/17 @ 4:30 pm					
Test Stop Time: 2/13/17 @ 12:00 pm					
Total Test Run Time: 427 hours					

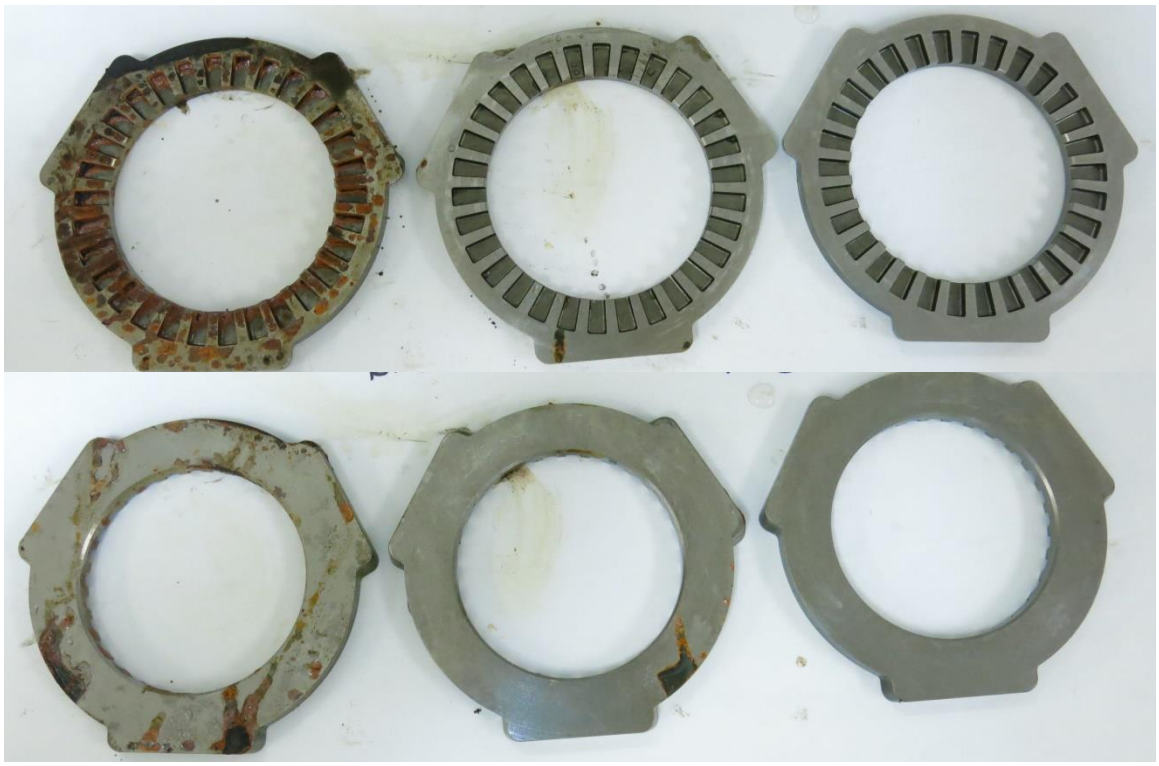
Photos:



Picture 1: Large Locking Plates – Turned, from left to right: Control, ZeRust Paper, Cortec VpCI-126 film + VpCI-146 paper.

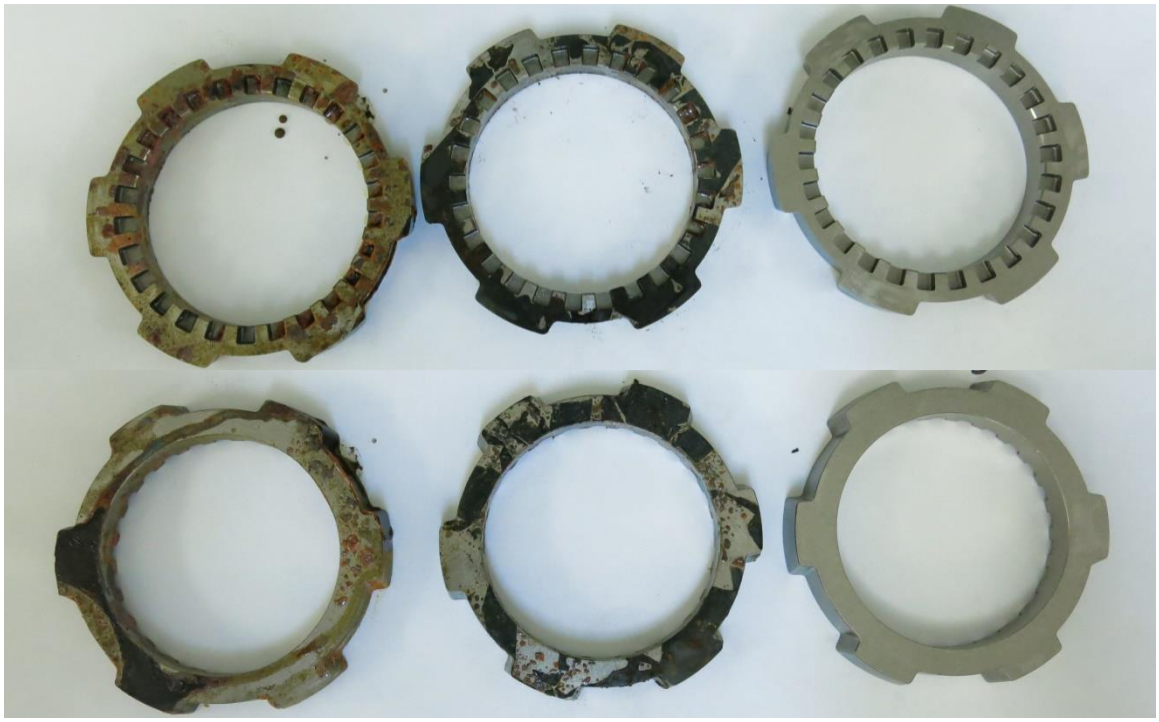


Picture 2: Large Locking Plates – Turned & Blasted, from left to right: Control, ZeRust Paper, Cortec VpCI-126 film + VpCI-146 paper.

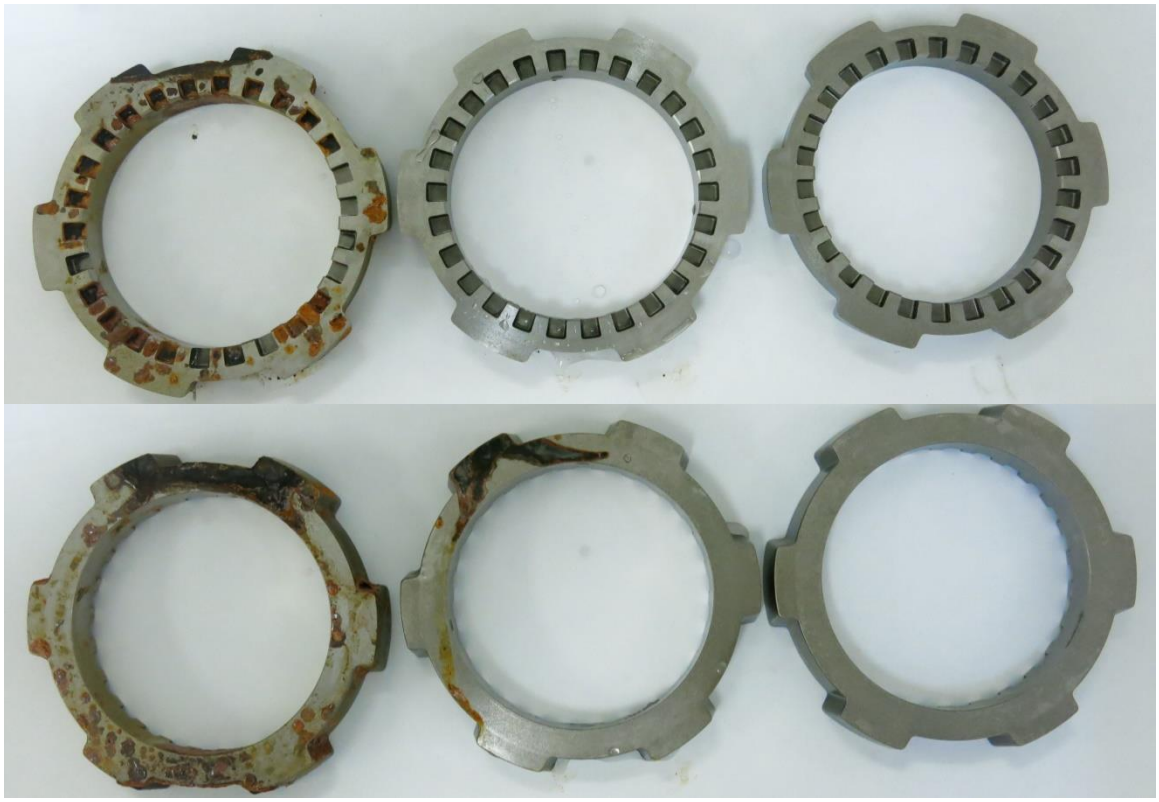


Picture 3: Large Locking Plates – Rust Preventative, from left to right: Compound RP-99S, BioCorr, BioCorr + VpCI-126 bags + VpCI-146 paper.

Picture 4: Small Locking Plates – Turned, from left to right: Control, ZeRust Paper, Cortec VpCI-126 film + VpCI-146 paper.



Picture 5: Small Locking Plates – Turned & Blasted, from left to right: Control, ZeRust Paper, Cortec VpCI-126 film + VpCI-146 paper.

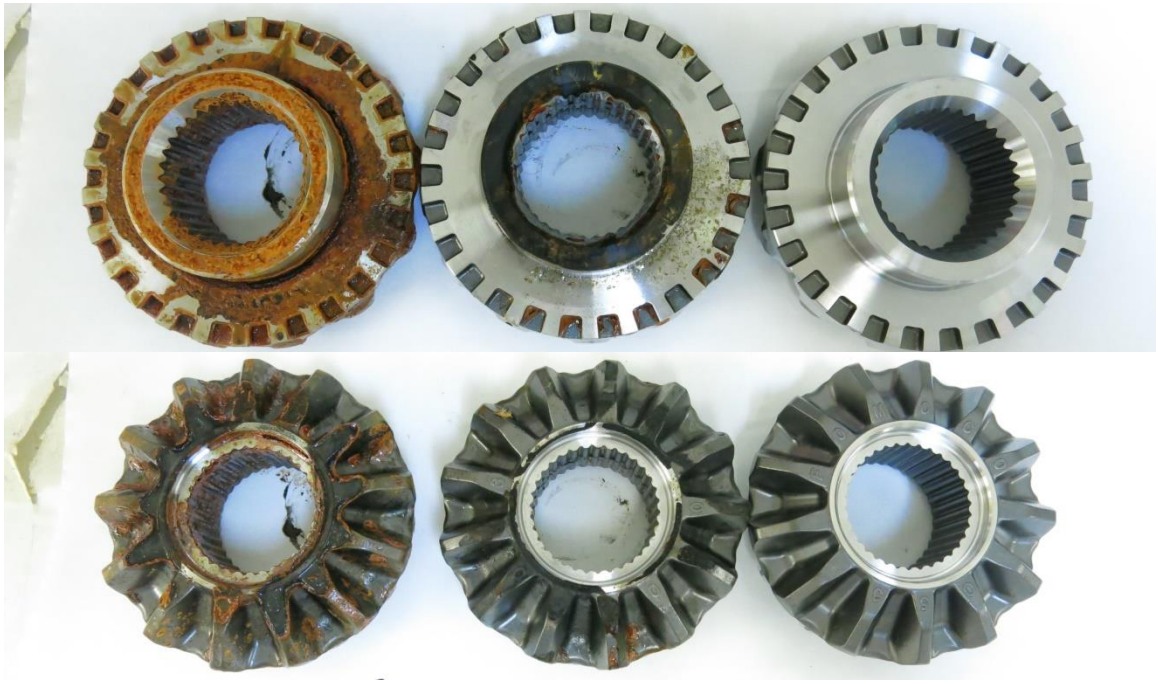


Picture 6: Small Locking Plates – Rust Preventative, from left to right: Compound RP-99S, BioCorr, BioCorr + VpCI-126 bags + VpCI-146 paper.

Picture 7: Side Gears – Turned, from left to right: Control, ZeRust Paper, Cortec VpCI-126 film + VpCI-146 paper.

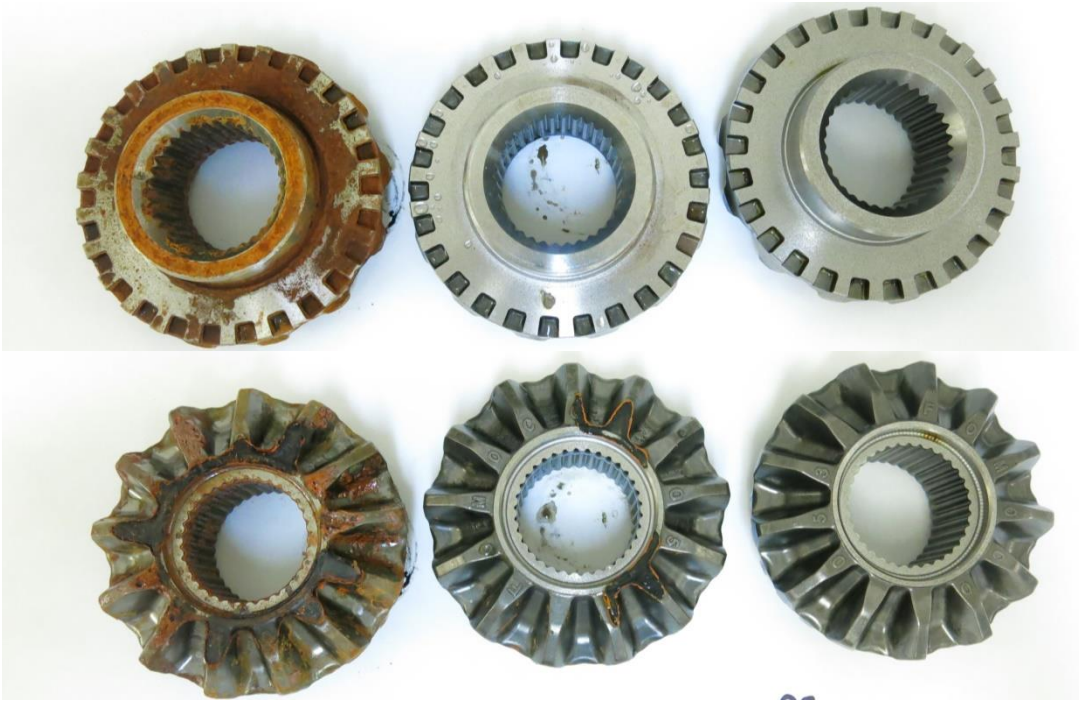
Picture 8: Side Gears – Turned & Blasted, from left to right: Control, ZeRust Paper, Cortec VpCI-126 film + VpCI-146 paper.

Picture 9: Side Gears – Rust Preventative, from left to right: Compound RP-99S, BioCorr, BioCorr + VpCI-126 bags + VpCI-146 paper.



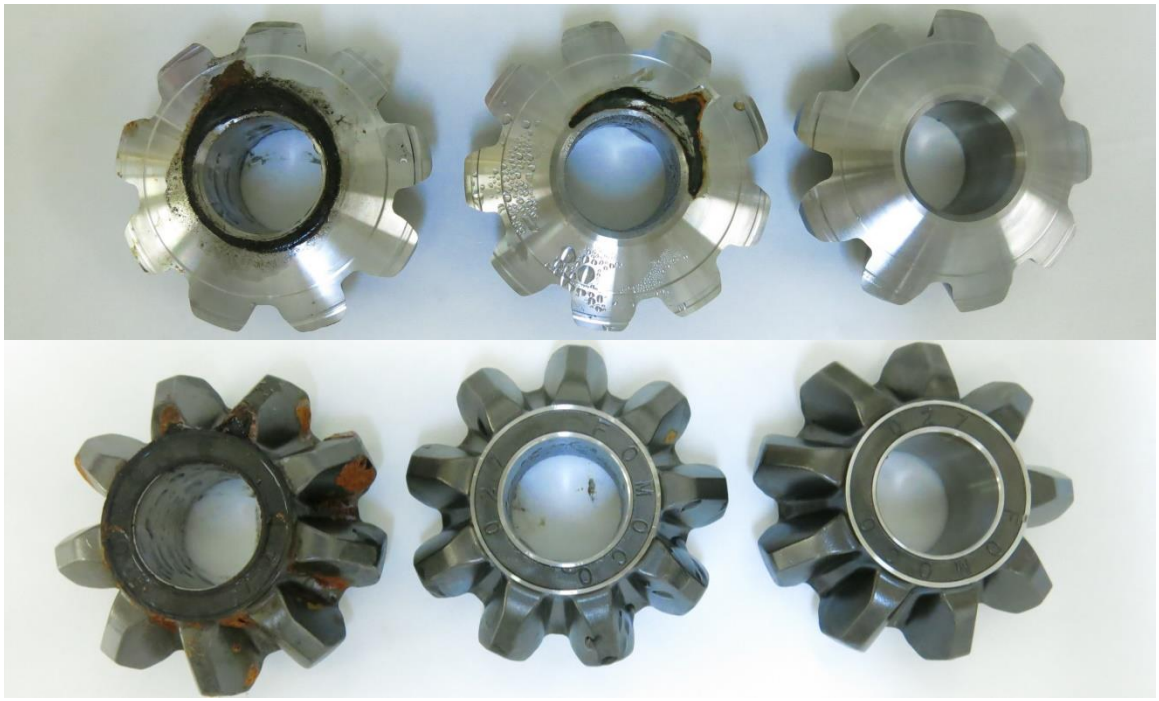
Picture 10: Locking Side Gears – Turned, from left to right: Control, ZeRust Paper, Cortec VpCI-126 film + VpCI-146 paper.

Picture 11: Locking Side Gears – Turned & Blasted, from left to right: Control, ZeRust Paper, Cortec VpCI-126 film + VpCI-146 paper.



Picture 12: Locking Side Gears – Rust Preventative, from left to right: Compound RP-99S, BioCorr, BioCorr + VpCI-126 bags + VpCI-146 paper.

Picture 13: Pinions – Turned, from left to right: Control, ZeRust Paper, Cortec VpCI-126 film + VpCI-146 paper.



Picture 14: Pinions – Rust Preventative, from left to right: Compound RP-99S, BioCorr, BioCorr + VpCI-126 bags + VpCI-146 paper.

Interpretations:

All control parts, tested without rust preventative, failed in less than 24 hours, as expected in the accelerated corrosion conditions of ASTM D-1735. While the protection of parts was extended using the ZeRust ExCorr paper, without a sufficient moisture barrier the paper soon became saturated with water. Once saturated, moisture being held on the surface of the parts promoted corrosion, causing significant failure. Though the onset of failure was delayed, significant corrosion developed as a result of the constant contact with the saturated paper. Parts packaged in Cortec's recommended packaging system (VpCI-146 + VpCI-126) should significant improvement over other packaging systems tested, where no rust developed over the 500 hours of testing.

In humidity testing BioCorr Rust Preventative out performed Madison Chemical's Compound RP-99S by both delaying the onset of corrosion and limiting spread of corrosion after onset. As with parts not protected with BioCorr, the addition of VpCI-146 paper and VpCI-126 bags proved to be an effective packaging method, preventing corrosion on almost every test part.