**Abstract:** An evolution into Autophoretic coatings with regard to field performance characteristics. The Autophoretic coating process has been used extensively in a wide variety of industries, such as the automotive industry, to provide a protective coating for “non critical” parts for many years, e.g. under carraige suspension components. The deposition process results in an energy savings and/or material savings over competing protective coatings. Due to the stated advantages, this process has gained interest in other industries, such as the appliance industry. It is well known that the field performance in many auto applications with regard to rust is limited, as indicated by the formation of rust on under carriage components. Published data with regard to field performance in indoor applications is not presently available. As such, a study has been commissioned to investigate coating failure, as defined by internal quality standards, resulting from rust. Multiple experiments will be conducted to identify the cause of failure while attempting to determine if the failure is material or process derived.

**Problem:** Autophoretic Coating (A-Coat) is used to coat a wide range of manufactured goods. However, it has been found that this coating will fail and corrosion will become evident over a relatively short period of time. It is possible that this coating will not meet most manufacturers’ quality standards at the recommended coating thickness. Theoretically A-coating should not perform powder paint while requiring a fraction of the coating thickness. However, observation in the automotive industry indicates that powder paint outperforms A-coat in terms of protection from rust. It is unknown if the coating is failing at its recommended thickness due to the coating material or from the coating process.

**Basics of Autophoretic:** Also known as autodeposition, A-coat or AP It is a waterborne process which depends on chemical reactions between a ferric part to be coated and the coating solution. Iron in the steel reacts with a mildly acidic latex emulsion polymer, as well as other undisclosed ingredients. These ingredients vary depending on company usage and desired properties. The mild acidity liberates a small amount of ions from the ferrous material. These ions interact with the latex causing a thin deposition layer to form. The chemical activators diffuse rapidly into a film and etch the surface simultaneously. Unlike an electrostatic coating, there is no external electric charge and the coating is dried for a set period of time of baking.

**Testing Objectives:**

- To determine if there are microscopic pores that exist and what caused them.
- To measure the residual acidity of the at surface level and coating/substrate boundary.
- Use microscopy to study the surface of the coating, before and after corrosion, to determine if the surface is undergoing erosion.
- Subject the coating to gaseous diffusion tests to determine the rate at which the coating allows air to pass back and forth between the metal substrate.

**Experiment One:** To determine if the corrosion is being caused due to a porous coating the surface porosity must be known. Varying coating thicknesses will be subjected to the Bruanuer, Emmet and Teller (BET) gas absorption/rejection test in order to determine pore distribution and size. A wide range of thicknesses will be used to determine if the coating is naturally porous and if increasing the coatings thickness will decrease the pore sizes present in the coating.

**Surface Porosity:** The Bruanuer, Emmet and Teller (BET) gas absorption method is employed to determine porosity of a specimen by determining the amount of gas which the specimen’s surface absorbs. The gas condenses in the fine pore structure creating a layer on the specimen’s surface. The gas pressure is increased till the surface pores of the specimen are saturated. Comparing the macroscopic surface area to the microscopic area, reveals pore size, pore volume and pore area in a specimen.

**Experiment Two:** To test if the coating is failing due to erosion, various corroded and non-corroded samples will be examined using two forms of microscopy. Identically coated sample specimens will under go the SAE J-2334 cyclical corrosion test for 10, 20, and 30 cycles. A coated and untested specimen will serve as a control group for each form of coating (ie. A-coat, or powder paint.) Using standard microscopic comparators the coating’s surface, along with its cross section, will be examined to determine if erosion has occurred. Selected specimens will also be examined using the more powerful Scanning Electron Microscope (SEM). An SEM analysis will also serve as a secondary examination of microscopic surface porosity. Finally, non destructive thickness detectors will be run on the specimens to determine overall thinning or reduction of the specimen.

**Experiment Three:** In order to determine if the coatings surface is “breathing” the samples will be subjected to a gaseous diffusion test. Various thicknesses of A-coat will be affixed to a test which will pass a known quantity of gas at a known pressure against a single surface. This test will allow an accurate detection of how much sample gas is allowed to pass through the coating. Water vapor and nitrogen are two sample gas options that would represent atmospheric conditions.

**Experiment Four:** To determine if residual acidity is causing the coating to fail several acidity tests will be run. The acidity levels will be checked at both the substrate boundary as well as external coating surface. These tests will be run on various coating thicknesses as well as material which has been coated and is uncured. Finally, uncoated but washed samples will also undergo Ph testing.

**Results:** Currently this project is still on going. No results were ready for publication at the time of this posters creation

**Estimated Project Completion:** January 30th, 2011

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**Autophoretic Coating Process**

**Step 1:**
- The base substrate is first cleaned in a multi-step process. Once cleaned the material is dipped into the emulsion and left to sit.

**Step 2:**
- As the material sits in the solution the iron begins to react with the acidity. During the ionic exchange pigments in the emulsion begin to attach to the substrates surface. The longer the time in the emulsion the thicker the coating will be.

**Step 3:**
- Once the desired thickness is obtained the part is removed from the emulsion and cured in an oven.

**Theories:** Several theories exist as to why Autophoretic Coating could be inferior to other methods.

1. **Microscopy of the Coating:**
   - Small pores may exist in the coating which allow air and moisture access to the substrate allowing for corrosion. These pores could be caused by the coating’s natural process or if water is trapped underneath the coating at the time of baking.
2. **Residual Acidity from the coating process:**
   - The acidity could be trapped between the coating and the substrate and slowly either cause the coating to fail or begin the corrosion process itself.
3. **Excessive diffusion of oxygen and water vapors:**
   - The coating could naturally “breathe” or allow air to pass through, at thin levels, which would allow the corrosion process to occur.
4. **The coating is being eroded causing failure to occur:**
   - Normal atmospheric conditions could be eroding the coating causing failure in its protection of the metal substrate.