Teflon® 858-916
Liquid, High-Build, Ruby Red, Permeation-Resistant Coating

Description
*Teflon®* 858-916 is a new filled version of a PFA liquid coating, specifically formulated to reduce permeation. It is an analog of *Teflon®* 532-5700 and *Teflon®* 532-13054 high-build, Ruby Red powder coating. The basic properties are those of *Teflon®* PFA. This product should be considered whenever permeation is thought to be a considerable risk to the performance of normal fluoropolymer coatings and where a liquid coating is desired. The coating is water based and has essentially no volatile organic content (VOC).

This new filled coating can be applied over a broad range of thicknesses. However, a coating thickness of 200 to 300 µm (8 to 12 mil) is recommended. Coatings of this thickness have been shown to be more effective than coatings of 500 µm (20 mil) of standard PFA in Atlas cell tests.

FDA Status
*Teflon®* 858-916 does not conform to FDA regulations governing components of coatings for direct food contact.

<table>
<thead>
<tr>
<th>Table 1</th>
<th><em>Teflon®</em> 858-916 Liquid Coating Typical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Ruby Red</td>
</tr>
<tr>
<td>Coverage, m²/kg/25 µm (f²/gal/mil)</td>
<td>8.39 (416)</td>
</tr>
<tr>
<td>Viscosity, cP Brookfield spindle #3 at 20 rpm</td>
<td>1100–2100</td>
</tr>
<tr>
<td>Volume Solids, %</td>
<td>28.7</td>
</tr>
<tr>
<td>Weight Solids, %</td>
<td>46.5</td>
</tr>
<tr>
<td>Density, g/cm³ (lb/gal)</td>
<td>1.37 (11.4)</td>
</tr>
<tr>
<td>Maximum use temperature Continuous, °C (°F)</td>
<td>260 (500)</td>
</tr>
</tbody>
</table>

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**Application Procedures**

When applying the coatings, it is best to have strong lighting, particularly from behind the sprayer or between the sprayer and the part, so the surface being coated is very well lit. This lighting arrangement allows the sprayer to see how wet the applied layer is. A conventional spray gun with a 0.8–1.5 mm nozzle and low atomization pressures (2.5–3 bars [35–45 psi]) is recommended. For thick applications (750 µm [30 mil]), a 1.2–1.4 mm nozzle is preferred. Hold the gun perpendicular to the surface at all times.

When trying to maximize thickness, the wet layer should be applied until it is visibly orange peeled and just short of the point where the liquid runs and flows. Any mechanism to accelerate the drying of the coating between passes, such as spraying it with air from the spray gun or air from a fan (being careful not to have such a high pressure that the coating is moved around on the part) will increase the viscosity of the applied coating and make it possible to apply more passes per coat. Care must be taken during auxiliary drying to avoid bringing dust into the area (e.g., if a large fan is used).

The time between two successive passes must be long enough to allow some drying. However, appearance of the last pass must be wet (like a mirror). Depending on the speed of spraying, you can apply up to 20–25 passes without sagging. The roughness of the cured coating is a compromise. Some roughness is needed to get cohesion between the layers, but too much can negatively impact the final film appearance. To prevent sagging when applying higher film thickness, the coating can be applied on a preheated part (30–40°C [86–104°F] maximum); 500 µm (20 mil) can be applied in a single coat in this fashion if desired. More can be applied, but mudcracking can occur.

**Drying**

Dry the part for 20–30 min. at 121–150°C (250–300°F) metal temperature. Oven temperature: 150°C (300°F) maximum.

**Baking of the First Coat**

It is important to control the baking cycle in such a way that the temperature does not rise too rapidly in order to avoid bubbling and blistering. For the first coat, the safest cycle is to bring the coated part to a temperature of 66–80°C (150–175°F), but no more than 93°C (200°F), holding it there for at least 15 minutes. This temperature will allow most of the water in the coating to evaporate without boiling. After most of the liquid has evaporated at this temperature, raise the oven temperature to approximately 150°C (300°F) for 15 minutes to complete the preliminary drying of the coating. After the 150°C (300°F) bake, increase the oven temperature to achieve a part temperature of 350–360°C (660–680°F). This temperature should be maintained for approximately 20 minutes.

**Baking Multiple Coats**

Drying and baking of the second and subsequent coats is the same as for the first coat. For optimum flow out of the topcoat, the last coat should be baked for 2–4 hr at a metal temperature of 340–360°C (645–680°F) (oven temperature not to exceed 360°C [680°F]).

**Topcoat**

A clear topcoat is recommended to improve the gloss of the coating, and more importantly, it serves as a protective coating for the red pigment. When the chemical exposure includes mineral acids such as hydrochloric, hydrofluoric, nitric, and sulfuric, it is recommended that a minimum of 4 mil of clear topcoat be applied. This topcoat eliminates the interaction of the acids with the red iron oxide of the filler, which can discolor both the coating and the liquid that comes in contact with it. Thinner clear topcoat layers can be used if the chemicals being contained will not react with the iron oxide.

There are two options for applying a clear PFA topcoat, 857-210 liquid coating and 532-5010 powder coating. When exposing the system to particular acids, the powder coating is recommended to maximize the thickness of the clear coat. 857-210 can be used to apply up to 100 µm (4 mil) of the clear coat, but it will require 2–3 coats of this product, each coat baked on at the high temperature. Because 857-210 has a low viscosity relative to 858-916, if it is applied wet-on-wet, it will lower the viscosity of the 858-916 which has been applied. If the 858-916 has been applied to a wet state, the addition of 857-210 may reduce the film viscosity too much resulting in sagging of the unbaked film.
For those applications where the clear coat is applied only to improve the final film appearance, a thin *mist* coat of 858-916 is sufficient and a *wet-on-wet* application can be used. However, for a higher gloss finish or when applying thick layers of the 857-210 topcoat, it is recommended that the first coat of 857-210 be applied only *after* the 858-916 Ruby Red has received a high temperature bake. In other words, when applying any substantial thickness of clear 857-210, do not use the *wet-on-wet* procedure. Also, care should be taken to initially bake the topcoat at 65–80°C (150–175°F) for 30 minutes prior to stage baking the part in intervals of 24–50°C (75–125°F), depending upon substrate and coating thickness. Hold times at each interval should be a minimum of 30 minutes to prevent browning of the topcoat with longer hold times required for thicker topcoat builds per coat (>37 µm [1.5 mil]). Too fast a ramp up to the high temperature will cause blistering and/or *browning* of the coating. The browning is due to the top surface of the coating becoming consolidated before the surfactants in the lower regions of the coat can evaporate or *burn off*. *Table 2* is a sample bake profile for the application of 857-210 over 858-916 on 1/4 inch thick steel.

**Repair**

If the coating is too rough or needs to be repaired, it is possible to sandpaper the coating. For high thicknesses, use P80–120 grit sandpaper; for thin layers, use P400. Be careful not to damage the primer; this could result in rust formation during the application of *Teflon®* 858-916.

**Spark Testing**

A coating of 500µm (20 mil), which is properly applied and baked, should easily pass a 4–5 kV porosity test.

**Thinning**

For application on parts with difficult shapes (e.g., when extensions of the spray guns are used), it may be necessary to dilute *Teflon®* 858-916 to a lower viscosity with water. The water should be added slowly, with stirring, to avoid destabilizing the material. Refer to *Figure 1*.

**Cleanup**

Use water for cleanup.

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**Table 2**

<table>
<thead>
<tr>
<th>Temperature °C (°F)</th>
<th>Hold Time (min.)</th>
<th>Ramp Temp. °C (°F)</th>
<th>Ramp Time (min.)</th>
<th>Cumulative Bake (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>54 (150)</td>
<td>30</td>
<td>105 (225)</td>
<td>5*</td>
<td>35</td>
</tr>
<tr>
<td>105 (225)</td>
<td>30</td>
<td>150 (300)</td>
<td>5*</td>
<td>70</td>
</tr>
<tr>
<td>150 (300)</td>
<td>30</td>
<td>220 (425)</td>
<td>10*</td>
<td>110</td>
</tr>
<tr>
<td>220 (425)</td>
<td>30</td>
<td>290 (550)</td>
<td>15*</td>
<td>155</td>
</tr>
<tr>
<td>290 (550)</td>
<td>30</td>
<td>345 (650)</td>
<td>20*</td>
<td>205</td>
</tr>
<tr>
<td>345 (650)</td>
<td>20</td>
<td>—</td>
<td>—</td>
<td>225</td>
</tr>
</tbody>
</table>

Total — 3 hr 45 min.

* Ramp times are totally depending on substrate thickness and oven efficiency.
**Storage**

Protect from freezing.

**Performance Testing**

The most important performance test for this product is the Atlas cell exposure test.

**Atlas Cell Testing**

Atlas cell is a test that allows the estimation of the resistance of a coating in contact with a chemical at a given temperature. Refer to Figure 2. The coating is applied on the inside of the panels, which close the glass pipe. A thermometer and a heating element control the temperature. The coating is exposed to both a liquid and a vapor phase. Visual inspection is done every week. After 720 hr (±1 month), the test is stopped and adhesion is tested.

Two panels and microscopic pictures are shown in Figure 3, where significant improvement in performance of the Teflon® 858-916 coating system over a standard high-build, pure PFA coating is evident.

**Note:** Under some extreme exposure conditions (high temperature H₂S for instance), the red pigment in the ruby red products can change color to black. Iron oxides are known to change color without a large structural change, so the color change has not affected any of the performance characteristics of the coating system.

**Safety**

Follow normal industrial safety practices for handling and applying Teflon® products. Industrial experience has clearly shown Teflon® materials can be processed and used at elevated temperatures without hazard providing adequate ventilation is used. Ventilation should be available at baking temperatures of 275°C (525°F) and above. Before using Teflon®, read the Material Safety Data Sheet (MSDS) and the detailed information in the “Guide to the Safe Handling of Fluoropolymer Resins,” latest edition, published by the Fluoropolymers Division of The Society of the Plastics Industry.

When grit-blasting Teflon® finishes off aluminum or magnesium surfaces, the possibility of explosion exists if the fines are allowed to heat up. Good housekeeping practices, keeping the residue wet, and keeping the ventilation and dust collection systems in good working order reduces this risk.

Figure 2. Atlas Cell Testing
Table 3
Atlas Cell Test Results

<table>
<thead>
<tr>
<th>Medium</th>
<th>Temperature, °C (°F)</th>
<th>DFT, µm (mil)</th>
<th>Time of Exposure, hr</th>
<th>Blisters</th>
<th>Adhesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCl 0.05 N</td>
<td>100 (212)</td>
<td>&gt;111 (4.4) (1 layer)</td>
<td>720</td>
<td>None</td>
<td>OK</td>
</tr>
<tr>
<td>HCl 0.6 N</td>
<td>100 (212)</td>
<td>125 (5) (2 layers)</td>
<td>&gt;744</td>
<td>None</td>
<td>OK</td>
</tr>
<tr>
<td>HCl 37%</td>
<td>90 (194)</td>
<td>186 (7.4) (2 layers)</td>
<td>&lt;120</td>
<td>Yes</td>
<td>NOK</td>
</tr>
<tr>
<td>HCl 37%</td>
<td>90 (194)</td>
<td>172 (7) (2 layers)</td>
<td>&lt;240</td>
<td>Yes</td>
<td>NOK</td>
</tr>
<tr>
<td>HCl 37%</td>
<td>90 (194)</td>
<td>552 (22) (5 layers)</td>
<td>&gt;240</td>
<td>None</td>
<td>OK</td>
</tr>
<tr>
<td>H₂SO₄ 20%</td>
<td>90 (194)</td>
<td>191 (7.6) (2 layers)</td>
<td>&gt;696</td>
<td>None</td>
<td>OK</td>
</tr>
<tr>
<td>H₂SO₄ 95%</td>
<td>50 (122)</td>
<td>184 (7.4) (2 layers)</td>
<td>&gt;648</td>
<td>None</td>
<td>OK</td>
</tr>
<tr>
<td>H₂PO₄ 85%</td>
<td>50 (122)</td>
<td>183 (7.4) (2 layers)</td>
<td>&gt;120</td>
<td>Yes</td>
<td>NOK</td>
</tr>
<tr>
<td>HNO₃ 65%</td>
<td>50 (122)</td>
<td>191 (7.6) (2 layers)</td>
<td>&gt;696</td>
<td>None</td>
<td>OK</td>
</tr>
<tr>
<td>Water</td>
<td>100 (212)</td>
<td>250 (10) (3 layers)</td>
<td>&gt;240</td>
<td>None</td>
<td>OK</td>
</tr>
</tbody>
</table>

Figure 3. Standard PFA Coating vs. Teflon® 858-916 Coating System

~10 mil pure PFA powder on primer badly blistered

~10 mil pure Teflon® 858-916 over primer unaffected except for slight color shift

Microscopic view of the blistering of the Atlas cell panel of standard PFA system

Microscopic view of the lack of blistering of the Atlas cell panel of Teflon® 858-916 system
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