Fact Sheet

DuPont®

Teflon®

Nonstick & Industrial Coatings

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 1
***Teflon®* 858-916 Liquid Coating**
Typical Properties

Color	Ruby Red
Coverage, $m^2/kg/25\ \mu m$ ($f^2/gal/mil$)	8.39 (416)
Viscosity, cP Brookfield spindle # 3 at 20 rpm	1100–2100
Volume Solids, %	28.7
Weight Solids, %	46.5
Density, g/cm^3 (lb/gal)	1.37 (11.4)
Maximum use temperature Continuous, °C (°F)	260 (500)

Application

Metal Surface Preparation

Aluminum, stainless steel, and carbon steel are acceptable substrates with the use of the proper primer. Best adhesion is obtained by thoroughly cleaning and then roughening the substrate. Cleaning is preferably done using a commercially available hot alkaline solution. Commercial solvent degreasing and steam cleaning are an acceptable alternate. Roughening is preferably done by grit blasting with aluminum oxide. The grit blast profile should be to an Ra of 100–125 µin (2.5–3 µm) maximum. This can be achieved with coarse grit (30–40 grit) using 90–100 psi air pressure. Prime and dry the substrate as soon after blasting as possible to reduce oxidation.

Primer

Teflon® 420-703 (solvent based) is the only recommended primer for this product. Filter the primer through 40-mesh (approximately 400 µm [16 mil]) stainless steel or nylon. Make sure the primer covers the substrate completely to avoid rusting of the substrate after the application of the first water-based coat. The primer should be applied over the freshly cleaned and blasted surface with a dry film thickness just enough to cover the substrate (10–15 µm [0.4–0.6 mil]).

Mixing

Mix *Teflon®* 858-916 before use. Use a propeller-type mixer at 500 rpm and mix for 10 min. Filter the liquid through 40-mesh (approximately 400 µm [16 mil]) stainless steel or nylon.

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 to not 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 ram 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.

Figure 1. ***Teflon*® 858-916 Viscosity**

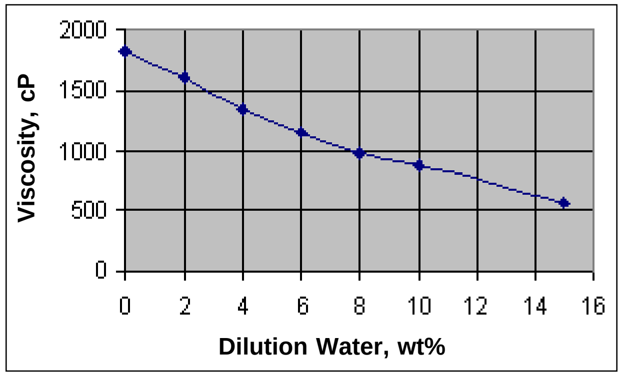


Table 2

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

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 H_2S 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

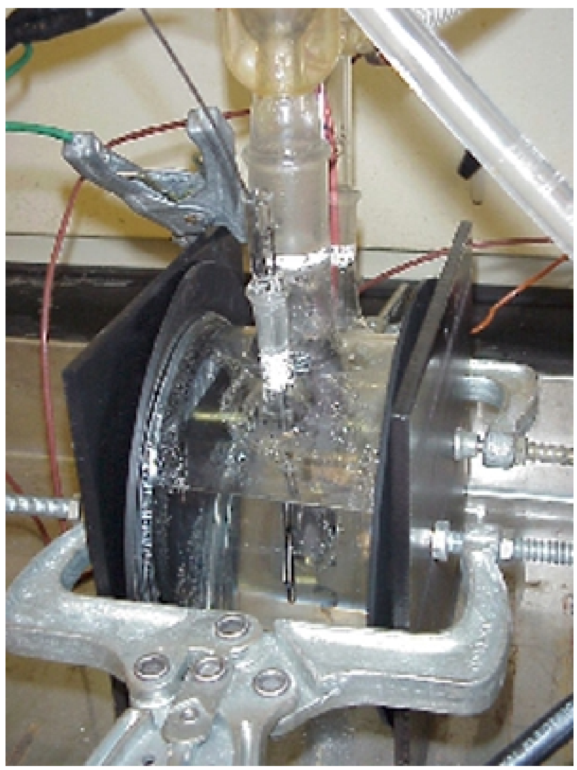
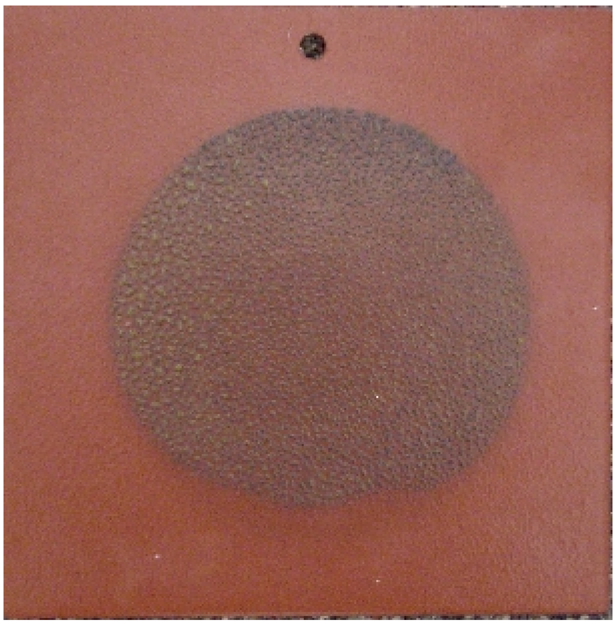


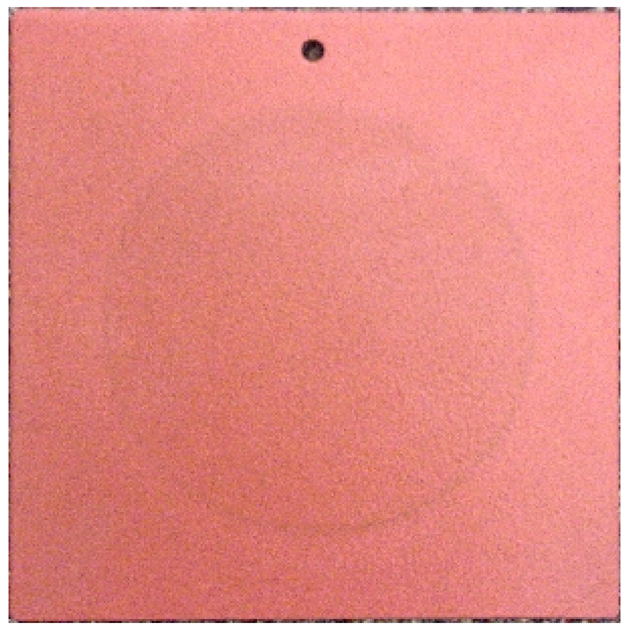
Table 3
Atlas Cell Test Results

Medium	Temperature, °C (°F)	DFT, µm (mil)	Time of Exposure, hr	Blisters	Adhesion
HCl 0.05 N	100 (212)	>111 (4.4) (1 layer)	720	None	OK
HCl 0.6 N	100 (212)	125 (5) (2 layers)	>744	None	OK
HCl 37%	50 (122)	186 (7.4) (2 layers)	<120	Yes	NOK
H_2SO_4 20%	90 (194)	172 (7) (2 layers)	<240	Yes	NOK
H_2SO_4 20%	90 (194)	552 (22) (5 layers)	>240	None	OK
H_2SO_4 95%	50 (122)	191 (7.6) (2 layers)	>696	None	OK
H_3PO_4 85%	50 (122)	184 (7.4) (2 layers)	>648	None	OK
HNO_3 65%	50 (122)	183 (7.4) (2 layers)	>120	Yes	NOK
Water	100 (212)	250 (10) (3 layers)	>240	None	OK

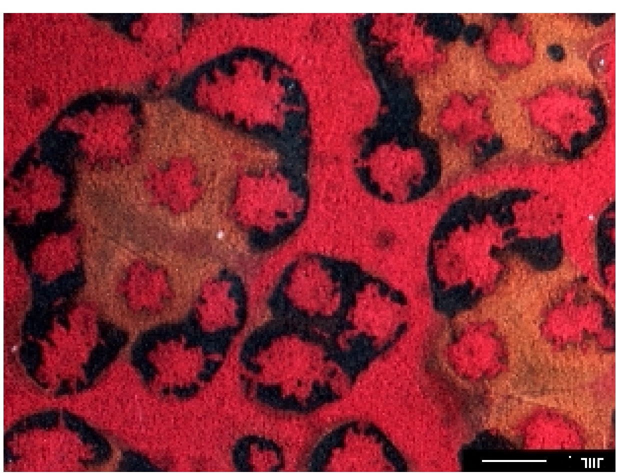
Figure 3. Standard PFA Coating vs. *Teflon*® 858-916 Coating System



~10 mil pure PFA powder on primer badly blistered



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



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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CAUTION: Do not use in medical applications involving permanent implantation in the human body. For other medical applications, see “DuPont Medical Caution Statement,” H-50102.

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(11/00) RWJ32 Printed in U.S.A.
[Replaces: H-85093-1]
Reorder No.: H-85093-2