

# COILWORLD

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- **Adjusting Coating Viscosity**
- **Hand-Held LED Color Measurements**
- **Passivated Steel: Debate Over Paintability**
- **Coil Coaters Capability Directory**



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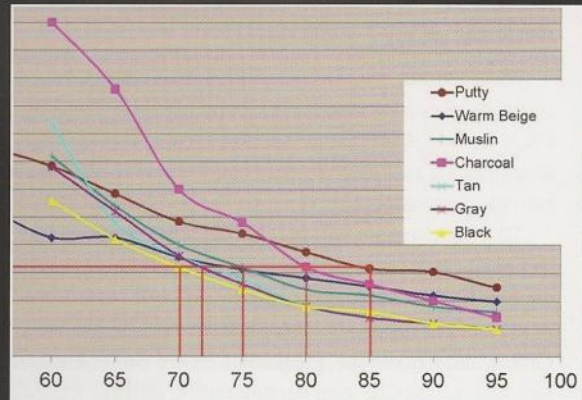
MICHAEL BONNER

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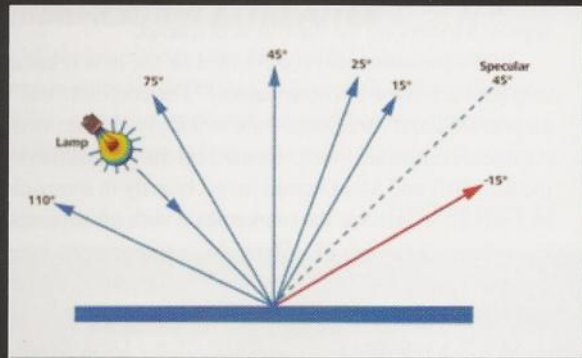
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# ADJUSTING COATING VISCOSITY

By Michael R. Bonner, Vice President, Engineering & Technology, St. Clair Systems, Inc.

Virtually all coaters understand the importance of fluid viscosity to the coating process. Performance parameters such as coating film build, color match, voids, chemical resistance, and the like can all be linked directly to the viscosity of the [liquid] coating material when it was applied. In addition, process parameters such as pressure, flow rate and coating speed are all dependent on coating material viscosity. For these reasons, virtually all coating processes begin with the measurement, and often the adjustment, of coating viscosity.

## Solvent Addition

By far, the most common form of viscosity adjustment is the addition of solvent to reduce the viscosity of the coating material. This is effective because most solvents have a viscosity that is orders-of-magnitude lower than the coating material to which they are being added. The viscosity of the mixture is a function of the ratio of the viscosity of the two liquids and the ratio of the volume of the two. As such, this relationship will be different for every coating/solvent combination. Figure 1 demonstrates this point showing the change in viscosity of two typical coatings when "reduced" with solvent. This demonstration was started with 30 gallons of virgin coating, and then solvent was added one gallon at a time and the viscosity measured with a #4 Ford Cup after each addition. Each coating was held at a constant 105°F throughout the experiment.

Here we can see some important phenomena. First, the change in viscosity of the two coatings is similar but unique; second, the flattening of the curve as the solvent

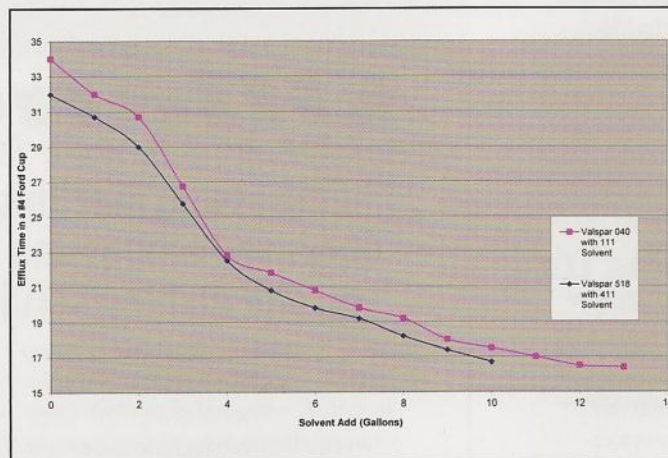
addition approaches 14 gallons; and finally, the importance of thorough mixing to homogenize the blend prior to attempting to measure the effect of the addition. After the fourth gallon of solvent was added, a bubbler was added to insure that the mixture was thoroughly blended before the viscosity measurement was taken. From this point on, the measurements were much more stable. In Figure 2, the trend of the relationship between percent solvent addition and viscosity for the 040 material is shown overlaid on the raw data:

By converting to a percentage, we allow the results to be predicted independent of the volume being mixed. In other words, the amount to add can be predicted as a percentage of volume and, therefore, works equally well with 5-gallon pails, 55-gallon drums or 300-gallon totes. For instance, if a viscosity of 26 seconds is required, it is easy to use the curve to calculate the volume of solvent to add in order to affect that change, which is shown here in Figure 3:

This shows how easy it is to predict the required solvent addition to achieve a specific viscosity. In addition, this also shows that for the first 20% - 25% of solvent addition, the change in viscosity is fairly linear, further simplifying the prediction and improving the chances of achieving the desired viscosity on the first try – but only at 105°F.

## Temperature Changes

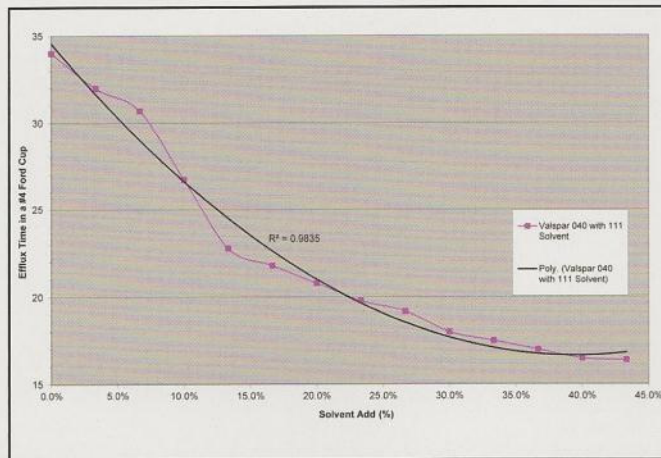
Just as the curve shifts for different coating and solvent combinations, it also shifts for changes in temperature. The reason for this is the change in viscosity



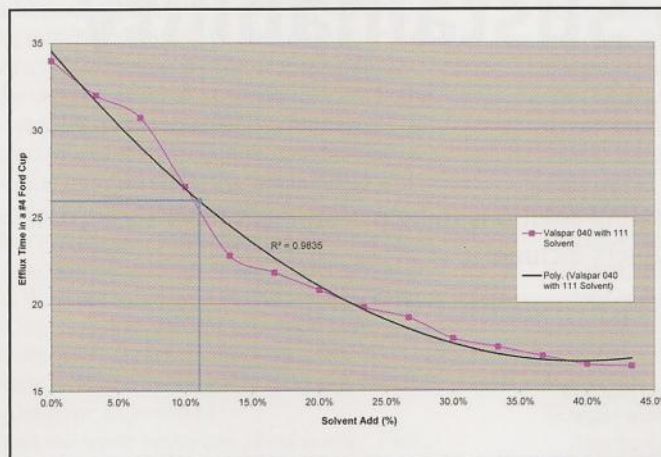
**Figure 1:** Effect on Viscosity of Adding Solvent to Coating Material

This shows the reduction in viscosity, measured with a #4 Ford Cup as solvent is added.

Though similar, these two coatings demonstrate that there is an individual relationship between each coating and solvent pair.

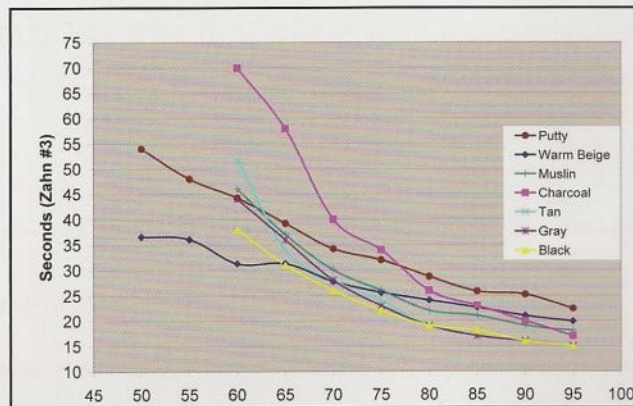


**Figure 2:** Trend of Viscosity as a Function of Percent Solvent Addition  
The black trace shows the trend in the reduction in viscosity, measured with a #4 Ford Cup as a function of the percent of solvent added. This smooths the errors caused by inadequate mixing and still shows a correlation  $>0.98$ . It also shows the flattening of the curve as addition rates increase.

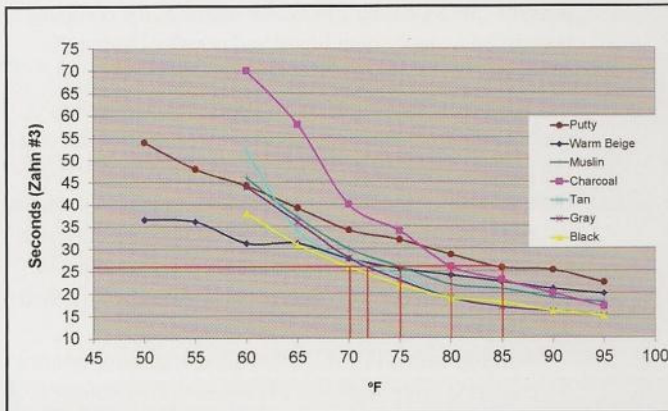


**Figure 3:** Predicting Percent Solvent Addition to Achieve a Desired Viscosity

This shows how to determine the volume of solvent to add to achieve a specific viscosity, measured with a #4 Ford Cup at a temperature of 105°F. This makes it easy to figure out the proper solvent add independent of the source volume.



**Figure 4:** Viscosity vs. Temperature Curves for a Group of Coating Materials  
This shows the change in viscosity as a function of temperature for a group of similar coatings. Though all comprised of the same resin base, the different pigments, fillers, and additives result in large variations in the shape of the curve for each material.



**Figure 5:** Temperature to Reach 26 Second Viscosity for Coating Group

This shows the temperature that corresponds to a 26s viscosity for each of the coatings in the group. The different pigments and additives cause each to reach the optimal 26s viscosity at a different temperature in the 70°F – 85°F range.

as a function of temperature common to all fluids. The viscosity vs. temperature curves for a group of similar coating materials are shown here in Figure 4:

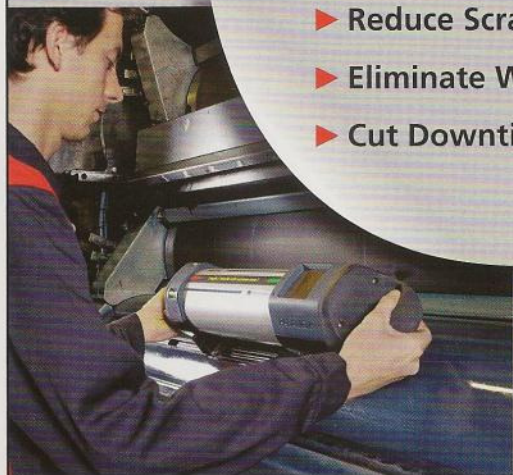
Each of these coatings are formulated from the same resin base and are considered to be identical – with the exception of color. From these curves however, it is clear that the differences in pigments, fillers, and other additives have a significant impact on the viscosity vs. temperature performance of each of these coatings. This causes each to perform optimally at a different point on its curve. For instance, if these specific coatings were formulated to operate optimally at a viscosity of 26 seconds in a Zahn #3 cup, each will reach that optimized point at a different temperature, as is shown here in Figure 5:

From Figure 5, we can see that the Black coating reaches its optimal 26-second viscosity at a temperature of 75°F, whereas the Gray and Tan both reach 26 seconds at about 72°F. The Muslin and Warm Beige are down to 26 seconds at 75°F, but the Charcoal and Putty don't reach this optimal coating viscosity until 80°F and 85°F respectively.

The interesting point here is that by manipulating the temperature of these coatings, the optimal coating viscosity can be achieved without the addition of solvents. On the surface, this would appear to be the most cost-effective option and, when a coating system is equipped with a temperature control system capable of selecting and maintaining a specific temperature as part of a coating "recipe", this is easy to realize. That being said, in many cases it may be more practical to balance solvent addition with temperature control to achieve a group of coatings that all work with a single coater setup, making it easier for the operators to change from color to color, saving time and setup-related issues, which may be even more cost-effective in the long run. While the need to control the temperature of your coating during application is clear, once the control of coating temperature has been achieved, the key is to work with your coating supplier to develop the highest performing, most cost-effective group of coatings for your specific operation. ●

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