Determining Volume Solids of Coatings

**Answer**

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The volume solids of a coating is the ratio of the volume of its non-volatile components to its total wet volume. The figure is usually expressed as a percentage.

Traditionally, volume solids were calculated from the formulation of a coating. This theoretical approach did not take account of pigment packing, solvent retention, and film contraction, and so calculated values did not always relate well to practical use. Subsequently, volume solids calculated from the formulation often resulted in an underestimation of coverage for some generic paint types and an overestimation for others.

Most manufacturers of protective coatings now favor the following more practical method of measuring the volume solids of a paint.

- Measure the dry film thickness (dft) obtained from a measured wet film thickness (wft).
- Calculate volume solids as follows: 
  \[
  \text{Volume Solids} = \left( \frac{\text{dft}}{100} \right) \div \text{wft}.
  \]

The coating should be applied at a wft, as recommended in the technical data sheet, and allowed to dry/cure as scheduled (typically 7 days at 23 ±1°C [73±2°F]) before the dry film thickness is measured.

Recommended laboratory procedures are described in ASTM D 2697-86 (Reapproved 1991), *Standard Test Method for Volume Nonvolatile Matter in Clear or Pigmented Coatings,* and reviewed critically in *Monograph No. 4 of the Oil and Colour Chemists’ Association (OCCA).*

For two-pack products, such as chemically cured epoxies and inorganic zinc riches, there are two options—to determine the volume solids of the base and hardener separately or to mix the two components together and then determine the volume solids of the mixed paint.

The volume solids of the mixed paint has practical significance, since the solvent release characteristics will be influenced by the curing mechanism. In addition, the volume of the mixed paint may not be the same as the sum of the individual volumes. For these reasons, it is preferable to determine the volume solids of the mixed paint. Care must be taken to mix the two components together accurately and to apply the film before any pigment can settle. The density determination is made on the mixed paint.

Volume solids of inorganic zinc-rich paints are best determined by measuring wet and dry film thicknesses (not volumes). The wft is calculated from the weight solids, the dry film weight of a known coated area, and the density of the wet paint. (Use of a density cup is recommended.) To calculate wft from weight solids, three hours at 105°C (221°F) is used in Method A of ASTM D 1644-88 (Reapproved 1993), *Standard Test Methods for Nonvolatile Content of Varnishes.*

Dry film thickness is best measured using a sensitive stylus or laser surface tracing technique. The coating is applied to microscope slides using a cube applicator, allowed to dry for seven days at 23 ±1°C (73±2°F), and the thickness of the resulting dry film is then measured.

**Question**

What is the best method to determine volume solids of coatings such as chemically curing epoxies and inorganic zinc riches?
A

Answer
S. Vonckx,
CoRI,
Limelette, Belgium:
Following is an easy and representa-
tive method to determine the vol-
ume solids of coatings.

• Mix the components as described in the technical data sheet of the product.
• Immediately after mixing, apply the paint on steel panels with different sizes of application knives (e.g., 150 µm [6 mils], 250 µm [10 mils], etc.).
• Immediately after applying the paint, measure the wet film thickness on the different panels.
• Cure the paint as described in the technical data sheets.
• After curing, measure the dry film thickness.
• Calculate the relationship (in per-
centage) of the dry film thickness to the wet film thickness on the several panels.
• Calculate the mean of all these results.

We have already used this method and have demonstrated that the results are representative of those ob-
tained with other methods.

Another method is found in ISO 3233, Paints and Varnishes–Determina-
tion of Percentage Volume of Non-Volatile Matter by Measuring the Density of a Dried Coating.

According to this method, a disc is coated with the paint to be tested after mixing its components. The mass and volume of the disc before the coating is applied and after the coating is applied and dried are de-
termined by weighing it in air and in a liquid of known density. From these measurements, the volume of the dried coating can be calculated.

From the density of the liquid coating (as determined by the method in ISO 2811, Paints and Varnishes–Determination of Density) and the percentage by mass of non-
volatile matter (using the method in ISO 3251, Paints and Varnishes–De-
termination of Non-volatile Matter of Paints, Varnishes and Binders for Paints and Varnishes), the volume of the liquid coating deposited on the disc can be calculated. The volume of the dried coating divided by the volume of the liquid coating and multiplied by 100 is the percentage by volume of non-volatile matter in the liquid coating.

Send Reader Responses to this month’s question to Karen Kapsanis, Editor, JPCL, 2100 Wharton St., Suite 310, Pittsburgh, PA 15203; fax: 412/431-5128; e-mail: kkapsanis@protectivecoatings.com.
Upcoming Problem Solving Forum Questions

- **What** are the detrimental effects of overly thick finish coats, (not primers) on a substrate; on the coating itself; on intercoat adhesion; and on the following: steel structures exposed to the environment; linings in immersion service; hot duty steel surfaces above 149 F (65 C).
  What is the best way to remedy over-thickness after the coating has dried or cured?

- **Which** preparation procedures and acceptance criteria can be used and applied for secondary surface preparation of shop primer?

- **How** is it possible to effectively remove soft coating materials and replace them with hard coating materials when ships are in service?

- **Given** the prevalent use of surface-tolerant epoxies on flash-rusted surfaces, is it time to reduce the Sa 2 1/2 (SSPC-SP 10) cleanliness standard for new dry-blasted? Likewise, what about the requirements for a specific surface profile?

- **What** types of coatings can be used on the inside of pipes used to supply potable water in high-temperature conditions?

- **What** differences in performance and speed of application exist among airless, HVLP, and conventional spray equipment for field painting of structural steel?

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