

PURPOSE

This section provides information on the key factors effecting coating coverage and costs. Consideration is also given to “stretching” a coating with thinner, and comparing costs per litre.

INTRODUCTION

The purchaser of protective coatings is responsible for selecting the most economic coating available which is suitable to achieve the required protection. The coatings field is complex and knowledge of coating calculation techniques and interpretation of data is required in order to make the appropriate choice.

VOLUME SOLIDS

Most liquid coatings contain a solids portion and a volatile portion. The solids portion consists of the binder, normally oil or resin, together with colouring and functional pigments, extenders and additives.

The volatile portion is the solvent or thinner that merely liquefies the solids sufficiently to carry them onto the surface being coated. The solvent then evaporates, leaving behind the dried film of solids, which provides protection and decoration. The coating user is most concerned with this remaining film volume or thickness because it is this, which provides the desired hiding, gloss, weather resistance, colour etc.

When selecting a coating the key is how much area will the solids cover per litre after the volatiles have evaporated?

SOLIDS CONTENT BY VOLUME OF SURFACE COATINGS

Solids content is a theoretical calculation based on certain assumptions concerning the densities of the raw materials used in paints. In practice, the solids content obtained can vary greatly from its theoretical value because of change in the following:

- Densities
- Temperature effects
- Small differences in the physical condition of the paint
- The methods and conditions of application

In addition, film contraction, solvent-retention and volatility of low molecular weight polymers can all contribute error. The determination of volume solids by AS/NZS 1580.301.2, is difficult to calculate and large variations have been observed in practice. For these reasons the volume solids values given in this manual are determined by a method which corresponds to ASTM method D2697 and ISO 3233 with a slight modification for use at practical film thickness and with usual curing and hardening requirements.

The calculations obtained are generally higher than the theoretical calculated volume solids, but the method approximates the spreading rates obtained under ideal conditions. Volume solids should not be used to gauge practical spreading rate as so many other variables have to be taken into account. For this purpose please use the data provided later in this section.

“STRETCHING” A COATING WITH THINNER IS A MYTH

Adding solvent or thinner to the liquid coating adds nothing to the hiding or spreading rate of the coating solids as the extra solvent evaporates. Instead, extra solvent merely increases the coating cost by the price of the thinner and increases application costs by the additional labour time required to mix the thinner into the coating. In the case of baking systems, the cost is increased by the greater amount of oven heating required to remove the thinner.

Adequate volume solids, not thinners, are the key to proper coverage by a coating.

COMPARING LITRE COSTS

Often buyers tend to select a coating strictly on a cost per litre basis without considering the volume solids of the paint. The user of a coating should be interested in the cost of finishing a given unit area and not the price per litre.

In the long run the coating user receives value only from that portion of the litre that remains as dried coating film after the volatile solvent or thinner has been released. Volume solids are the key factor in determining coating economies and not weight solids.

THEORETICAL SPREADING RATE

The theoretical spreading rate is a calculation of the amount of coating on average applied to a surface, assuming no losses or penetration into the substrate. It can be calculated as follows:

$$\text{Theoretical Spreading Rate (m}^2\text{/L)} = \frac{\text{Volume Solids (\%)} \times 10}{\text{Dry Film Thickness (in microns)}}$$

Example (I): A primer has a volume solids of 55% and needs to be applied at a dry film thickness of 75 microns. What is the theoretical spreading rate?

$$\begin{aligned} \text{Theoretical Spreading Rate (m}^2\text{/L)} &= \frac{55 \times 10}{75} \\ &= 7.33\text{m}^2\text{/L} \end{aligned}$$

Example (II): If 10% thinner was required to thin the coating to application viscosity and a dry film thickness of 75 microns is still required. The calculation would be as follows:

$$\begin{aligned} \text{Theoretical Spreading Rate (m}^2\text{/L)} &= \frac{55 \times 10}{75} \times \frac{100\%}{(100\% + 10\%)} \\ &= 6.67\text{m}^2\text{/L} \end{aligned}$$

PRACTICAL SPREADING RATE

Except under closely controlled conditions, Theoretical Spreading Rates are hardly ever achieved, therefore in estimating coating requirements and costs, allowance must be made for losses which occur during application due to such factors as surface roughness, application method and application conditions. An empirical relationship which may be used to calculate Practical Spreading Rate as follows:

Practical Spreading Rate = Theoretical Spreading Rate X Coverage Efficiency

The guide (table) below shows the approximate coverage efficiencies expected for various surfaces and application conditions.

Surface	Application Method			
	Brush/Roller	Airless Spray/Interior	Airless Spray/Exterior	Airless Spray/Windy Conditions
New Smooth Steel	0.87	0.78	0.68	0.49
Blast Cleaned Steel	0.83	0.74	0.65	0.46
Power Tool Cleaned Steel	0.79	0.70	0.61	0.44
Blasted Steel – lightly pitted	0.79	0.70	0.61	0.44
Blasted Steel – heavily pitted	0.74	0.70	0.58	0.41
Rough Concrete or Masonry	0.61	0.66	0.47	0.34

Example (I): An application had a coating with a theoretical spreading rate of 4.0m²/L and intended to airless spray lightly pitted steel, with only light winds. Calculate the practical spreading rate:

$$\begin{aligned} \text{Practical Spreading Rate (m}^2\text{/L)} &= 4.0 \times 0.61 \\ &= 2.44\text{m}^2\text{/L} \end{aligned}$$

CONVERSION OF SPREADING RATES TO USAGE RATES

It is sometime necessary to convert from spreading rates expressed in m²/L to a usage rate in L/m². This gives the amount of paint required to coat a square metre of surface:

$$\text{Usage Rate (L/m}^2\text{)} = \frac{1}{\text{Spreading Rate (m}^2\text{/L)}}$$

Example (I): A coating has a spreading rate of 2.5m²/L. What is the usage rate in L/m²?

$$\begin{aligned} \text{Usage Rate (L/m}^2\text{)} &= \frac{1}{2.5} \\ &= 0.4\text{L/m}^2 \end{aligned}$$

DRY AND WET FILM THICKNESS

It is often necessary to convert between a wet film thickness and a dry film thickness. This calculation assumes that a perfect film is laid and that after evaporation of the solvents there is no air or solvent trapped in the film. This calculation is not accurate for inorganic zincs that have a porous silicate matrix:

$$\text{Dry Film Thickness (microns)} = \frac{\text{Wet Film Thickness X Volume Solids (\%)}}{100}$$

Example (I): A coating has a wet film thickness of 100 microns and volume solids of 60%. What would you expect the dry film thickness to be?

$$\begin{aligned} \text{Dry Film Thickness (microns)} &= \frac{100 \times 60}{100} \\ &= 60 \text{ microns (DFT)} \end{aligned}$$

$$\text{Wet Film Thickness (microns)} = \frac{\text{Dry Film Thickness X 100}}{\text{Volume Solids (\%)}}$$

Example (II): A coating has a dry film thickness of 100 microns and volume solids of 80%. What would you expect the wet film thickness to be?

$$\begin{aligned} \text{Wet Film Thickness (microns)} &= \frac{100 \times 100}{80} \\ &= 125 \text{ microns (WFT)} \end{aligned}$$

MATERIAL COST PER SQUARE METRE

To determine the material cost per square metre we must know the coverage rate at the film thickness specified:

$$\text{Material Cost (\$/m}^2\text{)} = \frac{\text{Cost per litre (\$/L)}}{\text{Spreading Rate (m}^2\text{/L)}}$$

Example: A primer has a spreading rate of 6.0 m²/L at 75 microns dry film thickness. The cost of the coating is \$9.00/L. What is the material cost of the coating, assuming no losses?

$$\begin{aligned} \text{Material Cost (\$/m}^2\text{)} &= \frac{\$9.00/\text{L}}{6.0\text{m}^2/\text{L}} \\ &= \$1.50/\text{m}^2 \end{aligned}$$

ESTIMATING PAINT QUANTITIES FOR BOATS

The following table outlines the calculations for paint quantities for boats, an example is provided.

Boat Area & Quantity Calculation

Spars & Masts	length X mean circumference	=	square metres
Deck Areas	length overall X beam X 0.75	=	square metres
Topsides	(length overall + beam) X 2 X average freeboard	=	square metres
Underwater Areas	length at waterline X (beam + draught)	=	square metres

Example: Calculation of required paint quantity for a boat hull.

An underwater area of a steel vessel 15 metres long at the waterline, draught of 1.5 metres and beam of 4 metres.

The coating to be applied has a theoretical spreading rate of 7m²/Litre and the following application conditions apply:

Application method	=	Spray
Substrate	=	Blasted steel – lightly pitted
Location	=	Exterior – no wind
Area to be coated	=	length at waterline X (beam + draught)
	=	15 X (4 + 15)
	=	82.5 m ²
Practical Spreading Rate	=	Theoretical Spreading Rate X Coverage Efficiency
	=	7 X (0.61)
	=	4.27m ² /Litre
Paint quantity required for underwater area	=	82.5m ² /4.27m ² /Litre
	=	19.32 Litres
Practical quantity	=	20 Litres.



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