Theoretical & Practical Coverage

International Protective Coatings

Volume Solids and Theoretical Spreading Rates

INTRODUCTION

Estimating paint coverage is a key costing's factor for both owners and contractors.

On site, practical coverage is a function of many factors, with losses due to surface condition, paint distribution, application procedure and wastage being the major factors in determining the volume of paint required for a given specification. At the initial costing stage, however, paint usage is calculated from the quoted "volume solids".

The variety of methods used by different manufacturers to calculate, or determine "volume solids" can lead to confusion and misunderstanding, particularly when comparisons between paint systems are being made. These notes are intended to guide users and specifiers both in the practical assessment of paint losses, and in their theoretical calculations.

The technique and approach described have been adopted by International Protective Coatings throughout its worldwide organisation.

VOLUME SOLIDS

The volume solids of a coating is the ratio of the volume of its non volatile components to its total wet volume.

Traditionally, this figure was calculated from the paint formulation but, since this took no account of factors such as pigment packing, solvent retention, or film contraction, the value bore little relation to that obtained in practice. Also, since these factors vary in importance between paint types, the calculated volume solids can result in an underestimation of coverage of some generic types of paint and an overestimation of others.

To overcome this problem, International Protective Coatings (and most other manufacturers) use a more practical method to establish a paint's "volume solids".

The method used measures the dry film thickness obtained from a measured wet film thickness, and volume solids is given by:

$$\text{Volume solids} = \frac{\text{measured dft x 100}}{\text{measured wft}}$$

MEASUREMENT OF VOLUME SOLIDS IN THE LABORATORY

The volume solids figure given in the product data sheets is the percentage of the film obtained from a given wet film thickness under specified application method and conditions. These figures have been determined under laboratory conditions using the test method described in the Oil & Colour Chemists (OCCA) Monograph No. 4 - Determination of the Solid Content of Paint (by Volume). This method is a modification of ASTM D-2697 which determines the volume solids of a coating using the recommended dry film thickness of the coating quoted on the product data sheet, and a specified drying schedule at ambient temperature, i.e. 7 days at 23°C ± 1°C.

SPECIAL SITUATIONS - ZINC PAINTS

The volume solids of such paints are determined by different means because they are so highly pigmented. The high pigment loading means that the dry film contains voids and the extent of the voids is dependent, to some extent, on the techniques of application. An alternative method of measuring volume solids has therefore been used to circumvent the variable void content of the dry film and thus provide a reliable figure. Details of the methods used will be given on request. In general a modification of ASTM D-2697 gives the most meaningful results and is used on International Protective Coatings product data sheets.

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THEORETICAL COVERAGE DETERMINATION FROM VOLUME SOLIDS

The theoretical coverage can be determined from the two formulae below.:

Formula 1 (Metric)

$$\frac{\text{volume solids (\%) x 10}}{\text{measured dft (in microns)}} = \text{Theoretical Coverage (m}^2\text{/ltr)}$$

Formula 2 (US Measure)

$$\frac{\text{volume solids (\&) x 16.04}}{\text{measured dft (in mils)}} = \text{Theoretical Coverage (sq.ft/US gallon)}$$

Conversion from theoretical to Practical Coverage

INTRODUCTION

Estimating accurately the quantity of paint required for a particular job is complicated, since the theoretical coverage takes no account of the variable “losses” involved in converting paint in the can to a film on the chosen surfaces. Experienced contractors, with their knowledge of local conditions and their workforce etc, are best able to produce accurate estimates. These notes are intended to supplement this experience by highlighting the major areas of “losses”. Two types of loss are considered; “apparent losses” where the paint, though on the surface, does not contribute to the specified thickness, and “actual losses”, where the paint is lost or wasted.

THE EFFECT OF BLAST PROFILE

When paint is applied to an abrasive blasted surface, the paint thickness over the peaks on the surface is less than the thickness over the troughs.

However, in general, it is the thickness over the peaks which is most important in relation to performance. Therefore, it can be considered that the paint which does not contribute to this thickness is “lost in the steel profile”.

The surface profile produced by blasting and hence the extent of the paint “loss” is proportional to the dimensions of the abrasive used.

Where steel has been blasted by small round steel shot and shop primed, the influence of the fine surface roughness on paint loss is low, but when in situ blasting is carried out, particularly with coarse grit, then the allowance necessary for paint “lost on profile” is considerable.

Typical “losses” in dry paint film thickness for given blast profiles are suggested below:

Surface	Blast Profile	D.F.T. “Loss”
Steel prepared by wheelabrator using round steel shot and shop primed	0-50 microns (0-2 mils)	10 microns (0.4 mils)
Fine open blasting (e.g. J. Blast Super)	50-100 microns (2-4 mils)	35 microns (1.4 mils)
Coarse open blasting (e.g. J. Blast A)	100-150 microns (4-6 mils)	60 microns (2.4 mils)
Old “honeycomb pitted” steel - reblasted	150-300 microns (6-12 mils)	125 microns (5 mils)

(Note: For the shop primers and holding primers which are applied at low film thickness, the concept of losses in the blast profile is not appropriate. These thin coatings are not normally considered to contribute to the total film thickness of the paint system.)

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PAINT DISTRIBUTION

This is the loss of paint resulting from over-application when a competent painter is attempting to achieve, with reasonable accuracy, the minimum thickness specified. The extra paint used over and above that calculated from the theoretical spreading This is the loss of paint resulting from over- application when a competent painter is attempting to achieve, with reasonable accuracy, the minimum thickness specified. The extra paint used over and above that calculated from the theoretical spreading rate is very dependent on the method of application, i.e. brush, roller or spray, and also on the type of structure being painted. A simple (uncomplicated) shape with a high proportion of flat surfaces should not incur heavy losses but if there are stiffeners or open lattice work involved then obviously losses will be high.

The following approximate over-applications are suggested as being appropriate:

Brush & Roller	**"Loss"**
Simple structures	5%
Complex structures	10-15% (including stripe coat)

Spray	**"Loss"**
Simple structures	20%
Complex structures	60% for single coat (including stripe coat) 40% for two coats 30% for three coats

Where open lattice work is sprayed, no realistic estimate can be made of paint distribution loss.

ACTUAL LOSSES - APPLICATION

In those special cases where the specification calls for a minimum thickness at all measured points, then the distribution losses would be greater than those indicated above.

There is a real loss of paint during the painting operation, i.e. paint which drips from a brush or roller during the transfer from the paint container to the surface to be painted. With care this can be disregarded as a significant contribution to the overall "loss". The use of "man helps" to extend the painter's reach however can increase this type of loss, and in an extreme case could result in a 5% loss.

When application is by spray, losses are inevitable and their magnitude is dependent on the shape of the structure being painted, together with weather conditions.

The following losses are common:

Well ventilated but confined space	- 5%
Outdoors in almost static air	- 5-10%
Outdoors in windy conditions	- over 20% (obviously this figure can become exceptionally high if painting is attempted in unsuitably windy conditions)

PAINT WASTAGE

Some paint wastage is inevitable; paint is spilt, a certain amount remains in discarded containers; and in the case of two component materials, mixed paint may be left beyond its pot life.

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The following losses are common:

SUMMARY OF LOSSES

Single component paints - No more than 5%
Two component paints - 5-10%
Paint losses are summarised in the table:

Apparent loss	1.1	Surface profile
	1.2	Distribution
Actual loss	2.1	Application losses
	2.2	Wastage

Factor 1.1 effectively applies to the first coat. Factors 1.1 and 1.2 should be added and 2.1 and 2.2 compounded.

PRACTICAL COVERAGE

Given the theoretical coverage and the preceding loss factors, it is possible to calculate a practical coverage. However, due to the extremely complex nature of the calculations, and variability of a number of external factors which include surface roughness, ambient climatic conditions, complexity of structure, access limitations and application methods, it is advised that these calculations are performed by professional estimators who have the appropriate knowledge and experience of the application of protective coatings under various site conditions.