Volume solids, PVC and hiding power

Introduction

The purpose of this document is to introduce the terms volume solids, pigment volume concentration (PVC) and hiding power. We will carefully discuss each term and explain why they are so important. We will investigate how changes in volume solids and PVC affect paint properties. We will explain why some coloured paints have better hiding power than others.

Volume solids

Volume solids is a measure of the volume of solid film forming ingredients in a can of paint - the material that is left behind when the paint has dried. *In other words it is a measure of the volume of real paint in a can*. It may be used to determine the dry film build of the paint when it is applied at specified spreading rates. Paint can be extended out by addition of thickener and solvent. Thick paint is not always high in volume solids. If choosing between paints careful analysis of volume solids versus price is necessary, as well as considerations about colour durability, environmental friendliness and so on.

Most architectural paints are actually quite low in volume solids and may often contain 50-60% water or solvent. For example a can of Resene Flatcote has volume solids of 39%. This means that a 4 litre can has just over 1½ litres of solid film forming material (real paint) in it. The other 2½ litres is solvent. This solvent is needed to make the paint brushable. The solvent is not only bulky packaging for the solid paint but is also very undesirable for health and environmental reasons.

Resene Zylone 20 (see Data Sheet D37), as another example, has volume solids of 38%. Again there is only just over 1½ litres of solid film forming material (real paint) in a 4 litre can. However, there is a redeeming feature (as with most waterborne paints) in that most of the volatile material is water. Resene Zylone 20 does have some solvent but only 360 mls compared to 2500 mls (2½ litres) in Resene Flatcote. On this basis Resene Zylone 20 is at least seven times healthier to use than Resene Flatcote.

Composition of the solid material in paint

The solids in a can of paint are made up of the pigments, the binder and an insignificant (in most paints) contribution from thickeners and other additives. Pigments as you would expect are almost 100% in volume solids themselves. A small amount of moisture contamination prevents them getting a perfect score. Binders are generally not 100% solid materials but may vary from 30% up to 100% in solids. Typically the latex binders used in acrylic paints have volume solids contents of 40-60%. Alkyd resin binders may vary from 30% up to about 80% in solids.

The volume solids is a good measure of quality
The volume solids of a paint is a reasonably good measure of the paint's quality compared to another brand. You will usually find that budget lines are well padded out with extra thickeners and either water or solvent. Some of these budget brands may simply be thinned out versions of premium brands but don't bet on it.

Volume solids is expressed as:

$$VS = \frac{(\text{Volume of pigment} + \text{Volume of solid binder})}{\text{Total wet paint volume}} \times 100$$

The '**100**' is in the equation because volume solids is always expressed as a percentage.

How to make use of volume solids
The biggest benefit of knowing the volume solids of a paint (apart for helping to assess quality) is that you can readily calculate the spreading rate needed to achieve a required dry paint film build. The Dry Film Build (DFB) describes the thickness of paint that is left on a substrate after full drying of the paint has occurred.

Volume solids equations
These equations rely on the correct units of measurement being used for each variable.

- The dry film build (DFB) is always measured in microns (μms).
- The spreading rate (SR) is always measured in square metres per litre.
- The volume solids (VS) is always expressed as a percentage.
- The wet film build (WFB) is always measured in microns.

Equation 1 - $DFB = \frac{VS \times 10}{SR}$

Equation 2 - $SR = \frac{VS \times 10}{DFB}$

Equation 3 - $VS = \frac{DFB \times SR}{10}$

Equation 4 - $VS = \frac{DFB \times 100}{WFB}$

Wet film build
While on the subject of dry film build it is timely to consider the term wet film build. Wet film build is simply the thickness of wet paint that has been applied. There is equipment available in the form of wet film thickness gauges and roller wheels that enable this to be measured on the job. Painters who use this equipment can get a good idea of the dry film build by using the following equation derived from equation 4 above.

$$DFB = \frac{VS \times WFB}{100}$$

Wet film build gauges give a rough approximation only and should not be used with the idea that they are highly accurate. They depend on the substrate being even and also assume that no liquids have evaporated from the paint in the time it has taken between paint application and measurement.

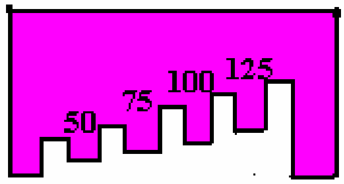


Diagram of a simple wet film gauge.

This is dipped into the wet paint until the two end prongs are pressed hard against the substrate. When the gauge is removed from the wet paint some of the prongs will be wet and others dry. If not, the wrong sized gauge has been used. If the prongs labelled 50 & 75 are wet (as an example) this indicates that the paint's wet film build is greater than 75µms but less than 100µms.

The wet film thickness of a paint can also be calculated if the spreading rate is known by the use of the equation below.

$$WFB = \frac{1000}{SR}$$

Comparing two brands of paint

The volume solids of a paint also enables you to evaluate different types of paints against each other. The really important figure to any customer should be how much it costs to achieve a given dry film build of paint.

It is the dry paint thickness on the wall that should be compared not each brand's specified spreading rates. If two paints are of the same type then it is fair to assume the physical properties of each will be similar and the only significant difference will be the volume solids.

What happens to paint as the volume solids is increased?

The volume solids of a paint may be increased simply by leaving water or solvent out of the formulation. The problem then is that the paint becomes too difficult to apply. It is the solvents and/or water in a paint that make it easy to apply. The paint designer can only go so far in making paints higher in volume solids. If they go too far the paint will be too sticky to apply properly. This introduces another criteria for a quality paint and that is that it is able to be applied easily.

What happens to paint as the volume solids is decreased?

Decreasing the volume solids of a paint is something easily done. We have the technology to add an extra 10-20% of water or solvent and disguise it with fancy thickening agents. In the marketplace the customer will see paint with excellent application properties but will have difficulty getting good film build and high gloss levels (from gloss paints) and will possibly need three coats to achieve the finish that would normally be achieved with two coats. If this is not compensated for the paint will fail sooner on exterior exposure because of erosion. The extra thickeners may also affect the durability of the paint.

Often customers do not see the effects of lower volume solids. This is particularly the case when dark colours with excellent (and cheaply obtained) hiding power are involved.

Low paint volume solids will result in:

- Lower paint dry film builds being applied.
- Possibly 3-4 coats being needed rather than 2.
- Poorer sealing properties and loss of gloss.
- Poorer durability because of added thickeners and a lower paint dry film build.
- In the case of protective industrial coatings there will be poorer barrier protection for steel.

The effect of thinning paint

The painter adding say 10% water to the paint can easily decrease volume solids. This makes the paint easier to overspread and instead of the paint being applied at the specified spreading rate of say 12 square metres per litre this may go out to 15 square metres per litre. With some paints other application properties, such as sag resistance (the paint's ability not to run off the wall), will also be compromised.

Pigment volume concentration (PVC)

Pigment volume concentration or PVC as we like to shorten it to, simply gives us an idea of how much pigment there is in the paint compared to the amount of binder. It is useful to know this because the binder has the very important job of binding all the pigment and other raw materials into the paint. There needs to be enough binder left over to enable the paint to stick (or adhere) properly to whatever it has been applied over

If a paint has no pigment at all it will usually be very glossy and have a PVC of zero. An example is clear gloss paints. Flat paints have a very high pigment loading and have high PVCs (probably in the range 55% up to 80%). Primers and undercoats vary from 30% to about 50% PVC as do semi-gloss, satin and low sheen paints. Gloss coloured paints can vary from 3% to about 20% PVC depending on the colour of the paint. Generally the darker the colour of the gloss paint the lower the PVC.

As a general rule, the lower the PVC of a paint is, the better its exterior durability will be. This assumes the paint is formulated on a durable binder in the first place.

PVC is always expressed as a percentage. The lower the PVC the less pigment there is in a paint and the glossier it is likely to be.

$$PVC = \frac{\text{Volume of the pigment}}{\text{Volume of pigment + Volume of solid binder}} \times 100$$

As PVC **increases**

• Gloss	decreases
• Exterior durability	decreases
• Scrubbability	decreases
• Adhesion	decreases
• Enamel hold out	decreases
• Hiding power	increases
• Density	increases

PVC of a range of Resene products

• Resene Woodsman	14%
• Resene Hi-Glo White	19%
• Resene Lumbersider White	37%

PVC and volume solids

When we discussed volume solids we said it was a measure of how much film forming material there was in a can of paint and that the volume of this film forming (or solid) material was made up of mainly pigments and binders. The PVC is simply the ratio of the volume of pigment to the total volume of solid pigment plus solid binder. PVC like volume solids is always expressed as a percentage and hence the 100 in the equation.

$$PVC = \frac{\text{Volume of the pigment}}{\text{Volume of pigment + Volume of solid binder}} \times 100$$

Whereas the volume solids is.

$$VS = \frac{\text{(Volume of pigment + Volume of solid binder)}}{\text{Total wet paint volume}} \times 100$$

Apart from the fact that the equations for volume solids and PVC both use the volume of pigment and the volume of binder there is really nothing that can be guessed about one from the other.

For example, a paint with a very high PVC of 60% could easily have a volume solids of only 10-20%. Another paint with a PVC of only 3% could have a volume solids of 90%.

Always remember that low volume solids may be disguised by adding artificial thickeners to make the paint appear good. Quality paints normally are the ones with the higher volume solids. The combination of very high PVC and low volume solids smacks of cost engineering because the extender pigments are much cheaper than solid binder. Note that the PVC of a paint is known only to the paint chemists who formulate paint and cannot be easily worked out.

PVC may be increased by different methods with very different outcomes. PVC can be increased by either removing binder from a pigmented paint or by adding more pigment. How much this affects the paint's properties obviously depends on how much of a change is made but it is also highly dependent on the type of pigment being added. The important pigment characteristic is the type of surface a pigment particle has. If you can imagine magnifying a pigment particle until it is the size of a golf ball, the shape you would then see would vary from a wad of cotton wool to a glass marble with untold variations in between depending on the pigment type. You should also be able to imagine the effect of adding each type of pigment to a small glass of water. The cotton wool would immediately dry up the water but the water would have little effect on the marble. If we go back to adding pigment to paint you will appreciate that you will be able to add a lot more marble type pigment to a paint than you will be able to add cotton wool type pigments.

Effects of different pigments on paint properties

Pigment name	*Type of pigment*	*Oil absorption Mls/100 g.*	*Surface area m^2/g*	*Max pig load at 50% VS*
Calcite	extender	12	0.6	62%
Talc	extender	30-40	20	51%
Synthetic silica	flatting extender (for clears)	100-200	400	14%
Diatomaceous earth	coarse extender	80-120	about 200	35%
Red iron oxide	inorganic prime	25	18	59%
Titanium dioxide	inorganic white	18	10-20	63%
Violet RL	organic prime	50-100	86	32%

Note: The figures in the above chart are approximations in many cases
Most commonly used pigments may be roughly slotted into one of the groups on the above chart. The numbers in columns 4-5 illustrate the large differences there are between pigments. The end column gives the maximum % weight of the pigment that could be added to the paint before the critical PVC is reached.

Oil absorption

These different pigment properties can be measured and we can classify pigments according to how easily they can be added into a liquid as in our example. The measurement of how much oil it takes to wet out 100 grams of a pigment is called the pigment's oil absorption. The oil absorption of a pigment can be easily determined by a chemist using a simple spatula and a set of scales. Another way of measuring the pigment's binder absorbing ability is to measure the pigment's surface area electronically.

What happens as PVC is increased?

We can increase the PVC of two paints by the same amount by adding the same volume of say marble type pigment (low oil absorption type) to one and by adding a cotton wool type pigment (high oil absorption type) to the other. In most paints the effect on the paint properties of increasing the PVC by 5-10% with a marble type pigment will be negligible but if the cotton wool type pigment is added there will be a noticeable drop in gloss and the paint will also be thickened considerably. This will necessitate the addition of water or solvent to thin it down and so the volume solids will be lowered.

This is one of the reasons that flat white paints are lower in volume solids than gloss white paints. It is also part of the reason it is so difficult to get good quality exterior bright red and bright yellow paints. These types of pigments generally have quite high oil absorptions.

If we begin with a basic paint formulation and slowly increase the PVC by adding pigment we will find that not only do the gloss and viscosity change but a number of other properties also change. The dry paint film permeability increases, the paint's adhesion decreases, the paint's exterior durability decreases, the paint's cleanability and scrubbability decreases, and the paint's density increases.

These changes are relatively minor until the stage is reached when there is simply not enough binder to hold onto all the pigment. Note that while the paint is in the can the pigment can be quite happy without any binder at all (as long as the paint is artificially thickened enough so it doesn't settle out like a rock). Our machine tinters are such compositions. It is only when the paint is applied and dries out that we become aware of the importance of the paint's PVC.

Critical pigment volume concentration

When the binder's 'holding everything together' ability is overloaded the paint is said to be at critical PVC. As you would appreciate the paint's properties after application change dramatically, mostly for the worse. The only good thing that happens, which we make use of in some flat ceiling paints, is that the hiding power of the paint increases by about 10-20%. This phenomenon is known as dry hiding. Paints made at pigment levels above the critical PVC are suitable for interior areas only as they have poor resistance to any sort of physical damage or even cleaning.

Hiding power

Hiding power or 'opacity' or 'coverage' are words that refer to a paint's ability to completely obliterate the colour of the surface it is applied over. A paint with excellent hiding power may completely hide words written in black paint on a white background in one coat applied at 12 square metres per litre whereas a poor hiding power paint may need to be applied in 3-4 coats at that spreading rate to achieve the same effect.

The hiding power of a paint is mainly related to the type of pigments used to make it. The PVC is obviously a factor and so is volume solids but if we assume that the paint is sensibly formulated the dominant influence is the pigment type. Hiding power relies mainly on prime pigments. Extender and anti-corrosive pigments have minimal effect on hiding power.

Note that the PVCs of differently coloured paints cannot be compared and are meaningless relative to each other unless you have a very good knowledge of the exact pigmentation in each paint. For example a gloss black paint may have a PVC of only 3% and yet have excellent one coat hiding power at 12 square metres per litre whereas a white paint at a PVC of 20% will have relatively poor hiding power and require two full coats to cover at 12 square metres per litre.

How do pigments generate hiding power?
The ability of a pigment to have good hiding power is related to whether it has good light absorbing properties or good light scattering properties. Pigments such as red iron oxides and carbon blacks have excellent light absorption properties and work by soaking up most of the light that falls on a surface. Black is the best because it absorbs light of all wavelengths (or colours). This absorption of light also explains why dark colours get hot in the sun.

It is a sad fact of life that the dirtier the colour of a paint, the better the hiding power. Without getting into too much detail the dirty toned pigments tend to have excellent hiding power. Carbon black pigment, for example, can give 100% hiding power to a paint at pigment levels of only a few percent by weight.

Efficiency of various white powders at scattering light
Light can be considered to be bundles of energy (called photons). The differences in the refractive index of white powders can be likened to their photon killing power.

Titanium dioxide and hiding power
Titanium dioxide is probably the most important prime pigment used in the paint and plastic industries. It is far superior to any other white pigment we have available and is non toxic. Just about everything you see that is white has titanium dioxide in it.

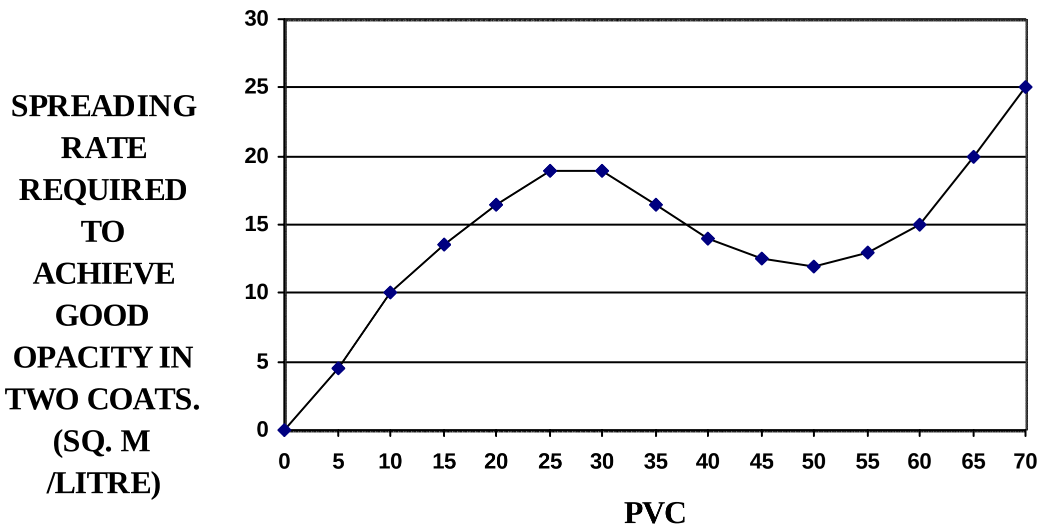
Pigments such as titanium dioxide get their hiding power from their ability to scatter light. The light scattering method is much less effective than absorption and relies on the pigment having a high refractive index. Refractive Index is what makes a stick appear to bend when we poke it into water. Pigments with high refractive indices act to bend incoming light until it goes back to where it came from.

Why are some pigments better than others in hiding power?
Imagine the surface of a white paint magnified a few million times until you can see, on any spot, a baseball batter. Every bundle of light energy (known as photons) that comes towards the surface is smashed away with a bat. As you look about you, you will find that the batters on paints with high refractive index pigments are top line professionals and are able to smash away all incoming light bundles. The batters on the paint surfaces containing extender pigments, however, are second rate and miss most incoming light bundles and they travel through the paint allowing the substrate to be seen. In contrast to this the surface of a paint pigmented with carbon black pigment could be pictured as a

muddy swamp. Any light bundle hurled at it just goes splat into the mud and has all the energy completely removed from it.

There are other factors that affect the hiding power of a pigment, such as the particle size of the pigment and the crystal structure of the pigment. This is particularly the case with pigments such as titanium dioxide. Crystal structure is the way a pigment has been built. As an example of this, carbon can come in one of three forms - graphite, soot or in the form of diamond. Obviously diamond is not going to be very good at absorbing light. However if it is crushed up to a very small particle size it would be similar to titanium dioxide in hiding power and be white rather than black. It would also tend to be more expensive.

GRAPH OF SPREADING RATE VERSUS THE PVC OF A WHITE PAINT



The above graph illustrates the relatively poor hiding power of titanium dioxide.

Take special note of the fact that after the PVC has reached about 15-20% that further increases show very little improvement in hiding power (opacity). Note that at a PVC of about 30% the hiding power actually decreases. This is due to pigment crowding. The graph starts to curve upwards as the PVC approaches 60% and this is because the critical PVC has been reached and dry hiding is being achieved.

Particle size of pigments is critical for good hiding power

The particle size of pigments with poor absorption properties but good light scattering properties is critical. This can easily be demonstrated by placing a few grains of sugar on a hard surface. You will see that the sugar grains are quite transparent. If you crush a grain with your fingernail you will find it suddenly becomes like a white powder and has good hiding properties.

Improving the hiding power of whites

Because of the way that titanium dioxide scatters light we can only get so much out of it. If we continue to add more pigment the extra pigment is literally crowded out and can't function efficiently. It is like asking two people to move a box of apples and then expecting to be able to do the job four times as fast by getting eight people on the job. In this situation the optimum number required is probably two with one on each side of the box. Any additional people will just get in the way and be a nuisance. In the graph on the previous page, you will notice for titanium dioxide that as a PVC level of about 20% is approached a large increase in PVC of about 5% results in an increase of only 1-2% in hiding power. At this level the durability of exterior paints will start to be adversely affected and the cost will rise dramatically because the titanium dioxide is quite expensive compared to the other ingredients in a normal paint.

Hiding power of red and yellow paints

One of the biggest technical problems we have in the paint industry is to get red and yellow paints that have good exterior durability, good hiding power and are affordable. 30-40 years ago the use of lead chromate red and yellow pigments was almost universal and these problems did not exist. Since the widespread recognition of the undesirability of lead containing paints these lead chrome type pigments have disappeared and left a huge gap, which we have still not filled satisfactorily. There are other reds and yellows available but these are either equally toxic or extremely expensive. The current pigments we use are organic types with high oil absorptions (the gloss and durability is affected if too much is added). They are extremely expensive, usually have poorer hiding power and tend to have poorer lightfastness (resistance to fading) compared to other pigments. This problem has still not been solved but there are a few special pigments we can call on if we really need higher performance in this area. There is a severe price penalty, however, as these may cost us up to $200 per kg compared to the $4 to $15 per kg range of prices for standard inorganic pigments.

Why are extender pigments so poor in hiding power?

The answer to this is that the refractive indices of extender pigments are very similar to that of any binder system. For a pigment that has poor absorption properties (i.e. is not a dirty colour) to have good hiding power its refractive index needs to be much higher than that of the binder. Titanium dioxide has a refractive index of 2.6 and most binders are about 1.5. The greater the difference, the better the hiding power.

Extender pigments

Extender pigments have a role to play in the hiding power of interior paints. If they are of a particle size about the same as the titanium dioxide pigment they can act to space the titanium dioxide and this results in better efficiency and can save about 10% in prime pigment.

In ceiling paints the critical PVC can be exceeded by adding the relatively cheap extender pigments rather than the expensive prime pigments. Titanium dioxide is about 10 times more expensive than common extender pigments.

Opaque polymer
We cannot talk about hiding power of paints without mentioning that there are clever people about and one of them came up with the idea of using beads with holes in the middle as a way of getting extra hiding power from a paint. The idea comes from the observation that any dry white powder (such as sugar, salt or calcite) that is small enough in particle size tends to have excellent hiding power when it is dry. If you wet a powder with water or paint binder it immediately becomes transparent to some degree depending on what powder you have chosen.

This happens because light scattering is dependent on refractive index differences between materials and their packaging. For dry powder the packaging is air and there is quite a large difference in refractive index between air and the powder. When the powder is wet the packaging is water or binder and there is very little difference in refractive indices. This means that as light travels through wet powder it is hardly scattered at all and the result is you can see through the mixture.

The clever people reasoned that if they could get some tiny air bubbles into the middle of the paint they could make use of the refractive index for air rather than that of the paint binder. They achieved this by making tiny hollow spheres of binder filled with water. These are added to the paint and as the paint dries the water evaporates out of the spheres leaving behind tiny air pockets. One of the developments in this area is an opaque polymer made from an acrylic base, which is very similar to standard acrylic latex binders, except of course the particles have holes in and are larger in particle size than standard latex binder particles.

Drying of paints containing air pockets
These paints are really fun to watch as they dry because, unlike other paints, they increase in hiding power as they fully dry and tinted colours actually get lighter in colour rather than darker. In the wet state these paints can also look quite dirty toned compared to their dry colour. This can be confusing for painters who would be justified in claiming these paints to be poor in coverage in the wet state compared to conventional paints.

Gloss and PVC
If everything else is equal the glossiest paints are those without any pigment at all (i.e. PVC = 0). This needs to be qualified somewhat because not all binders are as glossy as others and good gloss also depends on the paint, varnish or glaze having good flow and being applied over a smooth, sealed surface.

High gloss level pigmented paints rely on there being a layer of clear binder that is almost pigment free sitting on top of the paint coating. This gives the paint film a very smooth surface that reflects light perfectly. As more and more pigment is added to a binder it becomes more difficult to keep pigment particles away from the paint surface.

If small particle size, smooth shaped pigments are being added the gloss is dulled off rather than flattened. The head on gloss will be low but the low angle gloss will be quite high. The low angle gloss is the gloss you see looking along a wall rather than looking into it.

Different gloss levels

The type of gloss that results depends on the PVC, the particle size and shape of the extender pigments and the ratio of coarse to small particle size pigments used in the paint. If a paint is made by using only a small proportion of coarse extender pigments a sheery finish will result. A sheery finish may be likened to a polished table that has been allowed to collect dust for a month or so. If you bend over and look along the table with your head at table height the dust particles will be really prominent and look sheery. To get a really uniform flat finish there needs to be a large percentage of coarse extender pigments. The paint surface needs to be so crowded with them that there are no spots of undisturbed binder.

Effect of surface roughness on gloss level

Extra smooth surfaces are needed for a high gloss finish. The lower the pigment loading (PVC) the better it is. Semi-gloss or satin paints rely on a large quantity of relatively small rounded extender pigments. These are necessary to give a nice smooth finish that is also washable. PVC is usually about 35-40%. Flat paints need very coarse extender pigments to achieve a rough surface. These paints also need to be filled up with smaller extender pigments to help keep the coarse pigments against the surface. The other pigments also improve the scrub resistance of the coating.

Lighting angles

- **Low angle lighting:** In most situations, such as in a long corridor, the viewer is a long distance from the part of the wall the light is illuminating. In these situations the pigment particles really need to substantially roughen the surface or it will appear quite glossy. Paints that appeared to be low sheen or satin in gloss at head on angles may be quite glossy at low angles.
- **High angle or head-on gloss:** The viewer is closer to the part of an object being illuminated and the eye will pick up even small irregularities in the surface and it will not look glossy.

Summary

Volume solids

- Volume solids is the measure of the amount of real goodies in a can of paint.
- The volume solids is mainly made up of solid pigment and the solid part of the paint binder. A small but usually insignificant contribution to the volume solids is made by thickeners and other additives.
- Most architectural paints are quite low in volume solids, which may range from 35 to 55%.
- Weight solids is quite different to volume solids.
- Volume solids gives a rough indication of paint quality but if too high there will be application difficulties.
- Volume solids information allows you to calculate the dry film builds you can get by applying paints at different spreading rates.
- Volume solids data can be used to evaluate the cost per square metre to apply a specified dry film thickness of paint.
- Paint is easily cheapened by adding water and thickener, which in turn lowers that paint's volume solids and reduces the spreading rate.

PVC

- Pigment volume concentration or PVC is a measure of how much volume of pigment there is in a paint compared to the volume of solid binder.
- A gloss varnish has a 0 PVC.
- Flat paints have PVCs in the range 55-80%.
- Gloss paints can have PVCs from 0 - 20% depending on the pigmentation.
- If a binder is overloaded with pigment the paint is said to be above critical PVC.
- Some flat ceiling paints are deliberately formulated above critical PVC to take advantage of the dry hiding that occurs.

Hiding power

- Hiding power means the same as opacity or coverage. It is the ability of a paint to completely cover a substrate. Usually the dirtier the paint colour the better the coverage.
- Black and dirty coloured paints have better hiding power because the pigments absorb light in the full colour spectrum.
- Titanium dioxide containing white paints use light scattering techniques to get their hiding power.
- Red and yellow toned paints are quite often very poor in hiding power and may also have poor lightfastness in exterior situations.
- Extender pigments have very poor hiding power and are not usually used for this purpose. The exception is when they may be used to space titanium dioxide or used to cheaply reach critical PVC level in ceiling paints.

- An opaque polymer is a bead of resin that contains an air bubble. By means of refractive index differences this gives extra light scattering properties to waterborne paints.

Gloss and PVC

- Basically for good gloss paints the less pigment the better.
- Gloss black paints will have a PVC of only about 3% whereas a white paint will be nearer to 20% in PVC.
- Generally as extra pigments are added the gloss of a paint decreases.
- Coarse extender pigments that really roughen the surface of the paint are needed to reduce both head on and low angle gloss.