Technical Terms, Surface Preparation Paint Application, Health & Safety

In order to comprehend fully the technical data sheets and the various types of paints and painting methods, it is essential to have a fair knowledge of the terms used, surface preparation, paint application, health & safety.
The coatings field is complex and knowledge of coating calculation techniques and interpretation of data is required in order to make the appropriate choice. It is imperative to purchase the most economic coating available which is suitable to achieve the required protection.

TECHNICAL TERMS

MICRON (µ)
Metric unit used to designate film thickness.
1 micron = 1 mm / 1000 (One thousandth mm) = 0.000001 m (One-millionth m). Also written as µm or um.

MIL
American unit used to designate film thickness. Also called "thou". 1 mil = 25.399 microns ≈ 25 microns.

VOLUME SOLIDS
Volume Solids of paint is the ratio of the non-volatile components present in it to the total volume. Also termed as Solid Volume Ratio (SVR) or SV%. This is the most important factor which determines the coverage of paint, others being thickness at which paint is applied, nature of surface being painted, method of application etc.

DRY FILM THICKNESS (D.F.T.)
The thickness of the paint film is measured in microns when it is dry. An adequate film thickness is mandatory for the success of any coating system. Under application will result in premature failure of the paint system. Exceeding the specified film thickness can be equally dangerous. The recommended D.F.T. depends on the type of paint system and nature of surface.

WET FILM THICKNESS (W.F.T.)
The thickness of the wet film is measured in microns immediately after application. Measuring W.F.T. is essential to keep the D.F.T. at the desired level, by applying the paint at a pre-judged W.F.T; calculated by the following equation:-
WFT = DFT x 100 SVR

THEORETICAL SPREADING RATE (T.S.R.)
The area covered by unit amount of paint when applied is referred to as Theoretical Spreading Rate or simply Spreading Rate at a particular D.F.T. Since T.S.R. is a function of D.F.T., it should be clearly specified while stating T.S.R. It is calculated by the following equation:

$$\text{T.S.R. } (m^2/\text{litre}) = \frac{\text{SVR} \times 10}{\text{DFT (microns)}}$$

THEORETICAL PAINT CONSUMPTION
$$\text{Theoretical Paint Consumption (litres)} = \frac{\text{AREA } (M^2)}{\text{T.S.R.}}$$

PRACTICAL SPREADING RATE (P.S.R.)
Practical Spreading Rate is calculated from T.S.R. by providing the appropriate loss factor.

FLASH POINT
The lowest temperature, at which the solvent in the paint gives off sufficient vapour to form ignitable mixture with the air above its surface.

TOUCH DRY
When a very light pressure with the finger does not leave a mark on the surface.

DRY TO HANDLE
When the paint surface is sufficiently hardened to be freely handled without damage.

HARD DRY
When the drying has reached such a stage that if desired, a further coat can be satisfactorily applied.

SPECIFIC GRAVITY
Weight in Kg per liter of paint at 25º C.

CURING AGENT
Is the component which produces the chemical reaction linking the molecular chains of the binder together in original structure.

CURING
Hardening of the liquid paint by heat or by chemical reaction.

POT LIFE
The chemical reaction sets in immediately after the component of two-component paint is mixed, which starts thickening / gelling. The period after mixing the components during which the paint remains usable is called pot life.
Pot life depends on the temperature.

SHELF LIFE
The time that paint will remain in good, usable condition when stored in the original sealed container under normal storage conditions.

SHOP PRIMER
A shop primer is used to protect derusted "steel" against corrosion during the storage and erection period until the ultimate protective paint system can be applied.

HIGH BUILD PAINT
A paint that can produce thick dry films per coat.

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SURFACE PREPARATION

Surface preparation for any given paint is the single important factor that would determine its performance. Various surface preparation methods are adopted depending on the requirements of the paint system used and the substrate. The substrate could be steel, galvanized steel, aluminium, concrete or wood.

STEEL AS SUBSTRATE

Various methods of surface preparation are adopted viz. degreasing, high pressure fresh water hosing, hand tool cleaning, power tool cleaning, blast cleaning etc. Degreasing is done to remove all oil and grease prior to manual or blast cleaning. The most common method is by solvent washing followed by wiping dry with clean rags. A suitable detergent solution can also be used, and then the substrate has to be subjected to fresh water hosing to remove traces of detergents.

The Swedish Standard SIS 05 59 00 - (1967 - Pictorial Surface Preparation Standards for Painting Steel Surface) being the prominent among all surface preparation standards commonly followed worldwide.

SA-3: Blast cleaning to visually clean steel. Surface should be completely free from oil, grease, mill scale and rust.
SA-2.5: Very thorough blast cleaning to achieve near white metal inferior to SA-3.
SA-2: Widely known as commercial blast inferior to SA-2.5.
SA-1: Light blast cleaning to remove mill scale, rust and paint.
ST-3: Very thorough power tool cleaning to remove loosely adhering mill scale, paint and rust. However, it cannot remove tightly adhering mill scale.
ST-2: Loosely adhering mill scale, rust and old paint coatings are removed from steel by wire brushing, sanding, scraping and chipping.

ANCHOR PATTERN OR SURFACE PROFILE

Surface texture of a metal, produced by abrasive blasting, to assist the adhesion of a coating, is called anchor pattern or surface profile. Most paint systems, especially inorganic zinc coatings, require an anchor pattern-characterized by a surface roughness and a roughness profile to obtain proper adhesion. Anchor pattern obtained depends on the type of abrasive used for blasting. Using fine sand of mesh size 80, maximum height of profile is found to be 35-37 microns whereas with iron shot of mesh size 14, it is found to be 90 microns.

GALVANIZED STEEL AND ALUMINIUM AS SUBSTRATES

Galvanized metal as well as aluminium presents a very difficult surface for painting because of the problem of getting proper adhesion of the paint system to the surface. Galvanized metal is very smooth which poses a serious threat to adhesion. So, it is imperative that an etch primer be applied on the surface subsequent to degreasing before the application of a proper paint system. Application of the etch primer results in a tacky surface which ensures proper adhesion of the paint system to the surface.

CONCRETE AS SUBSTRATE

Although concrete appears as a dense, homogeneous material it contains a lot of small pores, which, if opened, contribute to a faster breakdown of the concrete. Fresh concrete possesses an alkalinity of up to pH 13. This alkalinity protects the reinforcement against corrosion. Reinforcement steel starts to corrode when pH of the moisture in the concrete is lower than 9. This happens due to the following reaction:
$Ca(OH)_2 + H2CO_3$ ----- $Ca\,CO_3 + 2H_2O$ (Carbonation)
$Ca(OH)_2 + H2SO_4$ ------ $Ca\,SO_4 + 2H_2O$ (Carbonation)
Both H_2CO_3 (Carbonic acid) and H_2SO_4 (Euphoric Acid) are reaction products of CO_2 and SO_2 present in the atmosphere.
Another troublemaker is laitance. **Laitance** is a thin layer of surplus cement and water that rises to the surface during setting of concrete. Unless removed, it will severely reduce adhesion and cause failure of the paint system. **Efflorescence**, seen as a salty stain on walls has to be removed before painting. Efflorescence is caused by moisture moving towards the surface of concrete.
Prevention of these faults is cheaper than renovation and this can be achieved by providing the concrete surface with a protective coating. The concrete surface should be clean, dry and sound prior to painting. When all trouble makers have been identified, they have to be removed which is best done by mechanical cleaning and power tooling combined with detergent cleaning if grease is present.
An alternative to blasting is acid etching.
For concrete, all coatings have to be alkali resistant. Furthermore, it has to prevent moisture, sulphur dioxide and carbon dioxide from penetrating the concrete.

WOOD AS SUBSTRATE

All new wooden surfaces like softwoods, hard woods, plywood etc. should be dry, clean and free from foreign particles. Smooth down with sand paper and apply a suitable knotting preservative. This should be followed by primer for protection against moisture. On previously painted surfaces, apply paint removers followed by the method described above.

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WEATHER CONDITIONS

Bad weather conditions are a perennial hazard in painting operations. Paint should never be applied on wet surfaces and therefore painting should be avoided not only in rain, sleet and fog but also when high humidity and low steel temperatures lead to condensation. Condensation is very difficult to detect on surfaces and will occur if the steel temperature is below atmospheric dew point. As a general guide, application should not take place when the steel surface temperature is less than 3ºC above the dew point.
Extreme temperature may present problems too. At low temperatures (below 5ºC), the curing of paints such as epoxies may slow down dramatically and for some paints stop altogether. Others are not seriously affected, chlorinated rubber - and vinyl paints may be used at/or below 0ºC as long as the surface is free from ice. As ice may be present in pores of the steel surface at these temperatures, generally however, painting below 1ºC should be discouraged. At high temperatures, solvent loss from paint atomized during application is very rapid; paint droplets do not coalesce on the surface (leading to a porous coat) and clouds of dry spray may also be produced. The problem may be rectified by the addition of thinners but these should never be more than a few percent of the weight of the paint. Generally, painting should be avoided during extremely hot hours – where paint operations are carried out in hot climates, the paint should be applied in the morning and early evening.

PAINT APPLICATION

Paint is not a finished product until it has been applied and dried on an appropriate substrate at the designed performance film thickness. Proper application therefore is critical to the performance of the paint system. High performance paint systems are especially sensitive to misapplication thus knowledge of the application characteristics and recommended film thickness are vital to obtain optimum results.

Application Methods

Three main methods are used in painting. The choice of method depends on the type of coating to be applied, the effect on adjacent areas and the degree of skill of the personnel.

Brush & Roller

Low viscosity paints are easily applied by these techniques to yield low applied film thickness. Modern, thixotropic paints are often specified at high film thickness specially where they perform a protective function. Therefore, where brush and roller methods are called upon (specially for "touching up "or" stripe coating") a number of coats may need to be applied in order to achieve the minimum specified dry film thickness. Although these techniques have largely been replaced by spray application, they may find use in maintenance schedules.

Conventional Spray

This technique mixes a jet of air with a stream of paint to propel a fan of paint droplets towards a surface. The mix of air with the paint particles gives high turbulence however and considerable "bounce back". Air atomization of paint can thus results in considerable over spray. Therefore not only adjacent areas must be protected but also paint losses may vary from 20% to 40% on steel and paint operatives must wear protection to avoid paint mist inhalation. The technique particularly suits low viscosity paints and is most commonly used for the application of conventional decorative paints and zinc silicate coatings.

Airless Spray

This technique relies on hydraulic pressure rather than air atomization to produce the spray.
Paint under very high pressures (1000 to 6000 psi, approx. 100 to 400 kg/cm^2) delivered to the spray gun and then forced through a very small orifice to atomize it. Thus there is more rapid coverage with much less over spray and much higher film thickness can be obtained.
Most of the products manufactured by Protective Paints can be applied by airless spray. Some products (e.g. anticorrosive) are designed to be applied at high film build, others (e.g. finishing paints) at low thicknesses. Follow the recommendations in the Product Data Sheets. If the recommendations are significantly exceeded and over-application results, sags and runs may develop - these are not only unsightly but may also have detrimental effects on the performance of the coating.
Finally, it must be remembered that airless spray ejects paint under very high pressure. Do not direct the spray at people nearby as injury can be easily caused and take due precautions when the equipment is being cleaned.

AIRLESS SPRAY APPLICATION TROUBLE SHOOTING CHART

(Defect - Cause - Suggested Correction)

Runs and Sags *Improper spray technique*
There may be a tendency for sprayers who are unfamiliar with airless application to deposit a paint film much heavier than specified.
Gun is passed too close to work piece
The spray gun should be held at a distance of about 1-ft. (30 cm) from the surface for general work.
Gun held at wrong angle to surface
Hold gun at right angle to the surface and move in a straight line parallel to surface.
Excessive deposit In addition to the above suggestions, check spray nozzle for excessive wear or improper selection.
Excessive dilution Paint materials have a value of viscosity and solids content below which it cannot be diluted, so the specified film thickness cannot be obtained. Therefore, do not thin the paint unless absolutely necessary.
Streaks *Wrong nozzle* Select a smaller nozzle.
Nozzle is worked out Select a new nozzle.
Incorrect overlapping of strokes
Follow the previous stroke accurately. Deposit a wet coat.
Too high viscosities Increase pressure/thin the paint.
Too high film *improper technique* See notes for "Runs and Sags" Use a smaller nozzle. Hold the gun at right angles to the surface.
Dry overspray *Excessive atomization Nozzle too small*
Improper technique Reduce pressure. Use a large nozzle. Hold spray gun closer to work piece. Trigger gun at edges. Spray at right angles towards surface.
Excessive spray fog *Excessive atomization* Reduce pressure.
Paint thinned out too much
Only the correct amount of thinner should be added.
Pinholes *Paint film too heavy* Apply less wet film thickness.
Poor atomization Increase pressure.
Orange peel *Paint not thinned sufficiently*
Add the correct amount of thinner.
Blistering *Rust, oil or grease on surface*
Degrease the surface properly before painting.
Moisture on or in the surface
Surface temperature must be above the dew point.
Solvents trapped under dried paint Use a slower solvent.

HEALTH & SAFETY

Protective Paints places great emphasis on the safe use of paint and wherever possible, products are designed to minimize potential hazard. Thus there are solvent-free systems within our product range which reduces the risk of fire and consequently reduces interference with other workers in the vicinity of painting operations. A lot of paints in current use are still solvent-borne and these are therefore; essentially flammable. Most solvents, many pigments and some binders, too, are toxic. Nevertheless, most paint materials are quite safe if handled with due precaution; accidents could be prevented by adopting sensible working attitudes and good housekeeping practices.

Fire Hazard

The opening of a tin of solvent-borne paint immediately releases solvent vapours. The faster paint solvent evaporates; the lower will be its flash point (defined as the lowest temperature at which the paint gives off sufficient vapours to form an inflammable mixture in air). If ambient temperatures are close to the flash point quoted in the Product Data Sheet there is considerable risk of fire or explosion in the presence of a spark or open flame. Even if ambient temperatures are well below the flash point there may be a fire risk. Therefore no naked flames, lighted cigarettes, motors, electrical equipment, electrical switches, torches, etc. should be allowed in the vicinity of painting operations and care should be taken to avoid sparking by using non-sparking tools and grounding all equipment (e.g. airless spray).
In addition, ensure that good ventilation exists to avoid vapour build up and the paint and solvent cans are closed when painting operations have stopped. It is acceptable practice to reduce vapour concentration, to less than 10% of L.E.L. (Lower Explosion Limit). Clean up solvent spills and dispose paint rags daily, with care.
In the event of fire, do not extinguish with water but use dry foam, powder or CO_2 fire extinguishers.

Health Hazard

Many paint materials are noxious, intoxicating, irritant or toxic to a greater or lesser extent. The route of intake into the body may vary:

Ingestion

It is unlikely that personnel will knowingly consume paint. However, in order to minimize the risk of this occurrence it is recommended that food not to be stored, prepared or consumed in paint stores or in the vicinity of painting operations. In the event of ingestion, consult a medical practitioner immediately.

Inhalation

Particular problems in this respect are due to the dusts generated by abrasive blasting and to solvent vapours and spray mists generated at application, particularly by spraying procedures. When surface preparation involves removal of old coatings, try to minimize the generated dust so as to protect workers and neighbourhood communities and dispose of coating residues carefully. Workers can be protected by the use of proper respirators with regular changes of cartridge.
Spraying operations may develop paint mists, which will then be present locally at the site of operation or may drift downwind affecting workers in other areas. The latter condition may be avoided by ceasing spraying in wind and spray operators may need the protection of a cartridge respirator to filter out these particles of paint. In bad circumstances, an air-fed hood or mask may be necessary.

Solvent fumes will be present around most spraying operations and as they are heavier than air they will be present near the ground, displacing air. Good ventilation should always be available to remove these fumes but care should be taken when entering areas where fumes could have accumulated. The most common symptoms of inhalation of solvent fumes are dizziness, drunkenness, headaches, general indisposition, sleepiness and nausea.
Operators experiencing these effects should be moved into fresh air and should not return until the symptoms have disappeared and the ventilation has improved.

Skin and Eye Contact

Paint materials may make contact with the skin and eyes, through spillage, splashes, and paint spray mists, etc. The best way to avoid this contact is to use sensible working clothes that cover as much as possible of the body, including gloves and safety goggles. Other areas of the body might still be exposed (especially neck, parts of the face around the goggles and parts of the arms) and it is recommended to use a non-greasy barrier cream here. If clothes get soaked with paint, change affected garments immediately and thoroughly wash them with soap and water.
Paint splashes on the skin should be removed with soap and water and not with solvents. In the event of paint or thinner coming into contact with the eyes, wash them with water and seek medical advice immediately.
Finally, always wash hands and rinse mouth after completion of painting operations.

From the foregoing we have derived some basic, minimum precautions:
a) Note carefully the precautionary notices on the paint tins.
b) Provide adequate ventilation during application.
c) As most paints contain flammable materials, keep away from spark and open flames and do not permit smoking in the vicinity.
d) Avoid skin contact and inhalation of spray mists and fumes.
e) If the paint comes into contact with the skin, wash thoroughly with soap and water.
If paint splashes the eyes, wash with water and seek medical advice immediately.

The above notes are not intended to be exhaustive and do not cover all eventualities during the storage and application of paint. They are intended as a guide to the minimum precautions that should be taken with all paint products.

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