Inspection prior to painting

Introduction

Once steel inspection and defects have been rectified by the responsible steel contractor then the surface to be coated must be inspected for contamination and suitability and deemed suitable for application of coating materials before any application commences.

The order of identification of and rectification of any deficiencies and acceptability for coating is important.

The preferred order for inspection is,

1. Oil and grease
2. Soluble salts
3. Cleanliness
4. Roughness
5. Dust
6. Climatic conditions – microclimate

Oil and Grease

In an industrial or heavy-duty environment, grease and oil is often present it is used for lubricating equipment and can easily end on a surface that is to be painted. Grease and oil form barriers that prevent adhesion of coatings, existing between the applied coating and the substrate or previous layer of coating. Grease and oil, even in small amounts prevent proper adhesion and cause cissing or fish eyes on the surface where coatings 'pull back' from the drop of grease or oil exposing it and leaving that area with no protection. In some cases, oil or grease can react with a coating changing its properties and reducing the protection it otherwise would provide.

The best time to check for oil and grease on the surface is prior to any other surface preparation, apart from steelwork which could introduce oil onto the surface from the lubrication of machinery – this will ensure that any test methods or cleaning methods will not ruin preparation work that has been carried out.

Oil and Grease – standards
There are no standards referring to the measurement of the amount of oil or grease present on a surface, but experience shows that the acceptable amount of oil or grease on a surface prior to applying a coating is below practical detection.

Assessment of oil and grease on the surface
There are some simple tests to check for the Prescence of oil and grease on the surface, if it cannot be clearly seen.
Splashing some water onto the surface can give an indication of the presence of oil and grease. If the surface is clean then the water will wet the surface, if there is oil or grease present then the water will bead up and run off. This test is obviously not practical for checking a surface that has just been abrasive blasted.
A chalk test may also be carried out. The method works as follows: 1. Draw a line at medium pressure with the piece of chalk from a clean area through the suspect area on to another clean area. 2. If the line through the suspect area decreases in intensity, but intensity is regained in the second clean area again, the suspected area is contaminated to the extent, that degreasing is required. You will probably need some exercise on the right pressure on the piece of chalk to get full benefit from the method.

A Hydrocarbon test with Isopropanol: 1. Approx. 1/4 square meter of the surface is washed with cottonwool and hydrocarbon free isopropanol. 2. After each washing the isopropanol is transferred from the cottonwool into a beaker by pressing. 3. Filter the contents of the beaker. 4. Mix in a test tube the filtrate with 2-3 times as much distilled water. 5. The mixture is shaken and must be allowed to stand for approx. 10 minutes. 6. If the sample in the test tube is cloudy, the surface is contaminated with grease and/or oil. 7. Make a blank mixture of the isopropanol with distilled water as a reference.

UV light may also be used to detect grease on the surface since most hydrocarbons exhibit fluorescence when exposed to a UV blacklight. However, there are some practical problems involved with this, as the area has to be completely dark to see small areas of oil or grease and, the lack of light can pose some safety challenges, and not all contamination may be detected.

The hydrocarbon test using isopropanol is the one which is recommended

Removal of oil or grease
As mentioned previously the best point to check for and clean any surface for grease is prior to any other surface preparation. This is since the most effective way to remove any oil or grease contamination is by using a degreaser or emulsifier and then plenty of fresh clean water, note that mechanical surface preparation methods will not remove oil or grease contamination and will often result in the contamination being spread by the equipment used. If the surface has already, for example, been abrasive blasted, then washing with water will result in the formation of rust on the entire surface. Removal of oil and grease prior to abrasive blasting and then ensuring that both abrasive and compressed air are oil free can minimise the chance of oil or grease contamination on the surface after abrasive blasting.

Very small spots of grease may be removed by using thinner, but this is a process that requires great care. A lint free cloth soaked in thinner should be used to dab the surface gently wetting only the contaminated area with the thinner, the cloth should then be discarded and the process repeated several times until all traces of the grease or oil are gone. Rubbing the surface with the cloth will result in spreading the grease to a larger area hence increasing the amount of defective area and could also result in the deposition of fibres from the cloth being left on the surface if it is rough.

Once the oil and grease has been removed from the surface then further contamination on the surface may be avoided by ensuring that any compressed air used is clean and dry, and checked according to the blotter test (ASTM D 4825) and that any abrasives are also checked for contamination by oil or grease. Note also that in cases where the entire area is washed with detergent and then hosed down with clean fresh water to remove all traces of the detergent, then this will also remove soluble salts on the surface.

Soluble Salts

Soluble salts are a common form of contamination found in or close to marine or industrial environments. The sources can be many and blasting media, chemical contamination, air pollutants and washing water, salt settling from fog and rain can all be sources of contamination.
Prescence of these on the surface when coatings are applied can lead to blistering due to osmosis in humid or immersed conditions and when their levels are high, they can also form a barrier between the substrate and the applied coating reducing adhesion. The resultant detachment will leave the structure exposed to the environment and unprotected. It is normally not possible to see soluble salts on the surface so tests must be carried out to assess the presence and level of soluble salts on the surface.

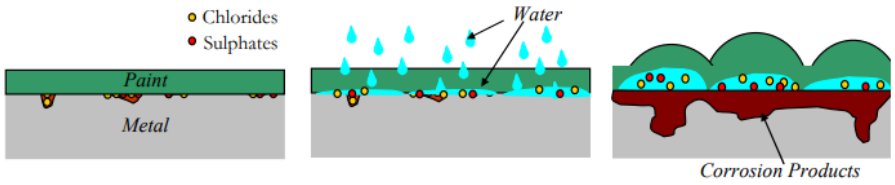

***Figure 1**: Osmotic Blistering of the coating and under film corrosion of the metal substrate due to presence of soluble salt.*

Soluble Salts – Standards and assessment of the level of salt on the surface
When soluble salts are dissolved in water, they increase the conductivity of the water significantly and this property is used to assess the presence or level of salt on the surface. The standards most commonly used are ISO 8502-6 and ISO 8502-9. ISO 8502-6 describes the use of an adhesive patch to extract the soluble salts from the surface and ISO 8502-9 which is the field method for determining the amount of soluble salt on the surface using a conductometric technique. These standards do not give any acceptable value for the maximum level of soluble salts that is allowable on the surface prior to coating, this should be referred to in the specification depending on the intended service conditions, either directly or by referring to a document that contains this information.

***Figure 2**: Example of coating inspectors' equipment*

General figures for levels of acceptance for Hempel products under certain conditions are in the table below:

***Table** 1: Water soluble salt levels for different specifications*

Specification / Remarks	Conductivity*		Equivalent Cl		Equivalent NaCl	
	µS/cm	mS/m	µg/cm²	mg/m²	µg/cm²	mg/m²
	2.5	0.25	0.6	6.0	1.0	10
NORSOK 1	5.0	0.50	1.2	12.0	2.0	20
	7.5	0.75	1.8	18.0	3.0	30
Hempel 2	10.0	1.00	2.4	24.0	4.0	40
IMO 3	12.5	1.25	3.0	30.0	5.0	50
	15.0	1.50	3.6	36.0	6.0	60
	20.0	2.00	4.8	48.0	8.0	80
	25.0	2.50	6.0	60.0	10.0	100
Hempel 4	27.5	2.75	6.6	66.0	11.0	110
	40.0	4.00	9.6	96.0	16.0	160
	60.0	6.00	14.4	144.0	24.0	240
Hempel 5	80.0	8.00	19.2	192.0	32.0	320
	125.0	12.5	30.0	300.0	50.0	500
NACE 6	185.0	18.5	44.4	444.0	74.0	740

1. Maximum conductivity accepted by NORSOK offshore standard.
2. Hempel's recommended maximum conductivity level for areas permanently immersed in demineralized, potable and hot water.
3. Maximum conductivity accepted by IMO Performance Standard for Protective Coatings and for tank coatings with Cargo Protection Guide or other Resistance guides.
4. Hempel's recommended maximum conductivity level for immersed areas and for Hempel's Multi-Strength products.
5. Hempel's recommended maximum conductivity level for non-immersed areas, equivalent to maximum conductivity accepted by NACE/SSPC SP 12: SC2.
6. Equivalent to maximum conductivity accepted by NACE/SSPC SP 12: SC3.
Levels given in µg/cm² is based on chloride. If sulphates are determined to be the major contamination species, these levels should be multiplied by 2.

*The conductivity readings are based on using 10ml washing water as described in ISO 8502-9

Removal of soluble salts

Soluble salts are by their nature soluble in water and thus the easiest method to remove them is by washing with clean fresh water. In order to adequately remove salts from surface, it is often necessary not only to wash but also to remove any corrosion products by the use of high-pressure

freshwater hosing or water hosing and at the same time using stiff brushes. Washing on vertical surfaces should always be from top to bottom to wash any salts away from the surface, and pools of water should be removed on horizontal surfaces. High pressure washing or even water jetting / hydroblasting is preferred since it has a greater possibility to penetrate into any pores or porous surface and remove salts. Water-soluble salts are not removed solely by mechanical surface preparation methods. On the contrary they may be embedded into the surface.

Note that once the soluble salts have been removed from the surface then it should be ensured that any operations undertaken afterwards do not contaminate the surface further, such as using a recycled abrasive that is contaminated with soluble salts.

Cleanliness

The degree of cleanliness and standard for assessment should be in the specification. In order to achieve the expected performance from the coating system applied, the cleanliness of the surface should be as a minimum at the level specified in the specification. Deviation from this can lead to poorer protection and a shorter lifetime of the system.

Cleanliness – standards and assessment of the surface
There are many standards that may be relevant when assessing the cleanliness of a surface. The relevant standard that is specified in the specification should be used according to the instructions in that standard.

These are some of the standards that refer to preparation using manual methods, abrasive blasting and water jetting of steel surfaces, there are other standards in use. Note that this is not a comparison table.

***Table** 2: Overview of most commonly used standards for surface cleanliness.*

Abrasive blasting	NACE No. 1/SSPC-SP 5	ISO 8501 - 1
	NACE No. 2/SSPC-SP 10	ISO 8501 - 2
	NACE No. 3/SSPC-SP 6	
	NACE No. 8/SSPC-SP 14	
	NACE No. 4/SSPC-SP 7	
Water Jetting	NACE No. 5/SSPC-SP 12	ISO 8501 - 4
Manual / power tool	SSPC-SP2	ISO 8501 - 1
	SSPC-SP3	
	SSPC-SP11	

Inspection of the surface to ensure that the standard of cleanliness before final cleaning can be an advantage if more work is required to reach the specified condition, however it should be remembered that the standard of cleanliness specified refers to the surface condition immediately prior to application of the first coat of the coating system.
See Hempel's Technical Guideline "Surface Preparation" available on https://www.hempel.com/service-and-support/technical-guidelines.

Roughness

Achieving the correct roughness on an abrasively blasted surface is one of the key factors in getting the best performance of the applied system, when important the roughness necessary for good performance should be specified in the specification.

Roughness must be checked after the abrasive blasting and rough cleaning has been carried out. Cleaning is necessary to ensure that the surface may be properly inspected to identify any holidays in the blasting, but also as some methods for assessment require a clean surface to be accurate (testex tape for example)

There are several methods for measuring roughness and to avoid confusion the standard used to measure the roughness, or the type of roughness must be included in the specification.

Assessment of roughness on the surface
Common methods for assessment of roughness on site include the use of a comparator, a needle gauge or pressure sensitive tape. An other method that is not so common on site is the use of a stylus gauge. Note that if a surface is to be abrasive blasted and a specific roughness is specified, then the grade of abrasive should be chosen carefully to ensure that the desired roughness is achieved. If the correct roughness is not achieved then it might not be possible with the size distribution of abrasive chosen, and a different abrasive might be necessary to correct the roughness level and achieve the desired roughness. It may be prudent to make a test area using the selected abrasive to ensure that the correct roughness can be achieved before the main blasting operation commences.

Standards for Roughness

There are several standards for the measurement of roughness, and it is important that, when a specific level of roughness is important, both the value required and the method for assessing the roughness are specified in the specification.

Common standards are ISO 8503 which uses various methods for assessing the surface roughness, ISO 8503-1 and ISO 8503-2 which use the ISO comparator, ISO 8503-4 which uses a stylus instrument, ISO 8503-5 which uses replica tape,

Dust

Introduction

In an industrial or heavy-duty environment, some level of dust will almost always be present in the air and will settle on surfaces to be painted. Whilst it will often not be possible to remove all dust every effort to limit the amount of dust on the surface should be taken. This is due to several reasons, whilst paint might adhere well to dust, the dust will normally not adhere well to the underlying surface, and this will result in poor adhesion and possible detachment of the coating system. Dust can have varying composition and some dust may be hygroscopic or water soluble which will result in blistering and detachment of coating systems in immersed or high humidity environments. Dust may also contain metallic particles from grinding work, and this may corrode leading to a poor cosmetic appearance and also blistering and detachment of the coating system. Application of coatings on duct with large particles may result in a rough surface with poor cosmetic appearance and greater dirt retention properties. The Prescence of dust under or in a coating will potentially have a negative effect on the properties of the coating and its ability to protect the substrate to which it is applied.

Safety

Use adequate personal safety equipment and follow sound procedures. Observe all safety instructions and avoid inhalation of dust, even if not considered hazardous dust and especially if the dust is of an unknown composition. Note that some dust when in contact with skin can cause irritation so ensure that you are well protected.

Dust Quantity and Size

The maximum quantity and size of dust permitted should be included in the specification, where a standard such as NORSOK M-501 is referred to in the specification then the dust values relevant for that standard are those that are valid for the specification. If no values are given then this does not mean that any quantity of dust or size is acceptable, common sense must prevail and good painting practise would dictate that levels that would have a negative effect on the performance of the coating system to be applied are not acceptable (consult Hempel for details). When there are no values in the specification then it is prudent to agree these before the project starts.

Assessment of dust quantity and size

The quantity and size of dust on a surface is normally assessed according to ISO 8502-3. A pressure sensitive tape is used, placing it on the surface to be assessed then on a surface with a contrasting colour to the dust on the surface, the dust quantity and size are then assessed visually. In the standard figure 1 is a pictorial reference corresponding to dust quantity ratings and Table 1 a description of duct particle size.

Removal of Dust

If the area to be coated is enclosed, then the preferred method for dust removal is vacuum cleaning. Using a vacuum cleaner will ensure that the dust is removed from the surfaces and does not settle again after cleaning. Other methods such as blowing with air and using extraction ventilation risk filling the area with air from outside that could be contaminated with other dust or have a high humidity resulting in condensation, and the extraction system may not effectively remove dust from all parts of the enclosed area.

Removal of dust outside is sometimes possible using dry clean compressed air, however some of the dust will re-settle on the surface and the process may have to be repeated several times to ensure that the surface is clean enough.

Dust may also, on occasions, be removed by washing with fresh water, as long as the water does not affect the surface to be coated in any way. This method is therefore not relevant for dust removal from surface with exposed steel or on surfaces where the water could react with uncured coatings.

Microclimate

Introduction
The microclimate consists of the ambient and surface temperatures, the dew point (calculated) and the relative humidity. These are measured and calculated at regular intervals using reliable equipment to ensure that there is no probability of condensation on the surface and that any temperature requirements for application and drying / curing of a specific product are conformed to.

The conditions must be correct immediately prior to and during application and drying / curing of the applied coating system. These conditions must be measured right next to the object to be painted and the surface temperature of the surface to be coated.

Safety
Measurement of the surface temperature is normally performed using a contact thermometer however care should be taken when accessibility is limited and if necessary proper equipment such as a lift or cherry picker with the appropriate safety equipment, should be used to ensure safe access.

Factors
Various different types of equipment are available for measurement of readings, from old fashioned analogue magnetic contact thermometers and sling psychometers to digital equipment containing sensors for measuring both surface temperature and relative humidity and displaying the calculated dew point.

The reliability of all types of equipment must be checked periodically to ensure that they are reading accurately. When using the equipment of any type then it is necessary to allow the equipment to acclimatise or adjust to the temperature where is it being used. Moving equipment of any type from a cold environment to a warm one (or vice versa) and immediately taking measurements can lead in some cases to incorrect readings. The equipment must be allowed to acclimatise and several readings with some minutes interval between them should be taken until consecutive readings are consistent and can be considered reliable. In particular magnetic thermometers which have a comparatively large amount of metal in contact with the surface to be measured, should be allowed to sit on the surface for quite some time. Electronic air temperature and humidity gauges that have sensitive sensors protected with sintered covers should also be exposed to the environment to be measured for some time to allow for the air at the surface of the sensors to have the same conditions as the surroundings. For both of these cases the times necessary may be found by taking several consecutive readings at 3 - 5 minute intervals (whilst the magnetic thermometer is attached to the surface to be coated and the electronic instruments held in open air away from any influences such as persons bodies, direct sunlight or water leaks) until there are consecutive readings with the same values.

Assessment of readings
When the readings have been taken at areas considered to be representative of the structures then they should be assessed. When reading show high humidity or a dew point that is close to the surface temperature then the surface should be carefully examined to ensure that there is no condensation present and unless specified the surface temperature must be at least 3°C (5°F) higher than the dew point.
The conditions should be regularly monitored by quality control personnel and any change in weather conditions such as a sudden drop in temperature or a change in wind direction should trigger extra checks to ensure that the conditions are still suitable for application.

Changing the microclimate
If the microclimate is not suitable for application of a certain coating or coating type then there are options to change the conditions, however there are practical limitations and sometimes large costs involved with this.

If the area to be painted is enclosed, then the ventilation used to remove solvent from the coatings may be combined with dehumidification and heating and may change the conditions inside to make them favourable for application of a coating system. The placement of the ventilation and quantities of air supplied are critical to ensure that here are no areas that do not have the right conditions and that any solvent from an application of a solvent based coating is both diluted and exhausted from an enclosed area.

If the area to be painted is outside, then options are very limited. Heating of the inner parts of an object that is to be coated externally can on occasions increase the temperature of the outer surface so that it is above the dew point however there would be both financial and practical challenges here.

Note that if the surface that should be coated is wet due to condensation, then removal of the condensation by air blowing wiping or using squeegees is not an option. As long as the conditions remain where the surface temperature is below the dew point then the condensation will reappear and for the majority of applications the surface temperature must be at least 3°C (5°F) above the dew point.

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