Statoil governing document

Thin Film Internal Epoxy Coating for Pipelines

Technical and professional requirements

TR1114, Version 1.01, Valid from 13.11.2003

Validity area:
Statoil group / All locations
Classification: Open

Contents

1 Introduction

1.1 Objective

This Specification covers the minimum requirements for internal flow coating of pipelines, with epoxy based material.

1.2 Warrant

Document is warranted in Statoil Area Requirement, "Pipe-laying and subsea operations" (AR07) (Statoil group/All locations)

1.3 Publication and follow-up

The mandate for publishing and follow up of this document including updating/revision lies with TEK PE K&P.

The processing of exceptions and suggestions for improvement of the document is described in "Dispensations, improvement and non-conformances" (WR0011) (Statoil Group/All locations).

1.4 Definitions

None.

2 Requirements

This Specification covers the minimum requirements for internal flow coating of pipelines, with epoxy based material.

The coating shall reduce friction and improve the flow conditions in non-corrosive gas pipelines. The coating may also offer corrosion protection during pipe storage, transport and installation.

3 Materials

3.1 General

The coating materials shall be fully tested and certified in accordance with API RP5L2, the colour shall be red-brown.

The paint shall be of the high gloss type, minimum 50 measured on air cured coating at an angle of 60^{o} according to ISO 2813.

The performance testing to API RP5L2 (Table 3.5) shall include a 100 % methanol immersion and 100 % triethylene glycol immersion test. The immersion time shall be 168 hours.

The coating shall fulfil all requirements both on test panels and on coated pipes.

If the storage period is one year or longer, special precautions shall be taken to avoid coating breakdown.

3.2 Components

The epoxy paint shall comprise the following components:

1. Epoxy base (epoxy resin, pigments, extenders, additives and organic solvent)
2. Curing agent (epoxy aliphatic/cycloaliphatic amine or polyamide).
3. Base and curing agent shall not contain fatty acids, oils, paraffin or chlorinated plasticizers, fatty acid esters, 2.3.dihydro-1.1.3.-trimethyl-3phenyl-1H-Indene ($C_{18}H_{20}$) or similar and other substances which can contaminate the natural gas. This implies polar high molecular weight components with very low vapour pressure and diffusion rate of the components within the paint film.

3.3 Properties of Coating Materials

3.3.1 Epoxy Resin

Molecular weight: 850-950
Epoxy equivalent (ISO 3001): 450-525

3.3.2 Pigment and Extender

The pigment and the extender shall not react chemically with the curing agent. The pigment shall include sufficient rust inhibitor to pass the salt water spray test ISO 7253 for minimum 500 hours.

3.3.3 Coatings

Epoxy coating shall be thixotropic and have a volume of solids (measured according to API RP 5D-2 **Appendix 1**) above 38% (non thinned paint).

Coatings shall flow, with no solids retention (refer to ASTM D 185, Mixed Paints), through a 90 microns sieve.

The manufacturer of the coating shall specify and communicate the pot-lift, the dry-to handle time (refer to ASTM D 1640) and the complete drying time (ISO 1517) at temperature intervals of 10°C (from 0°C to 60°C) and a relative humidity of 90%. In no case shall the pot-life, at 25°C, be less than 6 hours.

The coating shall be suitable for application by airless equipment and by brush in the following conditions:

1. Metal temperature between 10°C and 60°C.

2. Ambient temperature between 10°C and 40°C.
3. Ambient relative humidity up to 90%.

3.4 Control of Raw Materials

3.4.1 Identification

Each batch of the paint shall be clearly identified and all necessary batch certification shall be available.

IR-spectre shall be part of the batch certification. IR-spectra shall be subject to random control by coating contractor.

3.4.2 Package and Storage

The pots containing paints shall be kept in their original packing and wrapping until the moment of use. The storerooms shall be protected so that the recommended storage temperature range as indicated by the manufacturer, is maintained.

4 Preparation of pipe surface prior to coating

4.1 Inspection Before Cleaning

Prior to preparation of pipe surface, all pipes shall be visually examined for dents, laps, defect bevels and other obvious defects in order to avoid coating unserviceable pipes. Defective pipes shall be noted and, if they cannot be repaired by light grinding, they shall be removed from the coating area. Otherwise, following light grinding, pipes shall be resubmitted for acceptance.

4.2 Washing

Salts and dirt shall be removed from the pipe surface by using high-pressure fresh water and, whenever necessary, by brushing. Organic contaminants shall be removed by using hydrocarbon solvent (xylol mineral spirits) or detergents. Salt contaminations on the surface shall be measured by a Soluble Salt Detector, SCM 400 or equivalent, measuring conductivity. Requirement: maximum 10 mg sodium chloride pr. m^2.

The cleaning method shall be tested and documented for the actual coating method.

4.3 Pre-heating

Just before blast-cleaning, the pipe surface shall be pre-heated to a temperature of at least 3°C above dew point.

4.4 Abrasive Cleaning

Pipes shall be shot blasted to minimum Sa 2 ½ (ISO 8501-1). The finish shall be maintained until the moment of coating.

After completion of abrasive cleaning operations, the steel surface must be thoroughly checked. Any slivers, swabs, burrs, lamination and gouges shall be removed by grinding. After grinding, the remaining wall thickness shall comply with the requirements of minimum wall thickness according to MTO and OS-F101. All visible dust and solid particles shall be removed.

4.4.1 Surface Roughness

The surface roughness shall be fine grade according to ISO 8503-1.

5 Coating Procedures

The components shall be mixed thoroughly and, if necessary, thinned in accordance with the manufacturer's directions.

The paint shall be free of any lumps or skinning at the moment of application.

The viscosity of the mixed paint shall be monitored, before it is applied, by means of suitable equipment (e.g. apparatus as in ISO 2431), and adjusted if necessary.

5.1 Coating Application

After blast cleaning and during paint application

- The steel temperature shall be kept at a temperature of at least 3°C above dew point.
- The metal temperature shall be between 15 °C and 60°C. No heating of pipes between blast cleaning and paint application shall be performed.
- The ambient temperature shall be between 10°C and 40°C.
- The ambient relative humidity shall be maximum 90%.

The coating shall be sprayed continuously and uniformly onto the whole surface to be coated.
The coating shall be continuous for the full length of pipe, except for an area at each end of 50 mm ± 10 mm.
For application in pipes with an outside diameter above 12 inches, airless spray equipment shall be used. For pipes with an outside diameter less than 12 inches, the use of air spray equipment, provided with rotating jet nozzles, is acceptable.

The paint may be applied in either one coat or two coats. In the case of two coats, paint suitable for "wet on wet" painting shall be used. Applied coating shall be free from sags, runs, drips and pinholes.

5.2 Curing

The pipes shall be touch dry before any handling. Handling procedures must reflect curing of the coating. If accelerated curing is used, the steel temperature shall not exceed 100°C.

The curing method shall be tested and documented for the actual coating type. The coating shall be cured at a temperature recommended by the paint manufacturer.

5.3 Dry Thickness of the Applied Coating

Each single dry thickness shall be between 40 and 90 microns, with the majority of coatings having a thickness of between 60 and 80 microns.

For seamless pipe with an irregular surface caused by the manufacturing process, the dry thickness shall be between 50 and 110 microns with the majority of coatings having a thickness of between 60 of 90 microns. The thickness shall be measured in accordance with ISO 2808 Method 5.

6 Pre-production Qualifications

6.1 General

Any coating, material and coating procedure proposed in relating to this specification, shall be qualified prior to and during the plant start-up phase through suitable tests and inspection carried out at the Contractor's workshop. The qualification document shall be prepared and supplied to Company by Contractor prior to coating production commencement.

Minimum 3 pipes shall be used for the pre-production test. Inspection and testing shall be carried out and meet all requirements in this Specification.

Company shall have full access to inspect/monitor sub contractors.

7 Inspection and Testing

7.1 Paint Qualification, Laboratory Tests Required

7.1.1 Qualification Tests, Physical Properties

The following laboratory qualification test shall be performed in laboratories authorized to issue official certificates. Tests shall be made on steel panels in accordance with ISO 1514. Reference shall also be made to ASTM 823 and ISO 1513.

The contractor shall document and verify all Paint Qualification Laboratory Tests.

As a minimum, the following shall be determined:

1. An infrared scan.
2. Specific gravity of epoxy base, curing agent and mixed paint (refer to ISO 2811)
3. Viscosity of epoxy base, curing agent and ready to use paint (refer to ISO 2431)
4. Finesses of grind of mixed paint – Hegman scale (refer to ISO 1524)

5. Ash content (refer to ASTM 1650), volatile and non-volatile matters (refer to ISO 1515) of mixed paint.

Test panels shall be prepared with a film thickness according to requirements in this specification. The test panels shall be cured according to the curing procedure presented for the actual pipes.

7.1.2 Qualification Tests to be Carried Out on Normally Cured Paint

No measurements or observations shall be made within 5 mm of the edges of the specimens. A normally cured coating shall pass the following tests:

1. The salt spray test (refer to ISO 7253) modified according to API RP 5L2, Appendix 2 (see also ISO 4628/I)
2. The 180° bend test on a cylindrical mandrel, 3 mm in diameter, at 23 ± 2°C (refer to ISO 1519, type 1 apparatus), without any loss of adhesion, but without previous stretching.
3. Exposure for at least 1 hour in an oven at a temperature of 210°C, without appearance of unevenness in the coating film.

7.1.3 Qualification Test to be Carried Out on Normally Cured Paint After Specimen Stretching

A coating applied on test panels which have been normally cured and subjected to 2% elongation, shall meet the requirements of ASTM D 968, and API RP 5L2.

7.1.4 Indentation Test

The accelerated cured coating shall have a minimum indentation resistance as specified in ISO 2815.

7.1.5 Certification of the Results of the Laboratory Qualification Tests

When the required qualification tests are complete, the laboratory shall issue an official test certificate, which includes the following information:

1. Name and location of the laboratory and number of the test certificate.
2. Trade name of the paint manufacturer.
3. Identification of the components of paint being tested.
4. Type of curing agent (amine or polyamide-based or others).
5. Mixing ratio, by weight and volume, of paint components used in the test.
6. Paint colour.
7. Size of the specimens, brief description of the adopted cleaning procedure and obtained results (cleanliness degree, roughness observed with ISO 8503-1).
8. Number of specimens for each test and actual dry thickness of the paint applied on each specimen.
9. Certificates of calibration of instruments (whenever necessary), and employed test methods, results obtained on the single specimens and complete and detailed observation on their behaviour.
10. Temperature of specimen conditioning.

7.1.6 Qualification Validity Limits

No modification of the coating or its components is acceptable after the qualification tests have been performed.

7.2 Tests During Application

- Visual examination of all pipes before blast cleaning, ref. 4.1.
- Tests for salt contamination after blasting, once per shift, ref. 4.2.
- Humidity and air temperature shall be recorded continuously during blasting and coating application, ref. 4.3 and 5.1.
- The steel temperature shall be measured at start-up and once per hour.
- Visual examination of all pipes after blasting for cleanliness (dust, fat, particles) and defects, ref. 4.4.
- Control of surface roughness once per shift, measured with Perthometer, ref. 4.4.
- The viscosity of ready to use paint shall be monitored before coating application according to ISO 2431 and adjusted if necessary.
- During the coating process, test panels shall be inserted into the pipes (see ISO 1514). These panels shall be coated together with the pipe internal surfaces. Procedures, frequencies and acceptance criteria according to API RP 5L2. If a pipe fails in any of the tests, the pipe shall be returned for re-cleaning and re-coating. All pipes proceeding the failed test and after the last accepted test shall be returned for testing.

7.3 Final Inspection of Coated Pipes

Visual inspection shall be carried out for all pipes. All pipes shall be inspected internally for the following defects:

1. Coating defects due to insufficient cleaning prior to coating, the appearance of oil, grease or foreign matter, stains, etc.
2. Non-smooth appearance of the paint, presence of defects such as pinholes, bubbles, blistering, lack of paint) or presence of significant unevenness such as barber poling, fisheyes, sags, orange peel, casings, ringing and/or spirals), due to an excessive surface roughness or deficiencies in paint application.
3. Paint strains or drops on the bevels and pipe ends, due to the omissions, incorrect positioning or insufficient width of the masking tape.
4. Blushing (whitening) of the applied paint due to exposing it too soon to sunlight or to humidity.
5. Dry film thickness measurements shall be performed on every 10^{th} pipe. If the coating thickness to too low, all pipes coated after the last accepted pipe shall be tested.
6. Wet pinhole test at 9 volt on cured paint. Every 10^{th} pipe shall be tested at 4 locations 1 m from each pipe-end. If pinholes are detected review of the coating procedures are required.

7.4 Marking of Coated Pipes

After final inspection, internal marking of the accepted pipes shall be carried out as required by Company.

For this operation, epoxy paint, similar to the one used for pipe painting but of a different colour, is recommended.

8 Repairs

Any repairs shall be carried in accordance with a Company accepted repair procedure. The repair procedure shall be qualified during the pre-production qualification tests. Repair of coating is allowed in the following cases:

The presence of one or more of the type of defects described in section 7.3, requires the pipe involved to be recycled to the cleaning plant. But, if these defects are only localized and few in number and are accessible they may be cleaned and patched manually.

The presence of the type of defect described in item 4 of section 7.3 does not require any special repair operation. This provides, however, that the adhesion and thickness tests carried out as detailed in section 7.2 and 7.3 on the pipe and also on the white stained areas, give positive results after completion of paint cure in air. If the results are negative, the affected areas may be cleaned and patched manually.

9 Storage and Handling

Accepted pipes shall not be shipped before the coating is completely cured. Storage and handling shall be carried out in such a manner that damage to coating is avoided.

10 Reporting

Coating and inspection work shall be properly documented in a report including the following details as a minimum:

1. Pipe numbers
2. Details of surface defects and their removal
3. Pipe surface finish and profile
4. Material test certificates and IR spectrum from tested panels
5. Pipe temperature
6. All relevant coating application variables
7. Inspection (holiday detection, thickness, adhesion etc.) and details of any repairs.
8. Batch certificate according to item 3.4.1

11 References

This Specification has been prepared on the appropriate sections of the following specifications, standards and guidelines. Where differences occur between this Specification and the references, this Specification shall apply. Standards equivalent to those referred to herein may be used provided prior acceptance to the change(s) is obtained from Company.

Standards

OS-F101	2000	Submarine pipelines systems

API RP5L2		Recommended Practice for the Internal Coating of Line Pipe for Non-Corrosive Gas Transmission Service.
ISO 8501-1	1988	Preparation of steel substrate before application of paint and related products – visual assessment of surface cleanliness. Part 1.
ISO 8503-1	1988	Preparation of steel substrate before application of paints and related products – surface roughness characteristics of blast cleaned steel substrate. Part 1.
ISO 1513	1973	Paint and varnishes – examination and preparation samples for testing.
ISO 1514	1974	Paint and varnishes – standard panels for testing.
ISO 1515	1973	Paint and varnishes – determination of volatile and non-volatile matter.
ISO 1517	1973	Paints and varnishes – surface drying test – Bollotini method.
ISO 1519	1973	Paint and varnishes – bent test (cylindrical mandrel)
ISO 1524	1973	Paint and varnishes – determination of fineness of Grind.
ISO 2409	1972	Paint and varnishes – cross-cut test.
ISO 2431	1984	Paint and varnishes – determination of flow time by a flow cup.
ISO 2808	1974	Paints and varnishes – determination of film thickness.
ISO 2811	1974	Paints and varnishes – determination of density.
ISO 2812	1974	Paint and varnishes – determination of resistance to liquids.
ISO 2813	1974	Paints and varnishes – measurement of specular gloss of non metallic paint films.
ISO 2815	1973	Paint and varnishes – Buchholz indentation test.
ISO 3001		Plastics – epoxy compounds – determination of epoxy equivalent.
ISO 4628-1	1982	Paint and varnishes – evaluation of degradation of paint coatings – designation of quantity and size of common type of defects – general principles and pictorial scales for blistering and rusting.
ISO 7253	1984	Paint and varnishes – Determination of resistance to neutral salt spray.
ASTM D 185	1978	Coarse particles of pigments, pasts and paints.
ASTM D 823	1953	Producing film of uniform thickness of paint, varnish, lacquer and related products on test panels.
ASTM D 968	1951	Abrasion resistance of coatings of paint, varnish, lacquer and related products by the falling sand method.
ASTM D 1640	1969	Drying, curing or film formation of organic coatings at room temperature.
ASTM D 1650	1976	Sampling and testing shellac varnish.