Fig. 1: Blast cleaning

High performance coating for pipelines laid by Horizontal Directional Drilling

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New developments show some preferences for no-dig pipe laying (e.g. thrustboring, pipe jacking, linear microtunneling and horizontal directional drilling).

In case of trenchless pipe laying, coating materials of pipes and joints are particularly stressed by enormous abrasion and shear forces. Therefore line pipes are equipped with high performing three layer polyethylene or polypropylene factory coatings. The range of similar performing field joint coatings, which resist these high mechanical stresses while showing a remarkable flexibility, is limited.

These demands can only be fulfilled by two-component thermosetting coating systems based on polyurethane or epoxy resins. Both systems have in common that their structure is created by mixing of two components and later curing on site. Thus field coatings are created in alignment with the adjacent factory coating and provide extremely hard and flexible coatings which are characterised by outstanding high abrasion and shear resistance.

But the application of these systems proved to be very problematic as they have to be executed in several layers and working processes, which caused many application faults on site or resulted in an execution by special trained service companies. This paper presents a new procedure for the coating of welded joint areas of steel pipes with polyurethane reactive resins.

The innovative system DENSOLID® HDD was specially designed for horizontal directional drilling job sites and is a coating system based on a two-component polyurethane formulation, which is easy and secure to apply by inserting the compound into a transparent casing sheet. Application faults, e. g. false mixing ratio of components A and B are nearly excluded. DENSOLID® HDD deserves only a one step application for full protection of the pipe joint.

DENSOLID HDD complies with the requirements of EN 12090, coating class B for high mechanical and corrosives stress resistance, type 3 suited for permanent operating temperatures from –20 °C up to 80 °C.

The advantages of this new system on first view: due to the application in 2-chamber cartridges mixing faults or the enclosure of air bubbles will be avoided.

During the curing process the coating material must be protected from the influence of water, contamination and moisture. These requirements are perfectly met by using a casing sheet in which the 2-components polyurethane compound will be protected during the curing period.

The casing can be removed as soon as the polyurethane compound is tack free – approx after 2½ hours at 20 °C ambient temperature.

The average application time per joint will be around 30 minutes only varying slightly upon pipe diameters. There is in total a maximum

Fig. 2: Spacers mounted on each side of the weld bead

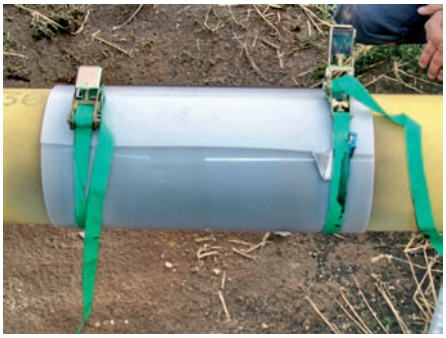

Fig. 3: Assembled casing sheet

Fig. 4: Filling of the casing sheet

Fig. 5: Discharging ahead of the flow front

demand of 5 casing sheets only, which can be reused at least three times.

At the time the volume for 2-chamber cartridges is limited to maximum 400 ml. Denso is developing a new application device to reduce disposal and material costs on site.

As the compound will be injected in a transparent casing, the permanent and even filling of the casing can easily be checked by the workers themselves. An equal and smooth surface will be achieved in the requested thickness even at problematic zones above the welding bead.

Application of DENSOLID® HDD

A sustainable application of DENSOLID® HDD requires a proper surface preparation. The areas to be coated must be clean, dry and free from dust and grease, transitions to a factory coating must be bevelled (min. 30°). Thereafter the steel surface must be blast cleaned (**figure 1**) to a surface cleanliness of at least Sa2 ½ (acc. to ISO 8501-1) and the adjacent factory coating must be carefully sweeped.

After removing the dust from the surface two spacers (e.g. plastic tape) are mounted (**figure 2**). The gap between the spacers and the

Table 1: Properties of DENSOLID® HDD

Property		Unit	Typical Value	Standard
Coating thickness		mm	≥ 1,5	ISO 2808
Stress class		–	class B, type 3	DIN EN 10290
Continuous operating temperature		°C	–20 up to +80	DIN EN 10290
Freedom from pores at 8 kV/mm (max. 20 kV)		–	passed	DIN EN 10290
Dielectric strength		kV/mm	25	DIN 30671
Impact resistance	23 °C –5 °C	J/mm	≥ 4,5 ≥ 3,2	DIN EN 10290
Indentation resistance	23 °C 80 °C	mm %	0.1 23	DIN EN 10290
Bending flexibility	23 °C 0 °C	–	passed	DIN EN 10290
Elongation at break		%	13	DIN EN 10290
Specific electrical insulation resistance	23 °C, 100 days 80 °C, 30 days 70 °C, 30 days 80 °C, 30 days 70 °C, 30 days	Ω · m2	$4.0 \cdot 10^9$ $1.5 \cdot 10^6$ $2.0 \cdot 10^6$ $1.5 \cdot 10^6$ $2.0 \cdot 10^6$	DIN EN 10290 DIN EN 10290 DIN EN 10290 DIN EN 10290 DIN 30671
Adhesion strength (X-cut)	23 °C 80 °C after H_2O-Immersion (80 °C, 100 h)	mm	< 1 mm (rating 1) < 1 mm (rating 1) ≤ 1 mm (rating 1)	DIN EN 10290
Adhesion strength (lift off)	23 °C 80 °C	N/mm²	18 3	EN 24624
Lap shear resistance	to steel to PE	N/cm²	> 400 50	DIN EN 12068
Adhesion strength after heat ageing	100 °C, 100 days	N/mm²	18	DIN EN 10290
Cathodic disbonding	23 °C, 30 days 60 °C, 2 days	mm	2,0 < 0,5	DIN EN 10290
Shore D hardness	5 °C 20 °C 40 °C 70 °C	–	75 73 59 36	ISO 868
Density		g/cm³	approx. 1.3	–

weld bead should be at least 50 mm and the heights of the spacers ensure a proper overlap of the welding bead of at least 2.5 mm.

On top of the spacers a casing is fixed by tensioning strips (**figure 3**). This casing guarantees the filling of the weld bead in a one-step application of DENSOLID® HDD.

A hole is drilled through the surface of the casing sheet to allow the insertion of the mixer jet of DENSOMIX 400 discarding unit. The transparent casing sheet permits a consistent filling. Ideally the filling of the casing starts at the 6 o'clock position to avoid air entraining (**figure 4**).

While changing cartridges an adhesive label prevents DENSOLID® HDD from leaking. After discharging a cartridge another hole is drilled ahead of the flow front of the fluid polyurethane material. The next cartridge is discharged into the new hole (**figure 5**).

This process enables the operator to handle the right amount of material for his application. The arising waste is minimised while application faults due to wrong mixing ratios are excluded.

After a few minutes the casing sheet is filled and the next weld bead can be processed.

After approx. 2.5 hours at 20 °C the casing sheet and the spacers can be removed. Steps in the transition of the factory coating and DENSOLID® HDD are bevelled after 12 hours curing to assure an optimum protection for the weld bead.

Properties of the high performance coating

DENSOLID® HDD is a polyurethane blend developed for corrosion prevention and applied as field-joint coating for pipes in trenchless horizontal drillings. Therefore the material has to match the requirements of EN 10290. The outstanding material properties of DENSOLID® HDD are displayed in **table 1**.

Conclusion

DENSOLID® HDD enables a corrosion protection which satisfies the huge demands (severe shear, abrasion and bending stresses) on construction materials used in trenchless pipe laying. The ingenious and easy application in combination with it's elimination of mixture faults and tailored cartridges enables the construction staff on site to execute this job in a secure and quick way and thus eases the operator's life and minimises malfunctions.

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