KEEPING COVERED IN ARCTIC CONDITIONS

Human beings need to be well prepared for extreme climate conditions, but does a good product need to be prepared too? Michael Schad, DENSO GmbH, Germany, provides an answer.

It seemed that Winter was never going to end with all the snow over Europe in March 2013. Everyone would be glad to escape from the cold and to fly to a warm and sunny island at that time of the year. But life very often has a different plan. Instead of travelling to a sunny island, DENSO GmbH Germany headed into the arctic cold.

JSC Transneft Moscow, the owner of one of the longest oil pipeline systems in the world, with a total network length of almost 50 000 km of pipelines, invited the leading heat shrink sleeve producers to take part in an extreme application test on its Zapolyarye-Purpe Pipeline in Western Siberia underneath the polar circle. The construction of this oil pipeline is in progress to transport oil from new basins of Yamalo-Nenets Autonomous Okrug.

The reasons for JSC Transneft to undertake these tests were occurring problems with applied shrink sleeves under severe conditions. The adhesion of the heat shrink sleeve onto the metal

Figure 1. Zapolyarye-Purpe Pipeline Western Siberia.

Figure 2. Extreme temperatures (-38.6 °C).

Figure 3. Galvanised high strength steel sheet.

surface of the pipe and especially onto the adjacent factory or mill coating had failed in the past. The company's prescribed high quality standards and the requested high peel strength on both metal surface and factory coating also had to be fulfilled under arctic conditions.

DENSO was invited on 13th March 2013 and the field tests onsite were scheduled for 25th March. The coating for the joints was to be executed on a 40 in. (DN1000) pipe section.

How does a human being prepare?

With more than 90 years of experience in the business of corrosion prevention for pipelines, DENSO and its engineers have encountered nearly all climates so far – from the very hot desert to freezing minus temperatures. The weather forecast predicted around -25 °C (-13 °F) for the scheduled application dates in Western Siberia in March 2013. In this part of Western Siberia, pipeline construction can only be carried out during Autumn, Winter and Spring as the ground is swampy and marshy. When it gets warmer and the ground thaws, the heavy pipeline equipment will immediately sink and there will be no chance to lay the pipeline accordingly.

The standard overalls of the DENSO team were proved for up to -40 °C (-40 °F), the warmest workwear to buy in Germany. The engineers expected to be well prepared for the predicted temperatures. Also, additional equipment and clothes were packed into the luggage in order to survive in the Arctic – something not needed on a sunny island!

When arriving on the jobsite on 25th March 2013, the DENSO team expected the forecasted temperatures of around -25 °C (-13 °F) and conditions. However, the weather had changed: the temperatures dropped down to -38 °C (-36.4 °F) with strong wind. These arctic conditions were real challenges for all people onsite. Despite being dressed in the best Winter equipment they could get in Germany, all team members were chilled to their bones.

The plummeting temperatures froze the oil for the mechanical movement of a wristwatch, the LCD screen and the release button of a digital camera and destroyed the control for the tele-lenses.

In this geographic area, diesel engines for trucks and generators are never switched off after October and run through until April. All trucks are fuelled under operation. Once the engine stops, it will not start again due to the low temperatures.

Do products need special preparations as well?

A human being obviously has to prepare him/herself for any extreme climate conditions. Unfortunately, there is no single solution for us humans for all climates but one has to adapt to all circumstances individually. In contrast, when developing products the lofty goal is always to find one solution that fits all circumstances and climate conditions.

Indeed temperatures of -38 °C (-36.4 °F) and strong wind are probably the worst conditions

Figure 4. Welding tent at site.

Figure 5. Shrinking of sleeves.

Figure 6. Peel tests.

found on earth – especially for a product type such as heat shrink sleeves, which due to its nature requires a preheating of the pipe and can only be applied with a torch flame. Based on experience, DENSO's first suggestion was to apply a product that would initially serve best under those conditions: a cold applicable real co-extruded tape system. These tape-systems have proved for decades their advantages saving energy cost, being easy to apply and providing fail-safe properties, even under cold climate conditions.

However, the company was invited to demonstrate its heat shrink sleeve material and had to find a way to work with the circumstances found on the jobsite.

Due to the short preparation time and expecting a higher temperature, the team decided to use the standard DEKOTEC HTS 70 shrink sleeve, which has been successfully applied in different climate zones in the past, from desert locations to minus temperatures. In addition, tests in cold chambers at different universities in Germany have been performed in the past, showing excellent results. But would the standard formulation of the hot melt adhesive and the epoxy primer still perform under the unsual arctic conditions in Western Siberia?

Application in Western Siberia

The factory or mill coating of the Zapolyarye-Purpe Pipeline consists of a three-layer polyethylene coating. The pipe ends were 150 mm on both sides, so the joint width was 300 mm.

The coating is executed with three-layer shrink sleeves on the field joints, which are designed for a maximum operating temperature of +60 °C (+140 °F). On top of the applied shrink sleeve, a thermo insulation layer by means of polyurethane foam will be applied. Above this polyurethane foam, a galvanised high strength steel sheet will be mounted.

As an additional corrosion prevention and mechanical protection, three more shrink sleeves in a width of 550 mm on both sides and a 450 mm wide sleeve in the centre are applied onto the steel sheet.

During the application of the sleeves on the joint, an unheated welding tent was set to cover the joint section. The temperature in the tent was expected to be around -10 °C (14 °F) only, but as the doors could not be closed and a strong wind was blowing, the temperature was even lower.

The applied shrink sleeve by DENSO was a standard DEKOTEC HTS 70, a sleeve system designed for operating temperatures up to +70 °C (+158 °F). It is a three-layer system equivalent to 3LPE factory coating. Its highlights are its peel- and lap-shear properties and the fact that it requires a lower application temperature compared to competitive products.

The sleeve system is DVGW C60 UV and GOST R 51164-98 approved. The thickness of the applied type was 2.6 mm. For easy application and a strong bond, it is applied together with the DEKOTEC EP Primer.

The DEKOTEC HTS 70 shrink sleeves were applied onsite in Western Siberia in the following procedure:

The pipe was preheated up to between +50 and +55 °C (+122 °F and +131 °F). The epoxy primer was put into an oven in the camp to keep it warm at all times. If the primer had not been preheated, it would crystalline within seconds when mixing components A and B at those polar temperatures. The epoxy primer was applied onto the pipe with a sponge and subsequently flame-cured with a gas torch at a temperature range between +90 and +95 °C (+194 °F and +203 °F).

Even under these severe application conditions, the application of the DEKOTEC heat shrink sleeve on a 40 in. (DN1000) pipe did not take longer than 37 minutes for preheating, primer application and the shrinking process of the sleeves.

The application of heat shrinkable sleeves under arctic conditions requires modified application techniques to achieve good results. In contrast to the application in moderate climatic zones, one has to carefully take care of the wind direction of the gas torch and one has to preheat the factory coating intensively to ensure an adhesion to the primer and the sleeve instead of activating the polyethylene only. The sleeves will be shrunk from the middle of the sleeve opposite to the wind direction.

Tests performed onsite

After 24 hours, all applied sleeves from DENSO and the other market participants were investigated and tested by LLC Transneftstroy, Tjumen, which is a subsidiary company of JSC Transneft, according to the required high quality standards.

As described before, the focus of testing by JSC Transneft at these polar conditions is laid on the adhesion onto the metal surface of the pipe and especially onto the adjacent factory coating.

Under regular conditions according to the leading international standards, the peel test, which measures the adhesion values, a cohesive separating of the adhesive layer from the backing material of the heat shrink sleeve is requested. Under those polar conditions at strong minus temperatures, this cohesive break will not be achieved by any heat shrink sleeve on the market.

Nevertheless, all other participating producers of heat shrink sleeves, which took part in this onsite test, prepare tailored epoxy primer and adhesives of the heat shrink sleeves, specially designed in order to withstand this cold climate. DENSO was the only manufacturer who presented its standard heat shrink sleeve product with its standard epoxy primer.

The tests of JSC Transneft showed that the standard DEKOTEC HTS 70 passed the required values of the peel test, both on the metal surface of the pipe as well as on the adjacent factory coating, and showed an impressive overall performance.

One solution for all extreme climate conditions

The DENSO engineers now know to better prepare themselves for the next tests in the Arctic, trying to find even warmer clothes – and keep in mind the useful recommendations from Russian friends, who know all the tricks how to survive in those climate conditions.

The DEKOTEC heat shrink sleeves from DENSO however – with the standard formulation – are well prepared for extreme situations under tropical conditions and even at -38 °C (-36.4 °F) in Western Siberia.