Field Joint Coatings for Deep Sea Pipelines

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Abstract

Carbon steel pipelines to transport hydrocarbons installed in the sea need not only to be protected against corrosion, but also to be insulated to maintain the temperature of the pipe contents and to assure the flow. Therefore a multilayer polymer coating is applied. After the individual pipe sections are coated with a factory-applied coating along their full length, the coating is cut back at the ends before welding them together during the offshore installation. After welding, a field joint coating is applied over the welded area by injection molding (Figure 1).

Several requirements need to be met for field joint coatings, among which an easy applicability in the field, the possibility to cure or crystallize optimally (hence as quickly and completely as possible) in the mold, and the prevention of the formation of internal cavities.
Regarding the adhesion onto the steel pipe and the factory applied coating, the interfacial stresses due to differential thermal, cure-induced, and crystallization-induced shrinkage during both coating application and pipe usage are the prime cause for failure. As a consequence, ensuring optimal application conditions for the application of the field joint coating during an offshore installation is far from straightforward.

COMSOL Multiphysics® is used to model the field joint application process, taking into account not only heat transfer, cure kinetics, and crystallization, but also thermal, cure and crystallization shrinkage and the resulting interfacial thermal stresses (Figure 2). Experimental data from the raw materials will be implemented in the model and the computational results will be compared with experimental results on industrial test pipes. By gaining deeper insight into the field joint coating process and the variables controlling the adhesion between the different materials, we aim at improving the selection and design of the materials and process.

So far, COMSOL Multiphysics® allowed the calculation of temperature and crystallinity profiles in the field joint as a function of time. Currently, specific volume changes and resulting interfacial thermal stresses are being implemented in the model. In a final stage, the filling of the mold will also be built in into the model.

Figures used in the abstract

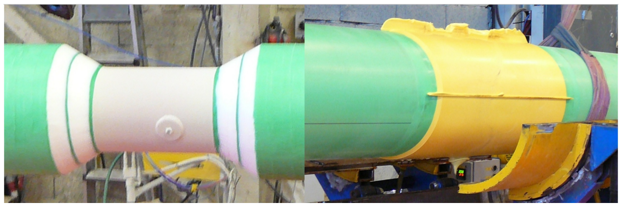

Figure 1: Welded pipe section, (left) after application of the corrosion protection layer, clearly showing the chamfers and (right) after application of the field joint coating.

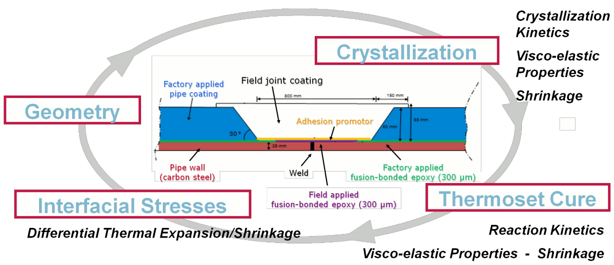

Figure 2: Schematical representation of the COMSOL Multiphysics model, taking into account crystallization and cure kinetics and specific volume changes.