



CORE Coat 010 *Statement on Environmental Impact*

Introduction

The CORE Coat (Crude Oil Repellent Coating) series consist of Sol-Gel derived organic inorganic hybrid coating systems with excellent repellent properties towards deposits commonly experienced in crude oil production and handling. CORE Coat 010 specifically, has demonstrated excellent repellent properties towards organic and inorganic deposits when used on titanium plate heat exchangers in offshore oil production. This statement describes the environmental impact expected from long term exposure of crude oil and produced water to the coating system.

Sol-Gel describes a method for the synthesis of glass ceramic like coatings from liquid reagents. Sol-Gel derived glass ceramic coatings do not, as conventional glass ceramics, require sintering at elevated temperatures. Instead, Sol-Gel coatings are typically cured at temperatures ranging from 140 °C to 200 °C. The low curing temperature, taken together with the nature of the components used for the synthesis, permit formulation of coatings with both organic and inorganic constituents. This forms the basis for the special properties it is possible to embed in a Sol-Gel derived glass ceramic coating – such as e.g. oil and limestone repellency, flexibility, substrate adhesion, etc.

Technical Description of CORE Coat 010

CORE Coat 010 forms an approx. 5µm thick, flexible and repellent coating. All components become either part of a cross-linked coating film or evaporate during curing. The inorganic part of CORE Coat 010 is constituted by a Sol-Gel derived siloxane (Si-O) network, forming a glass like structure. A large part of the backbone of the coating is thus constituted by a benign inorganic matrix. This inorganic matrix is stabilized through the inclusion of silicon-bound organic constituents including a urea motif, which provides essential properties, such as flexibility and chemical stability, to the coating. The urea motif is formed when synthesizing the liquid coating material by reacting an amine with an isocyanate. Furthermore, the coating includes a PDMS component to provide the coating with the repellent surface characteristics.

CORE Coat 010 IS NOT a 'NANO COATING'

CORE Coat 010 is a Sol-Gel derived hybrid coating. In the process of synthesizing the coating, no nano-particles are added, nor any other nano-materials (e.g. nano-flakes, nano-tubes, nano-sheets, etc.). The coating does therefore not constitute any hazard derived from the presence of added nano-materials, why the coating can be handled with the same care and diligence that any coated material must be handled. Likewise, erosive wear of the coating will give rise to fragments, like any other coating technology.





CORE Coat 010 does NOT contain FLUORATED COMPOUNDS

No PFOS, PFOA or any other kind of per-fluorated or poly-fluorated compounds are present in the CORE Coat 010 formulation. Such substances are known to be extremely persistent in the environment. The substances are known to bioaccumulate in marine species and ultimately in polar bears and other predators at the top of the food chain. Toxicological studies on animals indicate potential developmental, reproductive and systematic effects.

The repellent properties of CORE Coat 010 rely on an entirely different technology that is documented safe, and approved for food contact.



Steps to Ensure Fully Cured CORE Coat 010

To ensure a stable, functional coating and a minimal environmental impact, it is essential that the constituents of the coating are fully reacted. This is ensured by a series of discreet steps that each focus on bringing the isocyanate content to reaction:

- Stoichiometry during synthesis of the coating: The coating is formulated to achieve an optimal reaction ratio between isocyanate and reactant.
- Monitoring of the synthesis: In a step involving continuous pH measurements, the isocyanate:reactant ratio is closely monitored during the synthesis process. This ensures optimal reaction stoichiometry and marginal surplus of unreacted isocyanate groups.
- CORE Coat 010 employs solvent that reacts with eventual unreacted isocyanate groups present.
- CORE Coat 010 is stored for at least a week before application. This provides ample time for isocyanate reactions to come to completion.
- CORE Coat 010 is cured at 200 °C. The high curing temperature ensures reaction of eventual unreacted isocyanate groups, either with other coating components or ambient H₂O

Degradation of CORE Coat 010

CORE Coat 010 has, when applied on titanium heat exchanger plates for offshore oil production, demonstrated more than 600 days of efficient repellent properties without loss of adhesion or significant degradation.

CORE Coat 010 is extremely flexible and has been demonstrated to endure contact point wear very well. The flexibility, in what fundamentally is a glass ceramic like structure, is obtained by formulating the matrix structure with organic moieties that cross link and thus provide both flexibility and stability. Furthermore,



the superior adhesion of the coating to titanium plate heat exchanger plates in crude oil contact ensures that eventual contact point erosion remains localized and does not lead to regions of coating delamination.

Over time, it is expected that CORE Coat 010, primarily due to physical wear, will erode. This process will release small particles of the coating, which, given the physical constitution of the fully cured coating, will consist of a cross-linked network of silicone moieties (PDMS), ureas, aliphatic- and cycloaliphatic groups and siloxane. These components are, given the above composition, not believed to possess a significant environmental challenge.

In the case the coated materials are subjected to an operational environment with pH below, the coating may lose adhesion and come off in flakes. The approx. 5 µm thick flakes will quickly crumble to smaller particles and are thus not, given the above composition, believed to possess a significant environmental challenge.