SUBSEA COATING APPLICATION IN FREEZING CONDITIONS

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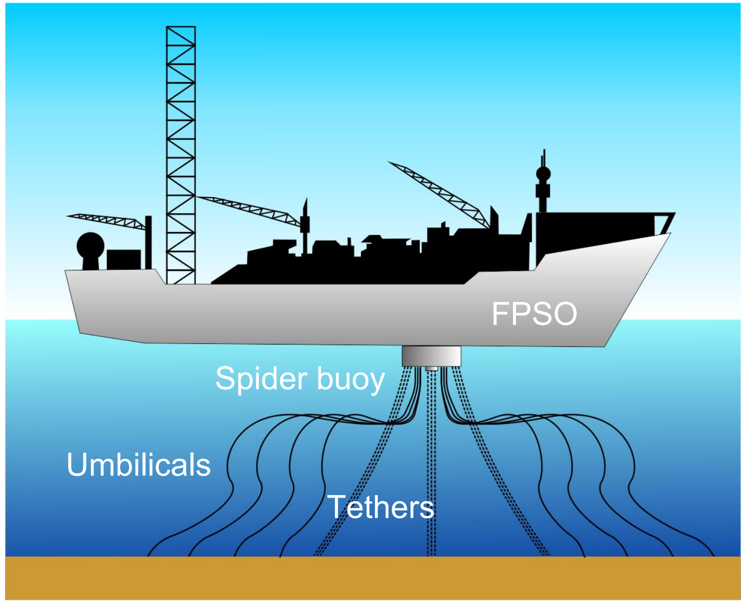
Flexible riser systems are crucial for the use of floating production systems in shallow water. Where ice is present, the riser system must also be disconnectable to allow the FPSO to move away from the production site in case of icebergs. At this site the water depth is around 300 feet (90m) at low tide with a potential wave height of up to 100 feet (10 m), creating a very challenging environment requiring considerable flexibility from the riser system which has a high number of dynamic flexible risers and umbilicals connected to a large spider buoy, anchored to the seabed. Normally located at the bottom of the FPSO's turret, the riser/mooring system can be disconnected when required and lowered to allow the departure of the FPSO.

For this project, I-tubes (to which the risers are connected) located on the underside of the spider buoy required recoating works with weld fatigue and several areas of coating damage. Water temperatures at the site were as low as 33°F (1°C).

The company responsible for the works is a large international oil and gas service and engineering group that had already successfully used Alocit for previous coating works in extreme cold-water conditions. Although the areas to be coated were relatively small, it was critical for the company that the integrity of the I-tubes was protected and Alocit was chosen for its proven ability to be applied and cure in near freezing conditions, providing the protection the system required.

FLEXIBLE RISER SYSTEM



Nevertheless, even for Alocit, the conditions and inaccessibility of the site were a challenge. The decision was made that all the preparation and coating works would be accomplished by divers operating from a diving bell suspended alongside the work area. The coating was to be mixed topside and delivered to the divers for application approximately 130 feet (40m) from the mix site. Following testing, a cartridge delivery system was chosen as the most efficient way of delivering the mixed coating to the divers.

The divers were operating 6-hour bell runs, requiring constant use of the bell for breaks and at the end of dives. Because diving bells have a limited volume (in this case 265ft3/7.5m3 - nearly half of which would be taken up by divers and equipment), the potential for uncured coating on suits and equipment entering the air space had to be considered. During the curing process, all coatings have the potential to ‘off-gas’, producing vapors for which strict exposure control limits are set. Following extensive testing, Alocit was found to be safe to use in these conditions, although some mitigations were put in place to reduce paint volumes entering the chamber to limit the need for clean-up as well as prevent potential air contamination. During the project, however, it was found that contamination from Alocit was significantly less than had been anticipated.

PROJECT DETAILS

Prior to any work taking place the target areas were assessed visually for marine growth and cleaned by high pressure water jetting following which a detailed visual inspection was undertaken to check for potential issues with access and mark the areas to be coated. Surface preparation was by grit blasting using aluminium oxide to SA 2.5. All areas were then thoroughly inspected for integrity prior to coating.

A two-coat Alocit index system was used with an overall target DFT of 16 to 32 mil (400 to 800 microns), with an initial coat of 28.15 Std Black followed by 28.15 Std White. The Alocit coating was overlapped on to the existing coating by a minimum of an inch (25 mm). Each I-tube required approximately 9ft2 (0.8 m2) of material. Eleven I-tubes were coated at a depth of approximately 130 ft (40 meters).

Immediately prior to coating surfaces were scrubbed to remove biofilm which can build up very quickly and affect adhesion. The first coat was applied to the substrate and then left a minimum 12 hours to become tack dry before applying the second coat. Divers moved between application sites during the twelve hours to avoid disturbance from umbilicals.

CARTRIDGE SYSTEM

Initially the plan for delivery of coating to the diver was to mix topside and pump directly to the diver via paint lines and a hand-held brush unit. However, the coating site proved to be too far from the topside pump to allow sufficient pot life once delivered. It was also very time consuming to reel in and clean the 40-meter hose after each application, as well as increasing the risk of paint contamination on divers and equipment.

Alocit USA proposed an alternative cartridge delivery system which proved to be extremely effective. The system used disposable cartridges, each capable of holding a ¼ gallon (1.25 kg) of mixed material. These were attached to a short whip hose and application brush with plunger inserted into each cartridge after filling. Once filled, the assemblies could be delivered to the diver by messenger line within five minutes where they were attached to a ¼” water line. Water pressure was applied from topside pumps to operate the plunger and dispense the coating via the application brush. Used cartridge assemblies could easily be swapped out using the messenger line.

Cartridge System

CONCLUSION

Applying a coating underwater in freezing conditions at a depth of 40 meters was never going to be easy and, despite extensive planning, some modifications to equipment and methodologies were required as the project proceeded. Nevertheless, in feedback from the divers it was found that the cartridge deployment exceeded expectations with easy management of coating spillage, no pot life issues and application times that could be as little as 15 minutes per I-tube. Despite lower than anticipated water temperatures (only one degree above freezing) the 12-hour cure time was sufficient to achieve tack dry, and coating was able to proceed as scheduled. Some viscosity issues were experienced but these were overcome as the divers gained experience with the product and adapted techniques to meet the challenging conditions.

Normally, a project such as this would be considered by many experienced operators to be impossible and, of course, its success was only achievable because of the skill and dedication of the personnel involved. Without Alocit, it probably would have been impossible and it is a testament to the coating’s outstanding qualities that it was such a success.

What is Alocit?

Alocit 28 series coating is a two-part mix of 5:1 resin and hardener

Alocit is not a traditional paint, which cure by evaporation of solvents. Instead, it cures by a physical-chemical reaction between the two parts. Before they are mixed, each part can off-gas. Once mixed, the reaction between the two parts “uses up” the volatile elements as the mix cures – once cured, there is no more off-gassing and the cured Alocit is inert.

The majority of the off-gassing happens directly after mixing, when the two parts have been mixed but have not yet fully cured, so a decreasing proportion of each part may still be off-gassing.

SAFETY DATA SHEET
ALOCIT 28.15 STANDARD WHITE

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product name	ALOCIT 28.15 STANDARD WHITE
Product number	AS29497C

1.2. Relevant identified uses of the substance or mixture and uses advised against

Identified uses	RESIN COMPONENT OF EPOXY SYSTEM

SAFETY DATA SHEET
ALOCIT H1 HARDENER

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product name	ALOCIT H1 HARDENER
Product number	AS33051A

1.2. Relevant identified uses of the substance or mixture and uses advised against

Identified uses	FOR USE IN EPOXY SYSTEMS

What work is being undertaken with Alocit?

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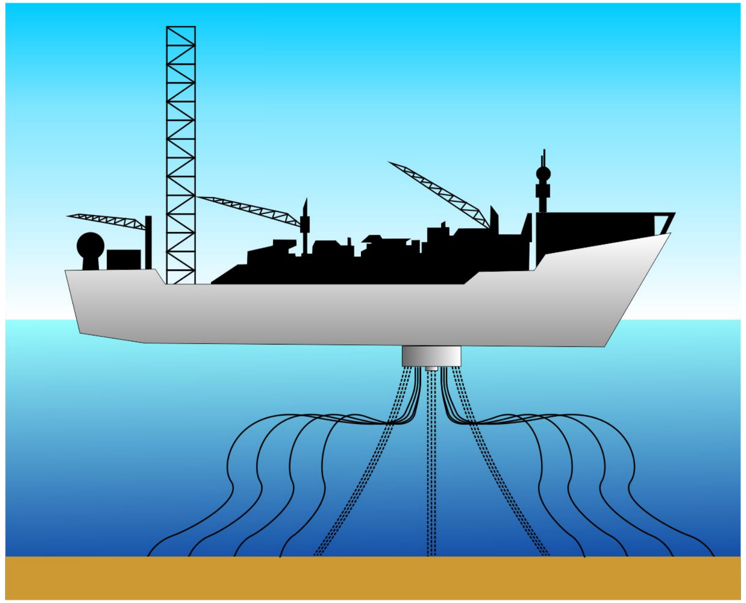
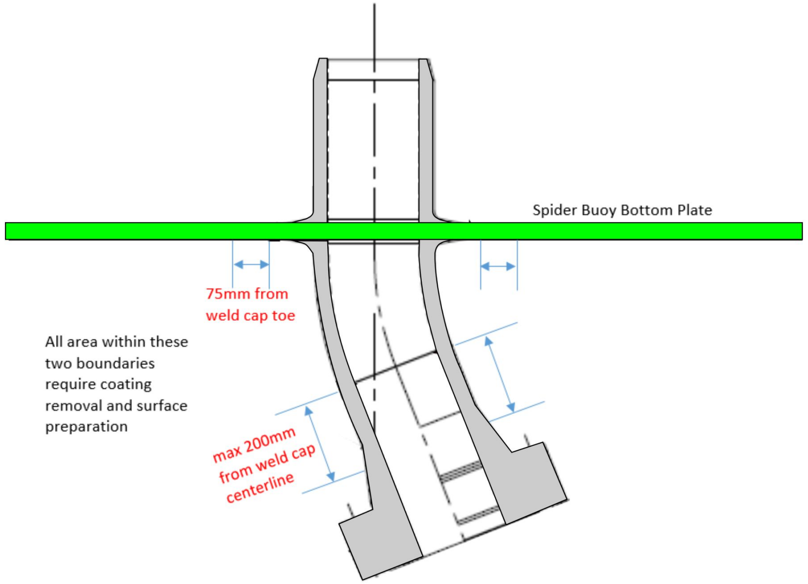
Alocit is being used to re-instate coating on 11 I-tubes under a spider buoy on a flexible riser system while the buoy is at midwater and FPSO disconnected. The location is close to the Arctic with water temperatures as low as 33°F (1°C). The underside of the buoy is at approx 42msw. There is damage to the coating on the I-tubes, as indicated in the diagram below. Grit-blasting will be used prior to inspection and coating. The surface area to coat on each I-tube is about 0.8m2 (total combined surface approximately 9m^2)

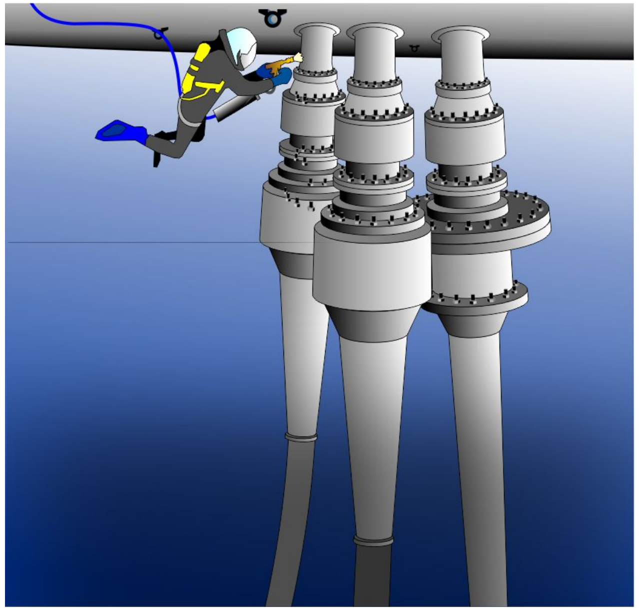
FLEXIBLE RISER SYSTEM



AREAS TO BE COATED



ALOCIT APPLICATION

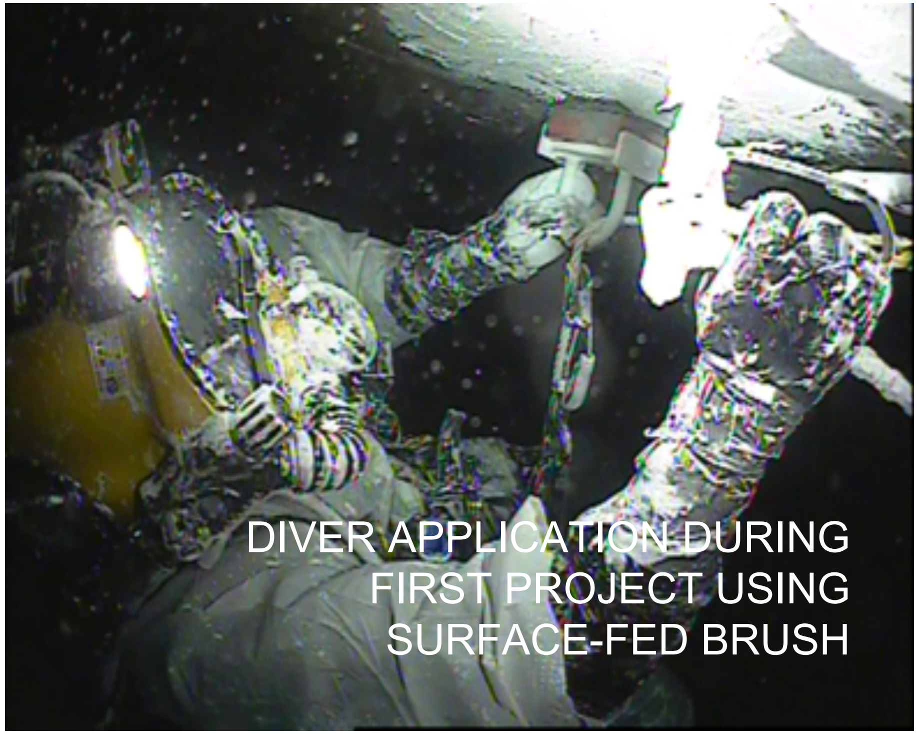


Has this been done before?

The same company used surface-supplied divers to apply Alocit three years previously, coating 10m2 of flat bottom on an FPSO (while in operation). Diving conditions were difficult due to high current and FPSO heave. Average dive time was 1 hour at 16-18msw. Diver harness, gloves, suits, helmets, stab jackets, and bailouts were reused without cleaning for the 10 days coating work but spillage was a concern. For the spider buoy a more controllable cartridge system was deployed with the aim of eliminating excess flow.

COMPARISON BETWEEN THIS AND LAST APPLICATION

	PREVIOUS FPSO	SPIDER BUOY
Diving method	Surface-supplied	Saturation on DEX
Worksite depth	16-18msw	42msw
Dive conditions	Heavy current and surge due to FPSO heave and shallow worksite	Little to no current at buoy, as observed with WROV
Dive duration	Avg 1 hour (max 2 hour)	6-hour bell runs
Surface to be coated	Horizontal and overhead 10m^2 of flat bottom	Mainly vertical at chest height, 0.8m^2 around each I-tube
Alocit delivery method	Continuous flow from surface controlled by trigger, divers asked to keep trigger open to avoid hose clogs	1.25L Alocit mixed per cartridge deployment, 2.5L needed per coat, per I-tube. Lower pressure flow.



DIVER APPLICATION DURING FIRST PROJECT USING SURFACE-FED BRUSH

Feedback from application team on Spider Buoy low temp. application

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Storage and Mixing of Product on Deck

- The product mixed as intended and with no more mess than during the coating trial in March 2020.

Deployment Method (Cartridge)

- Method exceeded expectations for keeping divers productive and working.
- Benefit in leaving hose deployed subsea and only swapping out the cartridge assembly. This improvement opportunity was quickly identified and acted upon by the team offshore.
- Use of neoprene cover, which connected to the diver's warm water, was improvised to pump warm water into the annulus to help improve product viscosity.
- No issues were encountered with potlife of product.
- Enviropeel were prepared to modify the application equipment to suit the ergonomic needs of the divers and provide flow assurance.

Product Application

- Cure time met expectations based on the results of the coating trial. A 12-hour cure time was sufficient to achieve tack dry at 40m subsea in 1 degree Celsius water temperature.
- Application speed per I-Tube far exceeded the anticipated duration with some I-Tubes being coated within a 15-minute period.
- Diver application of the Alocit product was positive. It was observed that during application of the product at 40m water depth, excess/stray paint was more easily controlled/managed than the previous campaign. Limited contamination of dive equipment was experienced and the cleaning facilities available onboard met the needs.

Other

- Positive VOC off-gas testing results for black/white product.
- Enviropeel onboard representatives were very knowledgeable with Enviropeel equipment and the Alocit product. They were also eager and collaborative working with the onboard crew to identify solutions to problems.
- Conducting the project specific trial contributed to the success of the product application.