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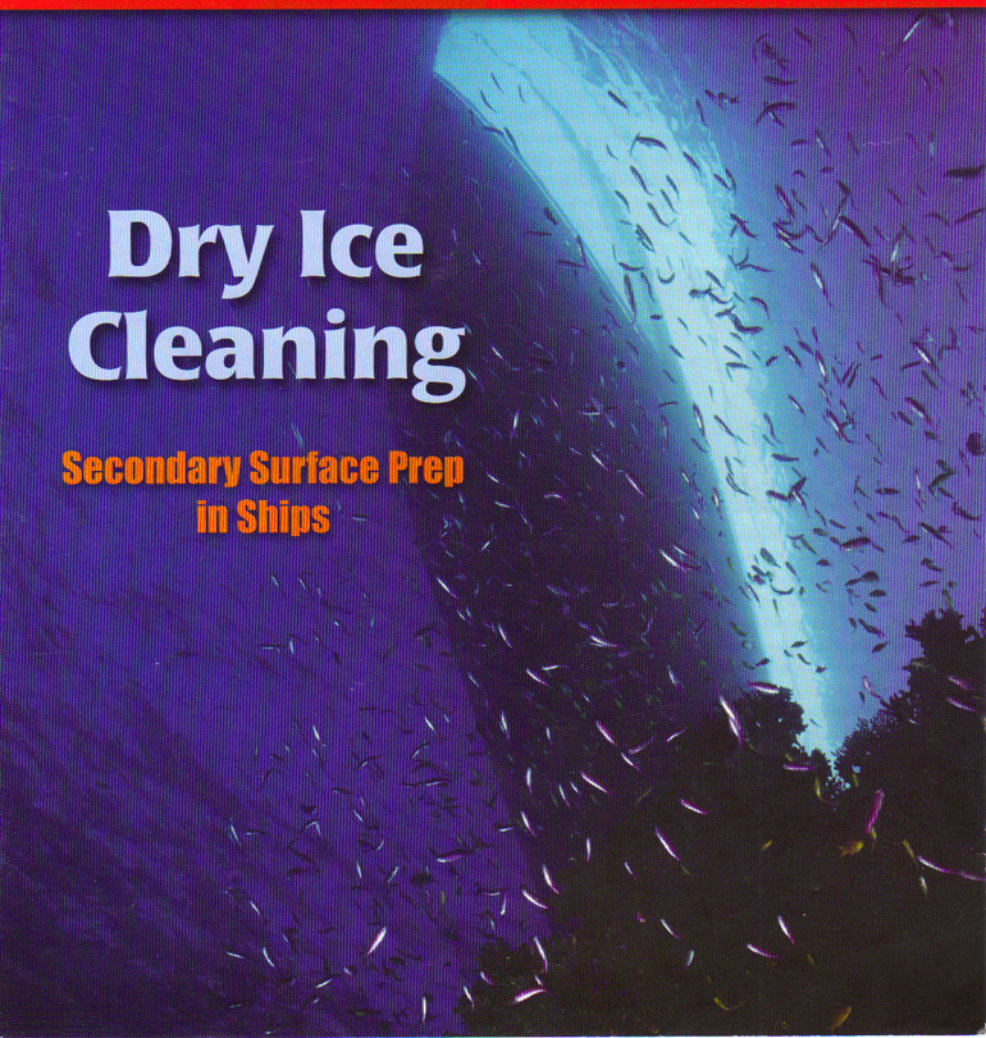
Dry Ice Cleaning

Secondary Surface Prep in Ships



Dry Ice Cleaning as Secondary Surface Prep in Ships

Editor's Note: It is common practice for many ship builders to have the steel plates blast cleaned and coated with a pre-construction or other type of primer in the shop. When the plates are then fabricated into blocks, primed areas damaged by cutting and welding in the fabrication process are repaired by blast cleaning, wire brushing, water jetting, or other conventional methods before applying the full coating system to the plates. Removal of the damaged shop-applied primer after fabrication is known as secondary surface preparation. (Intact shop-applied primer is typically overcoated with the full protective system.)

Meyer Werft in 2003
Photos courtesy of EDL, application team at Meyer Werft

In a paper presented at the September 24–25, 2008 JPCL-PCE Marine Coatings Conference, Lars-Eric Etzold of Meyer Werft (Papenburg, Germany) describes a less common method of secondary surface preparation, the use of dry ice blasting (or cleaning). Etzold's paper is titled "Dry Ice Cleaning for the 2nd Surface Preparation." The Marine Coatings Conference was held in Hamburg, Germany, in conjunction with SMM: The Shipbuilding, Machine, and Marine Technology International Trade Fair. His presentation is summarized briefly below.

Etzold, who is responsible for coating specification and deck coatings at Meyer Werft, notes in his paper that dry ice, or CO_2, blasting is not as commonly used for surface cleaning as conventional methods. However, over the past decade, Meyer Werft has started to recognize and record the possible benefits of using dry ice pellets as a secondary, efficient, and cost-effective way to clean and prepare a surface.

Before using dry ice, Meyer Werft used wire brushing or disc cleaning, but these methods created a lot of dust. Because the work was carried out in the main building hall, this resulted in time being spent cleaning the vessel and the surrounding areas. Using CO_2 cleaning reduced the dust by about 80%.

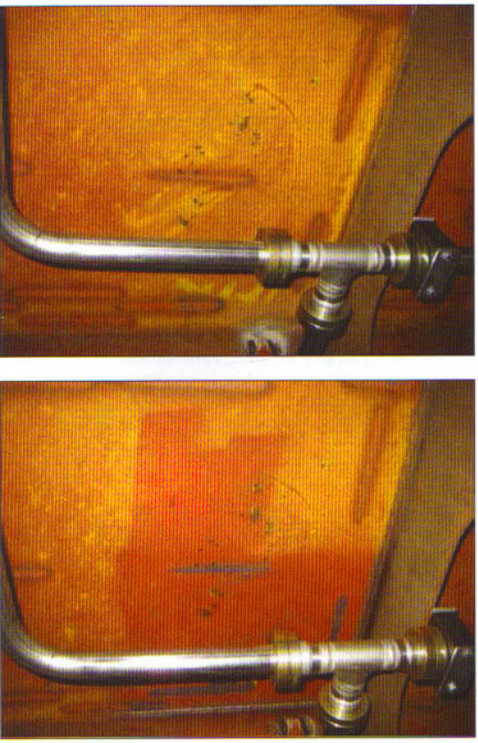
Meyer Werft, which manufactures cruise liners and special-purpose ships, started using the dry ice cleaning method in the 1990s as a secondary method for cleaning the internal areas of its ships. Since then, Etzold says, the company has successfully cleaned over two million square meters of steel.

Dry Ice: What It Is and How It Works

Etzold provides background on dry ice, noting that it is a solid form of the gas, carbon dioxide (CO_2), which comes from natural sources and arises during industrial processes where CO_2 results as a waste product.

> **"Because the CO_2 pellets sublimate, or turn to gas, after use, the method minimizes debris to be removed after cleaning."**

Dry ice pellets are blasted onto the substrate via an air pressure of 6 to 12 bars. When the dry ice pellets hit the surface, several effects take place. The thermal effect happens when tension caused by thermal expansion coefficients loosen the adhesion from the base material. The sublimation effect occurs as there is an abrupt volume increase of CO_2 during the phase change that causes a type of "explosion." An impulse transfer with a dry ice hardness of 1.5 to 2.5 Mohs removes any soiling in what is known as the mechanical effect.



Top: Before the CO_2 cleaning
Bottom: After the cleaning, even the burned shop primer has been fully removed.

How One Shipyard Uses Dry Ice Cleaning

At Meyer Werft, only new building is carried out and the substrate being cleaned is always steel. When Meyer Werft and contractor G.Th. Freese Bremen Company started using this cleaning method together in 1995, it was to clean the areas that would be insulated, also known as "cold steel" or "condensate" areas. The cold steel area is a non-corrosion critical area, but represents the largest area of steel on a cruise liner, as shown below in the distribution of steel surfaces.

- Underwater steel: 5%
- Vertical sides and superstructure: 20%
- Cold Steel: 40%
- Internal visible: 20%
- Tanks: 15%

The cold steel is first blast cleaned in the shop and protected with a preconstruction primer. Once the blast cleaned and primed steel is moved from the shop and assembled into the ship [block], cleaning the areas with conventional methods is not [always] practical or economical, says Etzold. Removing damaged paint by blast cleaning, water jetting, or wire brushing takes too much time and creates dust and other debris. The CO_2 method will remove paint damaged from welding or fairing work. The method will also clean off contaminants such as dirt, salt, and [weld] fume. (Removing the fume with a wire brush also increases the risk of an accident at work, says Etzold.) Because the CO_2 pellets sublimate, or turn to gas, after use, the method minimizes debris to be removed after cleaning.

After cleaning with dry ice, no wait time is necessary to start coating, says Etzold. CO_2 cleaning results in the original blast profile being exposed and slightly roughens the undamaged shop primer, so a standard coating system can be applied next, if desired and if compatible with the shop primer [before installing the insulation].

CO_2 cleaning has also been used on the vertical sides and superstructure and the interior of engine rooms.

Safety

Meyer Werft requires applicators to wear protective clothing as appropriate and to use carbon dioxide monitors with warning devices while cleaning with dry ice because as a gas, carbon dioxide above a certain level poses health risks to workers. Etzold adds that the company forbids the use of dry ice cleaning in tanks or other enclosed areas [where high concentrations of CO_2 gas could be especially dangerous].

Equipment and Costs

Etzold observes that dry ice cleaning pellets and equipment are currently available from several suppliers. The pellets are in a frozen state and require a storage box to be maintained at -79 C.

When compared to just the de-rusting and cleaning, dry ice cleaning is more expensive. However, if one takes into consideration the benefit to all parties and the ability to coat immediately, cleaning with dry ice becomes less expensive than more common methods, says Etzold.

Summary

Etzold concludes by saying that if de-rusting and outfitting work are being done in the same hall, the use of dust- or water-intensive methods will reduce the efficiency of the whole building process [compared to dry ice cleaning for secondary surface preparation].

For a copy of the paper, contact Brian Goldie, *JPCL*, at brianpce@aol.com.