Heat curing of tank linings

Introduction

Most epoxy coatings can reach their fully cured state after a certain time of curing at ambient conditions. However, some specially formulated tank linings may - due to their chemical nature - achieve a higher curing degree at elevated temperature thus increasing their resistance to chemicals and immersion in hot liquids. Resistance to certain liquids (e.g. methanol, acetone or vinyl acetate monomers) is only possible after heat curing.

Safety

Use adequate personal safety equipment and follow sound procedures. Apply only in well ventilated areas. Observe safety labels on packaging and paint containers and consult Hempel's Safety Data Sheets for the products to be applied.

Scope

This guideline contains instructions on heat curing procedures to achieve maximum curing of Hempel's novolac epoxy tank linings. This is relevant for Hempadur 15500, Hempadur 85671 and Hempadur Anti-Static 85170. The lining system to be heat cured should be specified as 3x100µm dry film thickness (DFT).

Other products do not benefit from the heat curing procedures and may in some cases be damaged if subjected to heat curing.

Heat curing may be done in cargo tanks of marine vessels, land based tanks and railcars tanks.

Heat curing procedure

In order to achieve the above mentioned maximum curing, a specific steel, substrate temperature must be achieved and maintained during a minimum period of time. Exceeding this minimum period of time is not detrimental to the coating system performance. The relation between steel temperature and heat curing duration is shown in the table below:

Steel temperature	Heat curing duration
60ºC/140ºF	16 hours
70ºC/158ºF	6 hours
80ºC/176ºC	3 hours

Table 1. Steel temperature and heat curing duration

The steel temperature shall be monitored with infrared thermometer and temperatures should be recorded hour by hour to have a clear idea of the conditions achieved during the complete procedure.
The following media can be used as heating media:

- hot air
- hot water

Please note that the heat curing rate depends on the temperature of the coating which may be significantly lower than the temperature of the heating media. This is the case when using hot air (lower heat capacity than liquid media) for heating in an uninsulated tank as well as for liquid media when the reverse side of the tank wall is in contact with a colder liquid, e.g. seawater. Stiffeners and other steel object on the reverse side of the tank wall may also act as local heat drains resulting in local areas with incomplete heat curing.

If air is used as heating media, enough time for solvent evaporation (e.g. 24 hours at 20ºC) must be allowed before initiating the heat curing procedure. If water is used, the coating must have reached its "fully cured" state according to the product data sheet (PDS), e.g. 7 days at 20°C with adequate ventilation before starting the heat curing process.
In both cases, the coating must have been visually inspected and any point of corrosion found shall have been repaired before heat curing. The tank shall have been cleaned with fresh water and mopped, ensuring there are no residues left.

Once the heat curing procedure is completed, the tank can be opened for ventilation. It is recommended to do a visual inspection to check its general condition.

Heat curing with hot air
Heat curing may be achieved by circulating hot, clean, dry air inside the tank. Heat transfer depend on the air speed and circulation is important to avoid stagnant areas with lower temperature.
This is the typical heat curing procedure for rail cars. In this case, the substrate is normally first heated up to 100°F/38°C and then the temperature is increased by 30°F every 30 minutes until the desired substrate temperature is achieved. Steel temperature shall not exceed 203ºF/95ºC. If the time the steel substrate is exposed to this maximum temperature is extended, discolouration of the light shades might be observed. E.g. off white shades will turn yellowish or light beige. This is only cosmetic and will have no influence on the performance of the lining system applied.

Heat curing with hot water
Heat curing can also be done with hot water, e.g. by using the cleaning nozzles in the tanks. This is quite common in cargo tanks in Marine vessels. Once the heat curing is completed, the water must be drained out and the tank must be ventilated until it is dry.

Marine vessels

Cargo tanks in Marine vessels differ from land based tanks and hence some precautions must be taken:

- ballast tanks should be empty in order not to have a cooling effect on steel during the heat curing process. This is of even more importance if hot air is used as heating media
- adjacent cargo tanks shall also be empty or carrying a cargo with a temperature of minimum 40ºC during the heat curing process

Heat curing with water can be done by heating the water in slop tanks with heating coils or similar up to 80-90ºC. It shall be ensured these slop tanks are completely free from previous cargoes. The cargo heat exchanger on the main deck shall circulate the hot fresh water from the slop tank to the cargo tank by means of the cleaning guns, normally 2 sets per tank. The water is circulated from tank to tank using the tank cleaning system. The heating system of the cleaning machine of the tank can be used to maintain the water temperature during the operation.

An indication of fuel consumption is given in the table below:

Vessel type	IMO type 2
DWT	App. 45,000
Tank capacity	50,000 m³
Fuel consumption for water heating	App 60 metric tonnes incl. Ballast water shifting
Sea water temperature	16-18°C
Air temperature	20-25°C
Tank cleaning machines per tank	2

Table 2. Example of fuel consumption during heat curing in a Marine vessel

.