# Suitability of thin coatings towards scale reduction in heat exchangers

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**Abstract**

Scaling is the unwanted precipitation of crystals formed in a flowing medium as well as the direct crystallization at the solid surface. Scaling of heat exchangers (HE) in the chemical industry, district heating, oil and gas, power plants, etc. results in a loss of performance which leads to production stops for cleaning and therefore increased operation costs. One approach to mitigate fouling is to alter the properties of the metal heat exchanger surface by applying a coating. For a coating to be successful in any heat exchanger application it needs to have a good adhesion to the metal but also to keep the heat transfer through the metal plates as unaltered as possible. This requires a thin coating with a relatively good thermal conductivity. In this study a new ceramic coating is tested that can meet these requirements. Initial tests with this coating in hard water were performed and the ability of the coating to minimize calcium carbonate nucleation/deposition and the easiness of cleaning was assessed. The results showed that the coating led to a reduction in the amount of scaling and a lower adhesion of the crystals to the coated plate.

**Experimental**

The scaling test was run with a total of four M3 plate heat exchangers (PHE) with 8 stainless steel 316L plates (16 * 42 cm). Two of these PHEs were installed with coated plates (version 1 and 2) and the other two with uncoated plates. The units were operated with hard tap water until they clogged or up to a period of 6 days. The tap water enters the test heat exchanger at a flow rate set at 2 L/min and is heated up to 87°C by circulating water at 98°C in the adjacent channel. The scaling test was run with one PHE at a time. The PHEs were running intermittently for 15 min and then 15 min without flow.

## Results

The development of scaling on the uncoated plates was monitored by the pump usage, the cold water flow rate and the valve position on the hot water side (it monitors the cold water outlet temperature (set at 87°C) and adjusts the flow in the hot water line so that this temperature is maintained) (results not shown). At the end of the scaling test the uncoated and coated PHEs were disassembled to allow for analysis of the internal fouling distribution formed on each channel. The visual appearance and amount of the scaling is shown in Fig. 1.

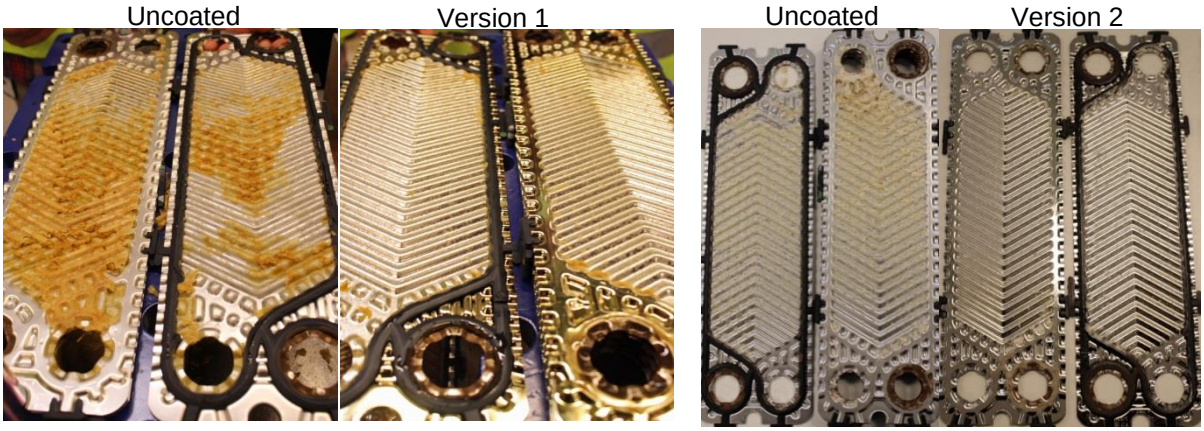


**Figure 1 -** Amount of scaling on the uncoated and version 1 and 2 coated HE plates after the scaling test.

## Conclusions

The NANOmel coatings, version 1 and 2, were efficient in reducing the amount of calcium carbonate scaling and had improved easy to clean properties compared to the uncoated SS316. This can lead to significant cost reductions for the operators who will experience longer uptime for their PHEs between cleanings. The lower scaling adhesion to the plates will further translate into shorter and milder cleaning programs. No coating failures were observed in neither coating system.

It was also demonstrated that it is possible to coat internal surfaces like those of copper brazed heat exchangers with these new types of coatings.