Vapor Infusion

A simple, cost-effective solution to reduce and remediate fouling

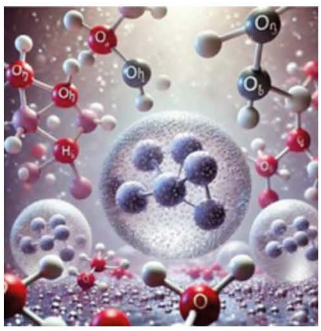
Vapor infusion is an environmentally friendly alternative that reduces fouling and protects heat exchangers and process equipment that use water as a process stream. It safely generates scrubbing, transitory macro-, micro-, and nanobubbles using ultra low-dose chemical catalyst vapor to create nanobubbles, which inhibit formation of foulants and initiate reclamation of heat exchanger surfaces.

How Vapor Infusion Works

The vapor infusion system injects (infuses) vaporous treatment into the water flow stream of heat exchangers and process equipment, creating a profusion of macro-, micro-, and nanobubbles. Macro- and microbubbles help mechanically prevent fouling, while nanobubbles chemically reduce it—together forming a three-pronged approach to protecting the internal surfaces of heat exchangers and process equipment.

1. The process begins with vapor infusion, where an ultra low-dose chemical vapor catalyzes the rapid formation of dense nanobubble emulsions (~$2.3\times10^{8} \pm 4.98\times10^{6}$ particles/mL) in water streams—without the need for high-energy nanobubble generation techniques. These nanobubbles alter interfacial charge and envelop/cluster scale-forming and other nano-fouling species. In the case of scale fouling, this interaction shifts the solubility equilibrium, promoting the dissolution of scaling deposits from internal surfaces. The resulting nanoparticle clusters are then carried away by the flow stream.
2. The dilute chemical bubble catalyst treatment, applied at low parts-per-billion (ppb) concentrations, helps inhibit biofouling and scaling, reinforcing defense against fouling.
3. Finally, macro- and microbubbles provide mechanical action by sweeping away sediments and residual foulants—including those enveloped by nanobubbles—ensuring cleaner surfaces and improved thermal performance.

Vapor Infusion Bubbles



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- Require less chemical treatment
- Mechanically prevent fouling formation
- Inhibit and remove scaling
- Reduce corrosion sites and sedimentation
- Improve heat exchanger efficiency
- Work during process operation (unlike cleaning in place, teardown, and other cleaning protocols)

HTRI

Environmentally friendly technology for heat exchanger applications using water as coolant

Vapor infusion is effective for applications that use fresh water, sea water, or water with high levels of scaling salt. Vapor infusion has successfully been implemented on plate-and-frame and
shell-and-tube heat exchangers, as well as evaporators and scrubbers.

The benefits of our vapor infusion system have been demonstrated
in studies conducted at various universities, commercial applications, and with the United States Navy. Positive results include

- dramatic reduction in fouling activity
- reduced environmental impact from heat exchanger fouling
- increased time between cleanings
- negligible levels of residual chemical in treated water
- significant decrease in need for heat exchanger cleanings
- reduced use of cleaning chemicals and disposal of chemical waste
- low operation and maintenance costs
- minimal capital cost

HTRI is the ***exclusive*** provider of vapor infusion technology. We currently offer a six-month trial that includes a free vapor infusion control device.

Contact us if you are interested in participating in a trial or would like a free presentation.
Visit www.htri.net/vapor-infusion for more information on how vapor infusion can be applied to your unique application.

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Successful implementation in industries

Drill ships and offshore rigs

Our vapor infusion system was installed on both the thruster and main engine coolers of a semi-submersible offshore drilling ship. Three months later, engineers determined that the thruster performed better duringpressure drop tests with high loads (including 100% load tests for 15 minutes). This customer subsequently implemented the vapor infusion system on all 16 heat exchangers (plus backups), resulting in significant improvement to the cooling system.

Fish farms and aquaculture systems

A commercial halibut hatchery uses plate heat exchangers to control the water temperature of its fish tanks. To reduce fouling in the tanks, the aquaculture farm had been backflushing the tanks weekly and using hypo-chlorination twice a week. Our vapor infusion system was installed as an alternative. After three months, the company had eliminated chlorine and substantially reduced maintenance and operating costs.

Cruise and cargo ships

In one cruise ship case, two sets of main engine coolers (forward and aft) had operated for over a year without cleaning. Our vapor infusion system was then installed. After fourteen months using the system (or 26 months in total operation), engineers openedeach exchanger for observation. Neither cooler exhibited significant fouling, indicating that vapor infusion systems can improve performance and extend time between cleanings.

Processing and power plants

A sulfuric acid plant used seawater as a coolant on a shell-and-tube heat exchanger. Our vapor infusion system was installed. Customer testing revealed no rise in seawater iodine levels, and temperature spikes were effectively stabilized. The systemexperienced a 6 °F increase in cooling water differential temperature, significantly enhancing the heat transfer process.

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