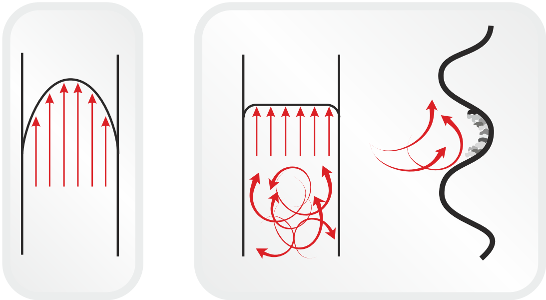
Cleaning in Place for harsh conditions

A brazed plate heat exchanger (BPHE) is normally self-cleaning, thanks to highly turbulent flows. In applications with a high risk of fouling or scaling, e.g. due to high temperatures, hard water, or high pH levels, cleaning may be required to maintain efficiency. This is achieved quickly and easily with Cleaning in Place, a method of cleaning the interior surfaces of closed systems by circulating a fluid. Disassembly is not required.

A DOVER COMPANY

What is fouling?

Fouling is an unwanted phenomenon in the world of heat transfer. In most cases, the fluid flowing through a heat exchanger contains traces of dirt, oil, grease, chemicals or organic deposits. This can result in a coating collecting on the heat transfer surface, decreasing the heat transfer coefficient. The thermal efficiency of the heat exchanger will be reduced and the pressure drop characteristics will change. Types of fouling include scaling, particulate fouling, biological growths, and corrosion.

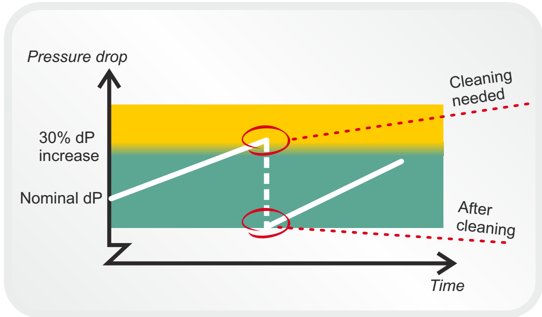


BPHEs are designed to have a high degree of turbulence. This creates a self-cleaning effect that prevents fouling.

How can I prevent fouling?

Fouling can be limited by maintaining a high channel velocity. The velocity controls whether the flow is turbulent or laminar. Turbulent flow is desired for several reasons. It keeps particles in the fluid in suspension, i.e. prevents them from collecting on the surface and causing fouling. It also improves heat transfer. SWEP BPHEs have a high degree of turbulence, with the fluid performing a scouring action to keep the heat transfer surface clean.

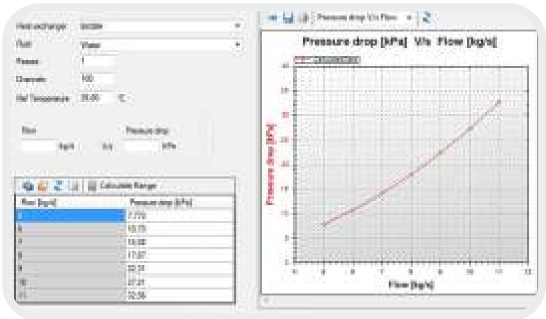
An even distribution of fluid through the exchanger is also important. This is strongly related to the plate pattern. SWEP BPHEs have a special pattern in the port areas, designed to ensure a well-distributed flow. Other heat exchangers may have areas sensitive to fouling due to low velocity, for example around gaskets, resulting in laminar flow. Fouling would start here and spread across the heat transfer surface.



An increasing pressure drop of 30% indicates cleaning is needed.

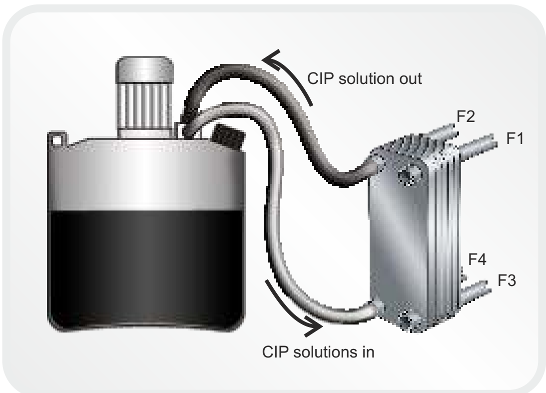
When is cleaning required?

Although a BPHE is less susceptible to fouling and scaling, it might need cleaning over the course of its life time if it is working in conditions of high temperatures, a high concentration of particles in the water, hard water, or high pH levels. Monitoring performance regularly will help you ensure the system is working with maximum efficiency, preventing energy waste and unplanned downtime. There are two indicators of the need to clean your BPHE: temperature differences and pressure drops. Make sure that water flow rates are according to specification, to ensure the indicators are not affected by flow rate changes.



SWEP's Pressure Drop calculation tool can help you determine signs of fouling in your installed BPHE.

Temperature differences less than specified indicate signs of fouling of the channel plate. The heat transfer surface is insulated and efficiency decreased. Pressure drops higher than specified indicate fouling constricting the channel passage and thus increasing velocity. SWEP's calculation software SSP offers a Pressure Drop tool that can be used to determine this. If you monitor the pressure drop at various flows and insert the measured flow rate data, these can be compared with the expected performance of a clean unit. An increase of 30% or more indicates cleaning is needed.



BPHEs can be equipped with extra CIP connections on the back to facilitate cleaning if this is expected to be frequent.

Which CIP fluid should I use?

Mineral acids

Mineral acids have a strong ability to dissolve scale. They include hydrochloric (HCl), sulfamic, nitric, phosphoric and sulfuric acids. However, all mineral acids are extremely hazardous. Also be aware that under certain conditions hydrochloric acid corrodes stainless steel and nitric acid corrodes copper, just like products containing ammonia. The use of corrosion inhibitors may be necessary.

Organic acids

Organic acids are weaker than mineral acids, in terms of both scale-dissolving and the risk of corroding the base material of the BPHE. These acids are also less hazardous, which makes them a good choice for BPHE cleaning. Organic acids include formic, acetic, and citric acids, and are commonly applied at concentrations between 1 and 5 volume percent.

Bases

Bases have the ability to remove oil, grease and biological deposits from the heat exchanger surface. They can be used to supplement cleaning, or at the end of the cleaning procedure, to neutralize any acid remaining in the system. A solution of 1-2% sodium hydroxide ($NaOH$) or sodium bicarbonate ($NaHCO_3$) before the final water rinse will ensure that all acid is neutralized.

How do I clean a BPHE?

SWEP BPHEs are cleaned quickly and easily with Cleaning in Place (CIP), a method used for the interior surfaces of closed systems, such as pipes, vessels, process equipment, and filters. A chemical fluid is circulated through the unit, without the need for disassembly. The chemicals dissolve or loosen deposits from process equipment and piping, giving uniform removal and lower overall operating costs. The BPHE can be equipped with customized CIP ports to make it even easier.

Below is a general description of the system setup, the CIP procedure, and the various cleaning fluids. You are welcome to contact us for advice on the fluid and equipment best suited to your specific application, or to discuss a CIP port solution for your units.

System setup

A BPHE can be cleaned using CIP provided it is not clogged. To facilitate CIP treatment, we suggest extra externally threaded connections on the back of the BPHE, of up to 2 inches depending on the model. For larger models, we recommend additional connections on the external piping. Using dP sensors will enable you monitor the cleaning process by referring to the design criteria.

CIP procedure

Turn off relevant pumps and empty the BPHE. Connect a CIP machine to the lower and upper extra connections. Pump the cleaning solution through the BPHE from the lower connection. Reverse the flow every 30 minutes and apply a flow rate of 1.5 times the nominal flow if possible. Monitor the pH and/or pressure drop. Cleaning is finished when the pH has been constant for 30 minutes, and/or the pressure drop has returned to its initial value. Drain the BPHE and flush it with water until the water is neutral. The steel can be passivized after cleaning by circulating 2% phosphoric acid at 50˚C (120˚F) for 4-6 hours. This will reduce the corrosion rate due to the precipitation of corrosion product on the metal surface, and inhibit further corrosion in water or in air.

Shut off relevant pumps, and primary side and secondary side valves.

Empty the BPHE.

Connect the CIP machine via inlet/outlets on front or back. Pump the solution into the BPHE using the lower connection to expel air. Reverse the flow direction every 30 minutes.

Stop the CIP machine. Drain the cleaning agent from the BPHE and CIP machine.

Flush the BPHE with water, starting from the lower connection until it is neutral (pH 7).

Stop the CIP machine. Drain the BPHE and CIP machine of cleaning agent.

Close the CIP valves and open the main valves.

Tap water with extreme hardness

– a case story

Ringsjön is a lake in southern Sweden from which tap water is drawn. The very hard water (dH 11) imposes severe stress on the equipment used. After 4-6 years' operation, four SWEP heat exchangers used for heating the tap water were brought to SWEP's laboratory for testing. The units showed signs of mild fouling, but were still fully functional.

The purpose was to observe how the heat exchangers had been affected by the hard water, and to evaluate a biodynamic CIP fluid for removing carbonates and metal oxides without the risk of corrosion. Thermal and hydraulic performance tests were conducted before and after CIP treatment on the tap water side. The same tests were used on all four units to verify the effect.

The test results showed improvements in thermal performance by 5% and in hydraulic performance by 2%. A visual inspection of a sectioned unit confirmed that the lime scale and metal oxides were completely removed, and testing also revealed no signs of internal or external leakage.

Visual reference, tap water circuit

Cleaned tap water circuit

Visual reference, primary water circuit

Cleaned primary water circuit