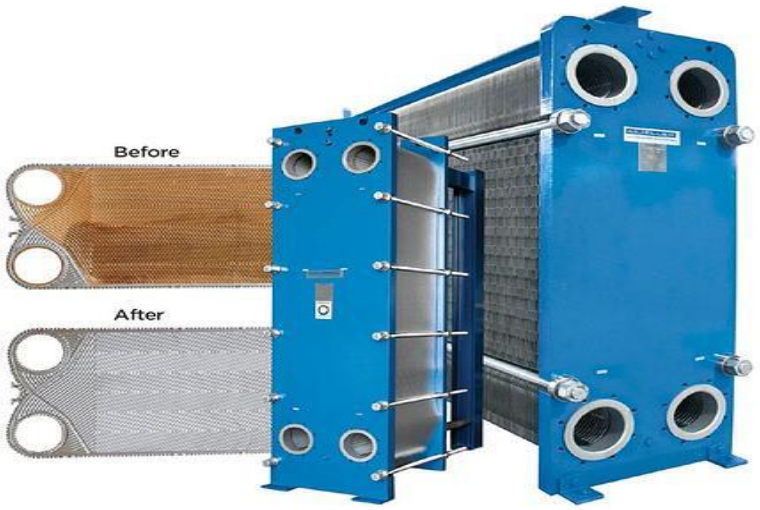
How to Troubleshoot a Plate Heat Exchanger



This article is dedicated to identifying issues your plate heat exchanger (PHE) might be having, and setting you on the path to the right solution. Nearly all issues boil down to some form of plate fouling or gasket failure, but it's important to determine whether it's a one-time problem or an inherent flaw in your system (the PHE is specified incorrectly). The first step is to identify the symptoms of your underperforming heat exchanger.

Identify Symptoms

The most common symptoms are the following:

- Increased pressure drop from inlet to outlet
- Loss of heat transfer efficiency
- Loss of flow and performance
- Process fluid leakage

The first three symptoms are all typically related to plate fouling, while the last is usually due to a gasket failure. However, gasket failure or the rarer case of plate cracks can lead to any of the four, so it's important to take some simple steps to figure out what exactly is going wrong.

Gasket Failure and Differential Leaks

When troubleshooting, it's usually best to first assume the most likely problem, as it also tends to have the easiest and least expensive solution. The easiest problem to identify is gasket failure – if a gasket fails, the pressure will force fluid through the leak and you'll be able to see fluid dripping out of the PHE. The fluid will drip out of the offending gasket, so you'll be able to easily locate the failure. To fix your PHE, disassemble it and remove the plate with the failed gasket and a plate adjacent to it (to keep the flow pattern intact). Then, if you have replacement parts on hand, simply replace them, reassemble and tighten your PHE to specification and put it back in service. If you don't have the replacement parts on hand and can't afford downtime while you wait for shipment, you can simply close your PHE back up and put it back into service as you wait – missing two plates will only have a small impact on

performance. However, be careful that you know how much to tighten the PHE with two fewer plates. Information about that should be in your manual, or can be provided by the manufacturer.

When the two fluids in a PHE mix due to equipment failure, it's known as a differential leak. Take a look at our article for more in-depth information on differential leaks.

The most common causes of a failed gasket are incompatible fluids and/or excessive pressure. Make sure your pressures are within specifications (and your system is free of potential water hammers) and the gaskets are rated for your materials. If gaskets are developing holes in them, your fluid is likely too hot or too corrosive, and you'll need to replace your gaskets with more ones that are more adequate for your process.

Plate Fouling and Corrosion

Plate fouling is the most common issue with PHE's, but can be difficult to solve because it's not generally covered for replacement under warranty. If your PHE consistently gets fouled up due to properties of your process fluid, there's not a great deal you can do other than regular cleaning. You can talk to your manufacturer about installing plates with a wider gap, but that solution has performance and cost drawbacks, and doesn't work in all cases. Generally speaking, a regular cleaning schedule is the best option. A clean-in-place (CIP) process is the easiest approach, but disassembling and cleaning by hand is also a possibility.

If the plates are corroded, that's a more serious issue than simple fouling. This, too, falls in the category of a differential leak. You can put your PHE back into service the same way, but a cracked or corroded plate generally signals that one of your fluids is too corrosive, and you may experience the same problem again. Check with your manufacturer that the PHE is properly specified for your application. If all is well, then the crack or corrosion is likely a manufacturer defect, and will nearly always fall under warranty.

How often do I clean my heat exchanger?

The frequency with which you clean your heat exchanger does not need to be based on a set schedule. The better way to determine when a cleaning is needed is based on pressure drop. A good rule of thumb is to clean when the pressure drop on either side increases by 50% above design pressure drop. For accurate readings, the system has to be operating at full flow.

If you don't know the design pressure drop, you should measure it immediately following a cleaning and use those values to make your determination for the next cleaning.

You could also use the approach temperature to determine your next cleaning. Again, clean when the reading increases by 50% or more.

What is approach temperature?

For a cooling system, the approach temperature is the difference between the incoming cold water temperature and the outgoing hot water temperature. So, in other words, your 80F cooling water supply cools the hot side down to 84F, the approach is 4 degrees.

Is cleaning in place (CIP) an effective method to clean my heat exchanger?

Only when deposits are very light and there is very little or no foreign material present.

The main reason that CIP is not effective is due to the flow rate of the CIP pump, which would be somewhere in the 25 to 50 gpm range in most cases. Remember that your plate heat exchanger is rated for several hundred or maybe several thousand gpm. So, you set up the cleaning apparatus to pump into the drain at the bottom of the heat exchanger and plumb the return hose from a vent or thermometer well at the top of the heat exchanger. You fill your empty heat exchanger with cleaning solution and every single plate channel will get exposed to the cleaner. The problem is that continued circulation will not renew the cleaner at the back of the plate pack. There is not enough flow (inertia) to overcome the path of least resistance, which is directly up to the return connection. The cleaner will circulate only through the first few plate channels and back to your tank.

So, if the initial filling is enough to dissolve the accumulated deposits, then your CIP will be successful. If the deposits are too heavy, you will still have fouled plates.

A caution about cleaning solutions. Anything that has Hydrochloric Acid, Muriatic Acid or Aqueous Hydrogen Chloride (these are all exactly the same thing) will break down into Hydrogen and Chloride ions. THERE IS NO CORROSION INHIBITOR THAT WILL PREVENT CHLORIDE ATTACK ON STAINLESS STEEL. YOUR PLATES WILL BE DAMAGED!

How often do the gaskets have to be changed?

For many industrial and food / beverage applications there are sanitary, chemical, exposure to air, etc. considerations that limit the useful life of the gaskets. For most HVAC and other water to water applications, the useful life of the gaskets comes down to time and temperature.

For standard EPDM and NBR gasket material the following is an approximate guide:

Max entering temperature	95F 120F 150F	25 years 15 years 9-11 years

	180F 210F	5-7 years 3-4 years

Please note: For heat exchangers operating at the higher temperatures, but not all year long (ie. building heating systems), add 25% to the useful life of the gaskets.

For those with heat exchangers outside and exposed to sunlight, it is best to keep the shrouds installed to eliminate deterioration of the gasket due to UV light.

For special gasket materials (neoprene, Viton, etc. and special conditions, it is best to consult with your OEM for recommended plate/gasket maintenance.

What additional maintenance is required for my heat exchanger?

- Exercise the isolation valves once or twice a year.
- Check strainers and clean as needed.
- Check to see that drain ports and vents are not plugged.
- Check pressure gauges, change as needed.

What is the recommended procedure for exercising isolation valves?

If you have VFD's, reduce the flow rate to 50%, otherwise, continue to operate at full flow. Close each isolation valve completely and then open the valve again to full open. Don't leave the valve closed too long because the circulation pump will be dead-headed. Please note that for those who have diaphragm valves, it is important to operate the valves very slowly to avoid water hammer. The opening and closing will loosen accumulated rust and debris, which will be carried away by the flowing water. Repeat this same procedure for all four valves.

What is the best way to refill my heat exchanger following a service?

Slowly fill one side with fresh water or system water from the bottom up until the water just comes out of the vent on the upper side of the heat exchanger. Shut off the water and close the vent with very little pressure on that side. Fill the second side similarly, close the vent when water flows from it, but continue adding water until you are at or near operating pressure. Go back to the first side and bring it up to operating pressure.

Please note that this procedure as described is for a single-pass heat exchanger. It is very difficult to purge all the air from a multi -pass heat exchanger, so the general rule is to fill it as much as possible and bring it up to working pressure as slowly as possible.

You can now start the circulation pumps without the water hammer effect that would occur as when pumping into an empty heat exchanger. If VFD's are used, bring the flow rate up slowly.

How do I test my isolation valves?

With the circulation pumps shut off, close the inlet and outlet valves on both sides of the heat exchanger. Test one side at a time. Slowly open the drain because the water is still under pressure. If the isolation valves are holding tight, the water will flow at a good rate until the pressure in the heat exchanger is released. At that point, you should have a slight vacuum effect where the water begins to gurgle out of the drain.

If water continues to flow, one or both of your isolation valves are leaking. Exercise both valves (see below) and try again. If you still have constant flow, try locating another valve upstream/downstream of one valve and close it too. This may stop the leak and you will have identified which is the bad valve.

If that still doesn't work, you will have to replace the leaking valves. An alternative to replacing valves is to drain down the system to below the level of the heat exchanger.

Can I open my heat exchanger if the isolation valves are leaking?

Yes, but only a small amount of leakage can be tolerated. With a ¾" drain, about one gpm is the most leakage you can have and still safely open your heat exchanger. With a larger diameter drain, you can have a little more leakage and still be safe. The idea is that the leaking water has to be able to fall out of the drain by gravity so that it doesn't fill up the heat exchanger while you are closing it.

If water (fluid) is leaking on the floor, do I have failed plates or gaskets?

It is possible to have a failed plate that results in water leaking onto the floor. This is very rare, so it is almost always a problem with the gaskets. There can be a gasket defect, debris under or on top of one or more gaskets or a gasket that is not properly seated in the gasket groove.

If water (fluid) is leaking on the floor, can I tighten my heat exchanger a little more?

In most cases, you can tighten your heat exchanger, but you have to check first. Also, note that a little more tightening will rarely stop a leak.

To see if you can tighten more, check the nameplate or specs for the "tightening dimension" or "A" dimension. This is the manufacturers recommended tightness, which is determined by the inside dimension between the fixed and movable frame plates. This is not an absolute measurement, but rather a range. Some manufacturers will specify a

minimum and maximum dimension. Others will state a specific measurement (in inches or mm) with a tolerance of plus or minus 1%.

Tightening to less than the minimum dimension will crush the plates and distort the gasket grooves. After over-tightening, your heat exchanger may not leak immediately because the gaskets move with the plates as they are twisted. It will certainly leak the next time it is opened for service!

If one fluid is leaking into the other fluid, do I have failed plates or gaskets?

You have failed plates. Two failed gaskets can cause cross contamination, but you would also see leakage onto the floor.

There is a simple test that will verify that you have failed plates: Close the isolation valves on both sides of the heat exchanger. It is important that at least on one side both valves hold 100% tight. Drain both sides of the heat exchanger from the bottom drain port until there is no flow or dripping. Using a garden hose, add water into the drain port of one side with a vent open at the top of the heat exchanger (normally by removing a pressure gauge). If, after draining, water is still dripping from one side of the heat exchanger, add water to that side. Fill the heat exchanger to the top until it flows from the vent. Close the vent and allow the pressure to build up to the water supply pressure (do not exceed the rated frame pressure). If there is a crack or pin-hole leak, water will begin dripping from the other drain. If there is no water, your plates are good.

Is Legionella a concern in HVAC systems?

It certainly is! As a matter of fact, a plate heat exchanger is the perfect breeding ground for bacteria.

Fouling materials become trapped between the plates, which causes areas of very low flow. This low flow allows microorganisms to attach to the plates and create a biofilm. The biofilm traps nutrient rich sediment, which adds to the fouling. Shock treatment programs are often ineffective in penetrating the accumulated mass to kill all of the organisms present.

If I have several heat exchangers servicing the same load and my system design includes VFD's, is it better to operate more heat exchangers at lower flow?

No! A plate heat exchanger is designed to operate at a specific flow rate and pressure drop. A lower than design flow results in lower turbulence between the plate channels, which allows more sediment and debris to accumulate. It is better to run at full flow.

Can I add more plates to get more cooling?

Yes, but not as many as you might think. Remember that some of the work is directed away from heat transfer efficiency to provide the proper pressure drop (turbulence) to keep the plates clean. Adding more plates will increase the surface area, but it will also reduce the pressure drop. A reduced pressure drop will increase the fouling factor accordingly as described above. Our recommendation is to add no more than 10% additional plates.