WARE
ALL WAYS STEAM
THE GRIME
Summer 2023 Newsletter

WATER HAMMER

By Mike Taylor

No matter how good your brake system, you can't stop your car instantly. That's because your car has mass, meaning it also has a lot of inertia when it's moving. That inertia is also the reason you can't do instantaneous 90-degree turns, and why turning your car too quickly can cause you to lose control or even roll the car.

That's the same principle behind water hammer. When water is moving along in a pipe, it has inertia. If it hits a sudden obstruction, it's going to slam into it. You may have experienced this in your home if you've ever shut a faucet or shower off too quickly and felt the pipes rattle a bit. However, there's a different kind of water hammer that's common in the steam industry.

SHOCKWAVE
As you know, steam is water in its vapor form. Apply enough heat and pressure to water in its liquid form, and it turns into steam. Cool that steam enough, or lower the pressure enough, and it reverts back to a liquid. But no matter what temperature it's at, it's still water, and it still has inertia.

Water hammer in the steam pipes can occur in a few ways. If a valve is closed too quickly, or a process suddenly shuts off, the flowing steam will cause a small water hammer effect. But water hammer can also occur if a steam pipe experiences a sudden increase in pressure. That sudden pressure increase can cause a pressure wave to travel through the pipes, which will pick up any condensate with it and smack it into the next solid surface it hits. That can sound like anything from a small rattle to a loud bang.

BUBBLES
Water hammer can also occur when steam is introduced to a larger amount of condensed water. Remember, steam is a vapor, so when it's suspended in water, it's going to form a bubble. This can often happen around valve openings, especially when high-pressure steam backflows into the feedwater. The resulting bubble of steam will start to shed heat until it reaches

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WATER SOFTNERS

By Jude Wolf

Part 1 - Softeners

If your facility has a boiler, its operation is probably important. And nothing is more important than water quality in maintaining the life and efficiency of your boiler.

In a perfect system, all of the steam a boiler has generated would be returned as condensate for reuse. This would mean that no new minerals or gasses are introduced to the system, because fresh water is the source of a lot of issues. In fact, the cold, fresh, mineralized water that we enjoy drinking is the enemy of our boiler system.

Have you ever looked at a bottle of water and seen the words "Minerals added for flavor"? Distilled water doesn't taste actually that good, so minerals and electrolytes are frequently added. Well, the water we feed a boiler from a municipal supply or a well is NOT distilled... so the minerals are already there. And when the mineral laden water is boiled, those solids remain in the boiler including on the tubes... which happen to be our heat exchange mechanism. So things are fouled, heat is not exchanged properly, and scale wreaks havoc with our efficiency. At some point later, the tubes fail from overheat and we are faced with expensive repairs or replacement.

How much scale is actually in a gallon of water? This is where a hardness test is important. It depends on where you are and where you get your water. Many areas of the country have 15-20 grains of hardness per gallon. Did you have a BB gun as a youth? Well a BB is about five grains of weight. So basically in a lot of places that mean we have 3-4 BBs worth of scale in every gallon of water if we boiled the water away - which is exactly what we are doing in the boiler. So a 300 horsepower boiler, at rate, is boiling away about 1,241 gallons per hour, or 30,000 gallons per day. If that is all fresh makeup water, we are talking about buckets full of BBs (actually scale) in a single day.

Your particular value is important, because it is key in setting up your water-softener. A water softener is a gate keeper for scale. By capturing and removing scale before it enters your boiler, we can protect the efficiency and life of your boiler investment. By testing the incoming water, and setting up the softener properly, we can make our softener as effective and efficient as possible. A softener contains resin that can capture about 30,000 grains per cubic feet. So if we know the capacity of the softener, and the hardness of the incoming water, we can trigger the softener to switch tanks and regenerate at just the right time. If it is not set up correctly, then we are either using excess salt (regenerating too soon) or we are allowing hardness to enter the system after the resin capacity is exhausted (regenerating too late).

So if we do the math we have a chance, but this is no place to rely on hope or good luck. We must test the softened water outlet at least daily, and ideally at the very end of its useful volume, right before regeneration. That way we can ensure that the water is soft for the full programmed volume, and make corrections or repairs if it is not. Your boiler's life depends on it.

Part 2 - Preheat and scavenging

We prefer to drink our water cold - with ice if possible! Once again this is opposite of what our boiler needs for two huge reasons. Oxygen corrosion and thermal shock!

All water contains SOME oxygen. We're not talking about the O in H2O, we're talking about

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DISSOLVED oxygen. And the colder the water, the more oxygen is usually dissolved in it - just ask a fish. When the weather is hot and water gets too warm, only certain fish can survive. That is why we don't usually catch trout in farm ponds... there isn't enough oxygen in the water. So, basically, the hotter the water, the less oxygen can remain. Watch your pot of water heat up on the stove when you are making some mac and cheese and you will see air bubbles forming at the bottom. WAY before the water is boiling, the air starts to be driven out. If we don't get rid of this oxygen, it attacks boiler steel in the hot aqueous environment, and can destroy our equipment in no time.

So heating water is the cheap way to get the oxygen out - the hotter the better, as long as we can still pump it. That is why we use preheaters in feed tanks, or even deaerators to make the most of this principle. The expensive way to remove oxygen is chemical scavengers, the most common of which is sodium sulfite. This molecule is just starving for oxygen, and when added to water above 160F, it will absorb any oxygen it encounters. While sulfite isn't actually that expensive (especially compared to oxygen pitting in the boiler), we pay for it twice! We pay once to add it, and a second time to remove it once it has done its job. This is because it adds to the total dissolved solids and conductivity of the boiler, and to stay in our target ranges we will have to blow down more of the boiler water.

Thermal shock occurs when we expose the boiler metal to alternating hot and cold temperatures. Just like a glass pan may shatter if taken directly from the oven to the sink, the metal in our boiler suffers from the addition of cold water. As water flow cycles on and off with the pump, or even modulates into the boiler, there is stress created. Steel will become more and more brittle, and cracks will form over time, ultimately failing and requiring repairs. So essentially, the closes the feedwater temperature is to the boiler temperature, the less stress will occur.

We have to test our sulfite levels and maintain a residual (or amount left over after the oxygen is gone) at about 30-60 ppm. And we need to monitor our feedwater temperature and keep it above 160, but preferably hotter - 227° if we have a deaerator!

Part 3 - In the boiler

We have to keep a boiler alkaline. That just means we often add caustic alkalinity builder to make sure our boiler water never gets close to acidic - where we would definitely have problems. And a certain level of alkalinity helps make this chemistry set experiment work out by enabling other chemicals to do their jobs - for example, the polymers and phosphates.

Basically silt and other compounds in our boiler water would like to stick to the boiler surfaces where water is evaporated.... the tubes. We need to prevent this to avoid scaling, etc. So if we want to get something clean, lets add soap! That is essentially the job of these type chemicals. Basically, these compounds are designed to prevent adhesion to the tubes, and facilitate bottom blowdown. In other words, they keep everything loose so that they can be removed

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WARE's YouTube CHANNEL

YouTube channel wareboilers has informational and fun videos involving boilers, burners and more from an industry leading boiler company

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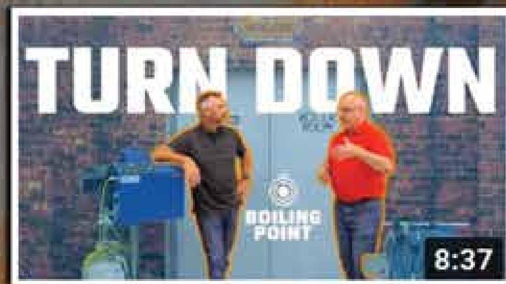

STEAM CULTURE

Steam Culture - Brent Falcone
Where steam and culture intersect.

BOILER UNIVERSITY WARE®

Boiler Tips - Jude Wolf
Learn boiler tips from a true Boiler professional

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NEW AND USED LIST

ALL EQUIPMENT LISTED IS FOR SALE OR LEASE AND SUBJECT TO AVAILABILITY

Unit	HP/PPH	Year	Manf.	Fuel	Type	PSI	Ctrl.
796	82,500	2016	Victory Energy Faber	(Low NOx) G/#2	Steam	350	IRI
797	82,500	2016	Victory Energy Faber	(Low NOx) G/#2	Steam	350	IRI
767	75,000	2011	Victory Energy	(Low NOx) G/#2	Steam/SH	750/750	IRI
747	75,000	2000	B&W	(Low NOx) G/#2	Steam/SH	750/750	IRI
791	75,000	2016	Victory Energy	(Low NOx) G/#2	Steam/SH	750/750	IRI
709	60,000	1979	Zurn	(Low NOx) G/#2	Steam	500	IRI
741	60,000	1979	Zurn	G/#2	Steam	550	IRI
795	40,000	1986	Cleaver Brooks	Gas	Steam	260	IRI
SWVB4	2500	2021	Victory Energy	(Low Nox) G/#2	Steam	250	UL/CSD-1
SWVB3	1500	2021	Victory Energy	(Low Nox) G/#2	Steam	250	UL/CSD-1
SSB-56	1200	2021	Victory Energy	(Low NOx) G/#2	Steam	250	UL/CSD-1
634	800	1972	York-Shipley	G/#2	Steam	150	IRI
620	800	1975	York-Shipley	G/#2	Steam	250	IRI
SSB-69	800 XID	2023	Victory Energy	(Low NOx) G/#2	Steam	250	UL/CSD-1
SSB-67	600 XID	2023	Victory Energy	(Low NOx) G/#2	Steam	250	UL/CSD-1
SB-139	500	2001	Cleaver Brooks	G/#2	Steam	150	
SB-277	400	2023	Victory Energy	(Low NOx) G/#2	Steam	150	UL/CSD1
SB-138	350	1994	Cleaver Brooks	G/#2	Steam	150	
SSB-71	300 XID	2023	Victory Energy	(Low NOx) G/#2	Steam	150	UL/CSD-1
SB-258	300	2016	Cleaver Brooks	Gas	Steam	150	ULs
SSB-65	250	2023	Victory Energy	(Low Nox) G/#2	Steam	150	UL/CSD-1
SB-278	250	2023	Victory Energy	(Low Nox) G/#2	Steam	150	UL/CSD-1
SB-148	200	1995	Kewanee	Gas	Steam	325	IRI
SB-264	200	2022	Victory Energy	G/#2	Steam	150	UL/CSD-1
SB-273	200	2022	Victory Energy	G/#2	Steam	150	UL/CSD-1
SB-146	200	1995	Kewanee	Gas	Steam	325	IRI

TURN THE PAGE FOR MORE EQUIPMENT →

NEW AND USED LIST continued

ALL EQUIPMENT LISTED IS FOR SALE OR LEASE AND SUBJECT TO AVAILABILITY

Unit	HP/PPH	Year	Manf.	Fuel	Type	PSI	Ctrl.
SB-267	175	2022	Victory Energy	G/#2	Steam	150	UL/CSD-1
SSB-53	175 XID	2020	Victory Energy	(Low NOx) G/#2	Steam	150	UL/CSD-1
SB-266	150	2022	Victory Energy	G/#2	Steam	150	UL/CSD1
SSB-66	150	2023	Victory Energy	(Low NOx) G/#2	Steam	150	UL/CSD1
SB-279	150	2018	Victory Energy	G/#2	Steam	150	UL/CSD-1
SB-274	100	2022	Victory Energy	G/#2	Steam	150	UL/CSD-1
SB-275	100	2022	Victory Energy	G/#2	Steam	150	UL/CSD1
SB-276	100	2022	Victory Energy	G/#2	Steam	150	UL/CSD1
SSB-60	100	2022	Victory Energy	(Low NOx) G/#2	Steam	150	UL/CSD1
SB-271	70	2022	Victory Energy	G/#2	Steam	150	UL/CSD-1
SB-272	70	2016	Victory Energy	(Low NOx) G/#2	Steam	150	UL/CSD-1
SSB-64	70	2022	Victory Energy	(Low Nox) G/#2	Steam	150	UL/CSD-1
SB-270	50	2022	Victory Energy	G/#2	Steam	150	UL/CSD-1
SB-263	50	2022	Victory Energy	G/#2	Steam	150	UL/CSD-1
SSB-68	50	2023	Victory Energy	(Low NOx) G/#2	Steam	150	UL/CSD-1
SB-268	10	2017	Lattner	Gas	Steam	150	

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WARE new and used List

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the condensation point, the temperature at which it turns back to liquid.

And while it does happen quickly, it doesn't happen all at once. As the bubble starts to collapse, it creates a vacuum into which the condensate flows. Since the bubble can collapse in the blink of an eye, that liquid water accelerates really quickly in a short amount of time. When the bubble completely collapses into liquid, that fast-moving water will either smack into itself, or into a metal surface, depending on its location in the boiler. Either way, it will create a shock wave that you will hear as anything from small rumbles to a loud banging or hammering sound.

STOP THE HAMMER

You wouldn't hit your boiler with a hammer, obviously. It might damage something, or weaken the metal. However, that's exactly what water hammer has the potential to do. If it hits hard enough against a valve or surface often enough, it will start to cause stress or damage that could lead to leaks.

That's why it's important to monitor and regulate the water and steam flow in your boiler any time they're going to come in contact with one another. That's also why it's smart practice to open and close valves – or shut off processes – slowly.

Another way to prevent water hammer in your boiler is with the installation of steam traps, condensate traps, and air vents. They're designed to help steam and water interact safely, while purging any excess steam or water that might cause a problem. That's why they're crucial pieces of equipment to install and maintain in any safe boiler.

Watch

WAREboilers channel

How to Prevent the Dangers of Water Hammer

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daily when the bottom blowdowns are performed. Skimming from the top of the boiler water is also very cost effective in removing the impurities that are bouyed up by the steam bubbles. Think about a pond.. scum on the top and mud on the bottom. Different types of blowdowns for different types of buildup.

Part 4 - The system

When we send steam out in to the system... we are done with water treatment, right? Nope.

When we soften fresh makeup water we remove the calcium and magnesium, but that stuff doesn't show up by itself. The other half of those dissolved compounds are carbonates (their friends call them CO3). When this continues into the boiler... it gets broken down into CO2, or carbon dioxide. What is fun about CO2 in water? Fizzy drinks! Well - there is no fizz here... just another problem - Carbonic Acid. Yep, it directly forms acid in our steel pipe condensate system. And this is why our condensate system leaks all the time - acid attacks. Just watch a few YouTube videos about dissolving stuff in softdrinks!

So there are two ways to prevent this. First, we could add a dealkalyzer to our pretreatment system. It also uses salt (but the cloride half) just like a softener, but with a different flavor resin that removes the CO3. By nipping that in the bud, we can prevent that whole issue.

On the other hand, we can use a chemical type called an amine. Amines are just ammonia compounds that boil away with the steam and neutralize the acid as soon as it forms! This will prevent a lot of condensate system corrosion and helps us get that condensate back which is what we want to feed our boilers in the first place!

Part 5 - Summary

Basically, a good chemical consultant can help you look at the challenges and requirements your system has. Certain chemicals are compatible or not, depending on your products and processes. Once you have a recipe for success... you have to follow it. It doesn't have to be complicated, but it is essential that chemicals be tested for the right levels, adjusted as needed, and for blowdowns to be performed. You have to make sure you keep ingredients on hand so you don't run out and have problems while you wait for more. Basically, if you have a cake mix and follow the directions - you should end up with a cake. See? Water treatment is a piece of cake!

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How a Water Softner Operates

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