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Austin Buckels: Hi everyone. Thank you very much for coming to another DB Sales monthly webinar. This is Austin Buckles, sales manager at DB Sales. This month, we have our presentation on Deaerator Product Trainings presented by Nick McBride and Brad Bishop from Lockwood Products. You know, just to give you a heads up on how we do our presentations, if there are any questions that you have, you can type them out in our in Q&A box. And I can stop, you know, Nick in appropriate moments so he can answer that question. Or, I will answer it for you in the Q&A box just by typing it out for you. But with that, I'll hand it over to Nick to get the presentation started. Thank you very much, Nick.

Nick McBride: Yeah, thanks a lot, Austin. And thanks, everybody for attending. Appreciate the time spent here listening to us and learning about deaerator. So yeah, I'll jump right in here to Deaerator Product Training. Okay, so we're going to go through just deaerators today. I'll start kind of very simple with a boiler feed system, you know, some definitions kind of thing first. But we'll talk about the different styles of deaerators that are typical here in the US. Spray scrubber style of deaerators, spray tray atmospheric I'm just going to go over dual compartment atmospheric deaerators today, and then surge systems as well since they're kind of a key component to a properly functioning and design deaerator system and in many cases, so.

So first, just generally what is a boiler feed system? A boiler feed system is a tank that provides a location to blend and store water before you pump it to a steam boiler. So, the blending aspect is taking makeup water, whatever that might be, any kind of makeup water that you're adding into the system, and condensate returns and blending those together. Additionally, you know, adding any chemicals in there, if need be, and then storage that you know the reason for the tank is to blend it and then store water before it's pumped.

So, on a typical boiler feed system you would see 15 minutes of storage and deaerator is a little bit less than, that typically 10 minutes. But that's kind of just generally what is a boiler feed system and boiler feed systems could cover everything from you know, just a small, vented atmosphere tank on a small boiler to a very large industrial deaerator and anything in between. So, I just kind of wanted to generally define boiler feed system itself, just a tank used to store and blend water in a steam system.

So then what is a deaerator? A deaerator is really just a modification of that. It's really a deaerating boiler feed system. So, it has the two main functions of the deaerator are the deaeration aspect, removing the gases and non-condensable; that air that we don't want in the feed water that we don't want to send to the boiler. So deaeration; removing the air and storage similar to a boiler feed tank. So again, it's just a modification of a boiler feed system is really what a deaerator is. And I'm going to go through all the different types in future slides here so.

Okay, so why would we want to deaerate? There are you know several reasons. The first and foremost is oxygen removal. And yeah, again, deaerate; to remove the air. This is the oxygen, the gases that are in the water that can cause rust in a system. So, you want to get that oxygen out of there to help you know almost as insurance protection to protect the carbon steel piping and the rest of your steam system or in the boiler as well really to protect the whole system against the carbon steel corroding and any piping wherever it might be in the system.

Also, a deaerator removes carbon dioxide to try and reduce carbonic acid in your condensate system. You want to get all that carbon dioxide out of there. So that's the removal of the gas, the two main gases that we're trying to get out of the water before we send it on down to the boiler. Chemical savings is why you would deaerate. So, if you just used a boiler feed system and you purely treated it with chemical to deaerate, then you know if you compare the cost of all the chemical that you would have to do to deaerate versus what a mechanical type of deaerator, which is equipment we'll be talking about today.

Mechanical deaeration, if you compare the two, there's a significant chemical cost savings in using a mechanical deaerator. So chemical savings would be the third reason. Reduce thermal shock. So, part of deaerating is just heating water up to the boiling point. So, an added benefit of deaerating is to reduce the thermal shock on the boiler. You're sending hotter feed water to that boiler and reducing any thermal shock on the tubes or the boiler. And the deaerator is a pressure vessel. So, flash steam recovery, it's a good place to send some hot condensate that could potentially flash inside the deaerator rather than flashing it and wasting that flash steam. You send it to the deaerator, and you can use that flash steam. So, those are the main reasons why we want to deaerate.

So, how does a deaerator work? Deaerator requires two things, it requires heat, and then either time or agitation. So, this chart here has two axes. I'm going to look on the vertical axis on the right-hand side over here, we're talking about the oxygen content rating of water. And on the horizontal axis, we're showing the temperature of water itself. So, the orange line is atmospheric pressure, that's the easiest to talk about and for most people to understand, so we'll talk about it in terms of atmospheric pressure.

So, the orange line follows. This chart you can find online, it's nothing specific to us, it's just the properties of water, you could Google it and find it on lots of different sources on the Internet. So, this is just the oxygen content of water at different temperatures. So, you know, the basic point of deaerating is to heat it up to the boiling point. And if you look at this chart, this chart shows the higher that you are on the vertical axis, the more oxygen content that is dissolved in the water.

So, the oxygen that we're trying to get out of the water is the oxygen, the O_2 that's dissolved in the H_2O. It's not the O as part of H_2O, it's the O_2 gas that's dissolved in H_2O. It's the reason that fish breathe and animals can live in water, because they're breathing the dissolved O_2 gas that's dissolved in the water. And it's that O_2 gas that we're trying to get out of the system. Because it's that O_2 gas that combines with carbon steel and causes rust and corrosion in piping. So that's what we're trying to remove - the dissolved gas not the O in H_2O.

So, you can see as temperature increases, generally speaking, this orange line is decreasing, right? It's not perfectly linear. But generally speaking, as we increase temperature of water, the amount of oxygen that can be contained in the water gets lower and lower, it's reduced right? Until we get all the way down here to the boiling point. So again, the orange line is based on 0 psi, water boils at 212 degrees. So, you'll notice where that orange line intersects the zero point down here where there's no oxygen, no O_2 dissolved in the water is at about 212 degrees.

So that means and all the lines seem to nearly parallel for that same line, right? And no matter whether you increase pressure or decrease into a vacuum, the amount of oxygen that can be dissolved at the boiling point is zero. When the water is boiling, you cannot have any O_2 gas that is dissolved in water at the boiling point. So, what our equipment is trying to do, what a mechanical deaerator is trying to do, is take water that's rich in O_2 gas and very quickly and effectively heat up the water. And so, as I said there are two things. So, heating up the water is first, it's the most important thing. But once you've heated up that water you need to agitate the water.

So, if you gave it enough time, the oxygen, the dissolved oxygen gases would just be removed from the water. They will naturally become removed much like if you have a Coke can if you leave it sitting out for long enough that Coke is going to go flat. That's because there's dissolved gases in that Coke, right? So, if you just leave it there the gases are naturally going to find their way out. Now in a mechanical deaerator like our equipment, we need to agitate that water because we want to make it happen fast. So, it's much the same as taking a Coke can and shaking it up, it's going to agitate it and help those gases be removed from that water.

Because water has such strong surface tension that it really helps to hold those dissolved gases down in the water very well. So, we want to agitate the water in order to break it up, break up that surface tension and allow the O_2 gases to be released. So, the same phenomenon you can see happening, you know, in a pot on the stove. If you think about a pot on the stove as an example, you know, you put your pot on the stove, you pour a bunch of water in, and you turn the burner on and kind of nothing happens unless you have a thermometer in there, you can see the temperature is going to increase and increase and increase until you get close to the boiling point.

And the closer you get to the boiling point, you're going to start to see all these bubbles that form on the outside of the pot. And that's the O_2 gas that can no longer be dissolved. So, at first, it's just a bunch of really small bubbles. So, you know somewhere in this part of the curve right here, you're starting to just see small bubbles that are being separated. And it's enough that they're gathering together and you can see them. And then as you get to the you know, closer to the boiling point, those bubbles are going to get bigger and bigger. And that's more and more of the O_2 gas that can no longer be dissolved separating out.

Now normally not until it comes to a rolling boil is the surface tension broken and that O_2 gas can normally be dissolved. But in our equipment, we don't really have that much time you'll see. And I'll go through a cutaway here in a minute kind of show you what it looks like and how it works.

Austin Buckels: Really quick, sorry to interrupt you there. I got a question here from John specifically relating to steam pressure and whether or not a deaerator or a feed tank can be used. So, does operating steam pressure under 15 psi or over 15 psi affect the cost benefit of the deaerator versus the tank chemical treatment?

Nick McBride: Does the operating pressure affect it?

Austin Buckels: Yeah. So above or below 15 psi is the question.

Nick McBride: So, the cost benefit, the Department of Energy, I think has put out a study on industrial systems. And they say that it's acceptable to go up to 43 parts per billion of oxygen content rating. Whereas most high-pressure steam systems, they wound down to in the five to seven parts per billion range of oxygen content. But as far as if the steam pressure like low pressure steam or standard pressure, high pressure steam, it doesn't have so much of a cost benefit. The cost benefit is not really related to steam pressure as much as it is capacity and operating hours. So, not really. I think I'll explain that a little bit more as we talk about the cost benefit a little bit later on in the presentation. But no, steam pressure doesn't have like deaerator correlation to the cost benefits. More based on how much water you're flowing through the system.

Austin Buckels: Okay, thank you.

Nick McBride: Absolutely. Yeah, good question. Keep them coming. Okay, and so to expand on this, so 212 degrees would be atmospheric pressure. But in this case, most deaerators are operated up somewhere in the, you know, 5 psi range, something like that. So, if we pick the, you know, if we pick 6 psi, and come all the way down here, 6 psi 5, 6 psi is somewhere around 225, 226 degrees Fahrenheit, I think I don't really look in front of me, but pretty close to that range. So that's about where we are on the chart right here.

So, the boiling point, the closer you get to the boiling point, basically, whether you increase the pressure, decrease the pressure, whether you're at atmospheric pressure, it has to be at that boiling point. So even if you are operating at 5 psi, by 212 degrees, so well, sorry, let's say 6 psi by 212 degrees, you can see this is the point where you would be on the curve, you might be at about two parts per million. So, you're not fully deaerated at that part. At that point, just because you're at 212, which seems like you're at the boiling point, that's the boiling point at atmospheric conditions.

So, when we operate a pressurized deaerator, it's got to be all the way up to nearly you know within a few degrees of saturation temperature, in this case up around the 225-

degree Fahrenheit range. Okay. So, again, well, yeah, we'll talk about pressurized deaerators, atmospheric deaerators. And then yeah, we're going to go a little bit in surge tanks as well. And we'll talk about kind of when to recommend what types of deaerators. But we're going to go through a couple different types of deaerators.

So, pressurized deaerators, they're going to have an ASME code vessel, the oxygen content rating is seven parts per billion or 0.005 CCs per liter. That's the industry standard for the US and all of our equipment meets that. We're going to go through a couple different types of models, two different spray scrubber models. One's called a tank car style. Another one which is a little more popular in the market nowadays is the low overhead. It's also a spray scrubber style of deaerator. So, we'll go over both of those and then we also offer a dual compartment spray scrubber deaerator. And then finally, we'll go into spray trade deaerators.

So, for pressurized deaerators and then we'll go into dual compartment atmospheric deaerators and with a dual compartment atmospheric, we can meet the same seven parts per billion or 0.005 CCs per liter, we can meet that same oxygen content which is typical for a pressurized deaerator when we use a dual compartment tank, so. And there are a lot of different rules of thumbs out there, we'll go a little bit into it more in depth, but we generally recommend a surge tank to be used with a deaerator when condensate return exceeds 50%. And I'll talk more about that a little bit to give a little more in depth on when we recommend that.

But the purpose of a surge tank is basically to blend any condensate return and make up water before we pump it in into a deaerator. And again, I'll get into surge tanks here in a little bit as well. Okay, so in terms of you know, most of the equipment that we sell is a packaged deaerator. It's standard components again are going to have an ASME code vessel for pressurized deaerators or just for a non-code tank for an atmospheric. It's mounted up on a support stand to make sure that the tank is elevated at such a height that the boiler feed pumps have enough NPSH and that we don't have to worry about cavitating.

So, the structural steel support stand we provide along with the tank, the deaerator vessel itself. The boiler feed pumps are usually mounted directly under the boiler feed tank. And there'll be some pictures here in just a few slides to kind of show a picture of all this, it'll all come together. Suction piping, you know connecting the tank to the pumps. Water level controls and a makeup valve. Now this is important.

On a deaerator, we're always using modulating level controls. On smaller boiler feed systems, it's popular to just use on/off controls. And that's fine on an atmospheric type of tank. But on a pressurized deaerator, it's critical to use a modulating water level control. And the reason for that is this, you could imagine that the deaerator is really not holding a significant amount of steam in the top of it. It may look like it has a pretty good amount of volume in cubic feet you know, but you are operating the deaerator at around 5 psi. And steam expands so much that there's really not a significant amount of energy in the steam side.

So, if you have any fluctuations back and forth, if you're not achieving a steady state flow of water flow, and temperature coming into the deaerator, then it's really hard to maintain that steam environment at a steady pressure. And maintaining a steady pressure in a deaerator is critical in order to get a long life out of it. So yeah, so we're always looking for modulating water level controls and we're always using modulating steam controls and the two of those systems when they come together have to work you know independently of each other. But they can easily start working against each other if you have fluctuations.

You know whether that be a makeup out turning on and off, on and off, or whether that be switching back and forth between hot condensate and cold makeup water. Those fluctuations can really be very detrimental to a deaerator. So, it's critical to use modulating water level controls on a deaerator in order to control your incoming water. Level alarms, we always use a high and low level switch on the deaerator. You know a low level in order to cut the pumps off and a high level just to sound an audible alarm to tell an operator that the deaerator may be getting ready to overflow some.

Control panels are always included. That would include you know usually a single point disconnect, single power connection point with a main disconnect, a 120-volt controllable control transformer, HOAs, run lights, contactors, circuit breakers, thermal overloads. We are normally packaging all of that typically in a NEMA 12 panel and UL 580. So, a full control panel that controls the functions of the deaerator as well as the powers and controls the functions of the boiler feed pumps as well.

Okay, now an overflow trap or an overflow drainer we're always including we usually use like a Warren 313. Yeah, 313 is pretty well, the industry standard. Some larger deaerators, getting more economical to go to an overflow valve, like a dump valve or something like that. But typically, it's pretty popular to go with an overflow trap. And that's to make sure that any water that needs to overflow can get out of the tank while we're still maintaining the steam environment inside of the tank. So, it's just an overflow trap.

A steam PRV. On most of the small and medium sized systems commercial to light industrial, we typically would use kind of a pilot operated regulator. This would be a pressure pilot operating type. So basically, this steam is taking the main steam straight off the header, fresh steam off the boiler, and using it to keep the deaerator at 5 psi. So, you're taking it from full boiler operating pressure, boiler steam header pressure and dropping it all the way down to five pounds to keep that deaerator pressurized at all times.

So even though the critical point of deaerating is to get it up to the boiling point in terms of temperature, in order to do that, we only have to maintain pressure in the vessel. And then a properly designed deaerator will function and get the water up to the boiling point within a few degrees of it. Very close to it. So again, we're typically using a pilot operated regulator on some of the larger heavy industrial applications. We may switch and use a control valve. Lots of different options there. But it's typically controlled by a pressure transmitter. Also, on there, we put two different types of relief valves.

First, we use a sentinel relief valve. The sentinel relief valve, since most of these package deaerators are typically using a vertical multistage pump, most of what we use is around FOSS lots of other options out there as well. But a Grandfa CR, with a low NPSH option is typically what we use. And the maximum temperature that those pumps can withstand is 250 degrees Fahrenheit, 2-5-0. So, we stay below that in normal operation. But if there was some flash steam that was coming back or something that was going wrong and that deaerator was not at its normal 5 psi operating range, and pressure started to creep up, then the Sentinel relief valve is set at 15. That's 1-5 psi.

And, if the deaerator was to stay at 15 psi for an extended period of time, then the water temperature would get up to that 250-degree Fahrenheit range and you could potentially ruin the mechanical seals on the [unsure word 23:07] pumps. So that's the purpose for that one. It's just a whistle and alarm horn if you will. It's the same as you know, it's a Kunkel-type spring loaded safety relief valve that is super typical in the industry. It’s set at 15 psi. But the purpose of it is just kind of an audible Hey, something's going wrong. It's also just trying to trim off if it's just a small amount of flash steam. You can kind of trim it off with a smaller valve rather than popping your main safety relief valves.

And those main safety relief valves are set at 50 psi, 5-0. That's the design pressure, that MAWP of the deaerators that we build are usually always 50 psi. So, we set the safety relief valve pressure at 50 to make sure that that is the main relief valves that prevent overpressure situation in the deaerator. The Sentinel is just there again to try and help trim off any small amounts of rising pressure or to prevent you from ruining your vertical multistage pumps so.

And then other than that, it's just basic trim items, gauge glass, pressure gauge, siphons, thermometers, wells, air vents, that kind of thing. Those are all small parts and pieces that are included with every packaged deaerator. Lots of other different optional components that we can meet. So, you know, we are a specialist in boiler feed systems and deaerators, and we are very good at customizing to whatever specifications might be out there. So, there's a lot of different options that we can put on our deaerators. We can build nearly any custom size you could think of. You want a certain you know larger than normal storage section or any kind of different orientation, we can do it.

You know, most of our pictures you're going to see here in a minute are horizontal storage sections, but we can do them at vertical, we can do them in single tanks, separate tanks, all sorts of different things you can think of. The most popular ones that we see, you know, in terms of options are, you know, sending our signals, sending some communication to a building automation system. Typically, on a deaerator, that's a couple different pressures, that's either the pump pressure, pump discharge pressure, or tank pressure as well, popular tank water temperature, and then the water level itself.

If there were VFDs another option, if there were VFDs on and we could send all sorts of information back from the VFDs, you know, VFD speed or whatever, we can send back as well. But lots of different options there that we can accommodate with anything you would want to look at. And PLC based controls, most of the you know, there's building automation systems. If somebody was just looking for one very specific signal, “Hey, I just want to see water level or just want to see tank pressure remotely”, then that you know, we can do that very simply at a relatively low cost. But if someone's wanting to see as many signals as possible to get all the communication, we would typically go to a PLC. Whereas on a simplistic system, you might have some other options with like a PID controller or something like that, a smart relay can do a lot of things to keep it kind of economical if there's just you know, one or two signals somebody wants to see.

But PLC based controls, we have our own PLC system, we call it the alpha control center. It's preprogrammed to meet almost any feed water system you could think of. It's based on two tanks we can do deaerator or a surge or condensate taking a surge whatever in deaerator whatever you might, whatever. Yeah, two tanks basically, it can accommodate. And it can do steam pressure, it can control any number of VFDs, tank pressure, temperature, water levels, backup steam valves, backup water level, make up the house, all sorts of different things. It's preprogrammed to be able to handle all that. So, that's our alpha control center.

It uses Siemens branded PLC, but we have lots of options to accommodate anything else; ABB, Allen Bradley, you name it, we can use anybody else's PLCs. For VFDs, we can do it with a very simple just little simple lead lag controller to turn on a lag pump or we can control them with a PLC. With VFDs the most price economical option out there is the grand false CRE. It has a VFD that's built into the motor itself, mounted right on the pump as one piece on the motor and that the VFD are in there together. And those are the most price economical and we've found them very reliable over the past 10 plus years we've been using them. And definitely the most economically priced so.

But we have options to use any other brand VFD you can think of. Scowl, again ABB, Schneider, Allen Bradley we can use any of those types of drives, we can use any of them so. And insulating the tank and putting a metal jacket on it, that's an option we do a lot of times. We can do that at our factory and make it come nice pretty painted same as everything else and do it before we pipe it all up and make it look as a nice, finished product. So, insulating and jacketing is something we do as well.

Okay, so here's spray scrubber deaerator, this is what's called a tank car style deaerator. So, this has a horizontal storage section and the heater compartment is you know sticking out, the vertical heater is sticking out of the horizontal section. This is called a tank car style. And this is not as popular to see on market nowadays. Most of the other deaerator manufacturers out there are doing the next style of deaerator that we'll look at which is a low overhead. But this one for me is a little easier to explain first when it's a little more separated.

So, in a spray scrubber style of deaerator, we have the first there's two stages to most deaerators and or at least two stages. So, in this one here, the first stage of deaeration is in a spray valve. And the spray valve in this case, so this here would be where you would connect any of your makeup water that's coming in for a blend if it's coming from your surge tank, your blended condensate and makeup water would come here. Comes through our makeup valve, comes over and comes into the very top of this vertical section here. And on the inside there's a spray valve or multiple of them depending upon the capacity.

And the spray valve will spray out a hollow cone of water, and it will spray that water into this steam environment. So, if you remember, you know, the water level is way down here at the bottom of this deaerator. So, the top half of this storage section and all of this upper heater section is just a steam environment. So, in this case, we're spraying water into this upper steam environment. And it sprays through that and it's rapidly heated, because we're spraying it in a very thin hollow cone, it's easy for that water to be very quickly heated.

So, we spray the water in into the steam environment, most of the heating is done up there in that spray valve, by maintaining a steady steam pressure. And then the water will collect in this lower tray right here. I should say pan, this is not a tray deaerator, spray scrubber style deaerator. So, it would then collect in this collection pan. From there, the water would fall down this here, this center section right here, and it falls down into this lower scrubber box. So that would be the second stage of deaeration.

So down here, you can kind of just barely make it out your screen here, there's a bunch of holes in this there's a baffle plate in here and it has a whole bunch of holes in that baffle plate. So, what happens is any steam that needs to be brought into the deaerator is going to come in through this steam inlet right here. So, this pipe actually going to, this next slide here has a cutaway kind of showing you a better pictorial picture here. So again, spray nozzles are spraying water into this upper steam environment, it collects in this collection pan, drops down into this lower scrubber box.

So, as we're bringing in any fresh steam, the steam that's coming in here, this nozzle doesn't stop at the vessel itself. It has a pipe that connects it all the way into the scrubber box. So, any steam that comes into deaerator has to go through this lower scrubber box. So as the steam comes in here, it's pushed through this baffle plate, and it really agitates. And so, you've number one, you're directly injecting steam into the water and heating it the rest of the way. But you're also really agitating it. And that agitation is what's going to help release, you know, break up the surface tension and release the final bits of oxygen before the water then the fully deaerated water then dumps out of the trough and down and stored in this lower storage section down here.

So again, first stage of deaeration is up here spraying water into the steam environment, it collects in a pan, drops down into the scrubber box, any incoming steam then has to push through that baffle plate, and through all this water. And then the steam can access. A lot of steam pushes and find its way all the way through that. So, water dumps down through here, and a lot of steam escapes the top and then we'll either pressurize this horizontal section, or most of the steam that we're consuming in the tank is being consumed up here, where we're heating up the incoming cold water that's coming in. So, that's a spray scrubber style of deaerator, this tank car style specifically.

Austin Buckels: Got another question here from John Burns, asking if there is a rule of thumb for deaerator to tank pressure versus operating system steam pressure. Saying that some buildings that he has worked on, they operate the steam pressure at between 4 and 8 psi.

Nick McBride: The pressure at which you operate the deaerator is kind of a personal preference. There are no specific real guidelines. Most of the time we tell people to operate them around 5 psi, operating them higher or lower, doesn't really have a major impact. So yeah, no correlation between operating steam pressure of the boilers and operating steam pressure of the deaerator. Either way, you just need to make sure that the deaerator is working effectively by making sure that your water temperature is within a few degrees of the steam temperature.

Austin Buckels: Okay. Thanks, Nick.

Nick McBride: Yep. And while that's on my mind, I'll bring it out here. But I point out we do include two thermometers on here. So, in order to make sure a deaerator is properly functioning, you'll see this lower thermometer down here is measuring the water temperature, whereas this upper thermometer up here is monitoring the steam temperature. So, those two thermometers should be within a few degrees of each other. If one's up at 230 degrees and the other is down at 210, then your deaerator, either it hasn't come up to temperature yet if you've just turned it on, or it's not properly functioning. So, you know, within an hour or two of operation, those two gauges should be or much less if you're at a high load should be very close to each other.

Spray scrubber style of deaerators are typically used in commercial to kind of light industrial. When you get to very heavy industrial applications, people are usually changing over to a tray style of deaerator. And I'll cover a little bit more of that when I get to tray deaerators. So, this is a, what we refer to as a low overhead spray scrubber style of deaerator. You can see the internal designs, it shows the cutaway right here, the internal design is very similar, you're still bringing your makeup water or condensate, your blended water up here into the top section, it sprays into the top, then catches this collection pan, goes down here to this scrubber box, and then comes out of that scrubber box and drops into the horizontal storage section.

Basically, in this style of deaerator, we just use a larger diameter tank, slightly larger diameter tank, and we orient the internals a little bit different such they're not quite as tall trying to. Yeah, get it shorter. But there's no significant difference between tank car or this SSL style of deaerator. And this is one that's you know, a lot more popular on the market. This low overhead style of deaerator does tend to be here recently, its cost has come down on this style of deaerator versus the tank car style. So, this can actually be a little less expensive. The only reason really why I would say, for me that the tank car style is a little easier to explain it, you can kind of picture it a little bit better. So, I explained it first, but the SSL is much more popular in the market.

But the one thing I would say that the tank car style of deaerator does have an advantage. If you had like a single large steam pipe that you were trying to avoid, sometimes this can be a little bit lower to the top of this tank, as compared to the top of this tank. So sometimes if you're just trying to avoid the height of one specific item, then the tank car style of deaerator can help you. Again, because it's a smaller diameter of storage section.

And the other reason would be if you know entranceway, if you had to get in you know go through a skinny area and say, “Hey, the doorway is only 36 inches wide, I just can't fit a bigger tank”, then sometimes this is a good option as well to go to the tank car style of deaerator. Again, the horizontal storage section is just a smaller section. So, that's helpful sometimes. But all the same, the same operations. You know everything is pretty much the same between the two operationally speaking.

So, there's also a dual compartment. This is a spray scrubber style deaerator with a dual compartment. So, we'll get into surge tanks and it's certainly possible to and my favorite is to do two separate tanks; have a separate deaerator in a separate surge tank. The deaerator typically lasts longer than a surge tank does. We do build surge tanks out of stainless steel to try and extend the life but still the deaerator is deaerating and protecting itself and the surge tank is in a much more susceptible part of the steam system that most people don't chemically treat.

So typically, the surge tank will fail before a deaerator. So, I personally really like to have a separate deaerator tank than surge tank. But sometimes you can't do that. If you just have too small of a space, then sometimes this SSL deaerator can really be a good option. So over here, you can kind of just barely make out that there's a band in between the two here. But basically, over here on this right side is a vented to atmosphere a non-code atmospheric surge tank over here. And then you have two transfer pumps here, and all the water level controls over here. And through this makeup out you would bring your soft water and your makeup water into this valve, they would dump into the tank, any condensate returns would dump into the surge tank, it would blend over here in this tank. And then these transfer pumps will pull water out of the bottom of the surge tank, they'll pump it up if you kind of follow my mouse here up through this interconnecting pipe and then pump through the deaerator's makeup valve.

And then the same deaerator, same SSL style of deaerator that we just looked at is what is over here on this left side over here. This is the deaerator compartment. So, it is two completely separate tanks. It just has a band that's welded between the two. Each tank has its own you know, internal head in there and the band just covers them up and weld them together so that there's you know only about an inch of space between the two tank heads. And then these three pumps over here on the left would be your boiler feed pumps pulling the fully deaerated water out of the deaerator and pump it to the boilers.

And you can see it's trimmed out with all the level alarms for each tank thermometers, main ways you know make up valves, gauge classes, it has everything. All the controls are fully packaged and ready to go with that dual compartment style.

Okay, so next we'll move on to spray tray deaerators. So, in this cutaway, you can see it's the same thing. We're bringing in any makeup water, any condensate blended with that is coming in into the top section up here, and we're spraying it into the steam environment. So, the first stage of deaeration between a spray scrubber and a spray tray style of deaerator is the same; it's a spray nozzle. You're spraying the water into the steam environment. And that's where the majority of the heating and deaerating is actually done is up there in that top section.

So, spraying the water into the steam environment. And from there, in a spray scrubber, the second stage of deaeration would be that scrubber box where the agitation is happening. But in a tray style of deaerator, it actually falls down into this tray stack down here. So, the water is sprayed, it's kind of hard to tell. But there are these black lines you can see around the outside so that the trays that are in here are these all stainless-steel trays. And they're contained in this tray box.

So, when you spray water in, you're spraying it in this box, stainless steel box that's inside of the tank. And then the water has to drip down through all these trays that's only shown three tall here, but just for pictorial reasons, but normally, it's much you know, it's 6 to 10, 12 trays tall, it trickles down through and then at the bottom, it drips into the storage section.

And any steam that we're bringing in is coming in in here and it's forced down outside of this box and then comes up the bottom. So, this is a counter flow type deaerator where your water flow is going from the top down and your steam is going from the bottom up in that tray stack. So, this is a counter flow type deaerator. So, this tray style of deaerator is typically used on heavier industrial, large heavy industrial applications. The tray style of deaerator is a more rugged design.

And generally speaking, tray style of deaerator is you know, can perform better at a high turndown ratio than a spray scrubber style of deaerator. Spray scrubber style of deaerators are much more common in the market. The tray style deaerators are significantly more expensive, you can imagine that the tank is generally the same size and cost, it's not too much different. But when you put all these stainless-steel trays and the stainless-steel box on the inside, it can be significantly higher cost than a comparable spray scrubber style of deaerator.

And again, the main reason that people would go to this is just it is a more rugged design, so in a large heavy industrial application steam critical, people do typically choose the tray style of deaerator. Now as far as cost benefit goes, going from a boiler feed tank to a deaerator, there is a significant cost savings. As we talked about early on, chemical savings can be pretty significant to use a deaerator. But as far as going from you know chemical cost savings, going from the spray scrubber to a spray tray, they have the same guaranteed oxygen level. They both guarantee the seven parts per billion oxygen content. Where the tray style of deaerator works better is at a high turndown though.

But at a high turndown in the low loads, you're using so little chemical that there's no significant cost benefit. And actually, even if you were using a spray scrubber style of deaerator at a high turndown the majority of the chemical. So, most of the deaerators even though we're mechanically deaerating, are also using some chemical deaeration as well. We get it down with mechanical deaeration, we get the oxygen content down to seven parts per billion. But we will chemically treat it to get it low or to get it all the way down to zero. And in most cases, the best way to do that and ensure that you have zero oxygen leftover in the water is by making sure you're maintaining an excess of the oxygen scavenging chemical.

So, what most people do is dose way too much oxygen scavenging chemicals. And they make sure that they can always measure an excess of that sodium sulfide or whatever it might be in the deaerator, I'm sorry, in the boiler. And as long as you have an excess of that oxygen scavenging chemical, then you know you have no oxygen left in your system. Now, that excess oxygen or the excess oxygen scavenger in the boiler, most of the chemical that is being dosed is actually to measure that excess.

There's very little chemical that's needed by a deaerator to get rid of the remaining oxygen that's left in the water. Most of the chemical that's being injected is just so that you can measure that excess in the boiler. So, because of that, so little chemical is needed, and that spray tray thrives at a higher turn down at very low loads. There's really, yeah, the cost benefit for a spray scrubber style of deaerator versus spray tray style deaerator. You'd never pay back the difference between the two.

But if you were at a large you know, if it was being used at a large heavy industrial facility where they want to have no risk of having any problems with deaerators or deaeration, the spray tray style deaerator is well worth the extra benefit, you know, the extra cost just as a more rugged design. So, that's typically why we usually see them in a large heavy industrial applications of spray trade style of deaerator. Whereas in the packaged boiler market, smaller commercial to light industrial facilities, we typically see the spray scrubber style of deaerator applied. Hopefully that makes sense to everybody.

Okay, so last, we'll go into surge tanks. I think I went over a little bit here already. But what is a surge tank? Surge tank is a tank that basically provides a location to blend and store water before it's pumped to a deaerator. So, a boiler feed system is a location to blend and store water before you pump it to a boiler. In this case, a surge tank is doing the same thing. It's just pumping it to the deaerator. And again, the reason for that is to try, two reasons.

Number one to protect the deaerator. Like I said earlier, you want to make sure that you always have a steady state flow and temperature coming into the deaerator to make sure that the deaerator can maintain a steady pressure inside of it. The lifetime of the deaerator can be significantly reduced if that pressure is constantly fluctuating. So, the surge tank will protect the deaerator.

So as the name implies, a surge system is recommended when there's any surges of condensate. So, it kind of very generally speaking, we say hey, if there's more than 50% condensate return, you kind of want to start to think about a deaerator just because that's a common way for people to talk about their condensate and what the percentage of it is. So, if you have very little amount of condensate, or you have a very steady flow of condensate, you may not necessarily need a surge tank. So, when you're deciding if you need or want a surge tank, you really have to study your process or what you're using your steam for rather than looking inside the boiler room itself. You have to look outside of the boiler room.

If your system is very batch-oriented, or even if your system is very modulating but the way that you return condensate is very batch-oriented, and that hey maybe in the plant you have 20 different traps but they all feed one really large condensate tank and those pumps are on/off, on/off, then hey that large pump on/off, on/off is going to wreak havoc on your deaerator. If you can modulate that, that pump pumping that condensate back, then you may not need a surge tank. But if your condensate comes back in a large batch or a large slug or a large surge, then yeah, you will want to have a surge tank.

The other reason for a surge tank is just some redundancy to the system. So having a surge tank is just a second tank that's sitting there. So, if you were to have problems or need to take down your deaerator, you do have a second tank there that you could potentially use. You could shut off the deaerator. We do usually offer that as an option but we can offer a deaerator bypass so we can have a connection on the side of the surge tank that pulls water out of the surge tank when it's in bypass mode and send water directly to the boiler feed pumps.

You could either pump the water from the transfer pump into the suction side of the boiler feed pump. Or you could have the boiler feed pumps if they were on the same level, you could have the boiler feed pump suction manifold pull water out of the surge tank or pull water out of the deaerator. That's it so that it's really just reconfiguring the piping. Normally, we would connect the boiler feed pumps like you see here where each pump has its own suction line going back to the tank. But if we were going to do a deaerator bypass, we would just have a manifold in here. So that there could be a valve in between the tank and that manifold. And then that manifold could again pull from either the deaerator or that valve can be shut off, and it could then pull from the surge tank.

So, that's the purpose of a surge tank is to help. It's a vented tank. So, it doesn't matter if you're switching back and forth between hot and cold water. You're not going to see any pressure swings, it's vented, right? So, it allows all the cold makeup water and hot condensate to dump into this tank and see a more even temperature. Even if you do have batches, the temperature in the large volume of water that's in the surge tank is not going to rapidly fluctuate. It's going to fluctuate a little at the quickest over a couple of minutes maybe. And that's going to give the deaerator plenty of time to you know keep up with that level of change versus something happening very abruptly back and forth. So, that’s surge tanks.

The last deaerator to go over here is an atmospheric deaerator. And again, with a dual compartment atmospheric deaerator we can meet the same oxygen content rating. With this, it's very similar to an SSL D style where we have one surge tank that catches the condensate and makeup water over here. And then in this case we heat it externally, we use transfer pumps and pump it through an external shell and tube heat exchanger where we superheat that water to 220 degrees. And then we continue pumping it over and we put it through a spray nozzle and spray that water into the deaerator compartment and then your boiler feed pumps are going to pull over here.

So, in this case, this external heat exchanger is doing the heating. And this spray nozzle is doing the agitating. So, it's still a two-stage DRA or one where we're heating the water in a separate where we're agitating the water. But this is a vented to atmosphere tank. And we usually make these out of stainless steel to help extend the life. And here's kind of a front back view of what that looks like. So, this is the front view over here with your boiler feed pumps over here on the right side and the deaerator compartment. You can see the transfer pumps over here.

In this back view over here you can see the transfer pumps are pulling water out of the surge tank, pumping them into this shell and tube heat exchanger. And then after it comes out when it's heated to 220, it then comes up and sprays in the top of the deaerator compartment. And again, same type thing. It's a package deaerator; we're using a panel and makeup owls level alarms. It just looks a little bit differently. But the principle and the packaging is all very similar.

So last to talk about, you know when to choose a deaerator versus boiler feed tank. It's usually a pretty common question. This is just a very general rule of thumb and it's really just looking at the return on investment of chemical savings. There are a lot of other reasons why you might include a deaerator. Some of it being you know maintenance wise or flash steam, poor chemical management, something like that could be various reasons why you would use a deaerator even if it doesn't pay for itself. But again, this is also based on a five-year payback.

So, if considering a deaerator will last 30 years, if you extend the payback out, then it can be justified to use a deaerator even larger. But basically, start over here, will this boiler operate 24/7. If it doesn't, then oftentimes it's better just to think about using a boiler feed tank. Because a deaerator is going to take at least a couple of hours to drive all the oxygen out of the water, out of the tank, out of the whole steam system, get all that oxygen out of there, it really has to kind of cycle through the whole system. It takes a while for that to happen.

So, if you were only going to run something for eight hours a day then the cost benefit would likely not be there. As well as you're just not moving as much water. So, if you're operating 24/7, you know, over 300 days a year, then, yeah, you're moving a lot of water, you would be using more chemical in order to deaerate that water. So, it's going to make more sense. So, if you are operating 24/7 and that average load exceeds 300 horsepower. So, this isn't the boiler, right? It's not like oh, they have 2 150s. This is the average load. Whereas, you know, many customers, and I'm very generalizing here, but many people operate somewhere in the 30 to 60% load capacity.

So, if they have 2, 300 horsepower boilers, but one of them usually runs pretty well flat out, then that average load would be about 300 horsepower. So, if the average load is above 300 horsepower, then the deaerator is definitely recommended, and it would pay for itself in less than five years. If it's not, you have to kind of consider what kind of payback you'd be looking at. Okay, do you mind paying for the expense of going to a boiler feed tank over a, I'm sorry, going to a deaerator over a boiler feed tank. This is really looking at that difference in money. Boiler feed tank would be required, right? So, it's looking at Hey, do you want to have the added expensive of a deaerator.

So, if your average load is less than 300 horsepower, then you might consider a boiler feed tank. So that's kind of just a general recommendation about when you would look at a deaerator versus a boiler feed tank. Again, there are other reasons. This is based on that five-year payback of justifying going up to the deaerator from boiler feed tank. Okay, yeah, so that's most of what I wanted to cover.

The only other one thing that I could point out here is other thing to consider when looking at a spray tray deaerator instead of a spray scrubber deaerator is that if you have a very high blend temperature entering the deaerator, so if we go back to the dual compartment one over here, this blend temperature in this example, you know, if you have 180 degrees if your surge tank is around 180, meaning that you have a lot of hot condensate and not very much cold makeup water. If this blend temperature is above 180, a spray tray style of deaerator would work a whole lot better. Because you're already kind of turning the deaerator down. The turndown ratio of a deaerator is not just the actual flow, the water flow of the deaerator, or the boiler capacity that's drawing on it. It's also an effect on the incoming temperature.

So, a deaerator is typically sized for 100% maximum capacity of the deaerator, you know, if it's a 30,000 pound per hour deaerator, that means it's sized for 30,000 pounds per hour of water coming in of makeup water coming in at 50, 60 degrees. So, you're already in effect using some of the turndown ratio of the deaerator by bringing back most condensate. So just simply operating a system you know, with a surge tank that you get back most of your condensate, even at maximum capacity, you're already into some of that turndown ratio of the deaerator.

And, yeah, the turndown ratio of the deaerator is more based on the amount of incoming steam required for deaerating rather than the actual water flowing through it itself. So, the spray tray deaerator operates at a better turndown because it doesn't, you know, very little steam coming in. This tray style of deaerator is really more based off heating surface area in this design, whereas in a spray scrubber style of deaerator, it's based on the velocity of steam coming through here to agitate. So, the spray tray style of deaerator works very well.

Even if you're spraying in a lot of hot condensate up in this top section, it still operates very well because you have more based on the design, is based on heating surface area in order to strip the oxygen and just agitation of dripping down through the tray stack. Whereas this design here, you're requiring it's based on the velocity, a higher velocity of water to strip away the oxygen down here in this lower section.

So, if you're bringing a lot of hot water up here into this top section, you're not going to require a large amount of steam coming through here and the velocity would be very low. Meaning, there would be very little agitation down here in this lower section. So, a spray scrubber style of deaerator does not work as well with a lot of hot water being sprayed into the top. Because obviously, hot water is going to require a whole lot less steam and heat up here in the top section so.

Yeah, so that was the last thing I wanted to talk about as well when a spray tray and when a spray scrubber style of deaerator. Alright, does anybody have any questions? Anything else I need to go over?

Austin Buckels: Thanks, Nick. I don't see anything in the questions and answer chat box currently right now. I guess we'll leave it open for a little bit if anyone wants to, you know, type in anything to ask Nick right now before we sign off is very much welcome. But I will say you know, thank you very much Nick and Brad, for putting on a presentation for us today. You know, anyone that has attended today, thank you very much. If you do have any questions, you know, need help with some system design selections, anything like that, feel free to reach out to anyone from DB Sales. You know, we are always in contact with Nick and Brad. You know, some of the questions that you know, your engineers, contractors that have attended today have come to us seeking for help in the different system designs that you have. So, feel free to reach out to us. Thank you, Nick. Again, doesn't look like we have any further questions, but we'll keep you posted on anything, any kind of feedback that we get from the presentation today.

Nick McBride: Okay, yeah. Thank you. Thank you, guys. And thanks everybody in attendance, appreciate you listening in today.