Webinar Date: October 29, 2001
Topic: Energy Recovery in Air Handling Units
Guest Speaker: Dariuz Szylman, CEO, Klimor
Moderator: Austin Buckels, Sales Manager, DB Sales & Service
Duration: 0:54:27

Austin Buckels: Hello everyone, welcome. Thank you very much for attending another new sales presentation. This month we have Klimor air handlers and presenting for us today is Dariuz Szylman will be presenting on examples of heat and energy recovery devices use an air handling unit. I did want to say if you have any questions, you know during the presentation please feel free to fill those out in the chat or the question box and we will do our best to stop at an appropriate time to answer them or to have dairies answer those questions. But with that, I will hand things over to Dariuz to get things started. Thank you very much.

Dariuz Szylman: Thank you, Austin. Hello, everybody. And welcome. Thank you for joining us this beautiful Friday. As I mentioned I work for Klimor USA. I'm responsible for West Coast and I will spend these 45 minutes with you talking about hidden edge recover regarding recovery devices in aerosol Limulus. I will focus on most common ones. Obviously, there's a large number of possible options, but umm today I'm going to focus on some of the common ones, and again, if some of the information that I'm presenting is not new to you, or is, you know kind of common, I apologize. But I wanted to give started this year on the hopefully first of many webinars as to give you a broader look. And maybe in future, do a little deep dive on some of them.

So, in the most common er V's, or an N recovery device that are found in air handlers, or energy wheels, plate heat exchangers, and counter Cross blood flow plate exchangers, and topping changers, that's a subsection of Blaikie exchangers, heat pipes, and glycol loops. Obviously, there's pros and cons to every solution. And we're, we're gonna talk a little bit about each of them. Let's start with energy wheels. Well, first of all, this is requiring an air handler to have a supply return air stream, those airstrip needs to be next to each other either Overlander or side by side. And what's very important is that it requires a counter flow of air streams for efficient operation, out of all of every device that we will talk this one, this is this,

today, this particular device requires it and basically, without control flow of air streams, it won't act properly, won't give you an efficient recovery.

Obviously, you know, I know the wheels can be manufactured in single piece and orange slices, especially for the big ones, it's, it's a very common solution to have them built in slices, even delivered to the job site. Because those really can be quite big. This is one of the energies and recover devices that that has moving pieces, that's why there are some people that don't like them, you know, when you have moving pieces, you have an option to fail, right? Obviously, the spinning the spin of the wheel is done by motor, and with the belt and all this and also, it's in the current standard of air handlers, they are usually those motors also have VFDs and this is how you control the recovery efficiency. And also, you know, provide frost control for climates that that you know, have an option of having a freeze of the wheel.

As I mentioned, the wheels can be quite large. They standard applications range from anything but with diameters from 20 inches to even 240 inches. The Fall thickness used in South Wales is you know, anything between 70 and 100 microns at and also the wheel itself the type of the wheel, there are different options there you have, you know, sensible only for only ladened recovery, you have full thermal wheel and then we'll talk a little bit more about that in a bit and the second wheel. As far as recovery efficiency, it's anything between 65 to 90%. Obviously, there's different, different umm different things impact the recovery efficiency, how fast the wheel is spinning, what's the how fast the air is moving through the wheel was the wheel thickness was the foil thickness was the coating there's the different thing and everything, obviously the application, each application can be different, and you know the efficiency also can differ.

I wanted to focus on one on one of the wheels that we're actually using in our air handlers. It's called Hugo and for Pirate it's a wheel manufactured by a company Klingenberg from Germany but also, they have manufacturing in US and in High Point North Carolina. And this this will be actually top of one of the you know, highest quality release on the market. What in addition to obviously, being only a full aluminum wheel, it also has this special coating they Fu Gazi light coating that they click with her, say, selective absorption. So, what it offers is that it doesn't transfer odor, has no fun, no fibers, and the aluminum surface is resistant corrosion resistant. And what it gives is get high very high performance and low pressure drops.

What we, what we've learned from using that wheel is that it actually, you know, offers quite a high quote quite a bit a quite a higher efficiency of recovery. And can be used in very hazardous environments, where, because of the coating that they use, and the way that they manufacture, it's a very

high-quality product. There is, as I mentioned, the, the surface of the, of the, of the wheel of the aluminum is coated with, with this zeolite coating. And it's offers not only, not only, you know, transfer of heat or, but also offers transfer of humidity. And that's something that those energy wheels, for thermal wheels, whatever you call them offer, as far as the wheel itself, you know, and what pros and cons will offer one of the things that I mentioned that engineers and people that use those types of equipment in the in the field don't like is that it has a moving part, right.

So, it's a device that can fail on because you know, it has a motor, it has a belt, that needs to be checked, it has a VFD all those things might be problematic, as we all know. And wheels, wheels have, there's always some bleeding between the restrooms that haven't been a wheeled yet the designed that is 100%, the 100% You know, they can separate Airstreams. So that's one of the you know, applications that we might not be might not be suitable is that you really want to exhaust full air from the building, you don't want to go any of that Eric being exhaust back to the two locations to the building.

So, you know, the wheel is probably the best solution, in my opinion, when there is no particular, you know, in when there's simple application, because it has offers very high efficiency and relatively low price and also and also low footprint. But there are some applications that wheels are not suitable, as I mentioned. The other one of the things that also we've not decided I don't have it on the slide is that recently they've been there's been a, let's say, a discussion battle about dumpers. I mean, bypasses, bypass done person bypass is on the wheel. And, you know, it used to be, there's some engineers that like to have bypass numbers on the wheeled in control efficiency in that way. And actually, ASHRAE also, and has it in their guidelines.

However, you know, especially as us like people from Europe, originating from Europe, we strongly believe that, you know, the bypass on the on the energy wheel doesn't really solve any purpose, right? It's an it's a, it's a solution that's outdated, that might be good when the wheel the before you know VFDs before you could freely control the spinning of the wheel, then maybe it had some uses, but now, the efficiency of the wheel and even ignore stopping completely the stopping the recovery completely can be done via the VFD very easily and also what it can and also you know, adding bypass damper and, you know, making the active area of the wheel smaller adds also a pressure drop to the whole to the whole potential pressure drop the whole application and also, you know, obviously limits the potential of recovery of efficiency of this solution.

So that's something that that we've been recently you know, seeing some push towards having the having the bypasses on the wheel and you know, an output We strongly believe that this is the service really no purpose, there are other ways to achieve what this seems to be doing. The second type of energy recovery devices are plate heat exchangers. And this is a bag of a lot of different a lot of different devices.

And first of all, you know, standard, you know, the cube pleasure center, we have in Ohio is it standard or high efficiency, then we have counter crossflow, which you see it you can see here in the bottom some of the diamond and lots of enthalpy words, the different in this solution from the wheel is that it has no moving parts the air streams to air streams that are separated by in order that flow through the Recover device are separated by aluminum fence and membrane. And in addition, you know, the fins can be coated for hazardous environments. So, it's also a good solution for, you know, high humidity or maybe, you know, some special obligations and recover efficiencies control by facing bypass numbers here and here.

As I mentioned, you know, in a we'll just set you know, the bypass dumpers are not a good solution. Because there are other ways to control efficiency here, bypassing dampers are here, and bypasses. So, this is the only way how you can control it right? Because there's no moving part you cannot stop the plate, what you can do is bypass it right. This is how you do first control. And there's you know, the sizes, the different sizes of those of those of those plate heat exchangers.

How those operate right in some operation feed from the outside air is transferred into outgoing air, reducing air conditioning costs and in winter, the outgoing energy transferred in the fresh air and incoming air and reducing the heating costs this principle is actually good operating principle for another recovery devices. How it works, how those placate exchanges work, especially aluminum plate exchangers, is that air travels two channels in the plates of the heat exchanger and supply and as I mentioned, supply and air, what are the main benefits now what or what, what's considered what's happens is that first of all supply and air return air streams or return are separated in a plate heat exchanger.

They're obviously not being there's very little risk of cross contamination. In aluminum placation. There's no transfer of moisture contaminants in orders. And obviously, recovery happens by transfer of heat between air streams, right, through those plates that are separating both our stream recoveries available in winter and summer. And that's as far as sizes.

Austin Buckels: There's no quick sorry to interrupt you. There is a question here from Scott Duncan. Asking how you deal with condensation inside the heat exchanger.

Dariuz Szylman: Well, which one general jet?

Austin Buckels: That's right.

Dariuz Szylman: Well, the condor is a different thing because the condensation on wheel is the is basically well as far as will condensation. Actually, this is what happens the you know, carryover of moisture or you know condense it's something that we want right you want the moisture to be carried over as far as plate heat exchanger, those plate heat exchangers and you know our controllers that contain them all usually have drain pans and because the way that they are installed, which you can see it's usually on the lower side here and so they're on the condensation and the moisture just flows out of the heat exchanger with gravity there's this is how it's how the proper pH exchangers should work right.

It's designed in the way that condensation and just flows out of the out of the plate heat exchanger naturally with the air coming out. Yeah, perfect. Thank you. Yeah. So as far as sizes, sizes of the of the of the of the blade exchanges we have everything from you know, small eight by eight inches cubes to I've seen application Since the fat, you know, 100 100 inches, by 100 inches cubes, what they're, you know, there's multiple manufacturers, they do it differently, there's, you know, people build walls with them because there's wood plate heat exchangers you can actually, you know, achieve bigger recovery or add to the CFM of the application by just adding those cubes, right and then you can stack them together, you can extend the area of the of the, of the recovery by just adding more and more of those cubes to the Airstream.

So that's a, you know, very good, elegant solution also to, you know, multiply and, you know, increase the recovery. I mentioned, there's no cross contamination, obviously, you know, you never say, No, zero, right, it's below 0.1%. Because, you know, as a, it's, the thing is that those air streams in the air handler actually cross so there's always some possible small cross contamination in on the seals on the on the, you know, screws on places like that we sell there is no, no, no cross commendation, obviously, there's a little always a little bit but you know, Bill below 0.1% is negligible in most cases, as I mentioned, that the plated exchanges can have a coating for various purposes.

For pool vacations for you know, for hospital applications, for some cleanroom applications that have different coating available for those plastic plate here, heat exchangers, we talked about bypass a little bit, usually the bypass is having the damper. And some of the manufacturers try to, you know, save on costs by providing only damper on the bypass. But really, really, as you can see here on the right, even in the middle, that really,

you know, high quality manufacturers would provide the facing bypass as well. So not only opening the bypass, but also closing fully the, the, the face of the of the heat exchanger.

As far as recover recovery efficiency. It's usually like heat exchangers has have a lower efficiency than then then we'll as I mentioned, but it's still pretty good. It's above 50%. And it's a solution, you know, comparable to we'll, especially in smaller applications, people prefer to install applications by smaller minimum 510 umm 10,000 cfm. Why because, again, we mentioned no moving parts, right. The placement exchanger, if properly maintained, and there's no mechanical damage will work indefinitely, right, there's like, if there's, you know, that if the air handler is properly maintained, and you know, filters are being replaced, it will just work for many, many years, without any, any issues. Let's move to the next slide.

One of the subcategories of plate heat exchangers are enthalpy plate heat exchangers. And we as a company we partnered with, with a company called core from Vancouver, British Columbia, which is those are basically have the older, older, same older benefits of naked exchanges. But in addition, because they have those membrane, as I mentioned, those are actually also carried moisture.

And this is, this is a nice, nice slide that shows how actually, those enthalpy plate heat exchangers work. So, as you can see here, we have this polymer membrane in the middle. And the way that is designed, the way is manufactured is that it won't allow, allow pass, you know, allow passing from return or stream to the supplier stream, you know, things like you know, contaminants, orders, things that we don't want to pass, but we actually haven't. There's the moisture, the latent energy, then in case of regular, you know, aluminum plate exchangers, the water doesn't pass here in the case of this enthalpy basically exchangers it does. So, we'd have with this with those new, relatively new designed enthalpy plate exchanges.

We are having, you know, a sampling of some of both worlds right a little bit, we have a plate heat exchanger that doesn't allow that that's state that doesn't allow cross contamination, no moving pieces, right. But on the other hand, allows for moisture, carry over moisture, you know, recovery, right, let them into recovery.

So that's why those, you know, relatively new membrane plate, heat exchangers, enthalpy, enthalpy exchangers are, are very, very, can be good, very good solution, particularly in small applications, those usually, again, are used for smaller applications. They're used very, very heavily in residential, residential applications for smaller ERPs. Yeah, and so that's, that's, that's another, you know, sub type of, of plate heat exchanger, what's,

you know, what's one thing that's, that's, let's say, a little less good in those play exchangers, they don't really the enthalpy plate heat exchangers, they don't, they're not best.

In high pressure applications, when you have a lot of differentiating pressure between you know, supply and return air, when you cannot contain in keep the same pressure on both sides of the of the plate heat exchangers, those usually won't, won't cut it right, because of the membrane because of the relatively, let's say, delicate construction of those, you know, they're not the best solution when you have, you know, when you, for example, have an application that has, you know, positive pressure on the supplier and negative pressure on the on the returner.

So, that's something to keep in mind, you know, in order for them to properly work, you will have to design a system that on both sides on in return and supply through the this bliss this enthalpy plate heat exchanger would have to have same, same pressure, right, negative or positive the same. So, it will kind of keep the device intact, right. So that that's one of the things that's you know, there nothing is perfect, right?

I mentioned that this device has some great utilities, but it's it also has some has some problems and it's not you know, and it's not a cheap solution to be honest, especially in you know 15 20,000 cfm the units with those devices can be can be really pricey and that's why you don't really see them in some big applications first and that they take up a lot of space the footprint will be quite as quite a big then and the cost of the of the of the of the equipment itself just adds up so as I mentioned, you know, we'll see it's always you know, you're always playing this game you know, between you know, a value for you know, what, what you're getting for how much money you're willing to spend, you know, it's it will be great if it wasn't the case but you know, that probably bearing me that it's usually a balance between the cost of the equipment versus what it gives the user or the investor.

One of the next energy recovery devices I'll talk about are heat pipes and heat pipes are you know, transfer devices capable of transferring heat and every several 100 times faster than conventional methods. And you know, traditional heat pipe is a hollow cylinder that's filled with liquid, right? How do heat pipes work? There, you know, they're absorbed the heat is absorbed in the evaporation section, fluid buoys and then heat is released from upper part of the cylinder to the environment right and, and liquid returns the gravity lower part of the of the cylinder, right this is this is basic, this is how it's done. And the heat pipe our heat pipes that are most commonly used and our handlers are not really because their efficiency is not high.

There are some other benefits which I will talk in a minute and I'm in a bit but what is usually is that it's used to improve the humidification right and recovery from exhaust air strips. Generally, there are two types of heat pipe that are most commonly used. And the first one is a wraparound a heat pipe. Here you can see on the on the, on the right-hand side, it's usually combined with standard training water coil. So, how would you use is that the first section is located in the in the in the beginning of the unit and commoner stream, usually right after filter section or mixing box. And then and then the air that comes out from outside passes to the heat pipes and refrigerant vaporizes right there and the heat is carried to the second section and in the middle, obviously, then if we wouldn't have a coil in the middle, then the heat pipe wouldn't really work in the single umm stream.

A unit you know, one thing that obviously here is the different that I haven't mentioned yet is this wraparound heat pipe works and only supply singles supply device, right? You don't need a return Airstream for this device to work. Because it's works only in one Airstream, right, that's why it's called wraparound, it's wrapped around the chilled water coil. So once the once the heat pipe there in the precog heat pipe there's a heated right it goes it goes to the to the to the reheat heat pipe, and so that the core and the heat goes there, but the air is cooled by the by the double the coil, usually evaporation coil or you know, some and then the air is over cooled, right.

So, it's at the humidifies there, and then the reheat pipe that is able to bring the temperature up to what we want to achieve. Right. So, it's this this and that recovery is used in a situation when we really want to humidify the air, we and we use the evaporator chilled water coil. So that's something that that that's worth considering always. It's, it's you know, free. And it's once the heat pipe heat pipe is purchased, it doesn't you know, require any energy additional energy so, so once you know, invest in a heat pipe, it's just producing only benefits, again, the efficiency of such heat pipes is not high, but it all usually can help out and you know, depends on the on the again and the air stream or the temperatures of other things, but usually can help out a whole device in recovering some of the energy that is used for dehumidifying there the other option of heat pipe that is very commonly used.

And it's that also very specially recently, we've seen quite an increase of use of those heat pipes is that is that those heat well, I call them true heat maps. Because first of all, the difference between this and the previous one, you need to Airstreams you need the return air stream and the supplier stream and there's Yeah, those heat pipes are again, there is no more moving parts the heat pipes are can be either built even in a single, single block, or they can have a separation first longer.

But they're designed in two ways either side by side, as you can see here on the on the on the screen or over on there that so basically you have a supply air stream or returning a stream above the other. And what what's great about this is that it offers in a very compact design, low pressure drop, and high optimizes and effectiveness and trouble-free operation.

As I mentioned no moving parts. So, it's a very good product for, for all parties. Again, maybe the efficiency of the recovery is not a lot, but it just adds to the whole the whole application or adds to them. unsex saves the investors you know, money helping out that the recovery has the equipment of energy of liquid equipment.

As I mentioned, the final bonds of heat pipes are that it's there's basically improperly manufactured equipment, there's no risk of contamination of supplier right. So, the separation of the supplier and Estrin can be done even can be completely split up to 60 feet, right. So, his bite like that might require some additional devices. But even in the in the heat pipe like you see on the on the right-hand side, the risk of contamination is completely gone.

And the final type of ERP, that device that I would like to just touch base a little bit, it's something that honestly we've have not seen, be very popular here in maybe general applications of air handlers, because the efficiency is maybe not be great and it's and the application then then the equipment and equipment itself can be quite pricey, or, you know, energy recovery, glycol loops, glycol loops around glycol loops, there's different names for the for the same application.

It's basically again, this requires having a supply and return air stream. And what did use is they use copper aluminum called standard, you know, calls that you that you are, you know, bread and butter of, of air handlers, right to water calls for workers here they pose they act a little differently. They those are usually you know, 1216 even 18 rolls with a standard fin pitch but you know that you know 1618 rolls, this is something that you don't see on the on the chilled water but this here, it serves a different purpose.

In addition, there's you know, as you can see, on the left side, you have one coil on the supply air stream and other coil and the returner stream. What and there's always like some kind of hydraulic installation between the coasts with the pump with some valves, there's, you know, different ways of moving the glycol between those two, what, what this application offers is that it offers a little higher efficiency, the heat pipe combat offers absolute no separation of supply, and return air stream this is an application that is usually used, you know, in hospitals in environments that absolutely cannot have a returner exhauster getting back to the supplier, this is this is the this

solution gives this gives us this option, as ignored on here on the right, you can see actually instance in the same cabinet in one unit. But actually those the way that those can be designed, they can be very far apart, they can be you know, in different locations of the building even right so and what's you know, some limits of how you know, how long you can you want to pump the glycol, but, but what it gives us again, is gifts an ever recovery option in a situation that you have basically two separate unit you have separate exhaust unit, maybe in one mechanical room and supply unit in the second mechanical room and the same floor or maybe different Florida and different floors, one on top of the other.

And you can have this glycol loop running between them and achieve energy recovery. So that's something that none of the previous options you know, it's gonna happen with a with a flaky addiction. It can happen with the wheels, all those units had had the same needed to be in the single piece, right single device area.

Austin Buckels: Yeah, I got a question here from Scott Duncan, asking about a detail of I guess how the inner rows of 16 Row coil are cleaned typically.

Dariuz Szylman: Well, yeah, that's the that's a good question. You know, and that's not well, it's not easy. It's not easy. That's why I don't usually those coils you know when you have 16 Roll call you usually have the, the fin pitch is a little lower right? So, the blades are a little a little farther apart. So, and also, you know, reduce the pressure drop. And you know, the cleaning is same as any standard coil, right? It's, you know, you just, you know, what, if you need to actually clean it, you have to, you know, use water, right pressure, that's the only good solution. Right? To be honest, you know, those if, if I want to say that, you know, if you have 16 and 18 Roll coils, the way that the dose units should be designed is that you shouldn't need to clean the coils. I know it's not exactly the answer that gentlemen is expecting, but that's the truth. You know, you don't want to you know, you don't want to have a clock, you know, akin row coil, because it's just not, it's, it shouldn't be needed to be cleaned. You know, maybe like this, I should say, like this.

Austin Buckels: Okay,

Dariuz Szylman: And there's that as a well, I guess, like a cop around answering the question. But, you know, again, it's a Stan what not standard, but at the same construction as chilled water coils, right, those glycol calls, is just, you know, again, in normal situations, you shouldn't need to clean the guard something bad happened if, if the column is cleaning, right.

Austin Buckels: Okay. Understood. Make sure.

Dariuz Szylman: Thank you. So yeah, so as I mentioned in I'm going to do a little reading here, but you know, a typical caloric energy recovery system places you know, extended surface, you know, Fin tube water coils in the supply and exhaust air streams, right, the coils are connected in a closed loop via counter flow piping through which an intermediate heat transfer fluid, typically water or freeze prevent preventive solution is pumped, right, as I mentioned, glycol, either ethylene or propylene, the system operates for sensible heat recovery on the right as again, there is no more because the air streams are completely separated, there is no there's no moisture carryover, there's no possible recovery of moisture.

So, what are the advantages of this solution? You know, as I mentioned, and one of the biggest, you know, advantages does not require that the two air streams be adjacent to each other, right? Several air streams can be used, right, because you can, you can actually loop those right has a relatively few more moving parts. This is, you know, something that's mentioned in the heat, heat pipe, you don't have any moving parts yet, here, we have a pump and control valves, right, nothing else moves. And the pumps are usually, you know, the least expensive part of this system.

So, if it fails, it's it, it's relatively expensive to replace. Especially efficient. Yes, because it's using, you know, it's again, this using the same size of air handler, like you normally have coils, the only additional you have those pipes between the supplier and return, the cooling or heating equipment has been reduced, right? It doesn't have to be maybe for the for CFM, the moisture removal capacity of existing cooling equipment can be improved. no cross contamination between Airstream render is something that cannot be understated enough.

What are the disadvantages, add to the to the first cost, right, as I mentioned, has 12 to 1618 Row coils, that's something that that that that costs plus a cold pressure drop for those applications is quite high, right with a glycol and everything those applications are very expensive and upfront right at the beginning requires edit glycol pump and buy big expansion tank freeway freeze protection controller, all those things connected to you know, having a glycol in the in, in the building, having the installation between those two units, and requires that their streams must be relatively clean and may require filtration.

This is you know, I want to say that, you know, in my or air handlers that require filtration because this is, you know, coming back to the question about cleaning, you know, you don't really want to clean those coils and that's why it's so, such important in addition to this, you know, expensive installation to have a proper filtration, you know, do all the improve pre

filter, final filter, so they catch everything that might, you know, get into the unit Right.

What are the applicate? The best applications for this type of solutions? You know? First of all, you know, create ventilation requirements and rising energy prices have stimulated interest in heat recovery system rather with heat recovery. existing systems capacity can be increased without adding chiller boiler capacity. This system is best applied in buildings where most of the supply ventilation, air and exhaust there isn't one or two ducts that are not too far apart.

What are the best applications as the system is for sensible heat recovery only it is best applied in locations when there is a sizable heating season? Again, maybe not. Maybe not California, I assume there are some parts in California that have a heating season. products that require a large percentage of outdoor air increases system efficiency by transferring heat in the exhaust to either precool or preheat in the coming air.

What are the possible applications you know, and the building one reducing the sensible load on the cooling equipment is advantageous and applications to avoid? Where there's a number of intake or exhaust air bags that must be piped, the benefits are likely not to offset the higher fun pump. First cost. So, you know, as I mentioned, this is this is a solution. This is a product that is, you know, we don't see as a as an error handling manufacturer, be very popular in United States.

Maybe it's popular in some applications that we just don't touch. But, you know, from our experience in Europe, that, you know, Eric and I are experiencing our shows that this is an application that has been fairly popular. Again, it's not, it's not popular as wheels are plated exchanges with for sure, we are seeing much more use of this type of applications that we see in the United States.

So that, that brings me to an end, you know, again, I'm sorry that maybe some of the information that I provided was very basic. But this was just the first in my will, I hope this is just the first of a number of such webinars. And I will be you know, we'll be glad if we can maybe, you know, get some information after that what type of energy recovery devices you would like to hear about maybe what type of problems you see or what type of you know, some do some deep dive on some of the applications of some of the solutions that we can offer.

Austin Buckels: Yeah, absolutely. I thank you very much. That was very good. I think we will get some feedback you know, from our participants today and see if there any particular topics, we can set up another webinar for to go into a bit more, deeper dive into that topic. But no, again, thank you very much. I

did have one question that we didn't answer during the meeting that I wanted to bring up so we can do that. And then again, if anyone does have any questions for Dariuz before we wrap up, you know feel free to write those into the chat now. Or if there's any particular topics you know, even now that you'd like to learn more about for a future webinar, we can take a look at that and try and plan for another one in the future. So that question one second Yeah, so this was this was from Scott Duncan again says for applications that are starved for maintenance and power and funding like the Department of Defense, where the filter change interval maybe from six to 12 months with no maintenance between the filter changes, what would be like a recommended solution for something for that particular application?

Dariuz Szylman: Plate heat exchangers, definitely plate heat exchanges.