TRI-SEN
TURBOMACHINERY CONTROLS

PODCAST EPISODE TRANSCRIPTION

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Episode Summary:

In this part two-of-two episode, Jim Jacoby (Senior VP of Technology at Tri-Sen), Tyson Johncock (VP of Engineering and Service), and Tom Bailey discuss compressor [control] surge margin.

Tom:
Hi, and welcome to the Turbomachinery Controls Podcast, where we'll be informally discussing turbomachinery controls and turbine safety-related questions and topics. Opinions expressed here are our own, and not necessarily those of Tri-Sen. I'm Tom, and in this episode, we'll be taking up the conversation from our last episode where Jim and Tyson were talking about picking a surge margin setpoint.

Jim:
[from last time] …that's probably a good example of why, if you're going to use the proportional offset, you'd probably have some constant added in there, because at lower pressure ratios, you're going to get really close to the line.

Tom:
Yeah. And so what do you guys see for bounce, though, in a flow transmitter? I know that back in the day-

Tyson:
Before or after we filtered it?

Tom:
Yeah, right, right, right. To where it's unusable. Before you filter...-

Tyson:
How much bounce do you want to see?

Tom:
Well, before it's filtered to where it's unusable for surge control. How about that?

Jim:
Yeah. For me, it's more about how big of a bounce the customer can tolerate in their process when the anti-surge valve opens, because the tighter you make that margin, the more aggressive that opening of that valve has to be to protect you when you start getting close.

Tom:
So I was just wondering, though, when we pick a surge margin, if you had to pick four or three determinants, how you choose it. We said 10%. 10% no matter what, or is it 10%... okay, that's what you're thinking, but really, what do you end- Do you end up with 10% when you go into one of these, or do you do something else?

Tyson:
So for me during surge testing, there's some different levels of surge testing. There's one where you go back and you try and find an actual surge point and you get a good response of what the system does.

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Tom:
Okay. So what happens then?

Tyson:
So then you take that and try and apply that to how much margin you can maintain. So you can set the margin to one, but if the valve's not fast enough, you're going to be getting surges.

And so, you get recalibrations or adaptive or some increment or self-correction of the curve, or intelligence of trying to adjust the curve, where if something happened the controller didn't like. So you try to set it to one, but the controller's going to come back and say, nope, that's got to be changed.

Tom:
Yeah, sure. But that assumes that you made a mistake that when you set the margin, though, initially. What I'm asking is just initial setting…

Tyson:
So, initial setting for me is strictly off the rate of change that I can get or hold. When I make those set point moves, and I dump the valve and bump it, put a perturbation on it and move it, how well does it hold it? Does the valve have to move back 15% to try and get it come back? How tight can I control that space? And you kind of figure that out because you're sitting there running the system back to do the surge test and you're getting some responses out of it. Problem is, is if the customer says, "We're not going to do a surge test, we want to just run off the calculated curve."

And you say, "Well, okay, I'm going to move it back and say that curve is safe." There's no surge. By then, it's dead steady, and you come back out and say, "Okay, you've not put any bounce or perturbations or upset on the system to evaluate how good it works." So, you say 10. I have no idea if that 10 is good or not. I have to see the system respond.

Tom:
I didn't say 10. You said 10 [last episode]. Just want to be clear.

Tyson:
Oh yeah, he said 10 first.

Tom:
But hold on, hold on, hold on. And I get what you're saying. I'm not being clear here. What I'm getting at is... so to be sure, process dynamics have got to figure heavily in this, and my guess is, they're not going to let you do a surge test with the machine heavily loaded.

Tyson:
Well, if it was heavily loaded though, you can't get to the surge curve, your valve closes off and you're not...

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Tom:
But that's a process condition.

Tyson:
Yeah.

Tom:
But you're still trying to validate, right, where that surge point would be.

Jim:
Yeah. The loading, I don't think, is quite as big an issue in dealing with the surge line determination, but the response of the system is key in it. The valve is a big part of that, but also all the piping, because some machines have... you come off and you branch off to the main flow valve or recycle valve, and then there's a check valve and you're good.

But others, you'll have a cooler in there, and then they'll have a knockout of some type because they have condensing going on in the cooler and they don't want to take a chance of running the liquids through the recycle valve. And all that just starts stretching out the time that it takes to drop your discharge pressure. So, you don't know till you start playing with it unless you've had the luxury of doing a dynamic simulation study ahead of time.

Tyson:
Yeah, I agree. It's response on the system. I'll tell you something else, that process... You can test that system, bounce it around and say, "Okay, it's good," right? But you're not seeing what the system [process] is going to do to the compressor when it's running. And you talk about all the volumes and all that stuff, but when we talk mole weight... mole weight came up a little while ago [the last podcast]. Do you have a compressor that's going to see a rapid mole weight change, where a stream or a feed is switched from one feed to another feed?

Tom:
Right.

Tyson:
And that compressor is operating with a high pressure ratio, and it's fed a lighter mole weight. It's not going to catch that, right? It's just hit with a mole weight that's lighter, and it can't sustain the same pressure ratio. You're going to have a surge event. And the recycle valve has to have enough time to get that pressure ratio down to [for] that new mole weight, and you wouldn't see that during a surge test because you're testing it for the response of the system that you're in. That would be a process response that you couldn't have tested for.

Tom:
Right. So how do you...

Tyson:
So you would have to have that interface with the process and somebody'd tell you, "Hey, we've got these things coming and going." Like an FCCU or something, depending on how they change their feeds or what mole weight they get. Some boosters that go from one feed to another feed, they get put in those situations, and that means you need to run with a big margin to anticipate those.

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Tom:
So you can't calculate it, though. I guess you've got to find it empirically?

Tyson:
You've got to find it empirically, and I think you need to-

Jim:
Well, unless you had the luxury of doing a dynamic simulation study, right?

Tom:
A pretty complex study, yeah.

Tyson:
Now, with all the information of what they're going to do to it, right? I mean, that's part of it.

Jim:
Yeah. In my experience, speed is the thing that always is the biggest enemy of surge avoidance.

Tom:
Talking about the valves' speed?

Jim:
No, speed of the shaft.

Tom:
Oh, the actual speed that you're running at.

Jim:
Yeah. Anything that will change your speed is the one parameter that will get you into surge faster than anything that can ever happen in the process. You dropped a speed 5% or something like that. Sometimes, man, that'll kick you in a hurry.

Tom:
So do we integrate that as part of the control strategy?

Jim:
Well, in general, if you've got performance control mixed in, it's not going to happen accidentally. I mean, it's not going to happen because of the controls. It's something went wrong in your system. You have a sticky steam valve or you slugged it with a condensate or something. These are probably not pertinent to this discussion, because these are accidents that you can't control against.

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Tyson:
Yeah. I agree with that. If your governor valve sticks and then lets loose on you, you're going to drop some speed. And if that's what you're setting your system up for all the time, I don't know that the right fix for that is to try and have the right surge margin. It's to have a good, reliable governor valve. I don't want to think that you designed that into your system to always be so fat or so conservative that when something breaks, you've got it covered because...

Jim:
The mole weight changes are something that can be ameliorated by integrating performance and surge control. When I've seen mole weights become a problem, it was because it was a fixed speed machine with a suction throttle valve and the DCS is controlling the suction valve and you got a surge control. And suddenly, they got a bunch of hydrogen coming in and they weren't ready for it.

Tom:
Yeah. This gets into that decouple range.

Jim:
Right.

Jim:
Yeah. The process controls are the most likely thing to drive you into surge.

Tom:
Okay. So when we set the margin, then, if we had three things, three or four things, if you just had to say most important, second to most, third, what would they be?

Jim:
For the influence?

Tom:
For how you set your margin. What are you thinking about when you set your margin?

Jim:
Until we get them all out on the table, I'm going to have to think about it. The first one that comes to mind for me is the customer's need, the process need. So for instance, if they can operate with a 15% margin and keep the valve closed all the time, then I'd say, pick 15, right? Because when the valve does have to react, it will be a lot more gentle on the process.

Tyson:
I would point at, just similarly, is protect the machine. And there's things you can do to try and make that happen better with having fast recycle valves and certain things. Making sure your valve controls well and that you've got boosters and things on it to respond.

Tom:
So it's the speed of response for you?

Tyson:
Speed of response to the valve.

Tom:
Right.

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Tyson:
Which will allow you to try and run closer to the curve. Because we're talking about the time constants for the response to the system. So for me, it would be protect the machine, protect the process, and then try and accommodate the operations of the process, which I would say is a little bit different than just the process. Operators make adjustments and make moves, and they want things to happen, which we accommodate through valves ramping open and closed and performance control, but the process swinging or moving to other controls. So I would say the valve, protect the machine, the process, and then...

Tom:
Remember we're talking about margin.

Tyson:
Yeah.

Tom:
Just to remind you of where you got me a minute ago [last episode].

Tyson:
I'll expand on that. I'll expand on that, because I may be able to run with a pretty-tight margin or small set point that can protect the machine. But it has to do it by really being aggressive with the valve. And so, that is going to rip the process around and have some impacts. And the surge controller isn't looking at the process, it's only looking at the machine. So, if you've got all of that response coiled up into a small space, that's going to be aggressive to the process. So you open that up a little bit and you can kind of soften up the response so the process doesn't take such a hit.

And then, with operations, what they're wanting to do is how the valves move or how it closed, how can they run up against that curve? And if you've got the curve all tied up against the end and every time they run up against it, it springs back out, it takes an aggressive response from an operations moving the process around, that's undesirable. So you need that place where you protect the machine, which is normally the smallest thing. The process is stable and operations can come up and hit that curve, meaning increase and decrease their throughput through the machine without having undesirable responses.

Jim:
Twenty years ago, I would have agreed completely with what Tyson said. Today, I'm going to put the process above protecting the machine.

Tom:
Tyson's an old soul. He's a young guy, but an old soul.

Tyson:
I actually agree with that. What I'm saying is the machine is here. The process is bigger. So by getting out to that bigger one, you're getting all three. What's in there is you want the whole thing to be... I agree. By the time you protect the machine...

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Tom:
Well, if you agree, it's not what we heard.

Tyson:
Well, no. I put it in order. You got to get the machine first. Protect the machine, which is whatever number it is.

Tom:
But I think that's what Jim is saying. But I get it. So you're saying that's a smaller number.

Tyson:
That's a smaller number. And so you come to the process-

Tom:
It's not more important, it's a smaller [crosstalk 00:11:16]

Jim:
No, no, it can be. The one thing that the customer may need is for you to keep that valve closed. I've seen refrigeration machines that they were always getting about 25 or 30% opening on the valve. And it was upsetting the temperature control on the first stage. And so by going to a tighter margin...

Tyson:
Which probably need better controls on their temperature control valve, but...

Jim:
Well, no, no. No, you can't. When you get the valve-

You can't get the temperature. If you're using quench to control your suction temperature, and you have a significant amount of recycle, you can't get the temperature you want, period. So, in some cases, you take a chance of bumping the machine. But an occasional surge, as rare as it is, for that customer was better than running all the time with a lot of recycle.

Tom:
Yeah. It's almost axiomatic where we talk about a compressor, especially centrifugal compressor. I think you've said it many times, right? If it can't take a surge, what the hell good is it?

Jim:
Yeah. I was actually quoting Roger Jones of Shell. He made that comment in a turbo machinery symposium, a discussion group, one time. I can't use his words in a podcast, but to that effect that if your machine can't tolerate an occasional surge, it's a piece of crap machine. So...

Tom:
So I don't think you guys are in disagreement. We're all saying the same thing. It's just how you-

Tyson:
How I work up to it, right?

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Tom:
Yeah.

Jim:
And most of the time, what you said is going to be right.

Tyson:
Well, you're talking about this distance. Let's talk about what affects those numbers that we're talking about too, and it's the valve. It's a big portion of what that margin can be. So, a lot of these big recycle valves are pneumatic. They've got a string of volume boosters on there. They've got maybe a manifold for opening and a manifold for closing, with three or four big volume boosters in an accumulator tank there to supply enough air to do it. So if you slowly move that valve, it's just moving on the positioner, and the amount of flow or air that's going into the actuator is quite small. So you actually have to get a big enough delta for the volume boosters to start kicking it.

But by the time you've put all that volume into a pneumatic system that's compressible, that valve is going to overshoot. Move more than you needed it to. But because you needed it to move fast, that's what you have to do. You almost have to kick the valve. Once you kicked it and it's moved, it's moving. So you got to live with it. And so, that's what I'm talking about, is you can get in there where you can protect the machine if the valve is fast

But every time you move it in there, you got to rapidly kick this valve to get it to move. And your operating point comes back out and overshoots. So, the customer doesn't like that because every time it kicks out, he's getting a process upset. So you soften out, string that response out over a little bit by increasing the set point of the safety margin. And you say, okay, hey, it's a little bit more time sensitive to get it. It can catch it.

And then operators, they'll decrease, they'll put the speed controller and manual and move it around. So, that may impact that a little bit too. Somebody is putting a speed controller in and moving it around and making moves. You may need to soften that up a little bit more. But to me, if the recycle valve is on a hydraulic actuator on a vent valve on an air machine, man, if that thing is fast and snappy, no overshoot and moves, you run that set point down to like 4%. It's good for everybody. It protects the machine. The process is solid and an operator can't upset it. And then that all plays into it together

So, to me, those three things have to all be accommodated. You have to be able to protect the machine. And usually if you can protect the machine, then you start looking at the process, how the process runs. And then you need to look at cases where operations may do something to a compressor that upsets it. And then how do you kind of play into that?

Tom:
Yeah. And I think Jim just said the same thing, only switched it around a little bit. That the first consideration would be the process, and then the machine, if I understood what you were saying.

Jim:
Yeah, my priority for what I'm trying to protect. But in general, most of the time it should protecting the process first. The machine will be okay. Because it's not that common in the refinery and petrochemical businesses that we run into a machine that has to run with real tight margin. If you set the control system up so that the controls have to react too aggressively, then based on all the other issues that Tyson mentioned, it's going to overreact. Now you've wrecked the process and the operators are not going to put up with that. Eventually they're going to take over control of that. And then you have no protection.

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Tom:
That’s what everyone says.

Tyson:
It’s the other guy.

Tom:
And on that note, that’s it for this episode. Drop us an email at turbomachinerycontrols@tri-sen.com. Let us know what you’ve got on your mind. Thanks for listening. And we’ll see you next time.

[END]