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Suction Throttling Valve Location for Fixed Speed Compressors

Mojtaba Habibi
Process Engineer at Wood Group

Dears,

I have seen two configurations for suction throttling valve location in comparison with recycle line for fixed speed compressors:

1. Suction Manifold => STV => Recycle Line => Compressor Suction Drum => Compressor

2. Suction Manifold => Recycle Line => STV => Compressor Suction Drum => Compressor

Could you please share your experiences that which of above mentioned configurations you have considered at your projects? also about the advantageous and disadvantageous of each configuration.

Many thanks for your time and help.

Best,
Mojtaba

Comments

7 comments

Stuart

Stuart Williamson
Dynamic Simulation Consultant at CB&I

Mojtaba
In my experience the STV location is often related to the ability or requirement to be able to restart a compressor from settleout pressure (SOP). When the machine trips and the loop settles out, the suction pressure will have risen and the discharge pressure fallen to an intermediate value based on the respective volumes in the system. This rise in suction pressure can be large depending on the configuration and volumes, and can be compounded if there are two stages which end up at a combined settleout pressure.
If there is a requirement to restart from settleout (without depressurisation) then the higher suction density will lead to much higher mass flows at the compressor suction during run-up and may result in the run-up stalling if the load torque reaches the available motor torque (also at start-up typcailly the voltage available will be lower).
If the requirement is to be able to restart from SOP then placing the STV in the recycle loop (i.e. in position (2) mentioned above) can lead to lower compressor suction pressures on run-up and hence an ability to restart from higher SOPs. However the start-up is a dynamic process and it will depend on the draw down in suction pressure and volumes around the compressor loop, as well as the compressor (and driver) inertia and how quickly it accelerates. Usually a dynamic simulation of the system will be able to predict the maximum starting pressure and whether placing the STV in the recycle loop improves the situation (and by what magnitude).
Also if the STV is placed in the recycle loop it needs to be installed with a minimum mechanical stop so that it cannot close and surge the compressor (as it is within the compressor anti-surge recycle loop).
If there is no requirement for restarting from SOP, or due to the motor size and system volumes, restart from SOP is not considered to be a problem then the STV can be placed outside the recycle loop, i.e. in location (1) above. In this location it requires no minimum mechanical stop as it is outside of the compressor anti-surge recycle loop.
If the STV is placed within the recycle loop, then it will interact more with the anti-surge controls

as any modulation of the anti-surge valve will impact the pressure drop across the STV (for a given opening) as the recycle flow changes (and hence the flow through the STV). This can be accounted for in the compressor anti-surge / capacity controls depending on how sophisticated they are.
Regards
Stuart

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Mojtaba

Mojtaba Habibi
Process Engineer at Wood Group

Dear Stuart,

Thanks a lot for your excellent explanation.

Could you please shed some light that:

1. I read at some resources that mechanical stop for control valve should be avoided as practicable as possible. So for this case can we rely on mechanical stop for STV?

2. If STV is located inside of recycle loop do we need extra pressure transmitter for anti surge controller located at STV upstream in excess the one located at STV downstream?

Best,
Mojtaba

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Stuart

Stuart Williamson
Dynamic Simulation Consultant at CB&I

Dear Mojtaba
To answer your queries
(1) If the STV is placed inside the anti-surge recycle loop you will need to have a mechanical stop for the valve. If the valve were to be allowed to inadvertantly close then the compresssor would surge which is highly undesirable. The STV would be a fail open valve and the control system can have a "soft" limit on the valve closing, but you would still want to use a mechanical stop to protect the compressor. There are sufficient examples of this configuration in existance so it must be possible to rely on the mecanical stop as protection.
(2) The anti-surge controller would need to use a pressure transmitter on the compressor suction (not upstream of the STV), however I would assume that the STV would be controlled by some upstream PIC so I would expect you would already have a PT present. I don't believe the anti-surge controller itself would need to know the pressure upstream of the STV, but there may need to be communication between the anti-surge and capacity controls to limit interactions between the two controllers / valves.
Regards
Stuart

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Mojtaba Habibi likes this

Mojtaba

Mojtaba Habibi
Process Engineer at Wood Group

Dear Stuart,

You mentioned STV inside of recycle loop would be fail open valve.This make sense from compressor surge protection perspective. But for STV outside of recycle loop as I checked some projects the valve is fail closed. Do you agree with such consideration? What if we change it to fail open valve?

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Stuart

Stuart Williamson
Dynamic Simulation Consultant at CB&I

Hi Mojtaba
On the last project I worked on the STV outside the loop was fail open, but the valve had previously been inside the loop (i.e. was moved) so possibly if outside the loop the action is less important. If fail closed it will rapidly stop the compressor feed (but the anti-surge controls should still be sufficiently fast to respond), while failing open may result in overloading the compressor (from a power perspective) depending on the normal STV pressure drop.
Regards

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Mojtaba

Mojtaba Habibi
Process Engineer at Wood Group

Dear Stuart,

You mentioned that:
"If the requirement is to be able to restart from SOP then placing the STV in the recycle loop (i.e. in position (2) mentioned above) can lead to lower compressor suction pressures on run-up and hence an ability to restart from higher SOPs."

I am thinking that at SO case the compressor train is at static condition and I suppose operating pressure at STV u/s and d/s equals to SOP. So could you please clarify how placing STV in the recycle loop can help to restart from SOP?

Many thanks for your time and help.

Best,
Mojtaba

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Stuart

Stuart Williamson
Dynamic Simulation Consultant at CB&I

Mojtaba
If the STV is inside the recycle loop then you are correct in that the u/s and d/s pressures equalize, however once the motor start occurs and the compressor shaft starts to rotate then the circulation flow around the loop will create a pressure drop across the STV, i.e. the compressor suction pressure will drop below what it would have been without the STV present. Hence including the STV inside the recycle loop will have an impact on the machine run-up to design speed, as the suction pressure to the compressor will be lower, and hence the mass flow and power of the compressor on run-up will also be lower. How effective it is depends on all sorts of factors including volumes in the loop (u/s and d/s of the STV and suction / discharge volumes), the run-up time, the motor torque speed curve, and the STV minimum stop, etc. However it will be true that with the STV in the recycle loop the torque required on run-up will be lower. How much lower needs to be determined and this is usually achieved by dynamic simulation of the start-up, which should allow the maximum starting pressure to be determined (both with and without the STV in place).
Regards
Stuart

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Mojtaba Habibi likes this

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