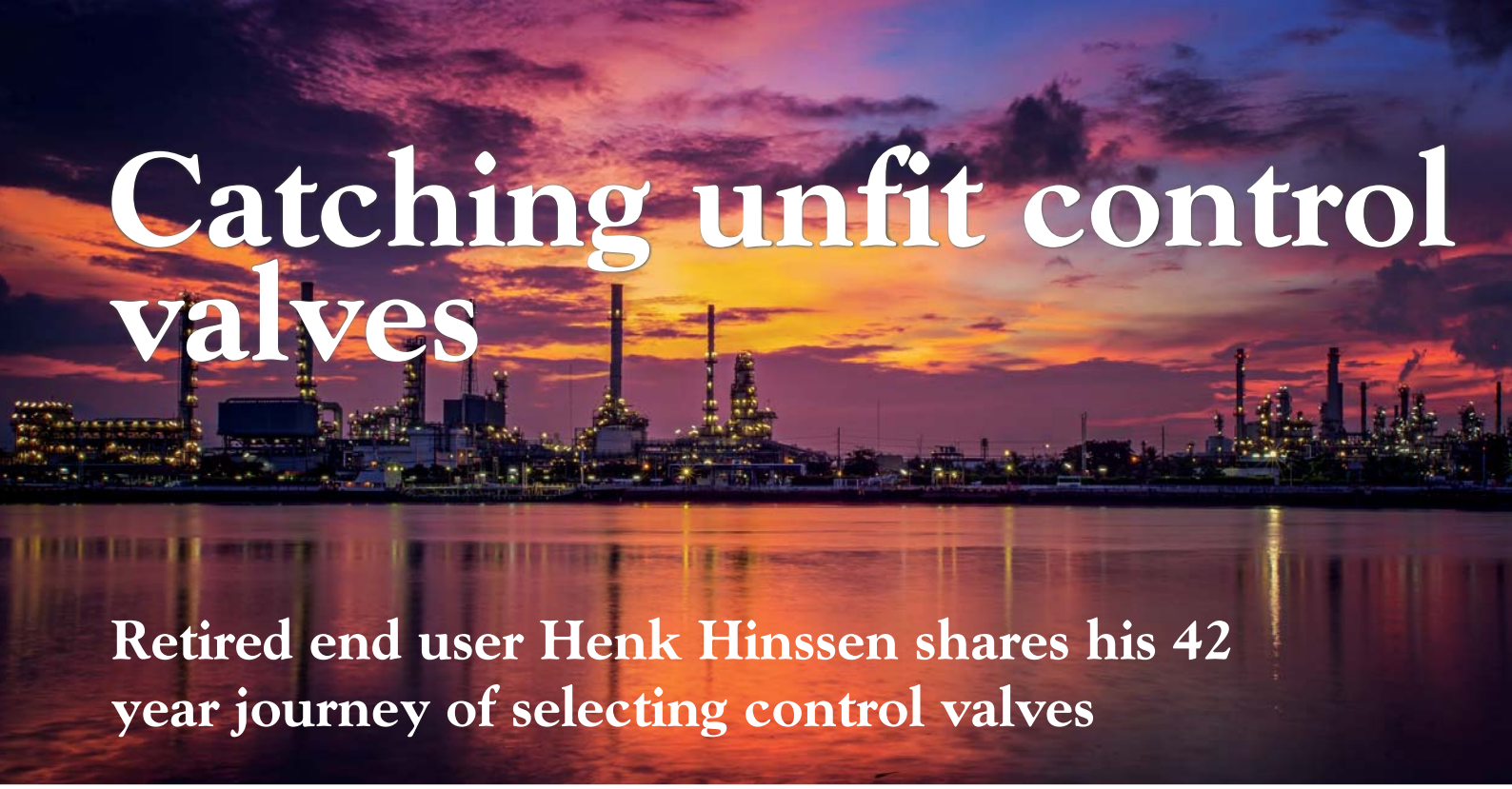


Catching unfit control valves

Retired end user Henk Hinssen shares his 42 year journey of selecting control valves

How do you catch those unfit control valves during your project before it is too late? I mean too late before it really hurts! Before it eats your energy! Before it gives you sleepless nights! During my 42 years in the petrochemical industry, working 35 years for an American oil and gas major, I was often involved in large and mega projects as the automation engineer responsible for the engineering, commissioning and startup of instrumentation and control including those control valves.

By Henk Hinssen, iHandl Engineering

How many of you have mastered the control valve sizing and selection process such that all your valves selected, except maybe a few, proved fit for the application and the plant started up without a glitch? In other words, you were never on the radar screen of the startup leader. You never got on the critical path of a startup. Never were you in a situation where people were waiting for you putting the hydrocarbons in and finally making the product…

How many times have you had to correct control valve selections during commissioning and startup? And work your butt off to get those redesigns expedited to getting the plant started up and running?

For those in this first top category, I deeply respect their skills to master the control valve sizing and selection process. I have been really jealous of them for many years!

For those in the last category, like me, I deeply feel your frustrations of, over and over again, going through endless weeks, days and nights of aggravation and stress to get you off the critical path to start up the plant! Well, then, this article talks about you and me, and I am sharing my experience in my journey to master that skill.

A roadmap to master the control valve sizing and selection process

My suggestions and personal journey to master the control valve sizing and selection process reads like solving a puzzle, a complex puzzle I must say. Solving four in a row may not be a good comparison and playing chess is not either. This valve puzzle or call it riddle, is somewhere in between.

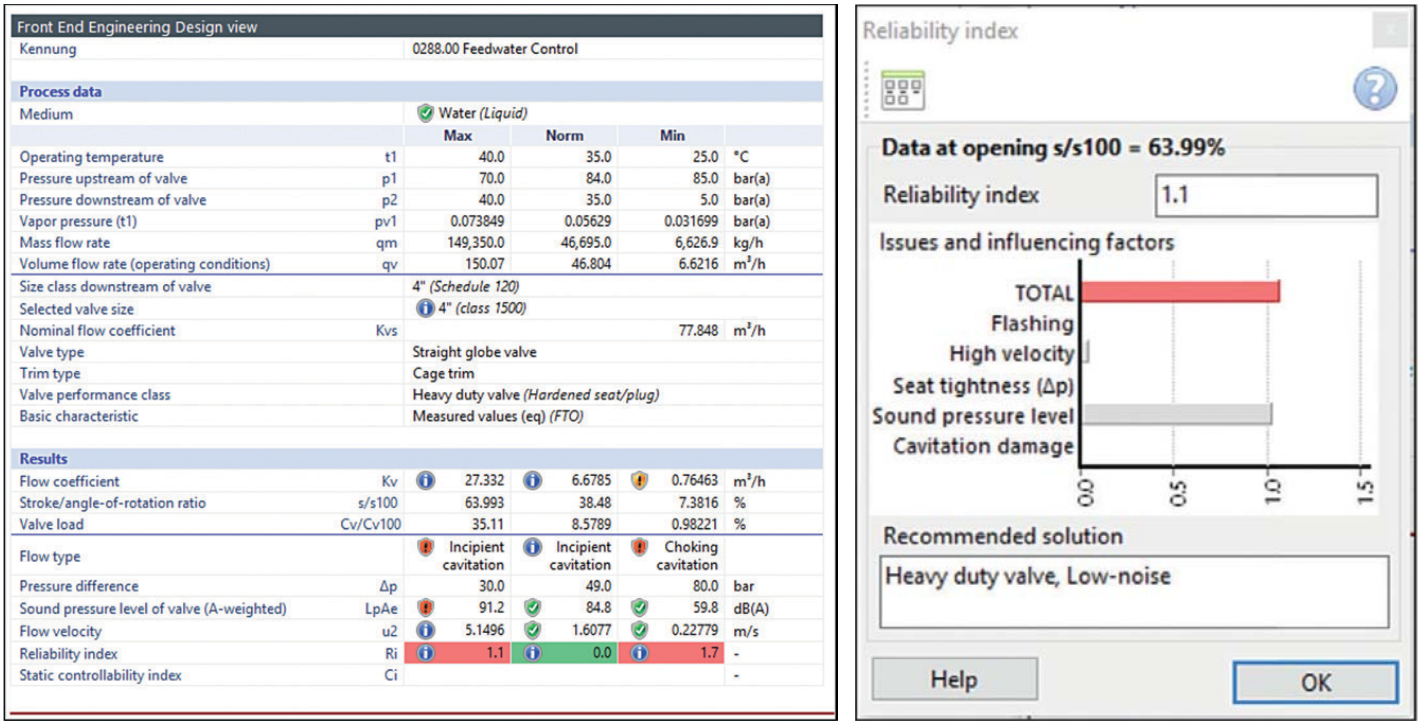
- Piece one of the riddle is understand the application. Ensure you get those requirements clear: What kind of control task (flow, pressure, etc) does the operating condition it is most of the time functioning? With this application picture the instrument engineer is able to decide where it is important to address the valve fittness and where not!
- Piece two of the riddle is to understand what makes control valves work. It has all to do with thermodynamics. The basic process parameters are Medium, Pressures Up and Down, Temperature and Flow. The process designers will generate those parameters for you. It is up to you to derive from them essential thermodynamic properties like Fluid phase and state, Molecular Weight, Density, Vapor pressure, Viscosity, and Isentropic Coefficient. Not all of them are essential for each application however, so getting that under your belt is a must. Process designers may provide those also, or the control valve vendor, but see it as you task to master the skill to get those essential parameters unambiguously and correctly derived. Often we get insufficient data; often we get too much data. It is up to you to get them clear and concise.
- Piece three of the riddle is to understand how phenomena like cavitation, flashing, choking, and outgassing behavior over the full working range. Getting those under your belt takes time. Grabbing those does not come overnight. You will learn to quantify such behavior using phenomena parameters. Fortunately there are good tools on the market that help you there. Unless you are a control valve wizard, do not try to grasp the mathematics behind it.

- Piece four of the riddle is creating awareness of abnormal conditions that potentially triggers reliability challenges from physical parameters like the pressure drop, the outlet velocity, the power dissipated or the noise generated by the valve / downstream pipe.
- Piece five of the riddle is predicting reliability challenges! Easy to say, but a challenge to master. Most often unreliability occurs due to combinations of flow phenomena with extreme physical parameters. Reflecting back on my journey, mastering that part of the puzzle is the most challenging and probably the critical success factor to make you become part of the top category of End-users that manages the sizing and selection process as it should. If you completed the puzzle I am sure you will be able to size and select a valve for your application.

My personal journey to master the control valve sizing and selection process

Let me share my journey of how I finally cracked this challenging sizing and selection puzzle.

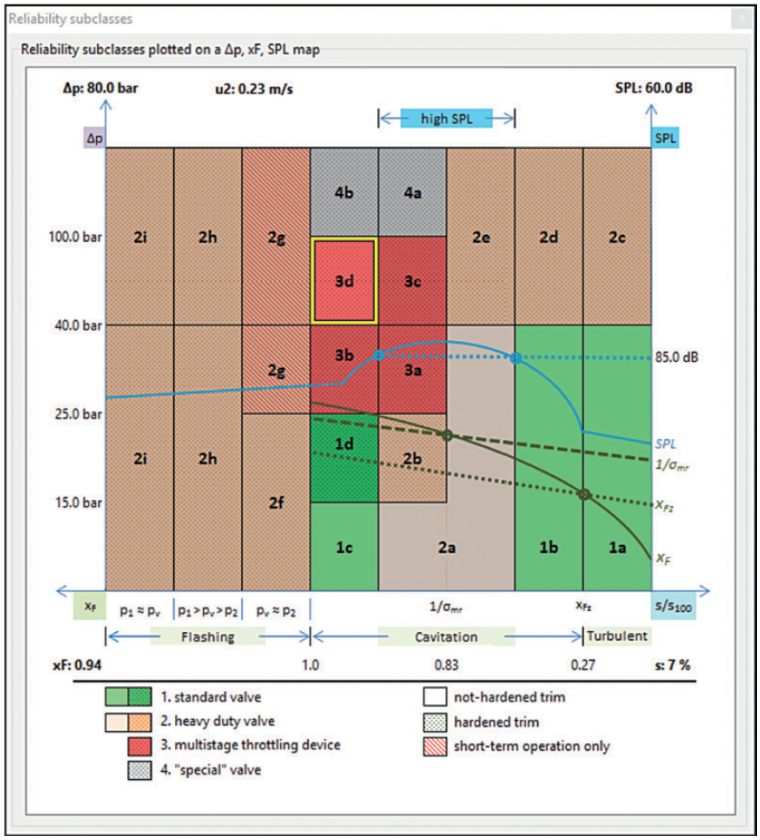
- Piece one was pretty obvious for me. I started as an instrument engineer with a project constructing a High Pressure Polyethylene Plant and mastered, I thought, the importance of getting minimum three working points. I noticed however so many valves were specified with only one working point. I learned later that with even two working points you can already drastically improve your reliability prediction versus having one working point. Very late however, I dove deep into the Heat and Material balances (HMB) of the process designer to better understand the challenge for them to create those max, norm, min and abnormal process conditions from those HMB's. And very recently I came across a project with valve selections with more than 10 working points even…
- For piece two I was lucky and gifted with a passion for thermodynamics. For me thermodynamics was one of the most difficult courses to get under my belt during my engineering study. Now I have realized why it was that difficult: the teaching, the handbooks and my notes were poor. Luckily for those engineers who are studying thermodynamics today, the tools around today are great to teach you thermodynamics! I bumped into a powerful tool approximately 15 years in my career, and it changed my ability to understand thermodynamics in general and for control valves in specific. Knowing which properties are essential for each application is something very important to master. You must focus on the essential ones only! Therefore you must ignore or weed out those of no use for each specific application. Mastering that I believe is also a critical success factor. It took me most of my career to feel comfortable. The better the tool to handle this, the more successful you will be, so make sure you get the right tool.
- Together with my colleagues we created a High Performance control valve category, estimated less than 10% population to distinguish them from the other 90% control valves, to create better focus to address reliability.
- To master part three and four of the riddle I had to convince my organization, after being with the company for almost 30 years, to globally roll out a vendor independent commercial sizing and selection tool and replace the widespread use of vendor sizing tools and sometimes home grown tools. This commercial software tool truly focuses on visualizing flow phenomena and calculating the effects of abnormal conditions. Half or more of my constituents perceived the tool as too complex in comparison to what they were used to and resisted to use it. The other half embraced it and took full advantage of its power.
- After retirement I spent over four years influencing the tool developer to create a user interface using Key

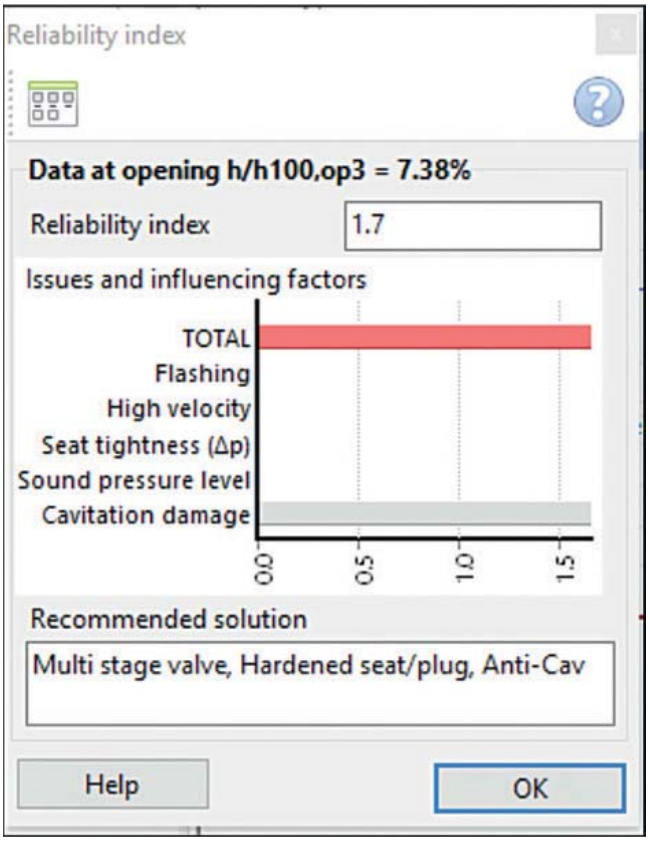


Front End Engineering Design view

Kennung		0288.00 Feedwater Control			
Process data					
Medium		Water *(Liquid)*			
		Max	Norm	Min	
Operating temperature	t1	40.0	35.0	25.0	°C
Pressure upstream of valve	p1	70.0	84.0	85.0	bar(a)
Pressure downstream of valve	p2	40.0	35.0	5.0	bar(a)
Vapor pressure (t1)	pv1	0.073849	0.05629	0.031699	bar(a)
Mass flow rate	qm	149,350.0	46,695.0	6,626.9	kg/h
Volume flow rate (operating conditions)	qv	150.07	46.804	6.6216	m³/h
Size class downstream of valve		4" *(Schedule 120)*			
Selected valve size		4" *(class 1500)*			
Nominal flow coefficient	Kvs			77.848	m³/h
Valve type		Straight globe valve			
Trim type		Cage trim			
Valve performance class		Heavy duty valve *(Hardened seat/plug)*			
Basic characteristic		Measured values (eq) *(FTO)*			
Results					
Flow coefficient	Kv	27.332	6.6785	0.76463	m³/h
Stroke/angle-of-rotation ratio	s/s100	63.993	38.48	7.3816	%
Valve load	Cv/Cv100	35.11	8.5789	0.98221	%
Flow type		Incipient cavitation	Incipient cavitation	Choking cavitation	
Pressure difference	Δp	30.0	49.0	80.0	bar
Sound pressure level of valve (A-weighted)	LpAe	91.2	84.8	59.8	dB(A)
Flow velocity	u2	5.1496	1.6077	0.22779	m/s
Reliability index	Ri	1.1	0.0	1.7	-
Static controllability index	Ci				-

FEED view Ri traffic lights, issues and recommended solution (Input Andreas Vogt – F.I.R.S.T GmbH)



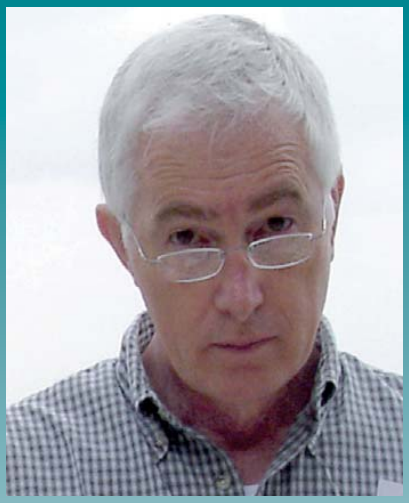


Ri issues, recommended solution and subclasses (Input Andreas Vogt – F.I.R.S.T GmbH)

Performance Indicators like a Reliability Index, a Reliability Curve over the full working range and Traffic Lights (Green meaning reliability OK, Yellow meaning revisit your design and Red meaning go back to the drawing board) to convince the other half of my prior constituents. The whole organization embraced it immediately and it became part of their daily life.

- As a side effect we enabled the process designers to address control valve reliability even during the FEED stage thereby identifying the High Performance Control Valves and securing the appropriate budget for those valves.
- After this journey we finally mastered our sizing and selection tool process and rolled it out to the instrumentation and process design communities.
- To go the extra mile, I convinced the tool developer to create an automatic batch routine to identify those valves unit for the application. I was thinking of a tool for use during the FEED or Detailed Engineering phases to automatically identify out of a batch of control valves those that are unfit for the application so they can be redesigned prior to purchase! Easy to ask, more challenging to get! It took another four years to materialize. It became a service offered to projects generating substantial capital efficiencies with an even higher than 100/1 benefit/cost ratio, not by lower the engineering man-hours but by reducing the capital expenditures needed to correct the design flaws during commissioning and startup. This method has now been proved successful on a major current project in Europe. The results are fascinating and convinced my prior company to consider this for each future major project. For those interested please contact me via email or see me at the tool developer's Valve World Americas booth # 932 where they will demonstrate the service.
- As a project spinoff End-Users are now approaching the tool developer to expand the service not only for projects but also for operational purposes. Time will tell if this approach will yield a service that can be applied for turnaround planning (which valves to take out for overhaul), for scanning (I am tempted to call it a DNA scan, to identify their High Performance Valves, to match the Bad Actor listing, etc.) or other potential operate and maintain applications.

About the author



Henk Hinssen, instrumentation engineering associate, has been working for the process industry over 40 years, of which 20 years for a major petrochemical company with HQ in Texas. He has been involved with Valve World since 2005 and has been moderating Valve World workshops since then in Europe, Asia and Americas. He has moderated workshops at Valve World Americas Conference such as "Fit For Purpose Valves" and one on "Effective Valve Engineering Tools".