Lifetime impact by installing a dP controller in the DH substation

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What effects lifetime of motor/valve

Focus on motor and valve lifetime depending on differential pressure across valve !

The wear of the components is assumed to be proportional to the work (Energy) done by the actuator:

E = Travel x Force

The basic principle is A)

To compare actuator travel length, (the force is assumed constant)

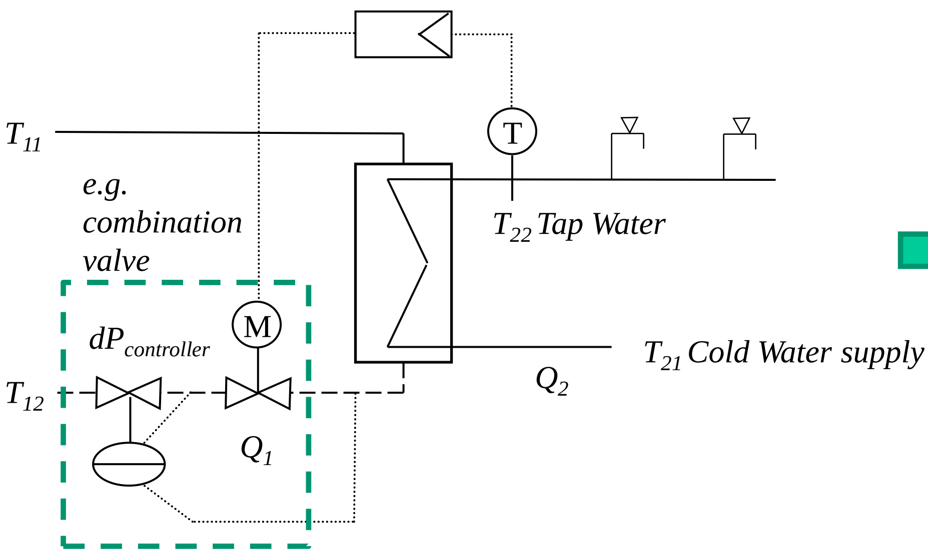
and B)

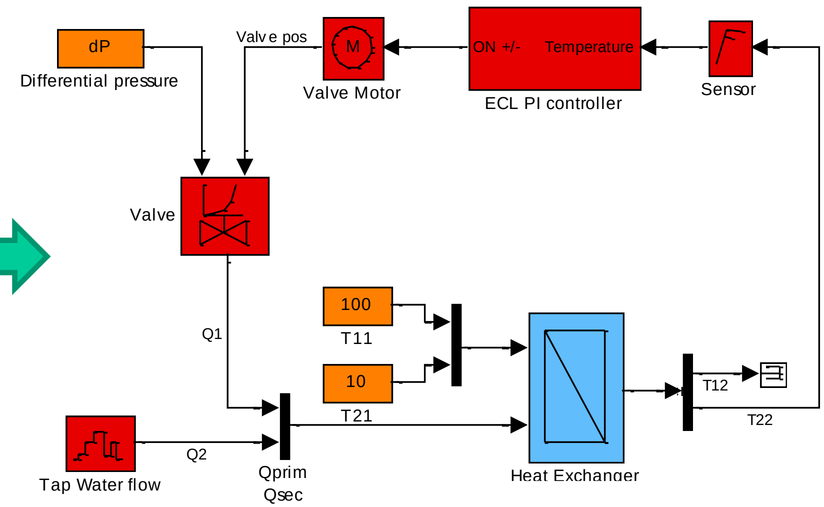
To compare the number of actuations (starts)

And C)

To compare the operation range (for HE)

The dynamic model, general





Dynamics depend on loop gain in the control loop, especially the impact from oscillations

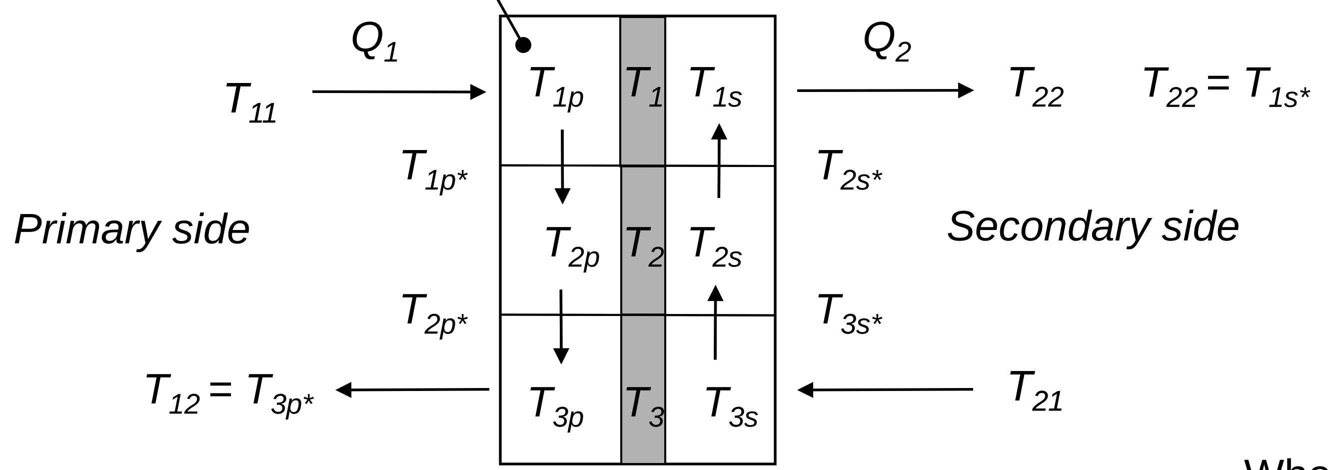
The actuator has a discrete nature

T21=10°C

The dynamic model, heat exchanger

$$Mc\frac{dT_{1p*}}{dt} = \dot{m}c(T_{11} - T_{1p*}) - hA(T_{1p} - T_1)$$

$$Nu = \frac{hd_{hyd}}{\lambda_w} = C\,\mathrm{Re}^{0.78}\,\mathrm{Pr}^{0.4}$$



Where e.g $T_{1p} = ½(T_{11}+T_{1p*})$

Only horizontal heat transfer implemented in the model

Simulation Boundary conditions

DHW:

dP from 1 to 6 Bar
Primary supply temp. from 65°C to 105°C
Split valve characteristic
Low dynamic setting &
High dynamic setting >
(loop gain multiplied by 1,5 !)

HE:

dP from 3 to 6 Bar
Primary supply temp. from 65°C to 105°C
(Valve dimensioned for dP=1bar)

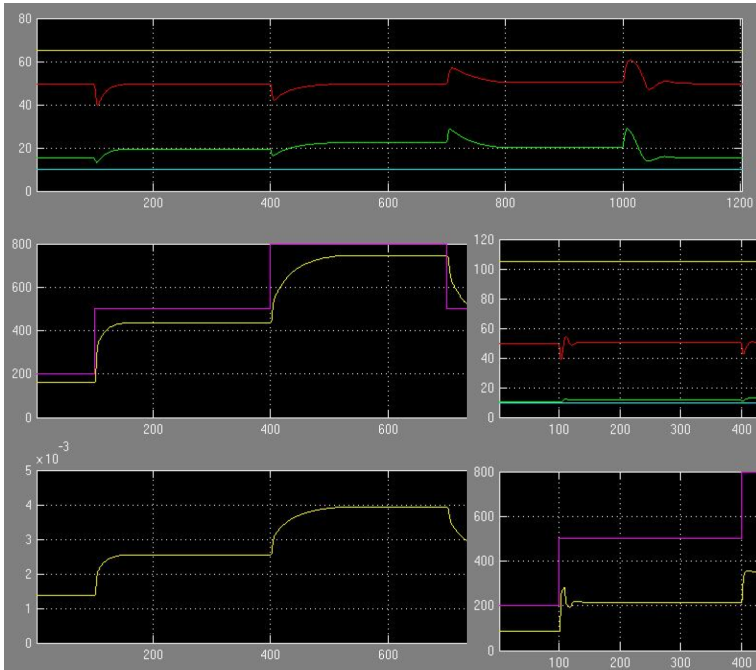
T11/dP	*65°C*	*75°C*	*85°C*	*95°C*	*105°C*
dP=1 Bar	1/8	1/8			
dP= 2 Bar	1/8	1/8			
dP = 3 Bar		1/8			
dP = 4 Bar			1/8		
dP = 5 Bar				1/8	
dP = 6 Bar					1/8

Duration of supply conditions DHW

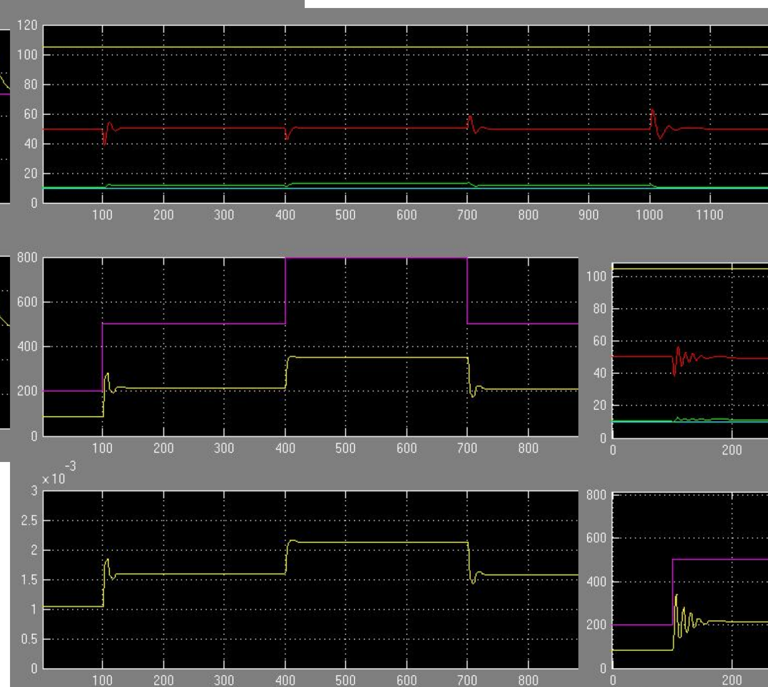
T11/dP	*65°C*	*75°C*	*85°C*	*95°C*	*105°C*
dP=1 Bar	**Not during heating season**				
dP= 2 Bar					
dP = 3 Bar		1/4			
dP = 4 Bar			1/4		
dP = 5 Bar				1/4	
dP = 6 Bar					1/4

Duration of supply conditions HE

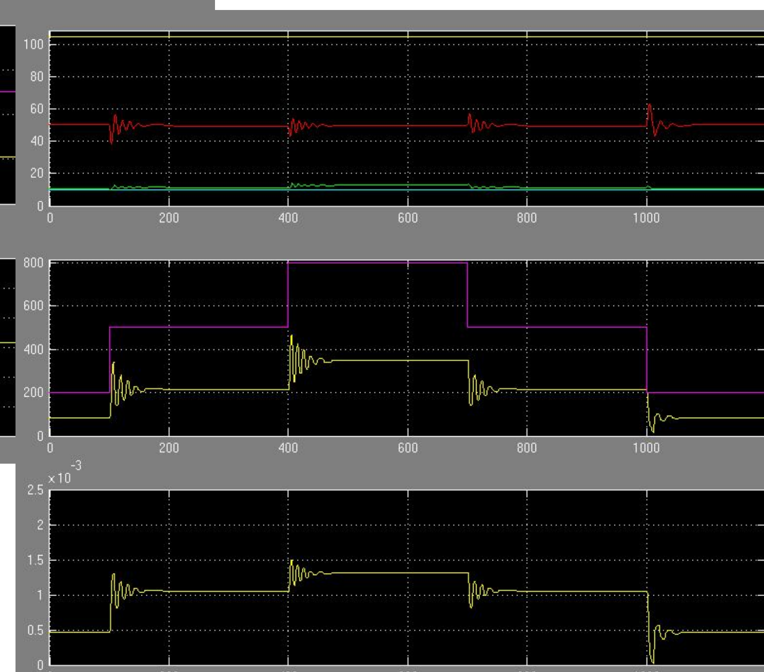
Dynamic Results DHW, low dynamics



a)



b)

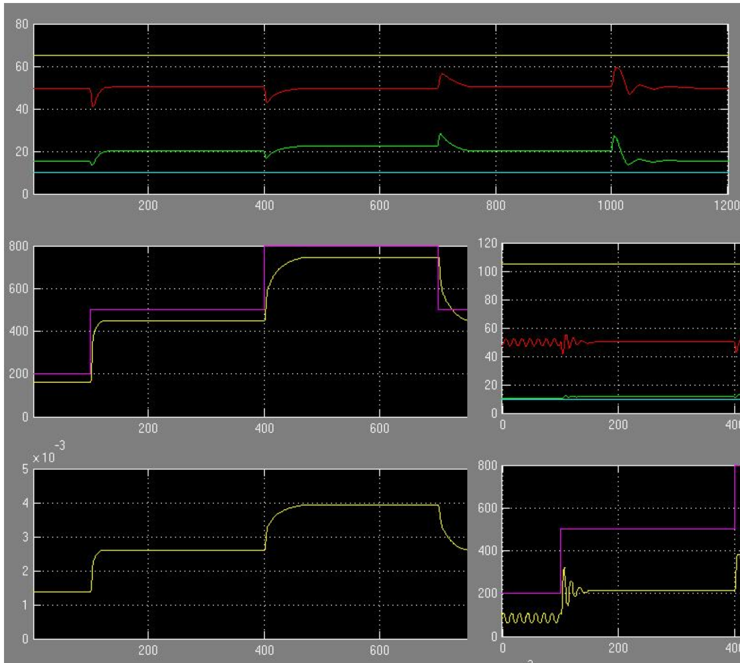


c)

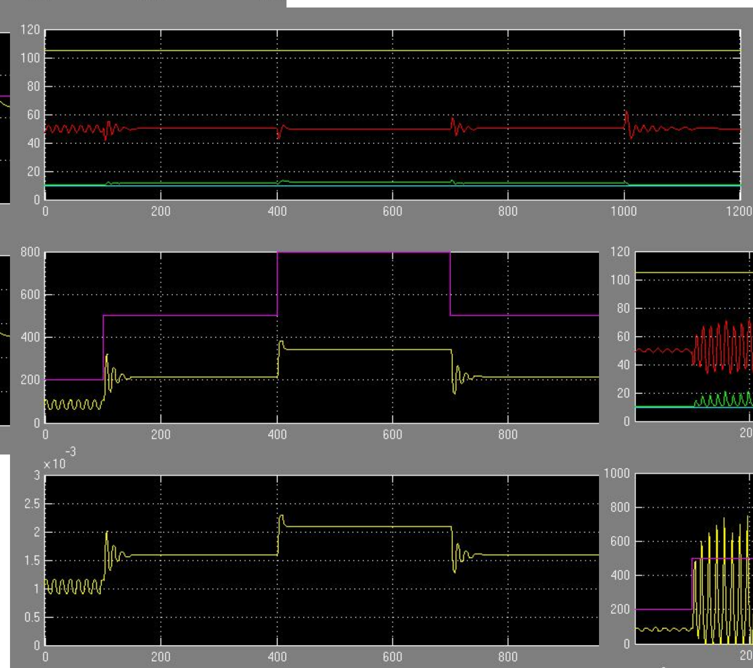
a) 65°C, dP = 1 Bar
b) 105°C, dp = 1 Bar
c) 105°C, dP = 6 Bar

Y-axis:
Temp(t)
Flow(t)
Valve position(t)

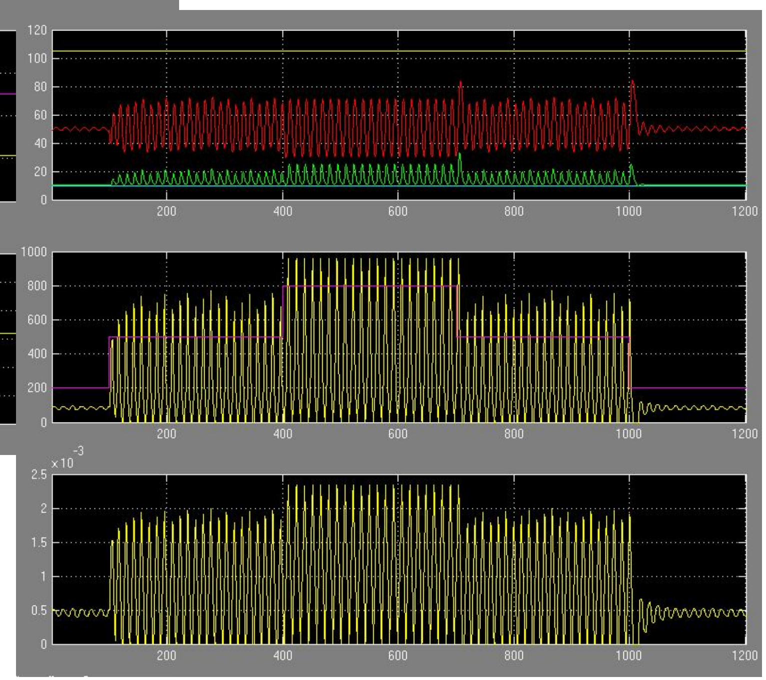
Dynamic Results DHW, high dynamics



a)



b)



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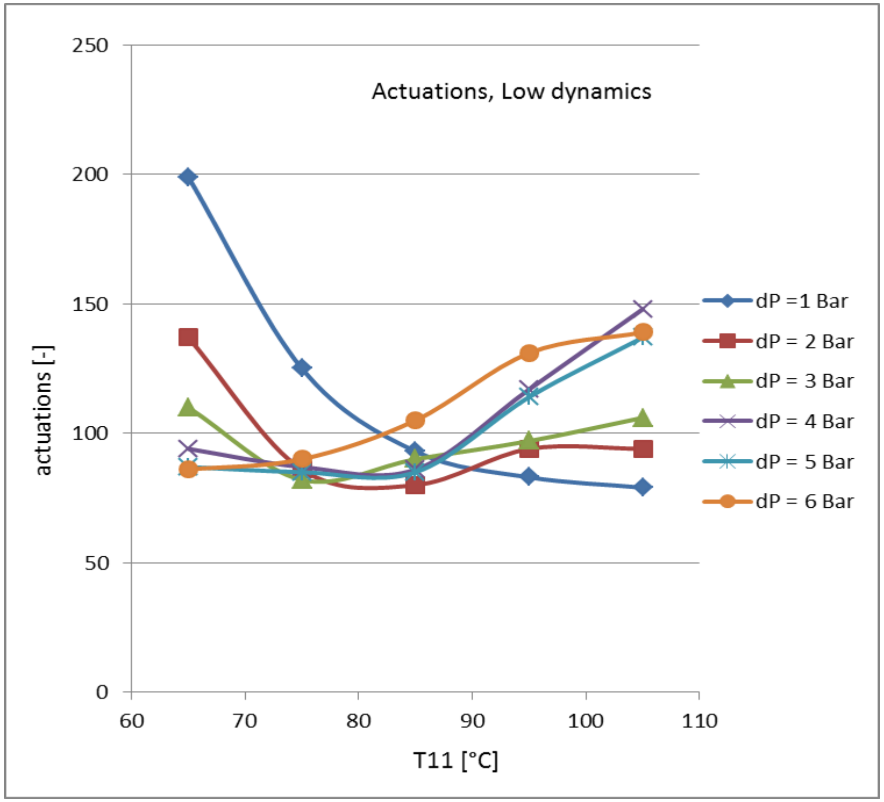
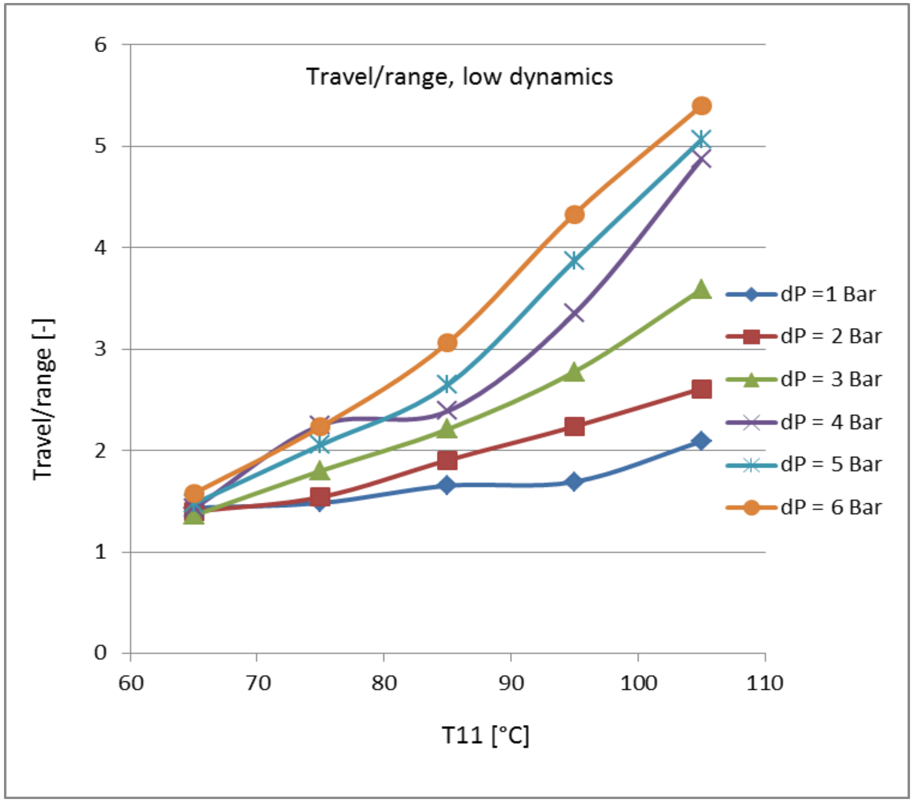
Lifetime results DHW, low dynamics

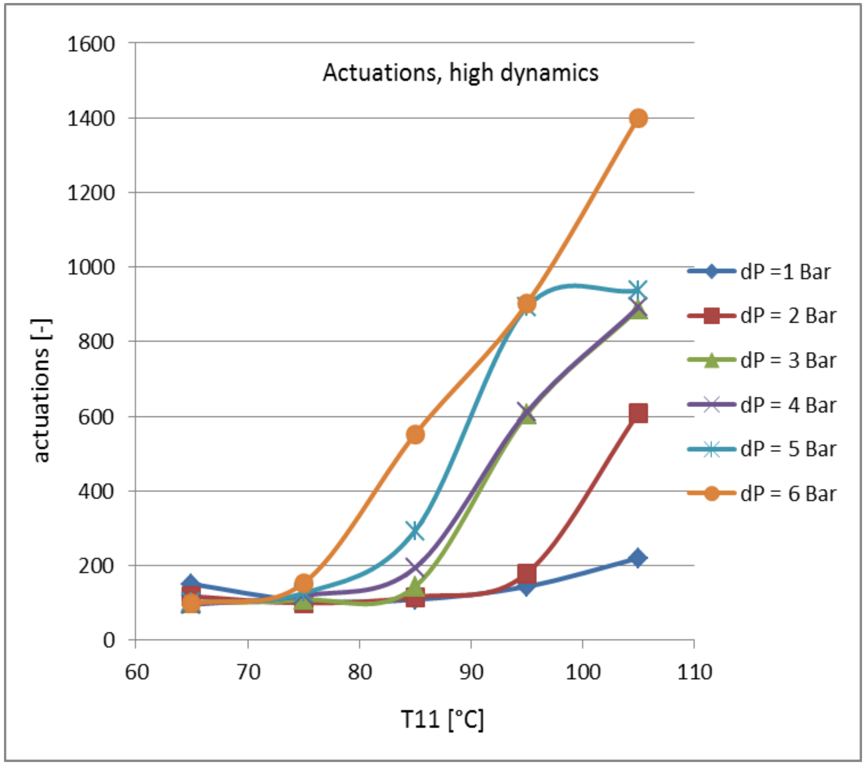


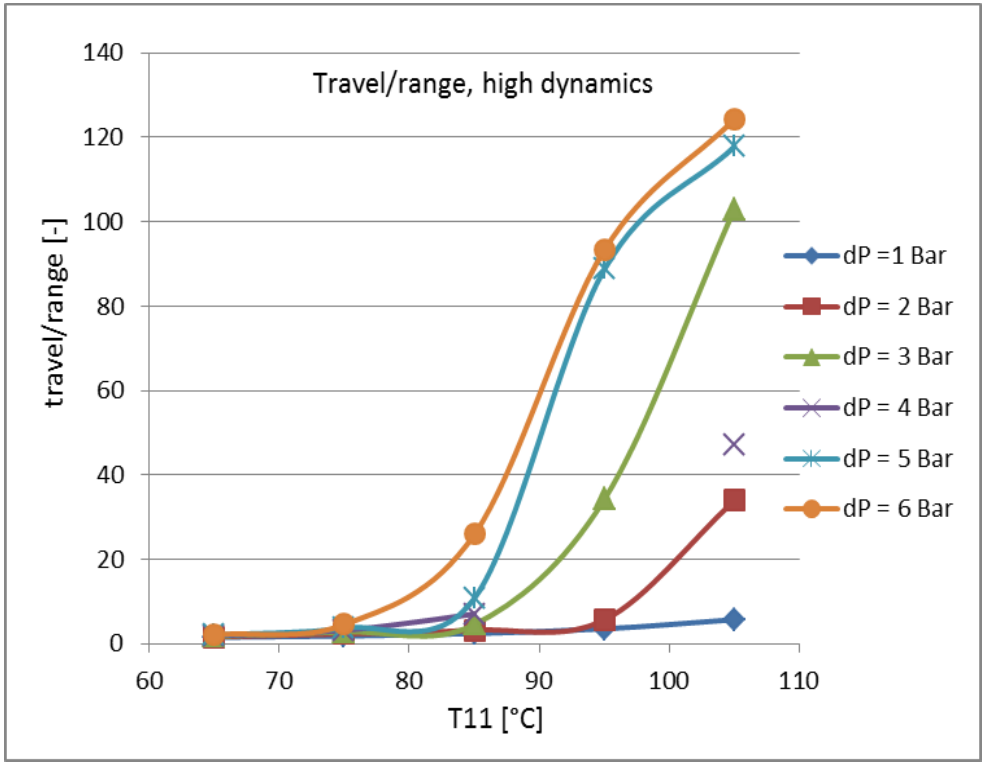


Higher T11 and dP > lower number of actuations, until dynamics gets more evident due to higher loop gain

Higher T11 and dP > higher number of travel pr. range

Lifetime results DHW, high dynamics





Higher T11 and dP > higher number of actuations, here the dynamics have impact even at lower supply conditions

Higher T11 and dP > higher number of travel pr. range, more evident for high dynamics (loop gain)

Lifetime results DHW/HE

DHW:

	SUM travel/range	life time factor
Low dynamics		
dP controller	13	1,5
no dP controller	19	
High dynamics		
dP controller	20	11,3
no dP controller	230	

	SUM Actualtions	life time factor
Low dynamics		
dP controller	1028	0,9
no dP controller	968	
High dynamics		
dP controller	1093	2,8
no dP controller	3069	

HE:

	Operation Range of valve/actuator
dP controller	100
no dP controller	48

By utilizing a higher operating range, the wear on the components are more distributed for the mechanical components, increasing lifetime

Discussion

The analysis is a starting point, and to be continued with dedicated measurements in the field.

Besides the lifetime benefits, there is a number of other benefits by applying a dP controller related to other aspects:

- Hydraulic balance towards the DH network, also in case of wrong re-adjustment
- Commissioning of station is easier, due to less loop gain range
- Valve sizing
- Noise in sub station
- Lifetime of heat exchanger related to thermal oscillations

Conclusion

The lifetime of the valve/actuator is increased by installing a dP controller

A ”low” dynamic and a ”high” dynamic boundary case is simulated

DHW:

By applying a dP controller, the valve / motor life time is estimated to be a factor 1,5 longer, based on the ”low” dynamic case. (High dynamics a much higher factor)

HE:

By applying a dP controller, the valve is utilizing the full stroke, compared to approx. half of the stroke if no dP controller is installed. Also travel/range is lower.

Main benefits towards the valve / actuator for DHW, but also the HE circuit valve/actuator has benefits regarding lifetime

Thank You for the Attention

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