1. Introduction

The pressure in a 6 barg steam network is controlled by letdown from the 60 barg steam network through either a turbine or through a direct let-down. The letdown from the 60 barg to the 6 barg is split up in a large and a small valve: 1310DP-PV (small valve) and 1310DG-PV (large valve). Normally the valve should be completely closed as long as there is some spare capacity on the letdown via the turbine. Due to wearing of the large valve there is some slip through, even when the letdown is completely closed.

The temperature of the superheated letdown steam is controlled by injecting water. The temperature is controlled by controller 13121-TC. The output of temperature controller 13121-TC is also split to a large and a small valve. The image below shows the control scheme as displayed on the DCS. The small valve takes directly the output of the temperature controller. The large valve uses the output from 13121-TC after correction of the valve position of the large let down valve 1310DG-PV. Flowrate is measured by instrument 13175-FC.

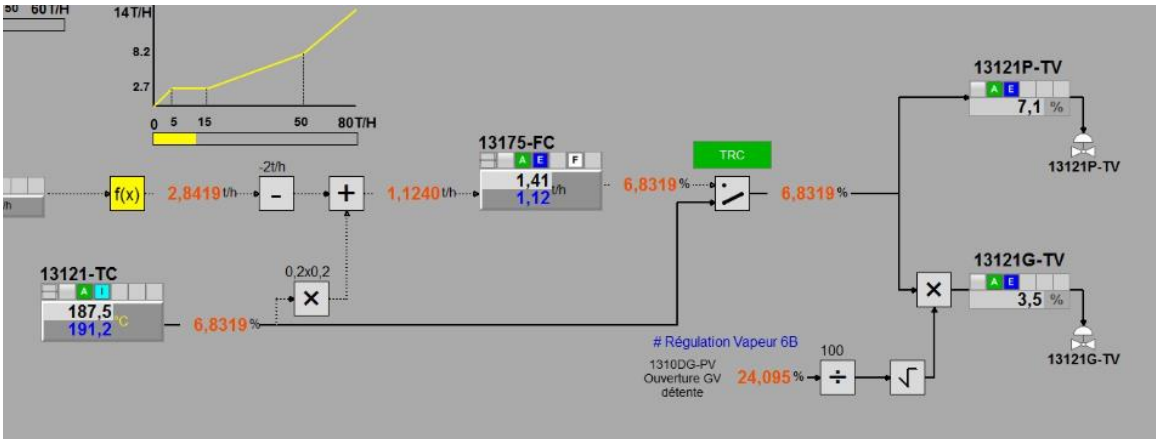


Figure 1 - DCS control scheme temperature control 13121-TC

The below graph shows the initial performance. Oscillation frequency was in the order of 10 minutes with an amplitude of +/- 12 degC around the setpoint. It could be noticed that flowmeter 13175F shows a block wave pattern, which is typical for a sticky valve. Each time the output to the large valve 13121G-TV reaches around 3.3% the flowrate suddenly increases and becomes measureable. At the moment that the flow 13175F becomes measureable the output to the small valve 1310P-TV was about 7%. Corresponding let down at via 1310D was approximately 15 t/h. As part an MPC project pretest, the problem related to oscillation of the desuperheating temperature control 13121-TC was examined.

It also needs to be mentioned as soon as the letdown was increased sufficiently, the oscillation problems stopped and the temperature was controlled well at setpoint. For this reason a letdown of about 16 t/hr was enforced by an increased opening of valve 1310D-PV.

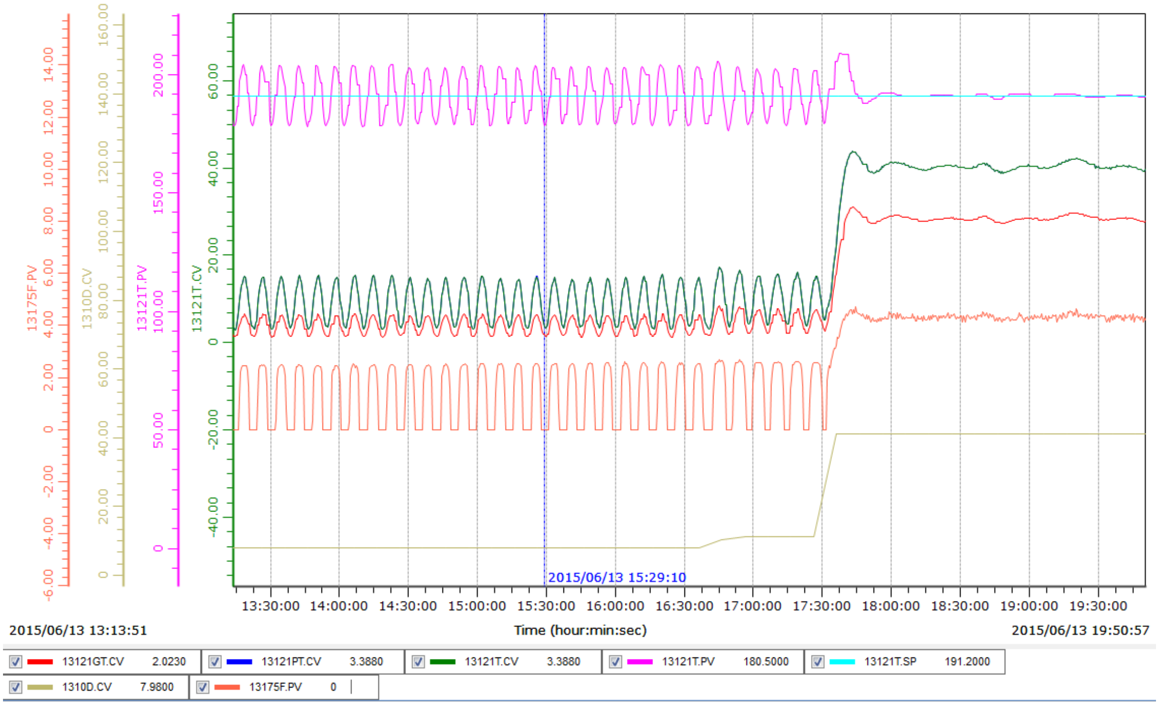


Figure 2 - Initial performance temperature controller 13121-TC

2. Description of what was done

Step tests were done first on the temperature controller 13121T directly to evaluate tuning parameters for 13121T. It was identified from the model that the dynamics of process require a higher reset time. The increase of reset time from 90 to 300 seconds did indeed improve the oscillation magnitude, but the problem still remained.

The reason is because the oscillation was mainly due to a more fundamental problem.
The stickiness of the large flow controlvalve and the limited required coolcapacity at low letdowns (< 16 t/hr) was the root cause of the problem. Each time the large control valve opened enough to overcome the stickiness, too much BFW was injected. Once the large control valve closed again, not enough BFW was added. This is directly responsible for the oscillation. At the same time the small control valve did not open typically above 10% due to the control structure. In other words, the capacity of the small control valve was not fully used at the moment the large control valve already started to open.

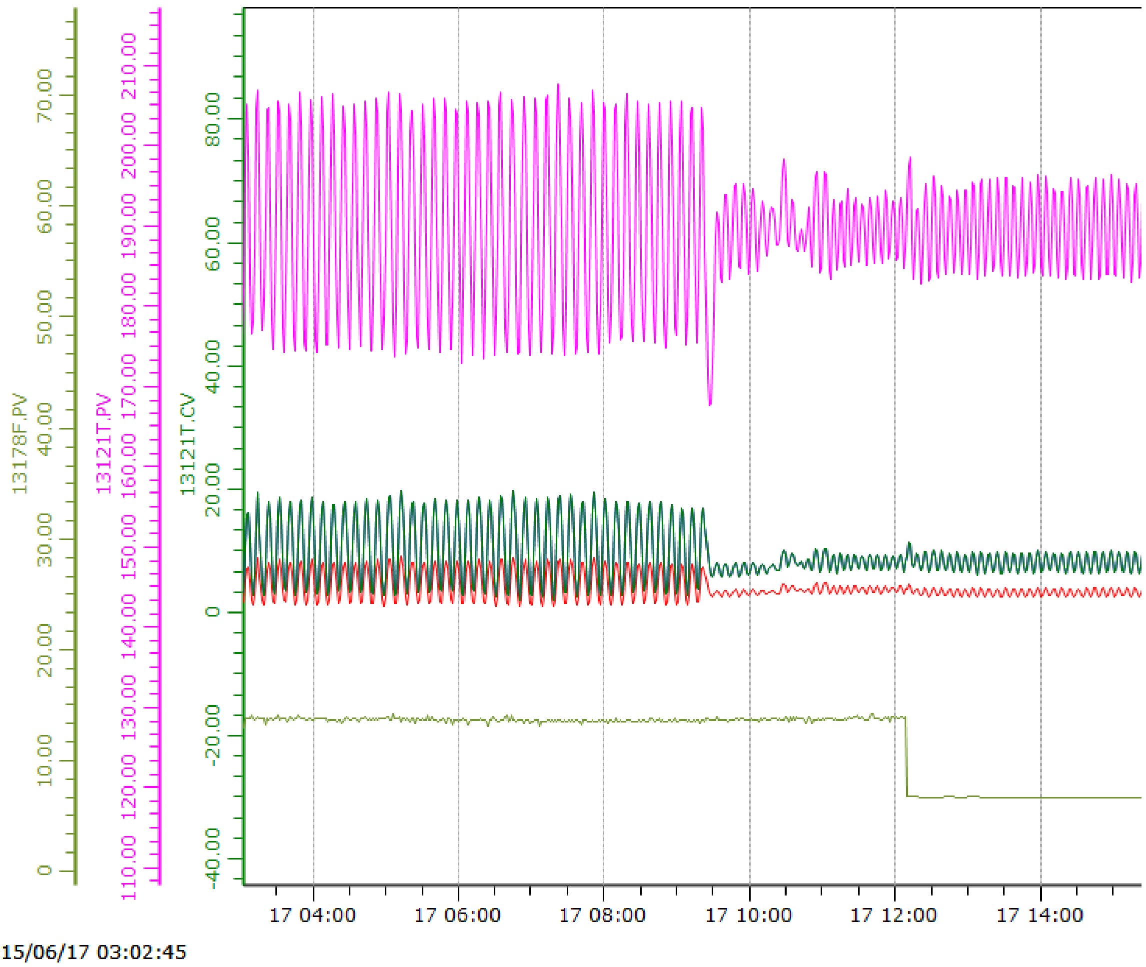


Figure 3 - Improved controller performance after changing the tuning

To this end the link with valve position of 1310DG-PV had to be cut and an optimized split range for the temperature controller 13121T had to be designed. To determine the optimal split, the relative gain of the large and the small control valve had to be tested. As the flow through the small valve is negligible compared to the flow through the large valve, steptest data of the general temperature controller 13121T.PV could be used. As shown in the graphs below, the relative gain of the large to the small valve is about a factor 10.

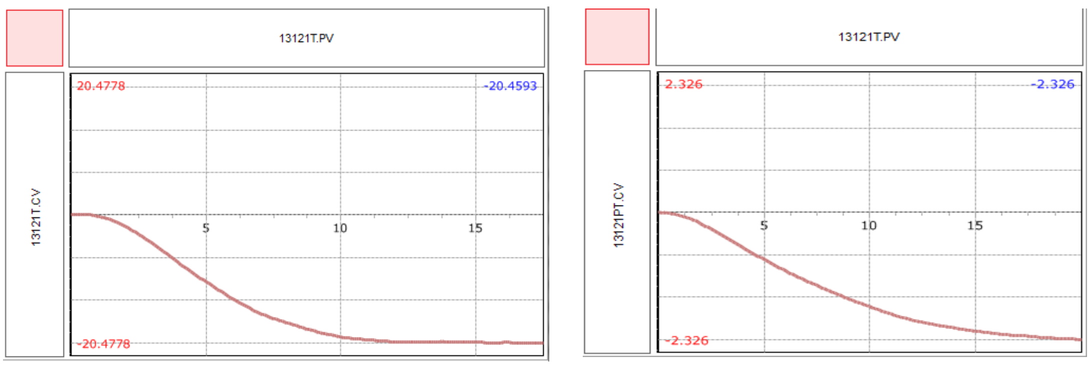
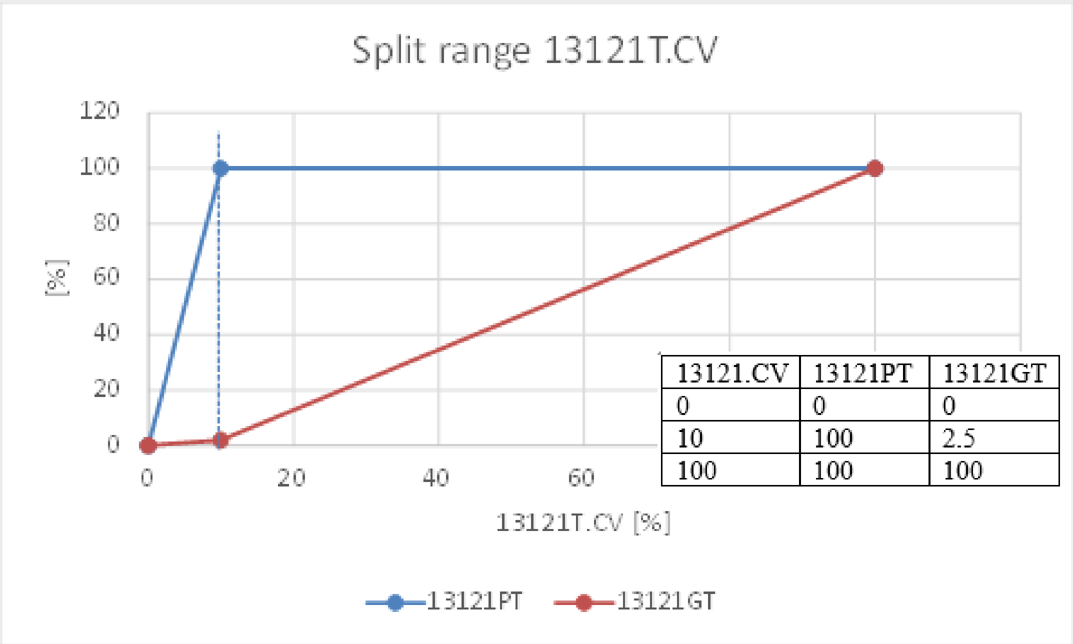


Figure 4 - Relative gain of the 13121GT (left) and 13121PT (right) to the temperature 13121T

Based on these tests the following split range could be defined for 13121T temperature controller. The first 10% of output of temperature controller 1312T will open 13121PT to 100%. At this moment the cooling capacity of 13121PT will be fully used and 13121GT will be opened to 2.5%.



13121.CV	13121PT	13121GT
0	0	0
10	100	2.5
100	100	100

Figure 5 – Transformation 13121PT and 13121GT in function of 13121T.CV

It was also found that the existing tuning is optimal for the large valve being in control. This was to be expected, given the good performance at the moment the total let down was increased (at the cost of less electricity production and lower turbine efficiency). Due to the transform, the action on the small valve is magnified with a factor 10. For this reason the gain was reduced in order to still give a good performance one the large valve enters the control range, but avoid having a too large gain when the small valve is in use.

Table 1 – Tuning parameter 13121-TC

Tuning before			**Tuning after**		
K	T1	T2	K	T1	T2
1.25	90	30	0.5	300	30

3. Results

Following graph shows the significant improvement in control stability directly after the control structure change was implemented. At a certain moment the oscillation started to reoccur due to the controller operating again in a region where the large valve started to open and close.

Figure 6 - Controller performance before and after implementation of split range control

At fully closed valveposition 1310D-PV in the current state, the letdown is about 6 t/hr. After changing the split point the controller operated as desired, the direct let down via 1310D (13178F.PV) could be reduced from 16 to 6 t/hr. This means that 10 t/hr of steam was let down through the direct letdown instead of passing via the turbine. Due to this, the efficiency and production of the turbines is reduced. Assuming an average efficiency of approximately 90 kW/t, this loss of 10 t/h steam costs approximately each hour 900 kWh. With electricity prices averaging between 40-45 Eur/MWh the annual savings due to the change corresponds to 315 – 355 kEuro per year. Even for the time before the letdown will be replaced (lead time ~ 4 months) the corresponding savings still exceed 100 kEuro.

4. Conclusion

A problem of oscillation in the desuperheating temperature control appeared due to a change in the process condition when a direct let down valve started to leak a relatively small, but significant amount of steam.

Control of desuperheating temperature was improved by making a change in the control structure and retuning the PID parameters. The changes in the control structure focused on optimizing the controllability.

Even though the letdown would be replaced in 4 months, the savings by changing the control structure still add up to about 100 kEuro.

Appendix – list of figures

Appendix – list of tables