S-LTS-1416-07-002 Rev. 0

MCL CONTROL

LoopTunerSentinel™

Resume

LoopTunerSentinel is a software for the automatic tuning of PID control loops, both for single variable and multivariable systems where the interaction between the control loops is important. **LoopTuner** allows to determine the decoupler in a multivariable system and the tuning of multiple control loops. Decoupling control. This application note shows an example of a multivariable process with interacting control loops, which required the calculation of the decoupler and multi-loop tuning with decoupling.

For this, **LoopTuner** allowed to specify the trajectory of the process and perform the tuning by optimization, obtaining the optimal parameters of the PID controllers.

Justification

The incorrect tuning of the PID control loops translates into control valves with inadequate performance and subjected to faster wear. The optimal tuning avoids having sudden changes in the control valves, prolonging their useful life and, consequently, making the processes more stable, improving the quality of the product and the energy resources of your plant.

Tuning is the procedure of adjusting controller parameters by feedback to obtain a specified closed-loop response. The values of the tuning parameters depend on the desired closed-loop response and on the dynamic characteristics of the other elements of the control loop, in particular the process. If the process is non-linear, as is often the case, the dynamics of the process will change depending on the range within the operational window. This means that a particular set of tuning parameters can produce the desired effect over an operational range, since common feedback controllers are basically linear devices. To operate in the entire normal operating window, it is necessary to find a set of robust tuning parameters, since the response will be slow at one end of the operational window and oscillatory at the other end.

Attunement Development

Below, Figure 1 shows the procedure for optimal tuning of control loops using the service offered by MCL Control.

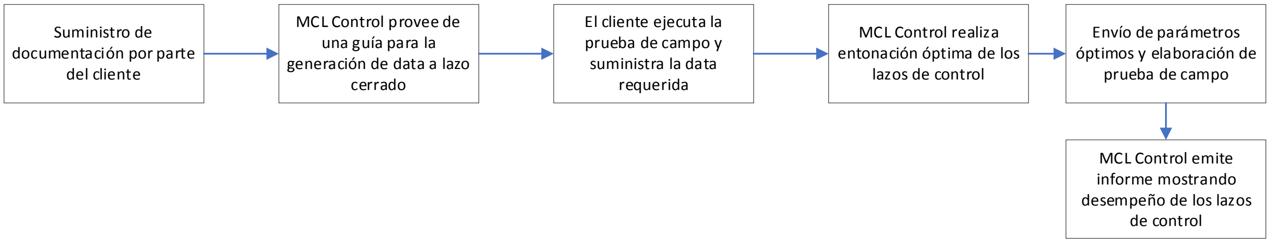

Figure 1. Intonation Process

Application

Figure 2 shows a schematic diagram of the process, which is an air blower from an FCC plant.

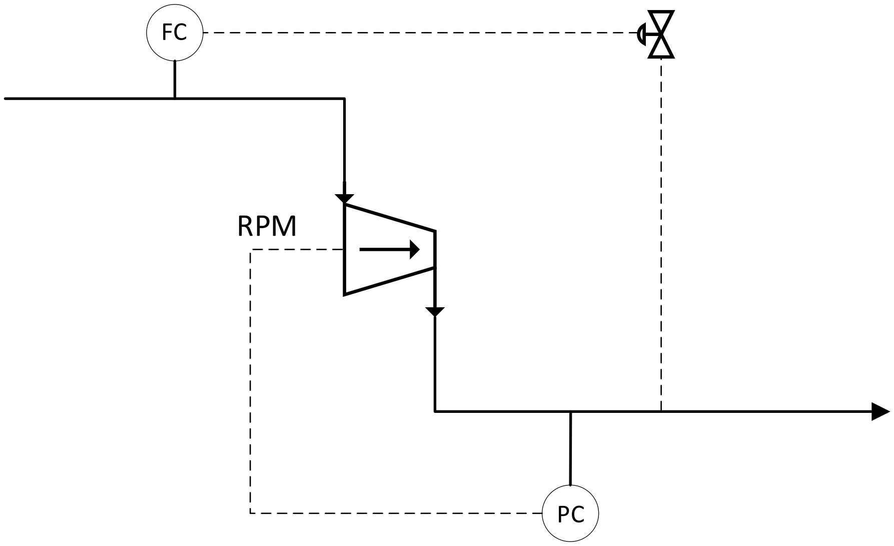

Figure 2. Antisurge Control

Air demand can drop to 0 in 8 seconds. Outlet pressure is controlled by adjusting the RPM of the compressor speed control. To prevent surge, a blow off valve is opened when the inlet flow falls below a control line.

The suction and discharge pressure flow control loops present high interaction. To reduce this interaction, a multivariate control with decoupling was applied.

Study Results

A closed-loop field test was applied, making changes to the pressure control SetPoint (capacity control) and changes to the flow SetPoint (ASC, Anti Surge Control).

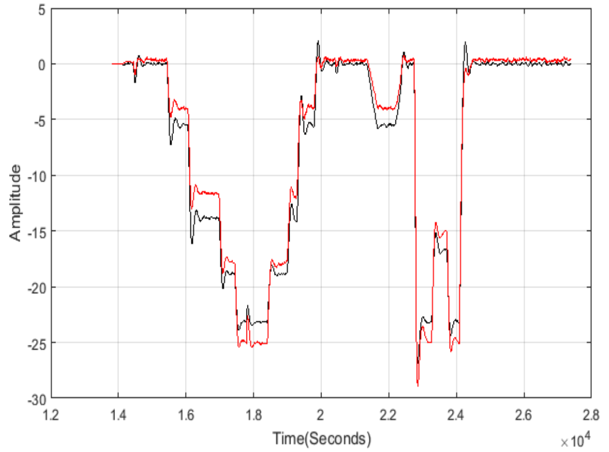

Figure 3. Closed loop (86.7% fit) Pressure

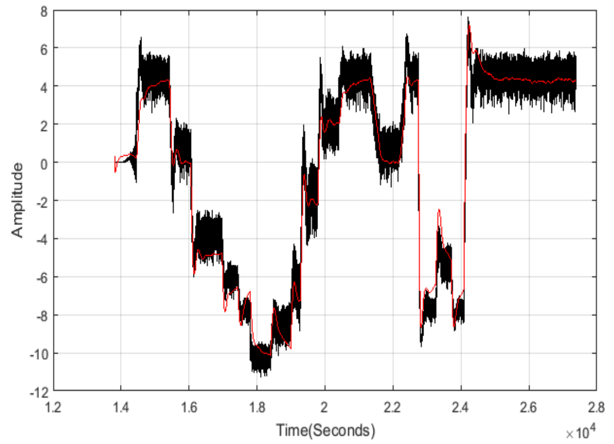

Figure 4. Closed loop (68.7% fit) ASC

Modelo del Proceso

$$\begin{bmatrix} & OP\ Presion & OP\ ASC \\ PV\ Presion & \dfrac{0.943}{1531s^2 + 117.4 \cdot S + 1} & \dfrac{-0.777}{0.285 \cdot s^2 + 26.85 \cdot S + 1} \\ PV\ ASC & \dfrac{1.14}{22.66 \cdot s^2 + 116.2 \cdot S + 1} & \dfrac{1.1}{102.6 \cdot s^2 + 220.4 \cdot S + 1} \end{bmatrix}$$

As shown in Figure 3 and Figure 4, the results obtained from the field test settings are presented, while the process models can be seen in the previous table.

Note that the decoupling matrix and the relative gain of the process were obtained in such a way that the tuning of the PID controllers is carried out taking these factors into account.

$$\begin{bmatrix} & OP\ Presion & OP\ ASC \\ Desacoplador\ Presion & 1 & 0.8242 \\ Desacoplador\ ASC & -1.028 & 1 \end{bmatrix}$$

Decoupler

$$\begin{bmatrix} & OP\ Presion & OP\ ASC \\ PV\ Presion & 0.5413 & 0.4587 \\ PV\ ASC & 0.4587 & 0.5413 \end{bmatrix}$$

Relative Gain Matrix

Next, Figure 5 shows the specification of the desired trajectory of the control loops in the event of changes in the SetPoint.

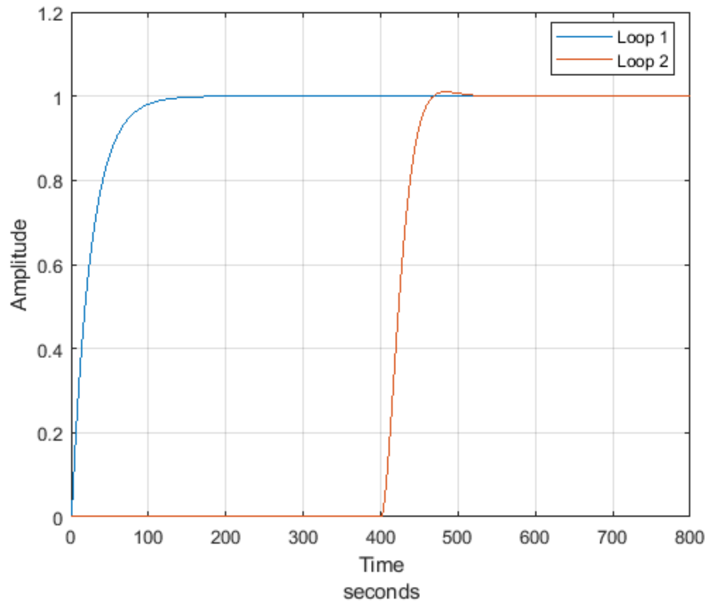

Figure 5. Desired Path Specification

Finally, Figure 6 and Figure 7 show the results of the intonation without and with decoupling of the interacting control loops.

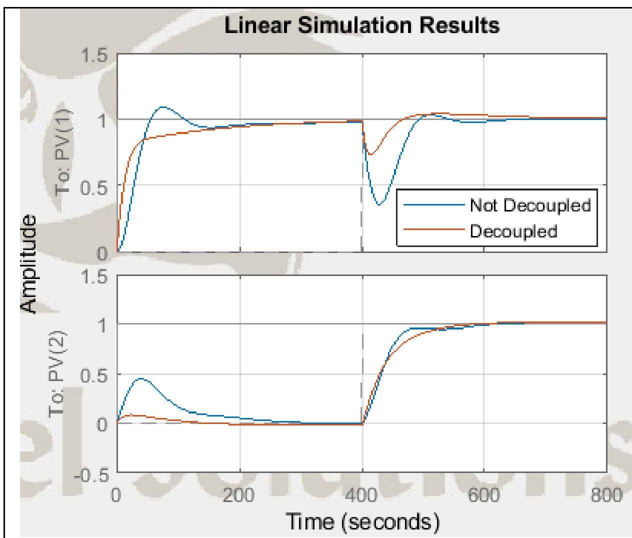

Figure 6. Attunement without decoupling

$$\begin{bmatrix} & Kc & Ti\ (s) \\ PIC & 2.22 & 158.3 \\ ASC & 1.64 & 112.3 \end{bmatrix}$$

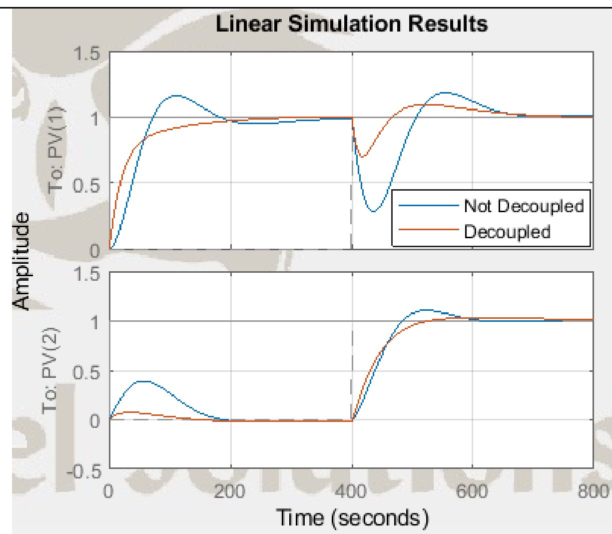

Figure 7. Attunement with decoupling

$$\begin{bmatrix} & Kc & Ti\ (s) \\ PIC & 1.31 & 80.6 \\ ASC & 1.5 & 84.3 \end{bmatrix}$$

Conclusions

- From a field test, within the operating window and through a MIMO multivariable identification process, models were achieved for a highly interacting two-loop system, with settings of 86% for the pressure loop and 70% for the loop flow control.
- For the selection of the final models, taking into account the specialized bibliography, different classes of models were tested, obtaining that the second order response is adequate for these ties.
- When tuning the loops without using decoupling, a deviation greater than 50% of the desired value was obtained according to the desired trajectory before a step change in the Set-Point, said deviation is attributable to the strong interaction of the loops. However, when using the decoupling matrix, after tuning, the deviation was reduced to less than 20%, which demonstrates the importance of using decoupling.
- The decoupler used in this work was static and to improve controller performance it is recommended to use a dynamic decoupler.

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