PID Tuning Case Study

Tuning of cascade loop (Master-Slave) in single shot

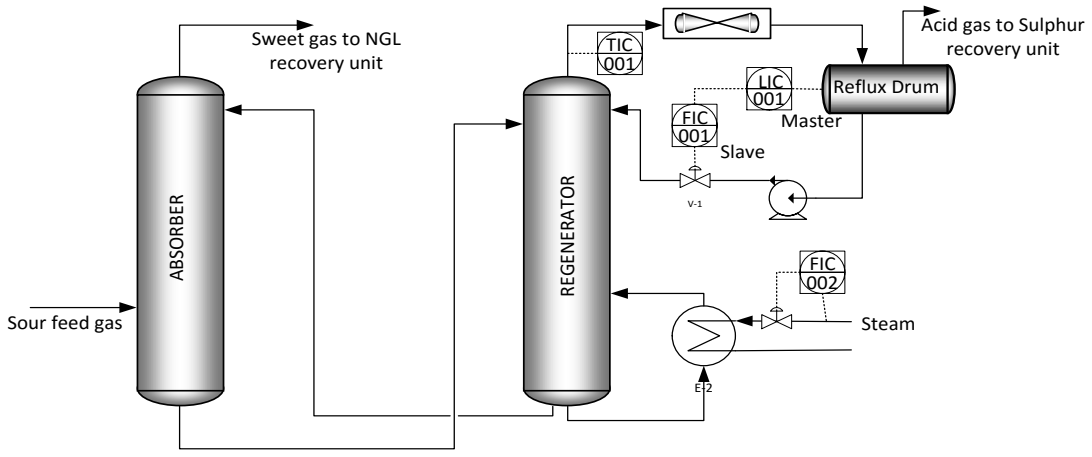
1. Introduction

A NGL recovery plant had a gas treatment unit for removal of H2S and CO2 from the sour gas feed. The sweet gas is then feed to gas de-hydration and NGL recovery unit for further processing. The removal of H2S and SO2 from sour acid gas is achieved by circulating amine solvent in absorber. The rich amine from absorber bottom is stripped in amine stripper/regenerator and lean amine is recirculating back to absorber.

Normally, Amine regenerator is a big energy consumer. It is important to control the regenerator overhead temperature optimally to reduce the energy consumption. Client had asked IPCOS to look into the PID controls of amine regenerator as they were facing the big cycles in the column reflux and overhead temperature PV. After an initial audit, it was observed that the PID tuning of reflux drum level and reflux flow were the main contributor to the unwanted cycles.

Reflux flow loop is cascaded with the reflux drum level and are arranged in master-slave configuration. Traditionally, in such type of arrangements, slave PID loop is tuned first with short rise time and then master loop is tuned. In INCA AptiTune with the introduction of new cascade functionality, both the master and slave loop can be tuned together in single shot and within very short time as it require only 2-3 steps in slave PID loop output. In this case, IPCOS used the cascade tuning feature of INCA Aptitune to calculate the optimal tuning of both the loops in single shot.

The following schematic shows an overview of the gas treatment unit. LIC001 (master loop) and FIC001 (Slave) loop tuned together by using the INCA Aptitune cascade loop tuning functionality.



DCS

Yokogawa Centum CS

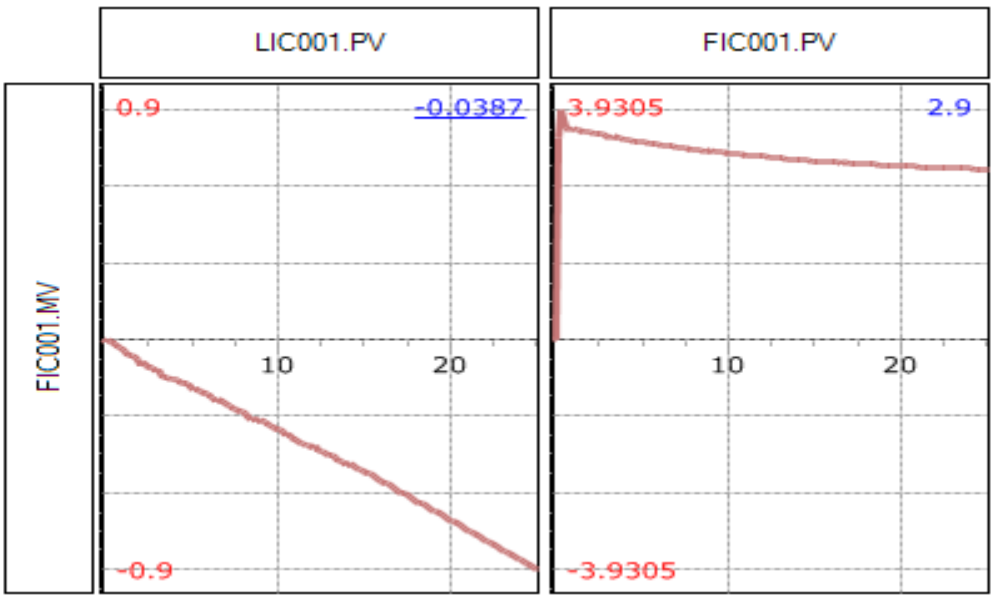
2. PID Tuning Approach:

Traditionally, for PID tuning of master and slave loop arranged in cascade control, the slave loop is tuned first with shorter rise time and then master loop is tuned by putting the slave in Auto mode and making few steps in its set point. This method requires to perform the step test twice and take longer time to calculate the desired tuning parameters. Whereas, In INCA Aptitune, optimal tuning of both the loops in cascade control can be achieved in single shot with one time step test and in very short time. The following steps were taken in order to improve the PID tuning of master and slave loop by using the cascade loop tuning functionality of INCA Aptitune.

a) Open loop step test
b) Open loop model identification
c) PID tuning with AptiTune
d) Verify the new tuning values by making few steps in the set point and observe for 2-3 days

To identify the open loop model, it is required to put both the master and slave PID controller in manual. Make 2-3 steps in slave PID controller output and collect high frequency (10-15 sec) data. The identified model is then will be used to get the optimal tuning parameters of both the loops in single shot.

Following is the open loop model identified for tuning parameter calculation.



3. Results

The controller was tuned by using the INCA Aptitune cascade tuning functionality. The tuning values are calculated with the use of identified open loop model. Without INCA AptiTune it would have been very difficult to determine the new optimal control settings in such a short time. The following trends shows the performance of both the master and slave PID loop before and after tuning.

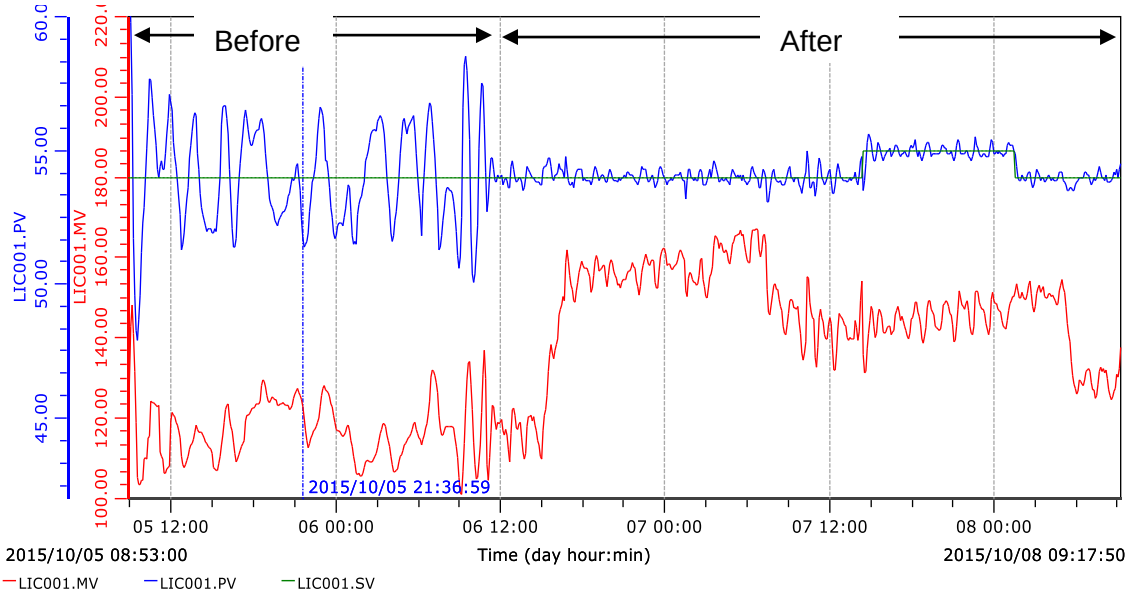


Figure 21: Performance check of Master level loop LIC001

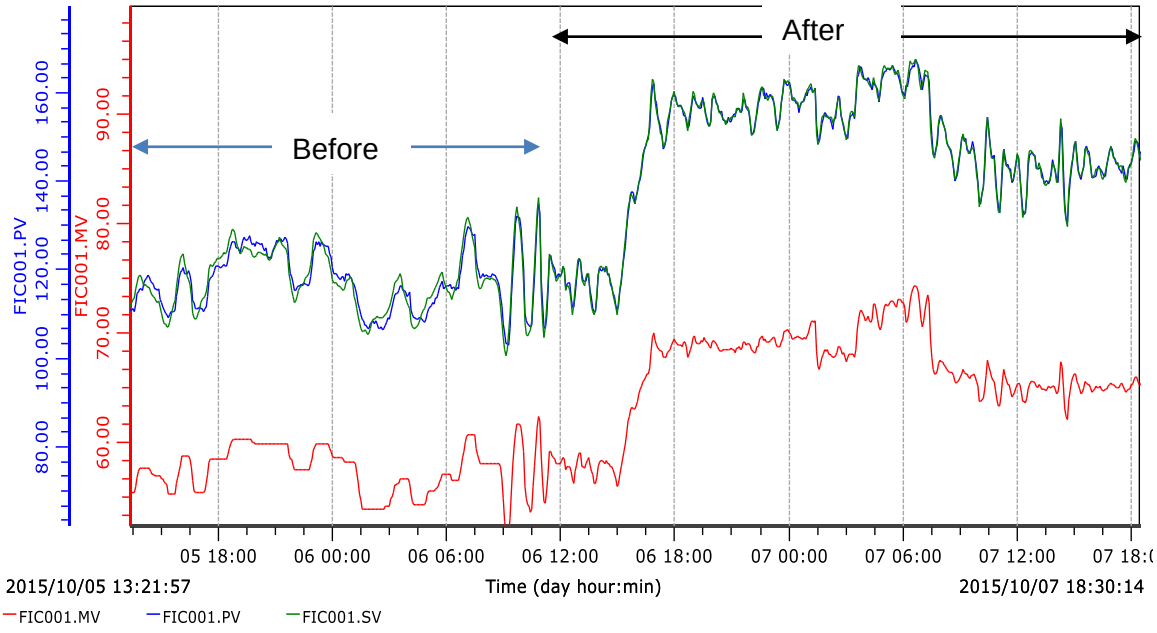


Figure -2: Performance check of Flow slave loop FIC001

Table 1: Comparison of tuning parameters

Loop Name	Initial Tuning parameters	Final optimal Tuning Parameters
LIC-001	PB=120; I=130; D=0	PB= 20; I=350; D=0
FIC-001	PB=200; I=50; D=0	PB=600; I=30; D=0

Yokogawa I-PD PID algorithm used which means Proportional and derivative term acting on PV and integral on error.

4. Conclusion

One shot cascade loop tuning functionality of INCA Aptiune allows to tune both the master and slave loop with single step test data and in much shorter time. Proper tuning of reflux flow and reflux drum level reduces the cycles in regenerator overhead temperature which stabilizes the regenerator operation and better control of lean amine loading. This stabilization of regenerator temperature profile allowed operator to reduce the regenerator temperature set point and save some steam.