PID Tuning Case Study

Tuning of expander inlet pressure (3x3 case)

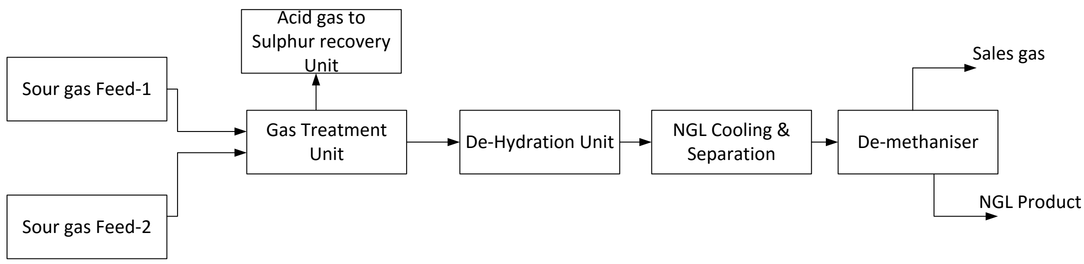
1. Introduction

A NGL recovery plant had a turbo expander/ re-compressor, the inlet pressure of the turbo expander is maintained by throttling the expander inlet guide vanes (IGV). The expander is equipped with a pressure controlled J.T by pass valve. During normal conditions, J.T. should be closed and expander inlet pressure is maintained by IGV only.

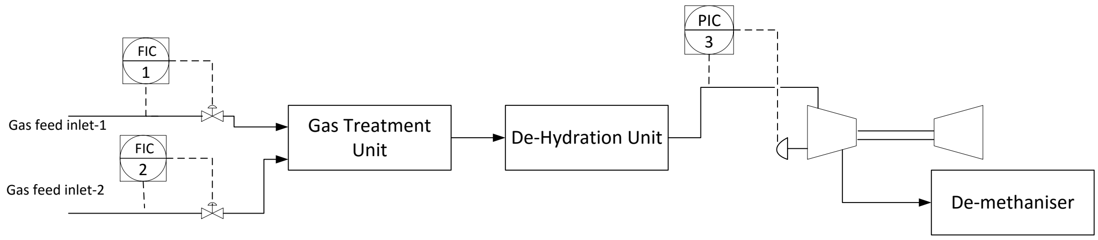
In any NGL plant, the main objective is to minimize the C3+ slippage in residue or sales gas from top of De-methaniser column and maximize NGL bottom product. Liquids from the turbo-expander knock out drum are passed under level control directly to top section de-methaniser. To achieve this, expander inlet pressure control plays a very important role to maximize the cooling across expander (by maximizing the pressure drop across expander) and to stabilize the gas feed flow as there is no other pressure control in-between inlet gas feed control valves and expander.

There are two sour gas feed inlet to NGL plant from two different sources. Sour gas feed is treated first in gas treatment unit and is then feed to de-hydrated and NGL recovery unit. For stable operation, both the feed flow need to be controlled tightly as any upstream disturbance in gas flow will pass to the NGL recovery section and can disturb the plant operation.

The client was facing problem of constant slow cycles in almost all the temperature and flow loops of NGL recovery section. IPCOS was asked to look into the problem. After an initial audit, it was found that the two gas feed flow PID controllers and expander inlet pressure control were the main contributor for those cycles. As expander inlet pressure and the two gas feed flows are highly interacting, both these three loops were tuned together in single shot by using the multivariable tuning approach of INCA AptiTune^{TM}. The schematic below shows an overview of the NGL recovery process.



The following figure shows the expander inlet pressure control and two gas feed flow inlet.



DCS

Yokogawa Centum CS

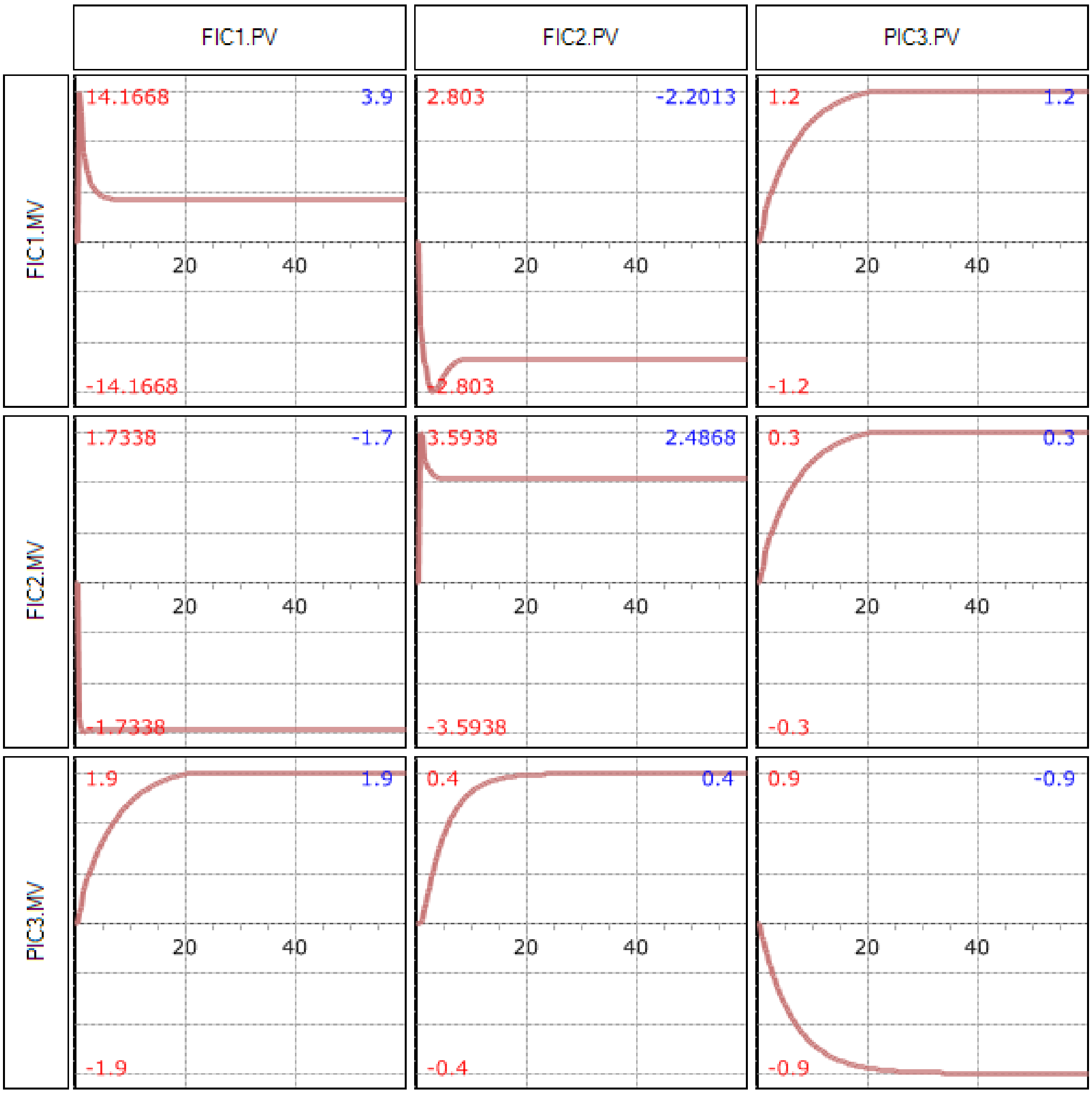
2. PID Tuning Approach:

The following steps were taken in order to improve the PID tuning of these three loops by considering the interaction among them.

a) Open loop step test
b) Open loop model identification
c) PID tuning with AptiTune

To identify the open loop model, it is required to put all the three loops in Manual. Make 3-4 steps in output and collected the high frequency (10 sec) data. The identified model is then used to get the optimal tuning parameters of all the three loops in single shot.

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



3. <u>Results</u>

The optimal tuning values are calculated by INCA AptiTune software with the use of open loop model. Without AptiTune it would have been very difficult to determine the new optimal control settings. The following trends shows the performance of all the three PID loops before and after tuning.

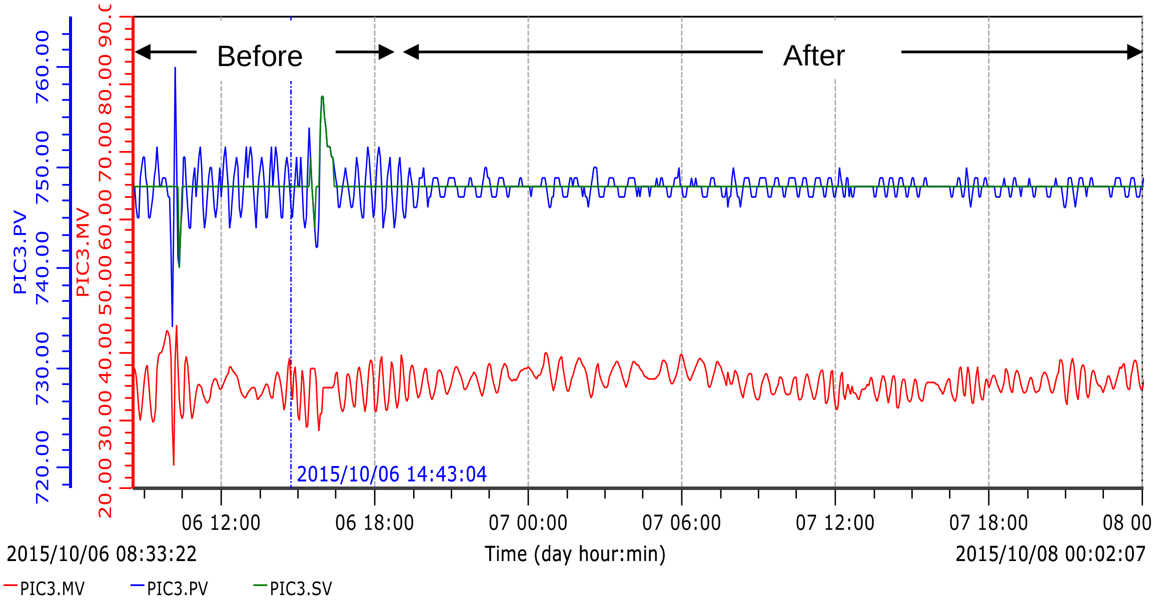


Fig1: Performance check of Expander inlet pressure before and after Tuning

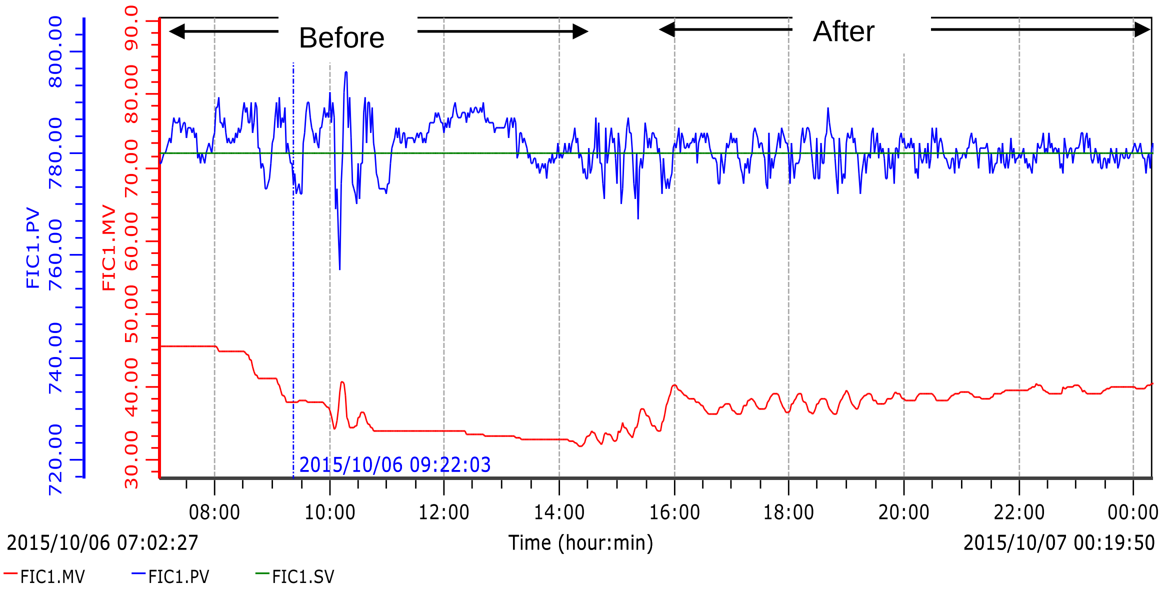


Fig2: Performance check of Gas feed flow inlet-1 before and after Tuning

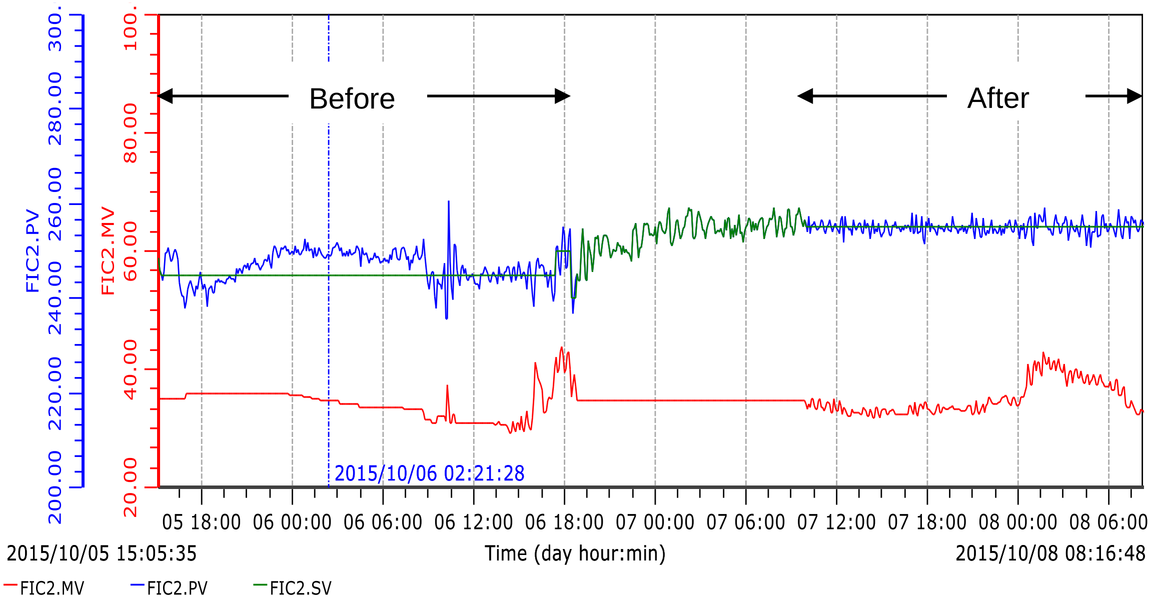


Fig3: Performance check of Gas feed flow inlet-2 before and after Tuning

Table 1: Tuning parameters

Loop Name	Initial Tuning parameters	Final Tuning Parameters
FIC-1	PB=100; I=50; D=0	PB=225; I=25; D=0
FIC-2	PB=100; I=70; D=0	PB=125; I=30; D=0
PIC-3	PB=45; I=30; D=0	PB=8; I=100; D=0

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

4. Conclusion

Proper tuning of expander inlet pressure and feed flows stabilizes the process, the slow cycles in almost all the temperature and pressure loops in chilling section reduced significantly. This stabilization of expander inlet pressure allows operator to increase the expander inlet pressure set point for more chilling which results in reduction of C3+ in sales gas from de-methaniser column.