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Proposal of Hierarchical Control System for Petrochemical Sour Gas Amine Treating Unit

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Abstract

Sour Gas Amine Treating Unit (ATU) new control structure may be considered as very important related to the impact of sulphur emissions generated by the tail lean gas. Mostly this type of lean gas is used as petrochemical complexes process furnaces fuel. The paper presents some contributions regarding the development of dedicated hierarchical control system, process structure and subsystems of ATU and also lean gas purity control. The hierarchical control structure proposed by author represents a real solution to reduce emissions generated by lean gas streams used as fuels worldwide. The solution considered represents also the most effective way to meet environmental regulation laws related to sulfur removal from tail gas fuel streams on each petrochemical facility.

Key words: *tail gas amine treating, hierarchical structures, process control.*

Introduction

It is known that, in actual instrumentation technique, the active devices do not represent separate units, but they are parts of a complex system which controls and manages the plant. The so-called "instrumentation engineers" must have all skills in order to keep functioning this integration between process control and instrumentation functions (from a safe and reliable prospective) [1]. From this perspective, hierarchical control systems implementation for petrochemical plants represents a continuous challenge for the field of advanced process control. A typical example can be the Sour Gas Amine Treating Unit, relevant for developing such a hierarchical control system due to the fact that it is characterized by multiple hierarchical control levels. Present work paper shortly outline a hierarchical control structure proposed for the above purification process.

Hierarchical control baselines

The meaning of hierarchical control is to separate a given large scale system into smaller subsystems and to coordinate them (including the optimization perspective) through a multilevel specific algorithm [1, 2].

The system which represents the proposal of this paper follows a typical trend, associating the control hierarchy with the plant management information system, as shown in [1]. Such a system aggregates the following items:

1. The Management Information System (MCS);
2. The Supervisory Control System (SCS);
3. The Distributed Control System (DCS);
4. The Emergency Shutdown Systems (ESD);
5. The Sequence of Events Recorders (SER);
6. The Field Input/Output Infrastructure (FI/O).

A possible general hierarchy, also adopted by the author of this work, was suggested by Elshafei in [1], it being represented in figure 1.

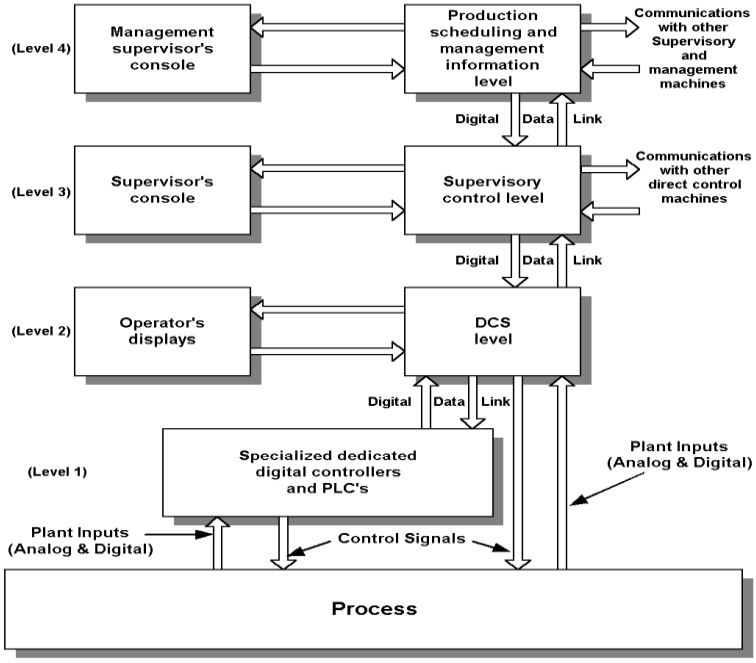

Fig. 1. Plant Control and information systems hierarchy [1].

Hierarchical control of sour gas Amine Treating Unit

The Amine Treating Unit represents a typical complex chemical system. The global process structure can be decomposed into the following subsystems (as indicated within figure 2): H_2S absorption section (subsystem 1), absorbent regeneration section (subsystem 2) [3].

The subsystem 1 associated to the absorber realizes separation of C_{5+} light cuts from the sour gas, the tail gas being purified through absorption of H_2S into lean absorbent water base solution.

The subsystem 2 associated to regenerator assures desorption of H_2S from the rich absorbent solution recovering as top product an acid gas being processed into a SR Unit.

As the open literature suggests, the hierarchical control structure proposed for the Amine Treating unit, indicated in figure 3 was structured on three levels (it being based on existing unit control configuration – shown by figure 4). The first level has been associated to the individual (basic) control loops. The second level is based on an IMC controller subsystem and a feed-forward controller (FFC). The third level corresponds to the plant management, which tries to get the unit performances and profit maximization [3].

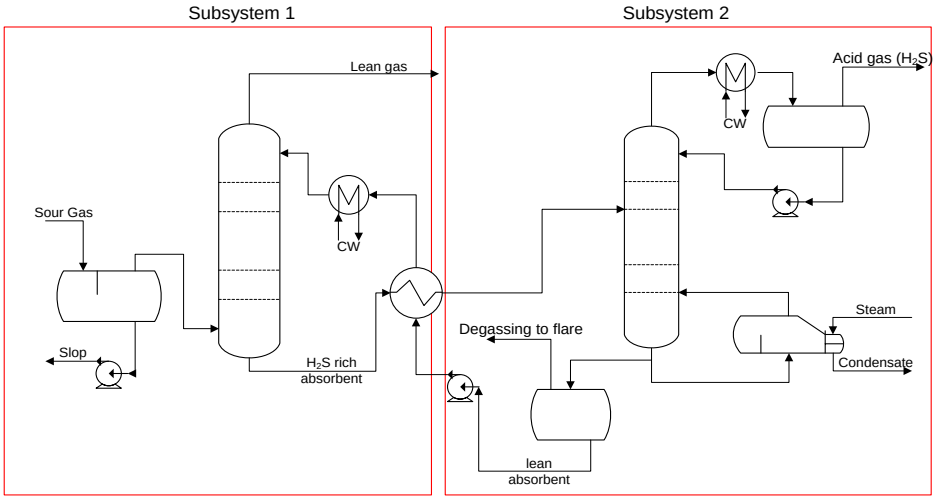

Fig. 2. The Amine Treating Unit sub-divisions.

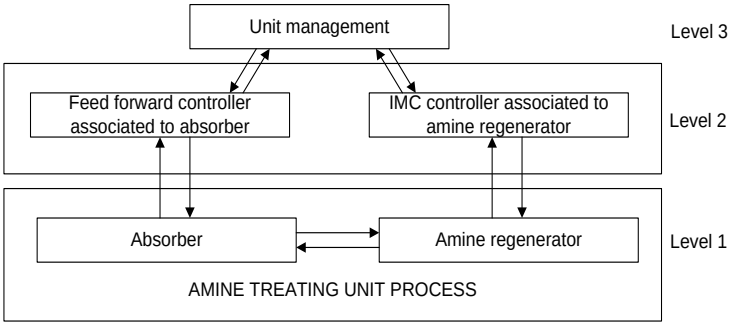

Fig. 3. Amine Treating Unit hierarchical control structure.

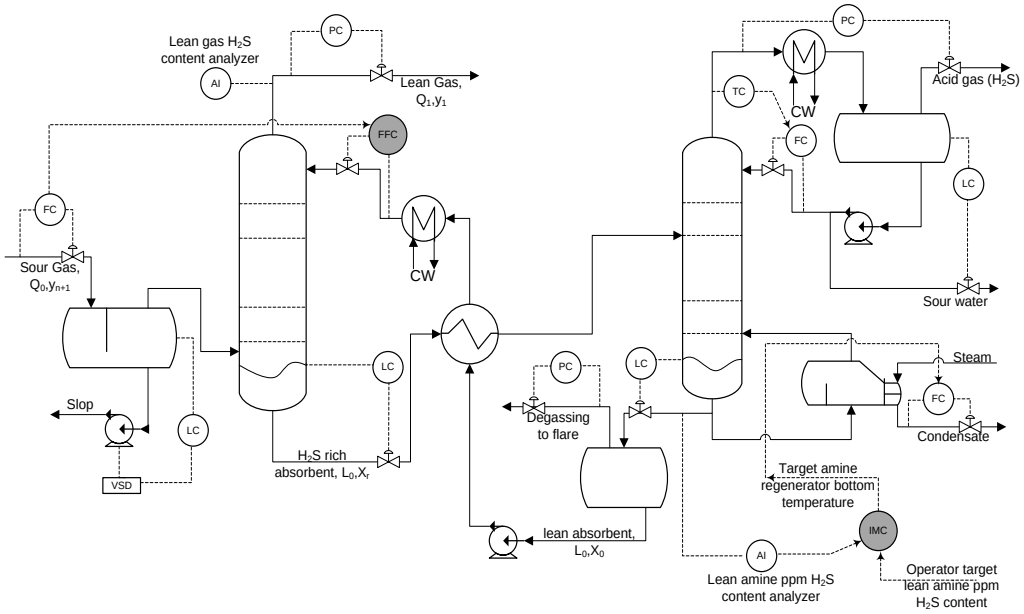

Fig. 4. The considered Amine Treating Unit control structure.

For the first subsystem considered within the hierarchical control (on second level) the setpoint of FFC controller associated to the absorber is the ratio between the lean absorbent/sour gas flowrates. The FFC controller output is the flowrate of lean absorbent. For the second subsystem, the setpoint used by the IMC controller is the H_2S content within the bottom product of the amine regenerator (lean absorbent). The IMC controller output is the flowrate of condensate evacuated from amine regenerator reboiler (which in fact controls the regenerator bottom temperature). The level three aims to the unit global optimization, it being used, for instance, for energy consumption optimization (for amine regeneration column subsystem) when maximizing the H_2S recovery through absorption.

Conclusions

The aim of this study was to develop the hierarchical control structures of petrochemical tail gas Amine Treating Unit. This unit may be considered as decisive regarding the H_2S elimination from the tail gas. Based on the classical hierarchical concepts, the authors of this paper propose a dedicated hierarchical control structure associating two subsystems to the petrochemical plant studied. It may a more reliable control structure which integrates two hierarchical control approaches for the absorber and amine regenerator subsystems. As research regarding the hierarchical control of Amine Treating Unit will be continued, in the next future the author will detail the validation principles of the proposed structure.

References

1. Elshafei, M. – *Modern Instrumentation Systems (Course SE43801)*. King Fahd University Dhahran, Saudi Arabia, 2009. (http://ocw.kfupm.edu.sa/user/SE43801/)
2. Brosilow, C., Joseph, B. – *Techniques of Model-Based Control*. Prentice Hall, 2002.
3. Popa, C., Pătrascioiu, C. – The *Hierarchical Control Structure of the Catalytic Cracking Unit*. Chem. Bull. "POLITEHNICA" Univ. (Timişoara), Volume 51 (65), 1-2, 2006.

Sistem de conducere ierarhică pentru instalaţia de purificare a gazelor reziduale rezultate din petrochimie

Rezumat

Elaborarea unei noi structuri de conducere a instalaţiei Purificare Gaze Reziduale rezultate din petrochimie prezintă o importanţă deosebită luând în considerare implicaţiile directe privind limitarea emisiilor de SOx rezultate prin combustia acestui flux tehnologic. În general acest tip de combustibil (tail gas) este utilizat la cuptoarele tehnologice din complexele petrochimice şi rafinării. Prezentul articol se constituie într-o contribuţie în domeniul structurilor de conducere de tip ierarhic cu performanţă ridicată, oferind flexibilitate în operare relativ la menţinerea unor valori constante de puritate pentru fluxul de gaze reziduale. Structura ierarhică propusă reprezintă o potențială soluţie privind reducerea emisiilor generate de combustia fluxurilor de gaze reziduale rezultate din complexele petrochimice. De asemenea, soluţia prezentată poate constitui o alternativă la cerinţele tot mai severe de protecţie a mediului impuse de autoritățile europene complexelor petrochimice şi rafinăriilor.