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Ph.D. Thesis

– ABSTRACT –

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CONTRIBUTIONS IN THE FIELD OF MODEL-BASED CONTROL OF THE CRUDE OIL PLANT

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THESIS CONTENTS

The objective of this PhD thesis is to bring its own contribution in the field of advanced control structures design for the crude oil plant. While most of the references from the literature present some advanced control systems based on steady-state plant model, this work proposes the use of a dynamic plant model, in a new, "structural" approach, together with advanced simulation techniques, as a tool for model-based control structures design.

This thesis is a result of the author's activity since 1997 in the "Advanced Process Control Research Center" from Petroleum-Gas University, Ploieşti, managed by Prof. PhD Eng. Vasile Marinoiu. In the same time, it is very important to emphasize that this work was possible due to our excellent co-operation with The Max-Planck Institute Dynamics of Complex Technical Systems, Magdeburg, Germany.

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The first chapter presents the actual achievements in model-based process control (MBPC) techniques, referring to the Internal Model Control (IMC) and Dynamic Matrix Control (DMC) mono- and multivariable structures. The basic principles of feed-forward control are presented too. The chapter in fact shows all the stages in the model-based control structures implementation methodology, emphasizing that an adequate dynamic model for the controlled process is a compulsory element for any MBPC strategy.

The second chapter shows the main thesis contribution in the field of crude oil plant mathematical modeling – as a contribution in the model-based control structures design for this process. The proposed dynamic model, although is based on classical principles (global and component material balance, energy balance and liquid-vapor equilibrium), is presented in a new, "structural" approach. The plant is now described by separate model for inter-connected "block-devices" such as the main column, sidestripers, pumparounds and the condenser with accumulator. The thesis also presents some original contributions related to the bottom level control for the sidestripers and proposes an inferential methodology for final products quality determination.

The third chapter compares the characteristics of some well-known simulation tools (and techniques) used in the research activities in the field of chemical and petro-chemical industry, such as PRO/II, HYSYS and "general simulation environments" – Simulink and DIVA. Due to its excellent performances, the author's choice for the implementation of a crude oil plant dynamic simulator is DIVA (Dynamische Simulation Verfahrenstechnischer Anlagen), a software environment developed at The Stuttgart University and The Max-Planck Institute Dynamics of Complex Technical Systems. This way, the crude oil plant simulation based on the aggregate "structural" model becomes an easy-to-solve problem, overriding many of the difficulties quoted in the literature. As shown in the first chapter, the dynamic simulator is a dedicated tool not only for researches as "look inside the process", but also for advanced process control structure design.

As example, **the fourth chapter** presents another thesis contribution: an improved product quality control structure (with dynamic quality loops decoupling). First, the model and the simulator behavior was validated for the case of a real plant – a very complex and delicate methodology stage. Then, using the simulator, the author developed a control structure based on a low-order dynamic model, built-up through identification techniques. After many simulation tests, the very good structure performances are proved, so the structure itself may become the subject for a real industrial implementation.

The last chapter presents the final conclusions, making in the same time a review of the main thesis contributions in the field of model-based control of the crude oil plant.

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