CHAPTER I

INTRODUCTION

This chapter introduces the importance and the reason for research, research objectives, research limitations, procedure and method, expected result and the research contents.

1.1 Importance and reasons for research

Nowadays, oil distillation business has very high competition. As a result, the refiners must find the way to reduce their production cost while still maintaining their product qualities in which declared by the law. One of the methods, to reduce the cost of product, is by increasing the production control performance.

The Hydro-desulphurisation process is an important continuous process in oil refineries for eliminating sulphur content in kerosene and gas oil, which is portions of crude, contains high sulphur and has high boiling points, by catalyst before fed over to separation units. The occurred reactions are nonlinear exothermic reactions, which is the important key point for controlling the amount of sulphur content to stay near its allowable limit. On the other hand, the least desulphurization results to the least energy consumption. Consequently, the catalyst life is extended and the important point is decreasing the risk of thermal runaway due to heat transfer rate limitation. In the past, using normal linear control technique e.g. PID control technique is quit limited for highly non-linear process, which is not enough for solving the above problem. Therefore, there is a requirement to have a higher performance reactor controller, robust and can really be applied to the industrial process. The Model Predictive Control (MPC) technique is an opinion for advanced process control. It has been developed to solve the above-mentioned type of problems. In which the control is based on the principle of the reliable

process mathematic model. The good point of this type of control is high control efficiency and high stability.

The hydro-desulphurisation process is a unit in which utilize catalyst in order to accelerate the speed of reaction. With high operating temperature would help in reducing the sulphur content in product. In contradiction, the catalyst life is shorter which is resulted from the more coke formation on the catalyst surface at high operating temperature. In the mean time, the energy used for increasing the temperature is unnecessary lost.

For this thesis, the experiments use model predictive control technique with Kalman filter state and parameter estimation for controlling the sulphur content remains from a continuous reactor, which is irreversible exothermic reaction.

1.2 Objective of research

1. Applying model predictive controller (MPC) on program MATLAB for controlling the effluent sulphur content from a continuous flow desulphurization reactor

2. Applying state and parameter estimation for sulphur content by using laboratory results for error correction in the model.

3. Test model predictive controller performance for controlling the effluent suplhur content from a continuous flow desulphurization reactor from MD feedstock compared with Generic Model Controller.

1.3 Research Boundaries

1. The Boundary for this thesis is only around the reactor at Alliance Refining Company (Rayong, Thailand) i.e. furnace control, feed preparation and preheating and downstream separation units are excluded.

2. The Operating range of the reactor inlet temperature is in range 340-360 °C and the reactor outlet temperature is lower than 380 °C.

3. Only software simulations (on MATLAB) will be used for building process models and controllers. Implementation to the real process is excluded.

4. Feed stock property and rate change are excluded from this study. Assumption was made on fixed feed flow and property.

1.4 Expected Results

1. To be able to control the effluent sulphur content from the continuous flow desulphurization process with middle distillate feed stock and to be able to use energy efficiently.

2. To be able to estimate a state and parameter for estimating effluent sulphur content from the continuous flow desulphurization process by using laboratory results for error correction in the model.

3. A model predictive controller with state variable and parameter estimation

1.5 Research Methods

1. Study and collect data, related research with model predictive control. Including study using MATLAB program.

2. Study and collect data in which related to controlling effluent sulphur content from the continuous flow exothermic desulphurization reactor.

3. Derive a process model and design a model predictive controller

4. Write a model predictive controller with stat variable and parameter estimation for controlling the effluent sulphur content from the continuous flow exothermic desulphurization reactor.

5. Test control performance model mismatches when heat transfer rate changed, mass flow rate changed, reaction rate changed and heat of reaction changed.

6. Analysis and summary

1.6 Research Contents

In Chapter I introduces the importance and reasons for research, objective of research, research boundaries, expected results, research methods and research contents

In Chapter II reviews the past literatures for applying model predictive control in industrial process

In Chapter III provides the reader about model predictive control theory in which explains the model predictive control structure, process mathematic models and model predictive control algorithm

In Chapter IV introduces the process model for this study i.e. kinetic reaction for hydro-desulphurisation process,

In Chapter V shows simulation results and analysis of effluent sulphur content control from the continuous flow desulphurization process, Kalman filter, applying Kalman filter in this thesis and sulphur content estimation.

Chapter VI summarizes the results from the simulations and recommendation for next researches.

At the end part is an appendix about generic model control principle.