Chapter 1
INTRODUCTION

1.1 Background

Ethanol was one of the first fuels used in automobile engines. It was used extensively in Germany during World War II and also in Brazil, the Philippines, and the United States. During the postwar period, as petroleum supplies became cheap and abundant, gasoline largely replaced ethanol as an automotive fuel. Not until the 1970s, when the supply of oil was restricted, did ethanol re-emerge as an alternative to or extender for petroleum-based liquid fuels.

In Thailand, the main portion of the country's automobile engines uses gasoline or diesel. In 2001, more than 600,000 barrels of fuel per day was imported [National Energy Policy of Thailand, 2001]. To reduce the country's dependence on costly imported fuel and to assist in creating a new domestic fuel industry, the Thai government is considering a proposal to replace the imported gasoline additive MTBE with ethanol. The country uses around 2-million liters/day of imported MTBE as an additive in gasoline to boost octane levels. The value of MTBE imports is around 5-billion baht per year. The government plan is to increase ethanol supply to 2-million liters/day in the next four to five years. Ethanol will be sold as a 10% blend with gasoline, in place of the toxic additive MTBE.

Ethanol is also known as ethyl alcohol or grain alcohol. Like gasoline, ethanol contains hydrogen and carbon, but ethanol also has oxygen in its chemical structure. Oxygen makes ethanol a cleaner burning fuel than gasoline. Ethanol can be used as a direct replacement for gasoline, or it is blended with gasoline as an extender and octane booster. It provides oxygen to decrease tail-pipe emissions of carbon monoxide (CO). Ethanol can be chemically produced from ethylene, and biologically produced from grains, agricultural wastes, or any material containing starch or sugar. Because ethanol can be produced from crops, it is then classified as a renewable fuel. One good reason to use this kind of fuel is because Thailand is an agricultural country. The main feedstocks for ethanol production in Thailand are cassava

and molasses. The country has annual surpluses of 2-4 –million metric ton of cassava and hundreds of thousand of tons of molasses, which depress the prices for these commodities. By converting these materials to ethanol, price will be stabilized, and oil import costs will be reduced.

In effective operation of the fermentation process, the kinetic characteristics of cell are necessary for controlling the process to achieve the result. In this study, the mathematical model for cell growth, substrate utilization and cell production will be constructed. The results will provide more understanding of the key parameter effects on cell activities and could be used for the effective design and control of ethanol fermentation process.

1.2 Objective

To construct the mathematical model that can describe dynamic behavior for ethanol fermentation by using yeast *Saccharomyces cerevisiae* M30.

1.3 Expected benefits

The outcome of this research will provide more understanding on the effects of substrate concentration and operating temperature on cell activities in ethanol fermentation system. The proposed kinetic model could be applied for the effective design and control for ethanol fermentation process.

1.4 Scope of work

1. Experiments are performed in shaking flasks. Substrate concentrations are adjusted between 3-25% w/v of reducing sugar with operating temperature range from 30-42°C.
2. Molasses is used as a carbon source in all experiments
3. Kinetic model with key parameters initial substrate concentration and operating temperature will be constructed from the experimental data.