CHAPTER I
INTRODUCTION

Due to the fast development in industry all over the world and significant changes in the living standards of human beings, the rising concern over energy consumption and increased pollution are becoming more and more serious global problems. Therefore, reducing air pollution during power generation is greatly required.

Nowadays, the use of heat engines, such as internal combustion engines and gas turbines employing the combustion of fossil fuels (namely oil, natural gas and coal) which are used as the primary fuel, has become an essential part of modern civilization and rapidly increased. This reliance on the combustion of fossil fuels has resulted in severe global air pollution problems, such as global warming due to the increase in atmospheric greenhouse gases concentration, particularly CO_2. In addition to health and environmental concerns, higher efficiency requirements than conventional heat engines is also important for new technologies aimed at energy conversion.

To meet the above requirements, a variety of alternative approaches has been proposed and applied to power generation, such as renewable energy approaches with hydroelectric power, wind, wave, solar and geothermal energies. Although these renewable energy sources can be easily used to generate electricity and are significant in reducing pollution, they are subject to seasonal fluctuation which limits the energy harvest, and to the application of these technologies. A fuel cell, one of the alternatives, has been identified as a promising and potential energy technology which meets the entire requirement above, and is also compatible with renewable energy sources.

A Solid Oxide Fuel Cell (SOFC), one of the five types by electrolyte classification, operates at high temperature resulting in high-quality waste heat to be further used for additional electricity generation. Thus, it provides greater efficiency than other types of fuel cells. Moreover, it has high fuel reforming performance; it can use other hydrocarbons, in addition to hydrogen, as a fuel, such as natural gas, syngas, reformate, etc. Therefore, SOFCs can reach the target of high energy conversion and produce less air pollution. It is thus becoming a more attractive technology for the 21st century.

While much is already known about how syngas composition, the presence of reaction products and other diluents affect the performance of SOFC with Ni-YSZ anode in a single cell testing (Trembly *et al.*, 2006, Costa-nunes *et al.*, 2005, Su-wanwarangkul *et al.*, 2006 and Weber *et al.*, 2002), there have been relatively little known about these factors that affect the performance in a stack testing (Marquez *et al.*, 2007). Therefore, the objective of this research is to develop a mathematical model that is able to predict the behavior and performance of a planar solid oxide fuel cell (PSOFC) stack operating with syngas (H_2, CO, CO_2, and N_2 mixture). Moreover, simulation results are validated and compared with the experiment.