1 INTRODUCTION

1.1 Motivation and statement of problem

Energy is one of the major issues that we are facing in this era of modernisation. The world energy demand is increasing exponentially as the technologies are evolving and getting generalized globally. This can be seen by the common example of the comparison in the local society around us in nowadays and the society in past decade. In the 20th century, where cars were once considered a luxurious item which can only possess by the rich and high social status person, however it has became a need for almost everyone who is working in the urban cities. These days tons of vehicles can be spotted everyday on the road, this illustrating the increasing high demand of energy in term of gasoline required to drive the vehicles in motion. Aside from the view of the increasing energy demand from gasoline, by looking at the electricity demand chart from TNB Malaysia also gives a solid prove on the increasing local energy demand. [1]

Figure 1-1 Installed capacity and maximum demand of electricity in Peninsular Malaysia by TNB
With the exponentially increase trend like this, there might be possibly that the running out of the crude oil reserves to be happened. The debate is nevertheless important because if without sufficient investment in demand of substitute sources of energy, a decline in the global production of conventional crude oil in the future could have major economic impacts. [2] Recently, the need to reduce the dependence on petroleum as feedstock and the continuous increase of natural gas proven reserves has generated interest in the extensive use of this natural resource. Unfortunately, the majority of world gas reserves are located either in small fields or in remote regions which cannot be monetized using conventional technologies (pipelines or LNG). In addition, some stranded gas reserves are associated to oil. The increase of environmental restrictions to gas flaring or ventilation makes difficult the development of these fields. The conversion of natural gas to liquid fuels, the so-called gas-to-liquids (GTL) technology, is a promising alternative to the monetization of stranded gas reserves and to fulfil the environmental restrictions. [3]

Synthesis gas is a mixture of hydrogen and carbon monoxide with the ratio varying depending on the desired product. The synthesis gas also usually contains inert compounds such as argon, methane, nitrogen, carbon dioxide, and so forth. Synthesis gas can be made in a variety of devices, but is almost always made by reforming natural gas. [4] Besides, hydrogen is also an alternative energy source that can be converted to electricity in a fuel cell device. [5,6] There are several ways in producing synthesis gas, like partial oxidation, steam reforming and autothermal reforming. However as compared to other syngas production processes, ethanol dry reforming (DRE) reaction is industrially advantageous since it yields syngas with H2/CO product ratio close to unity which is more suitable for liquid hydrocarbon production via Fischer–Tropsch synthesis and in the production of oxygenated compounds. The main drawback of DRE is its endothermic nature which requires fairly high temperatures to achieve high conversion values. This severe operating condition could cause catalyst deactivation due to accumulation of coke over catalyst surface and/or sintering of the active metal particles. Generally, the catalysts used for the DRE are categorized into two groups: supported noble metals (Pt, Pd, Rh, Ru) and non-noble transition metals (Ni, Co, Fe). [7]

Study on the catalyst development of this reaction has been focused on screening a new catalyst to reach higher activity and better stability toward sintering, carbon deposition (coking), metal oxidation, and forming of inactive chemical species. Recently, although not a focus of attention, it has been revealed that the supported cobalt catalyst shows considerable activity for dry reforming of ethanol process. Even though the catalytic performance, such as activity is neither superior to nickel nor to the noble metal catalyst, study on the supported
cobalt catalysts were also reported to find out the better catalytic performance. It is also probable that the mechanism of carbon deposition on cobalt metal is different from that on nickel metal. Cobalt catalyst, especially over silica and alumina supports, is also reported to have a good stability against temperature changes. These results suggest that cobalt catalyst is a potential alternative among non-noble metal catalysts with a small amount of carbon deposition. [8]

1.2 Objectives

The following are the objectives of this research:

- To synthesize and characterize the physicochemical properties of Lanthanide group promoted Cobalt catalysts, 3%Ce-10%Co/Al₂O₃, 3%La-10%Co/Al₂O₃ and 10%Co/Al₂O₃.
- To evaluate performance of dry reforming of ethanol by using different promoters on unreduced catalyst.

1.3 Scope of this research

The following are the scope of this research:

i) To fabricate the Lanthanide group promoted catalysts, 3%Ce-10%Co/Al₂O₃, 3%La-10%Co/Al₂O₃ from Co(NO₃)₂•6H₂O, Ce(NO₃)₃•6H₂O and La(NO₃)₃•6H₂O through the application of impregnation followed by drying process at temperature of 110 °C for 24 hours.

ii) To characterize the synthesized catalyst by using following advanced techniques like X-ray Diffraction Measurement (XRD), Brunauer-Emmett-Teller (BET) surface area measurement, thermal gravimetric analysis (TGA) and scanning electron microscopy (SEM).

iii) To test catalytic behavior of unreduced catalysts with different catalyst promoters for CO₂ (or dry) reforming process in order to locate ideal process settings for top performances.