CHAPTER 1

INTRODUCTION

The production of gasoline from coal and other non-petroleum
carbon sources will likely become a necessity before the turn of the
century. Until now, only two coal conversion processes have attained
any measure of commercial significance (1). These are the Bergius
and Fischer-Tropsch processes. In the Bergius process, finely
divided coal is slurried with recycle oil containing a small amount
of iron catalyst and hydrogenated at 900° F and 3,000-10,000 psi.
The product is a synthetic crude. This process was practiced
extensively in Germany during World War II, achieving a peak annual
production of four million tons of oil by 1944 (1). The Fischer-
Tropsch process is an indirect method for hydrocarbons at moderate
pressure and temperature. The Fischer-Tropsch process is commercially
practiced at Sasolburg, South Africa.

The major shortcoming of the Bergius and Fischer-Tropsch
processes is poor gasoline selectivity and quality. Products encompass
a wide spectrum of molecular weights ranging from methane to heavy
residue in the Bergius process and from methane to waxes with a large
amount of hydrocarbon oxygenates including low-octane gasoline in
the Fischer-Tropsch process. Extensive facilities are thus needed
to seperate and upgrade the products. The cost is thus very high.

Methanol is a potential motor fuel that can be made from
synthetic gas by existing technology (2). The process produces

essentially only methanol though it contains a small quantity of other light alcohols. This process has evolved through several phases and has seen many years of large-scale commercial usage. However, using methanol in an internal combusion engine (even as a minor component of gasoline) imposes a downstream investment burden on all sectors of society, from the methanol plant gate to the customer. Methanol's affinity for water, its toxicity, and its corrosiveness would all demand new capital were large-scale use to be implemented (3). These investments would encompass automotive engines and accessories, storage facilities, distribution system, and fuel additive formulations. In addition, a gallon of methanol has only half the energy content of a gallon of gasoline, so the volume produced, shipped, and stored (including storage in motorist's fuel tank) would essentially be double that of gasoline.

Converting methanol into gasoline would avoid these problems. Ideally, the cost of conversion (in terms of net energy consumed as well as dollars) would be less than the added cost of using methanol as a motor fuel(3). Recently, the conversion of methanol to hydrocarbons which predominantly in the gasoline fraction (C_5 to C_{11}) over ZSM-5 zeolite catalyst was reported by Mobil Oil Co. (3-4). Mobil has now demonstated a simple catalytic process to convert methanol quantitatively to hydrocarbons and water as (3,6)

$$x \ CH_3OH \longrightarrow (CH_2)_x + x \ H_2O \qquad (1.1)$$
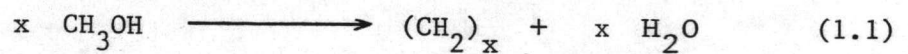
They showed that variation in product yields can be achieved by varying oparating conditions, reactant types, and catalyst properties (3,5). With respect to catalyst properties, we have learnt to dramatically control product selectivity by varying the geometry of their cavities and channel dimensions (7). For this purpose, new catalysts

with more suitable pore sizes, cavities and channel dimensions for shape selectivity have been saught. Further developments that may be expecteted in the future will combine at least two molecular engineering techniques, i.e., the use of an excellent organic cation template and the substitution of Al or Si by other elements (8). In the latter vein, new metallosilicate catalysts have been synthesized and a vanadosilicate catalyst with an, Si/V charged ratio of 3200, has been shown to be one of the best for the methanol to gasoline (MTG) reaction in this series, it shows higher activity and selectivity in gasoline fractions than ZSM-5 zeolite catalyst (9). Therefore in this study, vanadosilicate catalysts, were studied using reaction engineering tests. For this purpose, operating conditions, such as space velocity, reaction temperature, MeOH concentration, and Si/V charged ratios were varied. Furthermore, the relationship between the physical-properties and the catalytic performance of this catalyst was examined by using the Scanning Electron Microscope (SEM), and by examining BET surface areas, strengths of acidity (by using TPD (NH_3) method), actual Si/V charged ratios (A.A), and XRD patterns.