2. INTRODUCTION

The SASOL projects are the only major commercial undertaking of indirect coal liquefaction in the post-war period. A unique set of market forces made the SASOL projects a reality (67). Although no other near-term commercial projects are seen, there is a multitude of research and development activities. Some are aiming to improve on the SASOL technology, and others are focusing on new approaches. Among the new approaches, the use of slurry-phase reaction systems as a replacement of the conventional gas-phase Fischer-Tropsch (F-T) reactor is attracting much attention; therefore, it is the major subject of this report.

Key attractions of the slurry-phase F-T system are the ability to accept syngas of a low H_2/CO ratio and preliminary indications of higher yields of gasoline and diesel fractions than what is achievable by the gas-phase systems.

The ability to accept syngas of a low H_2/CO ratio is desirable because advanced coal gasifiers, such as the Texaco and Shell-Koppers gasifiers, produce syngas with an H_2/CO ratio below 0.7 which can be directly fed to the slurry reactor. This syngas would require substantial CO shifting before it could be used by the gas-phase Schulz-Flory (S-F) reactors.

The prospect of higher liquid yields is an equally important incentive of the current slurry-phase system research. It was originally demonstrated in the 1960's by Kölbel (69) and others (70,71,72), although the data lacked consistency. Together with more recent work (73,74), it is now widely believed that the slurry-phase system has the following process advantages over the gas-phase systems:

- Ability to accept syngas of lower H_2/CO ratio

- Higher selectivity to gasoline and diesel fractions

- Lower methane production

- Minimal production of water as a by-product; instead, CO_2 is the major by-product

- Higher single-pass conversion

Substantial economic benefits are anticipated from these advantages. In this regard, key findings from a major study by Mitre Corporation (66) are discussed in this report.

Despite the economic potential, the application of slurry-phase reactors is expected to take some time because the technology itself needs considerable development. Until recently, little has been known about the slurry-phase reaction system, and the science and engineering bases are currently being established. This is quite a contrast to the SASOL Synthol or Arge technologies, which have the support of extensive engineering information accumulated from long-standing industry experience with fixed-bed and fluizided-bed reactor design and operation. This report discusses the key areas of current research in slurry reactor design.

An important component of a synfuel plant is the coal gasifier. The SASOL plant uses the Lurgi dry-ash gasifier. This is a first-generation technology but was the best available for SASOL at the time of its development. It produces syngas having an H_2/CO mole ration in the 2:1 range. This is suitable to the Synthol or Arge processes, which can accept the Lurgi syngas with minor adjustment of the H_2/CO ratio. There are, however, some critical negative aspects of the Lurgi gasifier. These include low gasification rate, a large stream requirement, and large volumes of methane and tar by-products. These deficiencies weigh heavily against the overall process economics. Replacing the Lurgi gasifier with an advanced gasifier could improve the economics. This has been studied by Mitre Corporation (66), who evaluated the economics of synfuel production by various combinations of commercial and near-term technologies. These include the BGC slagging, Texaco, and Shell-Koppers gasifiers, and the Kölbel-type slurry F-T reactor. The key findings of the Mitre study are discussed in this report.