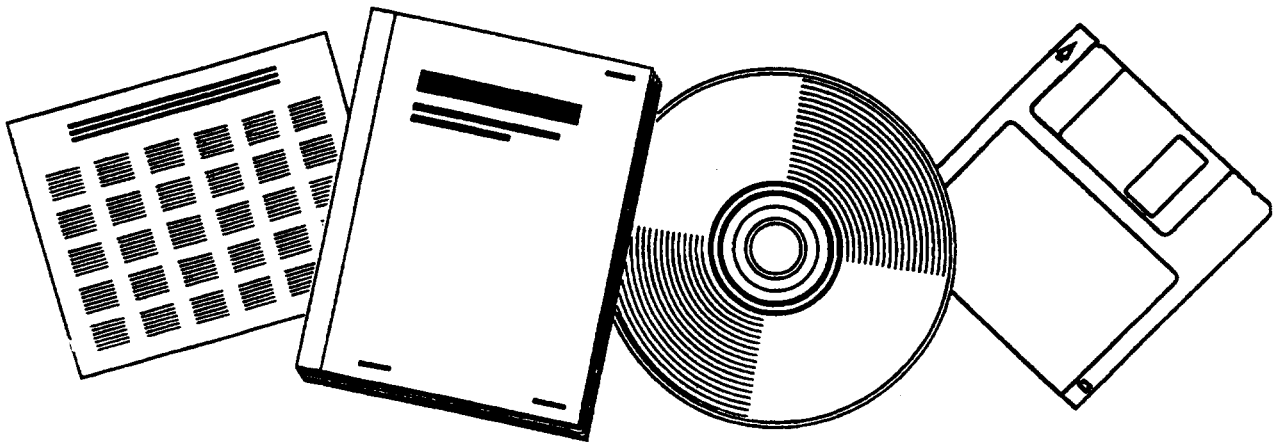
DE90006498

UPGRADING FISCHER-TROPSCH LPG (LIQUEFIED PETROLEUM GAS) WITH THE CYCLAR PROCESS

UOP, INC.
DES PLAINES, IL

28 APR 1989



U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

DOE/PC/90014-16
(DE90006498)
Distribution Category UC-108

UPGRADING FISCHER-TROPSCH LPG WITH THE CYCLAR PROCESS

PREPARED FOR THE UNITED STATES DEPARTMENT OF ENERGY UNDER CONTRACT NO. DE-AC22-86PC90014

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April 28, 1989

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UPGRADING FISCHER-TROPSCH LPG WITH THE CYCLAR PROCESS

CYCLAR TOPICAL REPORT

ABSTRACT

The use of the UOP/BP Cyclar^{R} process for upgrading Fischer-Tropsch (F-T) liquefied petroleum gas (LPG) was studied at UOP^{R}. The Cyclar process converts LPG into aromatics. The program was sponsored by the Pittsburgh Energy Technology Center of the U.S. Department of Energy.

The LPG derived from F-T is highly olefinic. Two routes for upgrading F-T LPG were investigated. In one route, olefinic LPG was fed directly to a Cyclar unit (Direct Cyclar). The alternative flow scheme used the Huels CSP process to saturate LPG olefins upstream of the Cyclar unit (Indirect Cyclar). An 18-run pilot plant study verified that each route is technically feasible.

The LPG olefins were shown to be easily converted in the Cyclar process. Compared to paraffins, olefins result in higher liquid product yields. This situation permits more flexibility in choosing process conditions, particularly with respect to process pressure. A significant disadvantage with olefinic feedstocks is that they can lead to excessive catalyst coking under certain conditions.

An economic evaluation procedure was designed to choose between the Direct and Indirect Cyclar options for upgrading LPG. Four situations involving three different F-T reactor technologies were defined. The main distinction between the cases was the degree of olefinicity, which ranged between 32 and 84 wt-% of the fresh feed. In the two lower olefin cases, Direct Cyclar was preferable, but for the two higher olefin cases, Indirect Cyclar was preferable. On the basis of what has been learned in this contract, a Cyclar unit that would best fit into an F-T upgrading complex would not use complete saturation. Instead, partial saturation of the feed would be employed to take

advantage of the LPG olefins, without the excessive costs associated with high catalyst coking rates at olefin levels above 65 wt-%.

The Cyclar process is a promising technology for use within an F-T upgrading complex. The Cyclar process directly addresses the problem of what to do with F-T LPG. The Cyclar process uses not only C_3 and C_4 olefins (which could be polymerized as an alternative), but also C_3 and C_4 paraffins. With the exception of alkylation (which uses isobutane), few process alternatives are available for the direct conversion of LPG paraffins into liquid products.

For a 5,675 MT/day Arge upgrading complex with a wax hydrocracker operating at high severity (large LPG production rate), a Cyclar unit would contribute more than 4,500 BPSD of high octane (106 R+M/2), low RVP (1.6 psia) aromatic product. The liquid product would be 89.1 wt-% benzene, toluene, and xylenes (BTX) aromatics and 10.9 wt-% heavier aromatics. Aside from the liquid product, the Cyclar process makes a valuable 95 vol-% purity hydrogen coproduct. The hydrogen production rate would exceed 1,200 SCF per barrel of LPG feed, or about 14 MM SCFD hydrogen production. This volume of hydrogen is sufficient to change the upgrading complex from a hydrogen consumer to a net exporter of hydrogen.