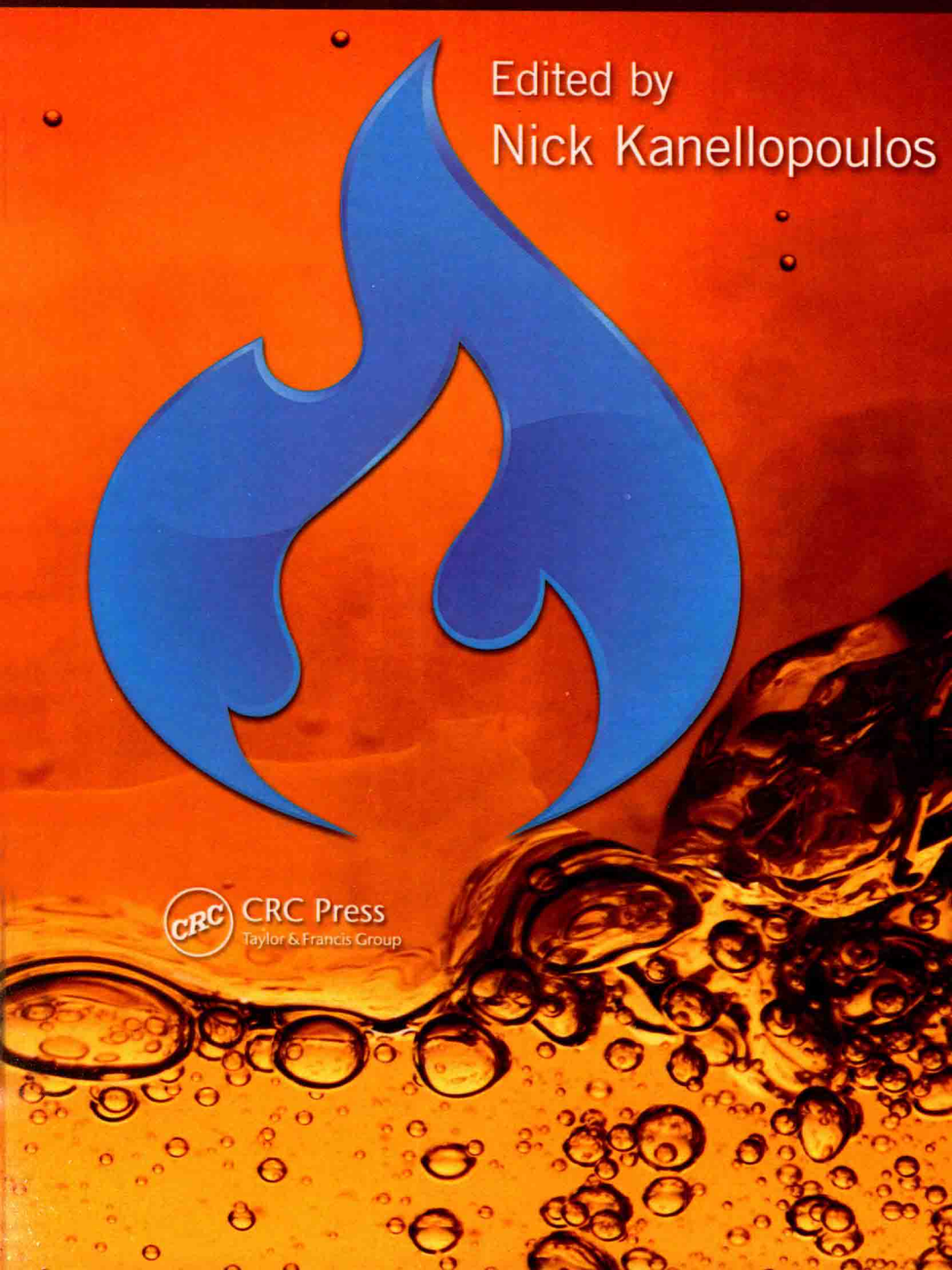
Small-Scale Gas to Liquid Fuel Synthesis



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Preface

It is estimated that a large fraction of the proven natural gas (NG) reserves are found in locations from where it is not cost-efficient to transport them. It should be noted that if these stranded NG reserves could be converted to synthetic fuels, they would generate around 250 billion barrels of synthetic oil, a quantity equal to one-third of the Middle East's proven oil reserves. In addition, the U.S. Energy Information Administration report on technically recoverable shale gas resources indicates a potential of about 23,000 trillion cubic feet of world resources, of which a large part is situated in areas that are difficult to be connected to NG pipelines. A more economical exploitation of these resources requires developing efficient methodologies to achieve long-distance transport of NG. Gas to liquid (GTL) technologies are among the most effective for achieving this objective.

The major hurdle for the extensive application of GTL conversion technologies is the high cost of the state-of-the-art GTL processes, the largest part of which is associated to air fractioning/syngas production. Therefore, there is the need to improve these technologies, on the one hand, and to explore alternative routes to conventional GTL process, on the other hand, producing higher-value products such as raw materials for the chemical industry.

This book overviews some of the exciting new developments in this area, based on (but not limited to) research activities in the framework of two large European projects, namely, "Innovative Catalytic Technologies & Materials for Next Gas to Liquid Processes" (NEXT-GTL) and "Oxidative Coupling of Methane followed by Oligomerization to Liquids" (OCMOL). These two projects investigated different routes, from the development of a novel energy-efficient syngas process scheme to routes for direct conversion of methane to methanol or aromatics and for the oxidative coupling of methane followed by its subsequent oligomerization to liquids. These frontier researches share not only the common general objectives but also the concept of how the progress in this highly challenging area derives from combining advanced process engineering tools to a tailored design of nanoporous membranes, catalysts, and sorbents.

Today, nanoporous materials realize a compromise in performance between demanding operational conditions and limited capabilities of materials. Manipulating porous solids so as to exhibit desired characteristics (engineered pore size, geometry, specific active sites, etc.) is currently at the cusp between tailoring and design. It is shown that *engineering in* the required nanopore structure and properties can lead to the establishment of *next-generation* GTL processes.

This book describes well the concept of integrated process engineering at the nano- and macroscale as the key approach for innovation. The first two sections of the book are devoted to the recent advances in the development of membranes, catalysts, and sorbents with tailored properties for GTL processes.

Next-generation GTL technologies are presented in the third section of the book, where innovative oxidative and nonoxidative GTL processes are discussed together with results on a novel membrane-assisted process scheme for syngas production.

The impressive list of internationally known contributors is what makes this book stand out. We thank every one of them for their invaluable contribution. Special thanks to Jill Jurgensen, Allison Shatkin, and their colleagues from Taylor & Francis Group for their help and patience.

Last but not the least, we thank the European Commission for funding the cited EU projects (NEXT-GTL and OCMOL), the three networks of excellence (IDECAT, INSIDE-PORES, and NANOMEMPRO), and the derived virtual institutes (ERIC aisbl, ENMIX aisbl, and EMH), which actively promoted and collaborated to the successful realization of the aforementioned projects and this book. Special thanks go to Dr. Helge Wessel, who was in charge of the integrated projects, for his valuable assistance and patience.

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Editor

Dr. Nick K. Kanellopoulos is the research director of the Membranes for Environmental Separations Laboratory. His research interests are the development, characterization, and evaluation of the performance of novel nonporous membranes. He is the author or coauthor of more than 170 publications in peer-reviewed journals, and he is the editor of 5 books in the field of nanoporous membrane applications. He has received a total funding of €12 million from over 50 European and national programs, and he participates in two high-tech companies in the field of nanoporous materials. He participated in the National Representation Committee of Greece for the FP6-NMP and FP7-NMP European programs in nanotechnology from 2001 to 2009. He was the coordinator of the European Network of Excellence in nanotechnology in-situ study and development of processes involving nano-porous solids (inside-pores.gr) and of the committee for the preparation and submission of the proposal for a Greek National Nanotechnology program. He has been a member of the National Committee for Nanotechnology in Brussels over the past 10 years, a Fulbright scholar, and president of the Greek Fulbright Scholars Association. Since 2011, he has been the president of the National Research Center Demokritos, and since 2013, he has been the chairman of the Committee of the Presidents of the Greek Research Centers.

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