MIGRATION OF FINES IN POROUS MEDIA

Theory and Applications of Transport in Porous Media

Series Editor:
Jacob Bear, *Technion – Israel Institute of Technology, Haifa, Israel*

Volume 12

The titles published in this series are listed at the end of this volume.

Migrations of Fines in Porous Media

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Springer-Science+Business Media, B.V.

Library of Congress Cataloging-in-Publication Data

ISBN 978-90-481-5115-8 ISBN 978-94-015-9074-7 (eBook)
DOI 10.1007/978-94-015-9074-7

Printed on acid-free paper

Originally published by Kluwer Academic Publishers in 1998.
Softcover reprint of the hardcover 1st edition 1998

to:
Students, Staff and Faculty of the
Department of Chemical Engineering,
IIT, Bombay, Mumbai

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PREFACE

This is the first book entirely on the topic of Migration of Fine Particles in Porous Media. There are two purposes for the use of this book. First, the book is intended to serve as a comprehensive monograph for scientists and engineers concerned with problems of erosion, pollution and plugging due to migration of fines in porous media. Second, the book is recommended to be used as a reference book for courses offered at senior or graduate level on the topics of flow through porous media, soil erosion and pollution, or formation damage.

The migration of fine particles in porous media is an engineering concern in oil production, soil erosion, ground water pollution and in the operation of filter beds. As a result, the topic has been studied by researchers working in a number of disciplines. These studies in different disciplines are conducted, by and large, independently and hence there is some repetition and perhaps more importantly there is a lack of uniformity and coherence. These studies, nevertheless, complement each other. To illustrate the point, consider for example the migration of fine particles induced by hydrodynamic forces. Studies are reported in geotechnical literature related to soil erosion as well as studies reported in petroleum engineering literature related to the decline in oil production. These studies even though reported with different terminologies and with different perspectives do complement each other in terms of the fact that once the particles are released, they are either entrapped to cause decline in permeability or transported with the flow causing phenomenon such as soil erosion. With these ideas in mind our primary objective is to bring together these studies and develop an unified theory and understanding on this topic.

The book is organized in a systematic manner. Chapter 1 presents the practical consequences of migration of fine particles in porous media related to different engineering disciplines. Chapter 2 begins our unified treatment of the phenomenon by characterizing both the porous media and the fine particles. Although, this chapter focuses on natural porous media such as rocks and soil and the indigenous fine particles present in these media, the techniques and the approaches discussed are general in nature.

The mechanism of release is probably the most important basic process in the phenomenon and therefore two chapters, Chapter 3 and 4 are devoted to it. Chapter 3 presents both the statics and dynamics aspects of the release of fine particles due to colloidal forces (colloidally induced release). Chapter 4 discusses the same phenomenon for the case of release of particles induced by hydrodynamic forces (hydrodynamically induced release).

Chapters 5, 6 and 7 focus on the mathematical modeling of the migration of fine particles. Chapter 5, discusses in a quantative manner whether, fine particles will get entrapped (plugging) in or move through (piping) the porous media. Criteria are presented to predict whether piping or plugging would occur along with practical applications such as soil erosion and sand filtration. In Chapter 6, macroscopic balance equations are presented to model the permeability reductions due to migration of fine particles. Both the mass and population balance equations are presented along with their solutions and applications. Chapter 7 uses network modeling approaches and presents the permeability reduction models primarily due to size exclusions.

The prevention of the migration of fine particles is an important practical consideration and this subject is discussed in Chapter 8. This chapter presents the various prevention techniques (known as clay stabilization techniques) developed in recent years in an unified manner.

Chapter 9, the last chapter, discusses soil pollution due to migration of fine particles. Both, the facilitated transport of organic contaminants and the migration of biocolloidal contaminants are discussed in terms of mathematical models.

We thank our publisher for showing patience when we failed to meet the deadlines and her unfailing co-operation. We also wish to thank the Kluwer editors for making valuable suggestions to the contents of the book. KCK is indebted to the porous media research group of Prof. Scott Fogler, at the dept. of chemical engineering, the University of Michigan, for providing the milieu to learn and work on the topic both during the periods of graduate studies and visiting assignments. We are indeed thankful to Mr. S.T. Jambigi, for meticulously word-processing the manuscript. We also thank Ms. Ingrid Ward for word-processing a part of the manuscript. We thank Dr. V. Ramchandran for scanning all the figures. Two past members of the porous media group, Dr. Ravi Vaidya and Dr. K.K. Mohan who have made research contributions on the topic have also contributed to the making of this book in many ways. We are thankful to them. We thank Mrs. Jaya Khilar for proof-reading the pre-final version of this manuscript. Some of our colleagues and students both

at IIT Bombay and at the University of Michigan have indirectly contributed to the completion of this book. We wish to thank them all. Finally HSF thanks his wife, Janet for supporting yet one more book-writing project. KCK thanks his parents and his wife for their support and particularly his sons, Kunal and Mrinal for being considerate during the writing this book.

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