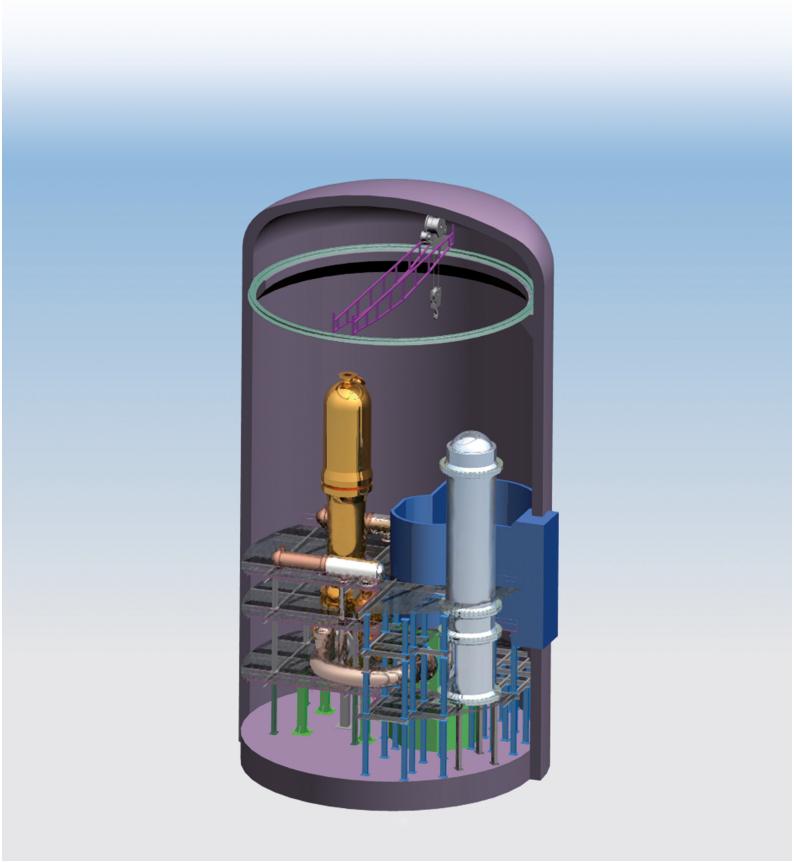
Manuali

Scienze e Tecnologie

Nuclear plants

Maurizio Luigi Cumo



University Press

Sapienza Università Editrice

Collana Manuali 18

Scienze e Tecnologie

Nuclear plants

Maurizio Luigi Cumo

SAPIENZA
UNIVERSITÀ EDITRICE
2017

Sapienza Università Editrice
Piazzale Aldo Moro 5 – 00185 Roma

www.editricesapienza.it
editrice.sapienza@uniroma1.it

ISBN 978-88-9377-029-3 (paperback part 1)
ISBN 978-88-9377-034-7 (paperback part 2)
ISBN 978-88-9377-024-8 (eBook)

Printed in september 2017

Iscrizione Registro Operatori Comunicazione n. 11420

In copertina: rappresentazione del reattore MARS (Multipurpose Advanced Reactor inherently Safe).

Table of contents

Preface

Maurizio Luigi Cumo

Many nuclear power plants are today in operation in the world to produce electric energy. New designs are developed to co-generate jointly electricity and heat for civil use (desalination of sea water and district heating). Advanced designs regard the thermo-mechanical water separation to produce hydrogen in future competition with natural gas, as fuel.

Some reactors of the 4th generation can multiply one hundred times the energy which is contained in natural uranium, ensuring an availability duration of thousand years from the present amount of uranium reserves. These same reactors may destroy the most dangerous and long living nuclear wastes, with a great help for geological repositories.

"Nuclear plants" include power and research reactors, fuel factories, uranium enrichment plants, reprocessing of exhausted fuels, waste conditioning, decommissioning of old plants, surface and geological repositories, etc.

Nuclear disciplines span from nuclear reactor physics, thermal fluid-dynamics, metallurgy, and nuclear chemistry, all in continuous evolution. Nuclear engineering is often a compromise among opposite requirements of the above disciplines: this should be one of the future nuclear engineer's main task.

Original results of experimental and theoretical researches performed in thirty years by the author in the Italian State for its nuclear energy Institution are utilized in this book.

Many of these researches pertain to critical situations in heat and mass transfer in extreme conditions for reactor safety.

The author has been enriched by important information coming from the Nuclear Energy Direction of the French Commissariat à

l'Energie Atomique, where he served as chairman of an International Scientific Committee from 2002 to 2010.

For this book, the author is greatly indebted to Mrs. Lisa Kassab for her continuos assistance, without whom this book would not have been possible.

For english translation a group of ENEA researchers (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) whose names are specifically indicated in pages 883-887. Their work was enriched by the addition of new scientific evidences in the last years also for this contribution goes to them my deep gratitude.

An appendix to Chap. 10 dedicated to Chernobyl accident and its very long evolution has been elaborated by Dr. Ivo Tripputi, SOGIN director and co-author of the book "Nuclear plants decommissioning" Università Sapienza of Rome, ISBN 88-900812-0-1.

Il Comitato editoriale assicura una valutazione trasparente e indipendente delle opere sottoponendole in forma anonima a due valutatori, anch'essi anonimi. Per ulteriori dettagli si rinvia al sito: www.editricesapienza.it

Collana Manuali

1. Il Tempo e la Verità
   Ernesto Capanna
2. Aerodinamica
   Giorgio Graziani
3. Medicina Nucleare in Oncologia
   Francesco Scopinaro e Maria Gemma Parisella
4. Impianti Nucleari
   Maurizio Cumo
5. Accounting for Equity and Other Comprehensive Income
   Francesco Bellandi
6. Gasdinamica
   Filippo Sabetta
7. Segnali - Processi Aleatori - Stima - Vol. I
   Gaetano Scarano
8. Segnali - Processi Aleatori - Stima - Vol. II
   Gaetano Scarano
9. Esercizi di analisi matematica
   Paola Loreti e Daniela Sforza
10. Meccanica dei fluidi sperimentale
    Antonio Cenedese e Monica Moroni
11. Impianti Nucleari - 2ª edizione
    Maurizio Cumo
12. Lettere in classe
    Percorsi didattici del TFA di area letteraria della Sapienza
    a cura di Paola Cantoni e Silvia Tatti
13. Gastrostomia Endoscopica Percutanea (PEG)
    Massimo Chiaretti, Alessandra Santiloni, Giovanna Angela Carru
    Annalisa Italia Chiaretti
14. E questo tutti chiamano Informatica
    L'esperienza dei TFA nelle discipline informatiche
    a cura di Anna Labella
15. Creando saberes
    Aproximaciones a la didáctica de E/LE en el aula
    a cargo de Daniela Rago, Elisabetta Sarmati, María Pilar Soria Millán y Patricia Toubes González

16. Der Weg ist das Ziel
    Imparare il tedesco in un mondo plurilingue
    Jörg Senf
17. Conoscere la famiglia
    Strumenti clinici e di ricerca
    a cura di Mimma Tafà
18. Nuclear plants
    Maurizio Cumo

This book of the Publishing House of Sapienza University outlines the operative experience of a great number of nuclear power plants and devices of the nuclear fuel cycle. With main reference to nuclear plants of the so called third generation (III or III+, i.e. advanced ones) of the European Union and of Euratom research Centres the prospects of future plants of fourth generation (IV, years 2050s) are also described.

Large advancements have been obtained by extended cooperation of EU with USA, Japan and connections with Russia, China, India, Canada and other Countries. After Chernobyl (1986) and Fukushima-Daiichi (2011, 3 reactors) accidents with heavy consequences, people interest in nuclear energy decreased all over the world. This book examines in details such accidents to obtain safer designs Gen. IV reactors.

In 2003 an initiative of the DOE (USA Department of Energy) launched the so called Generation IV International Forum with 13 Countries (USA, England, France, Canada, Japan, South Corea, South Africa, Argentine, Brasil, Switzerland, EU with Euratom) to design and realise the future reactors of Fourth Generation to substitute third generation reactors at the end of their operative life. Lectors have so a description of the evolution of future reactor types and of prospects that nuclear energy may offer to mankind.

Maurizio Luigi Cumo is em. prof. of Nuclear Plants at the University of Rome Sapienza and is member of the Foundation Sapienza, Institution which gives prizes to Sapienza top students and may propose to Sapienza Administrative Council new researches to be undertaken. He was engaged in many international nuclear Institutions and Organisations. In years '80s he was engaged in the design of a small-medium reactor inherently safe called MARS (described in this book). Presently, he is in the group of senators and electors of the European Academy of Sciences and Arts of Salzburg, representing Italy, and is president of SIPS, the Historical (1839) Italian Society for the Advancement of Sciences.

ISBN 978-88-9377-024-8

9 788893 770248

www.editricesapienza.it