

## CONTENTS

1.	INTRODUCTORY REMARKS— FUSION POWER FEASIBILITY . . . . .	1
1.1	Fuel Cycles and Breeding Reactions	2
1.2	Energy Balance and Reactor Conditions	3
1.3	Approaches to Fusion	6
1.4	Magnetic Confinement	6
1.5	Magnetohydrodynamic (MHD) Instabilities	11
1.6	Microinstabilities	15
1.7	Whence Fusion Power Feasibility	17
2.	BASIC PROCESSES AND BALANCES IN FUSION REACTORS . . . . .	21
2.1	Energy Balance and Ignition Temperature	21
2.2	Bremsstrahlung Power	23
2.3	Cyclotron (Synchrotron) Radiation	26
2.4	Power from Fusion Reactors	28
2.5	Particle Balance and Burn-up Fraction	32
2.6	A More Detailed Plasma Energy Balance	35
3.	SOME ASPECTS OF THE NEUTRONICS IN FUSION REACTORS . . . . .	43
3.1	Neutron Diffusion	44
3.2	Tritium Breeding and Doubling Time	52
3.3	Neutron Radiation Damage in Reactor Materials	60
4.	PHYSICS OF NEUTRAL BEAM HEATING . . . . .	81
4.1	Introduction	81
4.2	Plasma Heating by Energetic Heavy Charged Particles	83
5.	PLASMA HEATING BY RELATIVISTIC ELECTRONS . . . . .	131

6.	RADIOFREQUENCY (RF) HEATING OF FUSION PLASMAS . . . . .	157	13.	DESIGN CONSIDERATIONS OF FUSION REACTORS . . . . .	313
	6.1 Transit Time Magnetic Pumping	161		13.1 Wall Loading	314
	6.2 Guiding Center Theory of Transit Time Heating	162		13.2 Magnetic Field and Plasma Density	317
7.	ADIABATIC COMPRESSION AND IGNITION OF FUSION REACTORS . . . . .	183		13.3 The Containment Parameter $n\tau$	319
	7.1 Tokamak Geometry	185		13.4 Mirror Reactor Feasibility	326
	7.2 Derivation of the Vertical Field	186		13.5 Main Design Parameters of a Mirror Reactor	330
	7.3 Application	199		13.6 Design Characteristics of a Pulsed Fusion Reactor	335
8.	DYNAMICS AND CONTROL OF FUSION REACTORS . . . . .	203	14.	RADIATION DAMAGE TO MATERIALS IN FUSION REACTORS . . . . .	351
	8.1 Thermal Instability and Feedback Stabilization	203		14.1 Sputtering Theory	352
	8.2 The Dynamic Behavior of a Low Beta Tokamak Reactor	214		14.2 Sputtering Damage in Fusion First Wall	375
9.	AN ENVIRONMENTAL ASPECT OF A FUSION POWER PLANT—THERMAL EFFICIENCY AND WASTE HEAT . . . . .	231		14.3 Erosion Due to Evaporation	389
	9.1 Analysis and Results	232		14.4 Wall Damage by Blistering	400
	9.2 The Principle of Direct Conversion in Mirror Systems	249	15.	HEAT REMOVAL AND THERMAL CONSIDERA- TIONS IN FUSION REACTOR BLANKETS . . . . .	405
10.	FISSION-FUSION HYBRID SYSTEMS . . . . .	255		15.1 The Equations of Magnetohydrodynamic (MHD) Flow in Ducts	406
11.	INERTIAL-CONFINEMENT FUSION SYSTEMS . . . . .	263		15.2 Some Physical Aspects of MHD Flow in Ducts	416
	11.1 Technical Considerations of a Microexplosion	266		15.3 Calculation of the Pressure Drop and Pumping Power	424
	11.2 Effects of Electron Thermal Conduction and Alpha Heating	272		15.4 Stress Considerations in Coolant Ducts	430
	11.3 The Concept of Laser-Fusion	277	16.	A COMPARATIVE STUDY OF THE APPROACHES TO FUSION POWER . . . . .	441
	11.4 Economic Considerations	290		16.1 General Formulation of the Power Balance Equation	442
	11.5 Laser Absorption	292		16.2 Calculation of Q for Pulsed and Steady-State Systems	449
12.	RADIOLOGICAL ASPECTS OF FUSION REACTORS . . . . .	297		16.3 Application to the Various Fusion Concepts	452
	12.1 Relevant Nuclear Reactions	299		16.4 Intercomparison and Conclusions	478
	12.2 Radioisotope Inventory	305			
	12.3 Nuclear Afterheat	307			