INTRODUCTION

	PEASE - ERICE SUMMER SCHOOL ON PULSED REACTORS. INTRODUCTORY REMARKS	3
	 Energy supplies and fusion Technological forecasting Characteristics of pulsed reactors Conditions in pulsed systems experiments Principal discharges Theta-Pinch Electron beams Lasers Drawbacks of the pulsed systems Conclusions References 	
SCIE	NTIFIC FEASIBILITY	
J.G.	LINHART - ENERGY FROM THERMONUCLEAR FUSION - BASIC PHYSICAL PARAMETERS	28
	1. Introduction 2. Astrophysical prelude 3. Explosive fusion 4. The trigger-criterion 5. Magnetic confinement 6. The high magnetic field confinement 7. Microexplosions 8. Economics References	
H.A.	B. BODIN - CONFINEMENT OF HIGH-BETA PLASMA	48
	Lecture 1.	
	<pre>INTRODUCTION AND HIGH-BETA STELLARATORS (HBS) 1. General introduction 2. Compressional High-Beta Stallerator 2.1. Introduction 2.2. Theory of High-Beta Stellarator 2.3. Stability 2.4. Equilibrium 3. Comparison with experiment</pre>	
	3.1. General 3.2. Detail of HBS experiments 3.3. Results on toroidal equilibrium 3.4. Stability and instability 4. Conclusion and summary	

Lecture 2.

REVERSED FIELD PINCH (RFP)

- 1. Introduction
- 2. Comparison with Tokamak
- 3. Theoretical considerations
 - 3.1. Equilibrium
 - 3.2. Ideal MHD stability
 - 3.3. Dissipative MHD
 - 3.4. Non-Ideal MHD effects
 - 3.4a Microinstabilities
 - 3.4b Trapped-particle effects
 - 3.4c Diffusion particle and energy confinement
- 4. The Zeta experiment
 - 4.1. General
 - 4.2. Conditions for Quiescence
 - 4.3. Properties of the discharge during quiescence
 - 4.4. Self Reversal
 - 4.5. Why does Self Reversal lead to stability in Zeta and not elsewhere?
 - 4.6. The energy losses and volt-second consumed during Setting-Up
- 4.7. Radiation losses at current up to 900 kA
- 5. HBTX I Experiment
 - 5.1. General
 - 5.2. Classical behaviour
 - 5.3. Stability Comparison between theory and Experiment
- 6. Self Reversal
- 7. Summary

References

Lecture 3.

PLASMA HEATING IN HIGH-BETA SYSTEMS

- 1. Introduction
- 2. Different approaches to heating High-Beta Reactors
- 3. High-Beta Stellarator heating
 - 3.1. Conventional 0 Pinch heating
 - 3.2. Ultra fast Implosion or Piston heating
 - 3.3. Staged heating
 - 3.3.1. General
 - 3.3.2. Simple analytic model
 - 3.4. Wave heating and Neutral Injection heating

4. Heating in Reversed Field Pinches
4.1. General
4.2. Scaling Laws
4.3. Experiments

References

J.G. LINHART - SOME NOTES ON LINERS

110

- 1. Introduction
- 2. Power amplification
- 3. Propulsion of liners
- 4. The use of liners fort CTR

References

C. MAISONNIER - PLASMA FOCUS AND THERMONUCLEAR FUSION

131

- 1. Introduction
- 2. Mechanism of neutron emission
- 3. Analysis of a particular shot
- 4. Energetic consideration and scaling laws
- 5. Extrapolation to larger devices
- 6. Conclusion

References

K.A. BRUECKNER - SOME ASPECTS OF COMPRESSION AND HEATING

155

Lecture 1.

ANALYTIC ESTIMATES OF ENERGY PRODUCTION

- 1. Scaling laws
- 2. Direct Laser heating of uncompressed spheres
- 3. Thermal conduction heating of uncompressed
- 4. Summary of results for uncompressed spheres

Lecture 2.

ANALYTIC ESTIMATES OF ENERGY PRODUCTION

- 1. Uniform sphere with compression and self-heating
- 2. Non-uniform compressed sphere with self-heating

COMPRESSION 1. Introduction 2. General features of hydrodynamics 3. Compression and fusion yield in a single convergent shock 4. Shock sequences in a plane 5. Shock sequences in spherical geometry Lecture 4. PROBLEMS OF IMPLOSION PHYSICS 1. Preheat by fast electrons 2. Asymmetries in compression 3. Induced magnetic fields	R•	Introduction 1. Magnetic confinement 2. Magnetic fields 3. Magnetic energy density 4. Some structure considerations 5. The plasma current 6. Ohmic heating 7. A practical comparison with a Tokamak design 8. Normal conductors or superconductors? 9. Circuit voltages 10. Modification to scaling factors 11. Conclusions	277
L.I. RUDAKOV - SOME REMARKS ON THE POSSIBILITY OF USING HIGH POWER ELECTRON BEAMS FOR THERMONUCLEAR REACTORS	237 T.E	. JAMES - ELECTRICAL ENGINEERING PROBLEMS IN PULSED MAGNETICALLY CONFINED REACTORS	297
1. Introduction 2. Energy deposition 3. Focusing 4. Conclusions References		Abstract 1. Introduction 2. Reactor parameters 2.1. Theta-Pinch Reactor (TPR) 2.2. Reverse Field-Pinch Reactor (RFPR) 2.3. Tokamak Reactor 3. System design aspects 3.1. I circuit (RFPR and Tokamak)	
Abstract 1. Basic concept of Theta-Pinch systems 2. Principles of operation and major reactor parameters 3. Reactor design and component considerations 4. D-T Burn dynamics 4.1. The burn cycle 4.2. The direct-concersion cycle 5. Plasma cooling by a neutral gas layer 6. Energy balance 7. Blanket system References	246	3.2. Magnetic field energy ratios 3.3. Direct conversion of plasma energy (TPR) 3.4. Circulating power fraction 4. Pulsed Power Supplies (PPS) 4.1. PPS ratings for RFPR and Tokamak 4.2. Rotating inductive store for TPR 4.3. Shock heating systems for TPR 5. Eddy current losses 5.1. Eddy current losses in Blanket regions 5.2. Eddy current losses in field coils 6. Magnetic forces 6.1. Forces on field coils 6.2. Transient forces on Blamket structures 7. Conclusions References	

Х

B. :	BRANDT	-	NEUTRAL	GAS	LAYER	FOR	HEAT	REMOVAL
------	--------	---	---------	-----	-------	-----	------	---------

320

S. FÖRSTER, F.H. BOHN, H. CONRADS, J. DARVAS, B. SACK - "SATURN"

364

A CONCEPTUAL DESIGN OF A LASER FUSION POWER PLANT

1. Abstract

- 2. Objective
- 3. The gas blanket at steady state
- 4. Pulsed gas blankets
- 5. Application in the RTPR
- 6. The pumping requirement
- 7. OLIPHANT'S results
- 8. Open questions
- 9. Appendix

References

A.P. FRAAS - CONCEPTUAL DESIGN OF A SERIES OF LASER-FUSION POWER PLANTS OF 100 TO 3000 MW(e)

331

Introduction

- 1. Boundary conditions
 - 1.1. Fuel cycle
 - 1.2. Breeding
 - 1.3. Blast containment
 - 1.4. Radiation damage
 - 1.5. Materials compatibility
 - 1.6. Heat removal
 - 1.7. Reactor safety
 - 1.8. Cost
 - 1.9. Life and reliability
- 2. Reference designs
 - 2.2. Blast containment
 - 2.3. Flow sheet
 - 2.4. Plant layout
 - 2.5. Pellet injection system
- 3. Blast containment system
 - 3.1. Blast containment experiments
 - 3.2. Distribution of the energy deposition
 - 3.4. Thermal energy transport
 - 3.5. Blast wave stresses
 - 3.6. Choice of design parameters
 - 3.7. Stresses in the pressure vessel
- 4. Injection port design
 - 4.1. Splash prevention
 - 4.2. Activation of structure
 - 4.3. Coupling to the Laser system
- 5. Limitation on tritium concentration in the blanket
 - 5.1. Tritium recovery system
- 6. Major uncertainties

References

Introduction

- 1. Main design data and general assumptions
- 2. Energy deposition in the reactor
- 3. Pellet injection
- 4. Ignition system
- 5. Blanket design and performance
- 6. Shields
- 7. The modules
- 8. Reactor support structure
- 9. Renewal of blanket
- 10. Servicing an repair
- 11. Tritium balance
- 12. Safety design
- 13. Energy balance
- 14. Economics aspects
- 15. Summary

References

Tables

- 1. Principal design data and assumptions
- 2. Particular design features
- 3. Discussion of principal design data and design features
- 4. Energy deposition areas and heat removal
- 5. Effects on walls exposed to the reaction products
- 6. Blanket performance characteristics
- 7. Design data and design features of the power modules
- 8. Design data and design features of the vacuum modules
- 9. Tritium balance
- 10. Energy balance
- 11. Cost situation survey

Figures

- 1. "SATURN" Overall design
- 2. Complete mechanical separation of ignition/pelletinjection system from energy recovery/concersion-system
- 3. Example for close nesting polyeder design of cavity surface
- 4. Pellet injection system arrangement
- 5. Pneumatic pellet injection device
- 6. Pneumatic pellet injection with laser correction
- 7. Optical chain arrangement
- 8. Optical chain characteristics
- 9. Two alternative blanket solutions
- 10. The "SATURN" modules
- 11. "SATURN" servicing and repair areas and safety design
- 12. Specific costs of steam turbines depending on number of units (total power 1200 MWe, for one unit)
- 13. Comparison of dimensions of HTGR direct cycle power plant with SATURN power plant

	BABUEL-PEYRISSAC - LECTURE ON THE IMPLOSION EXPERIMENTS AT THE CENTRE D'ETUDES DE LIMEIL. DESCRIPTION OF THE SET-U
	OF THE EXPERIMENT AND THE PROBLEM OF THE TARGETS.
	1. The present state of the studies concerning the implosion by laser light at Limeil
	2. Beam delivery
	3. Targets problems
	4. The cylindrical implosion experiment at Limeil
J. RO	BIEUX - HIGH BRIGHTNESS LASERS FOR GENERATING HOT AND DENS PLASMA
	Introduction
	1. Desired characteristics of lasers
	2. Physical principles governing the choice of the amplifying media the most suitable for producing the high
	laser energy within a short time
	2.1. Neodynium-doped glass laser
	2.2. CO2-N2 molecular laser
	3. Neodynium-doped glass lasers
	3.1. Overall self-focusing
	3.2. Perturbation self-focusing
	3.3. Optimization of an amplifier taking account of self-focusing phenomena
	3.4. Typical Neodynium-doped glass lasers systems
	3.4.1. Common trunk
	3.4.1.1. Electro-optical master oscillator
	(P.E.O.)
	3.4.1.2. Pulse shaping
	3.4.1.3. Amplification of the common trunk
	3.4.2. Separation system
	3.4.3. Power amplifying chain
	3.4.4. Increase of chain energy in the nanosecond range
	3.4.5. Use of the chain in the pico-second range
	3.4.6. Pico-second oscillator
(Conclusion. Present state and future developments of the
	Neodynium-doped glass technology
•	4. CO ₂ -N ₂ lasers
	4.1. Physical properties of CO2-N2 lasers at pressures
	close to atmospheric pressure
	4.1.1. Difficulty of excitation resulting from discharges instability at high pressures
	4.1.2. Typical solution found: Messrs. Dumanchin
	Farcy's transverse excitation laser
	4.1.3. Statistical properties of electrons
	4.1.4. Transfers between the different energy leve:
	of N and CO and conversion of the vibration

	4.1.5.1.	Masters oscillator
	4.1.5.2.	Amplifying chain
	4.1.5.3.	High pressure amplifiers
	4.1.5.4.	Injection of the pump energy in
		synchronium with the wave tra-
		velling along the propagation
		axis
lusion.	Present sta	te and future development of the

Conclusion. Present stat

laser technology

5. Chemical lasers

415

435

- 5.1. Physical principles
- 5.2. Hydrofluoric acid chemical laser
 - 5.2.1. Production of fluorine atoms by means of

an electric discharge

- 5.2.2. Production of fluorine atoms by high energy electron bombardment
 - Decomposition of SF₆
 Decomposition of F₂
- 5.3. Ability of the chemical laser to deliver a laser energy within a very short time of the order of a few hundred picoseconds

Conclusion

A.P. FRAAS - TOPPING AND BOTTOMING CYCLES

552

Introduction

- 1. Special cycles
 - 1.1. Organic Rankine cycles
 - 1.2. Bottoming cycles
 - 1.3. Supercritical CO, cycle
 - 1.4. SO₂ cycle
 - 1.5. Dissociating gas cycles
 - 1.6. Binary vapor cycles
 - 1.7. Mercury vapor topping cycle
 - 1.8. Potassium vapor topping cycle
 - 1.9. Cesium vapor cycle
 - 1.10. Combinations of gas and steam turbine cycles
- 2. Comparison of major cycles
- 3. Cycles under active development
 - 3.1. Gas turbine topping cycle
 - 3.2. Blade cooling
 - 3.3. Ceramic blades
 - 3.4. Potassium vapor cycles
- 4. Comparison of developmental problems Bibliography

4.1.5. Problems connected with TEA laser delivering and energy pulse of 10-9 duration

nal energy to laser energy

K.L. KOMPA	- HIGH POWER GAS LASERS FOR FUSION EXPERIMENTS: PRESENT AND FUTURE	572	W. DANNER - PROBLEMS OF TRITIUM PRODUCTION, RADIATION DAMAGE AND NEUTRON ACTIVATION IN BLANKETS OF PULSED FUSION REACTORS	651
PROBLEMS CO	MMON TO ALL PULSED REACTORS		Summary 1. Introduction	
			2. Blanket design features	
G. ROSTAGNI	- ENERGY STORAGE AND TRANSFER	594	 3. Tritium production 3.1. Tritium generation and breeding 	
			3.2. Tritium extraction	
49 .			3.3. Tritium economy	
Abstra			4. Radiation damage	
	roduction		4.1. Radiation damage to structure materials	
	ergy and power requirements be properties of different forms of energy		4.2. Radiation damage to insulator materials	
	prage and transfer		5. Activation and afterheat	
	. Electrostatic store		5.1. Activation of the niobium structure	
	. Magnetic store		5.2. Biological hazard potential	
	. Kinetic storage		5.3. Afterheat	
	• Electromechanical energy conversion		6. Conclusions	
	. Constant magnetic energy systems		References	
	Other transfer elements			
3.7	. Summary of energy storage methods		TENTEROD TENTEROD OF THE TOTAL PRODUCT OF THE PRODU	
	omparison of the proposed reactor schemes		W. KÖPPENDÖRFER - SYSTEM ANALYSIS OF MAGNETICALLY CONFINED PULSED REACTORS	682
	. Laser driven reactor		PULDED REACTORS	902
	. Theta pinch reactor			
	RFP Reactor		1. Introduction	
	. Tokamak pulsed reactor		2. Reactor Dimensions and Plasma Parameters	
5. Con Refere	clusions		3. Power Balance Considerations of Magnetically	
reiere Tables			Confined Pulsed Reactors	
Figure	·		4. Remarks on the Cost Structure of Pulsed Systems	
rigure			5. Conclusions	
			References	
G. CASINI -	THERMOMECHANICAL AND EROSION EFFECTS IN THE FIRST			
	WALL AND BLANKET OF POWER THERMONUCLEAR PULSED	I.		
	REACTORS	625	s. FÖRSTER - SYSTEM ANALYSIS OF INERTIALLY CONFINED REACTORS	696
· · · · · · · · · · · · · · · · · · ·			1. Introduction	
	roduction		2. Ignition system	
	escale of Events		3. Thermodynamic characteristics	
	out of the First Wall and Blanket Configurations		4. Design of reactor and of whole plant	
	ergy Deposition in the Blanket		5. Economic aspects	
•	est Wall Surface Effects		6. Potential of system	
	est Wall and Blanket Thermohydraulics		7. Conclusions	
7. Con Refere			References	
*! G * G * C	**************************************			

 Outline of consequences of main parameters choice for the ignition system 	
2. Design characteristics by using helium as reactor	
coolant	
 Overall design objectives Survey of the design approach of the reactor and of 	
the whole plant	
5. Background questions for evaluation of plant costs	
6. Background questions for the evaluation of running costs	
7. Problem identification for evaluation of development	
expenses	
Figures	
1. System analysis background	
Energy flows in a laser driven fusion reactor and plant net efficiency formula	
3. Modular reactor design scheme (proposed for SATURN	
design)	
COMPARISON OF DIFFERENT KINDS OF REACTORS	
M. SILVESTRI - THE ENERGY GROWTH : AN ASSESSMENT	725
Abstract	
1. Introduction	
2. Italy's energy supply and production	
 USA energy supply and production Comparison between EEC countries and Comecon in 1972 	
5. Worl data	
6. Ford Foundation's Energy Policy Project	
7. Conclusion	
References	
R. HANCOX - CRITERIA AND METHODS FOR THE COMPARISON OF	
ALTERNATIVE REACTORS	733
1. Introduction	
2. Possible criteria	
2.1. Physical feasibility	
2.2. Technological feasibility	
2.3. Operational acceptability	
2.4. Eventual use 3. Methods of comparison	
3.1. Parametric studies	
3.2. Conceptual Reactor Design Studies	
3.3. System studies	
3.4. Cost-benefit analysis	
4. Conclusion	

Tables

		Introduc						
		Intermed Alternat						
	4.	Programm	che	oices				
		Manpower Conclusi		costs				
	٥.	Conclusi	on					
List	of	Lectures	and	Member	s of	the	School	Committee

747

756