

INVESTIGATIONS ON SOME FUELS FOR UTILIZATION  
IN OPEN CYCLE MHD POWER GENERATORS

BY

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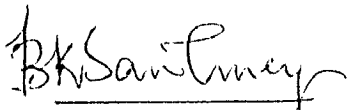
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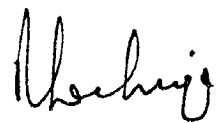
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TO MY PARENTS

C E R T I F I C A T E

It is certified that the thesis entitled "Investigations on some Fuels for Utilization in Open Cycle MHD Power Generators" being submitted by Ami Chand is worthy of consideration for the award of the degree of Doctor of Philosophy and is a record of the original bonafide research work carried out by him under our guidance and supervision. The results contained in this thesis have not been submitted in part or full to any other University or Institute for award of any degree or diploma.

  
Dr. B.K. Sawhney

  
Dr. R.P. Dahiya

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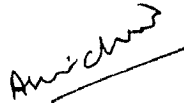
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## PREFACE

The electrical conductivity of the working fluid plays a significant role in extracting power from an MHD generator.

The electrical conductivity depends on the fuel used and on other parameters like seeding ratio and pressure, in the MHD generator. In this thesis, therefore, investigations on hydrogen, liquefied-petroleum-gas (LPG), watergas and biogas fuels have been carried out in order to assess their suitability for utilization in open cycle MHD power generators. The combustion temperature and the electrical conductivity of these fuels have been analytically evaluated and their dependence on seeding ratio, preheating and/or oxygen enrichment of air, pressure and C/H ratio and calorific value of the fuel have been studied. Experimental measurements of the combustion temperature and the electrical conductivity of seeded (with aqueous  $K_2CO_3$ ) combustion products of LPG/air, watergas/air and biogas/oxygen systems have been made for various percentages of oxygen enrichment of air, and seeding ratio at atmospheric pressure. Experiments have also been performed for various mixtures of LPG and acetylene ( $C_2H_2$ ) burnt with oxygen and oxygen enriched air to investigate the effect of C/H ratio on the electrical conductivity. The experimental values of the temperature and electrical conductivity are found to be in agreement with

the theoretically predicted results. The analytical investigations show that  $H_2/O_2$ , LPG/air and water gas/air systems may be utilized in open cycle MHD power generators even up to an operating pressure of 8 atm, while biogas/air-oxygen system can be operated up to 5 atm.

In addition to the achievable electrical conductivity of the seeded combustion products of the fuel, the cost and availability of the fuel also play an important role while selecting a suitable fuel for utilization in MHD power generators. Investigations have, therefore, been made to obtain an optimum combination of fuel from amongst various commercially available gaseous and liquid fuels so that the desired level of electrical conductivity (taken to be  $10 \text{ mhos-m}^{-1}$  in the present investigations) is achieved at minimum cost. The investigations show that a combination of LPG- $C_2H_2$  burnt with air and LPG-water gas or LPG -  $C_2H_2$  burnt with preheated air may be suitable fuel combinations for utilization in MHD power generators.

The analytically evaluated values of electrical conductivity have been expressed in the form of a power law in terms of pressure and temperature to facilitate the design analysis of constant Mach number open cycle MHD power generators. Cycle analysis of a portable MHD generator with  $H_2/O_2$  system and steam-bottomed MHD power generators

operated with  $H_2/O_2$  , LPG/air, water gas/air and biogas/air systems have been carried out in order to evaluate values of combustor pressure, duct length and fluid velocity at duct inlet to achieve highest possible efficiency of the plant. Influence of preheating and oxygen enrichment of air, and thermal input on the overall plant efficiency of an optimal designed MHD generator has also been studied. It is found that an overall plant efficiency in the range of 44-48 percent may be obtained by utilizing these fuels in steam-bottomed open cycle MHD power generators. Typically, for an  $H_2/O_2$  system an overall plant efficiency of 47.6 percent can be obtained when the duct length, combustor pressure and duct inlet velocity respectively are kept at 4.75 m, 6 atm and  $900 \text{ m-s}^{-1}$ .

## CONTENTS

Acknowledgements		iv
Preface		v
Nomenclature		viii
Chapter 1	INTRODUCTION	
1.1	An MHD System	1
1.2	Seeding	3
1.3	Electrical Conductivity	5
1.4	Cycle Analysis	7
1.5	Present Work : A Summary	10
Chapter 2	THEORETICAL ANALYSIS	
2.1	Introduction	17
2.2	Composition and Temperature	18
2.3	Electrical Conductivity	23
2.4	Power Law	26
2.5	Design and Analysis of MHD Generators	27
	2.5.1 Combustor and Nozzle	27
	2.5.2 Duct	31
	2.5.3 MHD Generator Efficiency	35
	2.5.4 Diffuser	37
	2.5.5 Steam Turbine Generator	38
	2.5.6 Compressors	38
	2.5.7 Magnet	39

Chaper	3	EXPERIMENTAL ARRANGEMENT AND METHODS OF MEASUREMENTS	
3.1		Introduction	41
3.2		Flow Measuring Unit	41
3.3		Combustor	44
3.4		Seeding System	46
3.5		Diagnostics	49
		3.5.1 Temperature Measurement	49
		3.5.2 Electrical Conductivity Measurement	50
3.6		Estimation of Error	58
3.7		Combustor Characterization	62
3.8		Biogas Combustion Experimental Arrangement	67
Chapter	4	TEMPERATURE AND ELECTRICAL CONDUCTIVITY	
4.1		Introduction	70
4.2		Effect of Oxygen Enrichment and Preheating of Air	71
4.3		Effect of Pressure	85
4.4		Effect of Seeding Ratio	88
4.5		Conclusions	95
Chapter	5	OPTIMUM COMBINATION OF FUELS	
5.1		Introduction	96
5.2		Selection of Fuels and Analysis	97
5.3		Results and Discussion	100
		5.3.1 Optimization of Fuel Combination	101
		5.3.2 Effect of C/H Ratio and Calorific value on Electrical Conductivity	121
5.4		Conclusions	128

Chapter 6	ANALYSIS OF OPEN CYCLE MHD POWER GENERATORS	
6.1	Introduction	132
6.2	Assumptions	133
6.3	Analysis	134
6.4	Results and Discussion	136
6.4.5	6.4.1 Portable MHD Generator	136
	6.4.2 Steam-bottomed MHD Generator	141
	6.4.3 Effect of Preheating, Enrichment and Thermal Input on Efficiency	150
6.5	Conclusions	163
	References	166
Appendix I	COMPUTER PROGRAMME	175
Appendix II	COMPOSITION AND CALORIFIC VALUES OF LPG, KEROSENE, DIESEL AND HEAVY FUEL OIL	184
Appendix III	COST EVALUATION OF WATER GAS	186
	Biodata	
	Reprints/Preprints	