

KINETIC AND OXYGEN TRANSFER STUDIES IN  
GLUCONIC ACID FERMENTATION

BY

PURNENDU GHOSH

THESIS SUBMITTED TO THE INDIAN INSTITUTE OF TECHNOLOGY, DELHI  
FOR THE AWARD OF THE DEGREE OF  
DOCTOR OF PHILOSOPHY

DEPARTMENT OF CHEMICAL ENGINEERING  
INDIAN INSTITUTE OF TECHNOLOGY, DELHI  
NEW DELHI-110029

APRIL 1976

CERTIFICATE

This is to certify that the thesis entitled "Kinetic and Oxygen Transfer Studies in Gluconic Acid Fermentation" submitted by Sri Purnendu Ghosh has been prepared under my supervision in conformity with the rules and regulations of the Indian Institute of Technology, Delhi. The research report and results presented in the thesis have not been submitted for any degree in any other University.

*T. K. Ghose*  
(T.K.Ghose)

### ACKNOWLEDGEMENT

I take this opportunity to express my sincere gratitude to my research supervisor Prof. Tarun K. Ghose for his thoughtful guidance, stimulating encouragement and keen interest throughout the work.

I am sincerely grateful to Mr. S.K.Tangnu, Dr. S.N. Mukhopadhyay, Dr. Vinod Bihari, Mr. R.G.Gupta, Mr. R.K.Sachdeva and Dr. H.N.Asthana for their enthusiastic cooperation.

I am thankful to Shri Subroto Sen Ray for his assistance while carrying out the experiments during the course of investigation. Finally I thank Mr. R.N. Shukla for nicely typing the manuscript.

*Purnendu Ghosh*  
(Purnendu Ghosh)

Biochemical Engg. Division,  
Indian Institute of Technology,  
Delhi.

## LIST OF FIGURES

<u>Figure No.</u>	<u>Title</u>
1.1	Possible oxygen transport pathways
3.1	Schematic representation of the experimental set up
4.1	Variation in state parameters with time at pH 5.8
4.2	Relation between rate of cell growth and cell concentration
4.3	Relation between cell growth and glucose consumption
4.4.	Relation between dissolved oxygen concentration and oxygen uptake rate
4.5	Variation in state parameters with time at pH 5.4
4.6	Vairation in state parameters with time at pH 6.2
4.7	Variation in state parameters with time at pH 6.6
4.8	Variation in state parameters with time at pH 7.0
4.9	Effect of pH on rate of growth

- 4.10 Effect of pH on gluconic acid production rate
- 4.11 Gluconic acid production rate and gluconolactone accumulation as a function of pH (resting cells)
- 4.12 Response of air input at individual stage of fermentation
- 4.13 Effect of aeration on gluconic acid production rate (resting cells)
- 4.14 Effect of agitation on gluconic acid production rate (resting cells)
- 4.15 Oxygen consumption rate of cells in the absence of aeration
- 4.16 Gluconic acid production rate as a function of dissolved oxygen concentration (resting cells)
- 4.17 Effect of cell concentration on gluconic acid production rate (resting cells)
- 5.1 Double reciprocal plot of glucose consumption for cell growth
- 5.2 Plot of ratio of dissolved oxygen concentration to specific oxygen consumption rate for cell growth vs dissolved oxygen concentration

- 5.3 Relation of rate of gluconic acid production and gluconolactone accumulation
- 5.4 Plot of Equation (5.1)
- 5.5 Experimental and predicted changes in cell concentration
- 5.6 Experimental and predicted changes in glucose and dissolved oxygen concentration
- 5.7 Experimental and predicted changes in the concentration of gluconic acid
- 5.8 Experimental and predicted changes in the concentration of gluconolactone
- 5.9 Effect of pH on  $v_L$ ,  $K_L$  and  $K_p$

## LIST OF TABLES

<u>Table No.</u>	<u>Title</u>
4.1	Glucose uptake for cell growth
4.2	Relationship of cell number and UOD
4.3	Effect of pH on reaction kinetics of gluconic acid fermentation by resting cells of <u>Ps. ovalis</u>
4.4	Effect of aeration on reaction kinetics of gluconic acid fermentation by resting cells of <u>Ps. ovalis</u>
4.5	Effect of agitation on reaction kinetics of gluconic acid fermentation by resting cells of <u>Ps. ovalis</u>
4.6	Effect of cell concentration on the reaction kinetics of gluconic acid fermentation by resting cells of <u>Ps. ovalis</u>
5.1	Kinetic constants of the mathematical models

## CONTENTS

CHAPTER-I:		... 1-28
SECTION-I:	INTRODUCTION AND OBJECTIVE OF PRESENT INVESTIGATION	
SECTION-II:	LITERATURE REVIEW	
CHAPTER-II:	THEORETICAL	...29-37
CHAPTER-III:	MATERIALS, METHODS AND EXPERIMENTAL PROCEDURE	...38-55
CHAPTER-IV:	RESULTS	...56-101
CHAPTER-V:	DISCUSSION	...102-133
CHAPTER-VI:	SUMMARY AND CONCLUSION	...134-137
	NOMENCLATURE	
	REFERENCES	