UNIVERSITI PUTRA MALAYSIA

INSULATED MONOPOLE SENSOR FOR DETERMINATION OF MOISTURE CONTENT IN HEVEA RUBBER LATEX

FARIZAH ANSARUDIN

FS 2012 25

DEDICATION

To my beloved husband Nurulhisham Musa,

parents, parents-in-law and

my little boys…Imran Mikael and Ilham Muqhriez

Thanks for everything

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

INSULATED MONOPOLE SENSOR FOR DETERMINATION OF MOISTURE CONTENT IN HEVEA RUBBER LATEX

By

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The thesis describes an investigation of the use of insulated monopole sensor as a new technique for the determination of moisture content in hevea rubber latex at microwave frequencies from 100 MHz to 5 GHz. The technique is investigated from the viewpoint of assessing its suitability as a simple, quick, non-destructive and flexible approach to determination of moisture content with comparable accuracy to the standard oven drying method. The analytical King's model was used to calculate approximately the variation in the reflection coefficients of the monopole sensor with frequency for various lengths of antenna, aspect ratios and type of insulated material. Extensive measurement results are provided in the thesis. The measured and calculated magnitude of the reflection coefficient using King's model were found to be in good agreement at 1 GHz for all samples of various percentages of moisture content but extendable to 3 GHz for moisture content less than 54.15%. However,

lowest error between measured and calculated phase was found in the frequency range from 2 GHz to 3 GHz coinciding with the profile of the variation in loss factor with frequency. Regression analyses were carried out to relate moisture content to magnitude, phase shift, conductance, susceptance, frequency shift of G-B peaks at different frequencies. These empirical equations were tested on 37 new samples by comparing the predicted moisture content with the actual moisture content obtained from oven drying method. It has been found that all the three empirical equations with good accuracy based on magnitude, phase shift and conductance shared similar operating frequency 0.52 GHz. The phase shift technique was found be to be most accurate in the determination of moisture content within 1.37% when compared to actual moisture content obtained using standard oven drying method.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

PENGESAN SEKUTUB BERPENEBAT UNTUK MENENTUKAN KANDUNGAN AIR DALAM SUSU GETAH

Oleh

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Tesis ini memperihalkan kajian terhadap penggunaan pengesan sekutub berpenebat sebagai teknik baru untuk menentukan kandungan air dalam susu getah pada frekuensi gelombang mikro dari 100 MHz hingga 5 GHz. Teknik ini telah dikaji melalui perspektif penilaian mengikut kesesuaiannya sebagai pengesan yang mudah, cepat, tidak-musnah dan fleksibel untuk menentukan kandungan air dengan perbandingan nilai ketepatan yang diperolehi dan kaedah piawai pengeringan ketuhar. Analisa Model King telah digunakan untuk mengira variasi pekali pantulan bagi pengesan sekutub berpenebat dengan frekuensi untuk pelbagai panjang pengesan, nisbah jejari penebat terhadap konduktor *b/a* dan jenis bahan penebat. Keputusan pengukuran dibentangkan dengan terperinci dalam tesis ini. Hasil perbandingan nilai pengukuran dan pengiraan pekali pantulan magnitud menggunakan Model King didapati baik pada 1 GHz untuk kesemua sampel pelbagai

peratus kandungan air tetapi hingga 3 GHz bagi sampel kurang dari 54.15% kandungan air. Bagaimanapun, ralat terendah diperolehi antara nilai pengukuran dan pengiraan bagi pekali pantulan fasa dalam julat frekuensi 2 GHz hingga 3 GHz mewakili variasi profil dalam faktor kehilangan dengan frekuensi. Analisis regresi telah dijalankan untuk hubungan antara kandungan air terhadap magnitud, anjakan fasa, konduktans, rentanan, anjakan frekuensi bagi puncak maksimum G-B pada frekuensi yang berbeza-beza. Kesemua persamaan empirikal yang diperolehi telah diuji pada 37 sampel baru dengan membandingkan kandungan air yang ditentukan dengan kandungan air sebenar yang diperolehi daripada kaedah pengeringan ketuhar. Analisa ini menunjukkan bahawa ketiga-tiga persamaan empirikal berdasarkan magnitud, anjakan fasa dan konduktans mempunyai nilai ketepatan yang baik pada frekuensi yang sama iaitu 0.52 GHz. Teknik anjakan fasa didapati adalah yang paling tepat dalam menentukan kandungan air dengan nilai ketepatan yang diperolehi dalam lingkungan 1.37% apabila dibandingkan dengan kandungan air sebenar menggunakan kaedah pengeringan ketuhar.

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I certify that a Thesis Examination Committee has met on 23 July 2012 to conduct the final examination of Farizah Binti Ansarudin on her thesis entitled "Insulated Monopole Sensor for Determination of Moisture Content in Hevea Rubber Latex" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the students be awarded the degree of Master of Science.

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DECLARATION

I declare that the thesis is my original work except quotation and citations which have been duly acknowledged. I also declare that is has not previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

_____

FARIZAH ANSARUDIN

Date: 23 July 2012

TABLE OF CONTENTS

		Page
DEDICATIONS		ii
ABSTRACT		iii
ABSTRAK		v
ACKNOWLEDGEMENTS		vii
APPROVAL		ix
DECLARATION		xi
LIST OF TABLES		xv
LIST OF FIGURES		xvi
LIST OF ABBREVIATIONS		xix
CHAPTER		
1	**INTRODUCTION**	1
	1.1 An Overview of Hevea Rubber Latex	2
	1.2 Microwave Sensors	3
	1.3 Dielectric Properties of Materials	6
	1.4 Problem Statements	9
	1.5 Research Objectives	10
	1.6 Scope of the Study	11
2	**LITERATURE REVIEW**	12
	2.1 Techniques of Determination of Latex Concentration	13
	2.1.1 Oven Drying Method	13
	2.1.2 Hydrometer technique	15
	2.1.3 Titration Method	16
	2.1.4 Buoyancy Method	16
	2.1.5 Optical Measurement Technique	16
	2.1.6 Microwave Techniques	18
	2.2 Microwave Measurement Techniques for Determination of Moisture Content in Materials	20
	2.2.1 Waveguide Technique	22
	2.2.2 Microwave Free-Space Measurement Technique	23
	2.2.3 Resonator Measurement	25
	2.2.4 Open-Ended Coaxial and Monopole Techniques	27
	2.3 An Overview of Monopole Antenna	30
	2.3.1 An Insulated Monopole Antenna	31
	2.4 Admittance Models for an Insulated Monopole Antenna	34
	2.4.1 Numerical Method	35
	2.4.2 Analytical Method	35

3	**ANALYSIS AND DESIGN OF AN INSULATED MONOPOLE SENSOR**		38
	3.1	Maxwell's Equations	39
	3.2	A Review of the Basic Principle of an Insulated Monopole Antenna	40
	3.3	Variation in Reflection Coefficient with Frequency for Various Length of Sensor, Aspect Ratios and Type of Insulated Material	46
		3.3.1 Variation in Sensor Length, h_a	46
		3.3.2 Effects of Aspect Ratio, *b*/*a*	47
		3.3.3 Variation Types of Insulation Material	50
	3.4	Effect of Permittivity of Sample and Radius of Insulation Material, *b* on |Γ|	51
4	**METHODOLOGY**		55
	4.1	The Insulated Monopole Sensor	55
	4.2	Sample Preparation and Moisture Content Measurement	57
	4.3	Experimental Set-up	58
		4.3.1 Reflection Measurement	58
		4.3.2 Permittivity Measurement	59
	4.4	Computational Procedure to Determine Reflection Coefficient based on King's Model	61
5	**RESULTS AND DISCUSSIONS**		64
	5.1	Variation in Permittivity of Hevea Rubber Latex of Various Percentages of Moisture Content with Frequency	65
	5.2	Comparison between Measured and Calculated Reflection Coefficient	72
		5.2.1 Magnitude of Reflection Coefficient (|Γ|)	72
		5.2.2 Phase of Reflection Coefficient (ϕ)	77
	5.3	Variation in Conductance and Susceptance with Frequency and Moisture Content	80
	5.4	Variation in Phase Shift with Moisture Content	84
	5.5	Performance Analysis of Insulated Monopole Sensor	88
6	**CONCLUSIONS AND SUGGESTIONS**		92
	6.1	Conclusion	92
		6.1.1 Main Contributions	93
	6.2	Recommendation for Future Work	93
		6.2.1 Analytical and Numerical Models	93
		6.2.2 Antenna geometrical dimensions	94
		6.2.3 Calibration	95
		6.2.4 Dielectric Permittivity Model	95

REFERENCES 96
APPENDICES 104
BIODATA OF STUDENT 122
LIST OF PUBLICATIONS 124