iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 **Issue:** II **Month of publication:** February 2016

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Significance of Separator Thickness for Supercapacitor

Pradip Mandake[1], Dr.P.B.Karandikar[2]
[1]M.Tech Student Department of Electrical Engineering, [2]Associate Professor Department of Electrical Engineering
[1]Bharati Vidyapeeth Deemed University, College of Engineering, Pune, India, [2]Army Institute of Technology, Pune, India

Abstract*— Supercapacitor also known as Electrochemical double layer capacitor. It is a advanced technology for the Storage of the electrical energy. Porous separator membrane that separates the electrodes of an electrochemical capacitor allows ions to spread out across to the opposite electrode, through the separator. Capacitance and ESR value of capacitor is most important in every energy storage system. It is known that power capability of supercapacitor is depend on the internal resistance of supercapacitor. Hence, capacitance and Equivalent series resistance (ESR) is considered as an output work in the presented paper. This paper presents the effect and significance of separator thickness of electrochemical double layer capacitors.
Keywords*— supercapacitor; separator; membrane; energy storage devices.

I. INTRODUCTION

Electrochemical double-layer capacitor (EDLC), also known as supercapacitor, is a type of important electrochemical energy storage device[1]. In batteries and the electrochemical energy storage devices, separator serves as an inactive fundamental component, and it plays an important role in determining the energy storage device performance [2]. A separator is a porous membrane/mat sandwiched between two electrodes[2]. Its main function is to physically separate the two opposite electrodes to avoid electrical short circuits, and also provide a way for ionic charge carriers transport in liquid electrolyte throughout the interconnected porous separator[3].

Supercapacitor consists of current collectors, electrodes, separator, and electrolyte[3]. Many researchers had given their efforts to produce a high performance supercapacitor for various focused studies such as the studies on the electrode, electrolytes and current collectors to have their high energy and power were reported[4]. On the other hand, only a few papers reported about the study of separator for the energy storage devices. Lots of research is going on supercapacitor due to its properties like high durability, high power density and fast charging and discharging mechanism [5]-[10]. To obtained high power, high capacitance, low ESR, high energy density, scientist have tried various types of porous membrane. More recently for separator material, they are focusing on natural porous materials[11]-[12].Supercapacitor also known as electric double layer capacitor consists of two electrodes immersed in an electrolyte solution. Charge storage mechanism is provided by electrodes while electrolyte provide conducting medium for them. The cell structure of supercapacitor is symmetric in nature i.e. Both electrodes have same materials. Supercapacitor offers very high capacitance per gram of material than conventional capacitor. In this Research work, the two different types of separators behaviors of supercapacitors comparatively studied. The separators are AGM and polyethylene are used, but there are nonwoven polypropylene (PP) mat, porous PP membrane, Al_2O_3-coated PP membrane, HI-SEP, PVC, and nonwoven cellulose paper use also.

II. EXPERIMENT

There have two types of separator used for experiment, which is increased thickness between the two electrodes one by one. For developing one prototype, two wire mesh SS316 of dimension 1cm X 3cm are taken. A manganese dioxide (50%) and Vulcun XC-72 (50%) with isopropyl are formed and a loading of 20mg/cm is applied on the wire mesh. After loading, wire mesh is kept dried for 20 mins by naturally, also it is dry by the use of dryer. After drying, wire mesh is sandwich in between one type of three separators with the help of fevibond paste which is used as a adhesive. The size of separator is 3cm X 4cm which is minimum and appropriate size of the designed electrodes. Another prototype was developed by using a manganese dioxide (50%) and Vulcun XC-72 (50%) with isopropyl are formed. When loading the different wire mesh care should be taken that each wire mesh has uniform loading. After drying, wire mesh is sandwich in between second type of three separators with the help of fevibond paste which is used as a adhesive. and it is compared with previously developed prototype on the basis of capacitance, internal resistance. For both prototypes, electrolyte used is potassium sulphate (K_2SO_4) because it got higher potential voltage.

After this, same process is repeated by increasing the layers of separator between two electrodes of supercapacitor of two different types of separator material. The layers of separator is increased the effect of capacitance and internal resistance are

Volume 4 Issue II, February 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

analyzed, And result and conclusions are drawn.

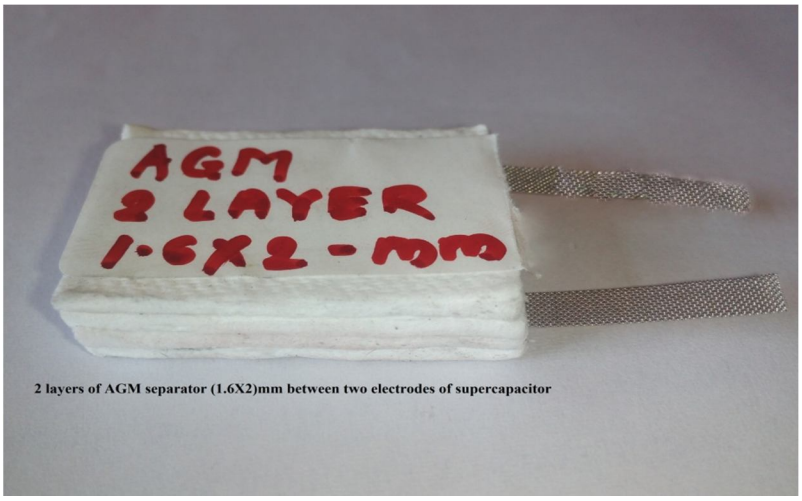


Fig1. Supercapacitor with separator double layer between two electrodes

III.ANALYSIS

The capacitance and ESR are the most important factors for design of the supercapacitor. There are analyzed the capacitance and ESR factors influenced by the multiple layers of supercapacitor with different types of separators.

TABLE I

COMPARISON OF SUPERCAPACITORS WITH MADE UP OF POLYETHYLENE (0.25MM) SEPARATOR THICKNESS

Thickness	C (f)	ESR
1 Layer	0.2815	49.72
2 Layer	0.3083	30.81
3 Layer	0.2944	23.77
4 Layer	0.2549	62.76
8 Layer	0.3548	38.04
12 Layer	0.4451	52.79

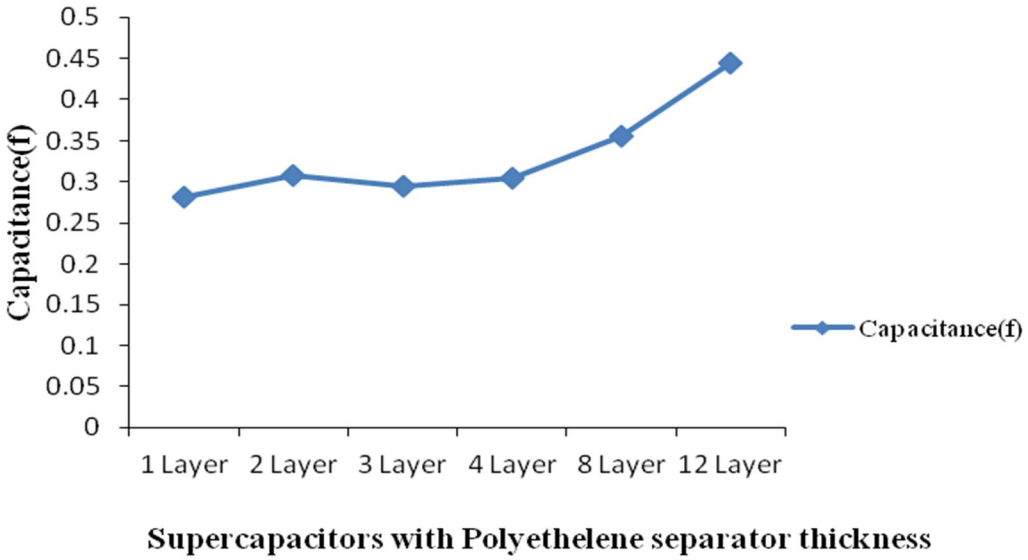


Fig2.Capacitance of Supercapacitor with polyethylene separators layers

Volume 4 Issue II, February 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

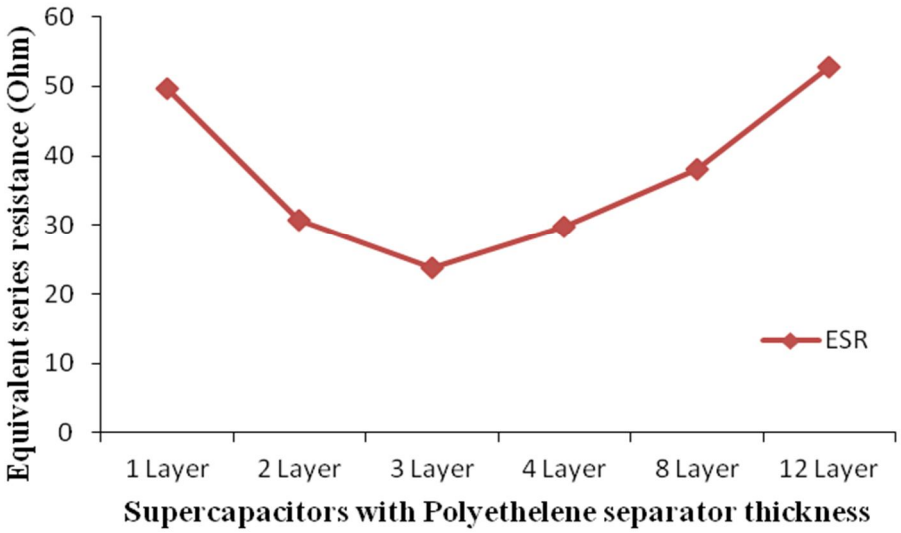


Fig3.ESR of Supercapacitor with polyethylene separators layers.

TABLE III
COMPARISON OF SUPERCAPACITORS WITH MADE UP OF AGM (1.6MM) SEPARATOR THICKNESS

Thickness	C (f)	ESR
1 Layer	0.3208	20.265
2 Layer	0.2974	23.537
3 Layer	0.326	23.003
4 Layer	0.3201	26.558
8Layer	0.3675	19.045
12 Layer	0.424	17.687

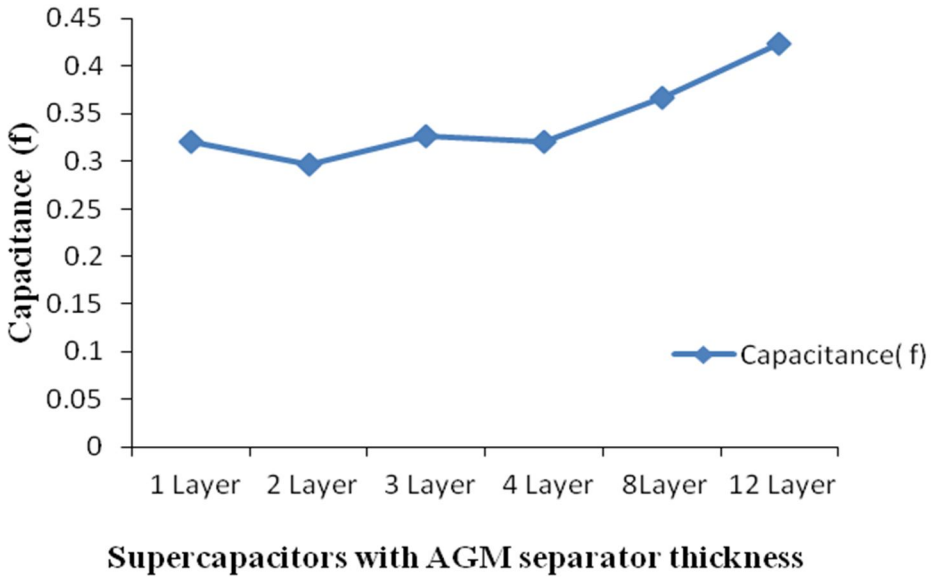


Fig4.Capacitance of Supercapacitor with AGM separator layers

Volume 4 Issue II, February 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

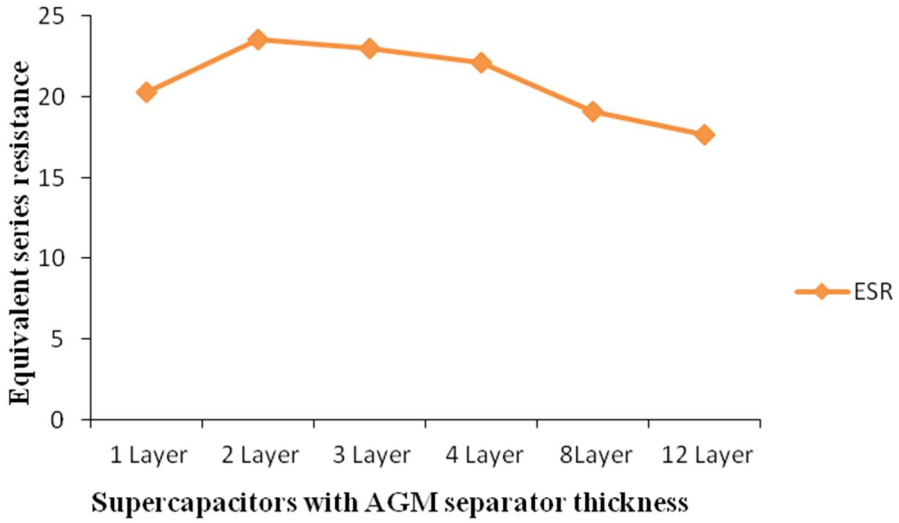


Fig5.ESR of Supercapacitor with AGM separator layers

IV. RESULTS

In the first case figure(2), the impedance of the separator in electrolyte is proportional to its thickness and inversely proportional to its porosity. Therefore the important characteristics for a membrane separator are high porosity, high strength and thin structure. A comparison of the ESR and capacitance of supercapacitors using 2 different separators is given in TableIII.

TABLE IIIII

EFFECT OF SEPARATOR THICKNESS ON ESR AND CAPACITANCE

Separator	Thickness(mm)	ESR	Capacitance
PE	0.5	30.81	0.3
PE	1	30.49	0.29
AGM	3.2	23.53	0.29
AGM	6.4	22.12	0.32

(3 cm^2,12 Cm^2 electrode, separator area respectively)

V. CONCLUSIONS

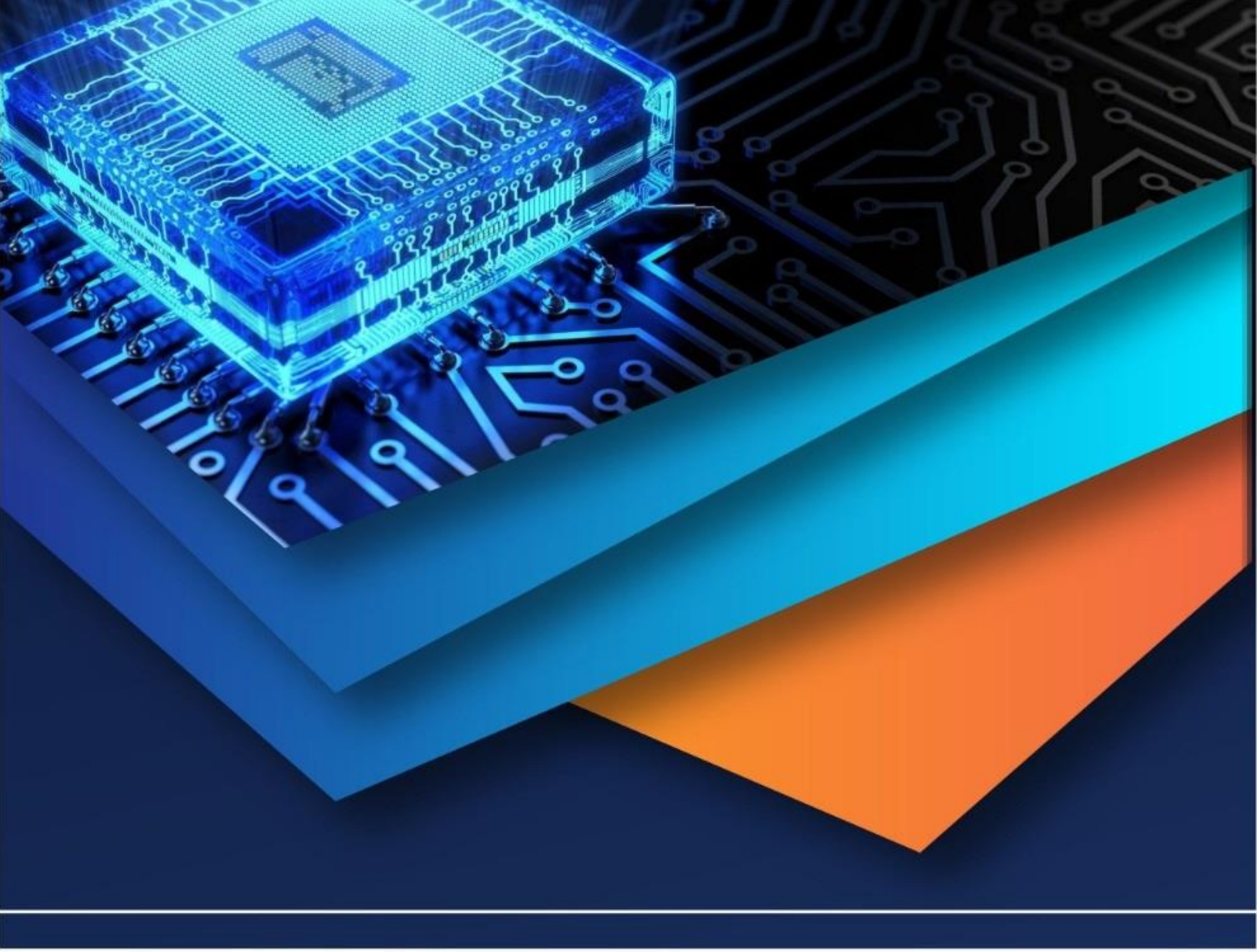
There are two characteristics of supercapacitor derived from various thicknesses of separator are studied and is compared with different types of separator. After studying it is observed that, Polyethylene separators of high thickness has high capacitance values and low internal resistance value as compared to high thickness of same separator at 3rd layer after this ESR is increased due to increase in thickness of separator. Also AGM separators of high thicknesses has high capacitance values and some about high ESR up to 4th layer after this the ESR is decreased during increase in thickness of AGM separator. It is clear that thickness and porosity not sufficient to determine the ESR and capacitance, but that other characteristics such as tortuosity and wetability, strength of separator material.

VI. ACKNOWLEDGMENT

The authors would like to acknowledge the management of Bharati Vidyapeeth Deemed University College of Engineering, Pune and Army Institute of Technology, Pune for providing academic and technical support throughout this research work. Authors would also like to thanks to Mr. D.M.Tagare former MD M/S. Madhav capacitors Pvt. Ltd. Bhosari Pune, Mr. Nikhil Kulkarni CEO PMK Energy Pvt. Ltd Jaysingpur, India and Dr.D.S.Bankar, Head of Electrical Engineering Department, Bharati Vidyapeeth Deemed University College of Engineering, Pune. Authors would also like to thanks Dr. (Mrs.) Sujata Marathe, Head of Applied science Department, Army Institute of Technology, Pune for her kind support during the course of this research work.

REFERENCES

[1] Gaurav Shekhar,P.B. Karandikar and Mukesh Rai "Investigation of Carbon Material Derived From Leaves of Tree for the Electrodes of Supercapacitor" International Journal of Emerging Engineering Research and Technology Volume 2, Issue 6, September 2014, PP 127-131.
[2] SUN Xian-Zhong,ZHANG,Xiong HUANG, Bo MA Yan-Wei."Effects of Separator on the Electrochemical Performance of Electrical Double-Layer Capacitor and Hybrid Battery-Supercapacitor" Acta physics.-chim.2014,30(3),485-491.
[3] P. Simon and Y. Gogotsi, "Materials for electrochemical capacitors," vol. 7, pp. 845-854, November 2008, 2008.
[4] Practical aspects & hurdles in the development of low-cost high performance supercapacitors A.G. Pandolfo, A.M.Vassallo, CSIRO Division of Coal & Energy Technology.
[5] R. P. Deshpande, Capacitor Technology and trends, Paperback 2013.
[6] Zhi Jun Jia ,Jun Wang , Yi Wang ,Tao Qi , and Chang Ming Li DOI: 10.1002/aelm.201500123
[7] X. Li, W. Xing, S. Zhuo, J. Zhou, F. Li, S. Qiao and G. Lu, Bioresour.Technol.,2011, 102,1118.
[8] C. X. Guoab and C. M. Li, Energy Environ. Sci., 2011, 4, 4504.
[9] S. Bose, T. Kuila, A. K. Mishra, R. Rajasekar, N. H. Kim andJ. H. Lee, J. Mater. Chem.,2012,22,767.
[10] Karandikar, P.B.,Pandey, A.K.,Negi, A.,Ku mar, S."Comparative study of rolled and stacked type aqueous supercapacitor",Global Humanitarian Technology Conference: South Asia Satellite (GHTC-SAS), IEEE, Year:2013, pp:260-263.
[11] Separator Membranes Produced from Polymers by Electrospinning for Applications in Electrical Double Layer Capacitors. Matt Biggers (Biomedical Engineering) – University of North Carolina at Chapel Hill.
[12] Alexis Laforgue'Lucie Robitaille"Electrochemical Testing of Ultraporous Membranes as Separators in Mild Aqueous Supercapacitors" DOI: 10.1149/2.020207jesJ. Electrochem. Soc. 2012volume 159, issue 7, A929-A936.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY