DISSOLUTION OF POLYETHYLENE TEREPHTHALATE (PET)
BY USING SOLVENTS.

MUHAMMAD ZUL HELMI BIN MD JALANI

A thesis submitted in the fulfillment of the requirement for the
award of degree of
Bachelor of Engineering (Chemical)

Faculty of Chemical Engineering
Universiti Teknologi Malaysia

JANUARY 2013
I hereby declare that I have read this thesis and in my opinion, this thesis is sufficient in terms of scope and quality for purpose to be awarded the Degree of Bachelor of Engineering (Chemical)

Signature : ..........................................................
Name of Supervisor : DR. TUAN AMRAN TUAN ABDULLAH
Date : 14 JANUARY 2013
I declare that this thesis entitled “Dissolution of Polyethylene Terephthalate by Using Solvents” is the result of my own research except as cited in the references. This thesis has not been accepted for any other degree and is not concurrently submitted in candidature of any other degree

Signature : ......................................................

Name : MUHAMMAD ZUL HELMI BIN MD
       JALANI

Date : 14th JANUARY 2013
Special devotion to my beloved father and mother,
whom are always give me alimentation and self-respect.
To my family thank you so much,
for most helping and giving me moral support to complete this thesis successfully.
Lastly, to all my lecturers and friends whom are always at my side,
helping me and aiding me all of the time,
thank you so much and be indebted for everything
and I love all of you very much.
ACKNOWLEDGEMENT

Alhamdulillah, all praise to Allah for blessing me with health, contingency and good fortune for me to complete this project flourishingly. First and foremost, I would like to express my sincere gratitude to my thesis supervisor, Dr. Tuan Amran Tuan Abdullah for his time and invaluable guidance and support.

I would like to acknowledge to my friends because they encouraging me along this project. Furthermore, it would be an honour to thank technician of Chemical Reaction Laboratory, Mr. Bidin, in providing all the technical support during the experiment.

Last but not least, to my parent Md Jalani Bin Md Zain and Norsiah Binti Darus, thank you for the support, their love, encouragement and inspiration. It would be hardly possible for me to finish this thesis without their love and moral support.
ABSTRACT

Plastic-made materials are widely used everywhere in the world, both direct and in-direct usage. The most commonly used plastics include poly vinyl chloride (PVC), polyethylene terephthalate (PET), polyethylene terephthalate glycol (PTEG) and others. Plastic can be distinguished by the structure of the polymer or by using resin code. The objective of this research is to investigate the effects of solvents toward the PET dissolution. Fifteen solvent such as phenol, methanol and sulphuric acid were tested regarding the solubility of PET. Among all, phenol and sulphuric acid were found to be able to dissolve the PET. The experiment was carried out using heating block and some other techniques such as filtration. There are 3 parameters involved, which are temperature, concentration of solvents and total surface area of polyethylene terephthalate (PET). The experimental optimization and analysis was determined by using Response Surface Methodology (RSM) and calculated using MINITAB. The result showed that phenol has a better dissolution towards PET, and the optimum condition in this study at temperature of 112.5 °C, concentration of 11.37 M and the surface area of 0.2 cm².
ABSTRAK

Bahan-bahan perbuatan plastik digunakan secara meluas di merata tempat di dunia tidak kira secara langsung mahupun penggunaan secara tidak langsung. Antara plastik yang biasa digunakan adalah poli vinil klorida (PVC), polietilena terephthalate (PET), polietilena terephthalate glikol (PTEG) dan lain-lain. Plastik boleh dibezakan dengan struktur polimer atau dengan menggunakan kod resin. Objektif kajian ini adalah untuk mengkaji kesan pelarut terhadap pelarutan PET. Lima belas pelarut seperti fenol, methanol dan asid sulfurik telah diuji untuk melarutkan PET. Kajian mendapati bahawa fenol dan asik sulfurik mampu melarutkan PET. Eksperimen ini telah dijalankan menggunakan blok pemanasan dan beberapa teknik lain seperti penapisan. Terdapat 3 parameter yang terlibat dalam eksperimen ini iaitu suhu, kepekatan pelarut dan jumlah luas permukaan polyethylene terephthalate (PET). Pengoptimuman dan analisis eksperimen telah ditentukan dengan menggunakan kaedah Response Surface Methodology (RSM) dan dikira menggunakan MINITAB. Fenol mempunyai pembubaran yang lebih baik dan kajian mendapati bahawa keadaan optimum dalam kajian ini adalah pada suhu 112.5 °C, kepekatan 11.37 M dan kawasan potongan 0.2 cm².
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td>ii</td>
<td></td>
</tr>
<tr>
<td>DEDICATION</td>
<td>iii</td>
<td></td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iv</td>
<td></td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>v</td>
<td></td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>vi</td>
<td></td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>vii</td>
<td></td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xi</td>
<td></td>
</tr>
<tr>
<td>LIST OF GRAPHS</td>
<td>xv</td>
<td></td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>xix</td>
<td></td>
</tr>
<tr>
<td>LIST OF SYMBOLS</td>
<td>xiv</td>
<td></td>
</tr>
</tbody>
</table>

1 INTRODUCTION
   1.1 Background of Study 1
   1.2 Problem Statement 5
   1.3 Objective of the Study 6
   1.4 Scope of the Study 6
   1.5 Significant of the Study 6
## LITERATURE REVIEW

2.1 Polyethylene Terephthalate (PET) 7

2.2 Solvent 9

2.2.1 Summarize of polymer and solvents 10

2.3 Experimental Design 12

2.3.1 Randomization Design 13

2.3.2 Size Reduction 14

2.3.3 Heating Block 14

2.3.4 Filtration Process 16

2.4 Chart and Mathematical Equation 17

2.4.1 Effect of parameters by using Pareto Chart 18

2.4.2 Percentage of yield 19

2.5 Software Approach 19

2.5.1 Response Surface Method (RSM) 20

## METHODOLOGY

3.1 Introduction 22

3.2 Materials 23

3.3 Apparatus 23

3.4 Experimental Procedure 25

3.5 Procedure 26

3.6 Parameter Investigated 30
4 RESULTS AND DISCUSSION

4.1 Solvent Screening 32
4.2 Experimental Result 33
  4.2.1 Sulphuric Acid 33
  4.2.2 Phenol (1-22) 34
  4.2.3 Phenol (23-31) 36
4.3 Study Parameters Effects 37
  4.3.1 Temperature 37
  4.3.2 Concentration 39
  4.3.3 Surface Area 40
4.4 Optimization : Reaction Surface Methodology (RSM) 42
  4.4.1 Respond Surface Plot 42
  4.4.2 Pareto Chart 52
  4.4.3 Observed Versus Predicted Values 55
4.5 Analysis of Variance (ANOVA) 59
  4.5.1 ANOVA Analysis of Sulphuric Acid (15 replicate) 59
  4.5.2 ANOVA Analysis of Phenol (replicate 1 to replicate 15) 60
  4.5.3 ANOVA Analysis of Phenol (replicate 23 to replicate 31) 60

5 CONCLUSION

5.1 Conclusion 62
5.2 Recommendation 63

REFERENCES 64
REFERENCES


