

الآية

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ

عَمَّا كَلَّمْتُمْ وَاَرْسَلْتُمْ قَوْلَهُ وَاَلْمُؤْمِنُونَ وَسَاتِرٌ دُونَ اَعْلَى عَالِمِ الْغَيْبِ
وَالشَّهَادَةِ فَيُنذِرُكُمْ بِمَا كُنْتُمْ تَعْمَلُونَ)

سوره التوبه الايه 105

Dedication

To all those who lighted others' minds with their knowledge, or gave the puzzled questioners the correct answers. Or showed with their lenience the Humility of scientists.

I dedicate this modest work to my father, who taught me success and patience and never skimp on me.

To my mother who taught me and suffered hardships and gave me tenderness and love.

I say to them both. You gave me life, hope and growing knowledgeable passion.

I also dedicate it to my all sisters. And all my family.

Then to all who taught me a letter which became gently illuminate my road. My teachers...My colleagues

To all of them I dedicate this modest work.

I asking god acceptance and success

AKNOWLEDGMENT

Praise be to Allah and peace and blessings be upon his prophet and messengers of our Prophet Muhammad and his family and companions after.

I thank the Almighty God first and foremost for me to reconcile the completion of this study, it is the Almighty deserving of thanks and praise and initial them. Out of saying peace be upon him "Who does not thank people does not thank God, "I extend my thanks and appreciation to Sudan University of Sciences & Technology.

Also extend sincere thanks and appreciation to Dr. Abd alfatah Belal, who is stingy on something and was more helpful to me in my studies, Me God divide him all the best.

To Almubarak Polystyrene Factory who helped in accomplishing this work.

I would also like to extend my sincere thanks to colleagues who were and still are a help and a beacon and a motivation for me in the process of life.

And thanks to all of gave me a helping hand in this academic work to light and inadvertently dropped his name, lastly my cause Praise be to Allah.

Abstract

The expandable polystyrene is a light weight material which has been widely used in constructions, packaging and Marines devices. The manufacturing of the expanded polystyrene products is a multi-step process that depends on extremely high mutually correlated factors. EPS density is considered to the main index in most of its properties. Most mechanical properties depend on the density of EPS. The cost of manufacturing an EPS block is considered linearly proportional to its density. Non -mechanical properties like insulation coefficients are also density dependent.

In this reach the pre-expansion process was studied to determine the effect of the expansion pressure, expansion time and size of bead on EPS bulk density. Analysis of test results confirmed that with increasing of beads size the bulk density of EPS decreases. Study showed that with increasing pressure the bulk density of EPS decreases. And with increase the expansion time the density decrease .Through the appropriate choice of time and pressure during the expansion process a wide range of density of EPS can be obtained.

المستخلص

يعتبر الفلين من المواد خفيفه الوزن ومتعدده الاستخدامات ويمكن استخدامها في مجال البناء ,التغليف ومعدات البحريه. صناعه منتجات الفلين تتكون من عدده مراحل تعتمد علي عدد من العوامل المشتركه.كثافه الفلين تعتبر من اهم الخواص حيث تعتمد معظم الخواص الميكانيكيه و الغير ميكانيكيه مثل معامل العزل علي كثافه الفلين .تكلفه صناعه منتجات الفلين تتناسب طرديا مع الكثافه .

في هذا البحث تمت دراسه مرحله التمدد لتحديد اثر ضغط التمدد وزمن التمدد وحجم الحبيبات علي كثافه الفلين.نتائج الاختبارات تؤكد ذلك انه عند زياده حجم الحبيبات تقل الكثافه وعند زياده ضغط التمدد وزمن التمدد تقل الكثافه ايضا.

من خلال الاختيار المناسب للزمن والضغط اثناء عمليه التمدد يمكن الحصول علي مدي واسع من الكثافات.

Abbreviation and Symbols

| symbols | Abbreviations |
|--------------------|-------------------------|
| EPS | Expandable Poly Styrene |
| L | Length of cube |
| r | Radius of sphere |
| ρ | Density |
| T | Temperature |
| $^{\circ}\text{C}$ | Degree Celsius |
| P | Pressure |
| $^{\circ}\text{F}$ | Degree Fahrenheit |
| lb | Pounds |
| ft | Feet |
| g | gram |

List of Tables

| Table No | Table | Page |
|----------|--|------|
| 4.1 | Dependence of bulk density from the time of expansion and the initial diameter of EPS beads. | 24 |
| 4.2 | Effect of expansion time on density of EPS at constant pressure $P=1.15$ bar. | 25 |
| 4.3 | Effect of expansion pressure on density of EPS at constant time $t=180$ s. | 26 |

List of figures

| Figures | page |
|---|------|
| Figure 1-1 thermal insulation | 4 |
| Figure 1-2 applications of EPS in packaging | 5 |
| Figure 1-3 seed-trays | 6 |
| Figure 1-4 Sporting Goods | 7 |
| Figure 2-1 chemical composition of EPS | 13 |
| Figure 2-2 production process of EPS. | 14 |
| Figure 2-3 packaged of EPS. | 15 |
| Figure 2-4 Manufacturing unit of moulded expanded polystyrene | 16 |
| Figure 2-5- Batch pre- expanders | 17 |
| Figure 2-6 continuous pre-expanders. | 18 |
| Figure 2-7 plastic mesh. | 19 |
| Figure 2-8EPS block mould and vacuum installation. | 20 |
| Figure 2- 9 Cutting machines of EPS. | 21 |
| Figure 1-3 graduated jug. | 23 |
| Figure 3-2 weight of the graduated jug | 23 |
| Figure 3-3 volume of EPS | 25 |
| Figure 3-4 weight of EPS | 25 |

| | |
|---|----|
| | |
| Figure 4-1 Beads of polystyrene before and after pre-expansion process | 26 |
| Figure 4-3 Dependence of bulk density from the time of expansion and the initial size | 27 |
| Figure 4-3 effect of expansion time on density of EPS at constant pressure $P=1.15$ bar | 29 |
| Figure 4-4 effect of expansion pressure on density of EPS at constant time $t=180$ s | 30 |
| Figure 4-5 Beads immediately after expansion, magnification x60 | 30 |

Table of Contents

| Item | Page |
|---|------|
| Dedication | II |
| Acknowledgement | III |
| Abstract | IV |
| المستخلص | V |
| Abbreviation and Symbols | VI |
| List of tables | VII |
| List of figures | VIII |
| Chapter One Introduction | |
| 1.1 Preface | 1 |
| 1.2 Objectives | 8 |
| 1.3 Literature Review | 8 |
| 1.3 Boundaries | 11 |
| 1.4 Thesis out line | 12 |
| Chapter Two Background | |
| 2.1. Introduction | 13 |
| 2.2 Manufacturing of Expandable polystyrene | 13 |
| 2.2.1 Polymerization and Impregnation | 13 |
| 2.2.2 Expanded polystyrene processing | 15 |
| Chapter Three MATERIALS AND METHOD | |

| | |
|--|----|
| | |
| 3.1. Introduction | 22 |
| 3.2. Materials | 22 |
| 3.3. Method | 23 |
| Chapter Four RESULT AND DISCUSSION | |
| 4.1. Introduction | 26 |
| 4.2. The initial process of pre- expansion of EPS | 26 |
| 4.3. Analysis of factors determining the pre-expansion process | 27 |
| 4.3.1. Effect of beads size on bulk density of EPS | 27 |
| 4.3.2. Effect of expansion time on bulk density of EPS | 28 |
| 4.3.3. Effect of expansion pressure on bulk density of EPS | 29 |
| Chapter Five CONCLUSIONS AND RECOMMENDATIONS | |
| 5.1. Conclusions | 31 |
| 5.2. Recommendations | 31 |
| REFERENCES | 32 |