INFLUENCE OF ADDING DIFFERENT FILLERS ON POLY ETHYLENE PROPERTIES

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ABSTRACT

The aim of this study was focused on the improvement of pouring, mechanical and thermal properties of high density polyethylene using chemically treated kawaline as a filler which is composed of 10% carbamide and 90% kawaline.

A composed had been made among the new filler (kawaline-carbamide), alumina and the pure kawaline in improving the latter properties of polyethylene.

It was found that all the mentioned properties affect deeply by filler type and its content. Also it was found that the suitable filler is alumina and kawaline –carrbamide in less performance.

KEY WORDS

Filler, polyethylene, kawaline, alumina.

INTRODUCTION

In plastics industry, plastics was mixed with some additives to get the desired properties for the product, one of them is the filler which is added to the product in percent reaches 70% by weight. The goal of this addition was to increase the mechanical strength and product weight in order to minimize allots of production especially in case of low cost fillers.

Many references[1-7] point the capability of using kawaline fillers in polyethylene and other thermoplastics polymers industry. The goal of adding kawakine is to increase filler surfaction in order to increase its activity to improve thermal and mechanical properties, more over kawaline addition is a simple and cheap method in comparison with ultrasonic treatment or covering with surfactant material. Another fillers like lignocellulose fiber have been used as a filler in HDPE production because of its excellent specific properties and have potential to be outstanding reinforcing fillers in plastics especially polypropylene and polyethylene. It exhibits a significant improvement in impact strength[2]. Other scientists improved the physical properties of polyethylene also biological property[8].

HDPE intended for all market applications especially pipes. Must provide superior resistance to failure that typically occurs by a slow crack growth mechanism which is tested with

other mechanical properties due to ASTM D-1693 and ASTM D-3350.

This study is intended to observe the influence of adding kawaline, kawaline-carbamide and alumina as filler in HDPE production on its physical and mechanical properties. HDPE was chosen because it represents one of the most commonly used polymers in Iraq and there is frequently a source of HDPE granules available.

The basis of this study was to generate an initial body of data for characterizing the above mentioned properties due to filler kind. A series of tests were performed using multiple apparatuses for testing the mentioned properties.

EXPERIMENTAL WORK

The experimental part of this work consists of two basic steps:

1. mixing of carbamide with kawaline as a suspended solution, after good mixing, water was evaporated, and the paste was dried till we get a constant weight at certain temperature 363°K (90°C).
2. Fillers (kawalline, kawaline + carrbammide and alumina) are mixed with different amount (0, 8,20, 25, 35 and 50 wt%) are mixed mechanically with the corresponding amounts (100, 92, 80, 75, 65, and 50%) of polyethylene powder.

3. Forming process was done after paste preparation. The paste was shaped on two rolls mixed turnery at certain temperature of 433° K for 5 minutes.

- Before using alumina filler it was dried at 393 °K for 12 hours after milling in a ball mill, this step allows the removal of water from the whole surface of filler powder[9], then powder was sieved in 0.063 mm sieve set.

Physical Properties

The bulk density can be determined using the water impregnation method[10].

Melting index was determined using an apparatus with 10 mm cylinder diameter, 2 mm melting tube under 25 kg weight load and a temperature of 433K.

Thermal Properties

Thelen Vicat temperature was measured using Vicat apparatus under 10N load[11].

Mechanical Properties

Tensile Strength

In order to test the tensile strength, a piece of filled polymer was made with 1 mm thick using thermal press under 50 kg/cm^3 compression force at 433 K, 5 minutes test duration and a rate of test equals to 100 mm/min[12].

RESULTS AND DISCUSSION

Effect of Filler Content on Density and Melting Index

Figure (1) and (2) show the effect of filler content on density and melting index.

It is shown that the density increases non-linearly as filler content increases for all tested fillers. This is due to relatively high filler density (aluminium (2.2 gm/cm^3), kawaline (1.8 gm/cm^3)) where at a lower filler content different solid structures were formed by polyethylene-filler assimilation[13].

Figure (2) indicates that melting index decreases as filler content increases in a case of using kawaline, whereas it reaches a constant value at 15% when kawaline-carbide and alumina used.

Effect of Filler Content on Vicat Temperature Measurement

Figure (3) show the effect of filler content on Vicat temperature value .

It was shown that with increasing of filler content Vicat value increases non-linearly, especially at 50% wt. filler, it increases by (11-22°)K. It is obvious from the figure (3) that the use of kawaline-carbamide and alumina as a filler exhibit the same result in increasing the thermal stability of polymer.

Effect of Filler Content on Mechanical Properties

Figure (4) and (5) illustrate the effect of filler amount (wt.%) on tensile strength and elongation ability.

Considering Figure (4) it is obvious that in cases of kawaline and kawaline-carbamide fillers tensile strength increases sharply at 50% content and reach its maximum value at 10.8% with respect to kawaline and 20% considering kawaline-carbamide. At this maxima the mixture turn to plastic phase. By other hand alumina keep its increasing in tensile strength gradually. This is due to large surface area of alumina, which attributes a cohesive structure between filler and polymer molecules.

Refers to figure (5) elongation decreases as filler content increases with respect to all filler types especially kawaline-carbide and alumina, where kawaline mixture reachs its maxima at 10 wt.%and keep up at this value till the maximum filler content of this experiment (30%). This is due to lowering of filler elasticity at concentration up to 10% resulting from decreasing of molecular kinetic energy, as a result, mixture turns to plastic phase at filler concentration range (10-30%)[14].

CONCLUSIONS

1) Adding of modified filler (kawaline-carbamide) increases tensile strength of polymer starting from 5% and above.
2) Elongation of polymer decreases with increasing of filler content with respect to all studied types.
3) Thermal stability of polymer increases with increasing filler content with respect to all studied types.
4) Melting index of polymer decreases with increasing of filler content with respect to kawaline , reaches its stability at 15% filler with respect to alumina and kawaline arbide.

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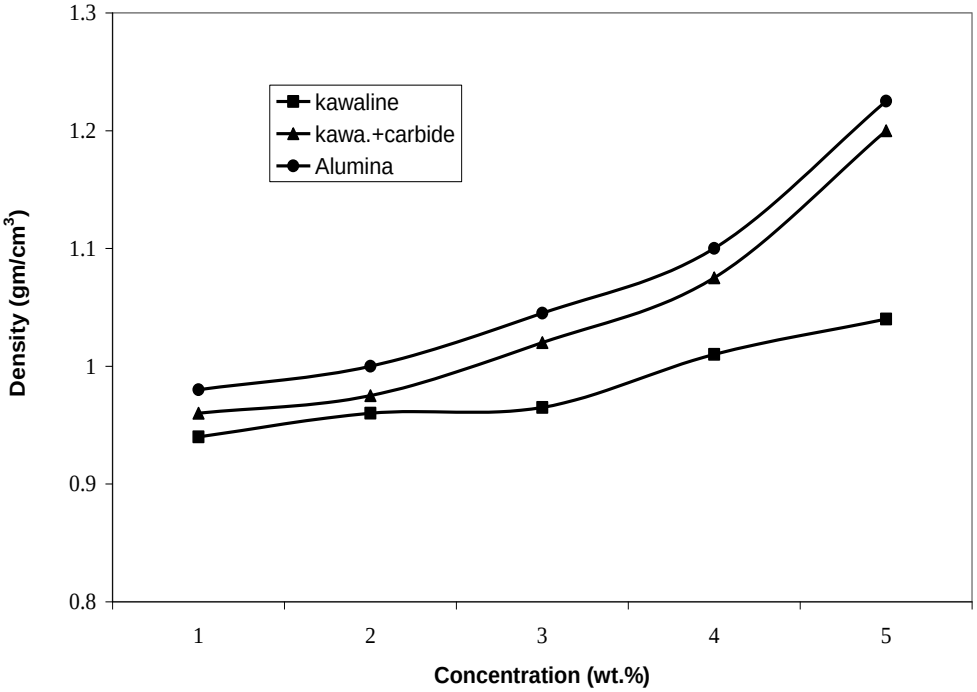

Figure (1) Effect of filler content on density

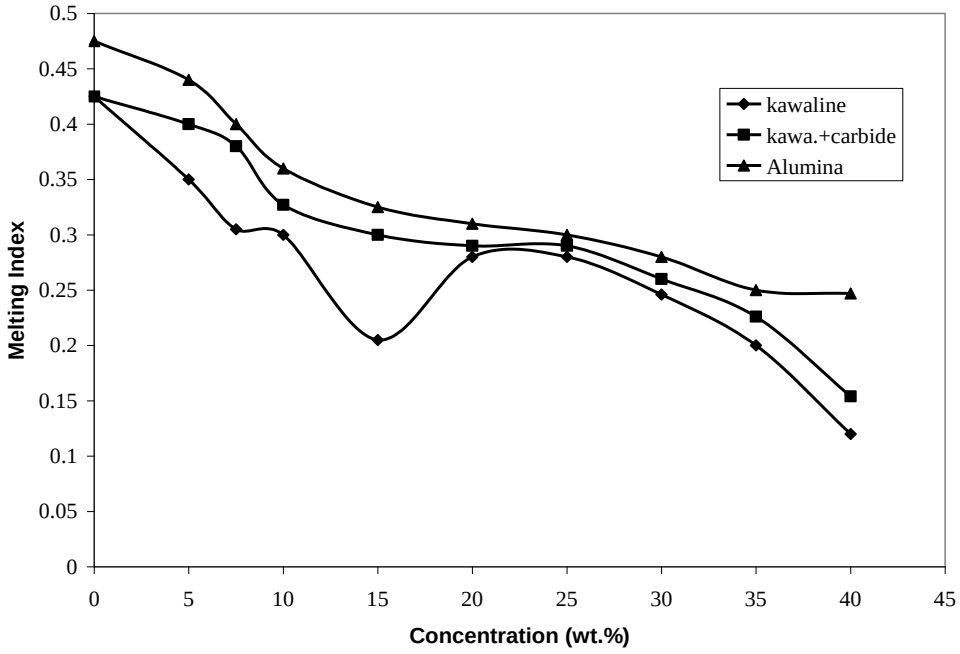

Figure (2) Effect of filler content on melting index

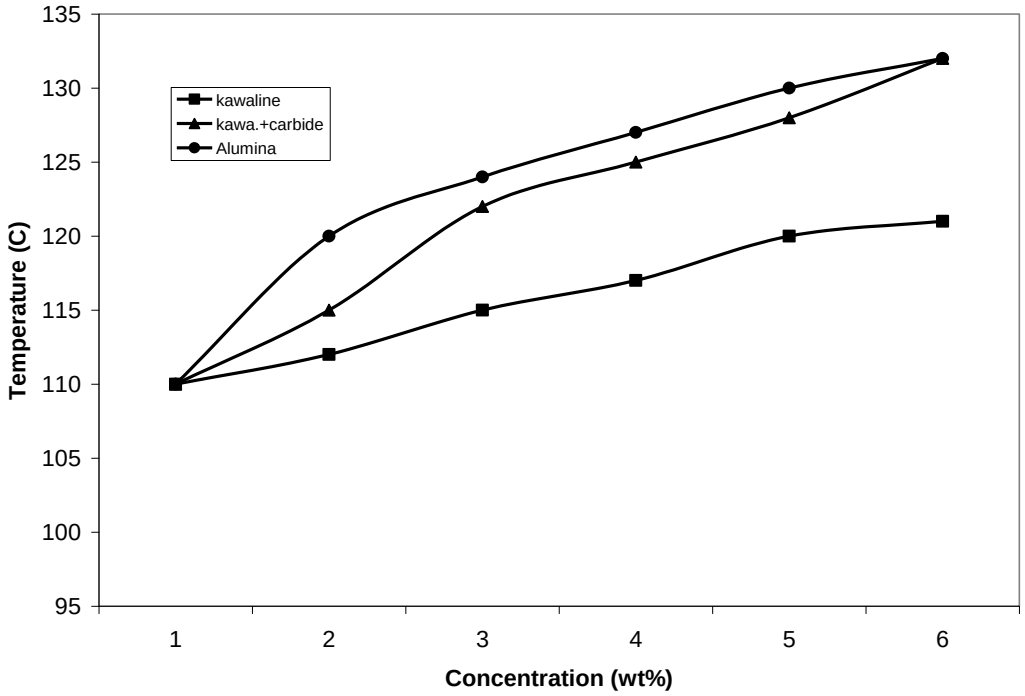

Figure (3) Effect of filler content on Vicat temperature

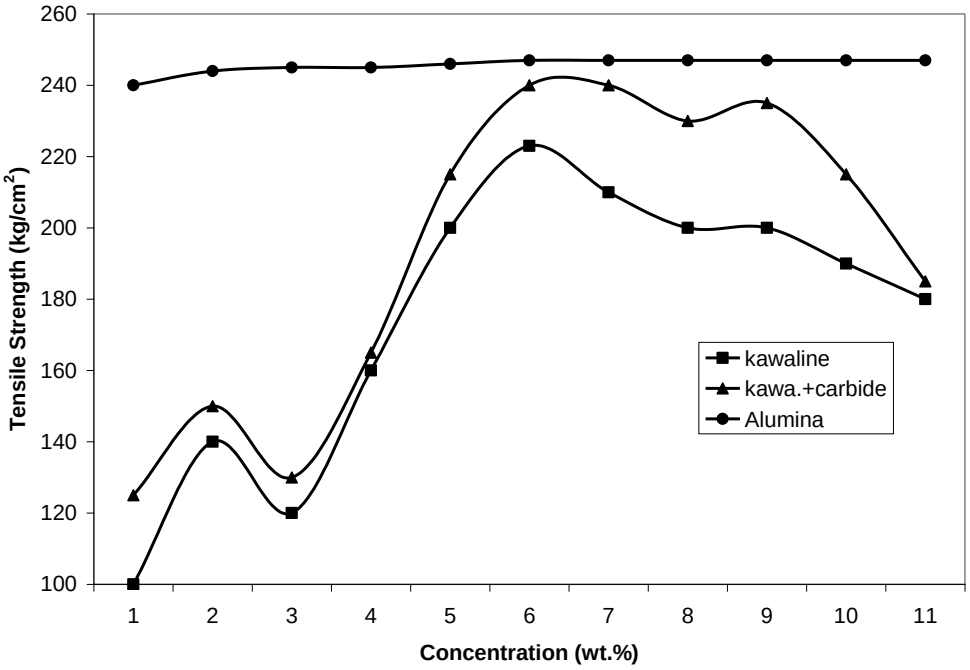

Figure (4) Effect of filler content on tensile strength

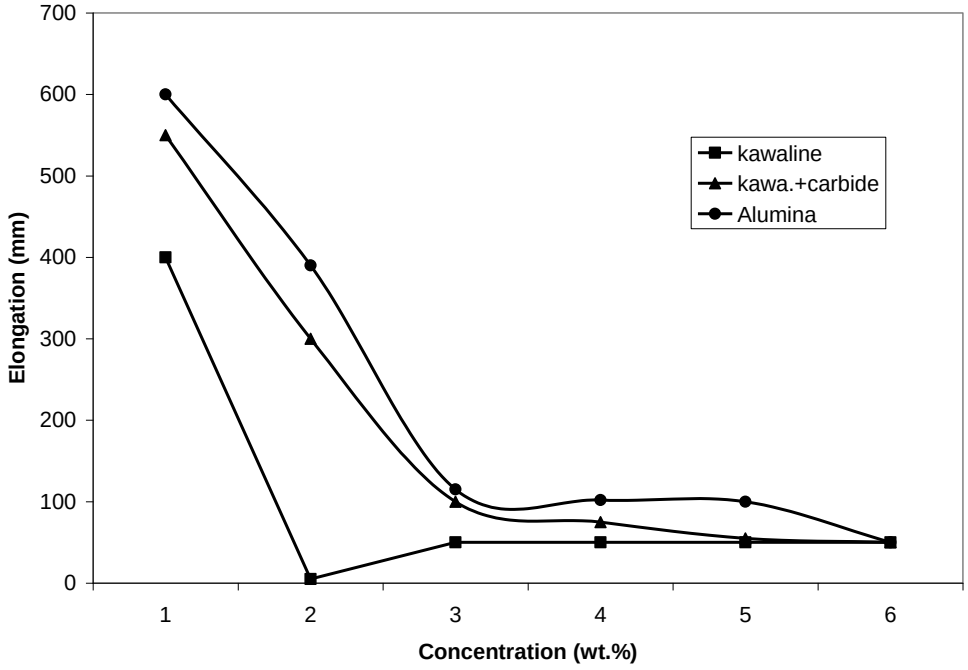

Figure (5) Effect of filler content on elongation

تأثير إضافة مالئات مختلفة على خواص البولي أثيلين

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الخلاصة

إن الهدف من هذه الدراسة يتركز على تحسين خواص الانسكاب، الميكانيكية و الحرارية للبولي أثيلين عالي الكثافة باستخدام الكاؤلين المعامل كيميائياً كمالئ و الذي يتكون من 10% كارباميد و 90% كاؤلين.

تم إجراء مقارنة بين المالئ الجديد (كاؤلين– كارباميد) ، الألومينا و الكاؤلين النقي و ذلك من خلال قيام كل منها بتحسين مواصفات البولي أثيلين.

وجد أن جميع الصفات المذكورة في أعلاه تتأثر بحدة بنوع المالئ و بكميته. ووجد أيضاً أن المالئ الأكثر ملاءمة هو الألومينا و بدرجة أقل في الأداء الكاؤلين– كاربامید .

الكلمات الدالة

مالئ، البولي أثيلين ، كاؤلين، ألومينا