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# Study of effect of accelerated ageing on strength of the blended High density polyethylene material with calcium carbonate in different ratio

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## Abstract

Accelerated ageing test were devised to study the effect of actual outdoor weather in a relatively short time period , these tests often produce misleading result that are difficult to interpret or correlate with the result of actual outdoor exposure . The reason for such contradiction is that in laboratory devices exposure the wavelength of light are distributed differently than in normal sunlight possibly producing effects different from these produce by outdoor weathering. All plastic seem to be especially sensitivity to wavelength in UV region , If accelerated device has unusually strong emission at the wavelength of sensitivity of a particular polymer , the degree of acceleration is disproportionately high compared to outdoor exposure . The temperature of the exposure device also greatly influences the rate of degradation of a polymer, the higher the temperature may cause oxidation and migration of additives which in turns affect the rate of degradation. One of the limitations of accelerated weathering device is their inability to simulate the adverse effect of most industrial environment and many other factors present in the atmosphere and their synergistic effect on polymer.

In present experiment Particular size of calcium carbonate is reinforced in high density polyethylene (HDPE) in different weight ratio .The objective of present experiment to study the tensile properties after ageing at +40°C and 95% relative Humidity (8Hrs:8Hrs) heat to condensation ratio of reinforced blended material as compare to neat material.

**Keywords:** Calcium Carbonate, HDPE, Tensile Properties, Ageing and relative Humidity

## Introduction

The test apparatus basically consist of a series of UV lamps, a heated water pan and test specimen rack. The temperature and operating times are independently controlled both for UV & condensation effect. The test specimens are mounted in specimen racks with the test surface facing the lamp.

The ageing is acquired through accelerated tests and actual outdoor exposure. The later being a time consuming method , accelerated test often used expedite of additive levels and ratios .A variety of light source are used to simulate the natural sunlight .The artificial light source include carbon arc lamps ,xenon arc lamp , fluorescent sun lamp and mercury lamp

Tensile strength, %Elongation and tensile modulus measurements are among the most important indication of the strength of material and are most widely specified properties of the plastic material. The forces applied to produce deformation per unit area of the test specimen is called as stress of the material and it is expressed in Newton per millimeter square ($N/mm^2$). It is tested as per ASTMD 638 standard test method.

The tensile testing machine of a constant rate of cross head movement is used. It has a fixed stationary member carrying one grip and a moveable member carrying another self aligning grip, used for holding the test specimen between the fixed and movable member to prevent alignment problem. A controlled velocity drive mechanism is used to maintain the constant cross head motion between the two grips. A load indicating mechanism is used for indicating total tensile load with an accuracy of the indicated value. An extension indicator, commonly known as the extensometer is used to determine the distance between gauge length of the test specimen, as the specimen stretches during the test.

Test specimen used for tensile strength is molded by injection molding with required injection molding machine parameter that is speed, pressure and temperature of the machine. The test specimen dimensions vary considerably confirming the requirement given in the ASTMD 638 Type 1. The speed of testing is a relative of grips during the test, in present investigation speed of testing used is 50mm per minute. The test specimen is positioned vertically between the grip of the testing machine, the grips are tightened firmly and evenly to prevent any slippage, speed of machine is set and the machine is started. As the specimen elongated the resistance of the specimen increases and is directly indicated on the display propositional to load cell. The force value (load)is recorded and the elongation of the specimen is continued until a rapture of the specimen observed , Load value at break is also recorded . The Tensile strength at yield is calculated as

**Tensile Strength at yield = forced/cross-sectional area**

**Experiment**

In present experiment, HDPE used for this work is Relene Grade. M60075 of Reliance Industries Ltd. [Density: 0.94 gm/cc; MFI: 8-10 gm/10 minute]. The nano-filler used in this work is calcium carbonate, purchase from local market in Maharashtra. The Calcium carbonate (coated) used is having average particle size 9-11 nm, Grade OMYACARB 2T –SA of Omya Malaysia SDN BHD Malaysia.

For tensile strength test universal tensile testing machine is used having capacity of 3000kgs of M/s Deepak polyplast pvt. Ltd Ahmadabad

**Fig. 1: Universal Tensile tester.**

In this investigation calcium carbonate of average particle size 9-11nm is blended with high density polyethylene in different proportion by weight as below and results of tensile strength at yield at different time period at +40 ±5°C and 95% relative humidity under the mercury lamp with 8hrs heat and 8hrs condensation, test is conducted up to 1064 hrs and result are stipulated below.

**Table 1: Tensile strength at yield values after ageing.**

| S.No. | Time | | HDCC blends | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | In Hrs | TENSILE STRENGTH VALUES IN Mpa. | | | | | | | | |
| | | HDPE | HDCC1 | HDCC2 | HDCC3 | HDCC4 | HDCC5 | HDCC6 | HDCC7 | HDCC8 |
| 1 | 24 | 20.8159 | 21.1440 | 22.8434 | 22.2280 | 20.5847 | 19.9816 | 18.5466 | 18.4641 | 16.8854 |
| 2 | 48 | 20.7571 | 21.7159 | 22.8095 | 21.8376 | 21.0589 | 19.8700 | 18.3467 | 18.4060 | 17.1446 |
| 3 | 96 | 20.7128 | 21.6182 | 22.7299 | 22.0746 | 20.8192 | 20.5612 | 19.0687 | 19.5255 | 18.1554 |
| 4 | 120 | 20.6722 | 22.2352 | 22.9726 | 22.7436 | 21.5911 | 21.0819 | 19.4536 | 18.7844 | 17.7661 |
| 5 | 144 | 20.6203 | 21.8059 | 22.7527 | 21.9137 | 20.9006 | 20.1816 | 18.7498 | 18.5064 | 17.6633 |
| 6 | 216 | 20.4678 | 22.6211 | 23.6793 | 22.7143 | 21.8756 | 20.9488 | 19.4175 | 19.8607 | 17.9661 |
| 7 | 312 | 20.3723 | 22.3487 | 22.6100 | 22.2343 | 21.3170 | 20.2885 | 19.2140 | 18.9336 | 18.1122 |
| 8 | 384 | 20.1792 | 22.3883 | 23.1113 | 22.3425 | 21.4671 | 20.2461 | 19.1483 | 18.5952 | 17.9728 |
| 9 | 480 | 20.1247 | 21.8807 | 22.3466 | 22.3954 | 20.9198 | 21.3794 | 19.5973 | 19.4415 | 18.2794 |
| 10 | 672 | 19.8211 | 23.1642 | 23.8367 | 22.9370 | 21.8168 | 21.2709 | 19.7228 | 19.5581 | 18.4821 |
| 11 | 868 | 19.5259 | 23.2726 | 24.3533 | 24.0724 | 23.1222 | 21.8862 | 19.8230 | 19.6510 | 18.3857 |
| 12 | 1064 | 19.0251 | 22.9378 | 23.8483 | 23.5315 | 22.0167 | 21.7939 | 19.8628 | 19.1167 | 19.1069 |

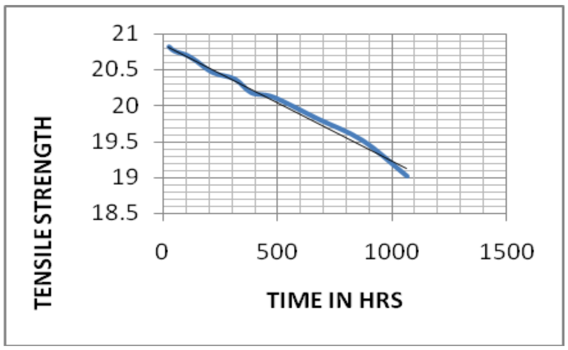

Fig 2: Graph for HDPE sample at different time span

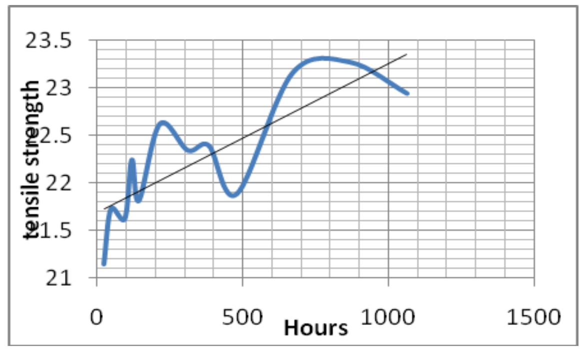

Fig 3: Graph for HDCC1 sample at different time span

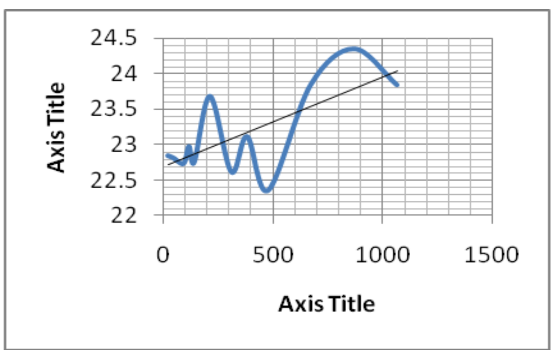

Fig 4: Graph for HDCC2 sample at different time span

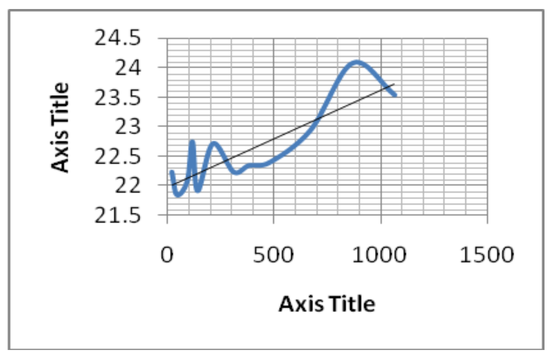

Fig 5: Graph for HDCC3 sample at different time span

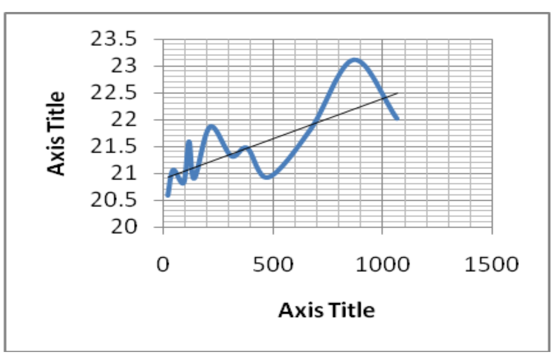

Fig 6: Graph for HDCC4 sample at different time span

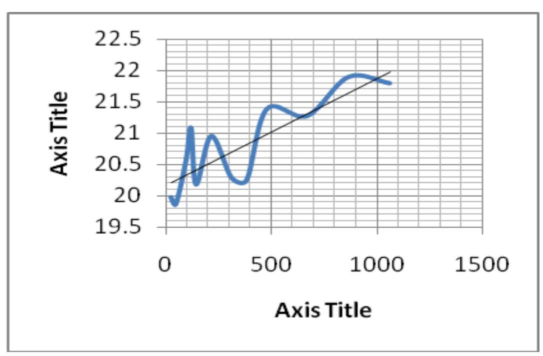

Fig 7: Graph for HDCC 5 sample at different time span

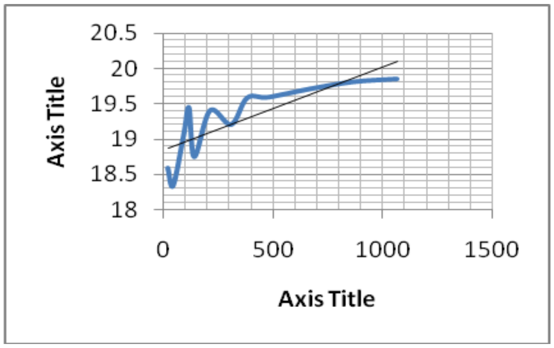


Fig 8: Graph for HDCC6 sample at different time span

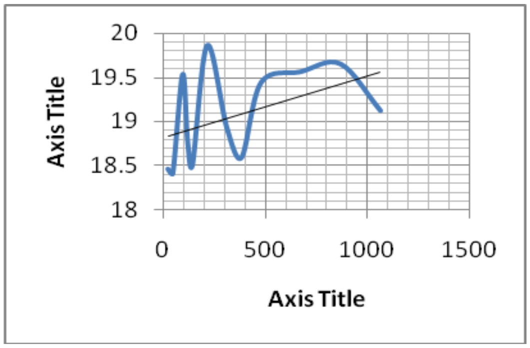


Fig 9: Graph for HDCC 7 sample at different time span

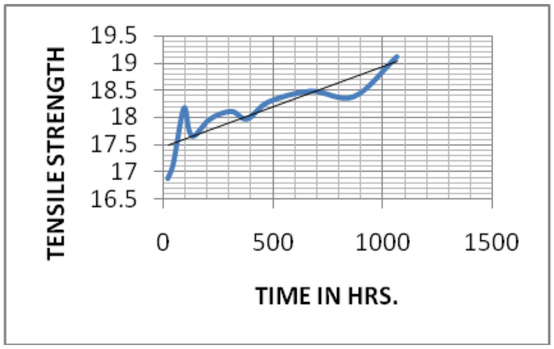


Fig 10: Graph for HDCC8 sample at different time span

**Result and conclusion**

The result obtained for tensile strength test for high density polyethylene material at different time span as tabulated in the table1, it is observed that value of tensile strength decreases slowly as the time of exposure is proceeding and its ranges from 20.8 Mpa to 19.0 Mpa.

The result obtained for tensile strength test for high density polyethylene material with 5% calcium carbonate at different time span as tabulated in the table 1, it is observed that value of tensile strength increases slowly as the time of exposure is proceeding and its ranges from 21.1 Mpa to 22.9 Mpa.

The result obtained for tensile strength test for high density polyethylene material with 10% calcium carbonate at different time span as tabulated in the table 1, it is observed that value of tensile strength increases slowly as the time of exposure is proceeding and its ranges from 22.8 Mpa to 23.8 Mpa.

The result obtained for tensile strength test for high density polyethylene material with 15% calcium carbonate at different time span as tabulated in the table 1, it is observed that value of tensile strength increases slowly as the time of exposure is proceeding and its ranges from 22.2 Mpa to 23.5 Mpa.

The result obtained for tensile strength test for high density polyethylene material with 20% calcium carbonate at different time span as tabulated in the table 1, it is observed that value of tensile strength increases slowly as the time of exposure is proceeding and its ranges from 20.6 Mpa to 22.0 Mpa.

The result obtained for tensile strength test for high density polyethylene material with 25% calcium carbonate at different time span as tabulated in the table 1, it is observed that value of tensile strength increases slowly as the time of exposure is proceeding and its ranges from 19.9 Mpa to 21.8 Mpa.

The result obtained for tensile strength test for high density polyethylene material with 30% calcium carbonate at different time span as tabulated in the table 1, it is observed that value of tensile strength increases slowly as the time of exposure is proceeding and its ranges from 18.5 Mpa to 19.7 Mpa.

The result obtained for tensile strength test for high density polyethylene material with 35% calcium carbonate at different time span as tabulated in the table 1, it is observed that value of tensile strength increases slowly as the time of exposure is proceeding and its ranges from 18.5 Mpa to 19.1 Mpa.

The result obtained for tensile strength test for high density polyethylene material with 40% calcium carbonate at different time span as tabulated in the table 1, it is observed that value of tensile strength increases slowly as the time of exposure is proceeding and its ranges from 16.9 Mpa to 19.1 Mpa.

From the results obtained it is observed that up to 20% of calcium carbonate with average particle size 2-11µm with high density polyethylene is good for the outer bodies of automobile , other household articles such flexible table , chair and other storage tanks , boxes used electric items and plumbing etc.

From the results obtained it is observed that from 25% to 40% of calcium carbonate with average particle size 2-11µm with high density polyethylene is good for blow moulding application mainly film bags , heat sealed overwrapping film and container liner for bulk transport, carton board /polyethylene laminated container etc.

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