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Preparation, Characterization, and Properties of Polyethylene Composites Partially Filled with Calcium Carbonate through Co-Rotating Conical Twin-Screw Extrusion

Amjad Wahab[1], Muddasar Habib[2], Nighat Nawaz[3]
[1,2]*Department of Chemical Engineering, University of Engineering and Technology Peshawar,kpk, Pakistan.*
[3]*Department of chemistry islamia university Peshawar, kpk, Pakistan*

Abstract: ***The ever-increasing demands for the high quality and specific properties of polymers necessitate the exploration of different methods for obtaining the polyethylene composites. This study has looked into adding a 20% $CaCO_3$ filler to characterize the resulting polyethylene composite. This addition to the high density polyethylene (HDPE) is expected to increase the market value by improving the noteworthy changes in some mechanical properties of the composites such as Young's modulus and worry at break. $CaCO_3$ addition was intensified by the use of a twin-screw extruder with high thickness polyethylene (HDPE) composites. These composite were characterized for their warm properties by means of checking the thermal strength by thermogravimetric examination (TGA) and differential checking calorimetric (DSC) to quantify the impact of $CaCO_3$ filler addition in the composites.***

Keywords: High density polyethylene, $CaCO_3$, warm properties, Composites.

I. INTRODUCTION

The market demand of high-density polyethylene (HDPE) is expanding a result of its enormous applications, particularly for car and mechanical applications. Be that as it may, its applications have been restricted contrasted with its potential, for some current applications the mechanical properties are insufficient high. (1) To enhance the physical and mechanical properties of HDPE, expansion of filler, inflexible particles, and much elastomer to HDPE is extremely normal. A standout amongst the most imperative filler, which is added to PE, is $caco_3$. It very well may be generally utilized as filler for all polymers. It is modest and can be utilized at high stacking. It is accessible in various evaluations: dry prepared, wet, or water ground, and can be effortlessly surface treated. They should indicate thermos ability and capacity to scattered effortlessly and quick in a polymer medium[2] Recently polymer nanocomposites are the concentration in new age material in perspective on their focal points and excellent properties synergistically got from nanoscale structure appearing physical, mechanical, thermal, electrical, and optical properties.[3] Further, these favourable circumstances can be cultivated even at astonishingly low combination of the Nano fillers conversely with normal polymer composites.[4] Therefore, it is essential to create common sense and sparing arrangements and preparing strategies for fitting practical material's setups at the nanoscale level. As of late, much advancement has been made in addressing these difficulties and in building up an extensive variety of business procedures, items, and gadgets because of the exploration endeavours and advances made by numerous researchers, designers, and technologists.(5) A wide assortment of strengthening specialists, for example, calcium carbonate ($CaCO_3$), mica, wollastonite, glass fiber, glass dot, jute, curaua fiber, silica (SiO^2), mud, carbon nanotube, and so on are being utilized to get ready polymer composites/nanocomposites.[6-10] PE and PP has effect to be used for different applications for inorganic fillers in polymers. Composite which is filled with small level of other composites with reasonable cost provide needed properties. At the point when the modulus and additionally the quality are expanded, the reduction in stretching to break and strength by and large results. High-Density polyethylene (HDPE) is one of the thermoplastic materials generally utilized as item plastics because of its low cost, adjusted properties, and simple process capacity. In any case, its low sturdiness, climate obstruction, and ecological pressure splitting opposition have constrained its application in numerous innovatively essential areas. [11] To enhance these properties, HDPE strengthened with assortments of fillers has been accounted for in the open writing. Calcium carbonate ($CaCO_3$) is a standout amongst the most broadly utilized minerals utilized in polyolefin composite industry as a result of its minimal effort and plenitude; in addition, it is accessible universally in an assortment of molecule sizes (full scale to Nano), shapes, and purities. [12]

II. MATERIALS AND METHODS/EXPERIMENTAL

High density polyethylene (HDPE) (MFI = 0.23 g/10 min, 1908C, 5 kg) HE3490LS used in this study was supplied by brogue company Dubai. And fine mesh size calcium carbonate (caco3) was supplied by local supplier new age chemicals industry Lahore. CaCO3 was mixed with HDPE material. At temperature profile of 150 to 180 degree in the single screw extruder mixture of compound is extruded from feed zone to die. Using 50rpm of screw speed, the compounds were extruded and palletized. Compounded pallets were compressed by hot press at temperature 190˚C.some of the properties of hdpe material HE3490LS Are following

Property	Reference test method	Unit	Value
Melt flow rate	B192 (ISO-1133)	g/10 min	0.23
Density	B292 (ISO-1133)	KG/M3	960
Carbon black content	B184 (ISO-6964)	%	2.24
Oxidation induction time	B162 (ISO-11357)	Min	42
Moisture content	B187 (ISO-15512)	Ppm	60
Total volatiles	B185 (En12099)	Ppm	210

At is indicated by manufacturer material was hdpe brogue polyethylene permeability and de bonding of the particle is improved by economical CaCO3 is economical.PE is used more than any other thermoplastic polymer .There is wide variety of grades and formulations available that have an equally wide range of properties.in general the outstanding characteristics of PE are toughness, ease of processing, chemical impact resistance, abrasion resistance, electrical properties, low coefficient of friction, and near-zero moisture absorption.

III. RESULT AND DISCUSSION

Mechanical, thermal and surface examinations were completed so as to explore execution of HDPE-CACO3 compounds and to contrast it and uncontaminated HDPE. Mechanical test incorporate Bending and elastic tests. TGA examination was utilized to explore conduct. SEM photos were taken to check crack surface of composites.

A. Mechanical Tests Results

Analyzations of Strength of Composites was carried out by tensile and elongation and three point bending test following results shown below is of average values of three samples per formulation.

B. Three Point Bending Test

HDPE-CACO3 composites were analysed for different weight fraction and size of HDPE Pellets. Table 4-1 shows relation of weight fraction of HDPE with bending strength and bending modulus.

Table Error! No text of specified style in document.**-1** Result of weight % of CACO3 on bending strength and modulus (500 µm caco3).

Sample	**Weight % of CACO3**	**Bending strength(MPa)**	**Bending modulus(GPa)**
H-p	0	61	3.1
H-1	5	58	2.9
H-2	10	60	3.0
H-3	15	63	3.5

H-4	20	61	3.6
H-5	25	60	3.7
H-6	30	62	3.4

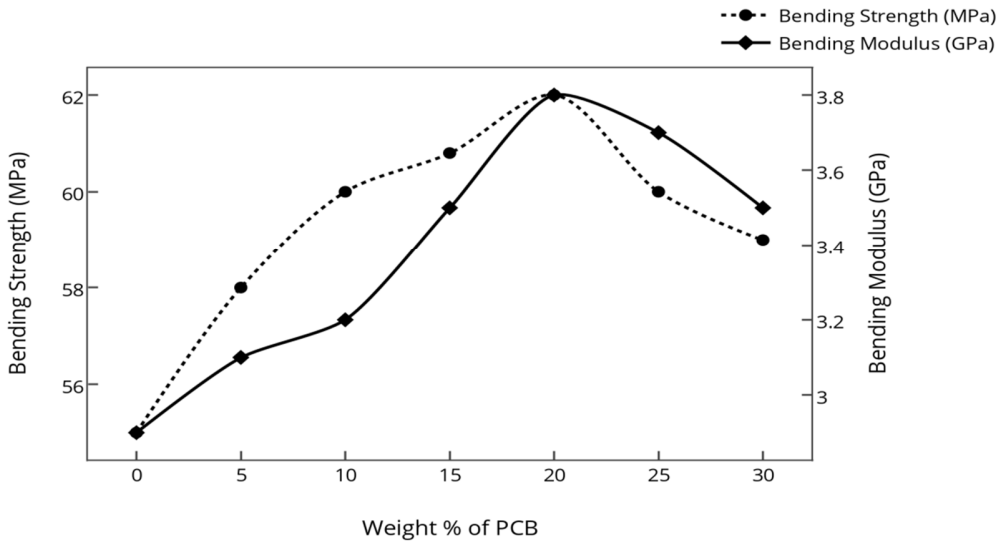

Table 4.1 gives normal qualities (Three examples for every detailing) of twisting quality and modulus for tests of various weight parts. Figure 4.1 demonstrates that there is increment and afterward decline in bowing quality and modulus with increment in weight division of caco3 powders. Most extreme quality is acquired when 20% weight division is utilized. Further increment in weight proportion of caco3 exacerbated the twisting quality and modulus esteems, because of the trouble in bond of various particles. At 20% caco3 the twisting quality and bowing modulus esteem was recorded to be ~62MPa and 3.8GPa individually.

IV. CONCLUSIONS

This examination was meant to research the plausibility of utilizing the caco3 in hdpe pipe as composites. Primary discoveries of this work were the upgrades in quality and surface morphology of the composites delivered. Results demonstrated that the caco3 can essentially and successfully improve the composite rigidity, elastic modulus, bowing quality and bowing modulus of hdpe without the expansion of some other sort of added substances and synthetic substances. A three-component show was utilized effectively to depict the viscoelastic conduct of the materials, which demonstrated the expansion of the unwinding time of the composites when contrasted with the perfect gum. The expansion of CaCo3 smaller scale particles did not influence the shear affectability ofthe composite, yet it expanded its thickness when contrasted with the flawless resin. Strong association holding still exists between the particulate and strands with higher arrangement of CaCO3. The composite hdpe/caco3 of both half and half composite frameworks was observed to be lower upon lower substance of HDPE which portrayed decreased measure of HDPE utilized, this is pair with the crystallinity substance of HDPE itself. Calcium carbonate joining do not influence altogether on the measure of crystallinity of composite.

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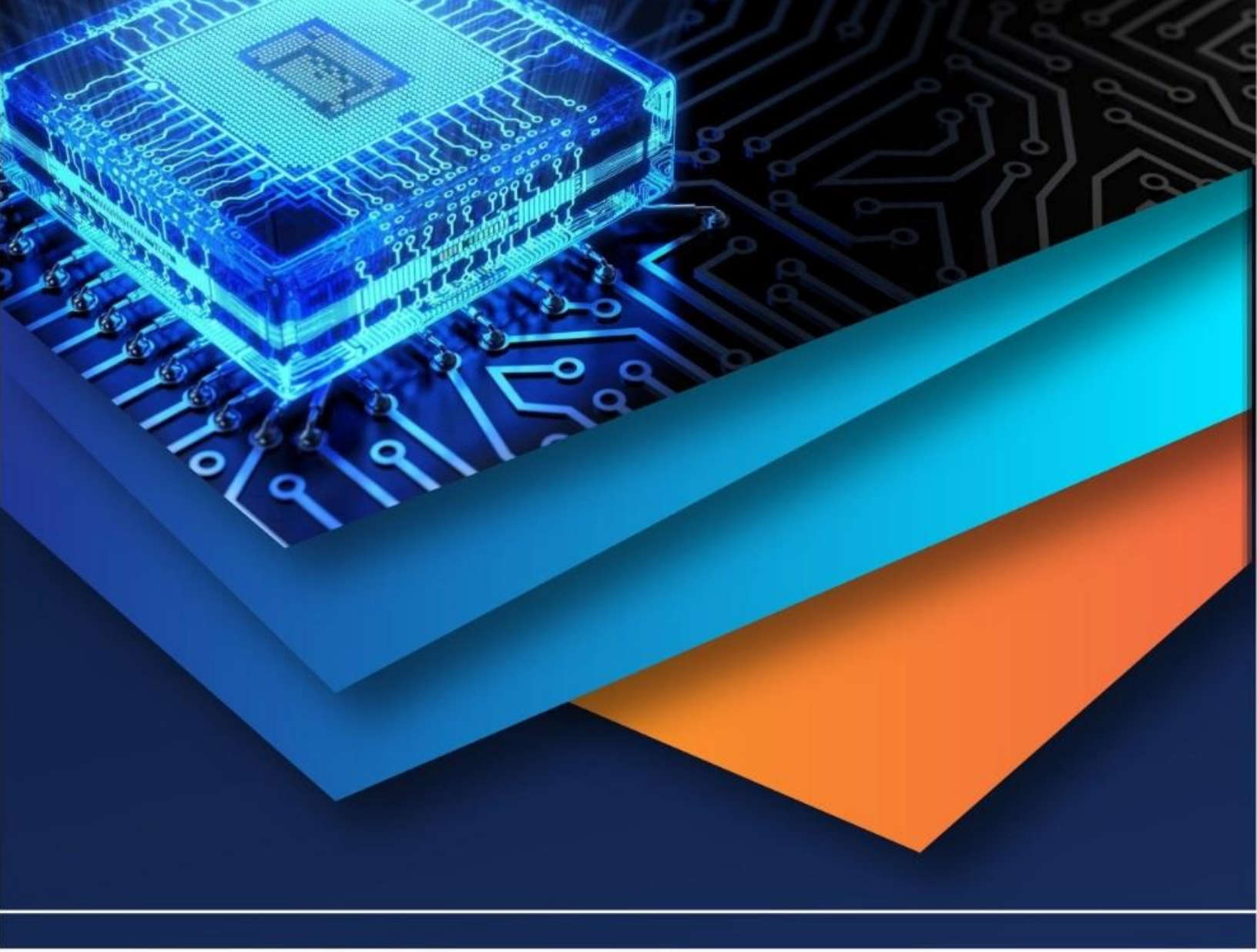

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