EFFECT OF FLY ASH PARTICLE AND VEGETABLE OIL ON THE MECHANICAL PROPERTIES OF FLY ASH-VEGETABLE OIL REINFORCED HARD PVC PLASTIC

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ABSTRACT: *Composites are those materials whose structure can be easily influenced by physical or chemical modification which depend on their use purpose. so in this paper a study on PVC reinforcement with different material were given to form a new composite. A review of effect of fly ash and vegetable oil as a reinforcing material has been discussed in this paper. As we all know that fly ash poses several environmental threat by contaminating by surrounding atmosphere and occupies huge land area for its dumping, so there is a solution to overcome from this problem is to use the fly ash in different projects, such as production of cement, concrete, as filler material or as a composite product. . PVC is a versatile thermoplastic which is used for the production of hundreds of products that consumer encounter in their everyday life, use of PVC with various class of fly ash and different kind of oil may result as a different product with highly effective properties. The result of the study indicates an interesting potential for fly ash and vegetable oil to produce useful material.*

Keywords: fly ash, vegetable oil, PVC, environmental protection, thermal conductivity, reinforcement, properties.

1. INTRODUCTION

In order to reduce the production cost of plastic products, and to improve certain characteristics, one or more fillers are usually used as an addition to the resin matrix.[1]Due to the environmental concerns and disposal difficulties, the utilization of fly ash has become of great importance.[1] Poly vinyl chloride commonly abbreviated as PVC is widely used due to it being flexible, inexpensive and durable. PVC is used in the applications such as in building materials pipe and plumbing.[4] The factors that should be considered in using PVC is safety and environmental issues. Reinforced plastic is a recent form of composite material, reinforced plastic structures have improved fatigue resistance, greater toughness ,higher creep resistance than other similar structure made from steel.[4][5]

2. REINFORCED PVC:

Reinforced PVC or plastic is basically a modified form of plastic to improve the mechanical and chemicalProperties of plastic to form a better composite material.
[19][20]

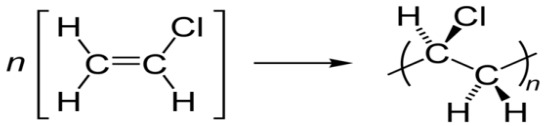

Fig: 01 polymerization of PVC [20]

2.1 OIL REINFORCEMENT:

Vegetable oils are too viscous and too reactive with atmospheric oxygen to establish significant markets for use in cosmetics, lubricants, and certain chemical additives.[2] Fortunately, properties such as viscosity, pour point, freezing point, and reactivity canbe decreased by chemically introducingbranching groups or side chains on the straight-chained fatty acids. Reinforced oil or modified oil can be used as stabilizer,lubricant, plasticizer, composite, surfactant, adhesive,nano composite and many more.[2]

The annual global production of the major vegetable oils (from palm trees, soybeans, rapeseeds, cotton, sunflower,palm kernel, olives, and coconuts) amounted to 84.6 million tons (Mt) in 1999/2000 and increased to137.3 Mt in 2009/2010 (an increase of 62%). The production of fatty acids is the highest volume oleochemical process and accounts for about 52% of industrially used oils and fats. The world supply of fatty acids has almostdoubled from 2001 to 2008 [23]

Here are some majored vegetable oils there production and consumption and export are given below:

Table: 01 Major vegetable oils: World production, trade and consumption (million tonnes) [24]

oils	2002/2003		2012/2013	
	Prod.	Prod.	Export	Consum.
coconut	3.16	3.52	1.70	3.75
cottenseed	2.51	2.16	0.12	5.19
olive	2.51	2.94	0.77	3.05
palm	27.71	52.33	40.36	51.69
soyabeen	30.57	42.69	8.50	43.57
sunflower	8.12	13.13	5.80	13.24
rapeseed	12.21	23.21	6.62	23.62

2.2 FLY ASH REINFORCEMENT:

Reinforcement of fly ash in PVC leads towards a developing a new product with some positive changes in their properties. By adding this low cost and highly abundant fly ash to PVC as a filler material we can form a new composition which can be utilized as substitute to a particular grade of plastic.[4]

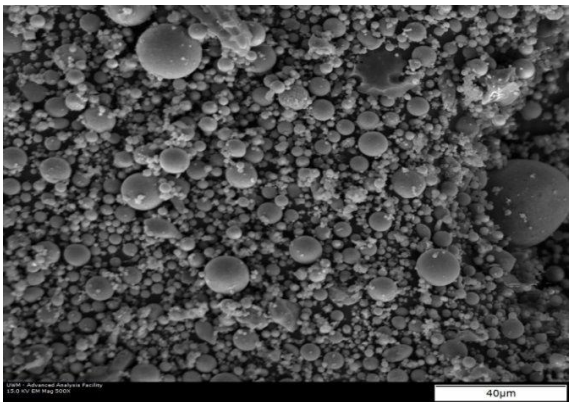

Fig: 02 SEM micrograph of fly ash showing particle sizes from 0. 0.02 To 2000Um 200X.[25]

Apart from that let us know that how much flyash produced here in India? so the answer is, According to one estimate, up to 150 million tones of fly ash will be produced in India in the year 2000, primarily by thermal power plants and, to a lesser extent, by cement and steel plants and railways. Here is a data chart which shows the fly ash utilization in India produced by different process.[29]

Fig: 03 fly ash utilization in different process in India [29]

Fly ash properties are unusual among engineering materials.Unlike soils typically used for embankment construction, fly ash has a large uniformity coefficient and it consists of clay-sized particles. Engineering properties that affect the use of fly ash in embankments include grain size distribution, compaction characteristics, shear strength, compressibility, permeability, and frost susceptibility.Nearly all the types of fly ash used in embankments are Class F.[26].The physical and chemical progenies' of coal ash are determined by reactions that occur during the high-temperament combustion of the coal and subsequent cooling of the flue gas. A considerable amount of research has gone into understanding how coal ash forms, its characteristics, and how it weathers in the environment. The properties of fly ash and bottom ash make them useful for a variety of construction applications. [27]

Table:02Typicalranges for geotechnical properties of fly ash and bottom ash. [27]

Property	Fly ash	Bottem ash
Specific gravity	2.1-2.9	2.3-3.0
Bulk density(compacted),lbs/ft^3	65-110	65-110
Optimum moisture content,%	10-35	12-26
Hydraulic conductivity	10^4-10^6	10^1-10^3
Porosity,cm/s	0.40-0.50	0.25-0.40
Angle of internal fraction,degree	25-40	35-45

2.3 SOMEOTHER:

There are some other materials are used for the reinforcement of PVC such as wood and fabric, Wood Plastic Composites (WPCs) are produced by thoroughly mixing ground wood particles and heated thermoplastic resin. The most common method of production is to extrude the material into the desired shape, though injection molding is also used. WPCs may be produced from either virgin or recycled thermoplastics including HDPE, LDPE,PVC, PP, ABS, PS, and PLA.Fibre-reinforced plastic (FRP) (alsofibre-reinforced polymer) is a composite material made of a polymer matrix reinforced with fibers. The fibres are usually glass, carbon,aramid, or basalt. Rarely, other fibres such as paper or wood or asbestos have been used. The polymer is usually an epoxy, vinylester or polyester thermosetting plastic, andphenol formaldehyde resins are still in use.FRPs are commonly used in the aerospace, automotive, marine, construction industries and ballistic armor.[13]-[17]

3. EFFECT OF FLY ASHREINFORCEMENT

Use of Fly Ash as reinforcement material can effect the properties of PVC in a positive manner. It effects the mechanical as well as chemical properties of the PVC, it increses the strength of plastic so it become more tensile.[6]

4.EFFECT OF VEGETABLE OIL REINFORCEMENT:

Use of vegetable oil as a reinforcement in PVC leads to form a new kind of product known as bioplastic. these plastics are made from renewable biomass sources such as vegetable oil and fats, corn starch or microbiota. It is biodegradable product so that it decomposes easily. This is also known as fossil fuel plastic.[7][11]

5.PROPERTIES OF BASE MATERIAL AND REINFORCING MATERIAL:

Here we are considering PVC as a base material and fly ash and vegetable oil as reinforcing materials so the properties of used material are as follows:

5.1 PVC (Polyvinyl chloride):

PVC is a thermoplasticpolymer. Its properties are usually categorized based on rigid and flexible PVCs.

(a) Mechanical property:

PVC has high hardness and mechanical properties. The mechanical properties enhance with the molecular weight increasing but decrease with the temperature increasing. The mechanical properties of rigid PVC (uPVC) are very good; the elastic modulus can reach 1500-3,000 MPa.The soft PVC (flexible PVC) elastic is 1.5-15 MPa.[4]-[8]

(b)Thermal property:

The heat stability of raw PVC is very poor, so the addition of a heat stabilizer during the process is necessary in order to ensure the product's properties. PVC starts to decompose when the temperature reaches 140 °C, with melting temperature starting around 160 °C.[4]-[8]

(c)Electrical property:

PVC is a polymer with good insulation properties, because of its higher polar nature the electrical insulating property is inferior to nonpolar polymers such as polyethyleneand polypropylene.[4]-[8]

5.2 FLY ASH

Fly ash is generally used as a filler material in metals, polymer and cements matrices due to its unique properties which are low cost, low density and smooth spherical surface.[3] Fly ash also used to improve polymer properties such as strength, stiffness, and wear resistance. An improvement in tensile, flexural, and impact properties of composite in the presence of fly ash was observed.[8]

Fig: 03An original image of class F and class C fly ash [31]

Fly ash is generally formed by different partials, it mainly contains quartz (SiO2), mullite (3Al2O3.2SiO2), hematite (Fe2O3), magnetite (Fe3O4), lime (CaO), and gypsum, (CaSO4.2H2O) [30]. The elemental and chemical compositions of fly ash were characterized by SEM-EDX and XRD,the composition of these partials are given in table 03:

Table:03 chemical composition of fly ash [25]

Component	Content (wt %)	
	Class F	Class C
Silicon	23.95	26.39
Oxygen	17.28	13.75
Aluminum	14.25	15
Iron	22.65	5.77
Calcium	13.22	26.78
Potassium	1.58	1.77
Sodium	1.05	1.27
Titanium	1.04	0.77
Sulfur	3.11	1.15
Magnesium	1.08	2.10
Carbon	0.53	0.57

There are some engineering properties of fly ash are also present, the given table gives a description about these engineering properties.

Table: 04Engineering properties of fly ash [28]

Parameter	Range
Specific gravity	1.90-2.55
Plasticity	Non plastic
Maximum dry density(gm/cc)	0.9-1.6
Optimum moisture content(%)	38.0-18.0
Cohesion(kN/m^2)	Negligible
Angle of internal friction (j)	30^0-40^0
Coefficient of consolidation C_v (cm/sec)	1.75×10^{-5}-2.01×10^{-3}
Compression index C_c	0.05-0.4
Permeability (cm/sec)	8×10^{-6}-7×10^{-4}
Particle size distribution(% of material)	
Clay size fraction	1-10
Silt size fraction	8-85
Sand size fraction	7-90
Gravel size fraction	0-10
Coefficient of uniformity	3.1-10.7

5.3VEGETABLE OIL:

The main property of vegetable oil is viscosity because of immediate and visible effect .the increase in viscosity subjected to rapid heating,it is closely dependent on temperature. The given table shows some other physical and chemicalproperties of vegetable oil.The two most immediately useful parameters for assessing the purity of vegetable oils are Saponification valuesand iodine value [21]

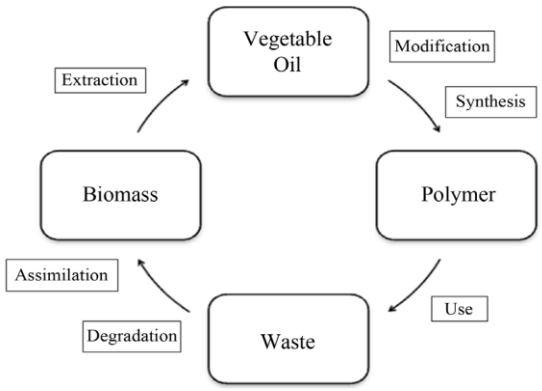

Fig:04 Cycle of polymeric material based on vegetable oils[22]

Table: 05 Physico-chemical properties of vegetable oils. [2]

Properties	Soybean	Sunflower	Rapeseed	Castor oil	Linseed
Kinematic Viscosity @ 40°C (cSt)	32.93	40.05	40.60	230.6	33.1
Kinematic Viscosity @ 100°C (cSt)	08.08	9.02	8.65	19.72	-
Viscosity Index	219	-	206	220	-
Saponification Value (mg·KOH·g-1)	189	-	-	180	190
Acid value (mg·KOH·g−1)	0.61	0.12	-	1.40	0.80
Iodine value (mg I2/g Oil)	144	85	-	87	177
Flash point (°C)	240	-	252	250	-

Although most plants contain some oil, only the oil from certain major oil crops complemented by a few Dozen minor oil crops is widely used and traded. These oils are one of several types of plant oil.[2] Vegetable oils can be classified in several ways, for example:

• By source: most, but not all vegetable oils are extracted from the fruits or seeds of plants, and the oils may be Classified by grouping oils from similar plants, such as "nut oils".

• By use: as described above, oils from plants are used in cooking, for fuel, for cosmetics, for medical purposes, and for other industrial purposes [2][9]

6. CONCLUDING REMARK:

From the detailed study of literatures it is concluded that fly ash and vegetable oil are used as reinforcing material in PVC,it is shown that there is excellent compatibility between fly ash and polymers. Use of fly ash as a filler increases the density and hardness of PVC so that tensile strength is also increases. On other hand use of vegetable oil with other raw materials to develop new products is also very challenging task for future developments and research. Use of modified oil is also a step towards the goal of green chemistry and it is strongly recommended to use in polymer area, in order to achieve further developments in this field improved methods and modification with less hazards are required.

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