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Studies on wollastonite reinforced recycled ABS (Acrylonitrile butadiene styrene) composites

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Abstract – The studies on wollastonite reinforced recycled ABS (Acrylonitrile butadiene styrene) composites were investigated. Powder-based wollastonite with a particle size of 13 microns was mixed with recycled Acrylonitrile butadiene styrene in various proportions of wt.%. Recycled ABS was homogeneously mixed and composite was prepared using a twin-screw extruder and it was pelletized. specimens were prepared using the injection moulding process and mechanical properties like tensile strength as per ASTM D638 was carried out and the results were compared with the properties of recycled ABS. It was found that the recycled ABS with 10%,20%,30%,40% of wollastonite improved the tensile modulus and as well as fall in tensile strength and elongation at break.

Key Words: calcium silicate, recycled ABS, Wollastonite, composites, injection moulding, plastic waste management.

INTRODUCTION

Plastic waste management is a very big challenge in day-to-day life. India faces major environmental challenges associated with waste generation and inadequate waste collection, treatment and disposal. The current systems in India cannot cope with the volumes of waste generated by an increasingly urban population, and these impacts on the environment and public health. The massive accumulation of plastic wastes has caused serious environmental & landfill problems [1]. It's time to rethink the way we manufacture, use and dispose of plastic items in the most favourable way. Recycling is very important as waste has a huge negative impact on the natural environment. Acrylonitrile-butadiene-styrene (ABS) was selected as the feedstock. It is a sought-after polymer due to its high impact resistance, resistance to chemicals and strength properties [2], it is useful in manufacturing a wide range of products like electrical devices, luggage cases, keyboards, television cases, refrigerator housing, grinder, mixer, washing machines, furniture's, building materials etc. Similarly, the waste which is generated from those resources is commendable. These wastes are recycled and reused. In general, after recycling the properties of plastic materials will be reduced This is due to degradation phenomena that occur during the item lifetime and, especially, during melt reprocessing operations that exalt and accelerate all the degradation effects. Of course, both environmental and melt processing degradation paths (and their synergistic combination) can cause dramatic changes in the molecular structure, with obvious consequences on the mechanical performance and the rheological characteristics[3]. To overcome this it has been added with wollastonite filler. Wollastonite is a form of naturally occurring white calcium silicate (CaSiO3) mineral. Wollastonite is a functional filler that has great potential to be used in thermoplastic composites, replacing more expensive reinforcement such as glass fiber [4]. So the recycled ABS was planned to mix with an inorganic functional filler calcium silicate called wollastonite to enhance its mechanical properties. The composites were prepared by wollastonite (calcium silicate) in different weight proportions 10%, 20%, 30%, 40% into the recycled ABS plastic and properties were examined and those results were compared with the properties of recycled ABS and virgin ABS. wollastonite reinforced 10%, 20%, 30%,40% with recycled ABS showed an increase in tensile modulus it shows rigidity/stiffness is increased as well as fall in tensile strength and elongation at break.

MATERIALS AND EXPERIMENTS:

Material: Virgin ABS (Acrylonitrile butadiene styrene) and Recycled ABS (Acrylonitrile butadiene styrene) Injection Grade

Filler: Wollastonite (CaSiO3) in the form of powder. The particle size of Wollastonite is 13.83 microns. Which was having 86.50% brightness compared with 100% MgO, Bulk density of 0.91 g/cc and chemical composition (CaSiO3) as Cao+Sio2 92.78%.

Preparation of composite: wollastonite with 13-micron particle size was taken in the form of fine powder and recycled ABS was taken in the form of granules. the various weight per cent of recycled ABS and wollastonite were taken and using twin-screw extruder it was compounded and code number given for various proportions.

Sample Code Details:

S.NO	Sample description	Sample Code No
1	Virgin ABS	A
2	Recycled ABS	B
3	Recycled ABS+10% wollastonite	C
4	Recycled ABS+20% wollastonite	D
5	Recycled ABS+30% wollastonite	E
6	Recycled ABS+40% wollastonite	F

Preparation test specimens: Test specimens were prepared using Injection moulding. ABS material is hygroscopic so it was properly pre-dried at 120^0C for 2 hours and then it was moulded.

Test Details: Studies on mechanical properties such as tensile strength was carried out.

Experiment:

Tensile properties: The tensile properties were carried out as per the ASTM D638 Type I specimen. Rate of strain 50mm/min. Tensile strength, tensile modulus and elongation at break were studied

Experiment results:30% to 40% of wollastonite filler with recycled ABS shows good improvement in tensile modulus. compared to 10% to 20% wt. proportions. Tensile strength and elongation at break gradually decreased after adding wollastonite Tensile properties test result details are mentioned in Table 1,2,3. Chart 1,2,3**.**

Table 1

The test result of tensile properties as per ASTM D638			
S.NO	Sample description	Sample Code No	Tensile strength at maximum load Mpa
1	Virgin ABS	A	50.4
2	Recycled ABS	B	42.7
3	Recycled ABS+10% wollastonite	C	41.3
4	Recycled ABS+20% wollastonite	D	36.1
5	Recycled ABS+30% wollastonite	E	30.8
6	Recycled ABS+40% wollastonite	F	30.64

Graph 1

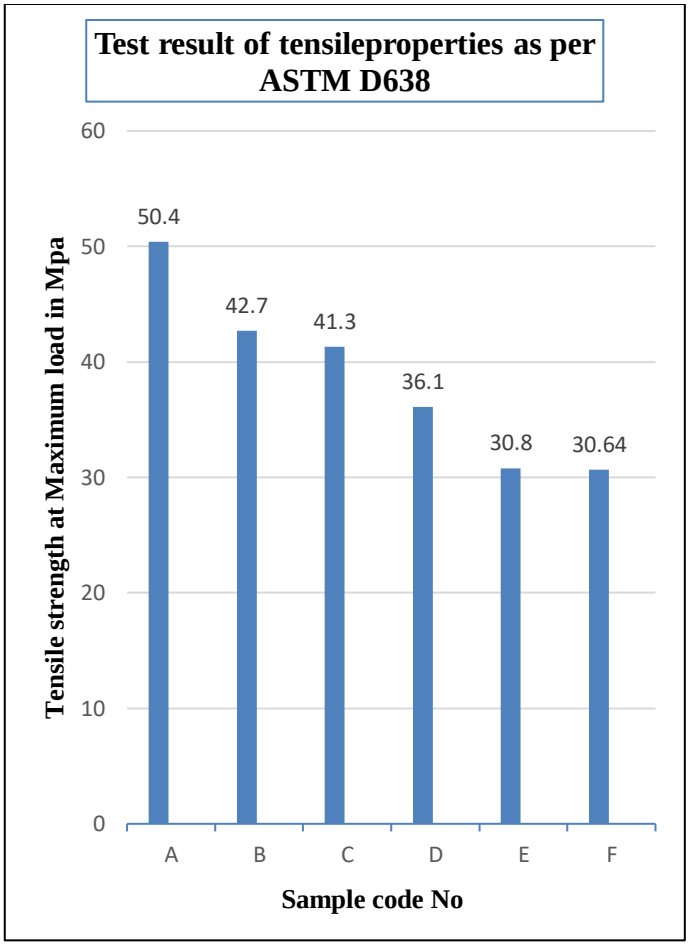
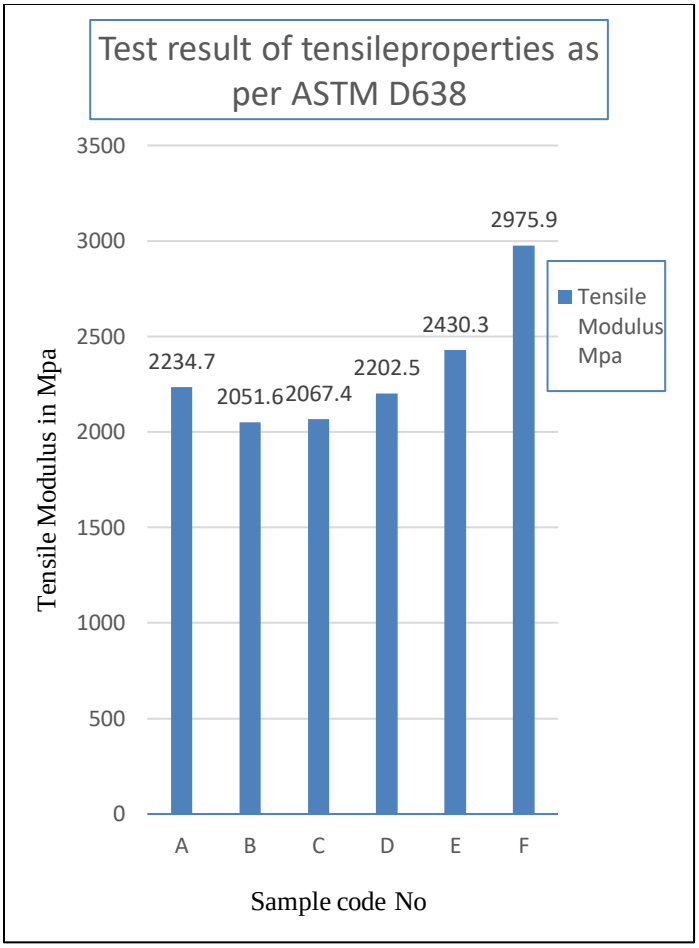


Table 2

The test result of tensile properties as per ASTM D638			
S.NO	Sample description	Sample Code No	Tensile Modulus Mpa
1	Virgin ABS	A	2234.7
2	Recycled ABS	B	2051.6
3	Recycled ABS+10% wollastonite	C	2067.4
4	Recycled ABS+20% wollastonite	D	2202.5
5	Recycled ABS+30% wollastonite	E	2430.3
6	Recycled ABS+40% wollastonite	F	2975.9

Graph 2



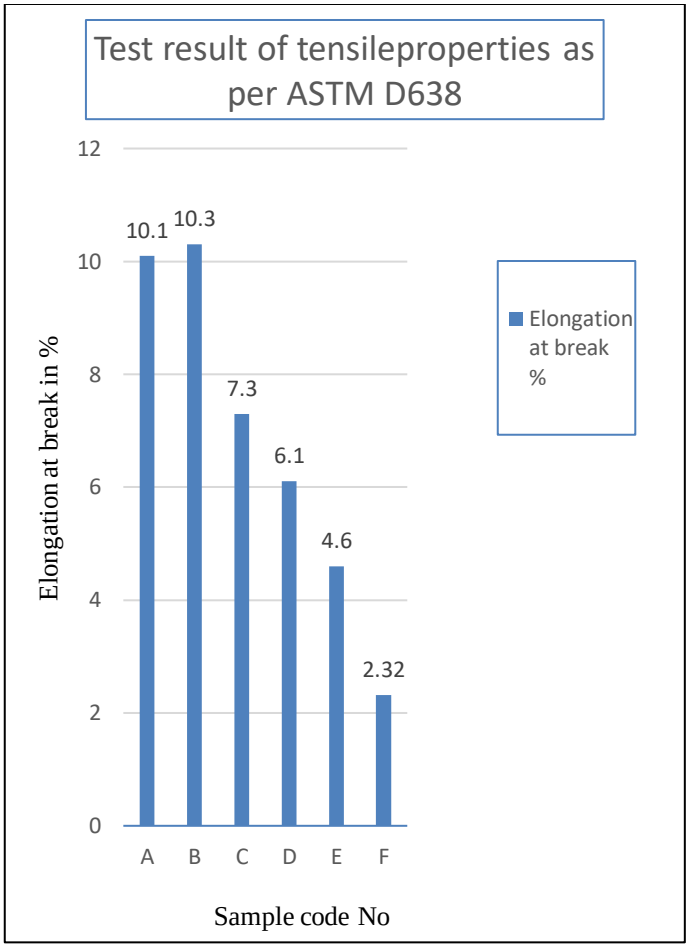


Table 3

The test result of tensile properties as per ASTM D638			
S.NO	Sample description	Sample Code No	Elongation at break %
1	Virgin ABS	A	10.1
2	Recycled ABS	B	10.3
3	Recycled ABS+10% wollastonite	C	7.3
4	Recycled ABS+20% wollastonite	D	6.1
5	Recycled ABS+30% wollastonite	E	4.6
6	Recycled ABS+40% wollastonite	F	2.32

Graph 3

DISCUSSION:

Tensile strength and elongation at break were gradually decreased with the increment of filler. Tensile modulus is gradually increased after adding various weight percentages (20%,30%,40%) with recycled ABS. For 20% it has given 7% increment in tensile modulus, for 30% it has given 18.5% increment and for 40% it has given 45% increment in tensile modulus. At the same time, it has been observed that compared to virgin ABS material it has given a 33% increment in tensile modulus with 40% of wollastonite filler with recycled ABS. So wollastonite can be added with virgin ABS also. So that the strength and modulus also will be improved effectively.

3. CONCLUSIONS

After adding wollastonite filler into recycled ABS an increase is observed in the tensile modulus by 45% with 40% of wollastonite as well as a fall in tensile strength and elongation at break. Which indicates an increase in the rigidity of the polymer. From all the above it can be concluded that the use of wollastonite as a filler for recycled ABS is possible only to lower the cost and impart rigidity. It can be significantly used in the places which virgin ABS is used example it is useful in manufacturing a wide range of products

like electrical devices, luggage cases, keyboards, television cases, refrigerator housing, grinder, mixer, washing machines, furniture's, building materials etc.

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