STUDY OF MECHANICAL PROPERTIES OF WHEAT STRAW FIBER REINFORCED HIGH DENSITY POLYTHELYNE COMPOSITES

Dr.R.S.N.Sahai[1], Lokesh Pundalik Kinage[2]
Department of General Engineering, Institute of Chemical Technology, Mumbai

Abstract

Wheat straw-reinforced plastic composites have attracted increasing interest because of the advantages of wheat fibers, such as low density, relatively high toughness, high strength and stiffness, and biodegradability.Polyethylene is a suitable material for use as a matrix in composites. In this study, the effect of the wheat straw with different filler concentration (5to25%byweight) on the mechanical properties of the high density polythelyne composites were studied. Alkali treatment was employed to wheat straw to decrease the hydrophilic nature of fiber and improve the adhesion between the fiber and the matrix. The polystyrene composites of wheat straw were prepared by Haake Rheocord 9000 twin screw extruder machine. The standard test specimenswere molded on compression moulding machine. Mechanical properties were determined using these test specimens. It was found that with the addition of wheat straw as filler in high density polythelyne composites, there is decrease in tensile strength with increase in filler loading. There is increase in impact strength and hardness with increase in filler loading. Initially there is increase in flexure loading followed by subsequent decrease in it with increase in weight percent of fiber loading. Water absorption increases with weight percent filler loading.

Keywords: High Density Polythene, Wheat straw

INTRODUCTION

The interest in natural fiber-reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, cheap, completely or partially recyclable, and biodegradable. High density polyethylene (HDPE) is suitable to be matrix in natural fiber-reinforced composites because they had lower characteristic temperatures and higher mold shrinkage although their mechanical properties were relatively low. Fatih Mengeloglu et al**. [1]** studied mechanical properties, morphology and thermal behavior of wheat straw flour (WF) filled thermoplastic composites. They found reduction in degradation temperature of the composites with incorporation of wheat straw flour in polymer composites. There was enhancement in compatibility between wheat straw flour and thermoplastic with addition of coupling agent. MAPE coupling agent was found more suitable for HDPE composite and MAPP for PP composite. Mohini Sain et al [**2**] studied wheat straw, cornstalk and corncob as suitable agro -residue reinforcement for thermoplastics. They found mechanical properties of wheat straw filled HDPE composites superior than cornstalk, corncob or wood flour filled composites. Mingzhu Pan et al [**3**] studied the dynamic, mechanical, thermal and rheological properties of the wheat straw filled polypropylene composites. Wheat straw was treated by alkalization, acetylation and maleic anhydride polypropylene (MAPP). High melt viscosity was observed in polypropylene composite reinforced with the alkalized wheat straw fiber. Addition of MAPP resulted in enhance flow behavior, better dispersion of wheat straw fiber and decrease in the melt viscosity. Sahai et al [**4**]studied mechanical properties of wheat straw filled polystyrene composite. They found increase in tensile strength, impact strength and hardness with increase in wheat straw concentration. Gujjala Raghavendra et al [**5**] studied properties of jute fiber reinforced epoxy composites. Epoxy and glass fiber composites were prepared for a comparison purpose. Addition of jute fiber resulted in better mechanical properties than virgin polymer however glass reinforced epoxy shown better mechanical properties than jute reinforced polymer composites. Temesgen Berhanu et al [**6**] studied mechanical behavior of Jute fiber Reinforced Polypropylene Composites. They reported improvement in mechanical properties with addition of jute fiber.K Sudhakar et al **[7**] studied the mechanical properties of rice straw fiber reinforced polypropylene composites. They found decrease in tensile strength with increase in weight percentage of fiber. Initially there was decrease in flexural strength and impact strength followed by subsequent increase in the value with increase in weight percentage of fiber. M. Ramesh et al [**8**] studied mechanical properties of banana fiber reinforce composites. The composites were prepared by hand lay-up process and mechanical properties like tensile, flexural and impact were evaluated. Cholachagudda et al [**9**] studied coir and rice husk reinforce hybrid polymer composite. They observed improvement in tensile strength and flexural strength of the hybrid composite material.

EXPERIMENTAL MATERIALS:

Wheat straw fibers, High Density Polyethlene and Sodium hydroxide(NaOH).

High density polyethylene (N1010865) with MFI 8.4 gm/10 min was obtained from Reliance Industries Limited, Mumbai, India. Sodium hydroxide (NaOH) for alkali treatment of wheat straw fiber was obtained from Thomas Baker, Mumbai, India

Compounding

Before compounding wheat straw was treated with sodium hydroxide(NaOH)(10%). Polystyrene andwheat straw were compounded in the counter rotating twin screw extruder Haake Rheocord 9000with 16 mm diameter and L/D 25:1 ratio. Theextrudate is quenched in water at a temperature ofabout 20-300 C. The compounding is carried in twinscrew extruder. Test specimens were prepared using compression moulding. Tensile strength test was carried out as per ASTM D 63,Flexural strength as per ASTM D 790,Impact strength as per ASTM D 256,Shore hardness test as per ASTM D 2240 and water absorption test as per ASTM D 570

Result and Discussion

Tensile Properties

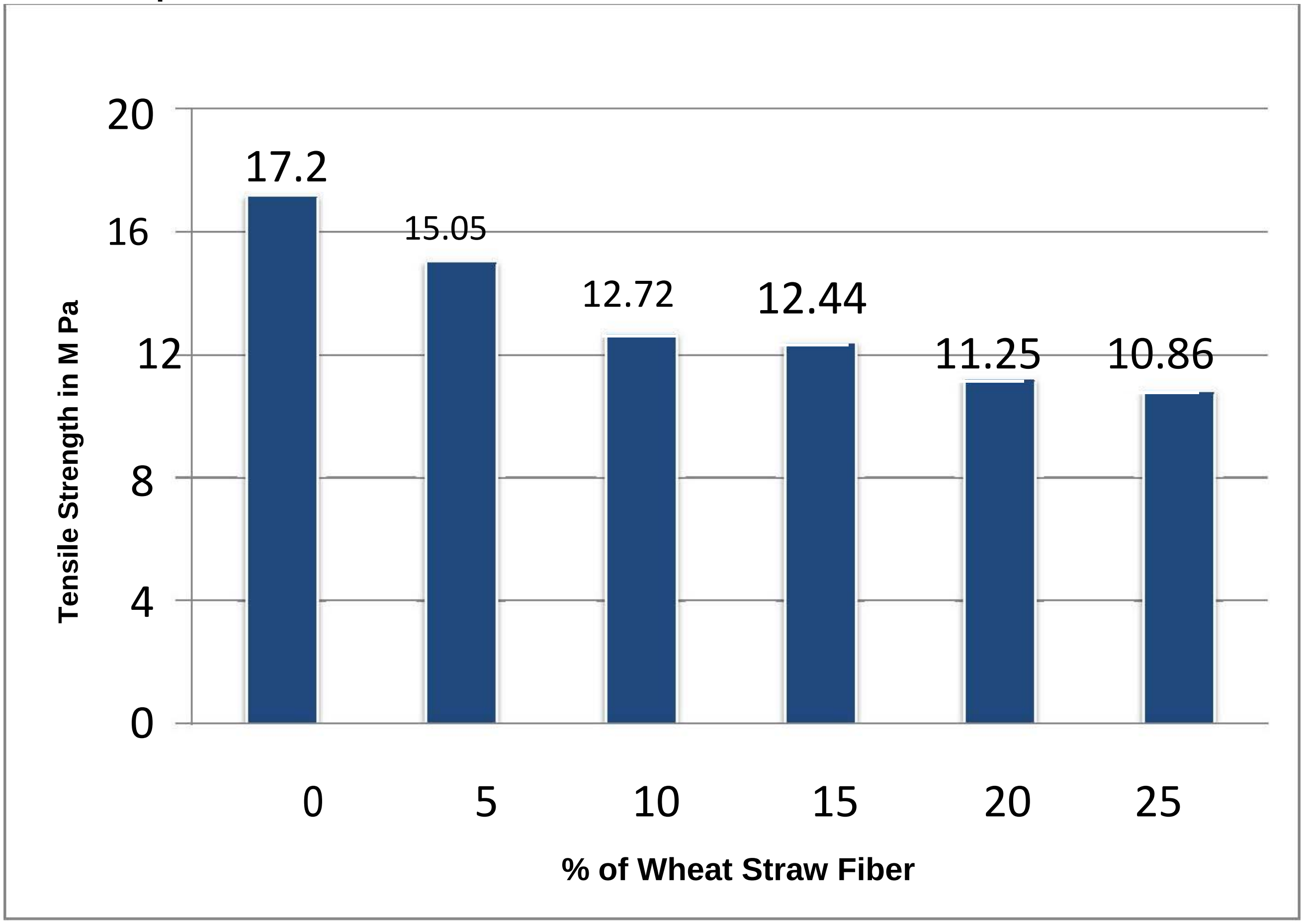

Figure 1 Variation in Tensile strength of wheat straw filled HDPE composites

Normally, thermoplastic polymers have rather high strain at failure compared to synthetic or natural fibers. The addition of wheat straw fibers to plastics results in more brittle failure, especially when short fibers are used as reinforcement. It is seen from figure **1** that tensile strength of wheat straw fiber reinforced HDPE composite decrease with increase of weight percentage (wt. %) of wheat straw fiber in the composite. This is due to increased reinforcement of wheat straw fiber in composite

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Flexural Properties

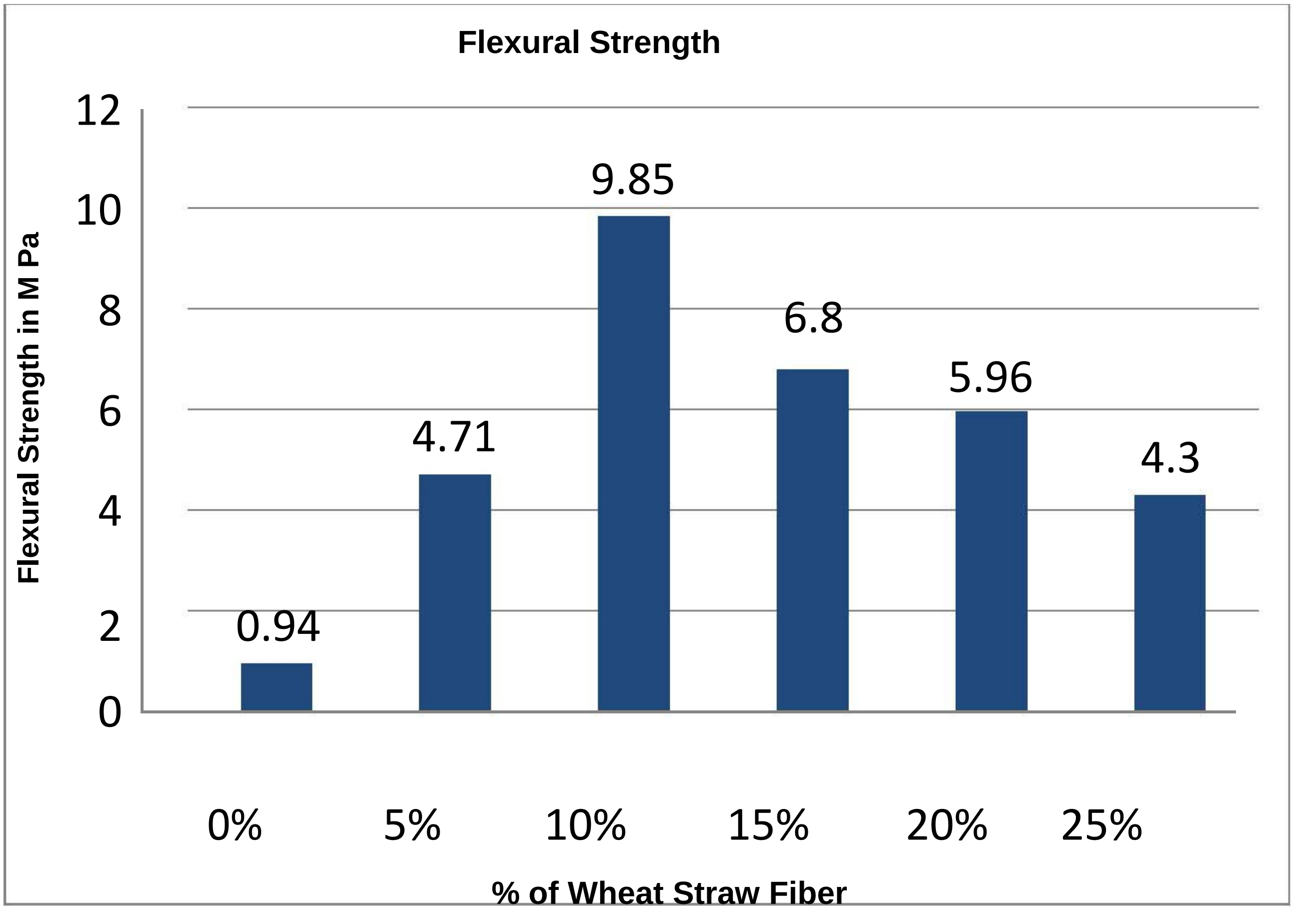

Figure 2 Variation in Flexure strength of wheat straw filled HDPE composites

From figure **2** it can be seen that flexural strength of wheat straw fiber reinforced HDPE composite increases up to 10% loading accompanied by subsequent decrease in it with further increase in fiber loading. However value at higher loading is greater than value of virgin polymer.

Impact Properties

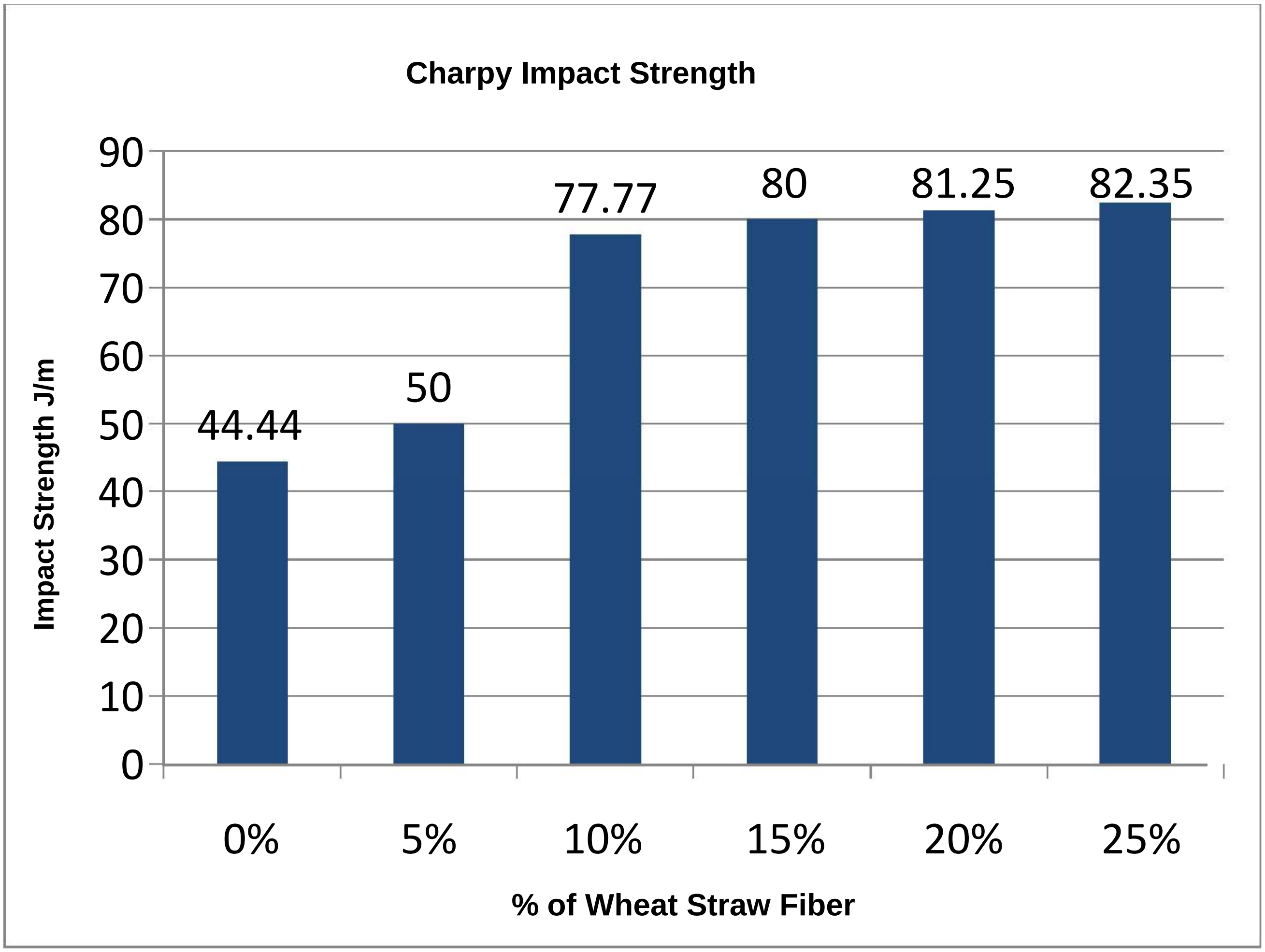

Figure 3 Variation in Impact strength of wheat straw filled HDPE composites

From figure **3** it can be seen that with increase of wheat straw fiber content from 5% to 25%, Charpy impact strength of wheat straw fiber reinforced HDPE composite increased from 50 J/m to 82.35 J/m. Charpy impact strength of wheat straw fiber reinforced HDPE composite is also higher than pure HDPE. It can be concluded that addition of wheat straw fiber results in increase of toughness of composite. Due to this impact property of composite has improved

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Hardness Properties

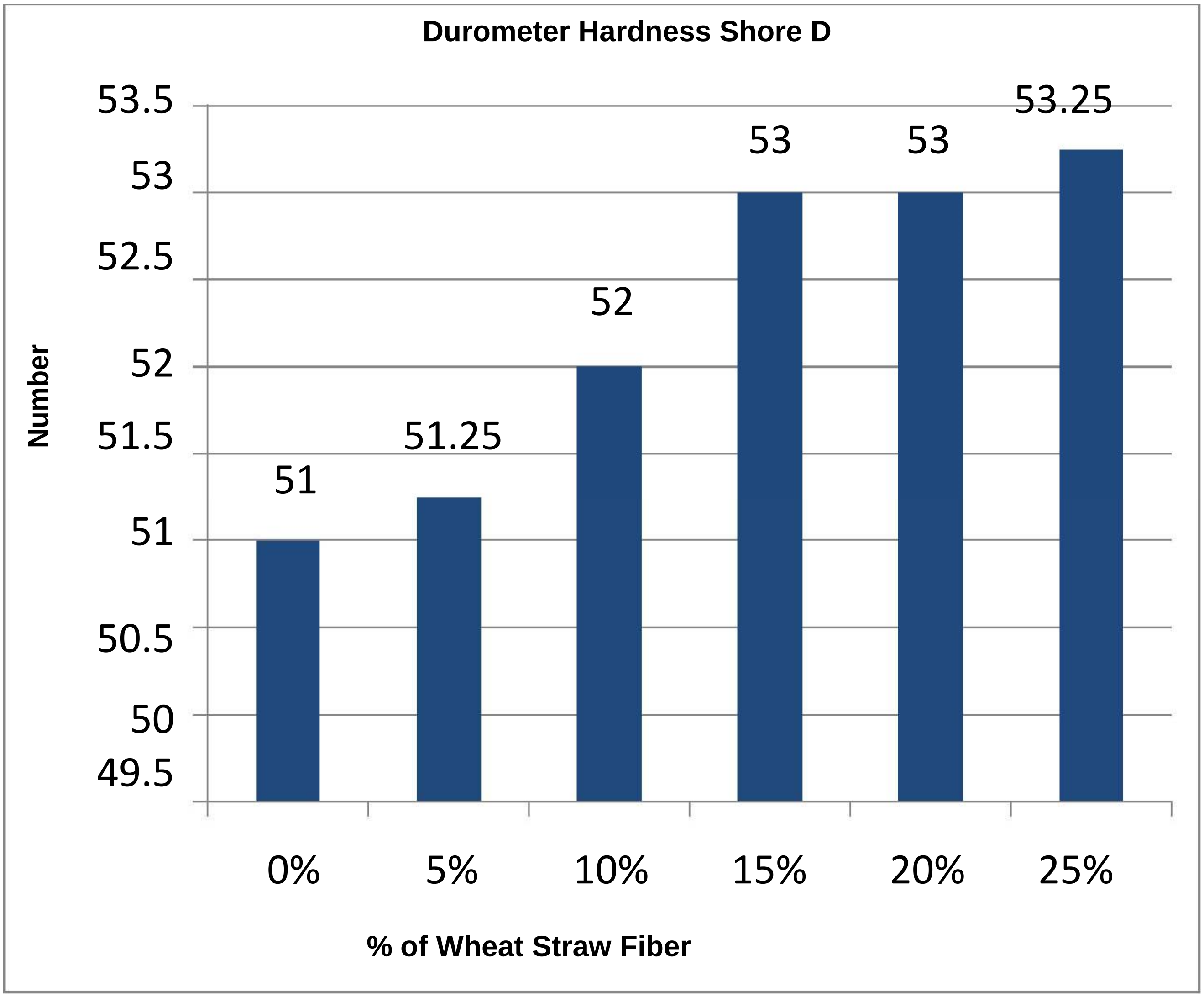

Figure 4 Variation in Hardness of wheat straw filled HDPE composites

From figure **4** it can be seen that the hardness of composite increased with increase of wheat straw fiber weight % in composite. This is attributed to increased resistance of composite to indentation due to improved stiffness of composite with addition of wheat straw fiber in composite

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Water Absorption Properties

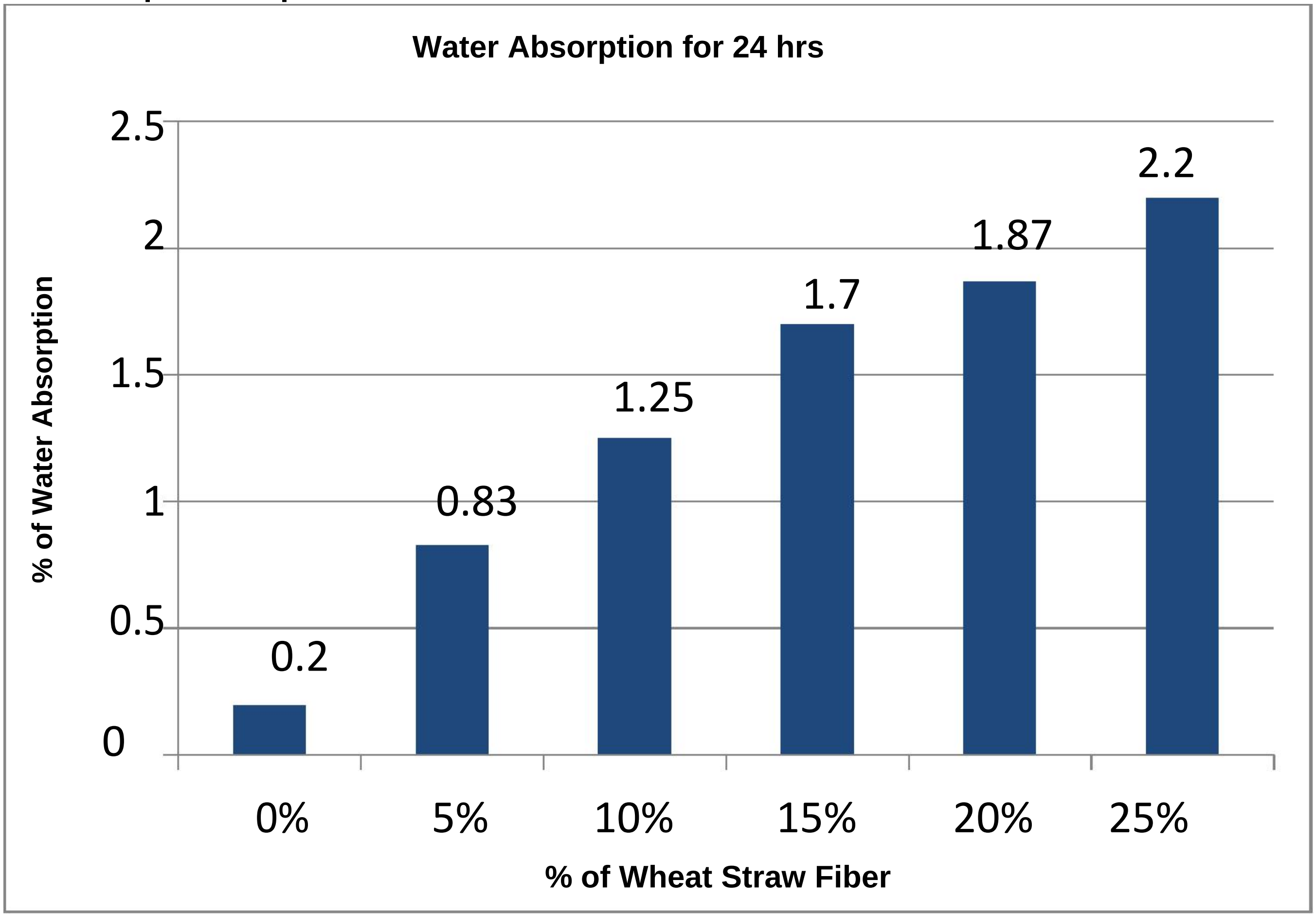

Figure 5 Variation in water absorption of wheat straw filled HDPE composites

The percentage (%) water absorption of pure HDPE polymer, and 5% to 25% treated wheat straw fiber reinforced HDPE composite are shown in figure **5**. The water absorption test is carried out for 24 hrs. It is observed that as percentage of water absorption of composite is increased with increase of wt. % loading of wheat straw fiber but it is within an accepted limit.

Scanning electron microscopy:

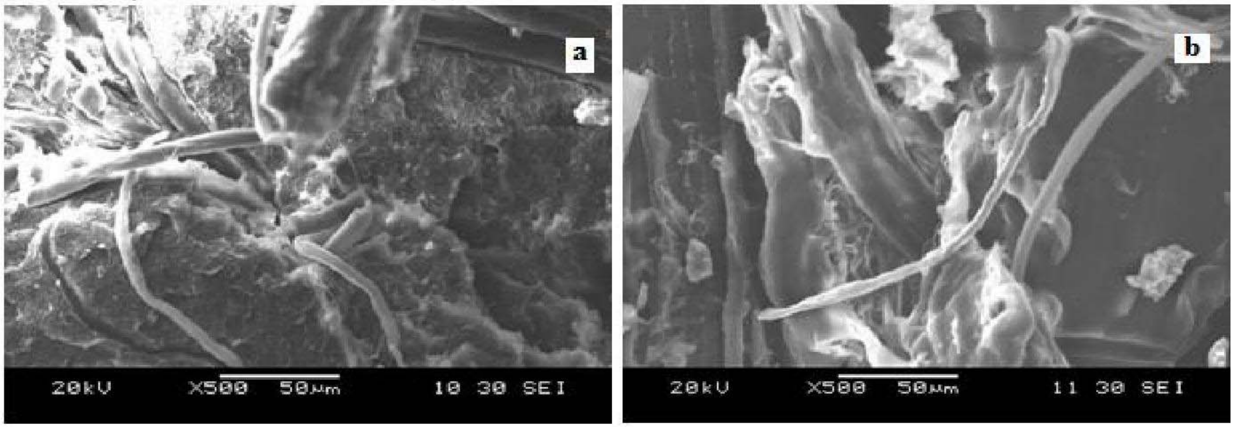

Figure 6 SEM images of tensile fracture surfaces (a) 15% loading of WSF (b) 25% loading of WSF

The SEM pictures of the fracture surfaces of both 15% loading and W25% loading are shown in Figure 6. Picture (a) reveal rough fracture surface, some fractured fiber particles and indentations left by fiber Particles as they dislocated from the matrices.

These kinds of morphologies increase stress concentrations.

Conclusion

It can be concluded that with the addition of wheat straw as filler in high density polythelyne composites, there is decrease in tensile strength with increase in filler loading. There is increase in impact strength and hardness with increase in filler loading. Initially there is increase in flexure loading followed by subsequent decrease in it with increase in weight percent of fiber loading. Water absorption increases with weight percent filler loading.

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