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Structure Property for Fiber Reinforced Thermoplastics

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Abstract

The mechanical properties of fiber – reinforced thermoplastics depend on the fiber length and fiber orientation distribution which them - selves are influenced by the processing condition. In the present work, specimens glass fiber reinforced nylon were injected moulded at different back pressure. It was found the back pressure effected on fiber – attrition during injection moulding and the mechanical properties like compressive strength and flexural strength vary with back pressure.

الخواص التركيبية للألياف المركبة مع اللدائن المطاوعة للحرارة

الخلاصة

يتضمن هذا البحث الخواص الميكانيكية لمادة مركبة نوع ثرموبلاستك مع الياف نوع ألياف الزجاج مع النايلون باستخدام أسلوب الحقن وبضغوط مختلفة حيث وجد إن تأثير الضغط الهيدروليكي أثناء عملية الحقن على الخواص الميكانيكية مثل قوة الانضغاط وقوة الانثناء وتغير هذه الخواص مع الضغط وباختلاف درجات الحرارة.

Introduction

Composite are combination of two or more materials presents as separate phase and combined to form desired structures so as to take advantage of certain properties of each component. The constituents can be in the form of particles, rods, fibers, plates, foams, etc.[1,2].

Compared with homogenous material, these additional variable often provide greater latitude in optimizing for a given application, such as physically uncorrected parameter as strength, density, electrical properties and cost.

Composite materials consist of a continuing matrix phase that surrounds the reinforcing-phase structure. The matrix has many desirable, intrinsic, chemical or processing characteristics, and the reinforcement serves to improve certain of the important engineering properties, such as compressive strength, creep resistance…. etc.

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A fiber reinforced plastics (FRP) is a composite material consisting of a network of reinforced fibers embedded in matrix, in (FRP), fibers and plastics with same excellent physical and mechanical properties, are combined to give a material with new and superior properties[1,3].

(FRP) are now a well – establish group of engineering materials in which the strength and stiffens of some fiber like carbon, glass, kevlar, etc. are effectively utilized by embedding them in a polymer matrix which can be either a thermoses (e.g. epoxy, polyester) or a thermoplastic (e.g. polypropylene, nylon). The processing techniques for thermoses matrix composite are not amenable to volume production this is not so for composites with thermoplastics as matrix material. Conventional processes like extrusion, injection moulding can still be used for fiber – reinforced thermoplastics. However, the reinforcing fiber safer appreciable length degradation during processing and this has a direct influence on various thermos mechanical[2,4].

Many researcher like Kelly Mittal et. al[2] and Wolf[3] have also suggested some steps to ensure longer fiber in the final product. Once of the suggestion is to long fiber pellets obtained by chopping pultrued rods containing perfectly distributed and coated single fiber of uniform length.

The present works carried out on injection moulded long fiber – reinforced nylon composite specimens. The influence of one important processing parameter viz. back pressure has been studied.

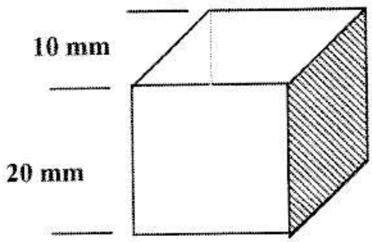
Experimental Work

The test specimens were prepared from pellets of nylon filled with long glass fibers (15 mm length and 16 μm diameter). The material is marketed by Hoechest AG, Germany under trade name " Celstran Gf 4004". The material had 20% volume fracture of fibers.

The material had (25%) volume fracture of fibers standard compressive strength specimens were injection moulded[5,6]. During injection moulded back pressure was varied while keeping other process variables like screw speed. Injection speed, injection pressure, mould, temperature, etc. The hydraulic pressure control were used, i.e., 1,10,15,20 bars. These correspond to back pressure of 15, 100, 200, 225 respectively. The barrel temperature was adjusted to maintain same melt temperature for all levels of back pressure. The following test procedure were carried out.

1- Compressive Strength

Hydraulic piston type Harris No. 36110 was used to measure the compressive strength of samples at different temperature of (25, 35, 45, 65) C° ASTM – D695 was used in the preparation of samples, these samples with the following dimensions the length of specimen were double its width in the ratio percent of 2:1 the width of the sample was equal to its thickness as showing figure below(7).



The samples were fixed the between of the piston, and the load was applied at constant rate, The compressive strength was calculated as follows: -

Compressive Strength (Mpa) = Load/ Crosse section area of sample before deformation

2- Flexural Strength

Flexural strength was measured by using three point bending load tester at different temperature (25,35,45,65) C° according to (ATM-D790) the samples were prepared with rectangular shape, hydraulic piston type Lyebold Harris No. 36110 was used to measure the maximum load on the middle of that caused failure and for the following relation the flexural strength were calculated by using the equation(5).

$$F.s = \frac{3pL}{2bt^{2}}$$

where:-
S = Distance between fixed point
P = Maximum load
L = Length of samples
T = Thickness of samples
B = Width of sample

3- Fiber Length Measurement

Fiber were separated by (ashing) method from small pieces of composite specimens, injection moulded at different buck pressure. Fiber length (15mm) were measured using combined sieving-image analyzer technique[4,8].

Result and Discussion

Compressive strength and flexural strength results corresponding to different hydraulic pressure and test temperatures are shown in Fig (1 and 2) respectively. It is seen from Fig.(1) that decreasing compressive strength with increasing temperature also Fig.(2) shows the flexure strength variation for different hydraulic pressure and test temperature. It is seen from Fig.(1), that there is a transition in failure strain dependence on temperature around a temperature of 45 C°. This is indicative of the change in failure mechanism[5,9]. At higher temperature fiber pull out is more probable while at lower temperature, fiber-breakage is the predominate mode of failure.

It may be suggested that failure in such fiber reinforced composites may take place trough a mechanism by which separation or dissociation starts at fibers-matrix interfaces. These local stress concentration will result into the development of inter laminar shear stress. The fiber-nylon will in turn fail, which results in to the final failure of the composite which is in good agreement with previous reports[8].

As the temperature increase the flexure strength decrease. This side to degradation of Matrix phase, and the de-bonding which occur between fiber and matrix and also may be due to the formation of voids which has an effect on the test[6].

Conclusion

It has been clearly established the during injection moulding of long discontinues gloss fiber reinforced nylon composite the back pressure plays an important role in fiber length degradation and in determining the skin /core thickens ratio. Both these features influence the mechanical properties of the composite.

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Table (1) Compressive strength Vs. hydraulic pressure at different temperature.

Compressive strength (Mpa)				Hydraulic pressure (bar)
25C°	35C°	45C°	65C°	
140	125	102	80	1
133	118	91	73	10
129	106	81	67	15
124	98	76	58	20

Table (2) Flexure strength Vs. hydraulic pressure at different temperature

Flexural strength (Mpa)				Hydraulic pressure (bar)
25C°	35C°	45C°	65C°	
215	210	187	152	1
208	200	177	135	10
201	193	160	120	15
196	185	145	100	20

Fig.(1) Compressive strength Vs. hydraulic pressure at different temperature

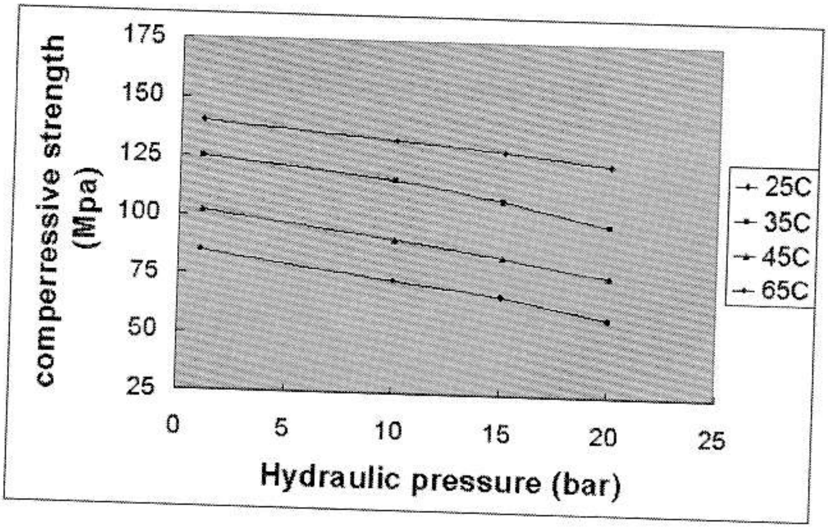

Fig.(2) Flexure strength Vs. hydraulic pressure at different temperature