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Wear Reduction and Analysis Used in Spur Gear Application

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ABSTRACT

In this project nylon 6 and E-glass fibre are aimed to combined together to get a polymer matrix composite. Nylon 6 gives the composite a high stength. Nylon 6 is widely used in gears and in many automotive industry. Due to low cost, high strength and high stiffness E-glass is used and also it is a strong and light weight material. The nylon 6 and the E-glass combination can be attain by using Twin screw extrusion process. This project is aimed to investigate the mechanical properties such as tensile, compression, impact with the sample preferred in ASTM standard. Here composite is fabricated in Injection moulding technique in various ratios[Nylon 6:Glass fibre (80:20) & (70:30)] **Keywords:** E-glass, Nylon 6

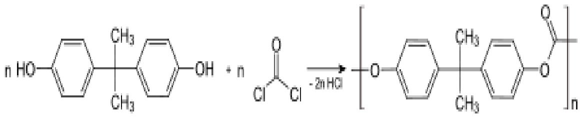
INTRODUCTION

Polymers make ideal materials as they can be processed easily, possess lightweight, and desirable mechanical properties. It follows, therefore, that high temperature resins are extensively used in aeronautical applications.Two main kinds of polymers are thermosets and thermoplastics. Thermosets have qualities such as a well-bonded three- dimensional molecular structure after curing. They decompose instead of melting on hardening. Merely changing the basic composition of the resin is enough to alter the conditions suitably for curing and determine its other characteristics. They can be retained in a partially cured condition too over prolonged periods of time, rendering Thermosets very flexible. Thus, they are most suited as matrix bases for advanced conditions fiber reinforced composites. Thermosets find wide ranging applications in the chopped fiber composites form particularly when a premixed or moulding compound with fibers of specific quality and aspect ratio happens to be starting material as in epoxy, polymer and phenolic polyamide resins.Thermoplastics have one- or two -dimensional molecular structure and they tend to at an elevated temperature and show exaggerated melting point. Another advantage is that the process of softening atelevated temperatures can reversed to regain its properties during cooling, facilitating applications of conventional compress techniques to mould the compounds. Resins reinforced with thermoplastics now comprised an emerging group of composites. The theme of most experiments in this area to improve the base properties of the resins and extract the greatest functional advantages from them in new avenues, including attempts to replace metals in die-casting processes. In crystalline thermoplastics, the reinforcement affects the morphology to a considerable extent, prompting the reinforcement to empower nucleation. Whenever crystalline or amorphous, these resins possess the facility to alter their creep over an extensive range of temperature. But this range includes the point at which the usage of resins is constrained, and the reinforcement in such systems can increase the failure load as well as creep resistance. shows kinds of thermoplastics.

Physical Properties	
Density (ρ)	1.20–1.22 g/cm^3
Abbe number (V)	34.0
Refractive index (n)	1.584–1.586
Flammability	V0-V2
Limiting oxygen index	25–27%
Water absorption –Equilibrium (ASTM)	0.16–0.35%
Water absorption – over 24 hours	0.1%
Radiation resistance	Fair
Ultraviolet(1-380nm)resistance	Fair
Mechanical Properties	
Young's modulus (E)	2.0–2.4 GPa
Tensile strength (σ_t)	55–75 MPa
Elongation (ε) at break	80–150%
Compressive strength (σ_c)	>80 MPa
Poisson's ratio (ν)	0.37
Hardness – Rockwell	M70
Izod impact strength	600–850 J/m
Notch test	20–35 kJ/m^2
Abrasive resistance –ASTM D1044	10–15 mg/1000 cycles
Coefficient of friction (μ)	0.31
Speed of sound	2270 m/s
Thermal Properties	
Melting temperature (T_m)	155 °C (311 °F)[1]
Glass transition temperature (T_g)	147 °C (297 °F)
Heat deflection temperature	0.45 MPa: 140 °C (284 °F) 1.8 MPa: 128–138 °C (262–280 °F)
Vicat softening point at 10 kN	145 °C (293 °F)[citation needed]
Upper working temperature	115–130 °C (239–266 °F)
Lower working temperature	−40 °C (−40 °F)[2]
Thermal conductivity (k) at 23 °C	0.19–0.22 W/(m·K)
Thermal diffusivity (a)at 25 °C	0.144 mm^2/s[3]
Linear thermal expansion coefficient (α)	65–70 × 10^{-6}/K
Specific heat capacity (c)	1.2–1.3 kJ/(kg·K)

PRODUCTION

The main polycarbonate material is produced by the reaction of bisphenol A (BPA)and phosgene COCl
2. The overall reaction can be written as follows:



The first step of the synthesis involves treatment of bisphenol A with sodium hydroxide, which deprotonates the hydroxyl groups of the bisphenol A.

$$(HOC_6H_4)_2CMe_2 + 2\ NaOH \rightarrow Na_2(OC_6H_4)_2CMe_2 + 2\ H_2O$$

The diphenoxide ($Na_2(OC_6H_4)_2CMe_2$) reacts with phosgene to give a chloroformate, which subsequently is attacked by another phenoxide. The net reaction from the diphenoxide

$$Na_2(OC_6H_4)_2CMe_2 + COCl_2 \rightarrow 1/n\ [OC(OC_6H_4)_2CMe_2]_n + 2\ NaCl$$

In this way, approximately one billion kilograms of polycarbonate is produced annually. Many other diols have been tested in place of bisphenol A, e.g. 1,1-bis(4-hydroxyphenyl)cyclohexane and dihydroxybenzophenone. The cyclohexane is used as a comonomer to suppress crystallisation tendency of the BPA-derived product. Tetrabromobisphenol A is used to enhance fire resistance. Tetramethylcyclobutanediol has been developed as a replacement for BPA. An alternative route to polycarbonates entails transesterification from BPA and diphenyl carbonate:

$$(HOC_6H_4)_2CMe_2 + (C_6H_5O)_2CO \rightarrow 1/n\ [OC(OC_6H_4)_2CMe_2]_n + 2\ C_6H_5OH$$

The diphenyl carbonate was derived in part from carbon monoxide, this route being greener than the phosgene method.

Polycarbonate is a durable material. Although it has high impact-resistance, it has low scratch-resistance and so a hard coating is applied to polycarbonate eyewear lenses and polycarbonate exterior automotive components. The characteristics of polycarbonate are quite like those of polymethyl methacrylate (PMMA, acrylic), but polycarbonate is stronger and usable over a greater temperature range. Polycarbonate is highly transparent to visible light, with better light transmission than many kinds of glass.

Polycarbonate has a glass transition temperature of about 147 °C (297 °F), so it softens gradually above this point and flows above about 155 °C (311 °F). Tools must be held at high temperatures, generally above 80 °C (176 °F) to make strain- and stress-free products. Low molecular mass grades are easier to mold than higher grades, but their strength is lower as a result. The toughest grades have the highest molecular mass, but are much more difficult to process.

Unlike most thermoplastics, polycarbonate can undergo large plastic deformations without cracking or breaking. As a result, it can be processed and formed at room temperature using sheet metal techniques, such as bending on a brake. Even for sharp angle bends with a tight radius, heating may not be necessary. This makes it valuable in prototyping applications where transparent or electrically non-conductive parts are needed, which cannot be made from sheet metal. Note thatPMMA/Plexiglas, which is similar in appearance to polycarbonate, is brittle and cannot be bent at room temperature.Main transformation techniques for polycarbonate resins:extrusion into tubes, rods and other profiles including multiwallextrusion with cylinders (calenders) into sheets (0.5–20 mm (0.020–0.787 in)) and films (below 1 mm (0.039 in)), which can be used directly or manufactured into other shapes using thermoforming or secondary fabrication techniques, such as bending, drilling, routing, laser cutting etc.Two-shot or multi-shot molds are designed to "overmold" within a single molding cycle and must be processed on specialized injection molding machines with two or more injection units. In the first step, the base color material is molded into a basic shape, which contains spaces for the second shot. Then the second material, a different color, is injection-molded into those spaces. Pushbuttons and keys, for instance, made by this process have markings that cannot wear off, and remain legible with heavy use.Molds are built through two main methods: standard machining and EDM. Standard machining, in its conventional form, has historically been the method of building injection molds. With technological development, CNC machiningbecame the predominant means of making more complex molds with more accurate mold details in less time than traditional methods.

Polycarbonate sheeting in a greenhouse.

A bottle made from polycarbonate

NICHE APPLICATIONS

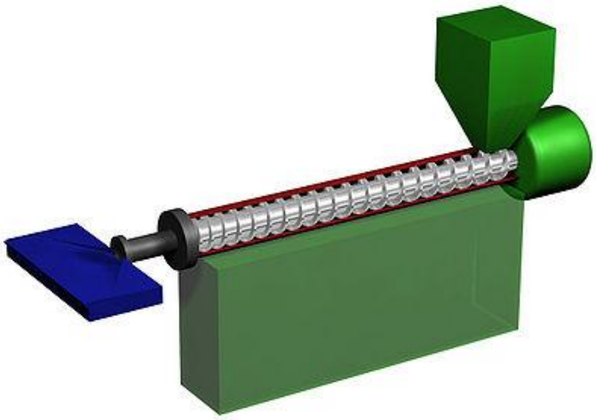
Polycarbonate, being a versatile material with attractive processing and physical properties, has attracted myriad smaller applications. The use of injection molded drinking bottles, glasses and food containers is common, but the use of BPA in the manufacture of polycarbonate has stirred serious controversy (see Potential hazards in food contact applications), leading to development and use of "BPA-free" plastics in various formulations.

Fiber type	**Tensile strength (MPa)**[10]	**Compressive strength (MPa)**	**Density (g/cm³)**	**Thermal expansion (µm/m·°C)**	**Softening T (°C)**	**Price ($/kg)**
E-glass	3445	1080	2.58	5.4	846	~2
S-2 glass	4890	1600	2.46	2.9	1056	~20

FORMATION

The bushing plate is the most important part of the machinery for making the fiber. This is a small metal furnace containing nozzles for the fiber to be formed through. It is almost always made of platinum alloyed with rhodium for durability. Platinum is used because the glass melt has a natural affinity for wetting it. When bushings were first used they were 100% platinum, and the glass wetted the bushing so easily that it ran under the plate after exiting the nozzle and accumulated on the underside. Also, due to its cost and the tendency to wear, the platinum was alloyed with rhodium. In the direct melt process, the bushing serves as a collector for the molten glass. It is heated slightly to keep the glass at the correct temperature for fiber formation. In the marble melt process, the bushing acts more like a furnace as it melts more of the material.

Bushings are the major expense in fiber glass production. The nozzle design is also critical. The number of nozzles ranges from 200 to 4000 in multiples of 200. The important part of the nozzle in continuous filament manufacture is the thickness of its walls in the exit region. It was found that inserting a counterbore here reduced wetting. Today, the nozzles are designed to have a minimum thickness at the exit. As glass flows through the nozzle, it forms a drop which is suspended from the end. As it falls, it leaves a thread attached by the meniscus to the nozzle as long as the viscosity is in the correct range for fiber formation. The smaller the annular ring of the nozzle and the thinner the wall at exit, the faster the drop will form and fall away, and the lower its tendency to wet the vertical part of the nozzle. The surface tension of the glass is what influences the formation of the meniscus. For E-glass it should be around 400 mN/m.



Plastic extruder to show the screw

Results and discussion

Molding tolerance is a specified allowance on the deviation in parameters such as dimensions, weights, shapes, or angles, etc. To maximize control in setting tolerances there is usually a minimum and maximum limit on thickness, based on the process used. Injection molding typically is capable of tolerances equivalent to an IT Grade of about 9–14. The possible tolerance of a thermoplastic or a thermoset is ±0.200 to ±0.500 millimeters. In specialised applications tolerances as low as ±5 µm on both diameters and linear features are achieved in mass production. Surface finishes of 0.0500 to 0.1000 µm or better can be obtained. Rough or pebbled surfaces are also possible.

The power required for this process of injection molding depends on many things and varies between materials used. Manufacturing Processes Reference Guide states that the power requirements depend on "a material's specific gravity, melting point, thermal conductivity, part size, and molding rate of the same reference as previously mentioned that best illustrates the characteristics relevant to the power required for the most commonly used materials.

With injection molding, granular plastic is fed by gravity from a hopper into a heated barrel. As the granules are slowly moved forward by a screw-type plunger, the plastic is forced into a heated chamber, where it is melted. As the plunger advances, the melted plastic is forced through a nozzle that rests against the mold, allowing it to enter the mold cavity through a gate and runner system. The mold remains cold so the plastic solidifies almost as soon as the mold is filled.As the number of cavities play a vital role in molding costs, so does the complexity of your part design. Complexity can be incorporated into many factors such as surface finishing, tolerance requirements, internal or external threads, fine detailing or the number of undercuts that may be incorporated. Rubber injection molding process produces a high yield of durable products, making it the most efficient and cost-effective method of molding. Consistent vulcanization processes involving precise temperature control significantly reduces all waste material.

The number of cavities you incorporate into your mold will directly correlate in molding costs. Fewer cavities require far less tooling work, so limiting the number of cavities in-turn will result in lower initial manufacturing costs to build your injection mold.

Conclusion

The materials have been selected with the help of the journals, for the required application. .

In future the materials will be blended in twin screw extrusion and then the specimen will be created with help of injection molding. As per the ASTM standard

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