Optimization Characteristics of Thermoplastic Gears

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***Abstract*: In various applications of machines (sewing machine, ATM etc) polymers gears are used to control various operations. The gears used are mostly made up of nylon 66 with addictive and they have some disadvantages like more wear, less life which increases the maintenance cost So new compound nylon with glass fibre is investigated whether they can overcome the disadvantages with FZG testing machines along with various tests. The idea of using asymmetric tooth profiles has repute in observe of gearing design. In a similar way to the symmetric normal rack gears, teeth action parameters are calculated in the course of the first stage, while the unified producing general rack for a pair of mating gears during the 2d stage. In designated cases the parameters of special normal rack enamel profiles are set for every gear in a transmission.. In a similar way to the symmetric normal rack gears, teeth action parameters are calculated in the course of the first stage, while the unified producing general rack for a pair of mating gears during the 2d stage. In designated cases the parameters of special normal rack enamel profiles are set for every gear in a transmission.**

Keywords: POLYMER GEARS, FZG

1. INTRODUCTION:

The engineering thermoplastic materials have found a wide variety of applications in the current technological world. Some of the thermoplastic at materials are polyethylene, polypropylene, polyvinyl chloride (PVC), acrylic, nylon, Teflon, etc. They have some good properties compared to the normally used plastics which include high mechanical strength and stiffness, high thermal resistance, etc. Because of these properties they are used in field of mechanical engineering for making gears, cams, shafts for some low power applications like in printers, ATM's, watches, etc.

Polyamides or nylons were the first materials to be considered as the engineering thermoplastics. Aliphatic polyamides such as nylon 66, 6, 10 and 11 are linear polymers and thus they are thermoplastic. They have some good mechanical properties like fatigue creep strength, stiffness, toughness and resilience. They can be used for prolonged service at higher operating temperature than the normal plastics. They are easily processable by conventional processing techniques like injection, extrusion, blow and rotational.

The properties of thermoplastics can be improved by the addition of fillers or additives to them by blending it. Some of the additives for polyamides are glass fiber PTFE, Nano particles, carbon fibers, etc. These additives improve the properties of the thermoplastics like dimensional stability, stiffness and rigidity, thermal properties.

There are even more some ways in which the performances of the engineering thermoplastics can be increased. The use of meshes in the thermoplastics can improve their bonding ability and also increase their mechanical properties. The mesh is used here with nylon 66 and its properties are compared with the nylon 66 without mesh to check for the improvement of properties by undergoing some mechanical testing as per the ASTM standards.

2. POLYMERMATRIX COMPOSITES:

Polymer matrix composites are often divided into two categories: reinforced plastics, and –advanced composites. The distinction is based on the level of mechanical properties (usually strength and stiffness). Polymer matrix composites are generically classified into two broad types, thermosets and thermoplastics solidified by irreversible chemical reactions, in which the molecules in the polymer –cross-link or form connected chains. The most common thermosetting matrix materials for the high-performance composites the expo. Thermoplastic on the other hand, are melted and then solidified, a process that can be repeated numerous times for reprocessing. Although the technologies for thermoplastics are generally not as well developed as those for thermosets, thermoplastics offer several advantages. First, they do not have the shelf-life problem associated with thermosets, which require freezer storage to halt the irreversible curing process that begins at room temperature. Second, they are more desirable from an environmental point of view, as they can be recycled. They also exhibit higher fracture toughness and better resistance to solvent attack. Unfortunately, thermoplastics are more expensive, and they generally do not resist heat as compared to other thermosets. The chief advantages of polymer matrix composites are low cost, easy processing, good chemical resistance, and low specific gravity.

A variety of reinforcements can be used with both thermoset and thermoplastic PMCs, including particles, whiskers (very fine single crystals), discontinuous (short) fibers, continuous fibers, and made by braiding, weaving, or knitting fibers together in specified designs Continuous fibers are more efficient at resisting loads

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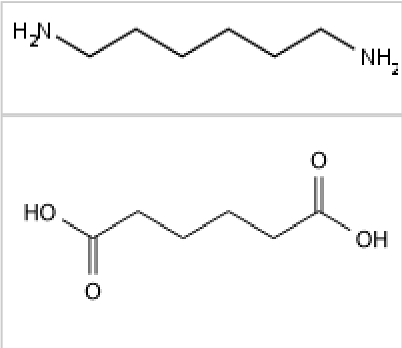
than are short ones, but it is more difficult to fabricate complex shapes from materials

2.3 NYLON 66:
Nylon 66 is a type of polyamide or nylon. There are many types of nylon: the two most common for textile and plastics industries are nylon 6 and nylon 66. Nylon 66 is made of two monomers each containingnylon66carbonatoms, hexameth ylenediamine and adipic acid, which give nylon 66 its name.

Synthesis and manufacturing



Hexamethylenediamine (top) and adipic acid (bottom), monomers used for polycondensation of Nylon 66.

Nylon66 is the synthesized by poly condensation of hexamethylenediamine and adipic acid. Equivalent amounts of hexamethylenediamine and adipic acid are combined with water in a reactor. This is crystallized to make nylon salt, an ammonium/carboxylate mixture. The nylon salt goes into a reaction vessel where polymerization process takes place either in batches or continuously.

$$n\ HOOC\text{-}(CH_2)_4\text{-}COOH + n\ H_2N\text{-}(CH_2)_6\text{-}NH_2 \rightarrow [\text{-}OC\text{-}(CH_2)_4\text{-}CO\text{-}NH\text{-}(CH_2)_6\text{-}NH\text{-}]_n + (2n\text{-}1)\ H_2O$$

Removing water drives the reaction toward polymerization through the formation of amide bonds from the acid and amine functions thus molten nylon 66 is formed. It can either be extruded and granulated at this point or directly spun into fibers by extrusion through a spinneret (a small metal plate with fine holes) and cooling to form filaments.

Properties:

Nylon 66 is a 30% glass-fiber-reinforced **nylon** 66 **material** whose important **properties** include high tensile and flexural strength, stiffness, excellent heat deflection temperature, and superior abrasion and wear resistance. The density of Nylon 66 is 1.31 g/cm3

3.1 ELECTRO GALVANIZED WELDED WIRE MESH WITH SQUARE OPENING

This type of welded wire mesh is designed for building fencing and in other infrastructural purposes. It is a corrosion resistant wire mesh that is largely used in structural building. It is also available in different forms like rolls and panels for industrial uses.

HOT DIPPED GALVANIZED WELDED MESH

This type of mesh wire is generally made up of plain steel wire. At the time of processing it goes through a hot zinc covering process. This type of welded mesh ware with square opening is ideal for animal cage structuring, fabricating the wire boxes, grilling, partition making, grating purposes and machine protection fencing.

INJECTION MOULDING:

Fig: INJECTION MOLDING

Injection molding is a manufacturing process for producing parts by injecting material into a mold. Injection molding can be performed with a host of materials, including metals, glasses, elastomers, confections. It is most commonly used to process both thermoplastic and thermosetting polymers, with the former being considerably more prolific in terms of annual material volumes processed. Thermoplastics are prevalent due to characteristics which make them highly suitable for injection such as the ease with which they may be recycled, their versatility allowing them to be used in a wide variety of applications, and their ability to soften and flow upon heating. Thermoplastics also have an element of safety over thermosets; if a thermosetting polymer is not ejected from the injection barrel in a timely manner, chemical crosslinking may occur causing the screw and check valves to seize and potentially damaging the injection molding machine.

COMPOSITE PREPARATION:

Fig: preparation of gear

PROCESS:

When thermoplastics are typically pelletized raw material is fed through a vessel in to a heated barrel with a reciprocating screw upon entrance to the barrel thermal energy increase and the van der wall force resist relative flow of internal chains are week end as a result of increased space. The screw delivers the raw material forward, mixes and homogenizes the thermal and viscous distributions of the polymer, and reduces the required heating time by mechanically shearing the material and adding a significant amount of frictional heating to the polymer. The material feeds forward through a check valve and collects at the front of the screw into a volume known as a shot. Shot is the volume of material which is used to fill the mold cavity, compensate for shrinkage, and provide a cushion (approximately 10% of the total shot volume which remains in the barrel and prevents the screw from bottoming out) to transfer pressure from the screw to the mold cavity. When enough material has gathered, the material is forced at high pressure and velocity into the part forming cavity. To prevent spikes in pressure the process normally utilizes a transfer position corresponding to a 95– 98% full cavity where the screw shifts from a constant velocity to a constant pressure control. Often injection times are well under 1 second. Once the screw reaches the transfer position the packing pressure is applied which completes mold filling and compensates for thermal shrinkage, which is quite high for thermoplastics relative to many other materials. The packing pressure is applied until the gate (cavity entrance) solidifies. The gate is normally the first place to solidify through its entire thickness due to its small size. Once the gate solidifies, no more material can enter the cavity; accordingly, the screw reciprocates and acquires material for the next cycle while the material within the mold cools so that it can be ejected and be dimensionally stable. This cooling duration is dramatically reduced by the use of cooling lines circulating water or oil from a thermometer. Once the required temperature has been achieved, the mold opens and an array of pins, sleeves, strippers, etc. are driven forward to de- mold the article. Then, the mold closes and the process is repeated.

RESULT AND ANALYSIS:

GEAR DESIGN CALCULATIONS:

Module (m) = 5 mm Pressure

Angle (φ) = 20^{o} Number of teeth (Z) = 20 Pitch
Circle Diameter (d) = m * Z = 5 * 20
= 100 mm

Work Pitch Diameter (d_W) = d_b (For spur gears) =
93.6 mm Tooth
thickness = 1.5708*m = 1.5708*5 =
7.854mm
N Radial force, F_R = F_T * tan

=820.98

WEAR STRENGTH CALCULATION:

Dynamic Load, = 2819.54*1.88

= 0.1*1*8.21* *0.018

Wear Strength, = d*Q*K*b

=0.1*1*8.21*0.018

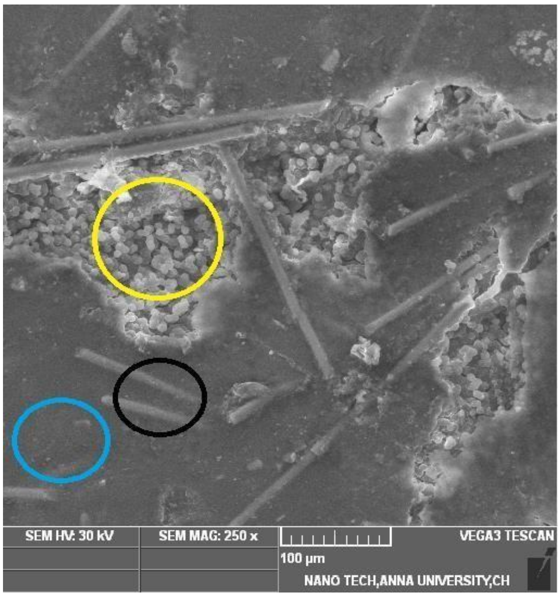
=14781.3N CRUSHING STRESS:
Crushing Stress, = 25*350*6
Crushing Stress = **384.762 kgf WEAR**

SETUP CALCULATION:
Diameter of the smaller pulley, d_S = 24mm
Speed of the smaller pulley, N_1 =1420 rpm
Speed ratio = (d_L / d_S) = (N_1 /N_2)
Speed of the larger pulley, N_2 = 1017 rpm Length of Open Belt Drive
(Lo) = (π/2 x (dL + dS)) + (2 x C) + ((1/ (4 x C)) x (dL-dS)2)
= (π/2 x (33.5 + 24)) + (2 x 440) + ((1/ (4 x 440)) x (33.5– 24)2)

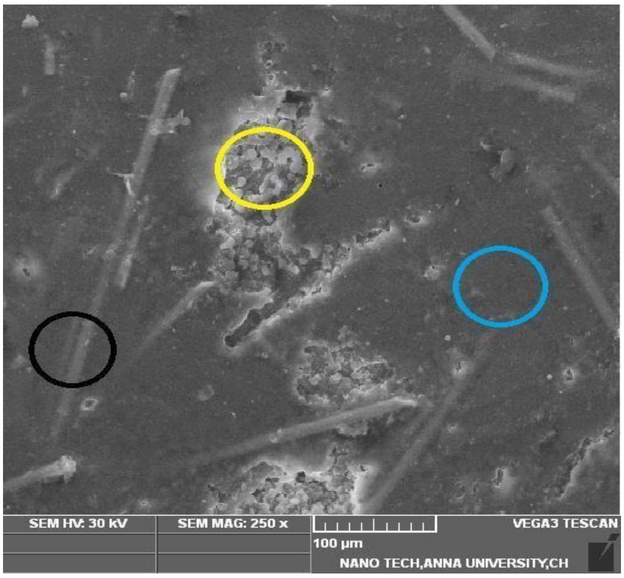
= 90.32 + 880

= 970.32mm

SCANNING ELECTRON MICROSCOPE TEST:



SAMPLE 1



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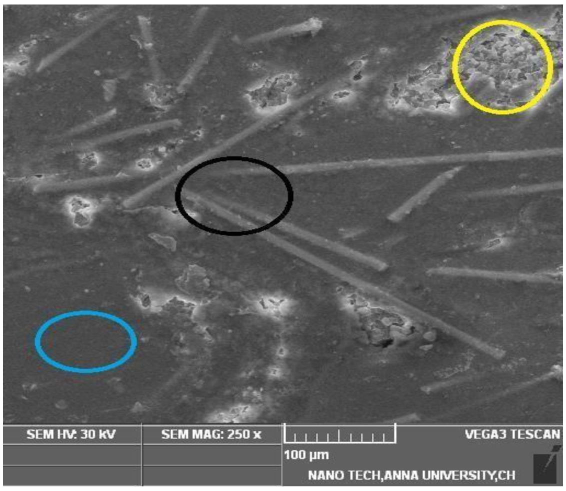
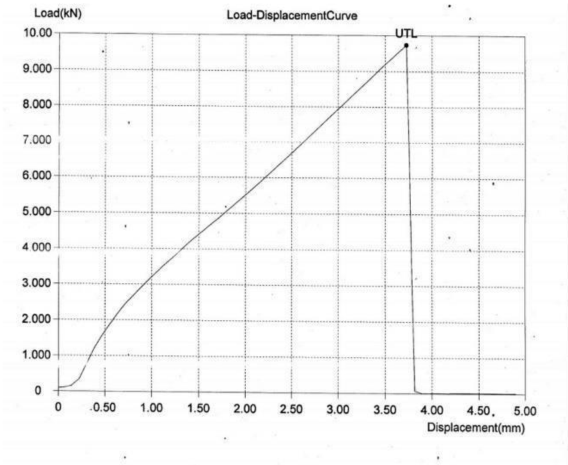


SAMPLE 3

Yellow region – lump formation due to improper diffusion.
Blue – materials are properly bonded. Black – glass fibre distribution.

TENSILE TEST:



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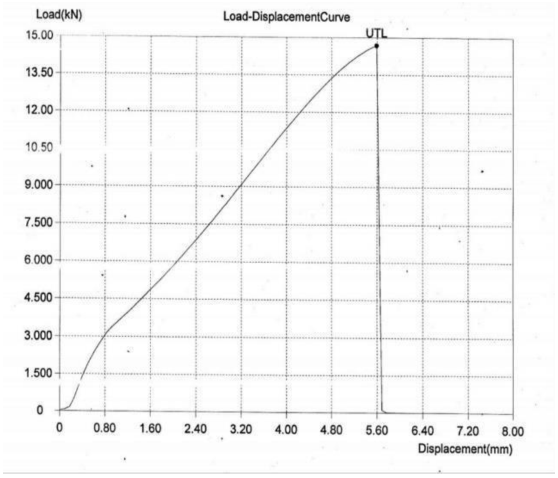

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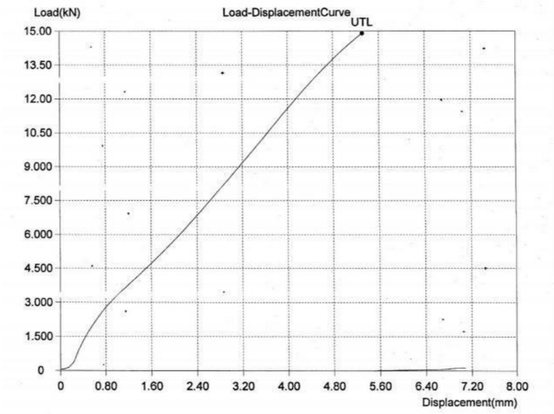

SAMPLE 3

PRO/E MODEL OF GEAR:

4.CONCLUSION:

A comparative investigation of plastic gears with symmetric and asymmetric teeth profiles shall be analyzed using finite detail analysis Ansys. The symmetric and asymmetric teeth profiles will probably be designed and modelled in 3D modelling program pro/Engineer. Structural and Fatigue analyses done on the designs by using ANSYS. in this thesis we considered four materials stainless steel, PVC, Bakelite and Nylon and also three different speeds are considered as 1000, 2000 and 3000 rpm. In structural analysis, deformation is less for stainless steel in all speeds both in symmetric and asymmetric models of gears while compare to remaining materials. In stress point of view nylon have less stresses of all speeds both in symmetric and asymmetric models of gears. But according to fatigue analysis life and safety factor is same for all speeds and symmetric and asymmetric models of gears, but damage is less for Nylon compare to other materials of all speeds comparing all materials and speeds, both in structural and fatigue analysis NYLON is suitable and preferred

REFERENCE:

[1] Y. Okay. Chen, S.N. Kuku C.J. Hooke,
[2] M. Rao, floor topography and wear mechanisms in polyamide 66 and its composites, Journal of substances Science 35 (2000) 1269-1281.
[3] M.H. Tsai, Y.C. Tsai, A procedure for calculating static transmission error of plastic spur gears utilizing fem evaluation, Finite elements in analysis and Design 27 (1997) 345-357
[4] V. Siva Prasad1, Syed Alta Hussain, V. Pandu, okay Palani Kumar, ―Modeling and evaluation of Spur equipment for Sugarcane Juice machine below Static Load condition through utilizing FEA‖ issue.4, July-Aug 2012 pp-2862-2866
[5] okay Bier and j. Str ―evaluation of stress and deformation in plastic gear used in gerotorpumps.21 December 2009
[6] Alexander "Geometry and design of involute spur gears with uneven enamel" Mechanism and laptop thought 35 (2000) 117 to one hundred thirty
[7] l. Lian Alexander L. Ka pe lev ich "uneven modified spur apparatus drives: discount of noise, localization of contact,
[8] simulation of meshing and stress evaluation" pc ways utilized Mechanics and Engineering. 188 (2000) 363 to 390