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Design Analysis And Application Of Nylon66 In Rotary Spars

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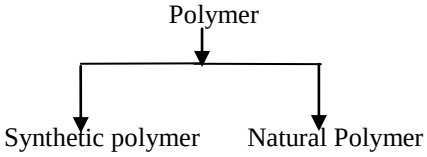
Abstract
Technology has led to the increased use of plastics as replacement to conventional materials in various sectors. The use of alloy steels in various rotary spares such as gears, cams, bearings, valve seats and other bearing and wear applications that requires quite operation, low coefficient of friction and wear resistance shall be replaced with nylon 66 as per requirements. In the present work I am applying nylon66 in gears and sprocket wheels used in automotive it is proposed to substitute the metallic rotating spares like gears and sprockets with nylon 66 to reduce the weight and noise. For this purpose different types of polymers were considered namely **Polyethylene, PVC, Polystyrene, Polypropylene and Nylon66** and their viability are checked with their counterpart metallic gear (Cast iron). Based on the static analysis, the best plastic material is recommended for the purpose.3D model of gears and sprocket wheel chain assembly has been modeled by using Pro-E WF4. The models are then pre-processed using hyper mesh 10 .The pre-processed hyper mesh file is subjected to Static analysis using ANSYS 10.0. Compared to metallic rotating spares the Nylon 66 spares are more suitable for operations under 260^{o}c temperature and limited load conditions. The designed gear shall be manufactured using injection molding. The die used for injection molding is machined with CNC and the CNC coding shall be generated for the given model. Application of nylon66 make a remarkable changes in cost factors, Weight factors, life factors, wear factors etc., hence the overall efficiency is improved. Keywords: Cast iron spur gears, helical gears, sprocket wheel assembly, Pre Processing, Static analysis, Nylon66.

I. INTRODUCTION

The automobile sector is marked by a constraint shift towards plastics. Especially, Thermoplastics has some wider range of applications in it. Nylon66 which is a leaf in the thermoplastic classification. The materials used for the manufacture of gears, sprocket wheels, chains and other rotating spares depend upon the strength and service conditions like wear and noise etc. The cast iron and steels is widely used for the manufacture of rotating spares due to its good wearing properties, excellent machine ability and ease of producing complicated shapes by casting method. Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes. The plastic materials have corrosion resistance, low electrical and thermal conductivity, easily formed into complex shapes, wide choices of appearance, colours and transparencies. The Nylon materials have high strength, good mechanical and abrasion resistance property, excellent wear resistance, resistant to most chemicals and self- lubricant. There are many different types of Nylon but the most suitable one to replace the conventional material used for making rotating spares is Nylon 66. Nylon 66 shall be applied for all rotating spares like gears, sprockets, cams, bearing etc. working at below 260^{o}C temperature. Also it shall be applied to other bearing and wear applications that require wear resistance, quiet operation and low coefficients of friction. Since Nylon 66 absorbs water, they are typically not preferred for wet applications however there are grades and design methods that can make them work for specific applications.

II. POLYMER

A polymer is a large molecule composed of many repeated subunits, known as monomers. In many polymers, only one monomer is used. In others, two or three different monomers may be combined. Because of their broad range of properties, there are both naturally occurring and synthetic polymers. Among naturally occurring polymers are proteins, starches, cellulose, and latex. Synthetic polymers are produced commercially on a very large scale and have a wide range of properties and uses.



The materials commonly called plastics are all synthetic polymers. Both synthetic and natural polymers play an essential and ubiquitous role in everyday life. Polymers are classified by the characteristics of the reactions by which they are formed. If all atoms in the monomers are incorporated into the polymer, the polymer is called

an addition polymer. Polyesters are an important class of commercial polymers, as are polyamides (nylon).The term "polymer" derives from the ancient Greek word (polus, meaning "many, much") and (meros, meaning "parts"), and refers to a molecule whose structure is composed of multiple repeating units, from which originates a characteristic of high relative molecular mass and attendant properties

III. SYNTHETIC POLYMER

Synthetic polymers are human-made polymers. From the utility point of view they can be classified into four main Categories: thermoplastics, thermosets, elastomers and synthetic fibres.

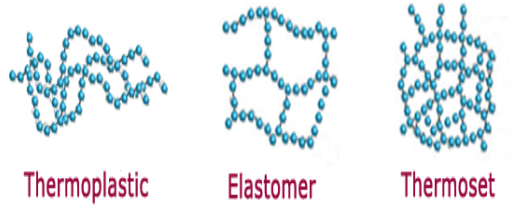


Fig: 3.1 types of Synthetic Polymer

IV. Thermoplastic polymer

Thermoplastic materials are those materials that are made of polymers linked by intermolecular interactions or van der Waals forces, forming linear or branched structures. A thermoplastic material it can be compared to a set of strings that are mixed on a table, each of these string is represents a polymer, the greater degree of mixing of the strings greater the effort will be made to separate the strings from each other, due the friction that occurs between each of the cords offers resistance to separate.

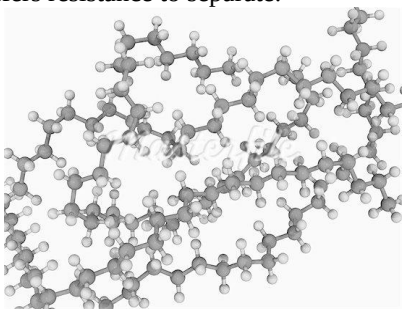


Fig. 4.1 Thermoplastic Polymer

The difference between thermoplastics and thermosetting plastics is that thermoplastics become soft, remold able and weld able when heat is added.

List of Thermoplastics

Thermoplastics are polymers that become liquid when heated and return to the solid state when cooled. This cycle of melting and freezing can be repeated, so that the plastic can be reshaped by heating it. There are many types of thermoplastics, some of which are presented below. They are useful for a variety of applications, including consumer goods, machine parts, medical equipment and packaging and storage materials. There are some of the Thermoplastics is given below.

i. Polyethylene (PE)
ii. Polyvinyl chloride (PVC)
iii. Polystyrene (PS)
iv. Nylon
v. Polypropylene (PP)
vi. Polyamide-imide (PAI)
vii. Polybutylene (PB)
viii. Polycaprolactone (PCL)
ix. Polycarbonate (PC)
x. Polyketone (PK)
xi. Polyester
xii. Polyhydroxyalkanoates (PHAs)
xiii. Polybutylene terephthalate (PBT)
xiv. Polybutadiene (PBD)
xv. Polyamide (PA or Nylon)
xvi. Celluloid
xvii. Acrylic
xviii. Polyamide-imide (PAI)

V. NYLON66

Nylon66 is a generic designation for a family of synthetic polymers known generically as aliphatic polyamides. Nylon is one of the most commonly used polymers. The automobile sector is marked by a constraint shift towards plastics. Especially, Thermoplastics has some wider range of applications in it. The current day to day application of nylon 66 is very limited than it is to be. The materials used for the manufacture of gears, sprocket wheels, chains and other rotating spares depend upon the strength and service conditions like wear and noise etc.. Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes. The plastic materials have corrosion resistance, low electrical and thermal conductivity, easily formed into complex shapes, wide choices of appearance, colours and transparencies. The introduction of plastic materials was made it possible to reduce the weight of the rotating spares without any reduction on load carrying capacity and stiffness.

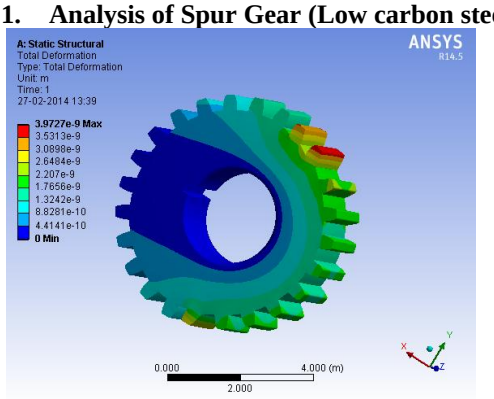
Comparison between steel and Nylon66

S.NO	PROPERTIES	STEEL	NYL 66
1	Hardness	106.8	118-120
2	Tensile Strength (N/Mm^2)	67.70	85
3	Flexural Yield Strength (Mpa)	40	145-310

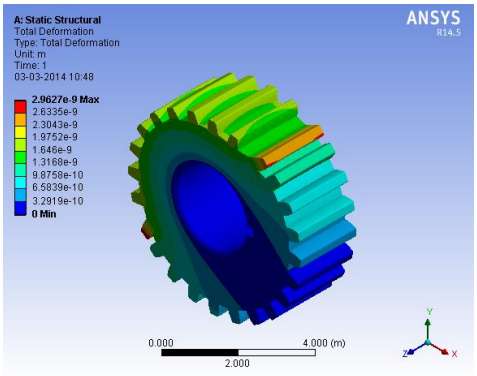
4	Elongation At Break (%)	13	5-640
5	Melting Point (Celsius)	1470	260
6	Thermal Conductivity (w/m-k)	46	0.53
7	Tensile Modulus(Mpa)	240	5500
8	Density (Kg/M^3)	7860	1400
9	Yield Stress (N/Mm^2)	285	82.8
10	Poisons Ratio	0.3	0.39

VI. FINITE ELEMENT ANALYSIS OF SPROCKET

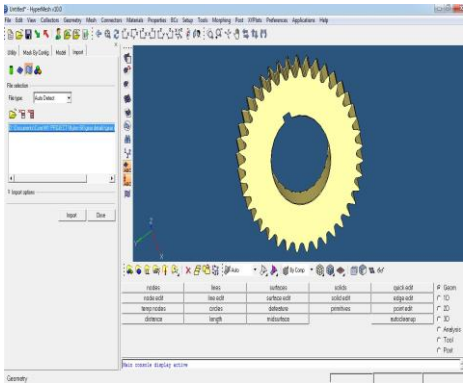
1. Analysis of Spur Gear (Low carbon steel)



2. Analysis of Spur Gear (Nylon66)



3. Meshing a spur Gear by using Hyper Mesh



Our Project work on plastic gear for Sprocket and helical gear is to provide the following advantages:

- Easy mass production
- Less number of operation
- Requires less labours
- Free from corrosion
- Smooth transmission

LIGHTWEIGHT 15-20% the weight of stainless steel components.
LUBRICATION requires no lubrication can be formulated to be non-Conductive, conductive or non-magnetic.
MASTERLINKS All links or the plastic chain is unit master links snap together and all chains are adjustable to any desire length.
INTERCHANGEABLE Completed with existing metal chain and sprockets drives. Plastic chain can be used with steel sprockets or plastic sprockets.
NOISE Noise Level is greatly reduced.
CHEMICAL RESISTANCE Excellent chemical and solvent resistance to corrosive environmental conditions.
CLEANINESS Excellent where cleanliness of drive is important.
DESIGN CAPABILITIES Various attachments as side link pins can be incorporated into design at minimal tooling costs.

VII. CONCLUSION

Replacement of Conventional materials with newer products for the practical application as reduced the pressure on the non-renewable resources. Plastics through non-biodegrade able can be recycled to minimize the ill effects of non-decomposable nature of these polymers. The plastic materials are chosen so that it can fulfill the physical and mechanical properties of the existing wheel in sprocket. The thermal properties of the materials selected most also are considered the plastic material chosen is a composite of nylon66, mos_2, and gas filled. The model of the plastic gear wheel is

developed using Pro-E, pre-processed using HYPER MESH and finally analyzed using ANSYS software. For the manufacture of the plastic gear wheel a mold is designed such that the component can be manufactures on a low capacity machine. Injection molding is selected to increase the productivity. Plastic are seen from the analysis results and mold design provide many advantage in the manufacture of plastic helical gear wheel and two wheeler Sprocket. This replacement is step towards reducing cost and the weight of the sprocket there by proving the flexibilities and functionalities of using plastics. The replacement of plastic gear wheel and two wheeler sprocket is visualized using RP's FDM technique this technique produces component at lower cost with shorter time.

VIII. ACKNOWLEDGEMENTS

I would like to sincere thanks to my guide **Dr. B.KANIMOZHI M.E, Ph.D.** of Mechanical and Production Engineering, Sathyabama University Chennai, for her invaluable guidance and constant encouragement and discussions throughout this project.

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