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Reverse Engineering of A "O Ring Structure with Internal Thread" By FDM 3D Printer

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***Abstract*—**3-D printing which has end up a brilliant topic in today's technological discussion in which a 3D item is created by laying down successive layers of material. it is a mechanized method in which 3-D objects are fast made on moderately sized machine related to a laptop containing blue prints for the objects. The concept "Additive manufacturing" reveal a diversity or miscellany of procedure in which material is linked or joined over control system to produce a 3-Dimensional object, where material is add up at the same time (material can be liquid fragment, powder dust and a thin wire made of thermoplastics for eg. PLA, ABS, PETG etc. or a composites made of a combination of PLA and wood powder or metal powder), in most cases layer by layer. One of the crucial advantages of Additive manufacturing is the capability to manufacture very complicated shapes and geometries for manufacturing any 3D printed part a CAD file of the 3D model is required which can be converted into stl file by CAD software and further converted into g-code extension by slicing software before it is fed to the 3D printing machine. The most-commonly used 3D-printing process is a material extrusion technique called fused deposition modelling. Here, The O-ring is manufactured using FDM 3D printer by designing the ring in CAD software using reverse engineering concept for dimensions for fixed implementation or in active applications where there is relative movement between the cross-section and the O-ring. Fixed implementation of O-ring may contain gas or a liquid fasten application

Keywords- *3D printing;thermoplastic filaments;FDM; Thermos ring.*

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I. INTRODUCTION

Around 1990s, additive manufacturing techniques were typically acceptable only for manufacture of practical or functional prototypes and a further suitable word used for 3D printing was rapid prototyping. As of 2020 the precision, repeatability and material range have increased to the point that some additive manufacturing techniques are typically capable to increase in industries-efficiency. Thus the term additive manufacturing can be used interchangeably or significantly with "rapid prototyping or 3D printing". The most-commonly used 3D-printing process is a material extrusion technique called fused deposition modelling. While FDM technology was invented after the other two most popular technologies, Stereolithography, and selective laser sintering; Fused Deposition Modelling (FDM) is usually the cheapest if we compare with the cost of Stereolithography (SLA) printer and selective laser sintering (SLS) or selective laser melting (SLM) also called as laser powder bed fusion (LPBF) by a huge gap, which contribute to the state of the operation.

Reverse engineering is a closed loop between product design and product creation. RE includes analytical steps to obtain information about the product that is available such as information on functionalities, geometry, materials. Then begin to bring back or re-establish the proposed CAD model to advance into a new 3D representation. Lastly, the 3D printer is used to form or manufacture the product. 3D printing is a rapid prototyping(RP) technology in which the product is made up of printing layers. There are numerous or several separate printing technique used on today. Some popular printing methods are selective laser melting (SLM), fused deposition modeling (FDM), direct metal laser sintering (DMLS).

Additive layer manufacturing or free form fabrication is a range of techniques that are able to transfer or convert virtual 3D design data into physical or dummy models in a rapid and easy process. The data is broken down into a series of 2D cross-section of a finite thickness. The particular sample or representation is supply into 3D printing machines so that they can be unite or merge, putting them with a layer-by-layer order to develop the 3D section. The structure of the section is completely mirrored or cloned in the 3D printing machine without having to alter or modify the manufacturing procedure like action of dealing with tooling, cutting, amount of taper for molded or cast part and altering the x-y-z direction of rotation of tool to execute numerous operations such as knurling, drilling, turning, facing, deformation etc. We can say therefore that the AM machine is what you see is what you build process that is particularly valuable the more complex the geometry is. The O-ring may be used in fixed implementation or in active applications where there is relative movement between the cross-section and the O-ring. Fixed implementation of O-ring may contain gas or a liquid fasten application:

(1) The O-ring is squeezed or pressed resulting in zero clearance.

(2) The O-ring material is treated with chemical or physical process to improve its hardness, strength, odor and elasticity So that it is not allowing fluid to pass through.

(3) The O-ring material resist the condition of degrading by gases and liquids.

O-rings are one of the familiar or frequent sealant used in machines since they are cheap, easy to manufacture, dependable and have simple organizing demand. This O-ring is stick inside to the thermos main body (hollow cylinder with incline parallel cross-section of one end closed and other end is open). To stick the design part we can use a food grade adhesive by permanent bond. These epoxy adhesive offer excellent resistance to water, food, cleaning fluid, heat & cold.

II. TYPICAL 3D PRINTER COST IN THE MARKET GLOBALLY

Budget 3D printer under $300; most popular FDM 3D printers in this range are reality's Ender3 and Ender3 pro. Entry level or hobbyist 3D printer between $300 and $1000; the most popular FDM printer in this price range is the prusa i3 MK3S.

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Professional and performance 3D printers b/w $1000 to $10000; as we enter into 4 or 5 digit price point of printers really get serious, here we encounter the renowned precision of SLA, the best of the best in fused deposition modeling and even multi capable 3D printers that are identical as cutting or laser engraving machines. The standard of prints on 3D printing machines should be remarkable and imperfections are hardly any.

Business and industrial 3D printers >$10000 plus; these printers are the highest grade and quality you can get intended for business and industrial applications. In this assortment or variety is originating printers that can feed materials such as metal and carbon fiber. The process used for printing varies widely including but not limited to FDM, SLA, SLS, Binder jetting etc. These are the variety of printers you suppose to find at a local firm or laboratory.

Some techniques melt the material to make the layers. In Fused filament fabrication, also known as Fused deposition modelling, the model or part is manufacture by ejecting small drop or beads of material which solidify instantly to form layers. A fiber (diameter of 1.75 mm) of thermoplastic, composites is fed into an extrusion nozzle head, which is mounted on the hot-end of the 3D printer, which warm up the material and at a certain critical temperature material is melted and turn into flow. FDM is rather limited in the sequence of appearance or form that may be constructed or manufactured. Another method combine the layer and then change position towards a higher level in the working zone, add up further layer of fragment and redo the process till the part has manufacture. This method uses standard support as well as experimental tree support in some slicing software when the overhang angle in the cad model is >45 degree or 50 degree, and when the gap between the part of cad model such as in 'H' shape is under 5 mm than it doesn't need any support. In some cases FDM 3D printer consist of more than one extrusion nozzle and different kind of thermoplastics filament is being used. In FDM 3D printer removing of support is difficult task and in the process of removing it may damage the manufactured part to eliminate it different properties of thermoplastics is used at the same time in a single operation for e.g. the prime material for the main part should be stronger than the secondary material which can be used to support the main piece or section so that the support is easily removed without any crack or tear in the manufactured part. Here in this technology 4 steps are blanketed inclusive of Analysis, Designing, Printing and Finishing. In 1st step we will take a look at if a fastener nut and bolt have a clockwise or anticlockwise thread on its each ends So that we can screw thermos cap with outside thread through a O ring with internal thread for you to be stick inside the topmost a part of thermos primary frame. To restoration this type of problem we want to examine and look at the thread direction on thermos cap. In 2nd step we use any CAD software program to create 3-D design. In 3rd step 3D printer create an item through the use of this design. And in 4th step finished object is removed from printer. This technology saves time and cost, it saves wastage of material unlike subtractive manufacturing. It has the ability to considerably rework many design, manufacturing and logistic processes. The present paper deal with the design and analysis of a O Ring structure with internal thread. The main objective of design is to manufacture a hollow cylinder with internal thread and stick it inside the thermos main body and to check if thermos top can screw through inside the main body of thermos. The material used in additive manufacturing of hollow shape cylinder is PETG and gyroid shape infill density is selected in 'open source 3D printer slicing software cura develop by ultimaker' to strengthen the structure of final product.

III. MATERIAL AND METHOD

A. *Material Selection*

The final product is develop by additive manufacturing process so in this case we have used desktop FDM (Fused Deposition Modelling) 3D printer (Geetech A30 Model). Geetech A30 Model is suitable for PLA (Poly Lactic Acid or Poly Amide), ABS (Acrylonitrile Butadiene Styrene) & PETG. Because of the improper structure of Geetech A30 model Nylon Can't be used. ABS is harder and more rigid but PETG(Polyethylene Terephthalate Glycol) is more durable than ABS. PETG has lower glass transition temperature at 80 deg. C compared with ABS 105 deg. C. ABS is approximately 20 percent less dense than PETG. Polyethylene terephthalate (PETG) will not distort or warp like acrylonitrile butadiene styrene(ABS) might if printed wrong.

Warping in ABS can be control by changing the value of cooling fan and by adding support bed adhesion in cura (slicing software). We decided PETG is more suitable to manufacture the final product because humidity in the environment can increase warping issue with ABS and it will be more difficult to control if we use ABS.

B. *Analysis Of Thread On Fastner (Nut & Bolt)*

Screw threads are angled helix that curls toward the cylindrical plane of portion like screws and bolts. They're organizing for converting energy into spinning and bilinear motion and make a way through. Fasteners with suitable threads can produce compressed seals for a broad variation of instruments.

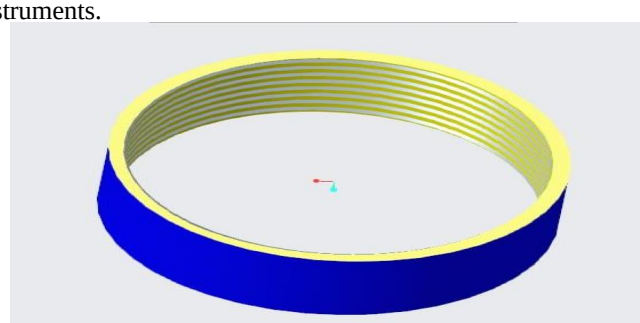

Figure 1. Designed Thermos ring

Screw hardness: anticlockwise or left hand threads and clockwise or right hand threads

Screw handedness introduces to the guidance that a screw's threads cover around its shaft. Clockwise or right handed threads bound clockwise, and left handed threads bound anticlockwise. The beginning of a thread's firmness or hardness is embedded in human anatomy: Screws accompanied by individual handedness are user friendly or ergonomics for people determined by their ascending hands. Nearly all screws on today apply clockwise or right handed threads, and it's limited to find a anti clock wise screw thread operate in some implementation that doesn't accurately call for it. Nonetheless,

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there are insufficient applications that exactly entitle for the use of anti-clockwise threads.

C. *Applications of left handed thread:*

Anti-clockwise threads are moreover recognized as reverse threads. These threads are apply in specially designed applications in which the discharge of pressure would force a clockwise screw or bolt to fall loose. Few applications that exploit from the use of anti-clockwise fasteners involve:

Automobile: few tyres bolts are reverse or anti-clockwise threaded to carry torque from unfasten them.

Plumbing: Pipes are usually equipped with both clockwise and anticlockwise threads to supply an additional layer of protection from discharge.

Safety: fluid supply valves use anti-clockwise threads to separate them from the valves that influence oxygen.

Fasteners are the nuts, bolts, screws, latch, buckle, clasp and further minor part or element of a machine and vehicle that retain equipment or apparatus and machine simultaneously in working order. Several fasteners work through the effectual utilization of threads (reverse or left hand thread and standard or right hand thread), which let nuts and bolts to nail simultaneously and successfully. But how threads work? The guidance in which employer screw and unscrew fasteners has a great deal to do with the implementation in which they recognize. Also, numerous separate sorts of threads remain to develop different method to fasten objects. In this blog, we discuss a handful of the numerous distinct qualities of threads as well as their applications.

Screw threads have many different uses such as:

Fastening: Screw threads noticeable on conventional fasteners such as nuts, bolts, screws etc. and they also help in fasten the threaded hoses, pipes, fixtures, and caps.

Depletion of Gear : Screw threads assist among gear depletion by adopting worm drives

Linear object motion: Fastener threads can be deploy to change rotary movement to linear mobility.

Thread proficiency and variety

Threads are uninterrupted helical rim on cylindrical fasteners. For sections or pieces such as screws, the rim will be on the outer surface, and sections like nuts have rim inside of their cylindrical surface. There are total amounts of usual expression to represent distinct feature of threads, which we explain under:

Exterior threads: Threads further blow all over the external surface of a fastener's rod

Interior thread: Threads that can bound across the inside of a fastener

Axis: central longitudinal lines utilize to estimate the extent of the fastener

Pitch: The gap between a tip on one sharp thread to a end on additional thread.

Prime diameter: The huge inner and outermost thread diameter

Secondary diameter: The small-scale inner and outermost thread diameter

IV. TEST AND RESULT

All dimensions are measured with the help of calibrated manual type Vernier calliper scale (Mitutoyo 300 cm S/N 11098838 C/N 532-121). Internal diameter (I.D) of the thermos main body (Hollow side) where O ring will be slicked is 89 mm or we can say it is external diameter of O ring. Internal diameter (I.D) of the O ring is measured and 82.1 mm is calculated. 3.45 is the measured thickness of O ring structure that we have obtained from the damaged O ring. Height of the O ring is measured to 25 mm.

We have calculated pitch value of the thread from external thread of thermos top by using WHITWORTH [British Standard Whitworth] metric thread gauge. Because of insufficient leaves present in thread gauge we have guess pitch value of the thread.

A. *Measured Dimensions*

The external diameter of cap is 89 mm along with thread diameter of the thermos cap is 82.1 mm, thickness 3.25mm, and height or depth 25 mm for design 1. All the dimensions are measured with the help of calibrated manual type Vernier calliper scale (Mitutoyo 300 cm S/N)

B. *Calculated pitch value of external thread from the thermos top*

The measured value of pitch by gauge is 1/8 = 0.125 inch. to convert this value into mm we will multiply it with 25.4 mm, so pitch value = 3.175 mm.

CONCLUSION

From the analytical solution & the analytical result it is clear that we can't screw nut with having clockwise or right hand thread on a bolt with having anticlockwise or left hand thread. So, if we want to screw through a hollow cylinder consist of an internal thread on the thermos top or cap having external thread. To fix this type of problem we need to analyse and observe the thread direction on thermos top or cap. In our case we found that the direction of cap thread is clockwise. So, we have designed and produce a hollow cylinder having internal thread with clockwise or right hand direction by desktop FDM 3D printer.

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