

Development of Biodegradable 3D Printing Filament for Rapid Prototyping Technology

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ABSTRACT

Three-dimensional printing (3-D Printing) is a method of forming three-dimensional elements using a layering technique (continuous formation layer by layer). The development of 3-D printing to date has been carried out using various materials such as polymers, ceramics and metal. One of the 3D printing concepts developed uses melted filament material as a layering product forming material. This method, known as Fusion Deposition Modeling (FDM), is a specific standard of 3D printing technology. Several studies are currently being conducted to develop biodegradable filament materials for 3-D printing to provide sustainable additives. There are several problems in developing biodegradable filaments related to the materials, processes and products produced. The problem studied in this research is related to equipment for the filament manufacturing process, namely the design of the filament making extrusion machine.

The development of 3D printing filament was carried out using the research and development method. In general, the implementation of the research consists of 3 stages: (I) making an extrusion machine for making filaments, (II) making 3D printing filaments from biodegradable polymer materials, (III) Using filaments to make 3D printed products. In the first period the research focused on the design of extrusion machines for making filaments. The research steps follow the product development process starting from (1). Data collection, 2) Planning, 3) Product draft development, 4) Initial field trials. 5) Revise trial results 6) Field trials. 7) Product refinement resulting from field tests, and 8) Field implementation tests. Data resulting from planning, manufacturing and testing processes are documented and then analyzed and described.

The results of this research are a prototype of an extrusion machine for making filaments. The specifications for the resulting tool have dimensions of length 800 mm, width 400 mm and height 886 mm. The extrusion machine consists of the main components of a screw conveyor, barrel, hopper, pulley-gearbox reducer, heating element, drive motor, control board and frame. The heating process in the barrel can be regulated from room temperature to 260 °C, using PID (Proportional-Integral-Derivative) temperature control. The rotational speed of the extrusion screw can be adjusted from 0 – 22 rpm, using a VFD (Variable Frequency Drive) speed controller. The driving motor uses a 600 watt single phase AC motor with an output torque of 234.17 Nm. The average filament production capacity is 1.2 Kg/hour. The resulting filament has a maximum diameter of 1.75 mm.

Kata Kunci: Filament, Biodegradable, 3D printing, Rapid prototyping