Novel Solid Fuel Fabrication using Multidirectional Direct Ink Writing

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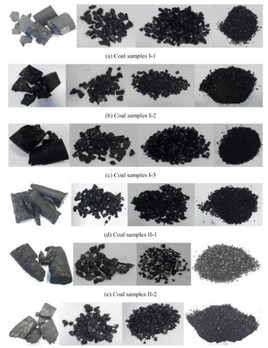
1. Introduction

The rapid global economic growth lifted the energy demand which remains overwhelmingly dominated by fossil fuels with coal, oil, and gas, accounting for a much higher percentage in 2030. Coal is one of the largest sources of energy consumption in the world. However, current manufacturing methods have become increasingly difficult in meeting the requirements of fuel material fabrication in terms of energy efficiency and environmental protection.

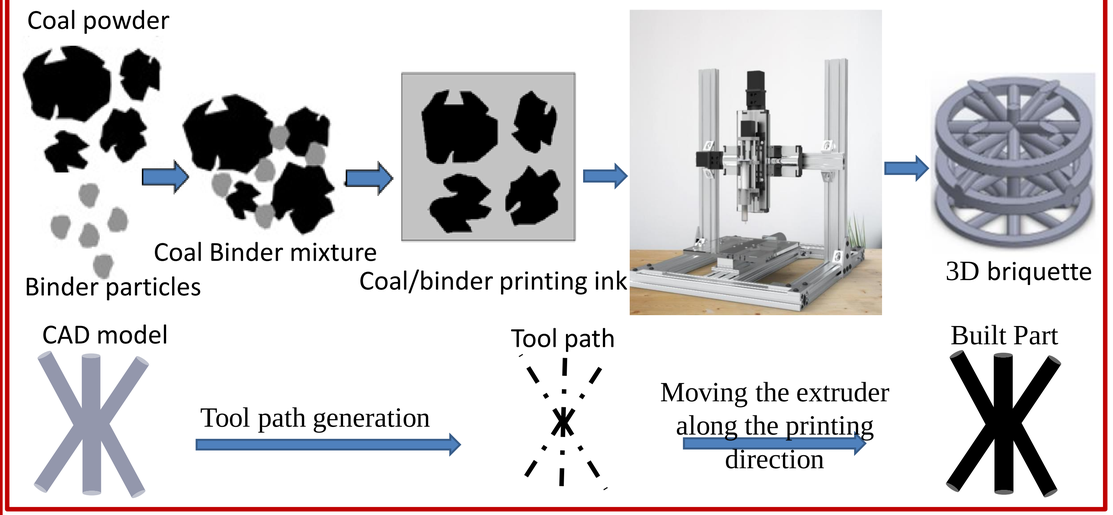


Coal samples

Charcoal Briquetting Making Machine

2. Abstract

Additive manufacturing (AM) demonstrates advantages in building three-dimensional (3D) objects from scratch. To solve the current manufacturing challenge, a multi-directional direct ink writing (*MD-DIW*) based prototype machine was designed and built. This developed *MD-DIW* will enable the fabrication of 3D solid fuel with optimized topology and geometric shape and provide a potential manufacturing solution for the development of sustainable energy resources in the future.

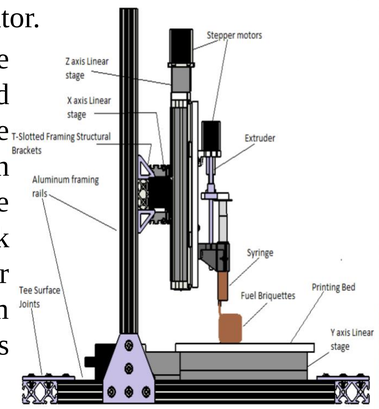


3. Construction of MD-DIW

Overview of the MF-SLA process

The 3D printer prototype was constructed on the aluminum framing rails for the rigid body support, and the printing size of this home build *MD-DIW* is 220 mm x 220 mm x 150 mm. The material extrusion module consists of the injection syringe and linear actuator. The material is deposited from the injection syringe when the syringe piston is pressed down by a linear actuator.

The extruder is mounted on the *Z* linear stage, which is fixed on the *X* linear stage, and the printing platform is placed on the *Y* linear stage to provide three axis motion. The fuel ink can be extruded by the linear actuator using the uniform speed, and the extruder follows the tool path .



Software

The Duet 2 ethernet motion controller board was used for the control of linear motions of *X/Y/Z* stages and the material extrusion in *MD-DIW*. The 24-volt external power supply was used, and the current of each stepper motor was adjusted. To enable the communication between the 3D printer and microcontroller, the YAT terminal emulation program was used to assign a network, and the firmware was set up to the home build printer with the connection of USB cable. The tool path is generated by using open source code, and the G-code will be uploaded to the Duet 2 Ethernet motion controller.

4. Future work

The *MD-DIW* based 3D printer was designed by using Solidworks and the prototype machine of *MD-DIW* was built in the lab for the fabrication of 3D briquette. Both the hardware and control software were developed. In the coming semester, the mechanism of self-support with special binder will be investigated. The process parameters such as layer thickness, extrusion speed, movement speed will be optimized.

Acknowledgments

Thank to the MORE program for the support of this project.

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