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Small-Scale Plastic Recycling

Sonali Hegde[1], Namita Manjunath[2], Bhairavi Jagtap[3], Sheetal Bhongle[4]

[1,2,3] *Students, Dept. of Instrumentation and Control Engineering, D. Y. Patil College of Engineering, Akurdi, Pune.*
[3]*Professor, Dept. of Instrumentation and Control Engineering, D. Y. Patil College of Engineering, Akurdi, Pune.*

Abstract - *The object of this paper is to present the idea of a plastic recycling machine that is implemented at a small scale level. The project is a microcontroller based project that uses basic concept of remodeling thermoplastic by melting and then remolding it. The temperature controller is used to utilize optimum heat in making the plastic pliable. Theoretically, the microcontroller in the system enables recycling of various kinds of plastic; however we are starting with HDPE.*

Key Words: HDPE, PIC microcontroller, thermocouple, electromechanical, prototype

1.INTRODUCTION

In India, 15000 tons of plastic waste is generated every day and 299 million tons of plastic worldwide. Most of the waste is disposed in landfills which results in land and water pollution leading to greater economic losses.

Thus, we find it necessary that plastic be recycled at every level and not just the industrial level that exists today.
The recycling of plastic in large scale is done 4-8 tons of plastic at a time. However, even though many such industries exist, the efficiency of recycling is less than expected.

Table -1: Components used

Part	**Module**	**Part**	**Module**
Thermocouple	Sensor	Crystal	12 MHz Oscillator
Load cell	Sensor	Buzzer	Electrical hardware
Heating unit	Hardware	LCD Display	Electronic Module
Motor	Electrical Hardware		

Our method is designed to increase the use of waste recycling process and spreading better awareness. The prototype that we have built is capable of recycling small quantities (0.5kg – 1.5kg) of waste HDPE plastic. Thus, recycling can be implemented everywhere and anywhere to reduce the plastic production without worrying about cost.

It is a microcontroller based prototype that utilizes softening and remoulding process with thermocouple as the temperature sensor, and load cell for accurate weighing purpose. Motor, hopper, heating coil and shredder make up the mechanical parts for the electromechanical process.

The microcontroller has been selected to control the temperature and weight parameters.

2. BASIC STRUCTURE OF THE PROTOTYPE

The mechanical process of shredding the plastic is the first step that is carried out. Waste HDPE plastic is fed into the hopper and then passed onto the shredder. The shredder cuts the plastic into small pieces. This makes it easy for the plastic to be softened in the later stage.

The shredder is a combination of high-utility steel blades and a motor to rotate them.

The shredded plastic is conveyed to the weighing machine container. Then it is transferred to the oven or heating unit.

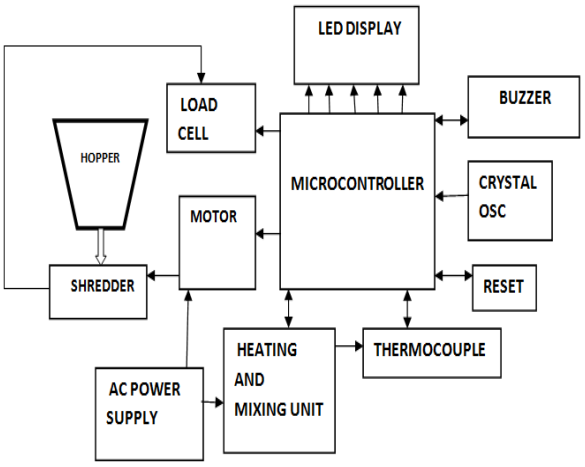

Fig -1: Basic block diagram of the prototype

The heating unit is made with nichrome (an alloy with high resistance that heats up when current is passed through it) coil. The temperature has been adjusted to the appropriate set point value (160 – 165 degree Celsius) to soften the HDPE plastic enough without melting it.

If the temperature rises above the desired value, then a buzzer is set to indicate the change and led display to show the output of the controller. The mixing unit is a part of the heating unit. The heating process is interrupted periodically to mix the softened plastic properly to obtain consistency.

Now the pliable mixed plastic is ready to remould and reuse.

2.1 Usage of PIC microcontroller (PIC18F452)

A microcontroller is compact device which is used to monitor and control the operations of the system in a process and in various other devices. We have used it for our prototype to control the electronic processes because the key features include wide availability, low cost, low power consumption, ease of reprogramming built in EEPROM (electrically erasable program read only memory)

The PIC18F452 is a 40-pin microcontroller and has many advantages.

The PIC18F452 features a 'C' compiler friendly development environment, 256 bytes of EEPROM, Self-programming, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I^2C™) bus and Addressable Universal Asynchronous Receiver Transmitter (AUSART).

Parameter	Value
Program Memory Type	Flash
Program Memory (KB)	32
CPU Speed (MIPS)	10
RAM Bytes	1535
Data EEPROM (bytes)	256
Communication Peripherals	1-UART, 1-SPI, 1-I2C1-MSSP(SPI/I2C)
Timers	1 x 8-bit, 3 x 16-bit
ADC	8 ch, 10-bit
Temperature Range (C)	-40 to 125
Operating Voltage Range (V)	2 to 5.5

Fig -2: Specification table of PIC18F452

3. SOFTWARE AND PCB DESIGN PROCESS

We began by laying out a rough block diagram of the machine. Then we moved to the schematic or circuit diagram and simultaneously, material selection.

The schematic was developed in Orcad's Capture software. For the simulation process, we used Proteus. The PCB design was done in ExpressPCB. At every step, the software was tested by an expert. The PCB board was tested for continuity before mounting the circuit components.

4. THE CONTROL LOOPS IN THE PROCESS

The temperature control loop starts with the thermocouple continuously monitoring the temperature of the oven/heater. It communicates the value to the microcontroller. The output from the microcontroller to the heating-coil is controlled according to the input from the thermocouple.

The temperature is ideally controlled in the range 160-165 degree Celsius. The real-time temperature is displayed on an LCD.

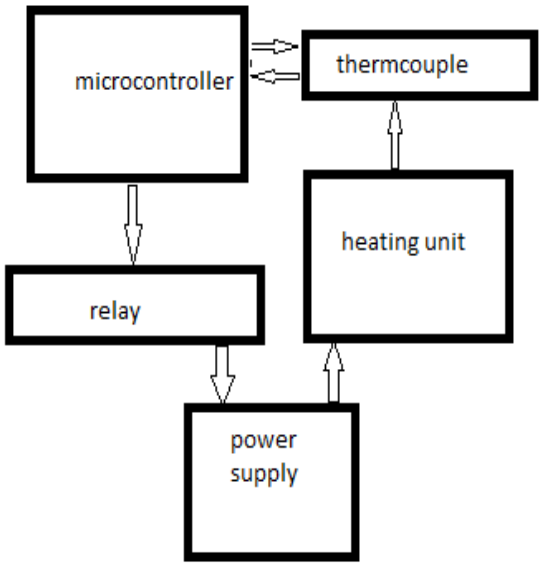

Fig -3: Temperature Control Loop

The weight control loop is necessary for the ON/OFF control of the shredder.

Plastic is fed from a hopper into the shredder. The pieces fall into a weighing machine, which is an input to the microcontroller. As soon as the weighing machine reads 1kg, the shredder stops, rather the motor stops. This loop controls the quantity of the plastic being fed at one time.

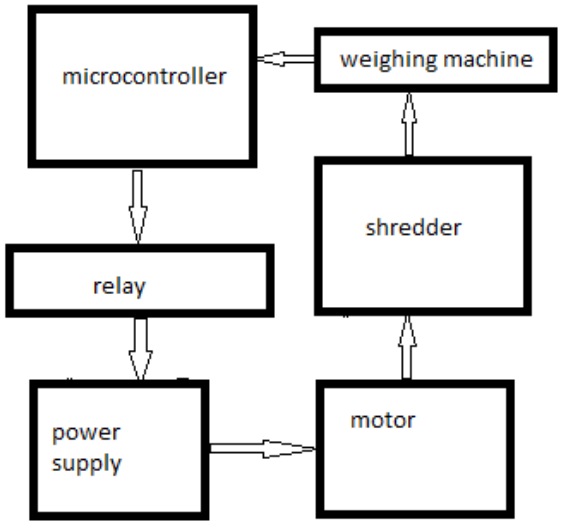

Fig -3: Shredder Control Loop

4. FUTURE APPLICATIONS

The machine that we designed and implemented is made for just one kind of plastic, i.e. High-density poly-ethylene or HDPE. However, without budget and time constraints, we can make a single compact machine that can recycle various kinds of thermoplastics like low-density poly-ethylene (LDPE), poly methyl methacrylate (PMMA), Acrylonitrile butadiene styrene (ABS), etc. automatically.

5. CONCLLUSIONS

The softened plastic is removed from the heater/oven and put into a mould. A whole new article is produced from collected waste plastic.

The actual motivation behind this is to increase the awareness of recycling and make it accessible to the public.

The machine is fairly low power consuming. If implemented and developed properly, there is a definite potential for its application in the improvement of the environment.

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