Laboratory Exercise 3 – Chemical Engineering Laboratory

The purpose of this laboratory is to examine exothermic and endothermic reactions. An exothermic reaction is a reaction which produces heat energy as one of its products. An endothermic reaction is one which absorbs heat energy in the reaction.

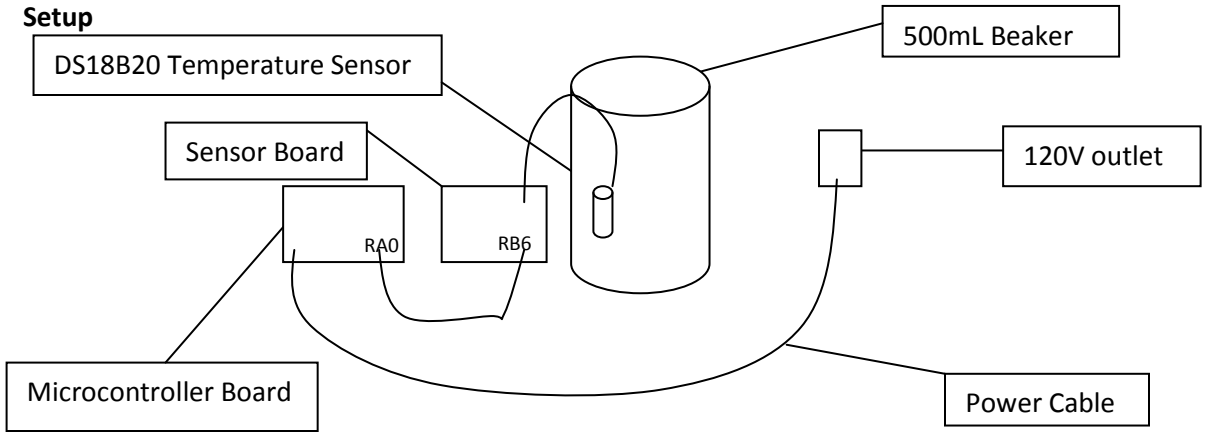
Apparatus

Materials

- 500mL beaker
- DS18B20 Temperature Sensor
- 300mL citric acid
- 50g baking soda
- 10g calcium oxide
- Wires
- Ribbon Cable
- 120 V outlet
- Water
- Sensor Board
- Microcontroller Board

Note the DS18B20 temperature sensor can be purchased at www.sparkfun.com, and the Lewis N Clark Immersion heater can be purchased from www.Amazon.com. Citric acid and baking soda can be found in most grocery stores. Calcium oxide can be easily found in dehumidifying bags.

Setup



Set up the apparatus as shown in the figure above. Note, that the temperature sensor attaches to the temperature module, then the RB6 pin on the sensor board is attached to the RA0 pin on the microcontroller board for direct monitoring.

Procedure

Below is a snippet from the sample code for pic16f877 that should be put on the microcontroller before continuing the procedure. The complete code can be found in the samples folder.

```
main(void)
{

TRISB = 0b11111111;
TRISD = 0;
lcd_init();
lcd_clear();
lcd_puts("Press * to start");
unsigned char Pressed = 0;
while(Pressed == 0)
{
        while(RB1 == 0) //Check if a key is pressed
        {
                ;
        }

        if( (PORTB>>4) == 0b1100)
        {
                Pressed = 1;
        }
}
```

```
while(RB1 != 0)  //wait for key to be released
{
        ;
}
Pressed = 0;
unsigned char init_temp = Get_Temp();
lcd_clear();
lcd_puts("Press * to stop");
while(Pressed == 0)
{
        while(RB1 == 0) //Check if a key is pressed
        {
                ;
        }
        if( (PORTB>>4) == 0b1100)
        {
                Pressed = 1;
        }
        while(RB1 != 0)  //wait for key to be released
        {
                ;
        }
}
        Pressed = 0;
        lcd_clear();
        unsigned char final_temp = Get_Temp();
        lcd_puts("Type of Reaction");
        lcd_goto(0x40);
        if(final_temp>init_temp)
                lcd_puts("Exothermic");
        else
                lcd_puts("Endothermic");

while(1)
{
;
}
}
```

Part I – Examining an endothermic reaction

The reaction shown below is an endothermic reaction between citric acid and baking soda.

$Ba(OH)_2 \cdot 8H_2O\ (s) + 2\ NH_4SCN\ (s) \text{ --> } Ba(SCN)_2\ (s) + 10\ H_2O\ (l) + 2\ NH_3\ (g)$

After loading the code on the microcontroller, follow the steps below:

- Fill the 500mL beaker with a 300mL of citric acid
- Insert the temperature sensor into the 500mL beaker
- Press * on microcontroller board to take temperature reading
- Pour in 50g of baking soda
- Press * to take temperature reading after reaction has occurred

In part one, a simple demonstration of an endothermic reaction is observed. The container should feel noticeably cooler, as indicated by the temperature sensor.

Discussion questions

1. By examining the chemical equation, why would the reaction between citric acid and baking soda be endothermic?

2. Repeat the above experiment with different amounts of baking soda/citric acid. Comment on any differences.

Part II – Examining an exothermic reaction

The reaction shown below is an exothermic reaction between water and calcium oxide.

$CaO\ (s) + H2O\ (l) \rightarrow Ca(OH)2\ (s) + heat$

After loading the code on the microcontroller, follow the steps below:

- Fill the 500mL beaker with a 300mL of water
- Insert the temperature sensor into the 500mL beaker
- Press * on microcontroller board to take temperature reading
- Pour in 10g of calcium oxide
- Press * to take temperature reading after reaction has occurred

In part two, a simple demonstration of an endothermic reaction is observed. The container should feel noticeably warmer, as indicated by the temperature sensor.

Discussion questions

1. By examining the chemical equation, why would the reaction between water and calcium oxide be endothermic?