FEEDBACK CONTROL SYSTEM WITH PULSE WIDTH MODULATION TO CONTROL WAVELENGTH OF INFRARED RADIATION

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Significant research efforts have been made in the recent past in the application of infrared radiation (IR) for heating foods. The present major constraints in applying IR heating efficiently is the difficulty of controlling the wavelength accurately. Therefore, an algorithm for a feedback control system with pulse width modulation (PWM) to control the wavelength of IR was developed. An experimental scale IR dryer and three 1000 W ceramic IR emitters were used with Raspberry Pi 3 Model B+ microcomputer. The temperature was measured using a K-type thermocouple with an amplifier and converted into wavelength using Wien's Law. PWM was programmed using Python 3.7 language based on the measured feedback in a closed-loop. The program was developed to change the duty cycle proportional to the existing error calculated as the difference between the set wavelength and the existing wavelength. The selected wavelengths of 8.968 µm, 7.766 µm, 6.849 µm, 6.125 µm, 5.540 µm, and 5.056 µm, correspond to temperature values of 50 °C, 100 °C, 150 °C, 200 °C, 250 °C and 300 °C, respectively, were tested. The suitable controller gain (K_c) for proportional feedback control at different set wavelengths was tested. The relationship between the set wavelength and K_c was graphed and fed into the program for automatic adjustment. The accuracy for the selected wavelengths were ±0.036, ±0.016, ±0.013, ±0.013, ±0.024, and ±0.018, respectively at mean wavelength values of 8.952 µm, 7.771 µm, 6.861 µm, 6.144 µm, 5.568 µm and 5.086 µm respect to set wavelength of 8.96 µm 7.77 µm, 6.85 µm, 6.12 µm, 5.539 µm and 5.056 µm. The results conclude that the developed program could rapidly reach the set wavelength and maintain a constant value during the IR exposure time.

Keywords: Drying, Duty cycle, Infrared radiation, Pulse width modulation, Raspberry Pi