Technical Note

Temperature control for laboratory scale anaerobic digesters

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Abstract

In laboratory investigations of anaerobic digestion processes, accurate temperature control is essential. For the smaller laboratory this can become an expensive operation. A space saving and inexpensive temperature control unit based on the Philips/Mullard TDA 1024 IC is described. A total temperature variation of less than 0,5°C was found.

Introduction

Temperature control for anaerobic digesters used in laboratory investigations, is normally done by using temperature rooms (Van

Velsen, 1977), waterbaths (Hawkes and Young, 1980) or by circulating a hot water stream through the reactor jacket (Sánchez Riera et al., 1982). Temperature rooms are expensive to build and are not available in smaller laboratories. Temperature control units used for aerobic fermentations are expensive and usually take up a large space while cheaper and smaller thermostats cannot be used when substantial minimum and maximum room temperatures are found. Thus, any system which simplifies the temperature control for anaerobic digesters will be beneficial, particularly in laboratories where temperature rooms are lacking. The purpose of this paper is to describe a simplified, inexpensive but sensitive method of temperature control for use in anaerobic digestion.

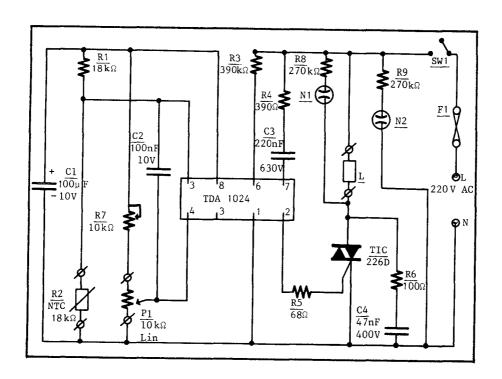
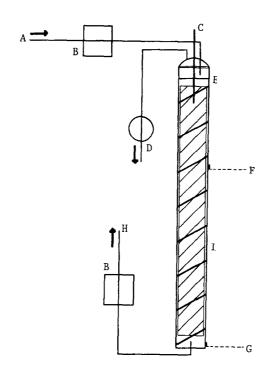


Figure 1

Circuit diagram of the temperature control set – up for anaerobic digesters (R = resistors; C = capacitors; P = potentiometer; N = neon indicator; SW = switch; L = load – heating tape; TIC = triac; NTC = negative temperature coefficient thermistor; L and N = electrical supply live and neutral points; F = fuse; TDA = Philips/Mullard integrated circuit).



- A = Substrate
- B = Peristaltic pump
- C = Thermometer
- D Gas collector
- E = Liquid 1eve1
- F = Temperature sensor
- G = Heating tape with temperature control
- H = Reactor effluent
- I = Reactor column with
 - bacterial carrier

Figure 2. Diagram of the downflow fixed film anaerobic reactor indicating the position of the temperature sensor (F) and the heating tape (G).

Temperature control

In the method, use is made of a solid state electronic unit with a temperature sensor probe combined with a heating tape of the type used to prevent the freezing of water pipes in winter. The unit, which can be constructed with little electronic expertise with parts available from most electronic component shops, is described here. The unit is based on the Philips/Mullard TDA 1024 IC design (1978), using a heating tape (L) to heat the digester. The heating tape, which is PVC coated, is available in different lenghts, supplying 7W per 30 cm. The tape is coiled round the digester and secured with friction tape. To prevent excess heat loss the whole digester is insulated with shock - absorbent plastic material. Depending on the size of the digester one or more heating tapes can be used, coupled in parallel. In Figure 1 the circuit diagram is shown. The electrical supply at 220 V AC 2,5 A is via a standard 15' A socket. The TDA 1024 IC contains a differential comparator and a zero crossing point trigger. Temperature is measured with an insulated negative temperature coefficient thermistor (R2 = NTC 18 k Ω) placed on the outside of the digester (Fig. 2). A total temperature variation of less than 0,5°C is obtained. When the temperature rises, the resistance of the temperature probe will fall and thus also the voltage between R1 and the probe (R2).

When the voltage falls below that of the present value of the linear potentiometer (P1 = 10 k Ω) the comparator output changes state and the circuit will switch off the triac (TIC 226D) which in turn controls the heating tape (L). With the temperature below the preset value the voltage between R1 and R2 will be higher than the voltage set by P1 and the triac will be switched on resulting in an increase in digester temperature at the same time switching on the cycle light (N1 = 220 V AC neon in-

dicator). The unit has a standard on/off switch (SW1 = 220 V AC 3A) and front panel on/off indicator (N2 = 220 V AC neon indicator). A 220 V AC 2,5 A fuse (F1) has been built into the system and the unit placed in an insulated box. It is of the utmost importance that the live and neutral electrical supply wires are connected correctly.

Five such units have been constructed in this laboratory and have been operating satisfactorily for more than a year. A variation of less than 0,25°C above or below the preset value on the potentiometer has been observed. The downflow fixed film anaerobic reactors on which the controls units were used, consisted of one metre long glass columns with a working volume of 3,5 l. The operational temperature was 35°C.

Acknowledgement

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