W SERIES

ANAEROBIC DIGESTER – W8

The Armfield Anaerobic Digester is designed as a benchtop training facility and as a means of providing operational process data for plant design purposes.

Anaerobic treatment processes involve bacteria that function only in the absence of air.

These processes are becoming more popular in the water-treatment industry as they have considerable advantages over aerobic processes, including low sludge production, tolerance of stop/start operation, production of a useful fuel (methane) and relatively high throughput.

INCLUDES BIO GAS COLLECTION

W8 reactor detail showing Bio-balls

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Issue: 2
URL: http://www.armfield.co.uk/w8
Applications
ChE CE IP

Description

The anaerobic digester comprises two five-litre upward-flow packed bed reactors with feed rate and temperature control facilities. This allows steady, continuous operation at up to seven litres per day over periods of several days.

The reactors may be operated in series or parallel. A buffer vessel between the reactors permits discharge of excess flow from the first reactor when the second reactor is operated in series but at a lower flow rate. The flow rates to the vessels are set and controlled by calibrated peristaltic pumps.

The temperature of each reactor is controlled by an electric heating mat wrapped around the external wall. The temperature distribution within each reactor is maintained to ±0.5°C. Reactor temperatures may be separately set at any desired value in the range ambient to 55°C.

The gas off-take from each reactor is taken to a volumetrically calibrated collector vessel operating by water displacement. A constant head, liquid seal device ensures the gas pressure in the reactor is maintained at a constant value throughout the test run.

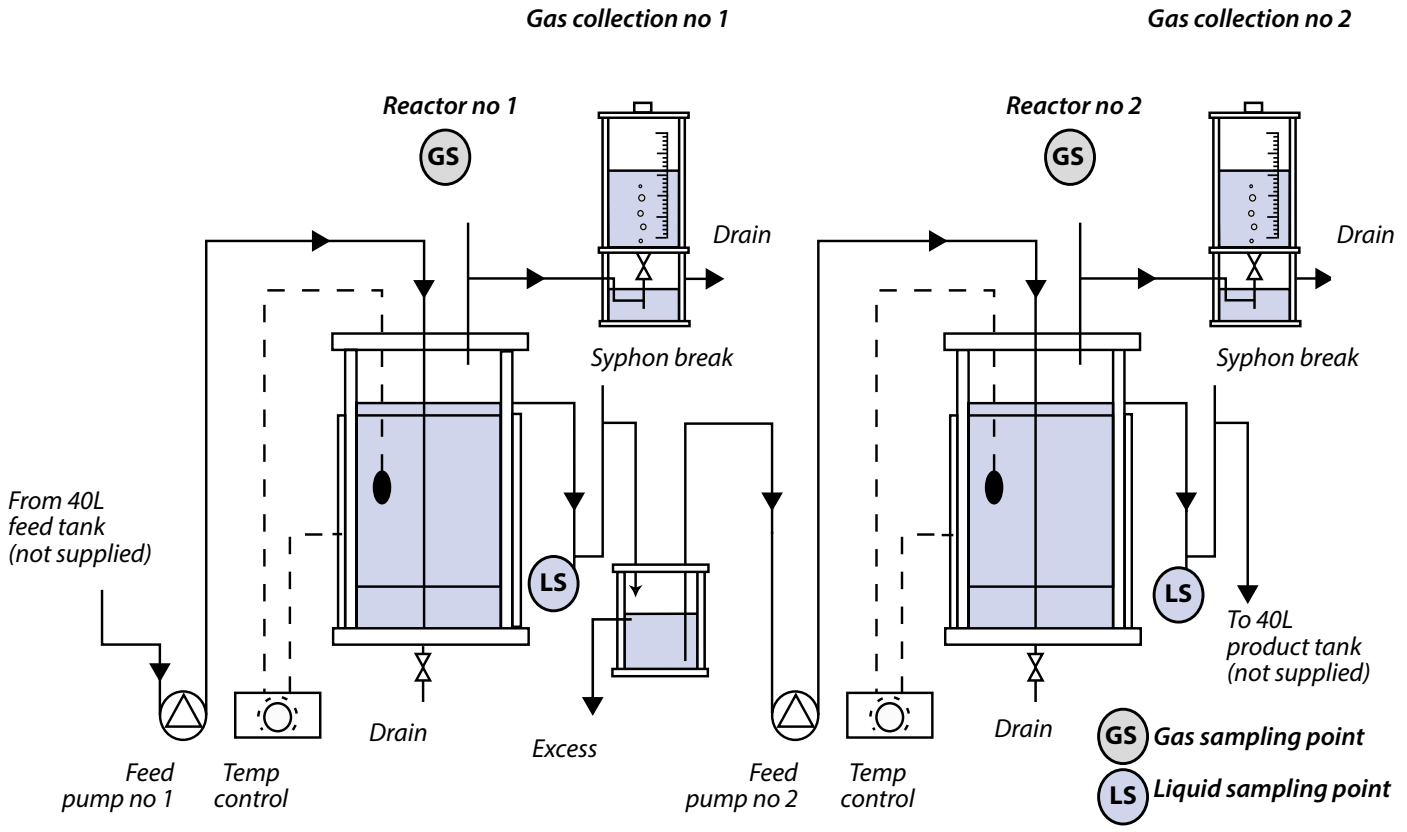
The collected gas can be exhausted from the vessel and the volume refilled with water during a run without breaking the liquid seal.

Liquid and gas sampling points are located at all strategic points around the reactors. Non-return valves and liquid seal syphon breaks are included in the process pipework to ensure each reactor operates at a constant volume without the ingress of air or the danger of accidental syphonic action.

The equipment is mounted on a vacuum-formed plastic base with an integral drain channel to cope with spillages and wash down.

Technical details

Reactors	Two identical reactors	
	Nominal capacity	5L
	Packed volume	4L
	150mm dia x 250mm high	
Reactor packing	25mm diameter Bio-balls	
Temperature control	For each reactor	
	200W heating jacket with PID control from a temperature sensor positioned inside the reactor, set point within range ambient to 55°C, the jacket is thermostatically protected by a cut-out set at 85°C	
Feed pumps	Two identical peristaltic pumps	
	variable speed using 10 turn potentiometer to 4rpm supplied with three tube diameters, 1.6, 3.2 and 4.0mm, flow rates from 0.2 to 5.8 l/day	
Gas collection vessels	Two identical linear-scale	0-5L Capacity



Flow diagram – W8 Anaerobic Digester

Process studies

The anaerobic process may be divided into two distinct stages: first the hydrolysis of large molecular species into acetic acid, and then the conversion of the acetic acid into methane and carbon dioxide.

This two-stage process can be demonstrated by operating the two reactors in series, one to produce volatile acids from the initial substrate – acidogenesis – and the second to convert the volatile acids into methane and carbon dioxide – methanogenesis.

In addition, the following basic differences of the two stages of the process can be demonstrated:

(a) the low level of methanogenic activity during acidogenesis compared to methanogenesis

(b) the low level of COD removed with the methanogenic stage.

Typical test results are shown below:

W8 insulated jacket around the reactor

TYPICAL TEST USING A PREPARED FEEDSTOCK FOR DEMONSTRATION PURPOSES

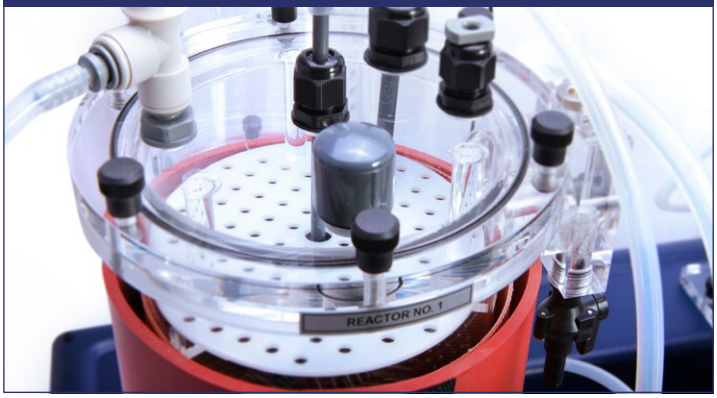
a) Test conditions

ITEM	REACTOR 1	REACTOR 2
Temperature	35°C - 37°C	35°C - 37°C
Feed	Prepared glucose substrate with appropriate nutrients	Effluent from reactor 1
Feed rate	2.5-3.5 L/day	1-1.5 L/day
Feed pH	Corrected to 6.0 with HCl	Without pH correction

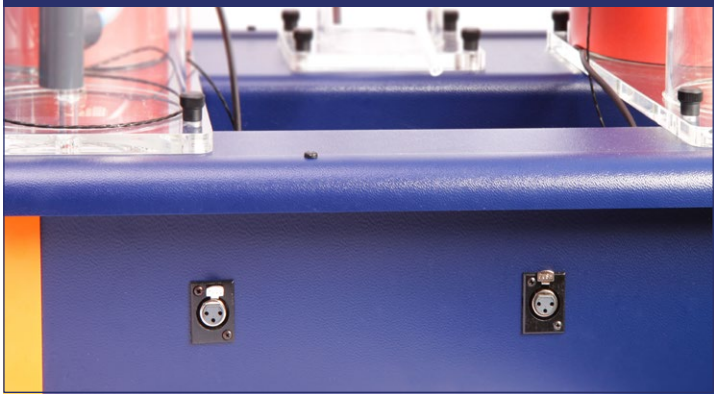
b) Expected performance

ITEM	REACTOR 1	REACTOR 2
FEED		
COD	7500-8500 mg/L	5000-6000 mg/L
Suspended solids	Very low	100-500 mg/L
Alkalinity	1000-1500 mg/L	1000-2000 mg/L
Total volatile acids	Very low	5000-6000 mg/L
ph	6.5-7.0	4.5-6.0
EFFLUENT:		
COD	5000-6000 mg/L	500-600 mg/L
Suspended solids	100-500 mg/L	50-200 mg/L
Alkalinity	1000-2000 mg/L	2000-3000 mg/L
Total volatile acids	5000-6000 mg/L	50-100 mg/L
pH	4.5-6.0	6.8-7.3
BIOGAS:		
CH_4	10-30%	65-85%
CO_2	70-60%	15-35%
COD		
REMOVAL:	20-30%	80-90%
GAS YIELD:	0.5 L/g COD applied	0.35 L/g COD applied

W8 reactor detail



W8 rear electrical sockets



Learning objectives

- Effluent treatability studies, including solids, carbon and biogas balances to determine purification (COD/BOD)
- Determining optimum operating temperatures, feed rates and ratios
- Observing effect of pH and influent nutrient concentration
- Process stability studies
- Determination of controlling kinetics
- 100% scale-up to industrial requiremen
- Preparation, warming and acclimation of an anaerobic reactor
- Demonstration of the multistage nature of anaerobic digestion
- Undertaking carbon balances
- Studying effects on purification performance of:
  - Hydraulic loading
  - Feed ratios
  - Temperature
  - Nutrient deficiency
  - Influent strength

Requirements

1Ph | PC | USB

Scale

- **Electrical supply:**

W8-A:	220-240V / 1ph / 50Hz
W8-B:	120V / 1ph / 60Hz
W8-G:	220V / 1ph / 60Hz

- Plastic feed and product tanks typically 30-50L, floor standing (not supplied)
- pH meter (not supplied)
- Synthetic waste water (not supplied)
- Analytical equipment as exists in most water quality laboratories for measurement of pH, BOD, COD, alkalinity, total volatile acids and suspended solids. (not supplied)

Technical details

Reactor vessel	2 x 5L (4.3L packed sestion)
Gas collecting vessel	2 x 5L
Heat jacket	2
Temperature sensor	2
Pump	2 x 0-40mL, supplied with 4.0, 3.2 and 1.6mm tubes

Overall dimensions

Length	1.00m
Width	0.50m
Height	0.76m
Packed and created shipping specifications	
Volume	1m^3
Gross weight	150Kg

Features / benefits

- Small Scales bench mounted design
- A major feature of the digester is that results obtained from tests can be scaled up precisely to industrial throughputs.
- Includes PID control
- Series and Parallel operation

Ordering specification

- A benchtop anaerobic digester for waste water treatment studies
- Equipped with two 5l packed bed, upward-flow reactors
- Each reactor has gas sampling & collection facilities
- Reactors may be operated in series or parallel flow arrangement, using variable-speed peristaltic pumps
- Feed flow rate to each reactor can be accurately & independently controlled to any temperature between ambient and 55°C, using 200W heating jackets
- Thermostatic cut-out set to 110°C
- Operational manual with teaching exercises including details of a proven feedstock (synthetic waste water) included

Ordering codes / electrical requirements

- W8-A
- W8-B
- W8-G

Warranty

Armfield standard warranty applies with this product