Safe Operating Procedure 002

Anaerobic Digestion Operations

GuyandWright

Site	Much Hadem	SOP Number	002
Date of Last Review	05/03/2025	Work Activity	Anaerobic Digestion Operations
Task Location	AD plant-	Associated Risk Assessment	Site Risk Assessment, Biogas Production Risk Assessment

Personal Protective Equipment Requirements	
✓ Hard Hat ✓ High Viz Vest ✓ Safety Boots ✓ Gloves	
Foreseeable Hazards	
✓ Moving Vehicles ✓ Pedestrians ✓ Animal by-products ✓ Spillages ✓ Dangerous Substances and Explosive Atmospheres ✓ Confined Spaces	

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Training and Competence	
To work within and operate the Anaerobic Digester, the operative must be trained in the procedure below and any other procedures as defined by the training matrix.	

Legislative Requirements

- Health and Safety at Work Act 1974
- Management of Health and Safety at Work Regualtions 1999
- Provision and Use of Work Equipment 1998
- Dangerous Substances and Explosive Atmospheres Regulations 2002
- Confined Spaces Regulations 1997
- Control of Substances Hazardous to Health Regulations 2002
- Animal By Products Regulations 2005
- Environmental Permitting (Engand and Wales) Regulations 2016

Safe Operating Procedure	
Feeding the Plant	1. Take a sample from the substrate inside the digesters; 2. Determine Volatile Fatty Acids; pH & Alkalinity 3. If the VFAs have remained constant by approximately +/- 10% then maintain the OLR. This would be the case if other important parameters like Temperature have also remained constant; 4. Adjust the feed on the SCADA system; 5. Take a sample of the soup inside the buffer tanks; Record VFAs and feed rate Site Diary daily. 6. Additional measures in place for glycerol (no more than 10 m3/ day feed limit). 7. Additional operational testing required if glycerol is being fed into the system.
Pre-digestion Processing	1. Incoming waste is subject to maceration, which ensures that there are no particles > 12 mm in any one plane. Liquid ABP material has a separate, dedicated macerator to prevent cross-contamination and is also pasteurised. This is a requirement of the ABPR Regulations, so the operator should check the particle size daily and record the results in the Site Diary. 2. Material that has achieved the size threshold (and also pasteurised if ABP material) is then pumped into one of four buffer tanks where it is stored until required as feedstock for the digesters.

Feedstock (Soup) storage	1. The buffer tanks operate as follows: 2. They are mechanically stirred; 3. They are not heated so hydrolysis is unlikely to happen in the tank; 4. They are cleaned regularly to remove grit and prevent it travelling to the digesters. The regularity of the operation is determined based on the levels found when cleaning; 5. Samples are taken daily to monitor the Organic Loading Rate to the digesters. The OLR is recorded in the Site Diary. 6. No more than 10 m3/day of glycerol we be added to any one of the buffer tanks.
Digester Monitoring	**Methane Concentration** **1.** The ratio of methane to carbon dioxide will vary widely with the type of feedstock and the loading/retention time of the digester. A typical range of methane concentration is 50% to 70%. **Temperature** **2.** The AD plant at Guy & Wright is a mesophilic digester. Mesophilic refers to a group of microorganisms that work best at moderate temperatures (35-42°C). Maintaining a constant temperature is important for biogas production. The Vineries AD Plant is run at 42°C. **pH** **3.** The pH in the digesters needs to be between 7.0 and 8.5 for microbes to work optimally and produce a high biogas yield, particularly in the methanogenesis phase. **4.** It is risky to only use the pH as a control mechanism as by the time the pH is acidic it might be difficult to recover the digester. It is better to look at the Volatile Fatty Acids (VFA) and bicarbonate alkalinity. **Volatile Fatty Acids** **5.** VFAs are short-chained volatile organic acids such as acetic acid, propionic acid and butyric acid. They are intermediate molecules in the anaerobic digestion process that are produced during the acidification step and are precursors of methane. Consequently, if they accumulate this often means that the production of methane is inhibited. **6.** The levels of VFAs within the digester can range from 10s – 1,000s mg/l. Typically, the higher the Organic Loading Rate (OLR) of a digester, the higher the residual VFAs. High VFAs would lower the pH and affect the microbes if the system does not have buffering capacity i.e. alkalinity. It would also be an indication that there is too much food for the microbe population. **7.** The VFAs should be looked at both in isolation and in conjunction with the Alkalinity. **Alkalinity Buffer** **8.** Methanogenic bacteria will only operate effectively within an alkaline pH environment. **9.** The alkalinity buffer within a digester acts as a safety net, offsetting these increases in acidity by absorbing free protons (hydrogen ions) so that the pH does not drop and inhibit the process. **10.** A stable digester will have an alkalinity concentration of at least 1,000 - 2,000 mg/l above the background VFA concentration **Trace Elements**

	11. For anaerobic plants to operate effectively they require a variety of micronutrients for the micro-organisms to grow and function properly. **12.** It is often the case that anaerobic digesters and biogas plants are lacking in these vital micronutrients which means they do not work at their optimum. This can lead to poor organic solids removal and elevated VFA levels. **13.** To combat these problems several companies have developed a range of bio available micronutrient solutions with the required trace elements which help to optimise microbial performance in the digester. Key Benefits: • Increased biogas production; • Increased methane content in biogas; and • Reduced digester VFAs. **Carbon: Nitrogen (C:N) ratio** **14.** C and N are both required to sustain the bacteria in the digester. For optimum biogas efficiency a C:N ratio of between 20:1 and 30:1 is needed, as the bacteria in the digester consume about 30 times more C than N. To gain this optimum C:N ratio, a blend of feedstocks should be considered, as the C:N ratio in feedstocks can vary significantly (cow slurry 6:1 and potato starch 200:1). However, it is difficult to control the C:N ratio using feedstock, and digesters will operate within a much wider range than 20:1 to 30:1 without ill effects. Too much nitrogen will result in high levels of ammonia in the digester which will ultimately be rate limiting, whilst too low a figure will inhibit biological growth.
Pasteurisation	**1.** To achieve the requirements for the ABPR and the ABP material must be pasteurised at a temperature of 70oC or above for at least 1 hour; **2.** Batches of up to 12 tonnes of ABP material are pumped into the pasteuriser; **3.** The frequency and volume of these batches will be dependent upon the daily operations, specifically the current feed, the level in the digesters and the available storage in the digestate storage tank; **4.** Control of the Critical Limits (temperature and retention time) are set, monitored and recorded by the computer control system; **5.** Digestate in the pasteuriser cannot move to the Digesters until the Critical Limits have been achieved; **6.** To ensure that the temperature is achieved the control system release temperature is set to 71 degrees C to achieve additional level of assurance; **7.** When these are breached alarms are raised (via email and text) with the Site Manager who can remotely control pumps and valves or instruct a site operative to undertake any required corrective action; **8.** The temperature probes are to be checked monthly and calibrated annually, with replacement temperature probes held as critical spares.
Storage of Digestate	1. The discharge of separated liquor into the Digestate Lagoon is manually controlled and a flow meter records the volume pumped from the Digesters.

	2. A height board is installed to provide a visual guide of capacity. A freeboard of 750 mm is maintained. The total capacity is 10,000m3. 3. During land spreading, a flow meter on the outlet pipe records the volume of digestate pumped from the Digestate Lagoon. Records are kept in the Site Diary.
Process Control	1. Underground pipework is fitted with flow meters and pressure gauges at strategic points and monitored continuously using the site's Supervisory Control and Data Acquisition (SCADA) software linked to pre-set alarms that notify users by text if levels are exceeded. Pipework and leak detection systems are subject to periodic inspection and regular testing. 2. Pressure relief valves have been installed on both the gas holder and the digesters and are subject to periodic inspection and testing. 3. Level sensors are installed in the liquid tanks, feedstock tanks and pasteuriser tank to control as well as in the gas holding tank and are subject to regular inspection and testing. 4. There are observation windows in Digesters 1 & 2 and control of levels is also undertaken by daily manual observation. 5. A flare is mounted as a contingency measure at the end of the gas mains route. This is used in case of malfunction of upstream systems and allows the biogas to be diverted to the flare to be combusted and converted to CO2 and avoid direct release of biogas into the atmosphere from the CHP engines. The flare operates at temperature over 850oC with a flow rate of 1,000 m3/h. 6. The flare is subject to periodic inspection and testing.
Spillages	1. If spillages occur, spillages will be washed down with hose. 2. Spillages / water to be directed to the catchment area. 3. Catchment area spillages will be fed back into the system for processing.