BEST PRACTICE CHECKLIST
OPERATIONAL PERFORMANCE

ADBA

Best Practice in Operational Performance

What do we mean by Operational Performance?

'Operational Performance' refers to how well a plant is delivering its intended functions. For AD plants, the primary function is to convert organic material into energy (in the form of biogas) and digestate. Operational performance more generally includes ongoing compliance with all applicable legislation and delivering a safe working environment for site operatives. See our checklist on Risk Management for more information on managing operational risks and relevant legislation regarding environmental protection and health and safety management.

In this checklist we focus on three aspects to operational performance at an AD plant:

- ✔ **Biogas quantity or 'yield'**
- ✔ **Biogas quality**
- ✔ **Digestate quality**

By optimising these three outputs, an operator can secure the best possible return on investment, simultaneously managing operational risks more effectively. In order to assist operators in improving performance, this checklist includes many aspects of plant operation that should be considered and monitored in order to contribute to good overall plant performance. This encourages a holistic approach to plant operation, from managing feedstock to monitoring the quality of outputs.

Why is improving operational performance important?

Put simply, a better performing plant is likely to make more money, which is directly beneficial to that operator and the plant owner. Ensuring high standards means the operator will maintain a better relationship with their regulators, insurers and investors.

If individual operators achieve good operational performance, the wider industry can also benefit: investors may become more interested in refinancing existing plants and funding new ones, and regulators and insurers may be more confident that the industry is operating to the highest standards. Over time this could help reduce insurance premiums and reduce regulatory burden.

Biogas Quantity

Increasing the quantity of biogas generated at a plant (yield) will directly increase its revenue, though there may be a limit on the size of the plant's engine, the grid connection or the network entry agreement. Biogas yield will vary depending on the feedstock used, but all operators can take steps to ensure their plant is delivering to its full potential.

Biogas Quality

The composition of biogas produced by an AD plant will depend to an extent on the type and quantity of feedstock used and so the expected quality will be determined based on site specific expectations. There is also likely to be biogas composition requirements, minimum thresholds and optimal values as determined by the chosen end uses. For example, gas distribution networks have relatively strict requirements on gas composition compared with specifications for biogas combustion in a CHP engine.

Digestate Quality

Good quality digestate can provide significant benefits to agricultural land, from increasing nutrient value to improving the physical structure of the soil. By managing their digestate well, AD operators can minimise the costs associated with digestate or even realise financial benefits. Using digestate can allow farmers to dramatically reduce their use of inorganic fertilisers, significantly lowering their costs while maintaining a high quality soil. Producing high quality digestate is vital to delivering these benefits, as well as farmers' confidence in the product. Operators should strive for as high quality digestate as possible; a key factor in the quality of what comes out of the digester is the quality and composition of what goes in, so appropriate feedstock management is crucial.

Regulators, insurers, farmers and landowners all view digestate quality as a key area of focus for the industry; there have been incidents involving the spreading of poor quality digestate and these risk negatively impacting on the reputation of the industry.

Best Practice in Operational Performance

How will this checklist help you?

This checklist is written primarily for operators but should be useful to all stakeholders in the AD industry. It highlights some of the key considerations for achieving a high standard of operational performance and highlights useful sources of information. Where helpful, key guidance documents, websites etc. are referred to within the document and these are captured in a full reference list at the end of the document.

The list comprises several recommendations from industry experts for improving operational performance, which are:

- ☐ **Monitor the process**
- ☐ **Achieve biological stability**
- ☐ **Manage feedstock effectively**
- ☐ **Focus on digestate**
- ☐ **Employ suitably trained staff**
- ☐ **Maintain plant, kit and infrastructure**
- ☐ **Manage grit and plastics accumulation**
- ☐ **Manage odour effectively**

The scope of this checklist is what can be controlled by the operator once their plant is ready to begin operation. Other issues, such as feedstock quality, may also impact on performance.

Monitor the process

Why is this important?

The saying 'knowledge is power' is certainly true in the context of AD. A good understanding of how a plant works and how well it is performing is vital for achieving a high level of performance. By monitoring a few basic parameters the operator can understand how effectively their plant is performing and can track any variations in performance. Monitoring enables the operator to be confident that either their plant is performing well and that they can continue as they are, or that it isn't performing to its full potential and they can re-evaluate their operational methods and procedures.

Operators who monitor their plant effectively and understand how to interpret the data are more likely to be able to recognise and respond appropriately to issues that could have a detrimental effect on plant performance. The costs involved in monitoring a few basic aspects are likely to be much lower than the financial losses associated with having to re-establish the effective operation of the plant.

Operators should monitor aspects of the digestion process, such as the feed-rate, temperature and pH of the digester, and should also monitor the quality of biogas and digestate. This gives the operator a complete picture of how efficiently and effectively the plant is performing.

CASE STUDY: THE BENEFITS OF MONITORING

Nick Johnn, an Environmental Consultant at Aardvark, explains how they have worked with an operator to maximise the value of their monitoring.

"A food waste based AD plant was struggling with poor performance and asked us to analyse their operational data to help them improve performance. They kept a simple log of feedstock in, biogas production and energy generated daily (this is a basic biogas/CHP plant). The plants SCADA system provided much more information than they were monitoring on a daily basis so we helped them to expand their daily monitoring report to include parameters such as DM%, OLR, gas to CHP, gas to flare & CHP run time.

"The data was monitored daily along with a written report for each day detailing which suppliers had provided feedstock material and any incidents which prevented their CHP engine from running. Over a period of 12 weeks were able to increase the plants performance by 23%. They suffered from issues with over feeding and monitoring OLR revealed this quite quickly. Monitoring supplier information enabled us to rule out any issues with individual suppliers. As well as operational issues, the plant was suffering from mechanical issues with their CHP. This was preventing the plant from achieving the full revenue it should have been possible to achieve. Once corrected through an improved monitoring and maintenance programme, the efficiency of the plant improved dramatically with less gas going to the flare and CHP efficiency achieving 85%."

What should operators do?

Step 1: Collect data

Monitoring should be an ongoing activity throughout the lifetime of the plant. In Table 1 below we have identified a small number of key parameters that operators should monitor. Some of these are indicators of plant efficiency and operational performance but others will give early indication of issues which can then be avoided. These are not meant to be exhaustive and operators should ensure they comply with any additional monitoring requirements, for example any stipulated in an Environmental Permit. It is recommended that the plant's monitoring programme should be designed in consultation with the plant designer, engineers and relevant technology suppliers.

The frequency of monitoring can vary depending on the complexity of the plant, the consistency of feedstock used and the stage of the AD project (for example, monitoring is typically very important during plant start-up as the process biology is likely to be less stable and most sensitive at this point). We have not included recommended frequencies within this checklist due to the level of variation, but we are working with industry to produce specific guidance on monitoring that will include indicative frequencies for the next stage of the Best Practice Scheme.

Many AD plants are run with automatic operating and monitoring systems, allowing an operator to check on the plant's status at any point and to generate regular, tailored reports detailing chosen parameters. Usually an alert system is put in place so that the operator is automatically warned of problems without needing to constantly look at plant data. Where these automatic systems are not available at a plant, alternative monitoring provisions may be required. Some operators use the data provided by their automatic system to keep daily records and build up a comprehensive data set on the performance of their plant. This can also be a helpful process for site operators to carry out as it actively increases their understanding of the plant and the implications of decisions taken.

Other testing and sampling is also likely to be required, particularly regarding the quality of feedstocks, digestate and biogas.

Step 2: Understand the data

It is important that not only can an operator obtain useful and accurate data, they must also be able to understand it. Although process monitoring can seem technical, in reality it is straightforward to understand and is worth the small amount of effort required. There are companies that provide monitoring packages or services that help you interpret your data and work out whether you can make any adjustments that could improve performance. See our Member Directory to find companies that offer this (note the Member Directory is a list of ADBA members and is not an exhaustive list of companies offering these services).

Step 3: Share the data

Some operational data may be sensitive, but there are ways to share it without compromising the operator's interests. Technology suppliers are likely to be interested in the data, as it can help them to understand how effectively the plant they supplied is working which can help identify issues and potential improvements, and provides them with a track record. By maintaining an ongoing relationship, the supplier and the operator can work together to optimise performance.

In addition, as part of the Best Practice Scheme ADBA intends to create a database that operators can contribute their data to and in return receive a benchmarking report showing how their plant performs compared to the industry average for similar types of plant that are treating similar types of feedstocks. All data will be anonymised and will be confidential. By sharing data, the industry can better understand its performance and have better evidence to support our policy aims. Please visit ADBA's website to see the latest on this and get involved – the more data from different plants the more useful it will be.

Find out more

- IEA Bioenergy: Brochure on Process Monitoring http://bit.ly/1H44goj
- Practical Guide to AD: The Anaerobic Digestion Process http://bit.ly/28KqRsk
- ADBA Member Directory http://adbioresources.org/member-directory

Monitor the process

Table 1: Monitoring Parameters Options

MONITORING OPERATIONAL PERFORMANCE AT AD PLANTS		
Parameter	**What will this tell you and how will it help?**	**How can you gather data on this?**
Feedstock composition	Changes in feedstock composition can cause instability in the digester's biology and affect the quality of digestate and quantity and quality of biogas produced. While feedstock composition is not always in the direct control of the operator, by monitoring it the operator can work out the composition that gives optimal results at their plant and aim for this. In some instances, the feedstock composition will be very well known, for example at plants using purpose-grown crops. Monitoring at these plants can be less frequent, but it is still useful to record the feedstock input so that performance can be analysed.	Samples can be taken of the feedstock and the developer can commission characterisation testing (typically at an off-site laboratory). See the IEA's document on process monitoring to view a list of feedstock characterisation parameters. Some AD plants, typically those treating food waste, may also include storage or buffer tanks. This allows the operator to sample and monitor key indicators, such as pH, and in the buffer tank to ensure it is suitable for entering the digester. Visual checks can identify the presence of physical contaminants, such as large stones, glass, plastics, but are unlikely to identify smaller items.
Feed rate	Changes to feedstock input rate can cause instability of the digester's biology, so it is important to keep track of the rate at which feedstock is being fed into the digester. Monitoring this can also allow the operator to identify the optimal feed rate.	Where automatic feeding system is used, this can monitor the feed rate. If this is not available, other methods to estimate volume can be used, such as number of shovel loads of feedstock input.
Feedstock retention time	In general the longer the feedstock is left in the digester the better quality the digestate will be and the more biogas produced per m^3 of feedstock (although the relationship is not linear, and reaches a point where increased retention time has negligible benefit). Tracking this alongside gas yield and digestate quality will help the operator to establish the optimal retention time for their particular plant and feedstock.	At most AD plants, this can be calculated if there is knowledge of the total digester volume and total daily input into the digester. See the IEA document on process monitoring (see 'References' section at the end of this document).
Organic Loading Rate	The organic loading rate (OLR) is the mass of volatile organic matter, or volatile solids (VS), treated per m^3 of digester volume per day. During the start-up of a plant, the OLR is typically increased slowly so that the microbes within the digester can adapt up to normal operating conditions. Monitoring the OLR can reveal whether there is over-feeding, which can cause accumulation of volatile fatty acids in the digester and subsequent decline in methane production, or if the feed rate is too low, which can cause low plant productivity.	Typically this can be provided through the plants automatic operating and monitoring systems.
Volume of biogas produced and its use	Monitoring this and the feed rate will allow you to calculate biogas yield per tonne of feedstock, a key indicator of plant efficiency and overall performance. Monitoring the use of biogas is also recommended, for example production of heat and power, injection into the gas grid, gas to flare or as a transport fuel.	Typically provided through automatic operating and monitoring systems.

MONITORING OPERATIONAL PERFORMANCE AT AD PLANTS		
Parameter	**What will this tell you and how will it help?**	**How can you gather data on this?**
Methane concentration	By measuring the volume of biogas and its methane concentration, the amount of energy and efficiency of biogas conversion can be calculated. The ratio of methane to carbon dioxide will vary widely with the type of feedstock and the loading/retention time of the digester. Methane concentrations should also be measured to protect a CHP engine, which are usually designed to work within a given range and within a maximum rate of change.	A measuring device can be installed to continuously monitor biogas flow and composition. Check the monitoring requirements of the end-use of the biogas (i.e. injection into the gas grid, combustion in a CHP engine etc.). It is clearly also necessary to monitor continuously at plants upgrading their biogas to biomethane.
pH	The pH in an AD plant needs to be between 7.0 and 8.5 for microbes to work optimally and produce a high biogas yield. Outside of this range, the microbes can become less active and the rate of biogas production slows. Therefore pH should be monitored so that if it approaches the upper or lower threshold, measures can be taken to prevent substantial slowdown in biogas yield and risk that the digester's biology fails.	Some AD plants, typically food waste plants, may also include storage or buffer tanks. This allows the operator to sample and monitor key indicators, such as pH and in the buffer tank before it enters the digester. The pH within the digester itself can be monitored through taking samples from outlets designed for the purpose. The sample can either be sent to an external laboratory or tested on site if staff have the necessary equipment and training.
Temperature in reactor	In the UK, the majority of AD plants are 'mesophilic', operating at moderate temperatures within the range of 25-40°C. Most mesophilic digesters operate around 37°C. To achieve process stability, maintaining a consistent temperature is important and this is a key monitoring parameter.	Typically provided through automatic operating and monitoring systems.
Volatile Fatty Acid concentration	The concentration of volatile fatty acids (VFAs) is critical in relation to alkalinity within the digester. VFAs are an intermediate breakdown product of the AD process and there is always a residual concentration. Changes in VFA concentration can indicate that the process is becoming imbalanced.	This can be tested for at an off-site laboratory, where they would likely use chromatography methods. For this to yield reliable results, there must be suitable sample handling, storage and transport procedures in place; the laboratory undertaking the testing should advise on this. On-site testing can be undertaken, but clearly this requires appropriate laboratory equipment and staff to be suitably trained in their use. It may be more cost-effective to use an external laboratory.
Digestate quality	Digestate quality is a key parameter in the overall performance of the plant and it is essential to monitor it both as an indicator of plant performance and in order to ensure that poor quality digestate is not spread onto land.	Quality can be monitored through visual inspection and through sampling and testing in a laboratory. Operators must put in place methods that satisfy the requirements of regulators and any applicable quality standards that they wish to meet.
Digestate quantity	Monitoring the quantity of digestate produced is important, both to understand how much is produced under normal conditions and therefore identify when the plant is operating abnormally, and to plan for the storage and spreading of the digestate.	Digestate quantity can be measured either by knowing the number and volume of containers filled (if liquid), or by automatic monitoring devices, or by recording the weight of transport vehicles containing digestate exiting the site via a weighbridge.

Achieve biological stability

Why is this important?

While AD uses natural, relatively simple and well-understood biological processes, the biology within a digester is still sensitive to change and can become destabilised for a variety of reasons. This can directly affect the quantity of biogas produced and lead to a total failure of the plant, which would have significant financial implications. Maintaining stable biology during digestion should lead to better, more predictable quality of outputs, in terms of biogas and digestate.

It is thought that digestion instability contributes to foaming, which can result in severe plant failure with significant recovery costs. Plants should be built to accommodate foaming but prevention is best if possible; ensuring biological stability is one way to do this.

What should operators do?

The stability of the digester's biology is likely to improve with consistent plant operation, so operators should aim to undertake day-to-day operations with regularity and consistency. Operators should have in place procedures or protocols which clearly set out how the plant should be run each day (under normal circumstances) and staff should understand their responsibilities.

It is particularly important to achieve:

- Consistent feedstock composition (as far as possible) and feed rate
- Consistent digester temperature
- Consistent intervals of stirring/agitation

Process monitoring (see above) should help operators to understand what works best at their plant, and this data should be used to inform operational procedures. The procedures should also include how site staff should respond to unusual events such as unsuitable type or quality of feedstock being delivered to site, to ensure that these events do not cause digester instability.

If you are thinking of making changes to operations that may affect stability of the digester's biology, it is advisable to do so gradually and to always seek advice from a technical expert and the technology supplier in advance of making the change.

Find out more

- Practical Guide to AD: The Anaerobic Digestion Process http://bit.ly/28KqRsk

Manage feedstock effectively

Why is this important?

There are a range of feedstock types that are suitable for use in AD plants, including agricultural manures/slurries and other farm biodegradable wastes, purpose grown crops, food processing and household food waste, sewage sludge, garden waste (plant tissues) and industrial effluents. Almost all organic material can be treated by AD but some materials are easier to treat than others, and the composition of feedstock has a direct influence on the overall performance of the plant.

Contamination in feedstock can adversely affect plant performance, for example blocking pipes or accumulating in a tank, and it can be present in digestate that is produced (which could represent a pollution risk to the land to which it is spread and reduce the end market options available.).

What should operators do?

Ensure there is sufficient feedstock available

Although this seems obvious, it is always possible that contracts fall through or that crops may not be successful, so it is crucial to the performance of the plant that there is a contingency plan. If sufficient feedstock is not obtained, the plant will either under-perform or fail completely.

Ensure that feedstock is suitable

As well as ensuring that there is a sufficient quantity of available feedstock, it is important to make sure that this is suitable for the plant, both operationally and in accordance with the site's environmental permit (if applicable). Aiming for consistency is recommended, but if a new type of feedstock is used the operator must establish if it is suitable for the plant prior to feeding it, irrespective of whether it is a waste or not.

Ensure that there is a suitable pre-treatment process in place

Depending on the type of feedstock it is likely that pre-treatment will be required, as shown in Table 2 below, which is taken from Chapter 3 of the Practical Guide to AD. Some requirements are due to applicable regulations, such as the Animal By-Product Regulations, but others are necessary to reduce operational issues and improve overall plant performance.

Table 2: Pre-treatment requirements and indicative gas yields of different feedstocks

	TYPE OF WASTE				
	AGRICULTURAL MANURE ONLY	AGRICULTURAL MANURE AND ENERGY CROP	ANIMAL SLURRY AND FOOD WASTE	ENERGY CROPS AND FOOD WASTE	FOOD WASTE ONLY
Land bank	x	x	x	x	
ABPR			x	x	x
Plastics removal			x	x	x
Grit removal	x	x	x		x
Metals removal			x	x	x
Paper and card removal			x	x	x
Waste reception building			x	x	x
Silage clamp		x		x	
Gas yield	* *	* * * *	* * * *	* * * * *	* * * *

NB Gas Yield Performance Rating (Lowest ** Highest *****)

Manage feedstock effectively

Monitor feedstock quality

At plants where the feedstock composition is known with a high degree of certainty, sampling and monitoring prior to digestion is not likely to be required frequently. An example of this type of plant is those that use purpose-grown energy crops.

However, some plants will require frequent sampling and monitoring in order to satisfy regulations, standards or contractual arrangements, and to maintain good operational performance. It is always advisable to monitor the composition of inputs if making any changes, and to undertake sampling and testing for composition and quality if a batch of feedstock is received from a new source. Some plants include one or more buffer tanks that allow the feedstock to be sampled prior to input to the digestion tank.

Input feedstocks at an optimal rate and make changes gradually

By monitoring basic parameters (see the section on monitoring, above) the operator should be able to determine the optimal range of feed-rate for their plant. To some extent this should be predictable prior to operation, however it cannot be guaranteed so monitoring is vital. Rapid changes in feedstock composition or feed-rate can cause digester instability which is highly likely to negatively impact the plant's performance as a whole. Therefore, changes should ideally be made gradually, with the guidance of the technology supplier or process engineer and the plant's biologist, and monitoring should be undertaken at all stages to enable advance warning of any problems.

Find out more

- Practical Guide to AD: Feedstocks http://bit.ly/28L5608

Why is this important?

Recent research into effects of applying digestate to agricultural land *'demonstrates that digestates and composts can increase yields with no negative impacts on crop quality or safety'* (WRAP, 2016). Despite this, digestate is sometimes viewed purely as a by-product or a waste to 'get rid of'. By producing as high quality digestate as possible the industry can maximise its agronomic value in order to have positive commercial value once transport and spreading costs are taken into account.

Where digestate is made from waste, in most circumstances its storage and use after being dispatched from the production site will be subject to waste regulatory controls. This means that the person responsible for the land where the digestate is stored and used must first obtain a permit from the regulator or register an exemption from permitting. The digestate must be stored and used as per all conditions in the permit or registered exemption document.

Good quality digestate can be marketed and sold as a product, becoming a potential revenue stream. Product status can be applied for when digestate has been made wholly or partially from suitable types of waste materials. For plants in England, Wales and Northern Ireland using suitable waste feedstock types, product status is only possible if the digestate meets the requirements of the AD Quality Protocol and PAS110. There is a separate position statement on the conditions in which waste-derived digestate can become a product in Scotland and only digestate that complies with this can be counted towards Local Authority recycling rates.

If waste-derived digestate achieves product status, it is important to check that its quality is adequate prior to its dispatch for use. If this is not done, inadequate quality digestate could pollute the environment and damage valuable agricultural land. This type of incident reduces confidence in the industry and the operator could potentially lose their digestate outlet (landbank) which is essential for the continuing operation of an AD plant. Removing contaminated digestate after it has been spread will incur substantial costs, and can lead to significant insurance claims to cover these environmental remediation costs.

Digestate quality is influenced by the types of feedstock used and factors that can be directly controlled by the operator, including the pre-treatment undertaken prior to digestion and the feedstock retention time in the digester.

Digestate from plants using municipal or commercial food waste is likely to be more variable in quality than that from plants that digest only energy crops, crop residues or slurries. This reflects the variability of food waste feedstocks, and their higher potential to include contaminants such as non-digestible plastics, pieces of metal and glass. Operators using this feedstock must have measures to ensure quality.

What should operators do?

Reject non-conforming loads

All feedstock loads should be assessed prior to being accepted into the process. Depending on the feedstock and its source, this can range from a simple visual check to a full chemical analysis. Any loads that do not conform to the specification or contract should be rejected. It is easier to reject a highly contaminated load than to deal with the problems it will cause throughout the process.

Use a suitable pre-treatment process

The type of pre-treatment needed will vary depending on the feedstock. Food and garden waste is likely to require a higher level of pre-treatment, such as de-packaging (appropriate for the packaging), and plastics, metal and glass removal. The same applies to garden/green (plant tissue) wastes, although de-packaging machinery is not applicable. Understanding the feedstock composition before commencing operation is vital and feedstock supply agreements should include criteria for acceptable feedstock composition, particularly in the case of contaminants in food and garden/green wastes. Operators should make sure that the technology supplier knows what feedstock will be used. Once in place and operational, monitor the depackager 'soup' for plastic quantity to ensure it is working to its maximum efficiency and as an early indicator for any issues.

Monitor the quality

Digestate that has waste status would not be allowed to be spread on land if its quality is deemed too poor by the regulator (this would be considered during assessment of an application for a permit to spread the digestate on land, and also when assessing a 'paragraph 7 exemption' for spreading waste status digestate in Scotland).

Focus on digestate

Plants that are certified as making digestate that has product status are required to operate effective Quality Management Systems, and this includes making frequent enough checks on digestate quality before dispatching it. If the digestate is poor quality and contaminated, it should not be spread on land. PAS110 requires the operator to ensure there is an effective HACCP plan in place with a robust quality management system to monitor the whole process of digestate production from input material acceptance criteria, through depackager monitoring to back end screens and final inspection of loads before they leave the plant.

As previously stated, digestate quality is heavily influenced by decisions made in the plant design and feedstock management, but it is also important to monitor the long term impacts of digestate spreading and work with farmers and landowners to ensure good practice is followed. This could include steps to:

1. Identify the farmers/landowners that will be using the digestate and clarify their requirements for digestate quality, how the digestate will be applied, when and where. You may want to offer farmers a site visit so they can become familiar with the digestate and the steps taken to deliver a high quality product.
2. Where the digestate contains animal by-products, highlight this to the farmer and ask them to confirm that this is acceptable. The Renewable Fertiliser Matrix provides farmers and operators with a quick look-up tool to identify how and when digestate containing ABPs can be used with different crops.
3. Where digestate contains animal by-products, operators, contractors and users must comply with statutory requirements. The requirements are described on Defra's webpages. http://bit.ly/28R8bKt
4. Digestate is typically rich in readily available nitrogen, the most important nutrient limiting crop yield, but it can also cause pollution. Follow good practice guidance to maximise the benefits and minimise the pollution risk, see in particular the AHDB's 'Fertiliser Manual (RB209)' and WRAP's Good Practice Guidance.
5. Sample the batch of digestate to be supplied and get an up-to-date nutrient analysis which can be provided to the farmer. This will be invaluable to helping them integrate digestate into the crop nutrient plans. AD operators with FACTS qualified advisers could provide farmers with an added value service by advising farmers on how to integrate digestate into their fertiliser plans. http://bit.ly/28R8DbB
6. Work with farmer customers to understand the regulatory and good practice requirements which effect how and when digestate can be used. The Nitrate Vulnerable Zone (NVZ) Regulations and the Code of Good Agricultural Practice are good examples. These are explained more fully in WRAP's Good Practice Guidance.
7. Good practice includes using precision application equipment, such as band-spreaders or shallow injection. Agricultural contractors can often supply this equipment if the AD operator or farmer cannot.
8. Arrange a time for the farmer to be present when you first deliver digestate. Let them check the digestate, e.g. by taking a sample in a bucket, and ask them to confirm that they are comfortable with the level of quality provided.
9. Provide farmer customers with a feedback mechanism should things go wrong, and work with them to provide a solution that addresses their concerns.
10. If you use an agricultural contractor, make sure that they are reputable and that they provide a best practice service that satisfies the points highlighted above. The National Association of Agricultural Contractors (NAAC) provides an assured contractors scheme and provides a specific module on 'Spreading Materials to Land'. www.naac.co.uk/SpreadingtoLand/

Find out more

- ADQP http://bit.ly/28KwwP9
- AHDB's 'Fertiliser Manual (RB209)' http://bit.ly/1Isfxy5
- Biofertiliser Certification Scheme www.biofertiliser.org.uk/
- PAS110 http://bit.ly/28Lehwg
- SEPA's Position Statement on Classification of Outputs from AD http://bit.ly/28KwHdg
- WRAP's Digestate and Compost Good Practice Guidance http://bit.ly/28KUrjD
- WRAP's Renewable Fertiliser Matrix http://bit.ly/28NhCM6

Ensure staff are suitably trained for their role ☐

Why is this important?

Ensuring that all staff on site are appropriately trained for their role is vital to achieving a high level of operational performance.

The minimum skills and knowledge needed will vary depending on the role, for example some staff will need only a basic understanding of the biological and chemical processes within an AD plant but others will need to have a much higher level of knowledge. Without the required level of knowledge, key decisions may be made incorrectly leading to sub-optimal plant performance. All operators should identify the individual training needs of each role and make sure that these needs are met on an ongoing basis. This will ensure that they have the competence needed to manage the plant most effectively and efficiently.

What should operators do?

Every operator should have a training plan that identifies the responsibilities and training needs of each role. The 'AD Competency and Skills Matrix' should help operators create this (see below); the matrix was developed by ADBA's Training, Safety and Environment Working Group with CIWM and is an indicative guide to the competency and skills required at an AD plant.

The training plan should detail which skills and competencies staff should have, what they already have and any gaps that you need to address. Operators should update the plan regularly and following staff changes, to ensure that the site is always run by staff with the required level of competence.

Operators should ensure that maintenance is only undertaken by competent persons – those that are suitably trained, qualified and experienced to perform the maintenance activity that is required. Site staff should only perform maintenance activities if they are competent to do so, and have appropriate clearance from the site management.

Where an AD plant aims to produce waste-derived digestate that achieves product status, PAS 110 requirements include that 'each person whose duties affect digestate quality shall be trained, instructed and supervised commensurate with those duties, such that he/she is competent'. Its section 4.3 sets out requirements relating to communication, awareness, training and competence.

Find out more

- AD Competency and Skills Matrix http://bit.ly/28MsRnD
- ADCORS document
- Practical Guide to AD: Training http://bit.ly/28Ky38L

☐ Maintain all items of plant, kit and infrastructure

Why is this important?

Failing to maintain plant, equipment, kit and site infrastructure properly can reduce plant performance, put it at risk of failing, increase risks to the environment and workers' health and safety, and invalidate warranties.

What should operators do?

In all cases, operators must ensure that plant and equipment is maintained in accordance with the manufacturers' guidance and any warranties and insurance policies. Operators should check any maintenance contracts and ensure that they are aware of their responsibilities and those applicable to the contractors.

Operators should always ensure that maintenance is undertaken by a suitably trained and qualified individual. Even if site staff could carry out the maintenance, they should only do so if they have the necessary training and qualification and it does not invalidate any warranties or put them at risk. Operators should be provided with a maintenance management plan by their technology provider, and the operator may decide to enter into Operation and Maintenance (O&M) or service contracts. These can often be performance-linked, helping to ensure the plant operates to a high standard and giving the operator and investors better peace of mind.

Operators should create a maintenance plan that covers each item of plant, kit and infrastructure. This should enable the implementation of 'planned preventative maintenance' which involves scheduling and undertaking ongoing maintenance with the aim of preventing unexpected breakdown and retaining maximum efficiency and performance. At sites which operate under Environmental Permits, a written maintenance plan that incorporates the principle of planned preventative maintenance may be required as part of the site's Environmental Management System.

Manage grit and plastics accumulation

Why is this important?

Many types of waste will contain grit, for example in the form of glass, stones, eggshells or sand. 'Grit' is a loose term to cover these items. This can settle within the digester and slowly fill up the tank causing loss of volume and eventually process failure. Grit of this nature is not the only type of material that can settle – any heavier items or fractions can also sink to the bottom and have a similar effect.

The removal of grit or other sinkables from within tanks may result in temporary unavailability of parts of the plant, potentially reducing biogas yield and putting the biology at risk. Taking measures that aim to prevent or reduce grit accumulation effectively can reduce the rate at which grit accumulates and minimise the disruption caused by grit removal activities, therefore maximising plant availability and biogas yield.

What should operators do?

Grit, if present in the feedstock, can be separated before entering the digester using plant designed specifically for the purpose. In all cases the operator should assess the likelihood of grit accumulation before operation commences, or a new feedstock is introduced based on knowledge from other plants that have a similar set up and feedstock. This should be considered in the planning and design of the AD plant - experts on this can be found in the ADBA Member Directory.

Depending on the feedstock used, in some cases the accumulation of grit may be inevitable and so will need to be removed from the part of the plant in which it settles, but it is possible to minimise the disruption caused during the removal process.

If grit accumulation is likely, it is sensible to create a basic 'grit management plan', which sets out procedures for managing the grit and when to schedule removal. The frequency of grit accumulation will depend on feedstocks, the mixing system and any inbuilt grit removal system; therefore it needs to be discussed with the technology supplier.

With gritty feedstock, it is useful to have a buffer tank to allow grit to drop out before it enters the digester; this can also more easily be cleaned. Cleaning a digester is likely to be required after a few years of operation and this is easier if there is more than one digester as the plant can continue to run (at a reduced throughput) while the cleaning is taking place. When de-gritting a digester, it must be taken offline and made safe prior to the degritting. Specialist contractors can be used to collect and dispose of the grit.

Find out more

- Practical Guide to AD: The Anaerobic Digestion Process http://bit.ly/28KqRsk

Manage odour effectively

Why is this important?

AD has the potential to generate odour emissions from putrescible feedstocks and the anaerobic degradation process. Poor management of unprocessed waste/substrate storage can lead to the generation of offensive odours, which can become a persistent nuisance to local receptors. In addition, exhaust and combustion gases from energy recovery plant can also contain odorous compounds. This may result in enforcement action being taken against the site operator by environmental regulators. Odours can also create negative perception of AD facilities by local residents and communities, which may impact on the long term viability of facilities and therefore needs to be planned for and managed carefully with each new facility.

What should operators do?

Developers and operators must employ all the appropriate measures necessary in the design and operation of the facility to prevent potential odour pollution or minimise it when prevention is not practicable. Operators should characterise odours likely to be generated from the expected feedstock and choose the appropriate abatement systems and techniques.

Operators of AD facilities should prepare an Odour Management Plan (OMP), in accordance with the Environment Agency H4 guidance. An OMP requires the operator to assess the potential level of odour pollution at the site or facility and to implement appropriate monitoring and control measures. As well as being a regulatory requirement, there are several additional benefits to the operator in producing an OMP, including;

- Identification and management of potential odour risks;
- Engagement and relationship development with stakeholders;
- Minimisation of odour management costs; and
- Optimisation of odour abatement equipment.

Monitoring odour should be part of measuring the effectiveness of operational practices, as it may identify an imbalance of the anaerobic degradation process or reveal the need to improve housekeeping and maintenance. There are a number of methods available for measuring odours and the right method should be chosen based on particular conditions, the degree of accuracy required and affordability.

REFERENCES

- ADBA Best Practice Scheme: http://adbioresources.org/our-work/best-practice-scheme
- ADBA 'The Practical Guide to AD' (various chapters): http://adbioresources.org/members-area/the-practical-guide-to-ad
- ADBA Member Directory: http://adbioresources.org/member-directory
- ADBA website: http://adbioresources.org
- AD Competency and Skills Matrix: http://adbioresources.org/library/working-group-documents
- ADCORS document
- Agriculture and Horticulture Development Board (AHDB) Fertiliser Manual (RB209): www.ahdb.org.uk/projects/CropNutrition.aspx
- Biofertiliser Certification Scheme: www.biofertiliser.org.uk
- Defra Code of Good Agricultural Practice (CoGAP): www.gov.uk/government/publications/protecting-our-water-soil-and-air
- Defra guidance on Animal By-products Regulations: www.gov.uk/government/publications/controls-on-animal-by-products
- Environment Agency (EA) Quality Protocol for Digestate (ADQP): http://bit.ly/28KwwP9
- Environment Agency (EA) H4 Guidance on Odour Management: http://bit.ly/28NmRve
- Fertiliser Advisers Certification and Training Scheme (FACTS): https://www.basis-reg.co.uk/Schemes/FACTS/About-FACTS
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