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Tackling odour

An overview of the common causes of odour in waste water treatment and options for tackling it.

Wastewater treatment has an inherent risk of odour which naturally can be particularly problematic where works are located close to housing or other developments. Environment Agency data shows that odour complaints associated with wastewater treatment works (WwTWs) make up a surprisingly low proportion of the total number of complaints, with landfills and waste treatment sites being the most problematic (Figure 1). The data presented in 2016 shows 398 reports of odour were made regarding wastewater treatment, associated with ten WwTWs.

Whilst this might indicate that odour is a fairly limited problem for the industry, when odour issues do arise, they can have a very high public profile and engineered solutions to mitigate against the issues can be costly.

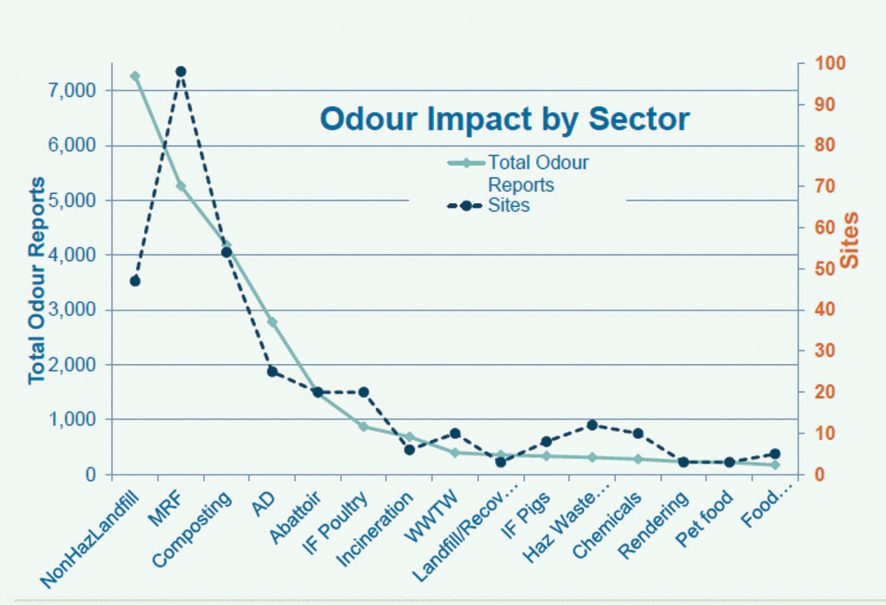

Figure 1: Environment Agency data on odour reports (source: A.Lyon, Emissions & Odour Control Conference, 2016)

Odour production

Sewage and sewage sludges are inherently biologically active and there is a sequential order in the nature of the biological reactions that take place in their degradation (Figure 2). Aerobic respiration whereby organic substrate is respired as carbon dioxide, is the most energetically favourable reaction. When molecular oxygen is depleted, nitrate is used as an oxygen source under anoxic conditions. Once nitrate is used up, anaerobic (or septic) conditions develop which allow sulphate to be reduced to hydrogen sulphide.

It is these anaerobic reactions that are responsible for odour generation, with the easily characterised rotting egg smell of hydrogen sulphide (H_2S) often being the most problematic component, along with ammonia and organic compounds such as dimethyl sulphide (rotting seaweed), mercaptans (rotting cabbages) and longer-chain volatile fatty acids (rotting food/body odour) also contributing to odour issues. As H_2S is the easiest of these compounds to measure, it is commonly used as a surrogate for odour in routine site monitoring.

The sequential order of aerobic, anoxic and anaerobic reactions means that redox potential can be a very useful tool to monitor conditions in the liquid phase (both within the network and across the treatment works) to identify where anaerobic conditions exist. When carrying out an initial odour assessment, combining redox measurement with an accurate sulphur mass balance across the wastewater and sludge process is a recommended approach to determine where H_2S production is occurring and to quantify the scale of the issue.

This information can be used either to try and avoid the onset of anaerobic conditions or to make sure that appropriate mitigation or treatment measures are in place.

Like all biological processes, the kinetics of degradation leading to odour production are time and temperature dependent, so onset of septicity occurs where extended periods without oxygen exist – and the process is more rapid in warmer months. Networks in low-lying catchments are more prone to odour issues, as are process units where excess dwell times and poor mixing exist. Odour potential also increases where a high proportion of readily biodegradable organic compounds exist. Indeed some of the most problematic works often have an elevated trade component (ie breweries, vegetable processing) which provide an ideal substrate to accelerate biological activity.

Saline ingress within a catchment is also often a key factor in odour production. Seawater contains >2,500 mg/l sulphate and so greatly increases the H_2S generation potential. Conductivity monitoring of

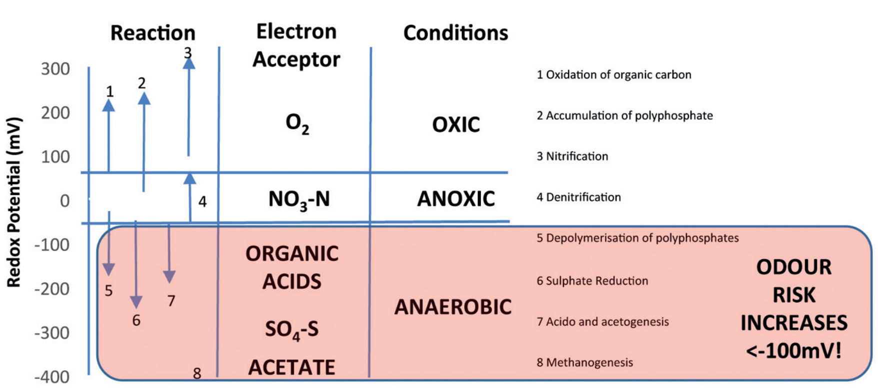

Figure 2: Terminal acceptors in biological processes

the incoming wastewater is the most effective way to identify peaks in salinity to assess the potential impact on downstream processes.

Mitigation options

Odour problems occur in the incoming wastewater or develop in subsequent downstream processes. A range of possible interventions are available to tackle odour.
The least cost option, where practical, is to remove the conditions allowing septicity to occur. However, where this is not practical, chemical dosing can provide a short-term and rapidly effective control strategy. Where a more robust treatment is required, then it may be necessary to cover process units, extract the air and treat this to a specified standard. In some instances, the only way to guarantee compliance with the regulations on odour is to cover treatment processes, extract the air and treat this to the required standard.

There are many odour treatment technologies on the market, with process selection affected by factors including size of air flow, contaminants to be removed, level of treatment required, CAPEX and OPEX. This is an extensive subject and it is not the intention to review these here but rather to focus on short-term interventions that may be applicable based upon the process monitoring discussed above.

1. Chemical dosing

There is a range of dosing chemical options which should be matched to the nature of the problem. These can be summarised as:

a) ***Precipitation with iron*** – Iron can be added (usually as ferric chloride) to precipitate sulphide. This is particularly effective where septicity already exists as well as being a preventative measure. Primary tank dosing for phosphorus removal will have the added benefit of some sulphide suppression in the primary treated effluent and sludge. Likewise, ferric dosing into sludges is also common for odour suppression as well as reduction of H_2S in the biogas from anaerobic digestion. Iron may be precipitated in other chemical reactions and it may be ineffective in tackling other odourous compounds.

b) ***Nitrate dosing*** – Addition of nitrate (as calcium or sodium nitrate solution) will create anoxic conditions and increase the redox potential, thus inhibiting any further anaerobic activity until all the nitrate has been metabolised. This is particularly effective as a preventative measure but less effective at removing odorous compounds once present. It is commonly dosed into networks but can also be dosed into specific process units. Jar testing can be used to predict the required dose to offset septicity for a given time period.

c) ***Oxidative compounds*** – There are a range of general oxidative products (ie ozone and peroxide) as well as products targeted specifically at odour removal. Generally, oxidative products are effective at removing existing odour prior to a potential emission point but an appropriate dosing regime could be employed as a preventative strategy.

2. Process optimisation

Primary tanks are a common cause of odour but this can be minimised through primary tank optimisation. Implementation of instrumentation to control desludging on sludge blanket height, sludge dry solids or redox can help to minimise odour emitted from the tank and downstream sludge processing. Minimising anaerobic conditions within primary treatment has the added advantage of reducing the opportunity for soluble BOD and ammonia release within the tanks, which can increase secondary treatment costs.

Where secondary aerobic treatment is fed on septic wastewater, the emission of odour through the volatilisation of volatile compounds is almost inevitable. The main opportunity for optimisation within the process is to ensure sufficient oxygen is present and mixing occurs to ensure no anaerobic conditions can develop. In activated sludge processes, the presence of unaerated selector zones may allow some potentially volatile compounds to be metabolised before they can be driven off into the atmosphere through aeration.

Through sludge treatment, the key to minimising odour, reducing return liquor loads and optimising the energy value of the sludge is to process the sludge whilst it is as 'fresh' as possible. This is often easier said than done as it relies on having the necessary available capacity, but sometimes simple changes to operation can help to maintain throughput. On a 1.1million population works, a change to the primary sludge handling to reduce storage before thickening, not only greatly reduced the odour but provided a saving of >£250k per annum in reduced chemicals for odour treatment and enhanced biogas yields.

3. Misting and deodorising sprays

More commonly used in the waste industry, these systems can be installed around problematic process units to partially reduce odour in the air by introducing deodorising products to mask the odour. This is a cheaper alternative to odour treatment, but may be less effective in general and is also subject to weather conditions influencing its performance.

4. Housekeeping and maintenance

Most issues concerning plant condition are well understood and largely influenced by budgets and availability of resources to maintain assets and deal with operational issues. However, housekeeping can still be overlooked, even where sites are under pressure to respond to odour complaints. Simple actions to tackle odour may include: covering skips containing screenings, removing spillages, keeping doors on buildings with ventilation and extraction closed to maintain negative pressure, proactively maintaining key assets to ensure optimised sludge throughput and replacing odour treatment media when required.

Conclusions

Some treatment works are inherently prone to odour issues and the location of potential receptors to the issues means that installation of a robust odour treatment solution is essential. Odour treatment has both a capital and operational cost. In some instances, particularly where the issues may be more transient or related to sub-optimal plant performance, investigating the chemistry of the wastewater, such as through redox monitoring and sulphur mapping, can help to build a clearer picture as to the nature of the problem and the likely point sources of emissions. In these circumstances, it may then be possible to deploy process interventions or short-term mitigation measures as a more cost-effective approach to capital solutions.

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