# Sustainable Odour Control in Urban Environments

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**ABSTRACT**

With an ever increasing focus on sustainability, the municipal recycling sector is increasingly locating recycling facilities in urban environments to be closer to their waste sources.

The odour control industry needs to respond in providing ever more efficient odour extraction technologies to minimise any odour nuisance to their residential community neighbours.

In addition, cost pressures (and social responsibility) drive the development and design of more energy efficient odour control systems for reduced carbon footprint.

This paper reviews some of the new design approaches and innovative technologies available, many of which ERG have employed in some recent installations.

**KEY WORDS**

Odour control, municipal recycling, odour dispersion, odour treatment, fugitive emissions, regenerable carbon, carbon filters, integrated odour control.

**INTRODUCTION**

Odour control technologies for the waste water and sewage sludge treatment sector are becoming increasingly based on established and proven technology. Abating the odorous discharges from even the most odorous sewage sludge secondary processes is now relatively straightforward. These established and proven solutions, however, often come at a heavy cost in terms of carbon footprint, particularly in urban environments where maximum odour discharge limits are now specified at levels which were considered unachievable even 10 years ago.

The municipal sector, with its new determination to recycle household waste, now faces the challenge of recycling waste in a sustainable fashion. Odour control for these recycling facilities is a significant operating cost as the odour control systems required to abate these new facilities have large carbon footprints.

This presentation will present some of the challenges facing odour control designer for these types of facilities.

**PREVENTING FUGITIVE EMISSION WHILE STILL CONTROLLING ENERGY CONSUMPTION**

In urban areas the process facilities are nearly always housed in large buildings. These facilities are maintained under slight negative pressure to prevent odorous emissions escaping and causing a nuisance to their local communities. The selection of the air change rate for these buildings typically dominates the carbon footprint of the odour control system.

For example, for a new sewage treatment works in a sensitive urban area for a town with a population of 250,000 in England, the specified hourly air change rate is 3 times the internal volume of the enclosing structure, even through all the odorous processes are fully enclosed. The extracted odorous volume is specified at 240,000m$^3$/hr and the odour control system consumes a staggering 1,200kW each hour. If, instead, an hourly air change rate of 1 air change had been selected for the enclosed structure the extracted overall volume would be 30% less and the power usage 25% less. At 9p per kW this is a running cost saving of £27/hr or £236,500/annum. Over the 20 years design life based on 9p/kW this equates to a saving of £5million.

However the difficulty is that odour control is often a highly political issue, so specifiers are forced to be excessively conservative.

Odour control emissions to atmosphere are often a key part of the planning process for a new facility in an urban environment. Maintaining a low carbon footprint often becomes secondary to the overriding importance of eliminating the risk of complaints from the community.

The solution to this is that the odour control system need to be designed such that operators can minimise the energy consumption whilst still providing maximum odour removal to avoid complaints.

Good examples of this in practice are the new in-vessel composting facilities which TEG Group Plc are building for the Greater Manchester Waste Disposal Authority (GMWDA) at Rochdale, Bredbury and Trafford Park.

The Rochdale plant processes about 750 tonnes of kerbside collected green waste together with about 50 tonnes of food waste per week, and converts this into about 600 tonnes of top soil suitable for agricultural use by employing a composting and maturation process which takes about 8 weeks.

The Bredbury and Trafford Park facilities are approximately twice as large as Rochdale.

The maximum extraction rates for the Rochdale plant are governed by the fact that even when the doors are open to allow vehicles to enter and offload, the extraction system must still prevent odour escaping. At Rochdale there are 2 large doors, so in order to ensure a net inflow of air through the doors when the doors are open, an extraction rate of 118,800m$^3$/hr was selected. This equates to about 3.3 air changes for the building per hour.

An additional challenge is that the waste being composted gives off a considerable amount of water vapour as the compost reaches 70$^o$C during its 17 day cycle. The water vapour then condenses within the building forming a fog. The extraction rate therefore has to also be able to clear the fog to improve visibility inside the building so that operators can work safely.

ERG, working in collaboration with TEG, has developed an odour control system which is able to modulate the volume of extracted air to meet the requirements. So, at weekends and at night the extraction rate falls off to only 20% of the peak extraction rate. Similarly when the doors are closed during the working day the extraction is about 50% of the maximum extraction. Only when the doors are open or there is a need to clear the fog in the building do the fans ramp up to peak extraction rate.

This increased sophistication gives at least a 70% saving on the fan power consumption compared with the fans operating at full extraction continuously.

Inverter drives for fans and pumps have dramatically reduced in cost over the last 10 years so this sort of modification is now relatively cheap.

**DISPERSION VERSUS TREATMENT**

The odours from most odour emitting plants are not harmful, so atmospheric dispersion is an alternative approach to treatment which minimises the carbon footprint of the odour control system.

Sophisticated computer dispersion modelling software is able to model the pattern of odour dispersion over the locality, and predict the frequency with which specific locations will experience odour concentration above defined levels.

So for example the model will generate an "isopleth" or contour line around the odour emission source or sources which represents a particular odour concentration, say $10ou_E/m^3$ at the 98%ile. This means that based on, say, 1 year's worth of digital hourly recorded weather data, this isopleth indicates that for 98% of the time the odour along this line will not exceed $10ou_E/m^3$.

If we assume for simplicity's sake that the odour generated was from a single 10m stack, then using the velocity at which the exhaust gas is dispelled from the stack, the model will calculate the odour dispersion characteristics, its temperature (buoyancy), its volume/hour and its odour concentration.

If we assume in this case that the odour at the outlet of the 10m stack is $1{,}000ou_E/m^3$, then the odour is diluted 100 times before it reaches the $10ou_E/m^3$ isopleth line.

Under the Integrated Pollution Prevention Control (IPPC) H4 technical guidance note guidelines, different processes are required to achieve different concentration levels. Waste water sewage works are allocated the indicative maximum odour limit of $1.5ou_E/m^3$ at the 98%ile levels at locations of potential inhabitants who might consider the odour a public nuisance and so complain.

So in this hypothetical case $10ou_E/m^3$ exceeds the required $1.5ou_E/m^3$ level by a factor of approximately 7.

Re-running the model will indicate that a maximum level of, say, $500ou_E/m^3$ is required at the 10m stack.

The model can then be rerun at different stack heights to calculate the height required to achieve the required isopleth condition of $1.5ou_E/m^3$. In this example the stack height would be 26m.

This dispersion approach is normally by-far the cheapest and lowest carbon footprint solution.

Instead of adding another stage of odour removal, such as carbon filtration, to achieve the $500ouE/m^3$, the $1{,}000ou_E/m^3$ odour is simply dispersed by a taller stack.

For one of the 3 Greater Manchester kerbside composting plants, the odour control stack is 37m high and the allowable odour concentration at the stack is $4{,}000ou_E/m^3$.

The stack might perhaps be considered a visual polluter but from the carbon foot print perspective it is a highly sustainable method of odour abatement.

**MINIMISING WASTE BY USING RE-GENERABLE CARBON**

All 3 Greater Manchester plants are located in urban areas and space is at a premium so biological systems were ruled out on grounds of size of their physical footprint.

Biological treatment is effective in abating about 80% of the odour generated from composting kerbside waste. However traditional biological filters have to be very large as they rely on a long contact time between the bio-media and the contaminated air stream being treated. In addition, biological systems would require a final polishing stage to achieve an acceptable level of odour reduction.

Thermal oxidation systems such as generative thermal oxidisers which recover nearly all their heat are not appropriate on grounds of running costs, as, even with the high level of heat recovery, the technology still consumes significant quantities of fossil fuel.

Plasma or ionisation odour control treatment is not able to achieve the required efficiency as this type of technology is better suited to low levels of odour.

So, the final solution was to use re-generable carbon to adsorb the odour. Activated carbon is ideally suited to this type of complex low solubility VOC based odour challenge and is able to achieve high removal efficiencies. The advantage of this approach is that the carbon is capable of being regenerated and reused up to 6 times before it is considered spent and disposed of to landfill. This is the approach ERG as TEG odour control sub contractor are using at the Greater Manchester sites.

The physical footprint of the carbon unit is highly compact as a single annular carbon filter 3.6m diameter by 8m in height is able to treat about 80,000$m^3$/hr of contaminated exhaust. The carbon needs only to be changed every 6 to 12 months.

For these installations, the hot wet extracted gas from the in-vessel composting area is cooled by a sub cooler direct contact scrubber to condense out up to 2$m^3$/hr of water from the extracted exhaust and so protects the activated carbon from becoming saturated. The scrubber also washes out some of the soluble VOCs and so reduces the VOC loading onto the carbon.

**NEW TECHNOLOGIES WITH LOWER CARBON FOOTPRINTS**

**$H_2S$ adsorbing re-generable carbon**

In the Middle East ERG regularly installs re-generable carbon filters at waste water treatment works which adsorb $H_2S$ to 99% efficiency. The carbon can then be regenerated by rinsing in water typically 2 or 3 times and washing away the leached dilute sulphuric acid back to the head of the works.

This means the carbon can be used up to 6 times before it requires replacement. This re-generable technology, which is more complex than the straightforward caustic impregnated carbon used so widely in the UK and which needs to be to be disposed of to landfill once it is spent, is likely to become more widely accepted in the coming years as landfill costs continue to escalate.

**Compact Bio-logical Filters**

Lava rock bio-filters are able to sustain bio-media depths of up to 6m unlike wood-chip or similar bio-media which are only able to operate at up to 2m depth. Thus lava rock bio-filters are able to treat the same gas flow with $^1/_3$ of the footprint while still achieving the same residence time of treatment for the gas. This type of technology has a low carbon footprint as it uses no chemicals, and its only waste is the sulphurous acid, which on a waste water works is simply returned to the head of the works.

Until now, large gas flows have generally been treated by chemical scrubbing, but as the cost of chemicals rise biological systems with their higher initial capital cost are being preferred as both their carbon footprint and operating costs are so much cheaper.

**Recovery of Nitrogen**

Secondary waste water sludge processing, such as composting with wood chip and drying, can generate high levels of ammonia which can be converted to 30% ammonium sulphate solution by scrubbing with dilute sulphuric acid. As the cost of fertiliser continues to rise this option may well become attractive to waste water processing. This type of fertiliser production has a far lower carbon footprint than fertiliser generated using natural gas.

**Recovery of sulphur**

At present, most caustic bleach scrubbers are designed to convert $H_2S$ to sodium sulphate using 4 moles of bleach. An alternative stoichiometric path is to use 1 mole of bleach to form sulphur. This approach uses ¼ of the bleach and so has a lower carbon footprint, and recovers sulphur which can be returned to soil. This however complicates the gas cleaning system which has to be able to operate the sulphur recovery stage by scrubbing with a slurry. Using less bleach, however, significantly reduces the carbon footprint of the plant.

**Recovery of energy**

The composting of sewage sludge and municipal kerbside green waste generates considerable heat which could be recovered to supply hot water via heat pumps or other exchangers. If a local use for this hot water can be identified this significantly reduces the carbon footprint.

**Integrated odour control**

Designers of odour control systems need to be constantly looking for integration opportunities so that the carbon footprint of the odour control plant can be minimised. ERG for example has been able to use filtered final effluent at a waste water works as the scrubbing liquor to scrub out ammonia given off from sludge stabilisation plants using lime and sludge dryers. This alkali liquor is then directed to parts of the works where the effluent is acidic. Using filtered final effluent removes the need to treat the ammonia using relatively expensive chemicals such as sulphuric acid to neutralise the ammonia.

**CONCLUSION**

ERG's technology and design approach can achieve significant carbon footprint reductions at relatively small additional cost. The Greater Manchester odour control plants, with the use of inverter driven fans properly integrated with the process they are supporting, together with the use of re-generable adsorbent media, show what can be achieved relatively simply.

The ERG approach to achieving sustainable odour control is to invest more effort into the initial stages of the design and to involve odour control suppliers earlier in the design process so that the overall optimum process plant which includes the integrated odour control, can be developed.

Designing sustainable odour control is an evolving challenge for odour control designers. In nearly all cases, the odour control plants for a more sustainable future require either a greater level of sophistication or a greater level of initial capital cost or both.