Patented peat filtration media for the treatment of odour and VOC emissions from solid waste facilities with considerable system performance and energy consumption

John Paul Phillips (Ian), B.Sc.Eng., Dip. Env. Eng., C.Eng., M.I.E.I.

Manager – Air and Water Solutions, Bord na Móna Environmental Ltd., Main Street, Newbridge, Co. Kildare, Ireland
Phone: +353 (0)45 439560, Fax: +353 (0)45 433330, e-mail: ian.phillips@bnm.ie

Summary

This paper will give an overview of the critical elements of developing an effective odour control strategy for a municipal waste management facility. In particular, it will look in more detail at the application of patented technology utilising high-quality peat derived filter media to overcome the limitations of conventional organic biofilter media. Detailed case studies will be cited with particular reference to process performance, energy consumption, media life and recycling of filtration media.

Key index words: biofiltration, volatile organic compounds, peat media, MÓNAFIL

Introduction

Bord na Móna Environmental Ltd. have considerable experience in the field of biological air filtration (600 installations). Initially, the majority of installations were on municipal and industrial wastewater applications, more recently installations have been installed on municipal solid waste treatment plants, food processing and general industrial applications.

It is difficult to overstate the importance of the emerging solid waste management sector in the context of environmental control. Aside from facilitating the implementation and enforcement of the preferred hierarchy of treatment of solid waste, the transport, handling and processing of municipal solid waste also gives rise to a number of complex and challenging issues. The location of waste handling and processing facilities close to or within the urban areas they service, whilst offering advantages in terms of reduced transportation and handling, has also given rise to major problems because of a lack of a comprehensive odour control strategy.

Typically, conventional biofilters utilise organic based media (peat, bark, compost, woodchips) have been employed on Municipal waste applications with low levels of organic and inorganic contaminants. The key advantages of biological process over alternative technologies are in the area of simplicity of operation, lower running costs (low energy) and higher system performance.

Understanding air emissions from solid waste

When considering the development of an emission control strategy for a solid waste facility, there are a number of key issues which need to be considered:

- The nature and make-up of the waste; source separated (organic/inorganic) or partially separated, the age/profile of the waste. The chemical constituents of the air emission varies significantly with age and make up of the waste.
- For municipal solid waste the major constituent in the air which gives rise to environmental concerns from an environmental nuisance perspective (odour) are volatile organic compounds.
- For fresh waste and composting processes, where aerobic conditions exist the emission tends to be characterised by the presence of alcohols and terpenes (Limonene).
- For older waste and where anaerobic conditions exist the make-up of the VOCs change and the emission is more characteristic of a landfill gas containing alkanes such as methane propane butane and other more gaseous species of VOC.

The contaminants in the air emissions derive in the main from the organic portion of the municipal waste. The age, composition and handling of the waste will have a significant impact on the emission.

A clear understanding of the inter-relationship between containment structures, ventilation rates, appropriate abatement technology selection, necessary removal efficiencies and importantly, capital and operational cost is required. Furthermore, to develop successful control strategies, an understanding of odour measurement, dispersion modelling and chemical characterisation of the constituents specifically responsible for odour is essential.

This information is essential for establishing inlet conditions and required performance parameters prior to selection of the emission control process.

One further point warrants reinforcement. The removal of the dominant odorous component from the air stream does not guarantee sufficient odour removal as other compounds which were previously masked will now contribute to an overall odour. The requirement for an effective odour removal plant is good removal performance for the full range of compounds, which have low odour threshold values.

Materials and method for developing a control strategy

For solid waste applications effective containment combined with forced ventilation and an effective emission control system should eliminate a high percentage of fugitive emissions and reduce the possibility of nuisance odour complaints from the surrounding areas. Traditionally, the most prevalent abatement technologies employed for air emission control on municipal solid waste and wastewater treatment applications are adsorption, chemical scrubbing and biofiltration. The principle advantage of the biological technology over chemical scrubbing is lower operating costs and simplicity of operation.

Biofiltration

Originally developed from soil filters where odorous air is passed through a bed of soil, the contaminants are removed and oxidised naturally in the soil by the action of specific bacteria. Early systems suffered problems due to drying out of the soil and the inhomogeneous nature of the material itself leading to channelling (particle size), uneven distribution and poor treatment. Soil filters also required very long contact time, large surface area and were limited to one metre deep as above this problems with compaction were encountered.

Significant improvements to the process were achieved by better selection of organic media and products such as peat fibre/heather mixes, bark and woodchip. Granulated engineered products such as patented MÓNAFIL product give further advantages. Specifically the development of this product overcame these problems by offering a more homogenous, engineered media with high specific surface area, high void volume, good water retention and drainage characteristics and good physical properties.

The patented peat media is branded as MÓNAFIL. The peat media is durable and offers longevity and excellent removal efficiencies for a range of sulphur and nitrogen based compounds. It also has excellent capabilities on the abatement of VOCs.

MÓNAFIL properties

Bulk Density (average)	400-500 Kg/m^3 (at 50% moisture)
Particle Size (w/w)	90% ≦ 20 mm
	82% ≧ 10 mm
	96% ≧ 5 mm
Van Post No.	6-10

The well decomposed sod fuel peat is highly degraded peat having von Post numbers of 6 to 10. It is specifically selected to produce nodules which are characteristically hard and consequently resistant to abrasion and load deformation and which will undergo minimum expansion when absorbing water.

Cost Comparisons of Abatement Technologies – Operating Costs

It is difficult to undertake a meaningful capital cost comparison on all of the various technologies without recall to detailed specifications. In general terms, the capital cost for chemical scrubbers, biotrickling and biofilters are broadly similar.

Activated carbon on a stand alone basis will have a lower capital cost, however, normally self cleaning de-dusting equipment is required upfront and this is at a significant capital cost, it will also impact on running costs. When evaluating the different options the real difference in costs emerge only when we study operating and full life cycle costs.

Operating costs annually for different technology options are given below in Table 1.

A close study of operational costs demonstrates that the use of biological treatment options offers significant savings in terms of operating costs and in particular, energy consumption and use of consumables.

The use of biotrickling filters as a stand alone technology is generally not sufficient as removal efficiency may not be adequate.

The use of biological filters using conventional organic media has a low operating cost. In addition, cross media

Table 1. Distribution of C (%) as determined by solution ^{13}C NMR spectroscopy in humic acids (HA), fulvic acids isolated by adsorption on XAD-8 resin (FAXAD-8), fulvic acids isolated as barium fulvates (FABa) and XAD-4 acids of the sedge peat

Case: 50,000 m^3/h @ 50 mg/m^3 VOC	*Media usage/ Replacement*[1] *€*	*Water Costs*[2] *€*	*Power Costs*[3] *€*	*Total Operational*[4,5] *€*	*Typical System Efficiencies*
Activated Carbon	210,000	0	25,000	235,000	95%
Wet Chemical Scrubber (2 stage)	50,000	10,000	50,000	110,000	70-85%
Bioscrubber	10,000	21,000	18,000	49,600	50-70%
Biofiltration Conventional Media	35,000	21,000	17,000	93,000	85-95%
MÓNAFIL Granular Peat	19,000	21,000	14,000	54,000	85-95%

Notes:
1. Estimate includes media, carbon, disposal, chemical usage.
2. Based on average water cost of €1.4/m^3.
3. Based on average industrial power cost.
4. Based on 24 hour day.
5. Power consumption on carbon including dust filter.

effects are minimal as no secondary pollutant occurs and the media at the end of its life can be composted in a similar manner to green waste.

The primary draw back with conventional biofilters is footprint size. Conventional biofilters are typically limited in depth to one metre. In addition, variation in media types can have a significant impact on back pressure, drainage characteristics and distribution of air through the filter. A further consideration is that some organic medias are not stable and prone to decomposition. This creates smaller particulate sizes which in turn increase resistance for air and water flow and results in high energy consumption and poor performance.

The engineered MÓNAFIL product overcomes these difficulties and it has been operating in installations for up to ten years without replacement.

Case Study/Results

High quality MÓNAFIL material has been used for a number of years in Italy for the treatment of air from composting of municipal waste processes.

One of the earliest and largest of these MÓNAFIL biofilters was installed in the composting plant in Milan, which treated organic waste from the city of Milan. The municipality leased a site near the centre of the city to four separate private companies to install four composting plants on the site. As the site was very close to residential areas, very severe odour limits were imposed by the environmental agency (200 OU/m^3 at the biofilter outlet).

Of the four separate companies, 2 of these companies utilised MÓNAFIL as the primary odour control media. These filters (a total of 3000 m^3 of MÓNAFIL media) passed all odour tests undertaken on them to meet the strict criteria laid down by the municipality and were in operation for 7 years without media replacement, whilst the other 2 biofilters on site had their media replaced a number of times. Even at the end of this 7 year period, the media condition was still relatively good, with very low back pressure across the media and very low running costs. The media has since been removed, rescreened and used in other plants.

Compost versus MÓNAFIL as biofiltration media – energy balance

One of the principle and defining characteristics of the MÓNAFIL -peat based material produced by Bord na Mona, is the very low pressure losses associated with moving air for treatment through the filters.

Backpressure across MÓNAFIL media remains at less than 50 mm H_2O (500 Pa) throughout the life of the filter. Pressure across conventional, non specialist materials (wood chips, compost etc) is generally much higher, rising substantially as the media breaks down a mean pressure drop of 150 mm H_2O is not unusual for these material types.

If we consider that with 8,000 m^3 of biofiltration media it is possible to treat ~800,000 m^3/h of air, it is possible to compare power requirements for air handling, using different media types.

MÓNAFIL

800,000 m^3/hr at a pressure of 120 mm H_2O (includes 70mm for ventilation).

Each 100,000 m^3/hr requires a motor of an absorbed power of ~68 kW = 545 kW for 800,000 m^3/hr

Other Media types

800,000 m^3/hr at a pressure of 200 mm H_2O (includes 70 mm for ventilation).

Each 100,000 m^3/hr requires a motor of an absorbed power of ~95 kW = 760 kW for 800,000 m^3/hr

Thus, the use of the MÓNAFIL media as a biofiltration medium can potentially save the consumption of ~215 kWh of power per year with a possible saving of ~Stg£132k per year in electrical consumption.

Secondly, with respect to this saving of ~215 kWh per year, according to methods of emission calculations from the Sustainable Energy & Economy Network, this may have a potential positive impact on CO_2 emissions from power generation of oil of:

1.65 lbs of CO_2 per kiloWatt hour
= 0.75 Kg CO_2 per kiloWatt hour
215 kWh = 161 Kg CO_2 = 1410 tonne CO_2 saving

These factors when taken with the other minimal cross-media effects of the MÓNAFIL material, make using MÓNAFIL peat in biofiltration an environmentally sound and sustainable method of air pollution abatement.

Expected media life of the MÓNAFIL media is above five years. After five years it may be possible to screen the media for removal of the fine fraction. The larger fraction (up to 60%) can be reused as biofiltration media.

Conclusions

- Peat use for biofiltration, environmentally sound and sustainable.
- Biofiltration represents BAT for mechanical/biological treatment of solid waste.
- The low backpressure and longevity associated with the MÓNAFIL material, allow a considerable saving in electricity and replacement costs (and use of materials).
- After several years of use in a biofilter (MÓNAFIL - expected life = five years) most of the media can be reused into a the same biofilter. The remaining fraction can be reused for horticultural purposes.
- Major contaminants in air emission from municipal waste are VOC's, the nature of which change with the make-up and age of the waste.

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