WR 1121 Bioaerosols and odour emissions from composting facilities

Executive Summary

Government policy requires that valuable resources should be recovered and recycled from biodegradable waste. A successful and growing organics recycling industry delivers this policy with composting being one of the principal technologies deployed to process suitable feedstock such as garden and food waste. Composting inevitably generates bioaerosols – particulate matter comprising cells or cellular components that are released into the air as a result of disturbance of composting feedstock or the processing of final product. Exposure to bioaerosols has the potential to be harmful to human and animal health. The Environment Agency adopts a precautionary and risk-based approach to the regulation of composting facilities which was developed on the basis of research by Wheeler et al. (2001) and which has been updated as new evidence has become available. The Environment Agency also requires site operators to monitor bioaerosols around their facilities using methods specified in a standard protocol which relies upon classical microbiology methods which are tried and tested but which are labour-intensive, slow and offer only a snapshot view of a highly dynamic system. A recent IOM review commissioned by Defra (Searl, 2009) on exposure-response relationships for bioaerosol emissions from waste treatment processes identified significant gaps in knowledge of exposure to bioaerosols and recommended that more research was needed into alternatives to viable microbial monitoring such as priority biomarkers (notably endotoxin) and potential surrogates such as particulate matter. The IOM review also concluded that there is a lack of information to support the development of appropriate stand-off distances.

The overall aim of this project was to provide evidence on bioaerosol production, dispersion and potential exposures from composting facilities in support of future developments in policy and regulation of biowaste facilities. The objectives were: (i) to undertake a comprehensive set of standard and novel bioaerosol measurements at representative composting sites to assess comparability between different methods and also to measure spatial and temporal variations; and (ii) to determine the odour emissions and then compare these with bioaerosol emissions to see if odour is a marker of significant bioaerosol exposure. Standard (AfOR, 2009) and novel (CEN filter method, endotoxin, glucan, qPCR, real-time particulates) bioaerosols measurements were taken on a minimum of three to a maximum of six occasions over a twelve month period at four different composting facilities in England. The composting facilities were selected to represent sites of varying sizes (tonnages) and to allow a comparison of bioaerosol concentrations at standard open windrow sites versus a fully-contained site. Additional supporting information was collected including meteorological data at the time of sampling, observation of site operations and measurements of odour at one of the sites. Supporting bioaerosol and odour dispersion modelling was conducted at the site where the odour measurements were made.

The spatial trend of bioaerosol concentrations described by Wheeler et al., (1991) and upon which EA regulatory policy is based was broadly corroborated by this dataset. Excursions above the EA acceptable levels at or beyond 250m from source were rare. Bioaerosol concentrations at the enclosed site were generally lower than at the open windrow sites. There was no evidence of a seasonal pattern in bioaerosol concentrations at any of the sites whereas between-sampling day variations were apparent. The cause(s) of these variations were not identified.

No consistent relationship was observed between the concentration of bioaerosols measured by the two AfOR standard methods. The two methods displayed certain strengths and weakness in different situations. The IOM sampling device proved to be better suited to situations where high bioaerosol concentrations were encountered (close to source); the Andersen proving to be more effective in the lower concentration range typically found upwind of a site or at distance downwind from source. The higher volume filtration device tested in this project (referred to as the CEN method) produced data that did not consistently match either of the AfOR standard methods. This device demonstrated greater sensitivity than the IOM filter method but suffered drawbacks associated with its weight and a lack of ease of use in the field.

Endotoxin concentrations were normally below the level recommended by the Dutch Expert Committee on Occupational Safety but occasional exceedances of this standard were detected at the larger open windrow sites. The majority of glucan measurements were below a widely referred to 10ng/m^3 threshold. Significantly elevated concentrations were detected at one of the larger open windrow sites.

The dynamic range of the qPCR method is wider (4-5-log) than either of the AfOR and the CEN methods. It is also quicker to carry out and has the potential for automation. The results from the qPCR method are mainly higher than standard AfOR methods, as the method does not distinguish viable and non-viable spores. The spatial distribution of *Aspergillus fumigatus* spores (by qPCR) along sampling transects, gives similar results compared to AfOR (and CEN) methods. Real time particle detection showed that both TSP and PM_{10} are correlated to *Aspergillus fumigatus* spore concentration.

No consistent relationship was observed between odour and bioaerosol concentrations (although this was a limited dataset). The envelope of modelled (back-extrapolated) bioaerosol emission rates straddles several orders of magnitude. Distinguishing the influences of meteorological conditions on this variability was not possible. It was not possible to predict bioaerosol or odour emission rates with confidence. This continues to hamper confidence in modelling of odours and bioaerosols from open windrow facilities.

The findings of this research have implications for the current standard monitoring protocol which should be reviewed accordingly. The findings of this multi-site survey accord with existing regulatory policy and are supportive of the general trend towards enclosed facilities. Notwithstanding this, continuing research is needed to enhance the database on emission from bioaerosol and odour abatement technologies (e.g. biofilters); to determine the cause(s) of occasional bioaerosol peaks from open facilities; to improve exposure assessments through better modelling protocols; and to link enhanced exposure information to future health impact studies.