Cumbria Waste Management Ltd – Use of the Strathkelvin Strathtox respirometer in waste acceptance testing

Cumbria Waste Management Limited is a local authority waste disposal company with 3 operational landfill sites at Distington near Workington, Hespin Wood near Carlisle and Flusco near Penrith. Prior to disposal to sewer, all of the leachate from these landfills is treated on-site in biological treatment lagoons which are run as sequential batch reactors (SBRs), these routinely achieve removal rates of >99% for both ammoniacal nitrogen and BOD.

As a consequence of the introduction of the Landfill (England & Wales) Regulations 2002, the disposal of all liquid wastes to landfill was banned in October 2007; consequently, alternative disposal routes have since had to be found for these wastes. The leachate treatment plant at Distington was identified as having spare treatment capacity, and (in theory at least) able to successfully treat most of the predominantly aqueous non-hazardous wastes previously being sent to landfill, so it was decided that a Liquid Waste Acceptance Facility be built adjacent to the existing leachate treatment plant which would provide a continuation of the liquid waste disposal service to existing customers, and hopefully an increasing source of revenue in the future through new business.

CWM Ltd. Distington Liquid Waste Acceptance Facility

Of paramount importance in the introduction of third party wastes, which potentially could be detrimental to the treatment process, is the safeguarding of the bacterial biomass. Partial or complete loss of the treatment capability of the biomass could result in exceedance of the site sewer discharge consent with possible financial penalties and/or prosecution. In addition, the resultant tankering of landfill leachate to an off-site WWTP would increase disposal costs substantially, and the re-seeding and re-establishment of an SBR would take many weeks. After witnessing an on-site demonstration by Strathkelvin personnel where the ease of use and especially the speed in obtaining useful results was shown, CWM decided to purchase a Strathtox respirometer to test incoming liquid wastes, the purpose of which is to act as one of the main lines of defence in ensuring that the health of the biomass is not compromised.

Since the purchase of the Strathtox instrument in 2006 and up to 2009 when treatment of liquids through the LWTF actually commenced, CWM made use of its biomass health monitoring capability to take a weekly snapshot of the biomass activity, the idea being to collect as much background information as possible on typical or 'normal' respiration rates prior to the introduction of other non hazardous liquid wastes into the leachate treatment plant.

An unexpected but interesting outcome of this regular health monitoring is that we have found that our SBR biomass respiration rates are not constant throughout the year, but that there appears to be an annual cyclical variation in the respiration rates. The reason for this isn't clear, originally it was thought to be down to seasonal variations in leachate concentration but this has since been disproved, we now believe that it may be seasonal temperature variations within the SBR which are having an effect on the makeup of the different bacterial populations.

The weekly routine health monitoring is still done to gauge whether or not third party wastes inputted through the treatment plant are having any noticeable effect, either negative or positive, on the biomass.

As mentioned earlier, actual treatment of third party waste liquids through the LWTF commenced in 2009, and since then the instrument has been used to screen all liquids destined for the LWTF. Some degree of respiratory inhibition is allowable, but generally if a liquid waste exhibits an EC_{50} value of 20% or less then it is considered unsuitable for treatment and is rejected. The majority of wastes which we treat are relatively harmless to the biomass and so usually generate the anticipated Strathtox traces, but occasionally we do test supposedly safe wastes streams which have in the past been ok which can throw up some unexpectedly high inhibitory results, so in these cases the Strathtox helps us to weed out any unexpected 'surprises'.

Core sampling of tanker for laboratory acceptance testing prior to treatment. Tanker discharging to LWTF reception tanks following satisfactory laboratory acceptance testing.

As well as using the Strathtox for its main purpose of toxicity testing of liquid wastes from our existing customers, we have also been able to utilise the instrument to test other potential candidates for treatment. Most of these tests have produced the anticipated results with regards to depression/elevation of respiration rates; however, some unusual findings have also come to light. For example, it was found that solutions of simple substrates that had previously been assumed to be readily metabolised by the biomass (namely carbohydrates such as glucose, sucrose and starch, and alcohols such as methanol) did not exhibit anything like the expected increase in oxygen uptake. Plans to incorporate one of these substrates into our own standard feed solution to be used in the Strathtox tests were subsequently abandoned; instead various feed solutions of sodium acetate (one of the major degradation products found in leachate) were trialed and were successful in eliciting the desired response.

Similarly, we found that biomass from our Distington SBRs could comfortably treat leachate from any of the three CWM landfills, whereas the respiration rate of the Hespin Wood SBR biomass was significantly inhibited when exposed to leachate from the Distington site (which contains high levels of phenoxyacid herbicides).

From these revealing observations we concluded that the bacteria in the biomass were more effective in metabolising those substrates which they were 'used to', i.e. those that they had been regularly exposed to in the leachate. Although the biomass can, given time, evolve metabolic pathways to deal with simpler substrates (as proved with our own in-house laboratory trials with methanol), or become adapted to deal with moderately high concentrations of toxic compounds (as is the case with phenoxyacids at Distington), the invaluable outcome of our tests with the Strathtox to date have shown us that it would be unwise to take for granted the ability of the biomass to instantaneously treat what would previously have been considered innocuous liquid wastes.

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