Scope for innovation in design of natural treatment systems

Low carbon technology for wastewater treatment

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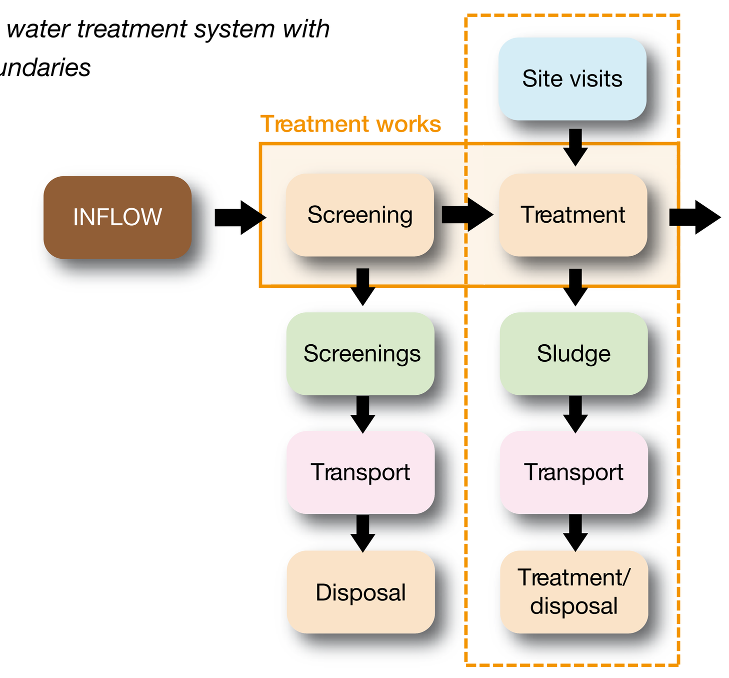
Introduction

There has been a recent trend of improvement in the standard to which wastewater is treated and an associated increase in the energy used in the treatment process (Water UK 2008). This is contrary to the current sustainability targets of the water industry. It is possible to reduce energy consumption by the use of treatment technologies that mimic natural systems, such as waste stabilisation ponds and constructed wetlands. Generation of renewable energy from biofuels manufactured from treatment by-products can also offset energy demand. If these two technologies can be combined, treatment systems that function as net energy producers are possible.

Figure 1 - Process diagram of waste water treatment system with carbon footprint study boundaries



To determine the efficiency of a waste water treatment system in terms of carbon emissions; a 'lifecycle' approach to the calculation was required (British Standards Institution 2008). In the absence of full life cycle analysis (LCA) data the embodied emissions was based on the major component and an estimate of 'dead weight'.

Hypothetical secondary treatment of 2000 population equivalent (PE) municipal wastewater was considered for a northern european climate. Three alternative treatment scenarios were considered:

- Extended aeration
- Septic tank followed by a subsurface flow constructed wetland system
- Waste stabilisation ponds (WSP)

For each of these options, a conceptual design for a treatment system was considered. A size for each of the three alternatives was calculated using established criteria. In each case, a conceptual design was created for the purpose of comparing the carbon footprint of each approach.

Results and discussion

A summary of carbon footprint for the three options is presented in Table 1 below and visualised in Figure 2. If the assumptions inherent in the model utilised prevail, the embodied carbon costs for EA and CWS options are seen to be broadly similar.

Plant	Surface area (m^2)	Embodied Carbon (tCO_2)	Operational Carbon over 20 year life (tCO_2)	Carbon footprint (20 year life)
EA 1	,800 5	34	2028	2562
CWS	19,625 3	97 5	3	450
WSP	20,700 1	16 5	6	172

Table 1 - Results of comparison

The whole life carbon footprint of CWS is thus believed to be around 18% of that of comparable activated sludge systems considered over 20 years. The origin of the treatment medium of the wetland appears to have a relatively small effect on this comparison, however has an appreciable effect on the carbon footprint of the CWS considered in solation. In a hypothetical case where

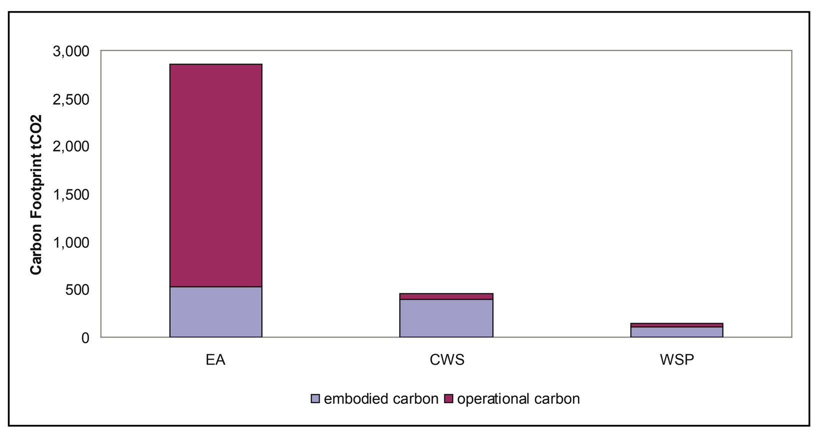


Figure 2 - Comparison of capital related and operational carbon

The embodied carbon of the extended aeration system is shown to be only a small proportion (20%) of its carbon footprint over 20 years owing to the high operational carbon. A breakdown of carbon for each component of the EA system (figure 3) shows the electrical

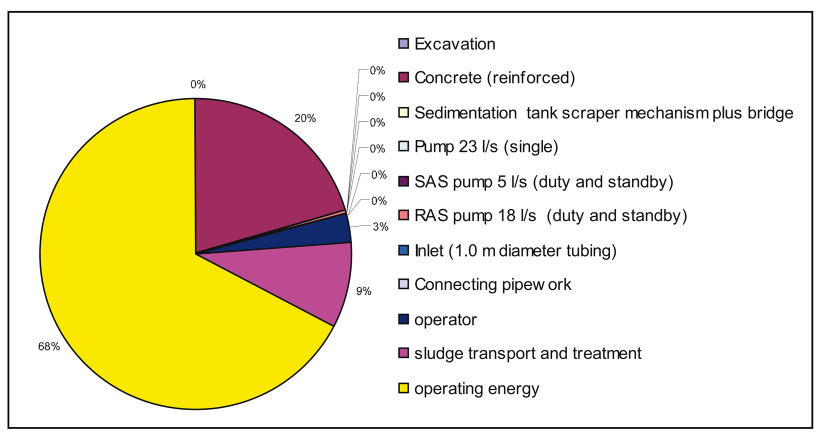


Figure 3 - Item specific contribution to 20 year carbon footprint for EA system

energy consumption to dominate the carbon footprint calculation over the whole life of the plant.

Natural treatment systems may be used to generate biogas, by capturing emissions directly from anaerobic WSPs. For example, Melbourne Water in Australia uses floating covers on the ponds to capture biogas, which is used on site to generate energy for internal use. 40,000 m3 of biogas per day is reported to be captured by the covers (DeGarie et al 2000, Melbourne Water 2005). If converted to electricity at 25% efficiency this may be expected to equate to energy offset of approximately 118 KWh/Ml.

The viability of anaerobic ponds is dependent upon climatic conditions and the concentration of effluent. Research has been undertaken in New Zealand by the National Institute of Water and Atmospheric Research (Craggs et al, 1999) and also in the UK by Halcrow in partnership with Cranfield University into recovery of biogas from municipal wastewater in colder climates.

Conclusion

There is clearly potential to reduce the carbon footprint of wastewater treatment by changing the way we approach treatment. The embodied carbon of activated sludge treatment systems accounts for only a small proportion of the whole life carbon footprint, therefore attempting to reduce carbon footprint of conventional sewage treatment would thus be better focussed upon reducing or offsetting operational energy.

By generating biofuels as a by-product of low energy wastewater treatment systems, it is possible for such systems to be a net exporter of energy and thus to have a negative carbon balance. More research and development of the technologies is needed.

P452

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