Paper 4 - The Use of Process Modelling Tools for WwTW Design

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SUMMARY

The need to meet the Urban Waste Water Treatment Directive by 2000 for all works with a population equivalent greater than 15,000 has resulted in a huge capital investment programme of some £540m in Yorkshire alone. With the size, number and cost of these schemes being high, it has been essential that value for money is obtained, and, more importantly, the Company has confidence that the schemes will meet the consent standards. It is with these objectives in mind, i.e. value for money and confidence, that greater use of sewage treatment process modelling tools, such as GPSX (Hydrommantis Inc) has been seen, employed as part of the design procedure. This presentation describes Yorkshire Water Services' experience of the use of these tools.

Traditional design rules are usually quoted in terms of BOD or COD loadings. More sophisticated models, such as the IAWQ activated sludge model used in GPSX, offer greater accuracy than traditional approaches because they are expressed in more fundamental terms. Instead of BOD and COD, the models solve equations for what are known as "state variables". These are a more fundamental description of the waste water, differentiating between soluble and particulate fractions, inert and biodegradable, etc. It is the fundamental approach which allows models such as GPSX to better account for changes to the waste as it passes from one process to the next. The problem is that these state variables are difficult to measure. A connection between measurable composite variables, such as COD and BOD, and the state variables used in the model must be made. This is known as the inlet "stiochiometry", and is specific to the waste stream under investigation. Typically a daily composite sample of an inlet would be taken for a couple of weeks to determine the stiochiometry.

The models themselves are a combination of hydraulic models and process kinetics. The kinetic parts in particular have many parameters which have to be set for the particular waste under investigation. Setting of model parameters is known as calibration and requires large amounts of data: typically a sample across each process every 2-4 hours for several days.

Examples from several works are described to illustrate how the models have been used in YWS over the past four years. Issues such as "hard" COD from traders, biological filter modelling, activated sludge plant models, and de-nitrification are discussed. The benefits to the Company of using models are also described. Some of these benefits can be quantified financially, such as the recent £5m saving on the Knostrop WwTW (Leeds) scheme, other benefits are less quantifiable but are nevertheless important: what price do you put on confidence?

DISCUSSION

Question

Tim Webster Severn Trent Water

With the increasing use of relatively large volumes of storage within the sewer system these are starting to cause problems at the WwTW in 2 forms

1. Prolonged periods of high flow causing process failure and solids carry over
2. Slugs of heavily polluted flow arriving at the works as the tanks drain out the last bits of storage

Can these sort effects be modelled in a process model ?

Answer

Absolutely this is exactly the sort of application the model can be used for. In the USA and Canada where the WwTW do not have storm tanks, the management of storm flows is a key issue in optimising the process design i.e. using stepped feed techniques.

We have not looked at this in detail yet in Yorkshire Water but it is an exciting are to investigate.

Question

Alan Wisdish WS Atkins

In our sewer modelling we verify the model against 3 events. What number of events do you usually use in calibration and verification of treatment works models ?

Answer

Normally we have 2 data sets one to calibrate and 1to test the calibration i.e. verification. For capital projects we tend to use long term data (say 6 to 12 months of daily composites). The data can be run through the model on a large time step and typically get answers within 5 %.