

EMBRACING THE 'DIGITAL REVOLUTION' DOESN'T HAVE TO BE COMPLEX, OR COSTLY



A brief case study on why the 'Digital Revolution' should be embraced and how digital plant data can be used for optimisation.



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With a brief case study, he explains why the 'Digital Revolution' should be embraced and shows how digital plant data can be used for optimisation.

Resistance to Digital

Over the past few months, I've noticed phrases such as "Digital Twin", "Big Data", "Artificial Intelligence" and "Machine Learning" appearing in water industry conversations and articles on an ever increasing basis, and, perhaps, rightly so! Computerised modelling and simulations are nothing new, yet the water sector has not yet fully embraced this digital revolution.

That's not me taking a dig at the sector, please don't misunderstand. There are several reasons why I can understand a slow progression, most likely that any failures for Water Companies can have extremely severe consequences; thus the sector is inherently risk averse.

But it is this risk averse attitude that makes me question the resistance to computerised

technologies. For example, a "Digital Twin" (a computer 'twin'/model of a physical piece of equipment or asset) can be used to simulate abnormal operating behaviours, so operators can plan to prevent catastrophic consequences. Why wouldn't you want this aid?

New pieces of equipment can be expensive, but computer models and decision making tools don't necessarily mean huge investments. Developing a 'bolt-on' decision making aid to improve plant robustness for NW's Wastewater Treatment Plant on Tyneside would be a good summary of my current research.

An Overview of the Plant

The Advanced Anaerobic Digestion (AAD) facility was designed to achieve higher biogas (a combination of biomethane and CO₂) volumes by pre-treating the sludge in a thermal hydrolysis plant (CAMBI). This biogas can be burned in on site 'gas engines' to produce electricity, or steam boilers to generate steam for the CAMBI process.

A later addition added a biogas 'up-grading' plant where CO₂ is removed from the biogas via a stripping column and the biogas quality (calorific value) is raised such that it is suitable for injection into the gas grid; that's right, part of the Tyneside gas network is powered by Pool!

Current operational decisions revolve around sludge levels and subsequently what to do with the biogas they produce: do they use it to make steam, to generate electricity and heat on site, upgrade it and inject into the gas grid for use in our homes, or should they buy it back off the grid to generate electricity?

Optimisation Strategy

So, how can we find the optimal biogas distribution on site? I decided against using highly complex non-linear equations or training a Neural Network to mimic plant operation, as these methods can take a long time to formulate and can be extremely computationally expensive.

Instead, I tried a less computationally taxing approach – Mixed Integer Linear Programming (MILP). MILP takes a series of linear equations and inequalities and, when passed through an optimisation cost function, calculates the best way of running the site.

The tricky part comes in trying to model the plant in a series of linear equations only. Remember the equation for a straight line ($y=mx+c$)? That's essentially all I can work with to create the plant model, just with a few more variables.

Luckily, NW collects and stores thousands of data points every minute. This large database could be seen as a plant logbook, and is often referred to as "Big Data" – literally millions of data points that can be analysed.

It's still in the early stages of development, but so far the model for biogas distribution alone has over 500 parameters, 20 variables and 24 different linear equations; the MILP model provides the operator with an 'optimal biogas distribution' to minimise costs and avoid flaring off biogas, and currently takes only a few seconds to produce results. Operators can now compare how they actually run their plant to the optimal solution, which helps in decision making and operation justification.

Currently, the model parameters are fixed, which means if the plant changes the model won't adapt. I'm going to introduce some "Machine Learning" to the model in the near

future, taking historic and fresh plant data to constantly update and validate the model.

Optimisation doesn't mean spending money

Honestly I could write pages on my work, but the point I'm trying to make is that embracing this new digital revolution won't always cause drastic physical change to your process, or require you to spend much money either. Computer models come in many varying forms, and not all of them are so complex, scary or costly; most can be generated with a little plant expertise, and the data you already have stored away.

Optimisation and innovation doesn't mean having to spend loads of money on new pieces of equipment. Instead, we can take information we already have and use it to make informed decisions on how we view and operate our existing plant to make savings and efficiency improvements. It's all just a matter of perspective really.