In the next issue

In this issue we've talked briefly about advanced oxidation and how it can be used to treat effluent that is otherwise difficult to deal with. But what about the really nasty stuff, the effluent that cannot be treated using conventional processes? In the next issue we look at how difficult effluents can be treated.

BWC Business Issue 9

Blackwell Water Consultancy Ltd News

- **IChemE Tyneside Member Network**

  The programme of events is growing steadily, with the next being the Newcastle University Chemical Engineering and Advanced Materials research event on the 5th and 6th of April 2011.

  Also look out for the corrosion event later in 2011, which will pull together the latest industry advice and academic research about corrosion in the process industries.

- **Signals from noise**

  We've recently been working with Lightfoot Solutions, a company that provides statistical analysis software. This isn't an academic product, however, as Lightfoot have used it to make huge savings for a number of large UK-based clients. Through detailed analysis of operating data, and the use of a range of statistical methods enormous benefits have been found from data that many companies have but don't use. We're not affiliated with Lightfoot in anyway but we're impressed with what they offer!

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BWC Business

In this issue

The 4Cs project

In January we launched a project we've called The 4Cs (capital cost correlation compendium). There are equations that can be used to estimate the capital and operating costs of water and wastewater treatment plant. The project will collate these equations, update them, compare them and give guidance about their use.

Who we are

Blackwell Water Consultancy Ltd is based in north-east England but operates throughout the UK. We give advice to businesses in all parts of the UK economy about water supply and effluent treatment. Our sister service, BWC Analysis, offers consultancy about mathematical modelling and data analysis.

Our website has more information about what we do.

The big freeze and what came next...........

In the middle of December 2010 the UK had its worst snow fall for many years. Two weeks (and more in some areas) of continual snow in Northern Ireland were followed by a very quick thaw just after Christmas Day. This led to many water mains bursting and mains water became unavailable in many parts of the province. It has been estimated that about 450,000 people were either without water or experienced shortages of water. The problems with water supply lasted until the 6th January 2011.

Shortly after the thaw, and when it became clear there were going to be shortages of water, many people blamed the problems on insufficient investment in the water mains in Northern Ireland. This idea may have come from a report in September 2010 by the Institution of Civil Engineers which stated that more should be spent on improving the water supply infrastructure in Northern Ireland as pipes aged. The Utility Regulator for Norhern Ireland has recently published a report, however, that discounts poorly maintained water mains as the cause. The report shows that the investment in water mains in Northern Ireland was adequate. Further, the report states that mains in the province were as robust as anywhere else in the UK.

The Utility Regulator explicitly blames poor managment for the problems, noting that 80% of the burst pipes were on customers' premises and so were not the responsibility of NI Water. It was found that the senior managers responded slowly to the water supply problems and it was also concluded that management of the customer call centre must be improved.

Of course it's always tempting to have a go at the politicians in this case. NI Water is owned by the state and surely the minister in charge should take some of the blame? A second report says this is not the case. NI Water had said that it could cope with freezing weather and the thaw that would follow and the second report concluded that the minister and other associated parties could not have been reasonably expected to question this any more than they did.

So, what were the general conclusions? The recommendation has been for NI Water to restructure by identifying the gaps in its skills. The recovery plan is wide in scope, comprising 57 recommendations. These include lessons-learnt exercises that will provide information that can be used to improve NI Water's asset design standards. And therein lies the classic test for all organisations: remembering why things go wrong as well as why they go right.

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The advanced oxidation family

As we've said in the main article on this page, AOPs can use chemical or photochemical methods. Here we give a little more detail about the chemical approach.

Ozone at high pH

When ozone decomposes it forms hydroxyl radicals which then oxidise many organic chemicals. The cost of the electricity needed to generate the ozone can be prohibitive. Ozonation is commonly used to remove taste and odour in drinking water.

Hydrogen peroxide and ozone

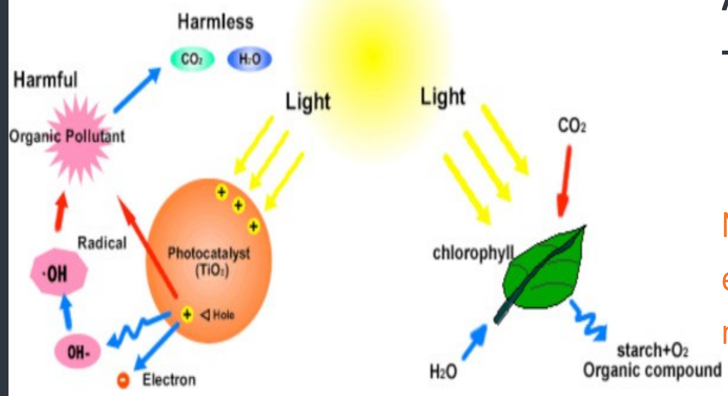
Adding peroxide to ozone boosts the oxidising power and has been found effective in removing pesticides in drinking water.

Fenton's reagent

This is a mixture of iron compounds and hydrogen peroxide. In use for over 100 years, Fenton's reagent has proved effective in destroying herbicides, organic compounds and general COD in effluent.

Chemicals plus a catalyst

Photochemical methods use titanium dioxide catalyst to increase the rate of oxidation. Using the same catalyst with chemical methods accelerates the rate of oxidation. Other catalysts have been investigated but the wide availability of titanium dioxide means it is currently favoured.



Advanced oxidation – why all the fuss?

New variations of an old approach to effluent treatment are becoming more popular

Many methods of wastewater treatment are biological processes that use bacteria to remove contaminants. Treating wastewater this way works very well all around the world. There are some substances, however, that are difficult to remove using biological means. Here we look at how advanced oxidation processes (AOPs) can remove troublesome substances from wastewater.

The term AOP hides a mass of complex chemistry but this can be summarised as follows: AOPs destroy chemical contaminants by converting them into less harmful chemicals. The process by which this happens is called oxidation. If oxidation reactions are allowed to proceed as far as they can then the end products are carbon dioxide, water and possibly nitrates, chlorides or other relatively benign species. Sometimes, however, the reactions are incomplete, which means more complex chemicals may remain in the wastewater. The main point is that AOPs destroy the contaminants, rather than converting them into a sludge or by-product that needs to be removed and treated.

What can they treat?

AOPs are very good at treating hydrocarbons such as benzene, toluene, ethylbenzene and xylene (also known as BTEX) as well as cyanide, sulphites and nitrites. Indeed, AOPs can treat many compounds that can kill biological processes.

How do they work?

Many AOPs rely on a very useful chemical species called the hydroxyl radical. These are aggressive and indiscriminate chemical intermediates that will react quickly with most organic compounds. There are a number of different types of AOP but they can be put into two categories, namely chemical-only and photochemically assisted.

"AOPs can treat a wide range of hydrocarbons, as well as cyanide and sulphites"

Chemical-only AOPs

AOPs that use only chemicals generate hydroxyl radicals using compunds such as hydrogen peroxide, ozone or Fenton's reagent (a combination of peroxide and iron compounds). Chemical-only methods have proved capable of destroying many organic chemicals but this comes at the expense of the chemicals used to generate the hydroxyl radicals. Careful testing is needed to work out if the cost of these chemicals means they're too expensive to operate. Chemical-only methods may also fail to destroy some compounds completely.

Photochemical methods

These approaches can use UV light with a catalyst or both plus an oxidant such as peroxide or ozone.

The catalyst is often titanium dioxide. When this is illuminated with UV light, hydroxyl radicals are formed. Photochemical methods appear to have a greater potential for oxidation than chemical-only methods. Studies show that many toxic chemicals can be degraded this way. Consequently this type of process holds great promise for removing toxic chemicals from industrial effluent and treated wastewater discharges.

Many sewers become clogged with fats, oils and greases, collectively known as FOG.

Clearing the FOG

Slowly, slowly the general public are becoming more aware of the problems water companies experience with sewer maintenance. A few TV programmes have recently shown the plethora of things that end up in our sewers and among the worst are fats, oils and greases (FOG).

Each time we wash up, grease and fat will end up in the sewer. Restaurants, takeaways and manufacturers also send FOG down the drain. Note that catering firms have a legal duty to dispose of FOG responsibly.

Fat can solidify in sewers, restricting the flow and, if not dealt with, blocking the sewer completely. This can cause flooding as sewage backs up. Decomposing FOG can also create odour problems. The cost of removing the FOG can be high and can be avoided simply by better management of FOG by those sending it to sewer.

As we've said, catering establishments are required to treat FOG responsibly. This can be done by scraping and wiping pans, plates and other cooking items rather than rinsing them (wiping them also saves water & hence costs)

The residue from scraping and wiping should be collected in a suitable vessel for disposal elsewhere. For example, research has shown that FOG can be used to produce biofuels or may be used in waste-to-energy plants to produce electrical power.

As well as preventing FOG from entering the sewer, grease traps can also be fitted to drains to prevent FOG accumulating. These work simply by slowing the flow of wastewater, allowing the FOG to cool, congeal and rise to the surface where it can be skimmed off regularly.

Q&A – Where does FOG come from?

Q: It's not me so who's doing it?

A: Actually FOG can come from domestic and industrial sources. FOG can come from cooking and then washing plates and dishes. Food often contains fats as do some detergents and toiletries.

Industrial sources include premises such as abbatoirs, food factories, takeways and restaurants. There are even small quantities in effluent from launderettes and photo processing companies.

Q: Surely something must be done!?

A: There is a range of legislation that covers disposal of FOG. These include the Hazardous Waste Regulations, the Landfill Directive, the Waste Oils Directive and trade effluent consents issued by the water companies. In short it is illegal to put FOG down the drain.

Experience has shown, however, that these laws, and others, are not effective and work is going on, we understand, to try to re-draft legislation.

FOG as a resource?

It's clear that FOG is a problem, and a big one. Anglian Water estimate that at any one time there is about 10,000 tonnes of at in its sewers. Water UK states that 75% of the UK's sewer blockages are due to FOG (there are about 200,000 sewer blockages each year so the number due to FOG is high!).

Biofuel production

We've all heard anecdotes about cars running on chip fat or supermarkets selling out of cooking oil because the locals are using it as fuel. These stories aren't too far-fetched, however. Processes are available that can take certain types of waste oil and convert them into biodiesel. If Anglian Water took the 10,000 tons of FOG from its sewers and converted it to biofuels it's claimed this could fuel 8,000 family cars for a year.

Electricity production

We've talked before in BWC news about anaerobic digestion. This is a process which, with a lack of oxygen, can degrade a wide range of material with biogas being a by-product. The gas can be burnt in a combined heat and power engine to prodyce electricity and heat. This turns the problem that is FOG into a resource for generating heat, light and power.

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