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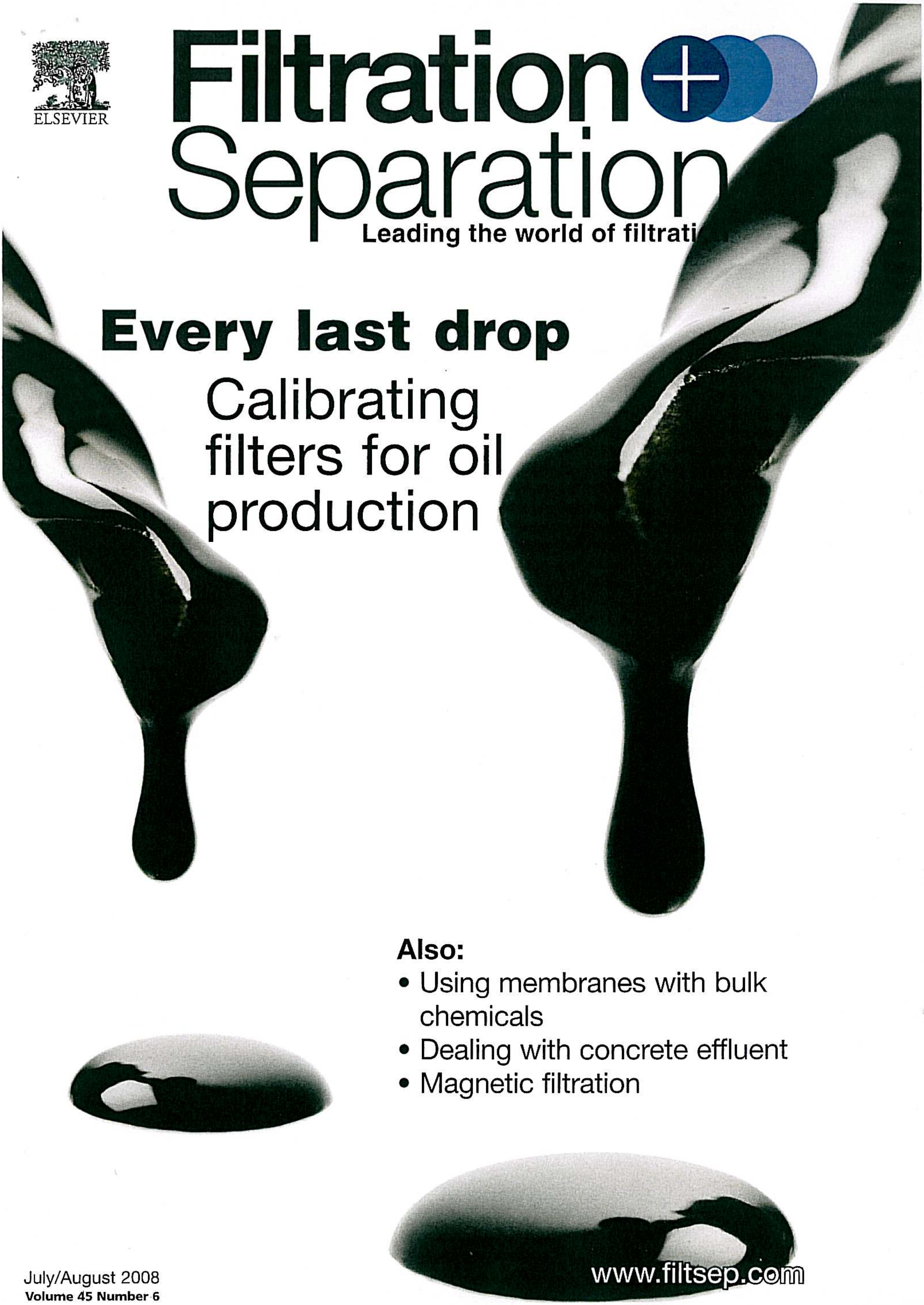

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July/August 2008
Volume 45 Number 6

www.filtsep.com

Bulk chemical effluent: Treating and recycling concrete waste water

Fibra (a Shell Technology Ventures Company), has developed a radically new but very simple, low cost and robust filter system, suitable for the most arduous and aggressive environments. Dr Christopher Flinn, Technical Sales Manager, explains about its use in the precast concrete industry.

Introduction

In recent years, pre-cast concrete companies around the world have come under increasing pressure to comply with discharge consent levels for their waste water. The waste water typically originates from washing operations, where equipment used during the batching of concrete needs to be regularly washed out to avoid the concrete hardening, which can result in major maintenance problems. Other issues arise from high rainfall runoff flowing over concrete stored in the open air, which can also pick up fine suspended solids and high alkalinity, creating higher loads for already strained treatment systems.

Traditional ways of treating the problem

The traditional effluent treatment method in these factories tend to be settlement pits, where coarse solids are allowed to settle, sometimes with the aid of flocculent addition. Settled solids would be periodically 'dug out' of the settlement pits, piled nearby and allowed to drain back into the pit for further settlement of the runoff water. The water at the end of the settlement pit would then be allowed to drain to foul sewer or surface water usually with mineral acid dosing, to reduce the high pH caused by the lime in the cement, which can be as high as pH 13. In extreme, but not that uncommon situations, the waste water is allowed to flow untreated to surface waters or allowed to soak away to the ground, causing immense pollution to the receiving water – be it stream, river or aquifer. Some sites have even been known to allow un-neutralised waste water to flow into surrounding streets from settlement pits, which are external to the works, where children could get easy access to the deep, highly caustic water (see Figure 1).

In many cases the existing treatment arrangements are incapable of providing the necessary improvement in water quality to meet new demanding discharge consent levels. Also, with water becoming scarce and more expensive there is now a strong sustainability movement within the construction industry, to recycle as much water as possible. Thus, precast concrete manufacturers are seeking new and dependable technologies, which can ensure compliance with these increasingly tighter standards and also giving the opportunity to recycle some or all of the treated water. The UK government is also encouraging manufacturers to recycle waste water and for those that can recycle a minimum of 40%, may be entitled to offset the capital cost of a new treatment system against their full year accounts, in the year the system is installed (see www.eca-water.gov.uk).

A need to change

Recognising the need to improve the standard of waste water treatment, Techrete, a major pre-cast concrete manufacturer

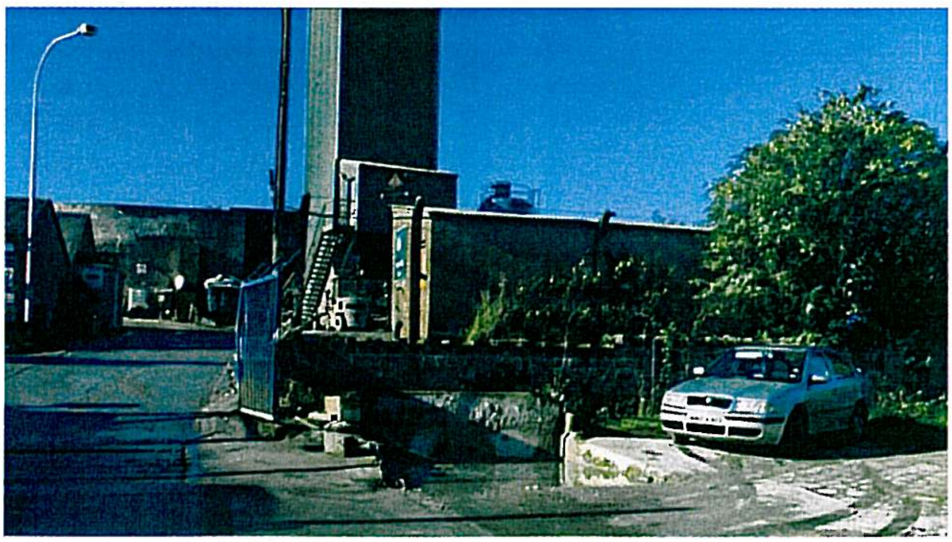

Figure 1: Poor waste water management.

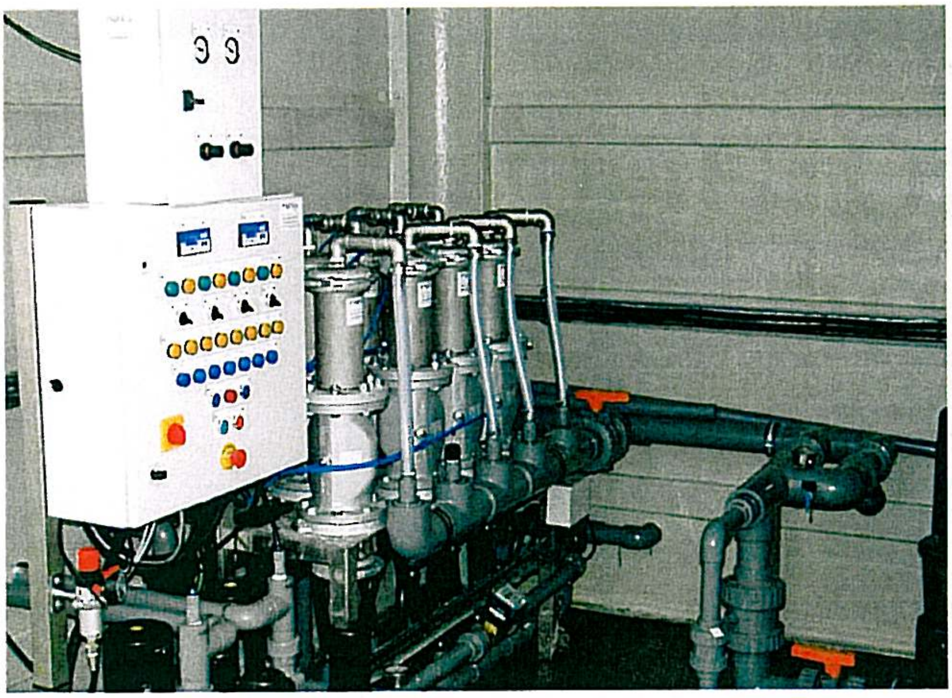

Figure 2: Techrete installation.

Figure 3: Fibre bundle and compression bladder.

with factories in the UK and Republic of Ireland, commissioned Fibra Ltd to design, manufacture and install a system capable of cleaning up the effluent of their new build pre-cast concrete factory at Balbriggan, about 25 miles north of Dublin. The waste water was generated from washing operations and from the polishing of architectural concrete panels. The treated waste water was to be recycled back to the polishing machines so had to be of very high quality.

Commissioned in April 2008 (see Figure 2), the challenge for the installed treatment system was to both reduce suspended solids levels in the effluent from up to 200 ppm to less than 10 ppm whilst at the same time reducing the pH levels from >12 to a range of 6.5 to 9.0. The volume of effluent to be treated was up to 4.5m^3 per hour, continuous over a period of 16 hours.

Fibra's novel Fibrous Filter Technology readily lends itself to this application and Fibra's DN100 filter together with a 0.15mm fibre diameter was selected in a duplexed bank of four, parallel filter housings, to allow for continuous treatment. Automatic system control was managed by PLC, also allowing for manual override if necessary. The Fibra filter works on a very simple basis of compression of a bundle of vertical fibres, which form the filter (see Figure 3). The fibre matrix is easily cleaned by releasing the compression pressure, which in turn allows the fibres to shake loose, followed by forward flushing with raw feed water to flush the solids back to the front of any pre treatment system. Flushing is a very rapid process and because the fibres are all in a vertical plane, stresses are kept to an absolute minimum, allowing the filter to deal with very abrasive solids without the need for regular filter replacement.

Neutralising acid

A specific requirement of the system was that no mineral acid was to be used. Traditionally, mineral acids such as sulphuric acid (up to 98% strength) or hydrochloric acid (up to 28% strength) are used for neutralisation, however, both acids are dangerous to operators so extensive personal protective equipment (ppe) has to be worn during their handling. In addition, hydrochloric acid fumes, generated when tanks are filled, would create a very dangerous environment, so fume scrubbers would have to be used adding to the extensive list of other equipment required for storage and dosing of the acid, from bunded storage tanks to dosing pumps all having to be located within a secure area adding hugely to the costs associated with acid dosing. Fibra, therefore, elected to use a carbon dioxide injection system in order to neutralise the pH.

The challenge for the installed treatment system was to both reduce suspended solids levels in the effluent from up to 200 ppm to less than 10 ppm, whilst at the same time reducing the pH levels.

The neutralisation of concrete wash water can be quite difficult using mineral acid as the water tends to be highly buffered with Alkali resulting in a fairly flat pH curve from pH 14 to about 12.5 after which the pH reduces rapidly often dropping well below the lower allowed pH limit of 6.5, resulting in the pH of the waste water having to be raised using a controllable alkali source such a sodium hydroxide – another potentially dangerous chemical. Carbon dioxide, however, gives a relatively straight neutralisation curve so is much easier to control down to the 6.5 – 9.0 pH range (see Figure 4). The other advantages of carbon dioxide are that the gas is dispensed from cylinders so that no expensive storage solutions are required. Also, it is not possible to overdose with carbon dioxide as in practice the pH reduction slows down considerably, once a pH of 7 is reached. In fact, if carbon dioxide is allowed to be overdosed over a long period of time it is near impossible to get below pH 6 for concrete waste water. All of this means that no ppe are required and there is no risk of spillage causing pollution problems. You can even off set your sites carbon emissions with the carbon dioxide used, as it is ultimately converted into carbonate from where it originally came from, as a by product of the fertiliser industry. It may even be possible, in the very near future, to capture carbon dioxide emissions from stacks where natural gas is burnt and use this to neutralise site waste water, thereby cutting out the gas supplier.

Dealing with the effluent

The system receives effluent from the customers existing bag filter system, which comprises of a lamella separator, from where settled solids drop into bags. Overflowing settled waste water then flows into a dedicated feed buffer tank where it is pressure boosted and Fibra filtered before passing through into either of two pH batch reactor tanks, operating consecutively. The filtration cycle is ten minutes of filtration followed by ten seconds of air enhanced forward flush, to wash the collected fine solids back

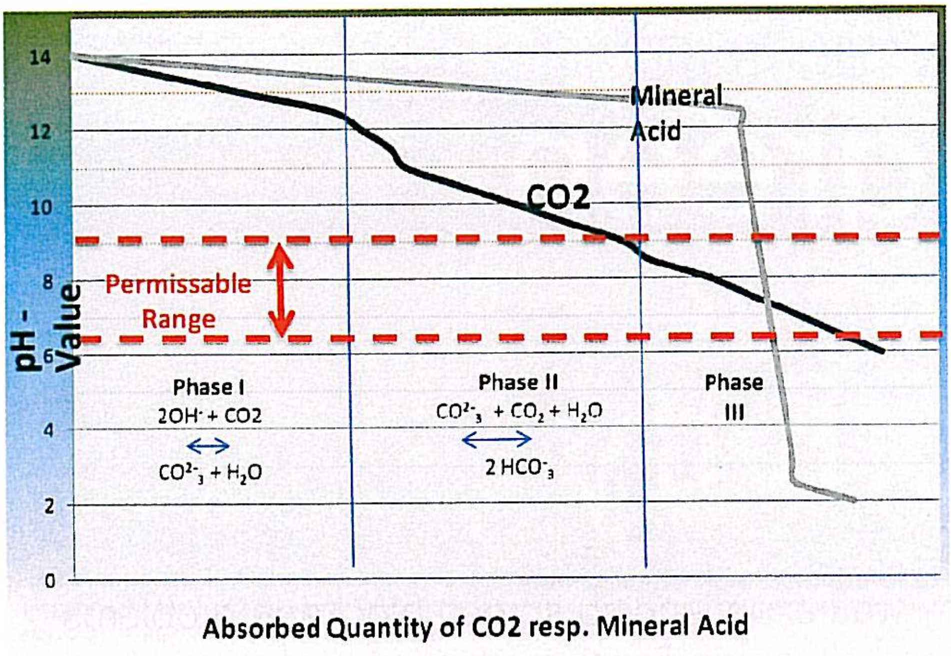

Figure 4: Neutralisation of alkaline waste water.

to the front end of the bag filter system for re-processing. Carbon dioxide is injected, under pressure, into a re-circulation loop on each of these tanks until such time as the target pH is reached. Upon reaching the pre-set pH value, the tanks are discharged into a dedicated below ground storage system, which re-supplies the factory with treated water for re-use in process for further wash down and concrete polishing. For some applications the carbon dioxide can be injected directly into the feed to the Fibra filters to simultaneously neutralise and filter waste water. This is possible due to the very efficient means to which the fibre bundles can contact gases with liquids due to micro-bubble formation between the fibres.

Energy use

The system has a low energy requirement, consuming an average 0.7kW/hr per 1,000 litres of treated effluent. Additionally, since the flushing waste is returned to the system head for a further pass through the bag filter system followed by Fibra treatment, the overall system recovery ratio exceeds 99%. Carbon dioxide usage costs are equivalent to mineral acid but without the extra capital costs.

Other applications

The same Fibra process can also be used to treat alkaline waste water from a number of other industries such as beverage (bottle washing, CIP), dairies, bakeries, textile and leather as well as other construction applications including hydro demolition waste water. ●

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Fibra offer a site demonstration service which is free of charge to UK precast concrete sites. For further details of this and other waste water treatment systems, please contact Christopher Flinn.