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Phosphorus removal: How to meet the rising demand for chemical dosing systems

Meeting increasingly stringent phosphorus removal standards, while maintaining profitability, will require a much greater number of chemical dosing systems, manufactured faster and supplied at lower cost. To achieve this, water companies, contractors and their supply chains must co-operate with manufacturers in the development and use of simpler and more standardised systems. This white paper examines the need for a collaborative, integrated approach to removing phosphorus, and outlines what the resulting solution will look like.

Problems with nutrient levels

Excessive levels of phosphorus are a key cause of eutrophication – the over-enrichment with nutrients which produces algal blooms in lakes, rivers and other surface waters. Today, nutrient levels in many water bodies and waterways are above the limits set by the UK's Water Framework Directive, and the problem is worsening.

In a previous white paper, entitled 'How to remove phosphorus more cost-effectively', WES spelled out the effects of eutrophication on nature, communities and the water industry. It summarised the phosphorus treatment options available and described the contribution that packaged chemical dosing systems could make.

We now look at how manufacturing capacity for dosing systems can be increased, and costs reduced, without compromising on their performance and integrity.

Essentially, there is a need to move away from the large, expensive and often over-engineered systems historically specified by water companies. The long lead times and high costs involved in manufacturing such systems are exacerbated by the typical insistence of companies on their own bespoke standards. Manufacturers can find themselves having to vary such items as control panels, lifting features, walkways and safety guards to suit different buyers.

By contrast, standardised small and medium-sized systems could be built quickly, in larger quantities which give an economy of scale, to satisfy the water industry's accelerating demand. There would be less need for costly duplication of outline design work and feasibility studies. Repeated application of standard designs and production practices would not only increase manufacturing efficiency but increase the consistency, quality and safety of the products.

WES believes that the water industry should use the current optioneering exercise to engage with colleagues and partners in exploring how standardisation and value engineering could be adopted. Collaboration could well be the key to better dosing systems, shared economic benefits and wider improvements in the field of phosphorus reduction.

The challenge

During AMP7, the water industry's Asset Management Period covering 2020 to 2025, pressure to reduce phosphorus is intensifying. It means stricter limits and, crucially, a need to introduce chemical dosing for many smaller sites which previously had no requirement for it.

Linked to this is the Environment Agency's Water Industry National Environment Programme (WINEP) – the largest environmental enhancement initiative seen in this industry since water's privatisation. Phosphorus removal is a strong focus, with a phosphorus programme accounting for up to 800 of WINEP's approximately 1,600 required outputs.

At the same time, industry regulator Ofwat's price review PR19 has challenged companies to deliver solutions more cost-effectively and efficiently than their framework designs have allowed to date. The goal is to improve services and give better value for money without increasing charges.

Ofwat recognises that efficient and effective delivery of WINEP can only be achieved through collaboration within the industry and its supply chain. To this end, it is consulting on a competitive funding mechanism which will encourage collaborative innovation initiatives. In addition, this will support the provision of long-term benefits to customers and their communities.

A related issue is the tendency of this industry to delay some improvements until the end of each five-year investment period. This strategy puts off the increase in operational costs involved in complying with new regulations but creates peaks in demand for materials, equipment and people which cause difficulties. Through industry co-operation and joint planning, these peaks could be smoothed out for the benefit of all.

Sharing plans and co-ordinating activities would enable all businesses to comply with regulatory requirements more cost-efficiently. However, in such a competitive environment, collaboration of this kind would require a change in culture.

Broader collaboration and integration

Looking at the big picture, phosphorus management needs to begin with collaboration to reduce the amounts reaching water treatment works in the first place. More precise monitoring and adjustment of phosphorus dosing of water supplies for plumbosolvency control would help. There should also be encouragement to reduce the amount of phosphate in detergents and food additives, along with greater use of composting and anaerobic digestion to remove phosphorus from waste food.

On farmland, soil testing for phosphorus levels can be used as a basis for better planning of fertiliser application to avoid wasteful and polluting overuse. Measures to contain slurry securely and to minimise washing away of soil are also important.

Amongst ideas being explored by the Environment Agency is 'catchment permitting', in which a single permit is granted to cover discharges across a number of sites. This spreads a water company's compliance risk over an extended area and enables it to achieve optimum benefit from its existing assets. This more flexible approach would aim to remove the required amount of phosphorus at a lower cost.

Chemical dosing is a crucial element in phosphorus removal, but it needs to be integrated with improvements in other treatment methods used before and after it. Technological advances continue in filtration, for example, and even in extraction of phosphorus – in crystal form – as a valuable resource which can be sold to offset wastewater treatment costs. There are various novel solutions in this field which promise to reduce the amount of chemical needed in the dosing process.

A further aspect of a plant's overall equipment which influences the effectiveness of chemical dosing treatment is its provision for mixing and flocculation. Where resulting phosphorus levels need to be very low, a useful strategy is to dose at two points.

The initial dose, at the front end, needs rapid mixing to achieve maximum effect from the amount of chemical used – otherwise larger doses are required. At the back end, a second dose accompanied by slow mixing promotes flocculation and thereby enhances removal of phosphorus through sedimentation.

What must a standardised dosing system provide?

Versatility is a key aim of dosing system standardisation. It should be possible to meet the needs of a wide variety of applications using a small number of products. Compact size immediately makes a system more versatile than its large predecessors, as it gives a greater choice of location. In particular, compact systems fit more easily into the many small sites which now require chemical dosing.

Weather protection, enabling both outdoor and indoor use, adds extra flexibility. Robust design and construction, throughout the system, are vital to ensuring durability, reliability and safety.

In addition to such common dosing chemicals as ferric sulphate and ferric chloride, the system should be adaptable to alternatives. This will allow for changes if increased industry demand reduces the availability and increases the cost of an operation's first-choice chemical.

It is largely a matter of specifying pump, valve, pipe and other materials suited to a range of chemicals. Chemical storage tank capacity needs to be carefully considered to facilitate convenient, cost-effective deliveries that will prevent runouts.

Reliable control of dosing levels is essential. On some very small sites with less stringent limits on chemical levels, an appropriate fixed dosing rate may be used. In the case of a small-to-medium site whose input phosphorus load varies with time of day, dosing can be programmed to follow a predicted diurnal profile. This is determined by a period of continuous sampling and analysis, which must be repeated at intervals to make sure the pattern has not changed.

For larger sites, a common approach is to adjust dosing automatically according to variations in the input water's flow rate. A cap on the maximum dosing rate may be needed to avoid overdosing when storms deliver very high volumes of water with relatively low levels of phosphorus. For the most precise matching of dosing rates to input water content on larger sites, phosphorus levels can be constantly monitored and fed back to the system.

As a safeguard, dosing systems should be equipped with telemetry so that any failure is immediately reported. Finally, each should come as complete, pre-assembled and pre-tested package which is quick and easy to install and commission.

What will a standardised dosing system look like?

The DS1500 unit from WES is a good example of a standard chemical dosing system which could easily slot into the industry's current thinking process around simplification and standardisation. Fully enclosed within a weatherproof, polyethylene, rotationally moulded structure, this compact and tough product is ideal for indoor and outdoor applications requiring small to medium capacity.

Safety features include separate lockable doors for its dosing and fill/control compartments, along with automatic leak detection cut-off, splash screens and an integral bund. A vertical tunnel through the bund protects and conceals power and signal cables, as well as dosing lines. Construction material options allow for use of different chemicals.

Also included in the integrated design is a 1,700-litre polyethylene chemical storage tank, with a 1,500-litre working volume. This is designed to accept 1,000-litre deliveries from commercial chemical suppliers, and it can also be filled by pumping from an on-site IBC (intermediate bulk container).

Digital dosing pump choices include single and duty/standby set-ups. Their user-friendly interface includes a screen on which dosing rates can be entered directly. With very wide turn-down ratios and no need for complicated stroke rate calculations, the system offers plug-and play simplicity. In addition to simple manual dosing rate control, over a range from 0.025 to 150 litres per hour, the pumps can be controlled automatically via input/output connections. Automatic duty/standby pump changeover and telemetry functions are further options.

Fully constructed and tested in the factory, the packages are operational very soon after arriving on site. They can be readily bought or hired from WES, which operates the UK's largest chemical dosing hire fleet.


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Case study

WES recently added two new packages to its range in response to a framework tender call from one water company. This specifically related to increased or upgraded dosing with ferric chloride for removal of phosphorus at multiple locations. The two resulting size variants, at 7,500 and 10,000 litres, offer versatility for a variety of different circumstances but with a standardised approach that saves on costs.

Even the largest version is compact and lightweight enough to be delivered easily on a single, non-articulated, flatbed truck. WES saves further time and expense by fully constructing and testing each package in the factory, rather than assembling it on site. With quicker installation, involving fewer personnel, on-site health and safety risks are also reduced.

Buy or hire

Complete chemical dosing set-ups can be bought or hired from WES, complete with all necessary storage tanks, bunds, filling and safety systems, pipework, connectors and control features. All components are pre-assembled and pre-tested to save on installation time.

WES operates the UK's largest chemical dosing hire fleet. In addition to their cost-saving application in testing of treatment strategies, as discussed earlier, hired systems are ideal for dealing with urgent needs, short-term increases in demand and scheduled shutdowns. In addition, they help conserve capital expenditure.

For further information, visit www.wes.ltd.uk.

How WES can help

WES is an independent company dedicated to the design, engineering and supply of chemical dosing systems and services. Because we aren't linked to any single equipment manufacturer, we can provide our clients with unbiased advice about the technologies, approaches and solutions that best meet their needs. Our services can be as simple as the supply of an individual component, or as complex as the design, build and installation of large scale bulk chemical dosing systems. We pride ourselves in our ability to solve problems and keep our customers' process running, whether that involves the rapid delivery or temporary equipment on a hire basis or the development of innovative solutions to the toughest chemical dosing challenges.

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