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The Tide is Turning

Chemical makers increasingly focus on water-related risks and opportunities

By Cate Lamb, Carbon Disclosure Project

INVESTOR INTEREST in water-related issues is on the rise with investors such as Norges Bank Investment Management stating that “water scarcity on a global scale represents a financial risk to the fund. Economic growth, industrialization and population growth are driving the increasing demand for water, while factors such as climate change, pollution and regulation are affecting the supply and costs related to water.” The chemical industry, being highly water intensive, certainly is exposed to water-related risks. Any efforts to manage these risks and capitalize on opportunities begin with the measurement and appreciation of how water may impact business, followed by the development of strategies to protect the business both now and in the future.

The Carbon Disclosure Project (CDP) (www.cdproject.net), London, an international not-for-profit organization, has worked with large companies around the world for over a decade, helping to accelerate awareness and management of environmental risk. It pioneered the only global system that collects information about corporate behavior on water security and climate change. CDP’s water program focuses specifically on mobilizing positive and tangible action on sustainable water management by enabling businesses, investors and policy makers to better understand the corporate risks and opportunities associated with water scarcity and other critical water-related issues.

CDP’s goal of enabling better decision-making

by providing high quality information on how companies are managing their responses to natural resource constraints has never been more important. Demonstrating the growing significance of water management as an investment issue, the 2012 CDP request for information on water, which was sent to 318 of the world’s largest companies listed on the FTSE Global Equity Index Series (the Global 500), was formally supported by 470 investors representing \$50 trillion in assets.

CDP received responses from 20 companies in the chemical industry. A total of 36 companies in five chemical sub-sectors were asked to respond — see Table 1. The response rate of just 56% was disappointing given the weight of investor interest in the issue and the increasing proportion of companies across all industries reporting water-related impacts, risks and opportunities.

Analysis of the responses provides some interesting insights into the preparedness of chemical companies in tackling water scarcity:

- Almost two-thirds of chemical industry respondents have experienced water-related negative impacts to their business in the past five years, and the majority of respondents have identified water as a substantial and current risk to their business.
- Encouragingly, the majority of respondents report that water represents a current strategic opportunity to improve their financial and brand performance, with some opportunities having

RESPONSES BY INDUSTRY SUB-SECTOR

Sub-sector	Number of Responses Received	Number of Companies Invited to Participate
Commodity chemicals	2	7
Diversified chemicals	6	11
Fertilizers & agricultural chemicals	5	8
Industrial gases	3	4
Specialty chemicals	4	6
Total	20	36

sales potentials of more than €800 million (\$1 billion) by 2020.

- Despite this, less than half of respondents have set concrete targets or goals with regard to water-related issues, suggesting that water isn't receiving strategic attention proportionate to its risks and opportunities.

A GROWING AND IMMINENT RISK

Water risk is a prominent issue among chemical industry respondents. Indeed, 65% report suffering water-related adverse business impacts in the past five years — this is significantly higher than the full Global 500 sample average (53%). Impacts include business interruption through the closure of major transport routes and property damage. DuPont's operations, for example, were affected by storm surges and flooding associated with major hurricanes in 2008.

Perhaps as a result of this, 70% of chemical respondents identify water as a substantial risk to their business, either in their direct operations or across their supply chains. Increased water stress/scarcity, and regulation of discharge quality/volumes leading to higher compliance costs are the most frequently reported risks (Figure 1). This perhaps isn't surprising given the inherent nature of the chemical industry and the hazards that some chemicals pose to humans and the environment. For example, DSM states that reputational damage resulting from water-related issues can negatively impact shareholder value and that water-related incidents can lead to severe business interruptions.

Given that the majority of the risks identified are reported to have the potential to impact businesses now or within the next five years, there

Table 1. More than half of the chemical companies sent questionnaires provided inputs.

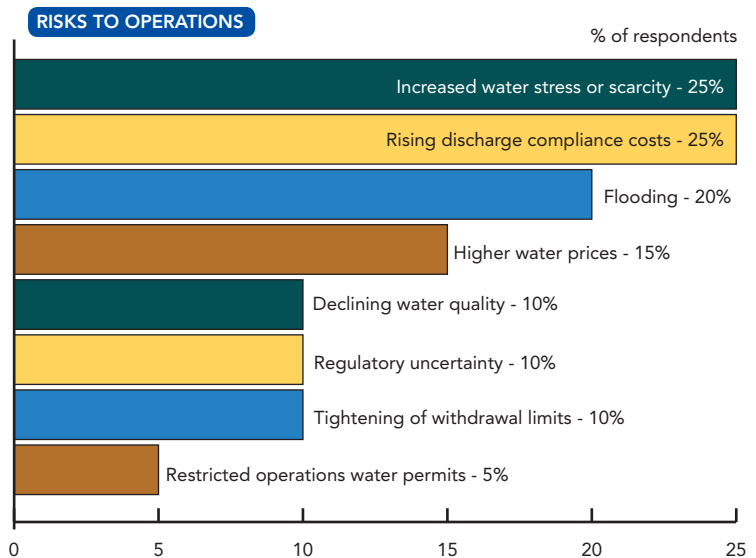


Figure 1. Risks cited by chemical industry respondents range from water scarcity to flooding.

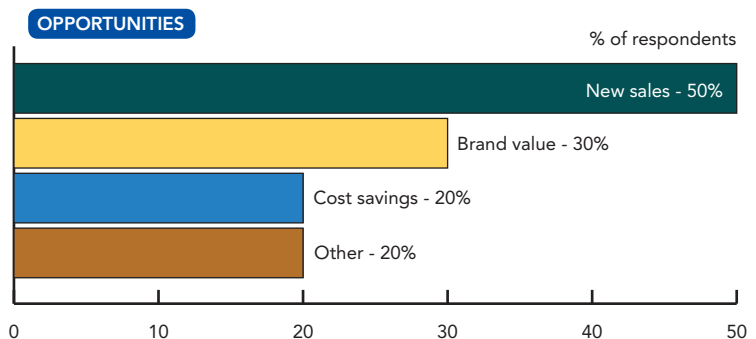


Figure 2. Four-fifths of chemical industry respondents foresee current or near-term opportunities.

is clearly an urgent need for companies to develop effective management responses.

Israel Chemicals provides a compelling example of the critical nature of a sustainable supply of water to business continuity. The company depends upon the Dead Sea as a significant source of raw materials, yet due to historic and current extraction practices, the sea's water level is dropping at a rate of around one meter per year. Solutions proposed by the Israeli Government are likely to affect the composition of the sea water and, hence, the quantity of materials the company can produce. It's anticipating "significant expenses" as a result.

As BASF stresses, "the sustainable use of water and the conservation of water resources are... important for our company's future success." It is therefore vital that the chemical industry engages with and understands the implications of water for their business. Because water-related risks extend beyond direct operations, the chemical industry should strive to understand their risk exposure across their entire value chain.

The supply chain features frequently as a significant source of risk among Global 500 companies. However, only 15% of chemical industry respondents report that water-related risks within their supply chain have the potential to substantively impact their business. Nonetheless, 50% of the identified risks, including reputational damage, increased water stress/scarcity and flooding, are anticipated to impact businesses now or in the next five years.

Of those companies noting they aren't exposed to supply chain risks, the majority, including Dow, DuPont and Potash, explain that their strategy of multiple-sourcing enables them to circumvent any risks. Other firms, such as Air Liquide,

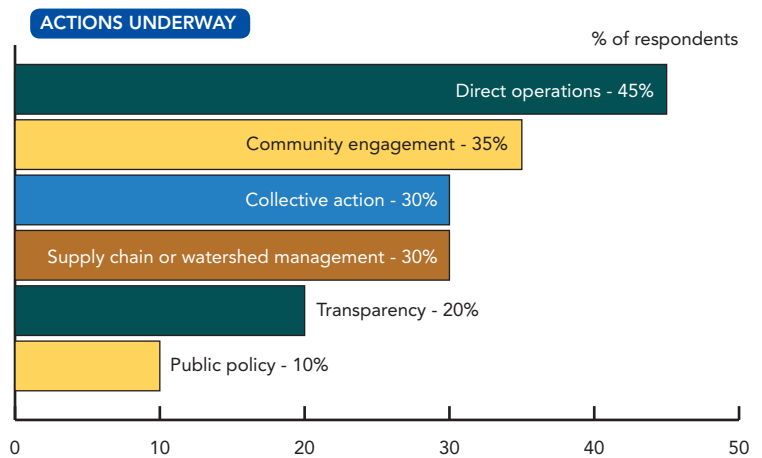


Figure 3. Some chemical companies report efforts to address issues beyond their own operations.

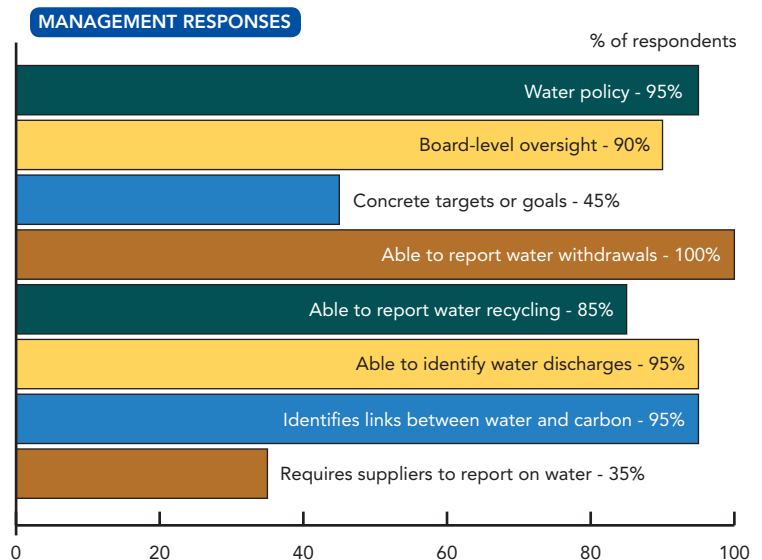



Figure 4. Less than half of chemical industry respondents have established concrete, quantitative water targets or goals.



Ecolab and Syngenta, rely on supplier engagement to mitigate risks.

Worryingly, however, over a third (35%) of respondents are unable to state whether or not they are exposed to risks across their supply chain. Many cite the sheer number of suppliers as a barrier to understanding these risks; others report they traditionally have focused on risks across direct operations but are in the process of broadening their analyses to cover supply chains.

Encouragingly, respondents are taking steps to address the uncertainty around supply chain risks, with 35% requiring key suppliers to report their water use, risks and management. It is recommended that other chemical companies consider engaging their key suppliers on water-related issues.

SEIZING OPPORTUNITIES

Water-related issues present substantive opportunities for their business say 80% of chemical industry respondents, a level somewhat higher than the Global 500 average (71%). These companies report a total of 43 opportunities — including creating new sales, enhancing brand value and saving costs (Figure 2) — all of which are expected to materialize within the next five years. To capitalize on these opportunities, many companies pursue water stewardship strategies that not only build business resilience, but also turn risk management responses into a source of competitive advantage.

Half of the respondents, including Akzo Nobel, Israel Chemicals and Air Products & Chemicals, foresee sales of new water-related products and services across diverse markets ranging from consumers to a variety of industrial sectors. The market should grow fastest in areas lacking access to safe drink-

ing water and sanitation, as well as those expecting greater impacts from climate change, where water efficiency, recycling and reuse are expected to become increasingly important.


“Adaptation to resource scarcity is an emerging challenge for our customers, especially in high-growth markets like China, India, Brazil and the Middle East. By recognizing the potential for water reuse, we can help our customers increase their capacity with less risk of competing for already scarce resources,” notes Ecolab.

BASF, for one, provides a range of products to meet current and future water needs in terms of production, use and purification. The company estimates these products have the potential to generate more than €800 million (\$1 trillion) in sales through 2020.

A number of respondents cite the cost implications of the research and development, regulatory and marketing resources required to develop, test, market and sell new products and services. However, they also note the benefits include significant opportunities to increase their market share as a result of newly developed technologies.

ADDRESSING CHALLENGES

A clear and urgent need exists for the chemical industry to develop effective management responses to water-related issues. Not surprisingly, companies are focusing most on their direct operations rather than on aspects that might better address some of the underlying issues related to water scarcity, such as community engagement or watershed management (Figure 3). Almost all have developed water policies (Figure 4). All are able to report their water withdrawals and nearly all can identify their discharges. However, only 45% have



established specific water-related targets or goals. This is much lower than expected considering the proportion of companies that have already experienced water-related negative business impacts.

Moreover, many of these targets focus on the efficient use of water (recycle and re-use) and reducing water consumption in general rather than on water quality management. This is surprising considering one of the risks chemical industry respondents most frequently cite is increasing regulation of discharge quality.

Some notable initiatives include:

Praxair is using the WBCSD Global Water Tool (www.wbcd.org/work-program/sector-projects/water/global-water-tool.aspx) to build a picture of water stress or abundance both now and over the next 15 years. It plans to use the findings as a basis to improve water management and reporting across the entire company.

Israel Chemicals has established an “ecological tax” — an intra-organizational tool that adds effluent treatment costs onto the total price of a product. This provides an incentive for production managers to reduce the quantity of pollutants and effluents at the source in addition to acting as a tool for estimating the “environmental” price of each product.

Taking collective actions to address water-related issues is becoming more popular. Chemical industry respondents are beginning to realize that no single company can address some of the underlying water challenges. So, for example, DuPont is taking part in the Aqueduct project of the World Resources Institute, Washington, D.C. (www.wri.org/).

This project’s objective is to “equip and motivate companies operating in water-stressed regions to minimize their water consumption and other impacts, drive markets for environmentally sound hydro technologies, and advance economic development without threatening freshwater resources in their communities.”

Meanwhile, Syngenta, recognizing the challenges it faces in offering timely advice on optimum agronomy solutions for crops to farmers spread over large, sometimes remote, areas, has teamed up with Nokia. “Syngenta has been working with Nokia LifeTools to set up an easy-to-use, graphical interface that works anywhere on Nokia cell phones. With this wireless application, Syngenta can provide growers with crop-specific tips on pest and disease management.”

A NEW IMPERATIVE

Water is a critical resource for the chemical industry. So, chemical companies should engage in water-stewardship initiatives to mitigate risks and seize business opportunities. Many companies are reducing their exposure to water-related risks and, in partnership, identifying ways in which water-related issues can positively impact performance. Disclosing water-related information (see sidebar) is an important step in water stewardship and water-related value creation. ●

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Water Wins Wider Attention

Chemical makers strive to cut consumption and improve treatment

By Seán Ottewell, Editor at Large

A COMBINATION of tougher regulations and the need to manufacture in water-stressed parts of the world is spurring chemical companies to focus as never before on their water usage strategies. One effect of this is that water optimization technologies originally developed for the power industry increasingly are gaining traction in the chemical industry. At the same time, chemical manufacturers such as Bayer, BP and Dow are developing their own, sometimes nonconventional, approaches.

GE Power & Water, for one, is finding growing interest outside the utility industry for its technology — vertical-tube falling-film brine concentrators and evaporators (Figure 1) that can recycle wastewater into a high purity distillate suitable for boiler and cooling tower makeup, flue-gas desulfurization blowdown, NO_x control and process use. According to the Trevose, Pa., firm, 15 to 20 years ago, 80 to 90% of demand for this kind of technology came from the power sector. Today, that figure is around 10% as demand rises in non-conventional oil and gas development, chemicals and other sectors.

“We’ve seen increasing demand from the chemical sector, particularly in the face of regulatory changes covering water use and wastewater discharge. Demand is strongest from companies located in areas where there is high population density and water stress — so, for example, much of the current demand is from companies in India and China in the chemical processing and coal-to-chemicals industries,” says Bill Heins, general manager, thermal systems — water and process technologies, GE.

He cites the example of a new Lanxess chemicals

and intermediates plant in India. That site also uses GE’s zero-liquid-discharge crystallizer technology to reduce the brine concentrate to a dry solid.

The increasing popularity of evaporation for wastewater treatment is a sure sign of changing times, Heins believes. With certain notable exceptions such as steam-assisted gravity drainage heavy oil recovery, you typically wouldn’t put in an evaporation system solely for economic reasons, he explains.

“Reverse osmosis (RO) is less expensive per m³ of water treated, unless you have a highly saline, contaminated wastewater stream where RO is not technically viable. In the chemical industry, we are typically seeing waste streams from processes that are very hard to treat due to highly scaling constituents and high levels of organics and total dissolved solids. We can recover and recycle the water from these,” Heins notes.

An added advantage is that GE can treat mixed wastewater streams from different processes such as boiler blowdown, demineralizer regeneration waste, RO reject and chemical processes. Such integrated solutions often include wastewater preconcentration with membranes prior to thermal treatment.

The company currently is working with two clients to develop the next generation of thermal technology. It particularly is focusing on optimizing the integration of evaporation technology with different waste-treatment methods such as membrane separation, electrocoagulation, and physical-chemical treatment. “Our focus is on lowering their capital cost, reducing their power needs, maximizing reliability

EVAPORATOR



Figure 1. Plants are opting for evaporators to handle certain wastewaters even though they aren't the lowest cost option. Source: GE Power & Water.

and reducing wastewater volumes as much as possible. Even a small change in water recovery results in a large impact in waste volume. For example, increasing from 98 to 99% water recovery at the tail end of the process means cutting the amount of water discharged in half. So from the user's perspective, it means better water quality and better, more-efficient waste recovery," notes Heins.

Another innovation is the introduction of a mobile evaporation unit. Designed for use by the unconventional gas industry, it now is finding wider applications — including with chemical companies that have waste ponds that need processing or that have filled more rapidly than expected due to high rainfall. GE is considering expanding its fleet in the face of growing demand.

MODULAR CONCEPT

Meanwhile, Bayer, Leverkusen, Germany, has developed a systematic and comprehensive process analysis called Resource Efficiency Check to uncover potential reductions in resource consumption, emissions and waste.

This modular concept enables the company to focus on specific issues relevant to production plants, for example raw materials' use, packaging waste and water consumption. It also helps to identify possibilities for

process-oriented optimization in boosting yields, recycling, utilizing byproducts and treating wastewater or waste air, so that these potential savings can be fully exploited.

First tested in pilot projects in 2011, the methodology now is being applied more widely to help Bayer companies optimize their water use. For example, Bayer CropScience currently is employing it on the synthesis processes involved in the production of trifloxystrobin, the active ingredient in the crop protection product Flint.

Bayer HealthCare also has used it to successfully finish the reorganization of rainwater management at its Bergkamen site in Germany. This facility produces intermediates, active ingredients and bulk pharmaceutical chemicals for steroid hormones via chemical and microbiological synthesis.

A clarifying and collecting tank, two pumping stations and a 1,500-m long subterranean tunnel have been installed at the site. The centerpiece of the project is the 12,500-m³ collecting tank. Water either can be pumped from here into the nearby river Lippe or used for operational purposes, mainly in refrigeration systems and air scrubbers.

Strategies such as this helped the company cut its overall water consumption by 20 million m³, or 6%, in

WETLAND PROJECT



Figure 2. Construction of wetland provided a cost-effective way to meet discharge requirements. Source: Dow Chemical.

2013 — and also raised to 36 the number of Bayer sites where treated wastewater or steam-condensate recovery water is reused as process water.

In addition, last November Bayer's main group board set a new water target within its resource efficiency program. This aims to establish a water management system at all sites in water-scarce areas by the end of 2017.

LESS WATER INTAKE

For its part, BP, London, reports a drop in freshwater withdrawal from 347 million m³ in 2012 to 312 million m³ last year. Refining, chemical and lubricant manufacture and storage terminals account for around 94% of this use.

Last year, the company began the systematic upgrading of wastewater treatment plants across the group. Now, 12 major sites — including the Gelsenkirchen and Lingen refineries in Germany, the Castellón refinery in Spain and the Rotterdam refinery in the Netherlands — are benefiting from new treatment plants. These systems were designed ahead of the introduction of new European Union refining standards due this year. New wastewater units also are in the works for the Whiting refinery in Indiana.

The growth of its manufacturing operations in water-stressed areas also has driven BP into developing new processes that have less impact on local fresh water supplies.

For example, the company's Zhuhai 2 purified terephthalic acid (PTA) plant, Zhuhai City, China, which started operations in 2008, today generates

75% fewer water discharges, 65% fewer GHG emissions and 95% less solid waste than a similar plant equipped with conventional technologies.

The company says that proprietary, but undisclosed, recycling technology allows it to reuse much of its water on-site, reducing the amount of freshwater required for operations. Many of these modifications were made during a 20% capacity increase that was carried out in 2012; elements of this approach are being introduced at other facilities around the world.


One such facility is JBF Industries' 1.25-million mt/y PTA unit currently under construction in Mangalore, India, that's slated for commissioning by the end of 2014. The Mumbai, India, firm cites the BP process's water and energy optimization technologies as key to its decision to license the process.

Meanwhile, BP itself currently is building a larger facility at Zhuhai. This plant, scheduled for 2014 startup, will be the first to incorporate the newest generation of its PTA technology — leading to further gains in efficiency and environmental performance, says the company.

NOVEL WASTEWATER TREATMENT

For Dow Chemical, Midland, Mich., constructing wetlands to treat wastewater at its Seadrift, Texas, plant has brought benefits in excess of \$200 million so far.

Seadrift is a large complex containing several manufacturing units involved in the production of plastic resins and other organic chemicals. Originally, wastewater from the facility and storm water captured in containment areas were routed through a system



consisting of primary (anaerobic/aerobic biological) treatment, secondary treatment and a shallow tertiary pond. The tertiary pond, covering approximately 267 acres with water depth ranging from 1 to 4 ft, operated as a solar stabilization pond with no active mixing.

However, lower organic loads and long retention time within the aerobic section and tertiary pond resulted in ideal conditions for phytoplankton and their floating algae blooms to thrive. This, in turn, caused the plant to exceed its 40-mg/l discharge permit criterion for total suspended solids (TSS) and required extensive pH adjustments. Eventually, it became clear that the site needed to upgrade its wastewater treatment plant — at an estimated cost of about \$40 million — if it was to meet TSS regulations.

Fortunately, an engineer's ingenuity and the willingness of site and business leadership to consider alternatives resulted in a very different solution: constructing wetlands for water treatment.

"The pioneering engineer based at the site, Mike Uhl, introduced the novel approach from projects he had seen previously outside of Dow," notes Mark Weick, director, sustainability programs and enterprise risk management. "At the time, green infrastructure was not a commonly considered approach and took some convincing among peers. Uhl proposed the alternat[iv]e plan to leadership and found a champion who supported pursuing the idea for consideration — a key part of the plan's success."

A one-year pilot-scale constructed wetland project was completed successfully and later implemented on a full scale in roughly 18 months (Figure 2). It remains in full operation today and not only allows the facility to meet all discharge requirements

for TSS but also has eliminated algal bloom issues and the need to adjust the pH of wastewater. Just as significantly, the initial capital cost was reduced from \$40 million to \$1.5 million, with additional savings in labor, maintenance and supplies.

"A financial analysis was completed in 2013 and showed the net present value of this project to be \$200 million, significantly higher than the initial capital savings, while providing the added benefits of wildlife habitats and educational opportunities," adds Weick.

Dow faced several challenges as it conceptualized this project, not least the lack of staff with the requisite skills or support from the culture necessary to bring this category of technology to scale.

"Given this lack of integration into technology capabilities, capital reviews or assessments, champions are required in today's organizations to investigate and drive these non-traditional cost-advantaged solutions. 'It's hard to sell a swamp to an engineer,' was a key message from the project team. Leadership emphasis and cultural change are needed more than further pilot projects," notes Weick.

"Opportunities for green infrastructure and other, more sustainable solutions abound, and we are always looking into options for how to enhance the sustainability of our operations at sites around the world. Further implementations of engineered natural technologies are expected to increase total return on investment," he concludes.

In another example of this approach, Dow is using trees to remediate dioxane in groundwater at its Terneuzen site in the Netherlands and elsewhere. (see: "Sustainability Gets the Spotlight," <http://goo.gl/GR9u4R>). ●

ADVERTORIAL

The Importance of Visible TOC Levels

By: Jason Padilla, Global Product Manager for TOC Analysis, Hach Company.

Many Chemical and Petrochemical plants consume large amounts of water for processing product. An understanding of the organic loading in this water at all times is critical to avoid upsets that can stop production, damage capital equipment, and create other costly issues. In recent years, TOC (Total Organic Carbon) analysis has been accepted as an alternative to the laboratory Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) analyses. TOC measurement has become the standard and the only reliable online method used to determine the contamination in waters, to control processes, and to minimize waste in the industry.

OVERCOMING TOC MEASUREMENT CHALLENGES

Online TOC analysis in the Chemical and Petrochemical industries is often extremely challenging due to the difficulties presented by liquid samples that typically contain high concentrations of organics and solids. Sampling issues can often lead to problems of clogging and analyzer downtime which result in high maintenance costs and low instrument reliability. If left unchecked, these issues can erode confidence in the measurement, which in turn can leave a process vulnerable to the costly problems the analyzer was originally intended to prevent.

Two Stage Advanced Oxidation (TSAO) was developed specifically by BioTector to overcome these limitations experienced by users. The key to the success of the TSAO process lies in the self-cleaning oxidation technique. This patented chemical oxidation process, using hydroxyl radicals, allows the complete oxidation of a large volume of sample fluid, which allows it to overcome limitations experienced by other technologies, including salt buildup inside

the reactor or inhibition of the oxidation process.


TSAO allows each analyzer to utilize up to 6 streams. This multi-measurement capability maintains high accuracy levels because the patented self-cleaning technology ensures that there is no cross contamination or carry over. The highly effective multi-stream option has been acknowledged by many companies to be a strong driver in their decision to purchase BioTector.

TSAO is the technology found in the Hach BioTector B7000 Online TOC Analyzer, which has built a reputation around the world for its ability to excel in the toughest applications. This ability, along with the potential value that can be extracted from reliable, real-time TOC information, can be found in some of the world's largest Chemical and Petrochemical manufacturers

MANAGEMENT INFORMATION TOOL

Typical sites discharge at a rate of thousands of gallons per minute and each plant usually has a maximum carbon loading. Real-time and reliable TOC information is critical to decision making. A significant commercial advantage of the Hach BioTector is that it gives confidence to Management and Operators in the TOC measurements. The Operations team can then use this information to drive operational decisions at the wastewater treatment plant (WWTP) including:

- Wastewater diversions to manage capacity and protect the WWTP from overload
- Selecting correct chemical volumes for wastewater treatment
- Managing energy usage levels for wastewater treatment



Management can make long-term plans based on information patterns obtained from the BioTector analyzer, for example, load sharing between different plants or production lines and managing ‘toxic’ loadings through holding facilities. Clients have reported that, because BioTector measures TOC reliably and accurately, they can build trends and averages and manage their operations based on what they know each area is putting into the stream.

RETURN ON INVESTMENT WITH BIOTECTOR

BioTector clients have been very emphatic about the operations savings to be made by using BioTector. The purchase price of the Hach BioTector B7000 is offset against a strong ROI and early payback period. In addition to this, BioTector also contributes to Corporate Sustainability Goals.

Worst case scenario, a lack of accurate and real-time measurement could overload the WWTP and shut down the site. This would cause significant disruption to production volumes.

REAL-TIME VISIBILITY AND EARLY DETECTION

Hach BioTector analyzers monitor TOC continuously, giving the operations team real-time visibility of wastewater loading and enabling them to respond rapidly to incidents or upsets.

For many clients in the Chemical and Petrochemical industry, BioTector is installed to monitor inbound river water, providing an early detection system. This water typically contains high volumes of silt and mud from local rivers. Analyzers are located at this point to ensure that there is no organic contamination from other

plants in the area, to assess treatment options before releasing this water into operations and also to ensure that overground and underground process lines have not ruptured, providing the site with information to stay compliant in a situation where inaccurate data would be extremely costly to the company.

ACCURACY & FILTRATION

Industry doesn’t provide clean samples for measurement therefore analyzers must work consistently with particles and dirty liquids. BioTector’s self-cleaning technology and powerful oxidation process eliminates sample build-up and tube clogging. This means that BioTector analyzers can use larger sample tubing. The B7000 tubing has an ID of 3.2mm (the industry standard is 0.8mm ID) which allows soft particulates of up to 2mm. Filtration is not necessary and no additional equipment or maintenance is required. And, after each cycle of measurement, every part of the analyzer that comes in contact with the sample is automatically cleaned 100% so that it does not suffer from drift or sample contamination. The end result is a more representative sample and therefore more accurate TOC results.

RELIABILITY & MAINTENANCE

BioTector reduces TOC analyzer maintenance costs significantly by eliminating recurring issues that arise due to particulates in the liquid sample. BioTector only requires a routine service every six months. Calibration is not required in between these services and no drift occurs.

Feedback we hear from clients consistently is that BioTector just runs and runs ●