

# Impeller

78:2008

A news magazine from ITT Water & Wastewater

## WINNING VIRTUAL WATER

Tony Allan awarded  
the Stockholm Water Prize

## THE ENHANCED N-TECHNOLOGY

Tougher and more flexible

## GREEN WATER TREATMENT

Ozone replaces chlorine

**THE WATER TREATMENT  
PLANT** in Langelau,  
Germany, relies on ITT  
Water & Wastewater for  
ozone production and  
injection equipment.

# PERFECT TOOLS

Simulation is key to advanced solutions

**S**imulations have enabled human-kind to undertake difficult research without the cost, and sometimes danger, that it would take to test something live. The results often mean incredible benefits for all.

At ITT Water & Wastewater we know what the reality demands. Smart simulation is key to developing better products, finding the best customer solution or for troubleshooting and system optimization within the water and wastewater business. Installations all over the world are proof that the simulation method works.

In this issue of *Impeller*, we look at how simulations are developed and what they are used for. Real-life examples abound: a water pump station in Wisconsin in the U.S. and another in Christchurch, New Zealand are the direct result of simulations. And this year's Stockholm Water Prize winner, Professor John Anthony Allan from King's College London and the School of Oriental and African Studies is an expert on "virtual water."

We haven't forgotten other pressing issues, however. A look at ozone cleansing in Langenau, Germany makes the case for smart long-term solutions in large water treatment plants – and is a good example of how we have broadened what we provide customers, with a Wedeco ozone solution, a brand that is now part of ITT Water & Wastewater.

PER-INGE BIRGERSSON  
CEO, ITT Water & Wastewater



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# BUILT TO SAVE AND WITHSTAND TIME

**PUMP STATIONS IN** connection to dikes and sluices are as important as they are common in the Netherlands, a country that features a considerable amount of land area that has been regained from the sea and must be protected from higher surrounding water. ITT Water & Wastewater has designed and is installing upgrade solutions throughout the country that promise to save time in installation and maintenance and in addition withstand the challenges of tough conditions over a lifetime.

The prefabricated pump stations, with concrete walls and Flygt N-pumps, can be easily installed, and grant a clog-free operation. Only a single annual service check is required. This solution has been the option for many water boards operating stations in the range of 1–14 m<sup>3</sup>/min. Large propeller pumps, in shaft or in horizontal installation, are the preferred choice where capacities of up to 840 m<sup>3</sup>/min are required. Since these solutions are based on standard Flygt products, the cost of the new stations is lower and the setup quicker than in customized solutions. 


**Prefabricated pump stations grant clog-free operations.**



PHOTO ITT WATER & WASTEWATER

## PUMP GROWTH IN UKRAINE

**THE CITY OF LVIV**, in western Ukraine, close to the border with Poland, has been growing rapidly, but its 750,000 inhabitants have found that improvements in infrastructure don't always match this growth. Things have gotten better, however, at least in terms of wastewater management. In December 2007, a completely upgraded main pump station, financed partly by the World Bank, was inaugurated by the local company Lviv Vodocanal, thus solving some of the city's most urgent problems.

Sergii Anisienko, the ITT Water & Wastewater representative in Ukraine, still remembers how he approached the city in 2001 to introduce the Ready 8, one of the smallest Flygt dewatering pumps for construction sites and clean-up operations. Over time that initial presentation has led to the purchase of much larger pumps: six Flygt CT3602 wastewater pumps, each of which can handle 400 times more water than the small ones. 

**The Armenian church in Lviv.**



“Once you have done the simulation with CFD, there is a huge amount of information available.” **GUILLAUME MERCIER**



# Stimulating **SIMULATION**

More and more industries are using simulation to design new products and to find new application benefits. No matter if it is to test how aeroplanes fly or the function of water pumps – simulation is an indispensable tool.

**SIMULATION IS THE SAME** as an imitation of real things, state of affairs, or processes. Simulating something means that certain key characteristics or behaviours of selected physical or abstract systems are represented.

Simulation is used in many contexts, including the modelling of natural or human systems in order to gain insight into their functioning. Other contexts include simulation of technology for performance optimization, safety engineering, testing, training and education.

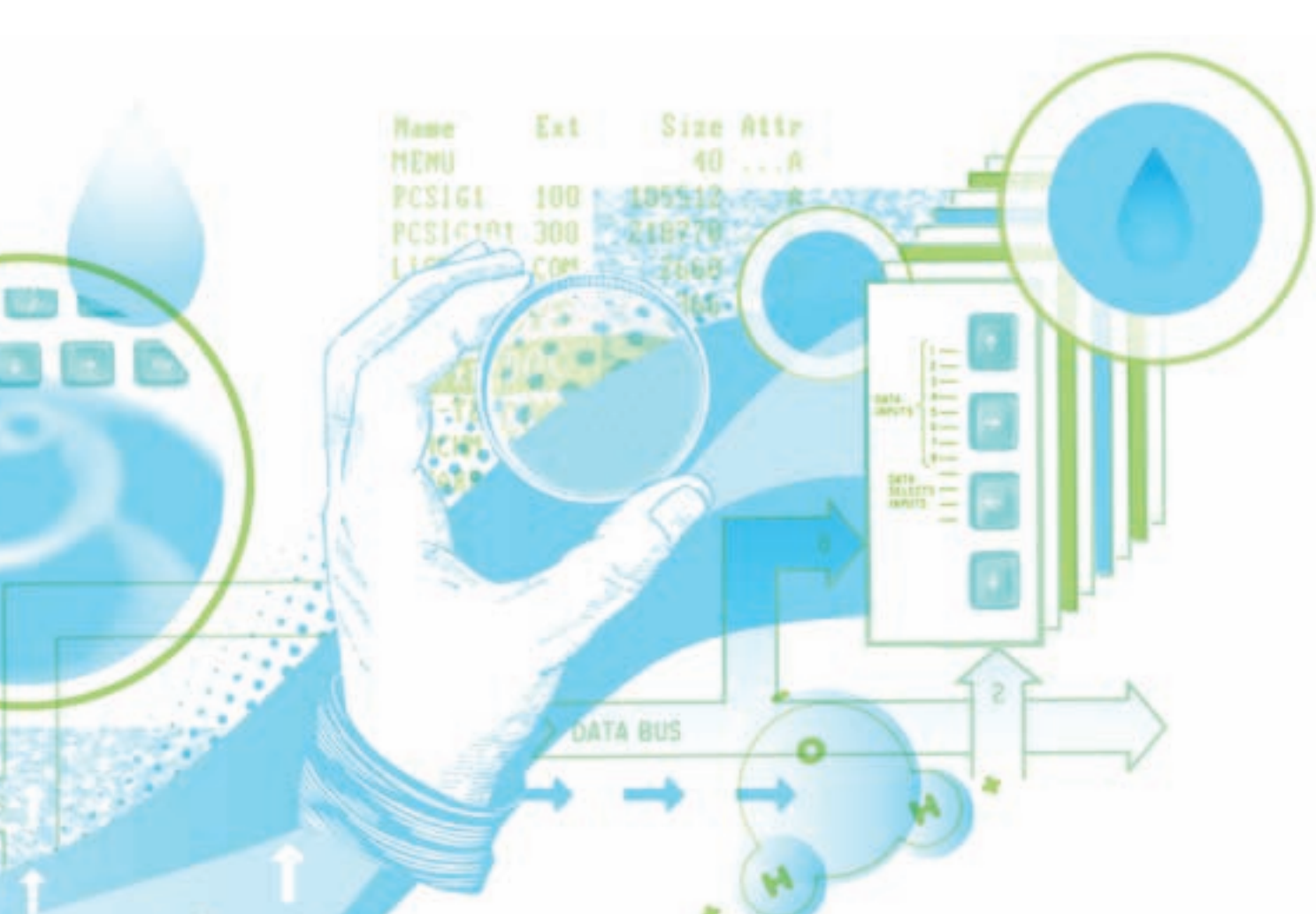
Already during the First World War, wooden mechanical horses were used to simulate the movement of real ones. Many years later, the first landing on the moon had not been able to take place without simulation techniques.

During the recent decades, physical models have been increasingly complemented by the use of computational fluid dynamics (CFD) simulations.

Understanding fluid dynamics problems often requires both virtual simulation and physical testing.

Industries are increasingly using CFD to develop products and applications. The aerospace and aircraft industries, for example, started to use CFD to simulate the flow of air around wings in order to measure the most efficient way to lift aeroplanes.

**The automotive industry** was also quick to pick up the new simulation tool. All auto makers now have CFD capabilities to be able to put their cars on the market as quickly as possible. CFD helps shorten the time spent designing and engineering new cars, and it is vital because there is so little time to build these cars to stay competitive. Computational simulation helps designers in the automotive industry address aspects such as the optimal shape of the car in



terms of superior aerodynamics and reduced fuel consumption.

Today, in all industries where various aspects of flow are involved, such as the ship and electronics industries as well as in the chemical process and water businesses, CFD is used to get adequate answers to design and application issues.

“Pump design analysis has come a long way from the days of slide rules and drafting tables,” says Guillaume Mercier, CFD team leader at ITT Water & Wastewater’s marketing department. “Over the past years, CFD has made its mark on the pump industry, reducing the need for expensive physical tests and cutting new pump development costs. In the past, engineers conducted experiments to see what happened inside pump stations by using models made of plexiglass, for instance.”

Pumps represent a challenging simulation problem, because they involve rotating internal components whose motion – particularly when combined with stationary components – needs to be included somehow in the model. For pumps, components such as impellers rotate, and their rotation drastically affects the fluid flow through the device. The CFD methods have greatly increased the ease and accuracy of simulating pumps.

Thanks to the contemporary advanced calculations and computer simulations, ITT Water & Wastewater engineers have gained a better understanding of what goes on inside a pump.

#### SIMULATION IMPROVES WEAR RESISTANCE

**THE PUMPS OF ITT** Water & Wastewater’s new Flygt 2600 line are more than three times more wear-resistant, compared with traditional dewatering pumps. They have been developed to offer superior anti-wear capabilities, thanks to the patented hydraulic system Dura-Spin.

“We wanted to prevent large particles from increasing the pump wear,” Fredrik Söderlund, head of hydraulic design at ITT Water & Wastewater, explains. “It was done by designing a spiral that was put to the suction cover and that works as a particle obstacle. The Dura-Spin spiral design forces the particles to the boundary layer flow on the shroud disk, which pushes them out of the pump. CFD has made it possible to understand the physics of particles in water and how to influence their track in this pump environment.”

This knowledge has already led to an improved design and shorter development periods.

“A CFD analysis yields values for pressure, velocity, temperature and other flow variables throughout the solution domain,” Mercier says. “A key advantage is that CFD provides the flexibility to readily change design parameters and determine the impact of those changes on performance.”

According to Slavica Žikić, application engineer and an expert in pump station design at ITT Water & Wastewater, system engineering simulation can typically be used at ITT for complex applications.

**For Water & Wastewater** it is important to prove that a product installed in a specific environment will preserve the promised performance.

“We assist the customers to design and dimension facilities where our products are installed,” she says. “It is necessary to ensure that products will work well in the requested application.”

Slavica Žikić adds that although CFD simulation is being used more and more in engineering, different phenomena are detected by CFD and physical model testing, so both are necessary.

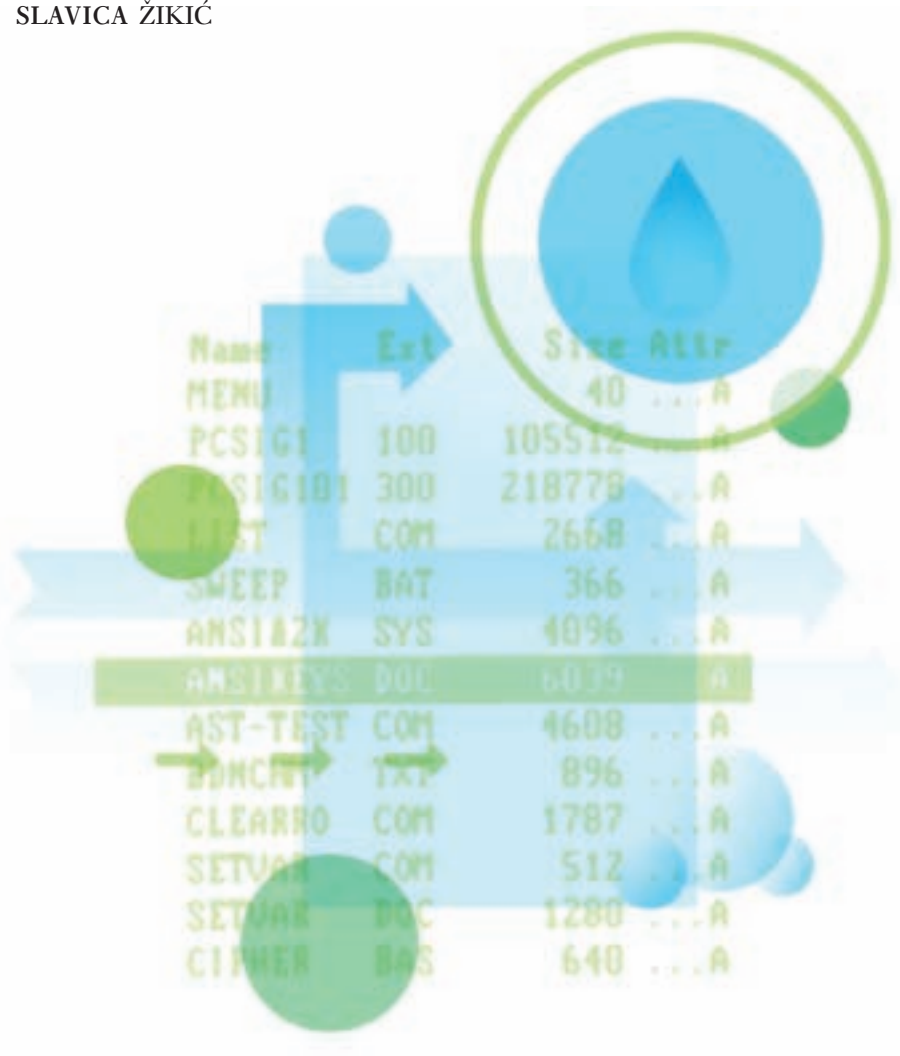
“ We assist the customers to design and dimension facilities where our products are installed. It is necessary to ensure that products will work well in the requested application.” SLAVICA ŽIKIĆ

Prototype testing has some drawbacks, compared with CFD, Mercier says.

“You really need to prepare the measures of the model and carry out careful calibration,” he says. “You cannot easily switch to measure several parameters, which you can do through CFD. Once you have done the simulation with CFD, there is a huge amount of information available, such as pressure and flow dynamic quantities. It is also easier and quicker to analyse all this data, thanks to CFD, than designing an accurate prototype.”

A direct benefit of CFD is that velocity and flow direction are simulated. From the data created by the CFD tool, it can be understood how the water flows and will behave in the real environment. The flow can be visualised in various scales from water drops to the large motion of a bulk flow. The velocity magnitude, which is the distance the flow travels in the application during a certain time, can be simulated at virtually any point. CFD also helps in establishing where the flow is slowing down or where it is doing unwanted recirculation.

“The benefit of simulation for customers is that it helps to show that pumps are not over-dimensioned for a certain application, but correctly selected,” Mercier says. “CFD can confirm that you do not over-engineer your application.”



## Dimensioning the right pressurised sewage systems

**THE PRESSURISED SEWAGE** systems of ITT Water & Wastewater are superior to the gravitational sewer system in some installations.

“The beauty of it is that we use a small pump, situated in each household, to transport the wastewater to the pipe exit,” says Torbjörn Norrhäll, research engineer at ITT Water & Wastewater. “The small pumps force the water forward in these pipes to a

wastewater treatment plant or a gravity sewer. This is more cost-efficient.”

In simulating an estimated network of 100 pump stations, for example, it is not feasible to assume that all the pumps are running at the same time.

“For this calculation, we have to use statistics and estimate how many of these pumps will run simultaneously, at a probability of between 5 and 10 percent,” Norrhäll says.

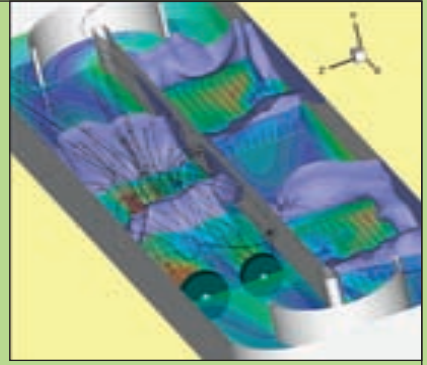
## STAYING AHEAD IN THE RACETRACK SIMULATION

**ITT WATER & WASTEWATER'S** Flygt mixers play an important role in the racetrack systems of many wastewater plants. Racetracks – large, oval-shaped oxidation ditches – are part of the wastewater treatment that uses long solids retention times to remove biodegradable organics from wastewater.

The propellers of the mixers rotate in a circular motion, providing the necessary thrust for the water and oxygen mixing needed in treatment process. Simulation methods are used to design

mixers to produce a thrust that will generate the most advantageous bulk flow velocity.

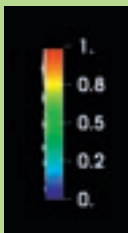
“We have used CFD to capture the hydraulic losses, including losses due to air bubbles, which break the bulk flow, and also losses due to bends,” says Thomas Börjesson, research engineer at ITT Water & Wastewater. “Determining these losses is essential for the proper mixer choice. We also use CFD to learn more about the flow field. We can simulate how the oxygen is transferred, what



**Racetrack systems are designed and tested using CFD simulation methods.**

zones are lifeless, and what zones are getting fresh oxygen in order to draw on the full capacity of the entire racetrack tank.

Volume  
Var: velocity\_magnitude



Max: 5.765  
Min: 0.000

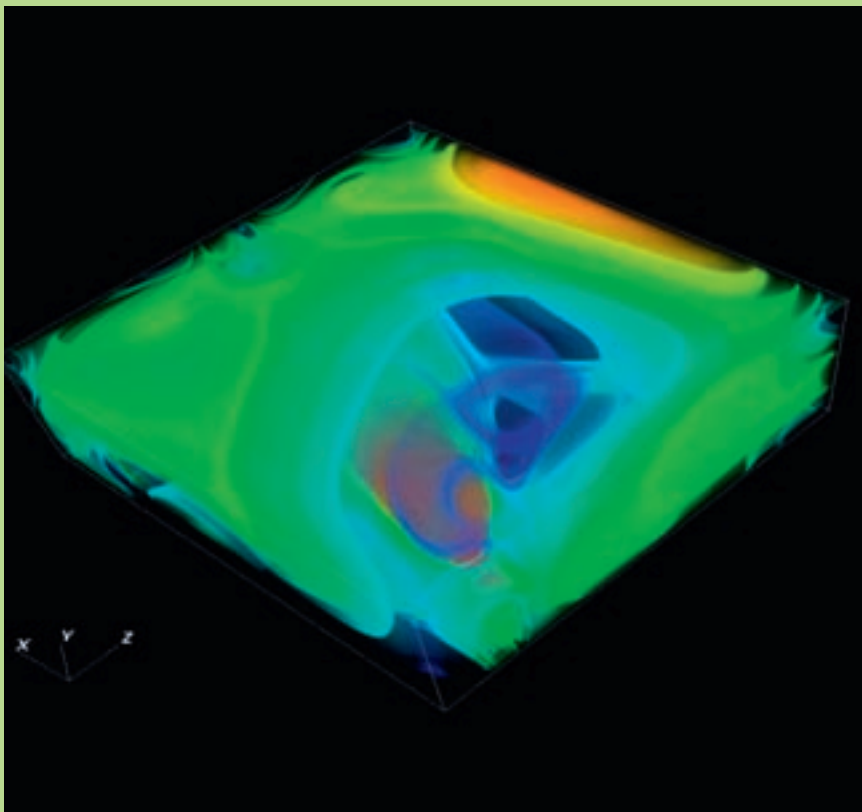
## Computational Fluid Dynamics

**COMPUTATIONAL FLUID** dynamics (CFD) simulations improve pump performance by allowing engineers to evaluate a far greater number of alternative designs on the computer without building costly prototypes. CFD involves the solution of

the governing equations for fluid flow, heat transfer and chemistry in tens or hundreds of thousands of computational cells in the defined flow domain. Engineers can obtain solutions for problems with complex geometry and boundary conditions.

CFD covers everything from simple solutions, which do not take into account the movements inside the pump, to complex computations that calculate all the turbulence that occurs. These complex operations, which require tremendously powerful computers, are carried out by scientists at universities but are not possible in an industrial context.

ITT Water & Wastewater uses Reynolds-averaged Navier-Stokes, or RANS. This is an advanced tool that uses turbulence models but calculates everything else – pressure, speed, load and so on. A Linux cluster with a large number of computers is used to carry out all the computations that this simulation requires.



**CFD involves the solution of tens or hundreds of thousands of computational cells in the defined flow domain.**

# NEW PUMP STATION SAVES THE DAY

**Cutting-edge simulation** helped one US city build an innovative new pump station to protect it from surges of storm water.

TEXT NANCY PICK PHOTOS TROY FREUND

**IN THE UNITED STATES**, the city of La Crosse, Wisconsin, stands where three rivers meet, so people there get anxious when it rains. To help control flooding, last year the city built a new storm-water pump station in a vulnerable neighbourhood on its north side. Last August, just a few months after the station was completed, La Crosse got clobbered with nine inches of rain in a single day. ITT Water & Wastewater's innovative new pump station – designed using computer simulations in distant Stockholm, Sweden – prevented what could have easily been a disaster.

It all began in 2005 with city leaders listening to complaints from north-side residents about their ongoing struggles with wet basements and flooded streets. The city decided to allocate 1.9 million US dollars for a pump station that would divert water out of the neighbourhood and straight into the Black River, which flows into the Mississippi just north of downtown.

**But there were** complications. The new pump station would have to fit into a very tight space. Worse, the storm water pouring into it would need to make a 90-degree turn before reaching the pumps. That's the

kind of unusual situation that forces engineers to think outside the box.

Three hours to the east, Jim Fischer, an engineer at ITT Water & Wastewater's Pewaukee office, learned of La Crosse's plans and the site's unusual demands.

Fischer turned to colleague

After being pumped away, the storm water discharges into the Black River, out of harm's way.



Slavica Žikić at ITT Water & Wastewater's headquarters in Stockholm. An architect by training, Žikić is an applications engineer who specialises in designing pump stations. She felt confident that ITT Water & Wastewater could deliver a workable plan. To make sure the water would flow straight as it approached the pumps, she focused on redesigning the suction intake.

**For help with** her redesign, Žikić engaged Viktor Bredwad, a design engineer in hydraulics at ITT Water & Wastewater.

Bredwad turned to computational fluid dynamics (CFD), the computer modelling technology that uses sophisticated math to simulate water flow. He used FloWizard software, a simplified version of the complex simulation programs usually used in the industry, to try out many different design modifications, sometimes running tests daily.

Bredwad found a geometry for a suction intake that he thought would perform well, under even tougher conditions than those at La Crosse. At that point, a physical model was built to verify the results. Not long after, construction of the new pump station began in La Crosse.

“Local residents say that if it weren’t for that pump station, they would have had a huge problem on their hands.”

GREG KOZELEK



## A STRONG TOOL WITH LIMITATIONS

WHEN SLAVICA ŽIKIĆ sees a design for a new pump station, she often requests computer simulation tests. “I can point to risk zones,” says Žikić an applications engineer at ITT Water & Wastewater’s headquarters in Stockholm. “I ask people from CFD [computational fluid dynamics] to analyse those risk zones.” CFD is computer modelling of water and other fluids. The goal, she says, “is to minimise the risk that something will go wrong.”

Using CFD, Žikić can test a pump station’s likely performance when a storm brings high winds and heavy rains. Although CFD is not a perfect tool, she says, computer simulation is great for letting engineers “very easily slice the whole fluid and see the velocity at each point.”

CFD is less ideal, however, for testing the effects of air bubbles that are very dangerous to the pump, as simulation is too time-consuming. For air bubbles, a physical model test works better.


“CFD has some limitations, and model tests have some limitations,” she says. “The best scenario is to use both.”

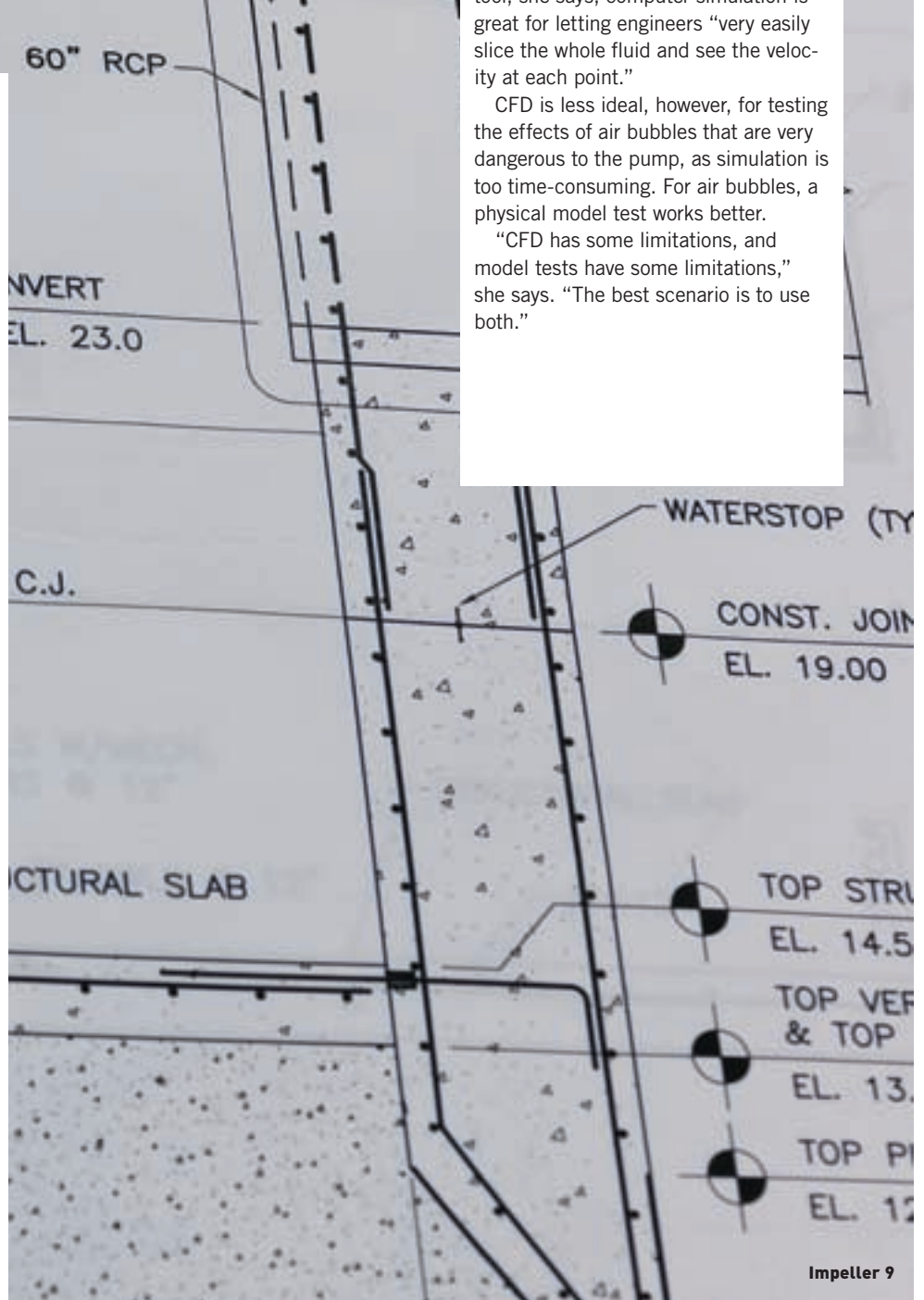
From the outside, the station isn’t very dramatic. Behind its frosted glass doors, however, are state-of-the-art electronic controls and a gigantic generator in case of a power failure. And some 25 feet underground are the two Flygt submersible pumps from ITT Water & Wastewater that together can handle 60,000 gallons a minute, or about two inches of rain per hour.

Back in Stockholm, Žikić admits that she was a little nervous when the pump station was put to the test in the storm last August.

“Pump station design is not an exact science,” she says. “There is so much insecurity in it, for nature is very unpredictable.”

But the new pump station did exactly what it was supposed to – as the computer simulation predicted it would.

Says Greg Kozelek, an engineer for the city of La Crosse: “Local residents say that if it weren’t for that pump station, they would have had a huge problem on their hands.” Not to mention in their basements. 





**CFD GIVES  
FIFTIES-PLANT  
NEW RUN**

A CFD analysis was used to test three critical parameters of the upgrade, says Bryan Hickling and Angus Buxton.



## The Christchurch Wastewater Treatment plant (CWTP) was recently upgraded using Computational Fluid Dynamics (CFD), to meet the needs of a fast-growing city.

TEXT JULIA MARSHALL PHOTOS CAMERON LAIRD

**FOR INTERNATIONAL VISITORS** to New Zealand, Christchurch – a smallish city on the East Coast of the South Island – is often the first stop. They find a city quaintly reminiscent of England, with its parks, English gardens and architecture.

Around 350,000 people live here, and it is one of New Zealand’s fastest-growing cities. Recently the Christchurch Wastewater Treatment Plant (CWTP) – the second-biggest in New Zealand – had a major upgrade, including four new pumps as part of the capacity upgrade, preparing it for another 20 years of growth.

Ninety-six pumping stations pump the sewage from low areas around the city. Five terminal pumping stations then pump 181,000 m<sup>3</sup> of wastewater per day to the CWTP.

The upgraded trickling filter pump station now has four identical pumps in parallel configuration, drawing from a common intake through individual suction tubes.

“The pump station upgrade was

very successful, with the assistance of the CFD analysis,” says Bryan Hickling, Christchurch City Council Pumping and Storage Engineer.

The original plant, technologically advanced for its time, was designed by a Californian engineer in 1957.

“The plant was well-built to start with, and we wanted to do it well again

– only this time we had to work with the constraints of what was already there,” says Angus Buxton, Senior Mechanical Engineer, Beca, the company which engineered the refurbishment put into commission in early 2008.

What was there was less than ideal.


The use of CFD to define the best solution to what Buxton describes as a set of “non-ideal parameters” was a condition of the pump supply contract.

“CFD was critical because we had a less-than-optimal fixed asset. The intake chamber was rectangular, which caused swirl. There are standards for intake designs which the station didn’t comply with. When it was built in the 1950s those standards didn’t exist.”

Buxton says CFD was also needed to understand the hydraulic characteristics of the intake of each individual pump, affected by butterfly suction valves, mounted close to the pump inlets. The third reason for the CFD work was to understand the effect on the pumps of a very low suction head.

**The CFD modeling** focused on unfavorable hydraulic conditions – non-uniform flow, unsteady flow, swirl, vortices and air entrainment. These factors can cause uneven load on the impeller, causing in turn increased vibrations and noise and in the worst case, physical damage to the pump.

Initial CFD results advised changing the suction valves under the pump, which were causing non-uniform flow.



**OPERATING DATA (2006/2007)**

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**Average Flow:** 181,000 m<sup>3</sup>/day  
**Average BOD Received:** 45.0 tonnes/day  
**Suspended Solids Received:** 56.8 tonnes/day  
**Faecal Coliforms Removal:** 99.999%  
**Gas Production:** 15,392 m<sup>3</sup>/day  
**Annual Electricity Production:** 11,250,000 kWh  
**Connected Population:** 323,019



“We get higher speeds and larger models and can incorporate more obstacles.”

THOMAS SVENSSON

Energy efficiency was one of the basic parameters of the CWTP upgrade. A recent energy audit shows satisfactory results.

Buxton asked for a more detailed analysis, with more accurate design of the valve.

“The butterfly suction valve is a lens-shaped valve: we had some old drawings from the fifties. We didn’t want new valves.”

The outcome of the CFD was to lift the pumps 200 millimeters. This relatively small change made a big difference.

“It was a very subtle change, but the CFD study showed that it mattered,” says Buxton. “Lifting the pumps by 200 millimeters moved them out of the eddy area created by the valves. The CFD proved it beyond all doubt.”

There was a limit to how far they could lift the pumps. “It was fortunate that the CFD showed we could move within that limit.”

Without the CFD simulation, “we would have had noisy pumps, and probably a lot of issues of wear and tear,” he says. “The pumps are now operating healthily and will have a long life. This was the purpose of the CFD; we wanted to make sure the pumps wouldn’t vibrate and cause damage, and would have acceptable hydraulic performance.”

“A CFD is based on a lot of trust, re-

## Computational Fluid Dynamics in motion

**THE MOST COMMON** parameters to consider in Computational Fluid Dynamics for pump sump hydraulics are swirl angles and axial velocity, says Thomas Svensson, Application Engineer in Computational Fluid Dynamics at ITT Water and Wastewater.

“The purpose of what we do with CFD is to see how obstacles will affect the performance of the pumps and to mathematically validate and predict the flows,” he says.

CFD was necessary for the Christchurch Wastewater Treatment Plant (CWTP), because it involved replacing old pumps. “The butterfly valve installed upstream was worrying for us,” says Svensson, “because it was so close to the pumps and was creating uneven axial velocity.”

Data and geometrical collection is an important part of the process.

To achieve good simulation, “you have to estimate what is important to the sump, how much it matters and how detailed the resolution and boundaries will be.”

The need for more advanced simulations drives computer development.

“We use computer clusters of parallel machines, so we get higher speeds and larger models and can incorporate more obstacles.”

He agrees it is very important to validate the codes used and also in some cases, as with CWTP, to measure more things.


“CFD is the result of cooperation between the system engineer, the measurement technician and the simulation technicians, combined with the customer who often has a very good feeling for and knowledge of the application.”

viewing and questioning,” says Buxton. “The chamber needed better modeling; but all the time we were coming closer to a more accurate model.”

Plant Manager Franz Resl, who came to New Zealand from Austria three years ago, says if you don’t evaluate and validate your model it is better not to have one. “Interpretation is the key.”

The CWTP is based on biological carbon reduction. The main job of the four pumps is to pump primary effluent

up to the trickling filters. This is one of two lift stations between primary and secondary treatment stages.

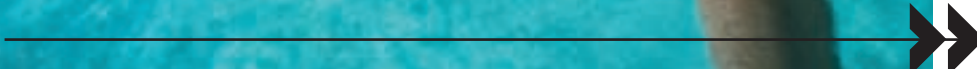
One of the basic parameters of the Christchurch Wastewater Treatment Plant was to save energy. The results of an energy audit three months ago shows the plant is efficient. “There are still some jobs to do, but we are exporting 5–6,000 kWh per day from the plant’s biogas power generating system,” says Resl. 

Just before leaving the plant, the water circulates at a rate of 10,000 cubic metres per hour through two tanks, whose grey-and-white supporting columns rise temple-like from the blue water.

TEXT KATHERINE SCHMIDT  
PHOTOS THOMAS MÜLLER

# SAFE WATER IN LANGENAU

The water treatment plant at Langenau, Germany, conceals within its modest structures a water treatment system replete with technological wonders. One is the ozone cleansing technique supplied by ITT Water & Wastewater.





ITT Water & Wastewater's Wedeco ozone generator type PDO 2500 comes into play at Langenau after solid substances have been removed.



Langenau has implemented an alternative that allows the plant to save costs on production of ozone and reduces down-times to practically nothing. (Left) Friedbert Holmer and Marco Rosner, ITT Water & Wastewater.

**IT'S A GOOD BET** that few of the people living in Stuttgart or other cities and towns in Baden-Württemberg give much thought to the clean water that enters their homes each day. Every year the Langenau treatment plant supplies 3 million people in Baden-Württemberg with 90 million cubic metres of water that is colourless, odourless and most important, free of disease-causing agents and chemical poisons.

Friedbert Holmer, director of operations for the Langenau plant, is quick to tell visitors that the idea behind the water company's founding in 1912 was to distribute water from those parts of Baden-Württemberg blessed with ample water supplies to drier areas of the German state. The Langenau plant takes about one third of the water it treats from the Danube River, another third from a total of 200 wells, and one third from water supply stations located on the eastern edge of the Swabian Alb.

The water treatment plant relies on a five-step process to remove three kinds of substances from the water – micro-

“ Our experience up till now is that the propensity for breakdowns with the system is practically zero.” FRIEDBERT HOLMER

organisms such as bacteria, viruses and algae p.e., inorganic substances such as particles, sand or clay, and organic substances such as humic substances, pesticides or herbicides, says Holmer.

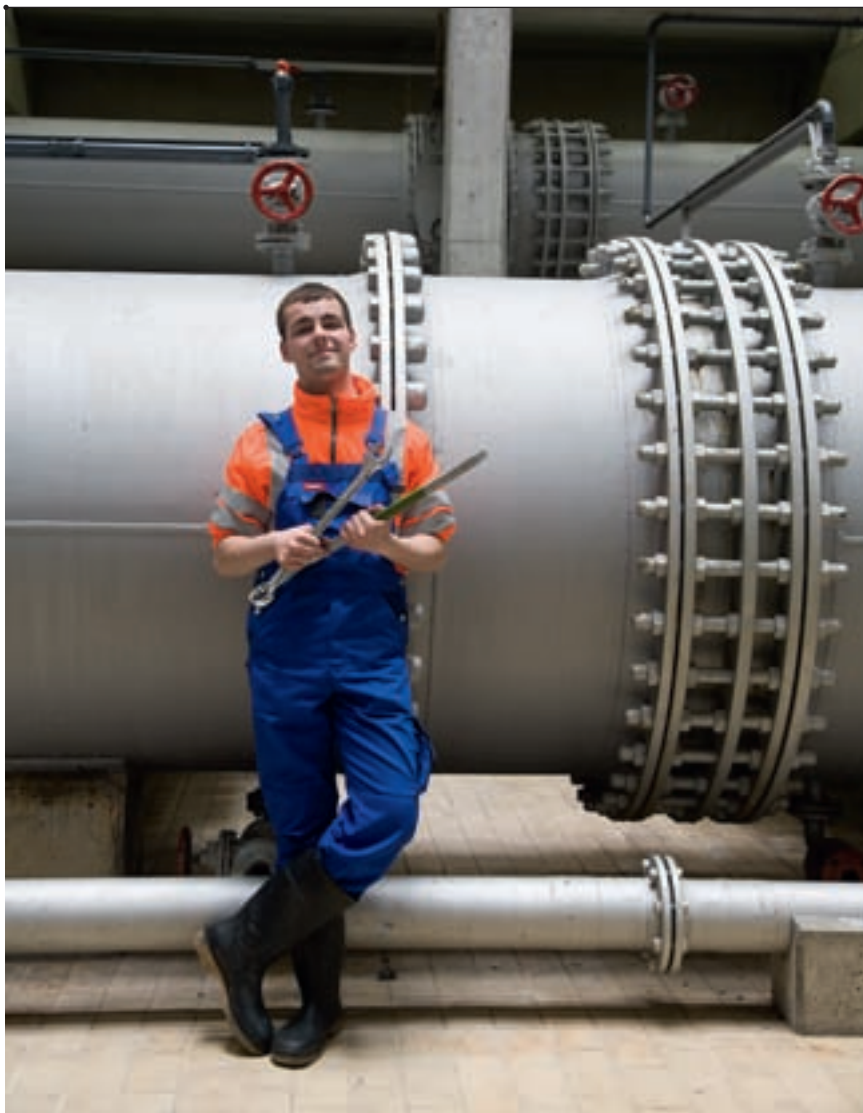
**In the first step** of the treatment process, called flocculating, a flaking agent is added to the untreated water. The flocs (aggregated particles) that are created and settle at the bottom of the tank to form sludge. In the third step, ozone is added to the water to kill microorganisms that could cause diseases such as cholera, typhus and giardiasis.

Following the treatment with ozone,

the water flows through a dual-media filter, which first removes particles (using sand filters) and then organic substances such as pesticides (using activated carbon filters).

In the final step, the filtered water is treated with a small amount of chlorine dioxide, to prevent the growth of bacteria and viruses in the distribution network.

Throughout the treatment process chemists and scientists at three laboratories conduct tests to check for impurities and toxic substances in the water, down to the smallest possible measurement – a nanogram per litre (equiva-




The Langenau treatment plant supplies 3 million people with 90 million cubic metres of water.

lent to one sugar cube in 12 olympic swimming pools). In the first laboratory, work areas radiate out from a central hub where 17 taps dispense water from various stages of the purification process. Here Thoralf Volquardsen's team analyses crucial parameters.

In the next building, a team of chemists and scientists checks samples for traces of more than 350 substances, including pesticides, heavy metals and pharmaceuticals, also in concentrations down to a nanogram per litre. The water is checked for the presence of microorganisms in the third laboratory. "The three fundamentally different laboratories, with their respective testing processes, together constitute the key element in our ability to guarantee a consistently high quality of drinking water," Holmer says.

The newest, most up-to-date part of the plant is the ozone treatment system installed by ITT Water & Wastewater in

2006. The equipment in use at the plant up to then, which was installed in 1973, was technologically outdated and cost too much to run, says Holmer. Another problem, he says, was that the ozone introduction system was located in three tanks that had to be cleaned out once a year, a process that took four days for each one. Also, the old ozone system was prone to breakdowns.

ITT Water & Wastewater, Holmer says, implemented an alternative that allows the plant to save costs on production of ozone and that reduces downtimes to practically nothing, since the ozone-injection equipment is not located in the contact tanks. "We worked together with ITT Water & Wastewater on a few points until we could meet all of our requirements and find the optimal solution," Holmer says. "And they accepted and took full account of our operational needs, even if it meant more time and effort on their part." 

## OZONE EFFICIENTLY KILLS MICROORGANISMS

### ITT WATER & WASTEWATER'S WEDECO

ozone generator type PDO 2500 comes into play in the middle of the water treatment process at Langenau, after particles have been removed from the water in two rounds of flocculation.

The Wedeco PDO 2500 consists of a cylindrical tank about 3 metres long and 80 centimetres in diameter. Surrounded by pipes and valves that regulate the inflow of oxygen, it's used to produce ozone and carry the ozone produced to the reaction tanks, where it is mixed with water coming out of the flocculation process. When oxygen molecules pass through this electrical field, some of them break down. Atoms set free in this process combine with remaining oxygen molecules to form ozone.

The ozone is transported through pipes to three contact tanks containing pre-treated water. Just outside the reaction tanks, the ozone is injected into the water using several static mixers and a pump injection system. The water containing the ozone flows into the reaction tank, where the ozone reacts with organic compounds and kills microorganisms by destroying their cell walls.

At the far end of the tank, the ozone-treated water flows out toward the next step in the treatment process, filtration and adsorption of compounds such as fertilisers. Small amounts of unused ozone gas flow upward out of the tank and are sent into a residual ozone destroyer. This prevents ozone gas from escaping into the atmosphere and causing harm to people and the ecosystem in general.

Along with PDA models from ITT Water & Wastewater, the Wedeco PDO ozone generators are the only large-scale systems on the market that are pre-assembled and tested prior to delivery. That ensures the highest level of reliability for the customer. "Our experience up till now is that the propensity for breakdowns with the system is practically zero," says Friedbert Holmer, director of operations for the Langenau plant. This is a much more cost-efficient ozone-producing system than we had before."

# THE WINNING WAY OF VIRTUAL WATER

**IT TAKES 140 LITRES** of water – virtual water, that is – to make a single cup of coffee. “The concept of virtual water helps us realise how much water is needed to produce different goods and services,” says **Tony Allan**, the 2008 winner of the Stockholm Water Prize.

**T**HE WINNER OF THIS year’s Stockholm Water Prize, John Anthony Allan, seems to have a natural affinity for water. He doesn’t hesitate to step into the impressive fountain of London’s Somerset House – close neighbour to King’s College London where Allan is professor emeritus – to allow that perfect picture the photographer wants.

**Date of birth**

29 January 1937.

**Career**

Started in the geography department at Durham University. After a period in the British National Service and five years in industrial management, returned to science at the School of Oriental and African Studies (SOAS) in London. After 35 years at SOAS, moved to King’s College London where he is now professor emeritus.

**Latest book read**

*Arabs*, by Mark Allen.

**Most influential person**

Kader Asmal, former South Africa Minister of Water Affairs and Forestry and Stockholm Water Prize winner in 2000. Kader Asmal is the only other non-engineer/water scientist who has been awarded the Stockholm Water Prize.

**Favourite quote**

Water flows uphill toward money and power.

**The best tap water ever had**

In 1987 in Damascus, Syria.

“Prizes such as this usually come late in the life of laureates,” says Tony Allan, 71. “However, I feel very honoured to have been recognised, and it gives me further energy to think that I have a few more years of creativity left. I also very much appreciate that the prize jury has acknowledged my interdisciplinary activity.”

Allan’s work has focused in part on helping people understand the hidden water use in products and services. He uses the example of a cup of coffee, which, he calculates, has 140 litres of water “embedded” in it. This amount of water is roughly the same as what is used daily by the average person in the UK for drinking and household needs.

“The concept of virtual water helps us realize how much water is needed to produce different goods and services,”

he says. “In semi-arid and arid areas, knowing the virtual water value of goods or services can be useful in determining the best use of the scarce water available.”

For more than 40 years, Tony Allan has been interested in the technical, environmental and socio-economic problems of managing water in water-scarce regions, mainly in the Middle East. As an environmental scientist his early preoccupations were with using water resources more efficiently.

While studying water issues in the Middle East, he developed the theory of using virtual water imports via food as an alternative water source to reduce pressure on the scarcely available domestic water resources there and in other regions short of water. Over the years, it became increasingly clear to him that the trade of virtual water is closely linked to aspects such as politics, economics, agriculture and climate change.

“Virtual water trade refers to the idea that when goods and services are exchanged, so is virtual water,” Allan says. “When a country imports a tonne of wheat instead of producing it domestically, it saves about 1,300 cubic metres of real domestic water. If this country is short of water, the water that is saved can be used for other purposes.” He explains that, by the same terms, the exporting country has exported 1,300 cubic metres of virtual water, “because the real water used to grow the wheat will no longer be available.”

Although all the water ministers in the world are aware of the issue of virtual water, the notion is still very disturbing to political leaders and senior water professionals, says Allan.

“Neglecting the implications of virtual water ‘trade’ enables political leaders and many millions of water consumers to be in denial for decades





## The Stockholm Water Prize

**THE STOCKHOLM WATER PRIZE** is a global award founded in 1990 and presented annually by the Stockholm Water Foundation to an individual, organisation or institution for outstanding water-related activities. ITT Water & Wastewater are proud to be one of the founders of the prize.

Stockholm Water Prize winners receive 150,000 US dollars along with a glass sculpture. The award this year was presented 21 August in the Stockholm City Hall. King Carl XVI Gustaf of Sweden is the patron of the Stockholm Water Prize.

Tony Allan was awarded this year's prize, "for his unique, pioneering and long-lasting work in education and raising the awareness internationally of interdisciplinary relationships between agricultural production, water use, economies and political processes."

### VIRTUAL WATER IN DIFFERENT PRODUCTS (L)

- 1 glass beer (250ml) 75
- 1 glass milk (200ml) 200
- 1 glass wine (125ml) 120
- 1 cup coffee (125ml) 140
- 1 cup tea (125ml) 35
- 1 piece bread (30g) 40
- 1 potato (100g) 25
- 1 egg (40g) 135
- 1 hamburger (150g) 2400
- 1 cotton T-shirt (medium, 500g) 4100
- 1 page A4 paper (80g/m<sup>2</sup>) 10
- 1 pair of shoes (bovine leather) 8000
- 1 microchip (2g) 32

**Source:** SIWI, UNESCO-IHE Institute for Water Education

“Neglecting the implications of virtual water ‘trade’ enables millions of water consumers to be in denial.”

about their immediate water crisis,” he says. Allan cites the insight of American business guru Peter Drucker, who says it is better to do the right thing badly than the wrong thing extremely well. One of the greatest challenges that we are facing today is shifting from doing the wrong things extremely well with our scarce water and energy resources to accelerating the adoption of clean technologies.

“To this end, individual families, global corporations and public sector organisations can all be provided with

estimates of the impact of their consumption of water and of goods and services on water resources,” he says. “Yet there are some good signs. Coca-Cola has been among the first [multinational companies] to recognise the role of water footprints and virtual water estimates. They want to identify how they can improve their performance in water management, because they do not want to jeopardise their reputation and brand.” One personal challenge Allan is facing is to become a full-fledged vegetarian.

“Vegetarian food consumers in the most advanced economies consume only half the water of a non-vegetarian,” he says. “This is crucial because 80 to 90 percent of the water spent in these economies is used in producing food.”



Boring 25 kilometres through the Asturias mountain range, the Pajares tunnels will shorten the railway line by 34 kilometres.

# NO ROOM FOR ERROR

**WHEN YOU DIG A TUNNEL DOWNWARDS** – especially if it is long and the gradient is steep, as in the Pajares tunnels in Spain – reliable pumping is essential.

TEXT ERICO OLLER WESTERBERG PHOTOS ITT WATER & WASTEWATER, KELVIN WAKEFIELD/ISTOCKPHOTO

**BORING 25 KILOMETRES** through the mountain range that separates the central Spanish plateau from Asturias, the Pajares tunnels will hold seventh place in the world's ten longest tunnels. With a price tag of 1.4 billion euros, two parallel single track tunnels will shorten the railway line by 34 kilometres and will make the trip even shorter as the trains will be able to increase their speed to 250 kilometres per hour.

The state-owned body ADIF (Administrador de Infraestructuras Ferroviarias), which is responsible for managing the project, divided the tunnelling into four sections, each one allocated

to four different consortia who worked simultaneously. The tunnels, which have to be delivered complete with the associated civil work by mid-2009, have been dug on a downward slope in both the first section, which starts at 1,000 metres above sea-level in Castile, and in the second section, whose entry point is halfway up the mountainside.

“A large proportion of tunnels are dug upwards but there are projects, such as this one, in which the relief does not allow this. Digging on a downward slope creates the problem of removing the water since, if it was to flood the tunnelling area, would damage the tun-

nel boring machine (TBM) and put us behind schedule,” says Ignacio Muñiz, FCC – Acciona's manager, the construction company contracted for the first tunnel section, which is 10 kilometres long.

Santos Sanz is the manager for Dragados, the company responsible for the second section: two tunnels measuring 3.6 kilometres, which have already been dug, and an evacuation and access tunnel perpendicular to the main tunnels. “In tunnel digging, unexpected things can happen, in spite of careful planning. It's just a fact of life. In this case, the problem has been the amount of water,” he says.

Ernesto Lago, Dragados' machine manager at Pajares, puts figures to the challenge: “On the basis of the geological forecasts, we installed two dewatering pipes with a diameter of eight inches each, but we had to install another three lines, each one with a diameter of 12 inches,” he says.



The tunnels have been dug on a downward slope in both the first section, which starts at 1,000 metres above sea-level, and in the second section, whose entry point is halfway up the mountainside.



The team from ITT Water & Wastewater Spain has overcome a lot of challenges.

“With a 6% gradient, there is less room for error. The water quickly accumulates at the cul-de-sac, so pumps must be efficient and reliable,” Lago adds, whose plant pumped out up to 25,000 m<sup>3</sup> daily for a few weeks.

Diego García, FCC – Acciona’s machine manager at the first section of tunnels, did not have to worry about steep slopes. His challenge was the sheer length of the tunnels – 10 kilometres – which required eight pumping stations and a sophisticated high-voltage switching system for the electricity supply, and the possibility of bypassing any stations that should become inoperative.

“The big challenge is zero error. When tunnelling on a downward slope, there must be total reliability; any flooding would immediately affect output and could cause very expensive damage. So, apart from designing the pumping, we also chose a pump supplier with a local presence for rapid supply and servicing and installed an early warning system to detect problems,” García explains, who operated at maximum

capacity (50,000 m<sup>3</sup>/day) for three critical days.

Sometimes, planning and foresight are not enough. Miners and tunnel-diggers throughout the world would be delighted if they could know beforehand what secrets lay hidden inside the mountains. Ernesto Lago is no exception. Within a few hours, and without his team being able to do anything to stop it, an inrush of water flooded the end of the tunnel.

“The TBM weakened a wall which must have held a water pocket. Suddenly, the infiltration increased drastically and, to make it worse, the water carried suspended in it an extremely fine and abrasive sand that immediately clogged tanks and pipes and damaged the impellers of many pumps. We didn’t have time to react and within an hour we were flooded,” he remembers.

In circumstances like that, a good relationship with the pump supplier is decisive. And Lago remembers, in this case, the prompt delivery of Flygt pumps to handle the emergency. But he also praises the technical advice and the

## A DECISIVE FACTOR

**THE PAJARES TUNNELS** project used a rental fleet of 120 pumps, with a 24-hour rental and repair service. 190 Flygt dewatering pumps were used, of which about 80 were BS2400. The usual layout of a pumping station was 5 90 kW BS2400 MT pumps (231), plus one 37 kW BS2201 HT (233) pump to give a peak flow-rate of about 700 l/s.

A number of pumping stations were equipped with advanced FMC controllers connected by WiFi to a SCADA Aquaview system, which enables each pumping station’s status and operation to be monitored from the offices located outside of the tunnel.

“Big projects like this challenge our products and our ability to give service. And it is a great satisfaction for us to have contributed to the project’s success,” says Miguel Cobos, project manager at ITT Water & Wastewater Spain.

monitoring of power consumption and efficiency by ITT Water & Wastewater at weekly meetings with his team while the project was in progress.

When the high-speed trains rush through these long tunnels, the untiring work of the pumping facilities and those who watched over them night and day during the digging will be just a memory. By then, probably, the force of gravity will be doing the job and the water will flow naturally downwards without causing any problems. 🌀

# IMPROVEMENTS SPELLED WITH N

The launch of the Flygt N-pump led to an entirely new standard in terms of operating efficiency and non-clogging operation. The new generation of Flygt N-technology is now here with better hydraulics, a wider range of materials and greater flexibility.

TEXT ERICO OLLER WESTERBERG PHOTO ITT WATER & WASTEWATER



**GREAT INVENTIONS ARE** often born by someone questioning a prevailing “truth”. And the N-pump, with its outstanding operating efficiency and ability to resist clogging, would not have been invented if the engineers at ITT Water & Wastewater just accepted one of the industry’s most long-lived myths: that only a large throulet can minimize clogging.

Since then, more than 140,000 N-pumps have proven this not to be the case. The N-pump established itself in the market as a very cost-effective solution for those prioritizing reliability, maintenance-free operation and long-term economy.

The durability of the enhanced N-technology impeller of hard iron was tested by pumping water with a high concentration of coarse sand for 200 hours. The engineers estimated the amount of sand pumped to be 2,400 tons or the equivalence of 65 fully loaded mining loaders of the largest model.

Now, ITT Water & Wastewater is launching a new generation of N-technology in which the pump’s design was able to be refined and its flexibility increased through research and product development.

“Continuous development efforts have been under way based on the experience we gathered since the launch of the N-pump and have been driven by market demand and customer wishes. The enhanced N-technology offers even better overall economy and, thanks to more material options and greater flexibility, a broader range of applications,” says Sarka Brydniak, Product Manager for the N-pump at ITT Water & Wastewater in Sweden.

One of the major advances with the enhanced N-technology is that it can be ordered in hard iron for applications that require greater wear and corrosion durability. Hard iron is recommended for the handling of oxygen-rich water (such as aeration tanks in wastewater plants) in applications with high erosion-corrosion impact.

“We have tested the new material both in the lab and at customers under real conditions, and the results have been unambiguous: in wearing or corrosive applications, the lifetime of the hydraulic parts can be considerably increased without losing any efficiency whatsoever. A customer in Australia, where we tested a pump impeller for nine months, has already specified hard iron as its choice of material for all of the N-pumps to be purchased moving forward. Despite the harsh saltwater

Another innovation is that the N-pump has been equipped with insert rings for greater flexibility.



## THE NEW GENERATION OF N-TECHNOLOGY

- Improved self-cleaning and highly effective pump impeller.
- Insert ring with relief grooves that, together with the impeller, create a clog-free hydraulic unit.
- N-impellers and insert rings made of cast iron or high chromium cast iron.
- Inspection chamber to check for possible leakage.
- Thermal contact that shuts off the pump if it overheats.
- Various motor powers.
- Cooling system as a supplemental option for dry-mounted installations.
- Plug-in-seal for greater reliability and rapid and safe replacement.

## SEVERAL TONS OF PROOF

**THE ENHANCED N-TECHNOLOGY** has been tested both in the lab and under real conditions at customers. Among other aspects, the durability of the N-pump of hard iron was tested by pumping water with a high concentration of coarse sand for 200 hours.

The engineers estimated the amount of sand the N-pump pumped to be 2,400 tons or the equivalence of 65 fully loaded mining loaders of the largest model.

“The enhanced N-technology offers even better overall economy.”

penetration that damaged the facilities’ pumps, the tested N-pump was practically intact,” explains Brydniak.

Another N-technology innovation is that the pump has been equipped with insert rings for greater durability and flexibility. The insert ring, with the relief groove and a well-conceived geometry, matches the pump impeller in terms of choice of materials and protects the pump housing.


“In very demanding applications, not only the pump impeller but also the pump housing was affected by the wearing or corrosive medium. Now

the problem has been solved without compromising on the hydraulics,” says Brydniak.

The insert rings have also made possible a broadening of Flygt’s pump offering in that an insert ring can be ordered with cutting edges, which converts the pump to a fertilizer or chopper pump. Pumps are used in applications where fibers or hard objects from extremely polluted water must be shredded. “Yet again, it is about increasing flexibility. The customer does not need to tie itself to one material or design. Should circumstances change,

the pumps can be adapted by switching material or design of the impeller and insert ring,” explains Sarka Brydniak.

“We will see many more N-pumps in sewage plants in the future. The improved durability of the hydraulic parts together with the N-pumps’ outstanding non-clogging operation make these pumps well suited to handling sludge,” says Sarka Brydniak and continues:

“Of course, a major advantage is that the pump can be converted into a chopper pump with nearly the same operating efficiency by changing an insert ring.” 

# OZONE

## the green treatment

Ozone might have a tarnished reputation but the fact is that the treatment of water with ozone represents an environmentally friendly alternative to chemicals. The ITT Water & Wastewater brand Wedeco is a world leader in the manufacture of ozone treatment systems.

TEXT ERICO OLLER WESTERBERG PHOTO MAGNUS CRAMER/FOLIO

**UP IN THE STRATOSPHERE,** ozone acts as a shield and protects us against excessive UV-radiation. That is the reason why the depletion of the ozone layer is a source of concern. On the contrary, ground-level ozone can reach levels that are dangerous to the health on hot sunny days in very industrialized urban areas with heavy traffic.

In other words, ozone may do well for you if in the right place.

In fact ozone has been used to improve the quality of drinking water since the early 1900s, when St Petersburg, Nice and Berlin began the practice. Since then, across Europe it has become standard to use ozone in the later stages of water treatment.

In much of the world chlorine remains the first choice in water treatment, but that it is set to change.

“The trend is to replace the use of chlorine with ozone wherever possible,” says Harald Stapel, Sales manager at ITT Water and Wastewater, a world leader in the manufacture of ozone treatment systems. “In Europe waterworks are upgrading their facilities with third-generation ozone generating systems, while in other big markets, such as the USA and China, engineers are going for ozone technology in many of the newly built plants or are replacing conventional oxidation and disinfection by ozone.

“There are economical and technical reasons for doing this,” Stapel says, “but the main reason, in these times of ecological awareness, is that operators do not want to deal with the by-products that are left after using chlorine in their processes.”

Ozone has been successfully used in the disinfection of fresh water, process water and cooling water, as well as for detoxification, decolouration and deodorisation. Ozone also improves flocculation, optimises filtration and breaks

### GREEN FROM THE BEGINNING

**THE WEDECO BRAND** of the ITT Water & Wastewater group, was founded as Wedeco AG in 1976 in Herford, Germany, to develop chemical-free and environmentally friendly methods of water treatment. The pioneering operation, with a staff of six, has grown into a market leader in the fields of UV and ozone disinfection, with a worldwide presence and more than 320 employees. ITT Industries acquired the company in 2004.

“We do not sell just ozone generators,” says Harald Stapel, Sales manager at ITT Water & Wastewater. “We sell complete treatment stages configured according to the needs of the end users, integrating the complementary techniques and features they may require. Operators can rely on a quick set-up and extremely low maintenance and service costs. Many clients still think that the electrode of an ozone generator is a consumable. The fact is that our electrodes have a service life of >10 years.

“ITT Water & Wastewater is able to supply the ozone equipment for upgrading existing plants as well as engineer and deliver complete oxidation and disinfection processes for a wide range of water treatment applications,” he says.


down endocrine disrupting compounds (EDCs).

Outside the water industry, another extended and well-proven use of ozone is in bleaching applications in the pulp and paper industry.

“But the main global market is the treatment of drinking water,” explains Stapel. “Treatment facilities are often not far away from populated areas, and operators do not want to have to transport hazardous chemicals such as chlorine to the plants. If you use ozone in the treatment, there is no need for a permanent supply and storage of chemicals. Basically, all you need is dry air or oxygen and electricity.”

Decades ago, many plant operators didn't consider ozone treatment a solid alternative to chlorine. This is because the use of chlorine was not put under scrutiny as it is today, and ozone technologies were not at their present levels of efficiency.

“The use of pure oxygen where possible to replace ambient air and breakthroughs in ozone generation, as in our Effizon® HP Electrode, have increased the performance of ozone systems dramatically,” says Stapel. “We are replacing systems that were able to produce ozone concentrations of 20 g/m<sup>3</sup> of ozone with state-of-the-art equipment that is exceeding the 200 g/m<sup>3</sup> mark.” And he adds: “Current oxygen fed generators consume some 40% less energy than 10 years ago.”

That is an important development. When used in appropriate concentrations, ozone acts rapidly and effectively. The output of the new systems, larger in terms of ozone per unit of oxygen and cheaper in terms of energy consumption per gram ozone produced, can improve the current treatment processes. Thus with a modern ozone system a plant can either process more water in the same amount of time or use smaller tanks to treat the same amount of water. 

# NEW SKYLINE FOR ROMAN SUBURB

**THE EUROPARCO BUSINESS PARK**, a new building development in Rome, will feature something particularly unusual in the “eternal city” – a skyscraper. The skyscraper, with 35 residential storeys, will be the first building in Rome to break the 100 meters mark. Europarco is situated in Eur, one of the recently integrated municipalities in the Italian capital. It covers 50 hectares and includes office buildings, conference halls, parks, an indoor sport arena and a shopping centre. It also includes green areas and modern infrastructure and communication systems – assets that are not always available in older parts of Rome. A drainage and rain water management system has been built to serve the newly developed area that is equipped with 12 big Flygt C and four N pumps from ITT Water & Wastewater. The pumps are installed submersed and fitted with a monitoring and control system with special features. The system, operating automatically together with remote controlled lifting gear, cycles all the units, including the back-up pumps, monitoring their condition while in service. This allows early detection of potential problems in the pumps and guarantees that they will be fully operational at any moment, ready to work at peak capacity if the need arises. 



PHOTO ITT WATER & WASTEWATER

The ITT Water & Wastewater pumps are monitored by a control system with very special features.

## LITTLE PUMP, GREAT WORKER

**ITT WATER & WASTEWATER** has launched the new Flygt DXG grinder pump, the most recent addition to the DX family of pumps for the residential market. The Flygt DXG manages household sewage with outstanding reliability, boasting a heavy-duty cutting device that will turn solid matter accidentally flushed down


the drain into sludge. This dramatically reduces the risk of clogging. The new pump has a capacity of 2.2 l/s and a maximum head of 25 m. In lab tests, the Flygt DXG has performed more than 22,000 starts, which equals 10 years of normal service, and it is still going strong. 

PHOTO ITT WATER & WASTEWATER





FLYGT  
SANTAIRE  
WEDECO  
LEOPOLD

## 6000 experts working in 140 countries around the world.

### Working on winning hearts and minds

Get to know us and you'll feel the difference. Perhaps it's the fact that we never, ever give up in the face of challenge. Or the fact that we thrive on setting standards for a greater, universal good. Whatever the reason, we are nevertheless 6000 people deeply committed to delivering the best, most effective integrated solutions possible to you.

This attitude is what makes us who we are: ITT Water & Wastewater. We are the grand total of our outstanding product brands: Sanitaire, Flygt, Leopold and Wedeco. And we draw on the support of our strong global resources to work in close partnership with you, wherever in the world. To us, there are 140 innovative ways of working on winning your heart and mind.

*ITT Water & Wastewater is wholly owned by the ITT Corporation of White Plains.*

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*Engineered for life*



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