

here

“The Alfa Laval rotary jet mixer Iso-mix has set new standards on how beer is going to be made.”

Thomas Paludan-Müller, *technical operations manager at the Carlsberg Northampton brewery*

REFINERY MAKEOVER
Italian refinery enjoys dual benefits after Compabloc retrofit

CLEAN COAL PROGRESS
New Alfa Laval technology helps tackle cost-efficiency issues

Great strides towards
CLEANER SHIPPING

Legislation and technology are effective ways to help the shipping industry reduce its impact on the environment.



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Marine momentum

editorial Since Alfa Laval delivered its first separator to the marine industry in 1917, we have expanded our offering to comprise more than 15 main product groups. They include solutions for oil treatment and cooling and heating as well as environmental protection, tank cleaning and desalination. Our marine business has grown over the years, and today three out of four oceangoing vessels have Alfa Laval equipment onboard.

Earlier this year we took the next big step in expanding our marine business when we acquired Aalborg Industries, the world's leading marine boiler engineering company and supplier of inert gas systems, thermal fluid systems and shell-and-tube heat exchangers.

As a result of the acquisition we have not only an expanded product portfolio but also an impressive service network, enhanced technical expertise and a marine business that accounts for a quarter of Alfa Laval's turnover.

ACCORDING TO ESTIMATES presented in *Fearnleys Annual Review*, seaborne trade has quadrupled in the past four decades, and today around 90 per cent of world trade is transported by sea. The marine industry is now facing stricter environmental legislation, and finding ways to supply green, clean and safe sea transport will be at the top of everybody's agenda.

With Aalborg Industries onboard, with its competence in waste heat recovery and exhaust gas cleaning, we have enhanced our ability to provide energy-efficient and environmentally sound solutions. Some of our focus areas are ballast water treatment, products for SOx and NOx reductions (you can read more about our combined scrubber solution on pages 10–14) and oily water treatment. But there is more to come. As always, we are committed to delivering high-quality products to meet our customers' demands.

BEING INNOVATIVE is one key success factor for Alfa Laval. Improving our customers' processes by providing innovative solutions is what makes us stay ahead of the competition.

In this issue you can also learn how our new mixing technology has changed the way Carlsberg makes its beer and how our compact heat exchangers transformed the API refinery in Italy from a traditional plant into a modern and profitable refinery.

Enjoy!

PETER LEIFLAND
EXECUTIVE VICE PRESIDENT,
ALFA LAVAL GROUP
PRESIDENT, MARINE & DIESEL DIVISION



Alfa Laval takes part in Qatar's natural gas boom

As Qatar continues to expand its natural gas production by developing the new Barzan Onshore gas production plant, Alfa Laval retains its strong position within the industry.

Alfa Laval will deliver various heat exchangers to Japan's JGC Corporation, which is building the gas plant in Ras Laffan Industrial City, north of Doha. The Alfa Laval heat exchangers will be used to recover energy in the gas-cleaning process and to cool the overall gas plant. The order is valued at about SEK 90 million (EUR 10 million), with delivery scheduled for 2012.

The Barzan project comprises both onshore and offshore gas processing facilities and is managed by RasGas Company Limited, a joint venture between Qatar Petroleum and Exxon Mobil. It aims to start commercial production in 2014 and to produce 1.4 billion cubic feet per day, mainly to meet domestic demand from power stations and petrochemical industries. The gas comes from the North Field, the world's largest reservoir of non-associated natural gas. The field was discovered in 1971.

Qatar's oil and natural gas industries are important contributors to the country's economy, accounting for more than 50 percent of GDP, 70 percent of government revenue and 85 percent of export earnings.

Decanters to help provide potable water for millions in Mexico

Recently, Alfa Laval Mexico booked an order for six Alfa Laval G2 decanter centrifuges with Los Berros, Mexico City, one of the largest potable plants in Latin America, which supplies potable water to a quarter of Mexico City's 25 million inhabitants.

The G2 decanter centrifuges will play an important role in Co-nagua's (Mexico's national water authority) 20-year plan to improve Mexico City's potable water system. The decanters will dewater sludge produced at the Los Berros plant, resulting in reduced transport, disposal and drying costs along with reduced adverse environmental effects.

Today, Alfa Laval is involved in the processing of municipal waste from at least 200 million people. Various product solutions are used in more than 1,000 industrial applications and help to produce 1.5 million cubic metres of potable water every day.

DID YOU KNOW THAT...

...you can access the Alfa Laval Virtual Showroom via your smart phone? Showroom applications for iPhone and Android are available in 22 languages. Just go to alfalaval.com/showroom, where new, innovative products are added continually.

81 is the number of Alfa Laval service centres following the acquisition of Aalborg Industries. The centres offer customer services on all continents.



Alfa Laval celebrates 100 years in Italy

In 1911, when Alfa Laval opened its first site in Italy, in Milan, the task was to sell Alfa Laval milk separators and De Laval industrial centrifuges. Today Alfa Laval has about 800 employees in the country and offices in Monza, Alonte, Florence, Genoa, Parma and Suisio, and it offers a wide range of technical solutions to numerous industries.

"We are really proud to celebrate 100 years of an Alfa Laval presence in Italy this year, and look forward to the next 100," says Göran Hedbys, managing director, Alfa Laval Adriatic. "We foresee a future of innovation and new technological achievements, and our mission will be to continue to optimize the performance of our customers' processes."

Italy remains an important and central market for Alfa Laval, Hedbys says. A proof of that is the recent acquisition in Bergamo of Olmi SpA, a leading global provider specialized in the petrochemical, power and oil and gas markets, and in Parma of Astepo, a company with proven experience in the preserved food industry and solid know-how in aseptic technology.

On the occasion of its centenary in Italy, Alfa Laval is providing support for the Genoa Aquarium's Emys project, which is aimed at preserving a type of marsh turtle that was once thought to be extinct in the Liguria area. The turtle, *Emys orbicularis ingauna*, has now been located and reinserted in a part of its natural habitat.

Membranes step up biorefinery process

In the second generation of cellulose-based biorefineries, membrane processes have been identified as an energy-saving technology with unique separation properties. In the United States, ZeaChem is the first company to select Alfa Laval membrane technology for its cellulosic biorefinery pilot plant situated in Boardman, Oregon.

The plant is scheduled to go online in 2011 and will produce 250,000 gallons (almost 950,000 litres) of cellulosic bioethanol per year. Since most second-

generation bioethanol projects are still at the research stage, it is a major breakthrough for ZeaChem to be using membrane technology in one of the world's few larger pilot plants.

While membranes have not really been considered in the design of first-generation bioethanol plants, they have been included in several of the second-generation projects. Hence there has been a shift in the industry away from conventional separation technologies towards low-energy/high-selectivity separation units.



Support for marine studies

In China Alfa Laval is raising the level of marine training a notch with the sponsorship of an automatic engine room laboratory in Shanghai.

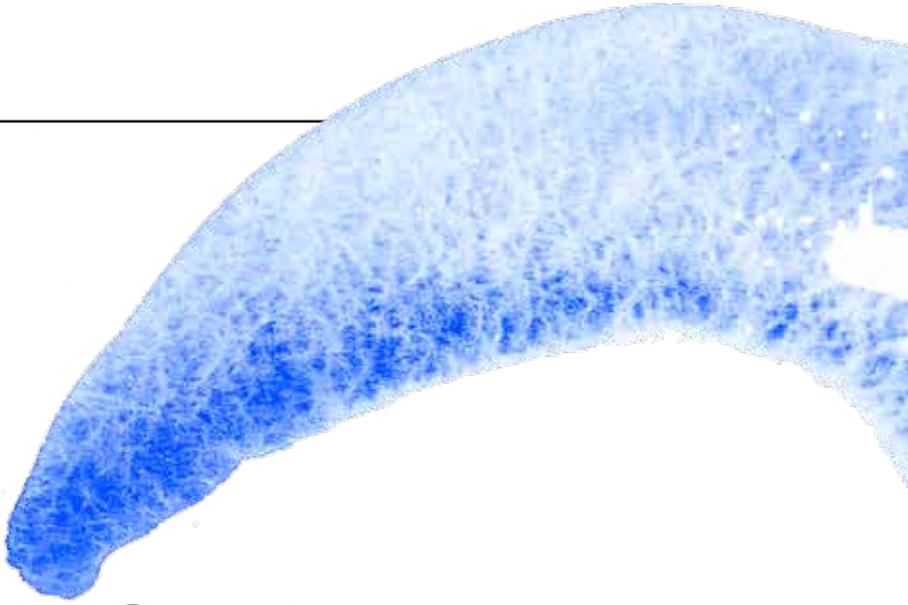
The new laboratory has been developed in Shanghai, in cooperation with Shanghai Maritime University to improve the physical conditions for marine training. The lab enables students to conduct research and learn how to operate marine diesel engines and engine room control systems based on the same standards onboard modern ocean-going vessels.

"This enables us to develop academic research on marine engineering much further, optimize the systems for ship engineering in our country and train the next generation of marine engineers to become even more competitive," says Professor Cai Cunqiang, vice president of Shanghai Maritime University.

Alfa Laval is sponsoring the new lab, further strengthening its cooperation with Chinese marine academies. It is the company's second cooperation in this field. Alfa Laval has a similar arrangement with the Dalian Maritime University in Northeastern China.

Building stronger relations with Chinese universities and students is an important part of Alfa Laval's recruitment strategy. China is Alfa Laval's largest capital equipment market, and all major shipyards in the country are Alfa Laval customers.





WAVE OF *clean* SOLUTIONS.

New clean technologies are helping the shipping industry to reduce its environmental impact and meet stricter legislation for pollution at sea.

TEXT: DAVID WILES ILLUSTRATION: JENNIE ARVENĀS

WHEN THE FIRST of the 20 Triple E container vessels ordered by shipping giant Maersk glides down its slipway in Korea in 2013, it will not only be the largest and most energy-efficient ship of its kind to ply the world's trade routes, but the massive 400-metre-long USD 190 million vessel will also be fitted with the latest technology to help the shipping industry clean up its act in two long-problematic areas: air pollution and water pollution.

The shipping industry, which handles some 90 percent of world trade, is very energy efficient compared with other modes of transport. But because of the dirty fuel burned by vessels and the pollution and invasive species that they introduce into the marine environment from their bilge

“ It has been accepted that the industry must move to low-sulphur fuel or use scrubbers to remove sulphur from the exhaust gases.”

SIMON BENNETT, INTERNATIONAL CHAMBER OF SHIPPING

and ballast water tanks, the industry is still far from being truly green. However, thanks to new clean technologies, legislation, a growing environmental awareness and pressure from customers, the shipping industry is reducing its environmental impact.

International Maritime Organization (IMO) regulations are targeting two key groups of hazardous shipping-related pollutants: sulphur oxides (SO_x) and nitrogen oxides (NO_x). Both are emitted from vessels' smokestacks, and both harm human health and the environment. The

number of premature deaths in Europe caused by these emissions is expected to reach 53,200 a year by 2020, according to a recent study by the Danish Centre of Energy, Environment and Health. Although this figure is disputed by the industry, the IMO is working to cut emissions of these compounds – in the case of NO_x by 80 percent – in certain emission control areas (ECAs) such as US coastal waters.

FOR THE PAST 50 YEARS cargo ships have been burning heavy fuel oil, which comes, quite literally, from the bottom of the barrel. “That suited everyone because the oil companies had a market for the sludge at the bottom of the refining process, and it was much cheaper than more refined grades of fuel,” says Simon Bennett, Director External Relations at the International Chamber of Shipping. “Recognizing the concerns about health, it has been accepted that the industry must move to low-sulphur fuel or use scrubbers to remove sulphur from the exhaust gases.”

The global fuel sulphur limit is currently 4.5 percent. This will be reduced to 3.5 percent in 2012 and then lowered to 0.5 percent, but not until 2020 (or 2025, subject to review in 2018). In ECAs such as the North Sea and the Baltic Sea, the current limit is set at 1 percent, which will be tightened to 0.1 percent by 2015.

Tests have shown that technologies such as exhaust gas recirculation and scrubbers can reduce NO_x and SO_x emissions to the levels set by IMO. Bennett says: “Scrubbers are an attractive alternative to using expensive low-sulphur fuel. There is always the challenge of retrofitting the equipment to existing ships, but there is optimism in many quarters of the industry about it.”



The five biggest threats to the marine environment

Overfishing: the single biggest cause of damage to the marine environment, affecting both target and non-target species.

Climate change: causes acidification of the oceans, a rise in sea temperature and a rise in sea level.

Invasive species carried in ballast water: can upset the balance of the ecosystem and cause damage to fisheries and aquaculture.

Pollution, both from the land and from shipping: can lead to “dead zones” where marine life cannot survive, due to depleted oxygen levels.

Coastal erosion partly caused by climate change and the associated rise in sea levels, but also by engineering projects and construction in coastal zones: can seriously damage and threaten communities and development on the coast.

Source: Olof Lindén, World Maritime University

IMO extends regulations for ship pollution

Sulphur oxides (SO_x)**

Worldwide regulations with limits for the maximum sulphur content of the fuel oils exist. Stricter regulations apply in emission control areas (ECA). These limits are subject to a series of step changes starting in 2012. The alternative to using low-sulphur fuel is to install exhaust gas cleaning equipment to reach the levels.

Nitrogen oxides (NO_x)*

Existing regulation requirements apply to installed marine diesel engines of more than 130 kW output power. Different levels of control apply based on the ship construction date. Stricter regulations will come into force for newbuild vessels in 2016 sailing in ECA areas.

Bilge water**

Bilge water overboard limit is 15 ppm.

Ballast water**

All vessels shall install ballast water treatment systems when legislation has entered into force. IMO has adopted a convention that will enter into force 12 months after it has been ratified by 30 states representing 35 percent of the world's shipping tonnage. Currently 28 states representing about 26 percent of the world's tonnage have ratified.

Energy efficiency and greenhouse gas emissions

IMO is pushing initiatives to stimulate more efficient shipping, both in design and operation of vessels. One initiative is for an energy efficiency design index, which is under development.

**valid only for newbuild vessels*

***valid both for newbuild and existing vessels*



▶ Another major threat to the marine environment comes from the transport of organisms around the world in ballast water. Invasive species of bacteria, microbes and small invertebrates taken up in ballast water cause ecological, economic and health problems in areas to which they are not native where the water is discharged. In 2004, IMO adopted legislation that will enter into force

12 months after it has been ratified by 30 states representing 35 percent of the world's shipping tonnage; currently 28 states representing about 26 percent of the world's tonnage have ratified.

"We've known for 25 years about these problems with invasive species in ballast water," says Olof Lindén, Professor of Marine Environment Management at the World Maritime University in Sweden. "Yet the negotiations for the convention drag on."

One example of invasive species is the explosion of the jellyfish population in the Mediterranean, the Black Sea and the Caspian Sea. "These jellyfish, which arrived from North America in ballast water, have caused a dramatic impact on local fisheries," says Lindén. "They have even had an impact on industry because the water used for cooling is so full of jellyfish."

A number of methods have been developed for preventing the spread of invasive species in ballast water, including chemical treatment, UV light, heat treatment and filtration. "The approved methods will probably make a difference, but we cannot expect that the problem will go away totally, even if the convention enters into force," says Lindén.

THE DISCHARGE INTO THE SEA of bilge water – containing a cocktail of water, fuel oil, hydraulic oil and detergents – is another source of marine pollution, and IMO regulations specify strict limits on oil content of bilge water discharged overboard. "In the wrong place even a very small quantity of oil can cause damage to seabirds," says Lindén. "In some of the cold seas you have hundreds of small spills every winter and many tens of thousands of birds killed."

Bennett says there have been important advances in the design of oily water separating equipment for machinery space bilges, and in the monitoring and control of the discharge of such mixtures. "These technological advances

SHIPPING FACTS



GETTY IMAGES

- About 90 percent of world trade is carried by the international shipping industry
- As of 2010, the world fleet was made up of 50,054 ships.
- Over the past four decades total seaborne trade has quadrupled, from about 13,000 billion tonne-kilometres in 1968 to more than 51,000 billion tonne-kilometres in 2010.



“I would argue that it pays to be one step ahead instead of being forced by regulation.”

SARA SKÖLD, CLEAN SHIPPING PROJECT

have allowed international regulations to be adopted, reducing the permitted operational discharge of oil effluent from machinery space bilges from 100 parts per million (ppm) to 15 ppm,” he says.

THE PROCESS FOR DRAFTING and enacting regulations for reducing shipping’s environmental impact can often seem comparable to getting a container vessel to change heading. Sara Sköld, environment specialist at the Clean Shipping Project, agrees with Bennett that one problem is that the industry is out of sight and out of mind. “Historically, politicians have been more focused on the land-based industries that are right under their noses,” she says. There is also a risk of developing regulations nationally, since they will “either make shipping companies flag out from a nation or not call on a port in a region with harsher regulations.”

The success of the Clean Shipping Index, where vessels are ranked on environmental performance to allow cargo owners to make “green” choices, shows that parts of the shipping industry are taking their responsibilities seriously, Sköld says. “Some ship owners were quick to understand that they have to focus on the environment and have invested in these types of technologies, but many others are reluctant to do so because of the cost. I would argue that it pays to be one step ahead instead of being forced by regulation.”

By doing so, Maersk’s fleet of mega-vessels could herald the start of a new era of green shipping. ■

PURE INNOVATIONS FOR THE MARINE INDUSTRY

Alfa Laval is behind a range of innovative technologies for tackling four of the shipping industry’s main environmental challenges. “We have a big focus on environmental issues within the marine sector,” says Lena Sundquist, market unit manager Marine & Diesel at Alfa Laval. “Under the PureThinking umbrella we have solutions for the issues of ballast water, oily waste and sulphur and nitrogen oxide emissions. In our entire range of marine solutions we aim for minimum energy use and minimum waste.”

Alfa Laval’s ballast water treatment system was launched in 2006. To date more than 170 systems have been sold. “The market for this solution is growing rapidly,” says Sundquist. “The second generation version of the technology, PureBallast 2.0, consumes less energy and is available in an Ex version for use in potentially explosive environments.” PureBallast offers a two-stage water treatment: The first stage uses filtration, and the second stage is based on advanced oxidation technology. It offers easy installation, a small footprint and a low life-cycle cost.

The PureBilge solution for handling

oily waste in a vessel’s bilge tanks uses a single-stage high-speed centrifugal separation system to clean large water volumes without the use of chemicals, adsorption filters or membranes. This well-proven technology can achieve an oil-in-water content of less than 5 parts per million and is fully automatic, requiring no supervision.

To enable ships to reach IMO demands for a reduction in NO_x emissions of 80 percent, Alfa Laval is collaborating with MAN Diesel to develop an exhaust gas recirculation (EGR) system for large two-stroke diesel engines. “Within this EGR process a scrubber removes pollutants from the exhaust gas, and Alfa Laval’s high-speed separators purify this water so that it does not interfere with the process, while meeting directives on the purity of water discharged into the sea,” says Sundquist.

On SO_x emissions, Alfa Laval is developing a complete exhaust gas cleaning process. The system, which is currently undergoing onboard tests, again sees Alfa Laval separators cleaning the dirty water coming from the scrubber before it is released into the ocean.



Ficaria Seaways docked in Gothenburg harbour after a nearly sulphur-free journey from Immingham in the UK.

FULL STEAM AHEAD

European shipping company DFDS has found an effective tool to meet coming international regulations for exhaust gas emissions at sea. The solution is an Alfa Laval Aalborg scrubber system – PureSO_x.

TEXT: DAVID WILES PHOTO: CIPRIAN GORGA

The families enjoying the late summer sun on their pleasure craft around the small rocky islands of the Gothenburg archipelago probably did not notice that the funnel on the DFDS ferry steaming past was more than twice as big as that on the other large ships in the harbour. But many would certainly have observed the unusual amount of white smoke billowing from the *Ficaria Seaways*' funnel.

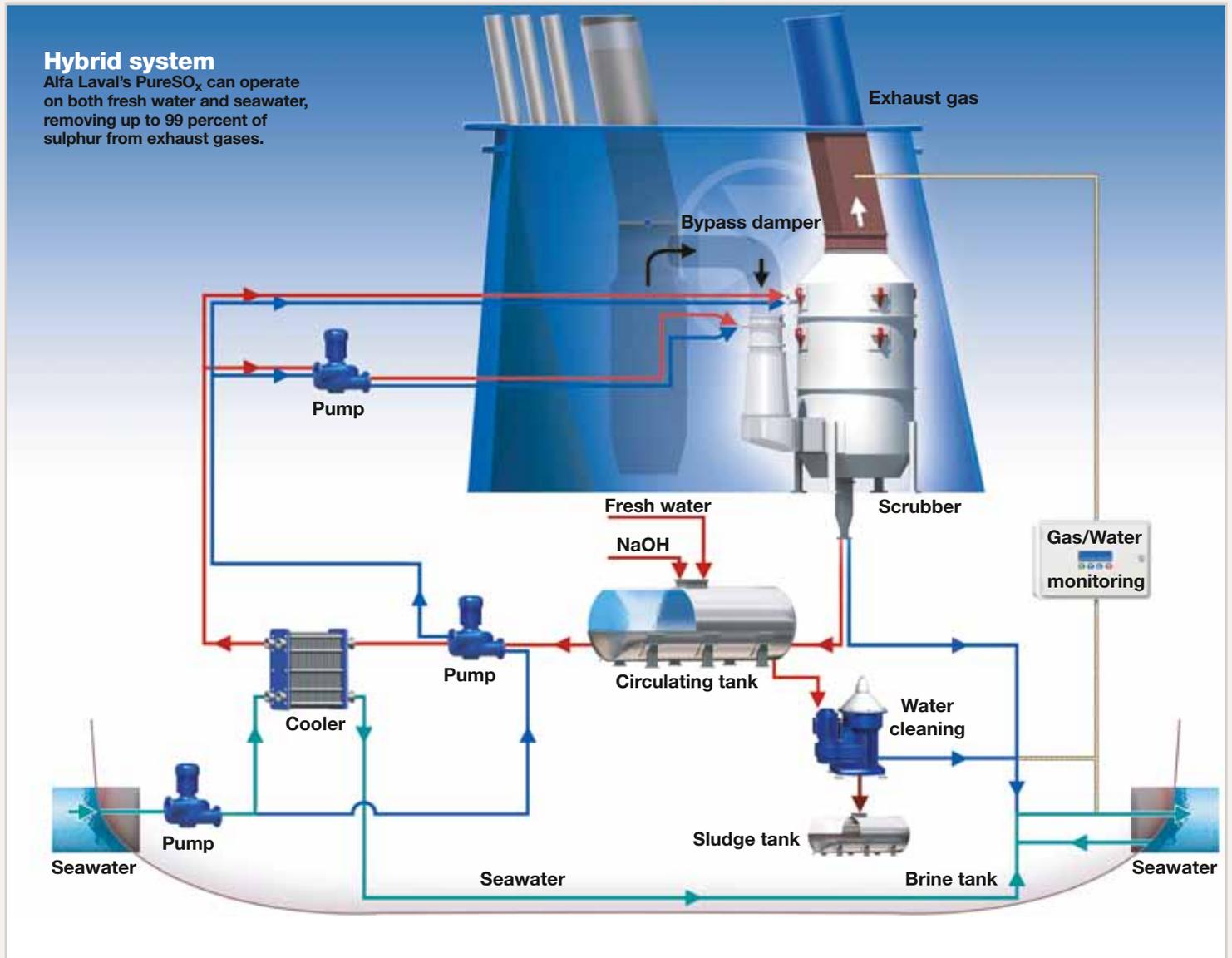
“People think it’s pollution,” says Søren Pedersen, *Ficaria Seaways*' chief engineer, as he stands on the ship's deck, looking up at the immense blue-and-white funnel. “They don't realize that the smoke is steam, and that it means that this vessel actually pollutes much less than most others.”

The reason for both the funnel's size and for the steam coming out of it is an environmental technology that removes virtually all of the sulphur oxide (SO_x) and most of the



Hybrid system

Alfa Laval's PureSO_x can operate on both fresh water and seawater, removing up to 99 percent of sulphur from exhaust gases.



Scrubber strips the exhaust gas of sulphur

Alfa Laval's PureSO_x, the exhaust gas scrubber fitted to the *Ficaria Seaways*, is the largest of its kind in operation on the world's oceans today.

The technology was first developed in a partnership between Alfa Laval and former Aalborg Industries (later acquired by Alfa Laval) and diesel engine manufacturer MAN. Based on Alfa Laval's separators and Aalborg's existing scrubbers used in inert gas systems onboard tanker vessels, the technology was reconfigured to clean diesel exhaust gases and tried out on a 1-MW land-based engine in Denmark. Following successful tests the technology was scaled up and installed on

the *Ficaria Seaways* in 2009.

The vessel is propelled by a 21-MW MAN B&W two-stroke main engine that emits 200,000 kilograms of exhaust gas per hour. The fuel burned by the *Ficaria Seaways* is heavy fuel oil with a sulphur content of 2.2 percent, and the exhaust gas is washed in the scrubber so that the SO_x content is brought down to the 0.1 percent level demanded by IMO regulations that come into force in 2015.

Alfa Laval's PureSO_x is a hybrid scrubber, meaning it is a combined seawater/freshwater system.

"It can be simply described as a big shower cabinet placed in the

funnel of the ship," explains Olav Knudsen, head of R&D Exhaust Gas Cleaning at Alfa Laval. "Using water, either seawater or fresh water mixed with caustic soda, scrubbers wash the exhaust gas from the main engine of the ship."

The first stage of the scrubbing process utilizes the heat in an exhaust gas economizer. In stage two, the exhaust gas is cooled by injection of water, and the majority of the soot particles in the exhaust gas are removed.

In stage three, the exhaust gas is further cleaned of the remaining sulphur dioxide. To prevent visible condensation and corrosion, the small droplets are then removed

from the exhaust gas before being discharged through the funnel of the ship.

"When we are operating in seawater mode, we can clean more than 98 percent of sulphur out of the exhaust gases," says Knudsen. "When we are operating on fresh water we can clean more than 99 percent, as well as trap up to 80 percent of particulate matter."

"We expect big market demand because it is a very good business case to put a scrubber onboard a vessel, especially after 2015 in emission control areas where there will be a very big price gap between low-sulphur fuel and normal fuel."

► particulate matter – basically soot – from the *Ficaria Seaways*' exhaust gases. Fitted with this exhaust gas cleaning system from Alfa Laval, the vessel will be able to continue operating on heavy fuel oil instead of the more



Gert Jakobsen

expensive low-sulphur fuel in order to meet regulations from the International Maritime Organization that come into force in emission control areas in 2015 and worldwide in 2020.

"I think it's a very good idea," says Pedersen when asked for his opinion of the scrubber. "With this system we can carry on running with high-sulphur fuel oil. If we don't have a system like this, then we have to start using low-sulphur fuel in 2015, and that will be very expensive. There is money to be saved here. They are talking about low-sulphur oil being up to twice as expensive as high-sulphur oil, so this system could pay for itself in a few years."

Alfa Laval's PureSO_x was installed on the *Ficaria Seaways* while she lay in dry dock in 2009. The system is 10 metres high – hence the need for the vessel's funnel to be more than twice the size of that on its sister ship. The scrubber is basically a giant shower where the rising exhaust gases are sprayed with water – hence the steam coming from the funnel.

WITHIN 12 NAUTICAL MILES of shore the system is in freshwater mode, which means it is a closed system where the water used for cleaning the gas is circulated. When in freshwater mode, an Alfa Laval high-speed separator is used to clean the water. "Otherwise we would have to change water every eight or nine hours," says Pedersen. "We don't have enough fresh water onboard to change it so often." The residue cleaned out of the water is collected for safe disposal onshore.

Once outside territorial waters, it is an open system where seawater is pumped onboard and used to clean the exhaust gases, before being released overboard. Seawater already has a high sulphate content, and experts say that even if all the sulphate from all the world's oil reserves were put into the sea, it would be hard to measure the change to sulphate levels.

The shipping industry faces a number of challenges to meet new and pending environmental legislation, but tackling

Søren Pedersen, *Ficaria Seaways*' chief engineer, says the scrubber solution will pay for itself in a few years.





The scrubber is installed in the funnel of the ship and can simply be described as a big shower cabinet.

“New technologies will be a very important part of the solution, and this scrubber will definitely be the most important one.”

GERT JAKOBSEN, DFDS GROUP COMMUNICATIONS

► sulphur oxide emissions will be the most testing, says Gert Jakobsen, vice president DFDS Group Communications. “The new regulation forcing us to go down to 0.1 percent sulphur in the bunker oil is our

biggest challenge,” he says. “In the regulation there is a paragraph that states that you have to go down to 0.1 percent sulphur or find equivalent methods. New technologies will be a very important part of the solution, and this scrubber will definitely be the most important one. We certainly wouldn’t be able to install it on all our ships by 2015, and not all ships can be fitted with one. But it will be a very good tool to solve part of the problem. We are very grateful that the scrubber has proven its efficiency in operation.”

Jakobsen says the solution has exceeded expectations. “It has had a very good effect not only on sulphur but also on particulate matter.”

But why did DFDS invest in such a solution a full six years before the SO_x regulations come into effect? Jakobsen says it was partly to assess the options so that it could prepare for 2015, but also as part of the company’s wide-ranging efforts to reduce its environmental impact. Like many other shipowners and operators, DFDS welcomes moves to improve the environmental performance of

the shipping sector. The company has set itself the target of reducing its CO₂ emissions by 10 percent over five years and has invested in new efficient propellers and a planning system to select the most energy-efficient route for its vessels in an effort to reach that target.

BUT THE COMPANY also believes the regulations are being brought in too swiftly. “In general we support the efforts to reduce the impact of our industry on the environment,” says Jakobsen. “But we believe the sulphur regulation comes too early and too fiercely. It could lead to more traffic being forced from the sea and onto the roads on routes that are parallel to shipping routes. We believe that will have the wrong environmental effect.”

Looking out over the idyllic scene of the archipelago dotted with white sails, chief engineer Pedersen says it feels good to know that his ship is a trailblazer for a new technology that has proved to significantly reduce harmful SO_x emissions and particulate matter. “We have to do something about these emissions into the air,” he says. “It is absolutely necessary. In general the legislation is a good thing, although in this case they go too far, too fast. But we have to do something, and legislation and technology are effective ways to do it, if they are done right.” ■

FACTS

DFDS

Headquarters: Copenhagen, Denmark

Founded: 1866

Fleet: About 50 vessels on 30 routes in the Baltic Sea, North Sea and English Channel

FICARIA SEAWAYS

Built: 2006, rebuilt 2009

Class: LR+100 A1 RoRo

Length: 230 metres

Deadweight tonnage: 15,990 tonnes

Speed: 22.5 knots

Route: Immingham, UK/Gothenburg, Sweden

Packinox raises the odds for cost-effective clean coal

Efficient heat exchangers are fundamental to making carbon capture and storage plants commercially viable. Now the world's first large-scale sites are being built, and Alfa Laval's Packinox technology, with its unique combination of size and process performance, looks set to facilitate critically needed economies of scale.

TEXT: ÅSA LOVELL ILLUSTRATION: ALEXANDER RAUSCHER

COAL-FIRED POWER PLANTS produce about a third of the world's carbon dioxide emissions, and their share is expected to increase to about 45 percent in 2035, according to the International Energy Agency. While huge efforts are being expended on finding and developing renewable energy sources, it will be a long time before these technologies are sufficiently developed to provide a serious alternative to coal and other fossil fuels. Thus finding cleaner ways to burn coal is of critical importance.

Carbon capture and storage, or CCS, is a group of technologies for capturing, compressing and storing carbon dioxide as a way to alleviate the problem. In the past five years, small-scale CCS plants have been built to evaluate CCS technologies. The world's two largest users of coal for power production, the United States and China, both are striving to be global leaders in CCS.

The two most common technologies to capture the carbon dioxide are pre-combustion and post-combustion. In post-combustion the CO₂ is removed after the coal is burned. This technology is developed for conventional coal-fired power plants where the coal is used as a solid fuel to produce heat and electricity through combustion. This is the most common way of producing electricity from coal.

IN PRE-COMBUSTION plants the carbon dioxide is removed before combustion takes place. The technology is developed for integrated gasification combined-cycle (IGCC) plants where a gasification process transforms the coal into a synthetic gas that is used to fuel the power plant. IGCC maximizes electricity output and reduces emissions of air pollutants, mainly NO_x and SO_x.

The CCS removal technologies are similar in post- and pre-combustion. The gas that contains the CO₂ meets a solvent that first captures the CO₂ and then releases it, allowing the carbon dioxide to be compressed and stored.

Once the CO₂ is captured it can be stored in geological formations. It can also be used for enhanced oil recovery (EOR) – a method in which carbon dioxide mixed with water is pumped into old oil wells to assist in extraction of additional oil. According to the US Department of Energy, EOR technology has the potential to increase domestic oil recovery efficiency from about 30 percent to more than 60 percent.

IN THE CCS PROCESS a lot of cooling, heating, condensation and re-boiling steps are required, making the energy cost a large part of the CCS process cost. Efficient heat exchangers are a fundamental factor in reducing the cost of CCS, making the process commercially more viable.

Alfa Laval is involved with heat exchanger technology in nearly half of the world's 30 to 40 small-scale CCS pilot plants. As the CCS technology moves into a new phase in which large-scale demonstration sites are being built, the Alfa Laval Packinox heat exchanger will be a valuable asset, especially for the pre-combustion process in IGCC plants.

The Alfa Laval Packinox represents the simplest plant layout on the market today, says Francois Reverdy, Business Developer at Alfa Laval. "As an indication, a state-of-the-art IGCC-CCS of 600 MW only requires two Packinox exchangers, versus many times that many for shell-and-tube designs," he says.

"Packinox also represents one of the lowest

capital-cost and operating-cost solutions available because of its ability to provide a combination of high heat transfer coefficient and very large heat transfer surface area per heat exchanger, up to about 20,000 square metres," Reverdy adds. These two features are important for the heat transfer process, as it involves very small temperature differences between the fluids as well as large flow rates.

ADDITIONAL SAVINGS using the Packinox come from the plate design, which has very low internal volume that minimizes the amount of solvent in the process loop. Moreover, the Packinox can operate at a pressure similar to that of the gasifier. "For pre-combustion plants, where the gasifier operates at high pressure, this allows cleaning of the syngas without having to decompress it first, thereby contributing to major savings in CO₂ re-compression costs later on," explains Reverdy.

The US government claims to have made the world's largest investment in CCS, the Department of Energy using close to USD 4 billion in federal funds, matched by more than USD 7 billion in private investments, in the pursuit of multiple demonstration projects.

In 2012, a full-scale IGCC plant in the US is expected to go online and be "carbon capture ready" – i.e., it has been engineered to be easily retrofitted for carbon capture in the future. Alfa Laval delivered two Packinox heat exchangers to this plant in 2009. Alfa Laval will also deliver two Packinox heat exchangers in 2012 to the 600-MW Mississippi Power Plant – the world's first full-scale IGCC plant to capture CO₂ from the beginning of its operation. ■

How it works: The operation of an IGCC-CCS plant

1. Gasifier

The gasifier transforms the raw fuel (e.g., coal and lignite) into a synthetic gas at high temperatures and pressures.

6. Condenser

The condenser then cools down (condenses) the steam into water, which is reused for cooling the raw syngas in step one of the process. While cooling down, the raw syngas heats up the condensate, which turns into steam that goes back into the boiler for further electricity generation.

5. Steam turbine

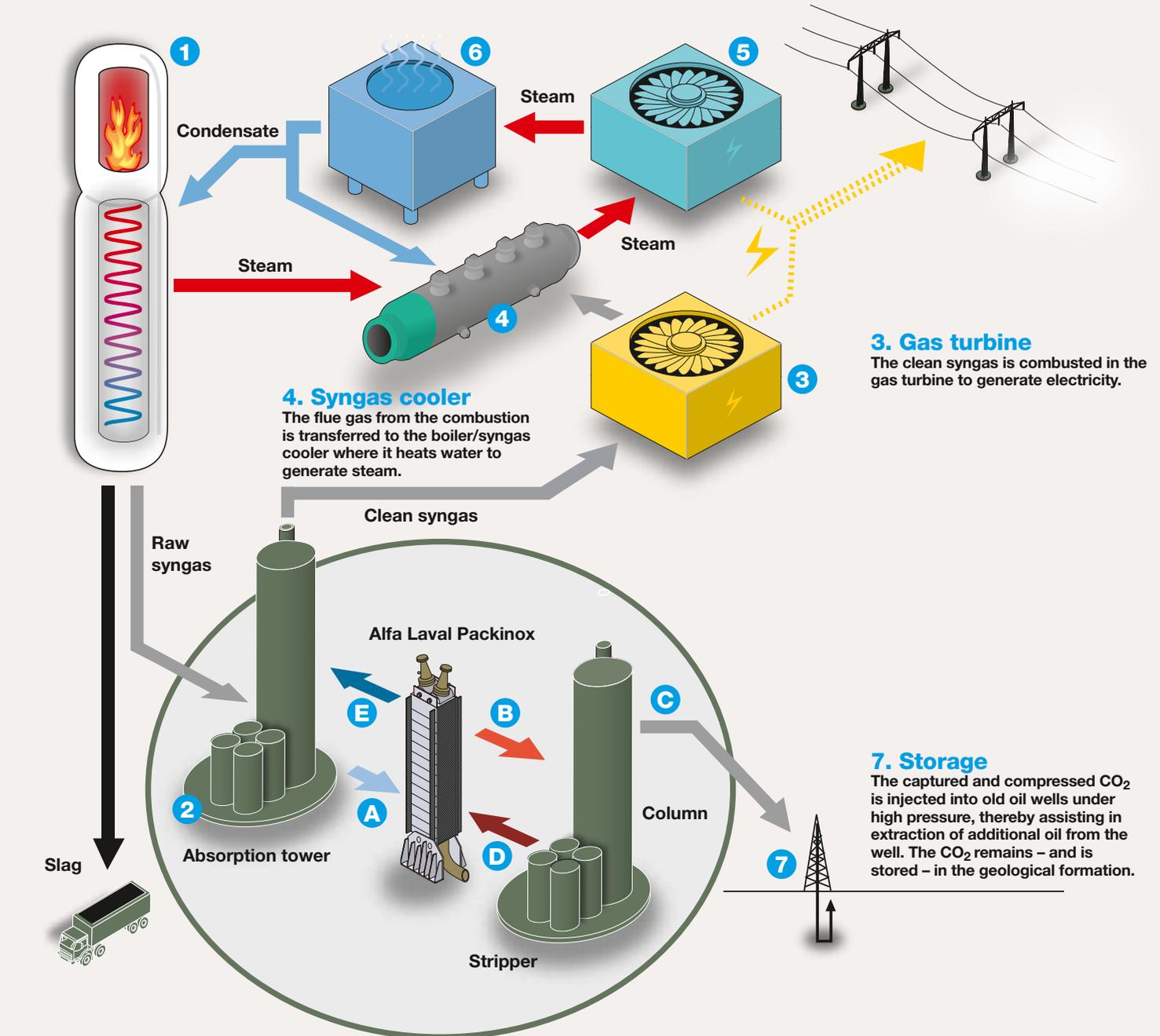
The steam generates additional electricity.

3. Gas turbine

The clean syngas is combusted in the gas turbine to generate electricity.

4. Syngas cooler

The flue gas from the combustion is transferred to the boiler/syngas cooler where it heats water to generate steam.



2. Gas cleaning

The cool raw syngas is introduced at the bottom of the absorption tower, where it makes contact with a solvent (selexol) that travels downwards through the tower's packing material. CO₂ is absorbed by the solvent. The rest of the syngas (now cleaned) goes on to the next stage of the process.

A. Cold solvent rich in CO₂ goes through the Alfa Laval Packinox heat exchanger and is heated up on its way to the stripper tower.

B. Warm solvent rich in CO₂ goes into the stripper tower, where steam reboilers provide the heat necessary to strip the CO₂ from the solvent.

C. The now-captured CO₂ leaves the top of the stripper in a highly

concentrated vapour stream. It is later cooled down and compressed prior to storage/injection into old oil wells.

D. The clean solvent goes back in a closed loop to the absorption tower. On its way back to the absorption tower the hot clean solvent passes through the heat exchanger and there heats up the solvent (rich in CO₂) that is on its way to the stripper tower.

E. When the clean solvent heats up the cold solvent (with CO₂) it is thereby cooled down. Back in the absorption tower the clean cold solvent is used to capture more CO₂.





MIXED-UP BEER

As part of a major multimillion-pound plan to upgrade its plant at Northampton in the UK to meet higher production targets, brewer Carlsberg opted to look at innovative ways to improve its beer-making process. Its choice of novel Alfa Laval Iso-mix mixing technology has had a significant impact on production and may have implications for the whole of the beer-making world. **TEXT: ELAINE MCCLARENCE PHOTO: EDD HARTLEY**

WHEN BRITISH LAGER DRINKERS pour the contents of a chilled bottle of Carlsberg into their glasses, they will likely be unaware of the quiet revolution that has gone into the manufacture of one of their favourite tipples. For the Carlsberg UK plant in Northampton is the first major brewery to undertake the plant-wide introduction of a novel liquid-mixing technology, Alfa Laval rotary jet mixer Iso-mix, as a standard part of the brewing process.

Beer brewing has altered little since our ancestors discovered that barley, yeast and water could be transformed into a potent beverage. The process is simple: The barley is germinated by soaking it in water and subsequently dried. This “malt” is then milled, and water is added and heated to release the sugars. The resulting liquor, called “wort,” is separated from the spent grain and moved into fermentation tanks where yeast is added. Yeast transforms the sugars in the wort into alcohol. Once fermentation is complete, the yeast is recovered for reuse, and the beer is conditioned, filtered and canned or bottled for consumption.

It is at the crucial fermentation stage that the Alfa Laval rotary jet mixer system is employed. Although fermentation time differs a lot from brewery to brewery and within the same brewery depending on beer

type, fermentation typically takes three to seven days plus one to four days for diacetyl acceptance. By continuously moving the mix of wort and yeast through the fermenter, Iso-mix increases the efficiency of fermentation, thus dramatically cutting the time needed for this stage of the brewing process. At Carlsberg’s Northampton plant it contributes to greater throughput and helps to meet higher production targets.

“It has set new standards on how beer is going to be made,” says Thomas Paludan-Müller, technical operations manager at the Northampton plant.

ESSENTIALLY, THE ALFA LAVAL Iso-mix technology ensures that the yeast is constantly kept evenly mixed with the wort in the fermentation tanks. By improving the contact between yeast and fermentable sugars, the conversion of sugars to alcohol is more effective. In conventional fermentation tanks, there is no forced mixing of the wort and yeast. Temperature differentials, which arise from cooling jackets along the length of the fermentation tanks, generate convection currents that have a mixing effect, but this is not as significant as the Alfa Laval Iso-mix rotary jet system.

A technical presentation by Alfa Laval showed Carlsberg the potential of the

Thomas Paludan-Müller, technical operations manager at the Carlsberg Northampton plant, says the Alfa Laval Iso-mix system has set new standards on how beer is going to be made.

CARLSBERG FACTS

- The Carlsberg Group current employs more than 40,000 people worldwide, operates in 150 markets and in 2010 sold 40 billion bottles of beer. Three of its brands, Baltika, Carlsberg and Tuborg, are among the six biggest beer brands in Europe.
- Northampton is now Carlsberg's only UK plant and employs around 230 people following the closure of its Leeds plant in June 2011. Thanks to recent investments, the plant has raised its production capacity to more than 6 million hectolitres of beer. Carlsberg decided to consolidate all UK production at the Northampton plant, where it produces a variety of brands including Tuborg, Holsten, Skol and San Miguel as well its leading Carlsberg brands.

Over the past 18 months to two years, the Carlsberg Northampton plant has increased its beer-making capability by 44 percent or 13 billion cans of beer.

► technology. Because of Carlsberg's commitment to quality, it embarked on rigorous testing of the Iso-mix system at Northampton in collaboration with the Alfa Laval team.

Once the potential savings in fermentation time were demonstrated and quantified to its satisfaction, Carlsberg took a bold decision: It would not only install the Iso-mix equipment in its larger-capacity fermentation tanks but also in 10 storage tanks – each with a 6,000-hectolitre capacity. The tanks were converted for fermentation by installing additional cooling using a heat exchanger in the tanks' circulation loop to ensure that the correct process temperature of 14 degrees Celsius was maintained in the tank. To meet the temperature requirements needed for fermentation, an external chiller was attached within the pumping circulation system. This also supports the rotary jet mixing system.

Usually the fermentation progress is tracked by measuring two key parameters – the specific gravity of the wort and the presence of the chemical diacetyl, which is produced naturally during fermentation. For the Northampton plant, in quantitative

“ Iso-mix has enabled us to introduce a novel downstream process that, in some cases, has halved our fermenting time. This process is the first of its kind in the brewing world.”

THOMAS PALUDAN-MÜLLER, CARLSBERG NORTHAMPTON PLANT

terms, Paludan-Müller says that with the Iso-mix system the end fermentation is reached 14 percent faster, there is a 23 percent faster gravity drop per day and the process is 17 percent faster to diacetyl acceptance, i.e. the level of this chemical has fallen to the required level needed to produce a good-quality beer.

ANOTHER AREA OF IMPROVEMENT relates to the performance of the yeast, which is normally recovered and rested before being used again. At Northampton, there has been a 4 percent improvement in yeast viability, which is a measure of the yeast's ability to ferment.

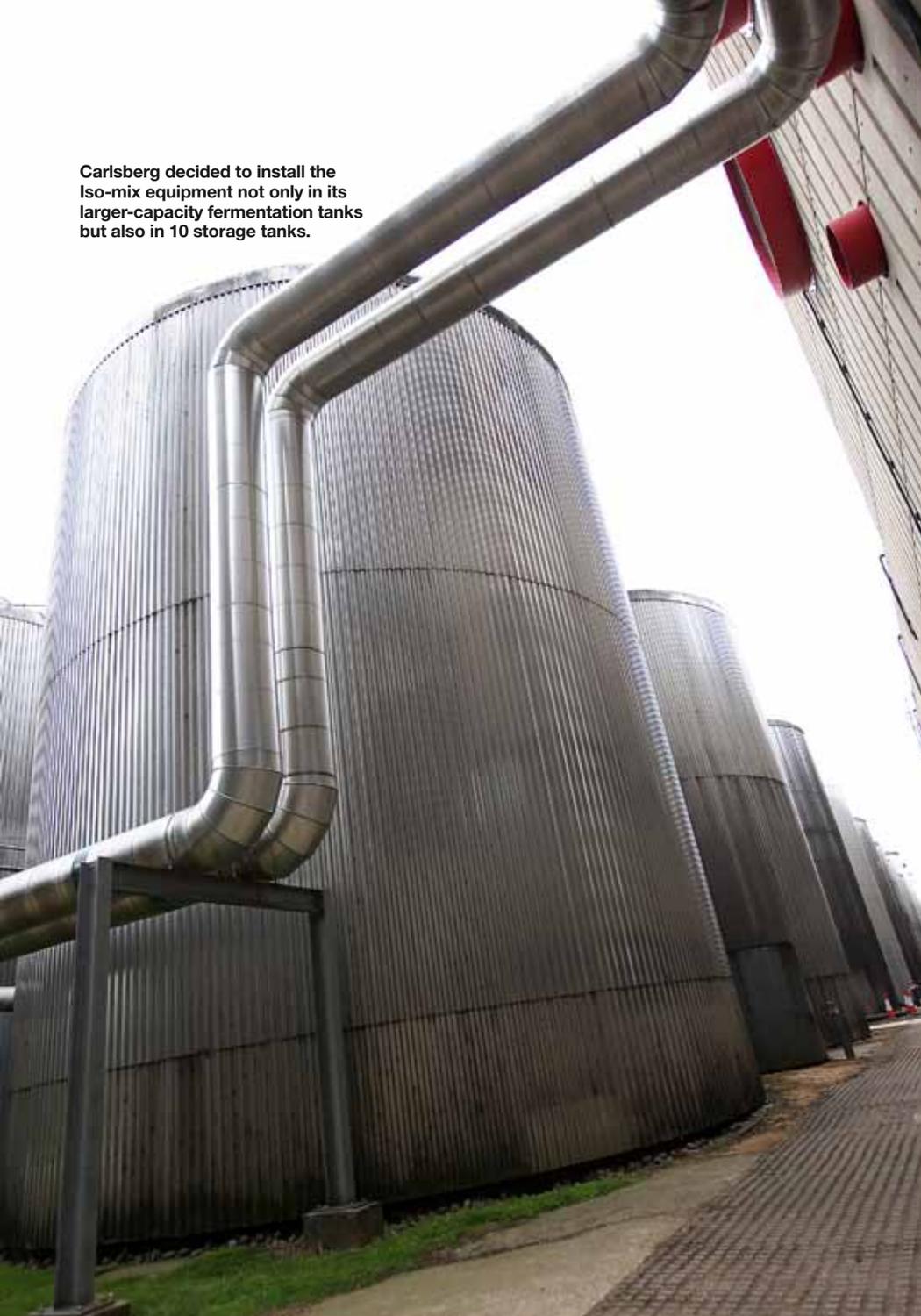
Paludan-Müller also notes that although Carlsberg uses a yeast strain that has low flocculent properties (it does not tend to clump together), for very flocculent yeast strains – another measure of successful

fermentation – real degree of fermentation (RDF) can be improved by 3 percent.

“The fermentations now are more consistent, which means that we can predict with greater accuracy when beer is ready to move to filtration, which is important for planning,” says Paludan-Müller. “It also allows us to determine when we want to crop, i.e. harvest, the yeast, as we will turn off the Iso-mix and the yeast will settle. This gives us better viabilities, as the yeast does not sit in the cone of the fermentation vessel warming up and being compressed.

“Overall this means that the fermentation process is faster, the quality, stability and fermentation capabilities of the yeast during fermentation are maintained, and the final consistency and taste of the beer is not adversely affected by the introduction of the mixing technology,” says Paludan-Müller.

Carlsberg decided to install the Iso-mix equipment not only in its larger-capacity fermentation tanks but also in 10 storage tanks.



TECHNICAL DETAILS

Alfa Laval rotary jet mixer system consists of four rotating jet nozzles installed about five metres from the bottom of the tank. The jet head is positioned under the liquid surface supported on the end of a pipe. The rotary jet mixer is brought into operation once the jet heads become submerged in the liquid and the speed of the rotation is gradually increased.

The mixing is achieved with the four nozzles rotating around both the vertical and horizontal axes. This double rotation gives excellent coverage of the tank and results in efficient mixing. An external pump in the recirculating loop ensures that the contents at the bottom of the tank are recirculated to the jet heads.

Iso-mix controls the yeast sedimentation at the bottom of the tank by redistributing the yeast in the entire vessel. In addition, a recirculation loop is established with suction from the bottom and re-injection through the rotary jet mixer. When the rotary jet mixer is in operation the content of the tank is gently mixed; the concentration of yeast is kept uniform throughout the tank, and temperature gradients are avoided.

At the Carlsberg Northampton plant, 27 tanks of various types and sizes, from 2,400 to 6,000 hectolitres in capacity, have now been fitted, and there remains the potential to convert other tanks if required. The brewery has also removed 57 smaller-capacity fermentation tanks that are now surplus to requirements, due to the capacity increase provided by this new technology.

Another feature of the technology, he says, is its relative simplicity and ease of installation. This is coupled with the fact that it has enabled savings of several million pounds in capital expenditure. Paludan-Müller says that having the rotary jet mixer installations in former storage tanks has made a contribution to increasing output capacity without the need for significant capital investment in new fermentation tanks.

“Over the past 18 months to two years, we have increased our beer-making capability from 4.5 million to 6.5 million hectolitres,” explains Paludan-Müller. That 44 percent rise is equivalent to 13 billion cans of beer, and the changes to production have been achieved while continuing to make beer without interruption. The ability to increase

production has been achieved in part thanks to the Alfa Laval system. Also, Paludan-Müller points out, “if we hadn’t taken this initiative we would have been struggling with capacity in the future.” He says that the Alfa Laval Iso-mix mixing technology helped the plant increase capacity in a limited plant space and also saved the company millions of pounds by avoiding the need to invest in new fermentation tanks.

“Iso-mix has enabled us to introduce a novel downstream process that, in some cases, has halved our fermenting time,” says Paludan-Müller. “This process is the first of its kind in the brewing world.”

So, while James Bond always preferred his martinis shaken, beer drinkers will come to appreciate their lagers well and truly stirred. ■



The Iso-mix rotary jet mixer mixes liquids faster and more effectively than conventional methods.

Membrane system recovers beer from surplus yeast

THE OETTINGER BREWERY in Moenchengladbach, Germany, has a production capacity of about 200,000 tonnes annually. This generates a surplus yeast volume of 7,500 tonnes per year with a dry matter content between 11 and 14 percent. The brewery has installed a system from Alfa Laval that uses membranes made of polymer to recover the beer from the surplus yeast. After filtration, the high-class beer product is re-dosed back into the normal process stream before it is filtered again.

Thanks to the membrane system, the brewery recovers 3,400 tonnes of good-quality beer per year – some 14,000 bottles a day – and has reduced the volume of waste yeast by 45 percent to 4,100 tonnes per year. The payback time for membrane technology is between 18 months and two years.

To the last drop

– reducing waste in beer production

Leading brewers are seeking more sustainable ways to better use raw materials and to optimize production by increasing yields and reducing losses, all while maintaining beer quality and expanding production capability. Alfa Laval provides a series of solutions.

TEXT: ELAINE MCCLARENCE PHOTO: JENNY UNNEGÅRD

IN A YEAR about 200 billion litres of beer are produced globally, corresponding to around 4 billion bottles and cans plus numerous kegs and truckloads of beer, worth some EUR 130 billion. Meanwhile, the various losses at different stages of production can be between 2.1 and 6.4 percent of total production, representing a considerable amount in terms of beer and money.

In the face of increased environmental legislation and its associated costs, the global brewing industry is challenged with reducing these losses and waste streams. Juan Jurado, Filtration & Separation specialist at Alfa Laval, says the need for greater efficiencies in the brewing process is driven by the desire for “higher productivity using the same resources.” In growing beer markets, brewers are also looking to “expand production with smaller footprint sites with lower investments and at reasonable operations costs,” he says.

The global growth rate for beer is 4 to 6 percent per year, led by Asia, Brazil and Africa. “In recent years Brazil has been the market leader in terms of the highest investment levels in breweries,” says Kim Dalum, market unit manager Brewery at Alfa Laval. “Globally some EUR 10 billion is invested in the industry each year, much of it driven by capacity and efficiency improvements.”

CHINA IS THE WORLD’S largest beer market and leads the United States, producing some 4.6 billion litres per year. Dalum notes Chinese beer consumption has risen six-fold over the past two decades, so greater efficiency is needed to meet the consequent increased production requirements. In all markets, companies want to become more environmentally friendly by aiming for a zero-waste operational philosophy, he says.

Essentially, brewing involves germinating barley by soaking it in water, then drying and milling it. Water is added and heated to release the sugars. This liquor, called “wort,” is then separated from the spent grain and moved into fermentation tanks where yeast converts the sugars in the wort into alcohol. After fermentation, the beer is conditioned and filtered.

Each stage of the process produces waste. For every 1,000 tonnes of beer produced, 137 to 173 tonnes of solid waste may be created in the form of spent grain, “trub” (an unwanted material generated during wort production), waste yeast and “kieselguhr,” a substance used to filter the beer. In China, around 500,000 tonnes of beer is left in the trub after fermentation. During filtering some



Wort recovery at its best

BRAINS BREWERY in Cardiff, Wales, has managed to save 5 to 7 percent of wort, thanks to an Alfa Laval decanter centrifuge that recovers wort from trub in the whirlpool. This translates into a payback time of about 18 months. In addition, the brewery can add the dry trub material from the centrifuge to the spent grains and sell it for cattle feed.

120,000 tonnes of kieselguhr slurry are generated and 5 to 6 million tonnes of spent grains are produced.

Jurado says breweries can reduce the waste problem in many ways. Some by-products of the brewing process – spent yeast and grains – can be transformed into potentially valuable products. A substantial amount of beer can be recovered in the main wort and beer lines, and volumes of waste for disposal can be reduced dramatically, he says.

ALFA LAVAL’S RANGE of BREW centrifugal separators and BRUX beer recovery separators used with M39 membrane beer recovery filtration modules can recover beer that would otherwise be lost. Here, the surplus yeast is collected in a tank and is further processed in the membrane system where the beer is separated from the yeast by filtration. The filtered beer of good quality is recovered and waste yeast is concentrated. Between 30 and 50 percent of the volume of the surplus yeast is reduced and a similar amount of beer can be recovered.

“This beer recovery percentage means an additional 6 million 33-centilitre bottles for each million hectolitres of beer capacity per year,” says Jurado.

Dalum adds, “Surplus yeast represents 2 to 4 percent of the beer produced, and 2 to 3 percent of the total produced volume can be recovered. At this stage, beer has a high gravity and represents a value of EUR 20 per

hectolitre. The total potential value of recovered beer from surplus yeast is then about EUR 500–700 million per year.”

ALFA LAVAL FOODEC

decanter centrifuges are used to improve waste and by-product handling to produce drier by-products with higher market value and effluent with a reduced biological load. Typical applications are dewatering of spent yeast, spent grain and kieselguhr plus recovery of wort and beer.

Typically, 500,000 to 4 million litres of high gravity wort can be recovered in the same brew, without mixing brews, for each million hectolitres of annual production. “On top of that,

another achievement is about a 50 percent reduction in water usage in the whirlpool, which is a classical vessel used in removing trub from the wort, ensuring much less contaminated effluent sent to the wastewater plant,” says Jurado.

In addition, kieselguhr slurry volumes can be reduced by five times. “For an average brewery producing 400 million litres,” Dalum says, “this is equal to about 1.2 million litres per year, or a reduction of around 1,200 tonnes of kieselguhr slurry.”

ALFA LAVAL TOFTEJORG JET HEADS, used in cleaning, can cut in half the amount of water used in various tanks during brewing. Generation G2 and G3 decaners and filtration MFG membrane modules find application in brewery sewage plants. Decaners provide efficient sludge dewatering to reduce by half the number of trucks taking solid waste from the brewers, while filtration modules reduced COD (chemical oxygen demand) content in final effluent by up to 10 times. COD is a measure of pollution by organic compounds.

“Alfa Laval’s solutions will help breweries achieve increasingly challenging environmental and financial targets,” says Jurado. “The solutions enable them to efficiently produce beer of a high and consistent quality, with minimal losses and improved management of value-added by-product, and ultimately improve their bottom line.” ■

ALFA LAVAL PRESENTS THE NEW OPTIGO AIR COOLER RANGE



Refreshingly cool with Optigo

Alfa Laval has selected the best features from its previous ranges of air coolers and developed the most effective range of commercial air coolers ever.

TEXT: CARI SIMMONS

OPTIGO IS ALFA LAVAL'S new range of Eurovent-certified commercial air coolers especially suitable for food preparation areas, chilled distribution depots, supermarkets, restaurants and other applications in small to medium-sized cooling and freezing rooms.

The new air cooler platform was launched early this year, starting with the release of the CS (commercial slim) models. Optigo combines the best of Alfa Laval's previous commercial air cooler ranges, says Harald Hoogendoorn, market manager, Commercial Refrigeration at Alfa Laval. "And now we have made life a little easier by merging the best features from all of them into one single product range," he says.

One of the main benefits of the Alfa Laval Optigo range is the energy savings. All Optigo coolers use modern EC motors as standard to drive the fans with superior energy efficiency, using up to 50 percent less energy than competing products. "A new coil configuration gives optimal performance with less refrigerant," says Hoogendoorn.

Alfa Laval Optigo's unique coil block has been designed specifically for the refrigera-

tion market with a very small tube diameter requiring fewer refrigerants to charge the system. This in turn reduces the amount of energy required. Optigo can utilize either natural refrigerants (CO₂) or HFCs.

The Optigo units are delivered assembled, ready for a quick installation. "Just connect the unit to electricity, fill up refrigerant and place the side panels, and the unit is ready to start," says Hoogendoorn.

THE COMPACT AIR COOLERS have high air quality, yet fit into small spaces. The Optigo CS20, for example, is just 15 centimetres high and can be wall mounted. At the same time, it is available in six different capacities, providing airflow of 500 to 1,700 cubic metres per hour. The CS30 model offers up to 20 variations, the largest of which provides airflow of 4,200 cubic metres per hour.

Designed for use in hygienic areas containing food, the Alfa Laval Optigo follows the HACCP (hazard analysis and critical control point) recommendations, an internationally recognized way of managing food safety. The air coolers are easy to dismantle for easy

Customer's voice



"We have installed six Alfa Laval Optigo CS units for a customer's poultry slaughterhouse in Poland. The Optigo units were the best choice because of their unique technical features, energy-efficient operation

and low noise level. The room temperature can now be easily remote-controlled from an installer office 60 kilometres from the slaughterhouse. The units easily maintain the required room temperature, even on very hot days, and can be run at two different speeds, to reflect differences in day- and night-time needs. Thanks to the Optigo units, employees can enjoy a better workplace, and we expect to see savings in energy costs.

"Alfa Laval provided easy access to products through local distributors, fast delivery and reliable technology. What was declared in the documentation was kept in reality."

Adam Goska,

Main refrigeration specialist, dipl. eng., Szron

cleaning. Optigo is made of durable plastic and powder-coated aluminium, which together help eliminate the risk of corrosion.

As part of Alfa Laval's continuing focus on air-cooling improvements for all customers and end users, another new range of coolers, this time designed for the industrial market, will be launched in 2012. ■

OPTIGO AIR COOLER RANGE

- **Energy savings:** Uses up to 50 percent less energy than competing products
- **Compact design:** Features the Optigo slim design (the CS20 is just 15 centimetres high).
- **Easy to install:** Is shipped ready to install, reducing installing time by 30 percent
- **Less refrigerant:** Uses a new compact coil block with a smaller tube diameter, minimizing the amount of refrigerant needed.

Advanced aquarium

For the past two decades, plate heat exchangers from Alfa Laval have provided the perfect living conditions for some 400 species at the dazzling Genoa Aquarium in Italy. TEXT: ERIC J LYMAN

IN A COUNTRY BEST KNOWN for the ancient (Greek and Roman ruins) and the merely old (Renaissance art and architecture), the Acquario di Genova is a kind of anomaly.

Pritzker-winning architect and Genoa native Renzo Piano, together with Peter Chermayeff, an American architect who specializes in aquariums, co-designed the facility. It was unveiled to coincide with the 500th anniversary of the discovery of the Americas by Christopher Columbus, Genoa's most famous native son. The striking façade has been designed to resemble a ship, with full white sails and masts high in the air. Drawing more than 1.7 million visitors a year, the aquarium is by far the most popular modern tourist site in Italy.

But the 10,000-square-metre facility is more than simply modern: From a technological perspective the aquarium is near the

cutting edge. And Alfa Laval plate heat exchangers are at the heart of the operation.

The plate heat exchangers have been in use at the aquarium since its construction in 1992. Counting those installed during an expansion two years ago, a total of 40 plate heat exchangers are in use today to regulate the temperature, filter water and control the conditions of the water in some 71 tanks visible to the public and more than 200 acclimatization tanks that recreate the specific environmental conditions to support more than 80,000 fish, reptiles, amphibians and birds representing some 400 different species.

ALL THE ALFA LAVAL plate heat exchangers are specially made units, cast in titanium to prevent corrosion from the constant exposure to the salt water in most of the tanks.

At the aquarium, the largest are used to exchange heat between the chiller and the seawater, while the smaller units are used to regulate the water inside the nearly 300 tanks according to the needs of the species living inside.

Engineer Marco Caraveo, the official responsible for most of the technical issues at the aquarium, explains that although Alfa Laval's plate heat exchangers are an essential part of the aquarium's infrastructure, they require little attention from the facility's staff.

"What I notice the most is how little we need to worry about them," Caraveo says. "They do the job they are supposed to do, which is the main thing. But they require minimal maintenance, which for me is also extremely important because it means we can focus our attention on other areas." ■

Clownfish are among the 400 species visitors can enjoy at the Genoa Aquarium, where optimal water conditions are achieved using Alfa Laval plate heat exchangers.





REFINERY REVOLUTION

One bold decision made all the difference to the Falconara refinery in Italy. By replacing an air cooler with two Alfa Laval Compabloc heat exchangers, the refinery not only cut its yearly costs by as much as EUR 3 million, but it also reduced its environmental footprint.

TEXT: **ERIC J LYMAN** PHOTO: **MAURIZIO CAMAGNA**

PERCHED FOUR STOREYS up the side of the topping facility at the Falconara Maritime refinery in Ancona, Italy, are two nondescript pale-blue boxes, roughly the size and shape of old-fashioned phone booths. These have helped transform the 60-year-old refinery into one of the most technologically advanced refineries in Italy.

The Falconara refinery, owned and operated by Rome-based petroleum giant Gruppo API, covers 70 hectares near the Port of Ancona and processes an average of some 85,000 barrels of mostly Middle Eastern crude oil a day. The refinery opened for business in 1950, and about 10 years ago it began its journey towards a position at the vanguard of Italian petroleum processing plants.

Step by step the different parts of the refinery have been examined and improved. A major breakthrough came in 2009 when

The two blue Alfa Laval Compabloc heat exchangers have helped to turn the Falconara refinery into one of the most advanced refineries in Italy.



Falconara's maintenance of the second-stage overhead air coolers in the crude distillation units showed that by making changes to the system the plant could optimize the heat it produced more efficiently. Officials had the option of either replacing the damaged air coolers with the same technology or installing new but unfamiliar Alfa Laval Compabloc welded plate heat exchangers designed to recover heat otherwise wasted in that part of the refining process.

IT WAS NOT A DECISION the refinery took lightly. Most refineries that choose cutting-edge heat exchangers as part of the distillation process do so when the refinery is being built. But at Falconara, the installation would require the complex and costly retrofitting of an existing facility.

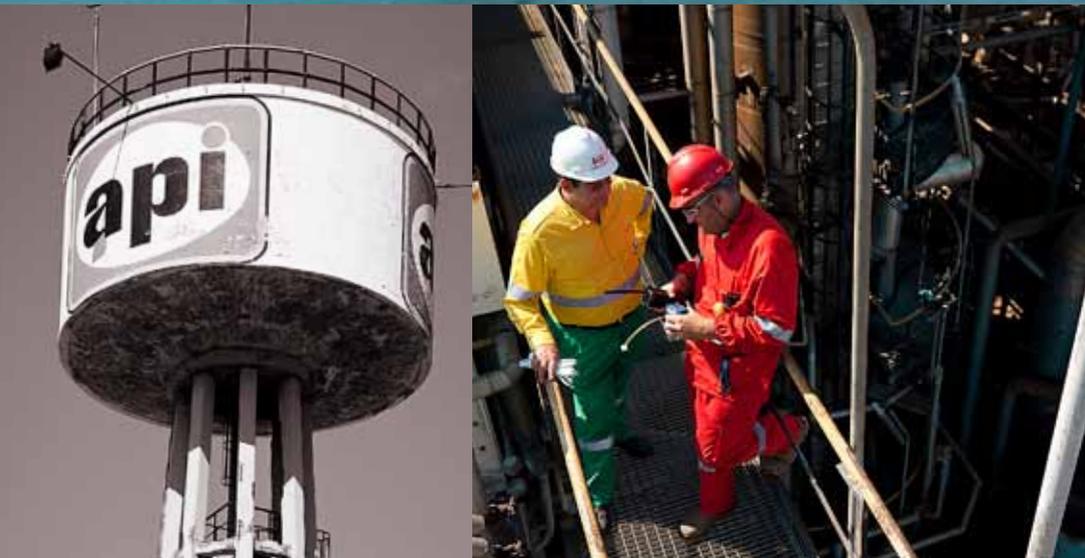
Before deciding, the company sent a team to Collombey, Switzerland, to study the

FALCONARA REFINERY IN SHORT

- API's Falconara refinery covers more than 70 hectares, with a total processing capacity of around 4 million tonnes per year and a storage capacity of 1.5 million cubic metres. Most of the refinery's crude oil comes from the Middle East.
- The refinery also produces around 300 MW of power via an integrated gasification combined cycle plant at the facility.
- Falconara is one of the oldest refineries in Italy, with roots dating back to 1939. The current facility opened for business in 1950.
- The refinery employs around 400 people. More than half are production workers, and turnover has historically been low.
- Thanks in part to the installation of the Alfa Laval Compabloc heat exchangers and other technical improvements, the refinery is now one of the most advanced in Italy and has been certified ISO 14001 for environmental standards, OHSAS 18001 for safety standards and ISO 9002 for quality standards. The refinery has also earned a European Union white certificate for environmental efficiency.
- In terms of methane, the refinery's marginal fuel, total savings are at least 7,200 tonnes per year, which translates to a monetary value of about EUR 3 million.
- The refinery is the only plant of its type in Italy to be using Alfa Laval Compabloc heat exchangers.



Reusing heat has not only saved the Falconara refinery a lot of money, but it also contributes to improving its environmental footprint.



COST-SAVING INSTALLATION

Alfa Laval's Compabloc is a high-efficiency laser-welded compact heat exchanger made of a pack of corrugated plates placed in such a way as to form media channels. The plates are supported by four side panels, all of which facilitate connections, plus an upper and lower head. With no inter-plate gaskets, operating costs and maintenance needs are reduced and compatibility issues are eliminated. The end result is a substantial cost savings, in addition to providing other advantages including environmental benefits such as cleaner air and lower greenhouse gas emissions.

At the API Falconara refinery officials estimate the costs savings will total around EUR 3 million per year over the 25-year lifespan of the two units operating there.

"Heating costs can be the largest expenditure at a refinery like Falconara," explains Alfa Laval's Alberto Mazzeo. "So it's a priority to keep those costs under control as much as possible."

Falconara technology manager Alfredo Punzo agrees. "The more wasted heat there is, the more money is wasted," he says. "These Compabloc heat exchangers do a great job at capturing a lot of that heat so we can reuse it."

In the first year of operation, the savings from the crude distillation unit at Falconara are estimated to total 85,000 Gcal/year. Converted to tonnes of methane, the marginal fuel at Falconara, the savings come to around 7,200 tonnes of methane per year. The refinery's original projections were that the installation of the Compabloc heat exchangers would provide total economic savings of EUR 2.5 million per year, but Punzo says that actual savings have been even greater thanks to the reduced need for maintenance.

► Tamoil refinery there. The Collombey refinery had made a similar switch to the same Alfa Laval Compabloc heat exchangers some 12 years earlier. The Falconara officials liked what they saw and heard and decided to make the change.

"We studied the problem very carefully," says engineer Alfredo Punzo, technology manager at the Falconara refinery and one of the API officials who made the exploratory trip to Switzerland. "Part of the evaluation was to speak to the engineer in charge at Collombey. He said that they had had no problem with the heat exchangers and that they would do it again. We learned the value of using the heat exchangers as well as the best way to design and lay the system out."

Once the decision was made, things moved quickly. The official proposal to install the Alfa Laval Compabloc heat exchangers was made in September 2009, with the feasibility study completed the following month and the process study finished a month after that, including modifications to other parts of the refinery to allow the new units to operate at maximum efficiency.

THE DETAILED PROJECT PLAN, including the strategy for shifting operations from the outdated air-cooling shell-and-tube unit that had been operating there to the new plate heat exchangers was finalized in February 2010. The training of workers got under way, and the start-up was carried out on schedule on 7 April 2010 – less than nine months after

the initial decision was made.

From the outside, the Alfa Laval heat exchangers look like simple metal boxes. But the simple exterior belies the complex work being done inside the two units, which direct heat from the top fraction, known as the virgin naphtha, so it can be used to preheat the crude oil feed to the furnaces and generate hot water for the refinery.

Previously this heat was released into the atmosphere, a common solution in the processing industries where, according to the International Energy Agency, some 50 percent more energy is used than necessary. At the Falconara plant the switch from the outdated air coolers to Alfa Laval

Alfredo Punzo is more than pleased with the performance of the Alfa Laval Compabloc heat exchangers and estimates the economic savings at more than EUR 2.5 million per year.



“It might be difficult to quantify the exact cost benefits from using these heat exchange units because many of the benefits are intangible or indirect. But so far we are very happy we made this decision, and we would definitely do it again.”

ALFREDO PUNZO, FALCONARA REFINERY

Compabloc heat exchangers has meant significant cost savings.

“The idea is to burn the least amount possible,” says Marco Silva, energy manager at Alfa Laval in Italy. “The Compabloc heat exchangers are designed to capture the heat so the refinery can reuse it.”

PUNZO ESTIMATES that the Compabloc units paid for themselves within a year through the savings generated. The units have an estimated lifespan of around 25 years. With

such a short payback period, savings start accumulating in the second year – an important benefit in a time of escalating energy prices.

There are other benefits as well. The technology helps the refinery to burn less fuel, meaning that it releases less carbon dioxide and other greenhouse gases into the atmosphere, making Falconara one of the few Italian refineries to earn an environmental white certificate from the European Union.

The reduction of heat released into the

atmosphere also improved working conditions for those operating near that part of the plant.

And the heat exchangers require minimal maintenance. Punzo says that so far the refinery has not had to contact Alfa Laval for any kind of cleaning or maintenance. “Based on their performance so far, I predict that the units may never need care,” he says.

All in all there are many advantages. “It might be difficult to quantify the exact cost benefits from using these heat exchange units because many of the benefits are intangible or indirect,” Punzo says. “But so far we are very happy we made this decision, and we would definitely do it again.”

Falconara officials believe that more Italian refineries will eventually choose to retrofit the technology into their plants and that as new refineries are built they will incorporate new heat exchangers into their designs. ■

IN PURSUIT OF PEAK PERFORMANCE

In Volkswagen's drive to become "the world's most environmentally friendly auto manufacturer," its climatic wind tunnel plays a significant role. This is where all new car models are tested to ensure driving safety and to improve aerodynamics, which in turn will reduce exhaust gas emissions.

TEXT: ULRICH HOTTELET PHOTO: CEM-KERIM DELIKAN/VOLKSWAGEN

WITH A VELOCITY of up to 200 kilometres per hour, a hurricane makes its way through a tunnel in northern Germany and strikes a car with full force. But it's no natural hurricane, nor is it an ordinary tunnel. The scene takes place at Volkswagen's climatic wind tunnel in Wolfsburg, a kind of weather chamber where all new car models are tested before they are released on the market.

The wind tunnel is part of Volkswagen's concept development, and it is the largest one in Europe – 64 metres long, 35 metres wide and 16 metres high, housed in a huge building.

The enormous size is important for several reasons. Firstly, although it may seem paradoxical, it has to be large because even small joints, edges or flanges on the vehicle affect the airflow. This effect can only be tested on the original part attached to a full-size vehicle model. Secondly, units such as the engine and radiator need to be installed in the vehicle for functional testing. Finally, Volkswagen's commercial vehicles are also developed and tested in the wind tunnel.

"Cars must be tested under all extreme weather conditions that can happen worldwide," says Ulrich Eikmeier, senior engineer at the Volkswagen wind tunnel. "All burdens for vehicles can be simulated, including driving uphill."

THE HURRICANE IS GENERATED using an enormous fan measuring nine metres in diameter, with 10 huge adjustable blades and an input power of up to 2.6 megawatts that forces air through the tunnel towards the test station where the vehicle is located. From the fan, the tunnel widens to a diameter of 14 metres. The

air is guided by baffles at every turn and then flows through a 38-square-metre nozzle, which boosts its velocity to up to 200 km/h. It is one of the largest nozzles in Europe.

Since the car stands on a turning platform, the wind can blow from the front and on a slope. Downstream from the outlet funnel, the air is once again guided around the corner by baffles before it is returned to the fan. At this point, the airflow has lost some of its energy, which makes it easier for the fan to generate airflow, and that in turn saves energy. In addition, the climatic parameters of the airflow can be adjusted. The temperature can be set at any value between 5 and 55 degrees Celsius. Colder temperatures are tested at a smaller wind tunnel. The humidity is completely variable, as is the intensity of solar radiation and rain in the test section.

"THE PURPOSES OF A WIND TUNNEL are, first of all, to improve driving safety and aerodynamics," Eikmeier says. "The more aerodynamic a vehicle is, the lower its fuel consumption. And less fuel consumption leads to reduced emissions such as carbon dioxide."

Alexander Wittmaier, the department head, adds, "Aerodynamics is already decisive at the early stage. But of course, subsequent improvements are possible as well." One key challenge is the variability of vehicle designs. "Designers handcuff us," Wittmaier says. "We must achieve the most efficient consumption with different auto bodies."

Since aerodynamics on the tops of vehicles have been tested exhaustively for decades, the biggest potential for further advancement lies underneath. Since the



“ The purposes of a wind tunnel are, first of all, to improve driving safety and aerodynamics. The more aerodynamic a vehicle is, the lower its fuel consumption.”

ULRICH EIKMEIER, VOLKSWAGEN



In the climatic wind tunnel in Wolfsburg, Volkswagen tests all its new models in every type of weather condition. Reproducibility is the key to success.

“The additionally installed heat exchangers for free cooling lead to enormous savings in operating costs, so we can reduce electricity costs and wear.”

ULRICH EIKMEIER, VOLKSWAGEN

► underside is bumpy because of shafts, wheel arches and the exhaust system, developers work on flattening this surface by casing.

Volkswagen aims to become the most environmentally friendly auto manufacturer by 2018, which means environmental protection ranks high among its corporate goals. The company aims to decrease carbon dioxide emissions both in its products and in its processes. In fact, it took many years to plan the testing facilities to meet the standards of Volkswagen’s sustainability strategy.

THE 11 ALFA LAVAL heat exchangers used for the heating circuits and closed-cycle cooling systems in the wind tunnel have clearly contributed to that goal. The heat exchangers were embedded into the circuits in 2008 and enable Volkswagen to change temperatures very quickly. “This is necessary to precisely simulate the varying conditions of crossing a pass in the mountains,” Eikmeier says.

A key element of Volkswagen’s cooling system is free cooling, which means cooling without using a chiller. Thanks to Alfa Laval’s heat exchangers, free cooling works as long as the difference between temperature outside

and the medium to be cooled is big enough. “The additionally installed heat exchangers for free cooling lead to enormous savings in operating costs, so we can reduce electricity costs and wear,” Eikmeier says. “We have yearned for free cooling for years.”

Besides using this tunnel for Volkswagen and Skoda models and Volkswagen commercial vehicles, Volkswagen also rents its climatic wind tunnel to other companies for different purposes. Companies use it to check the solidity of tents, the forces on doors of phone booths and the mounting of solar panels on roofs.

To increase the available capacity and the range of climatic conditions that could be simulated, a second and much smaller climatic wind tunnel was commissioned in 1985. It measures 33 x 13 x 8 metres. This fully



Ulrich Eikmeier, senior engineer at the Volkswagen wind tunnel, shows how the system works using a model.

computer-operated unit covers a wider range of parameters and is equipped with a two-axle roller dynamometer. It simulates driving conditions on the road. Tests of the climate, heating and cooling system of the car can be conducted there. The temperature in this tunnel is adjustable from -30 to +60 degrees Celsius. Functional tests on full-size models can be carried out in the second tunnel despite its smaller flow cross section. However, aerodynamic tests on full-size vehicles and models are only possible in the large tunnel, whether they are normal winds or hurricanes.

If all these tests were conducted on the road, the results would be severely affected by natural conditions that cannot be controlled, such as shifting wind direction (resulting in uncontrolled air flow), rain and fluctuating temperatures. In contrast, the simulation of driving conditions in the wind tunnel has the advantage that each test can be repeated at any time, right down to the last detail. This repeatability is key, since a vehicle needs to be continually improved during the development phase. “Reproducibility of tests is more important than achieving identical conditions in the test and on the street,” Eikmeier says. ■

VOLKSWAGEN FACTS

- Wolfsburg, Volkswagen’s headquarters, is the largest car production site in Europe. The company employs 50,000 people there.
- 7,000 employees work in the R&D department in Wolfsburg, 750 of them in research only.
- 7.2 million vehicles were delivered to customers in 2010. This represents an 11.4 percent share of the world car market.
- Volkswagen has 63 production facilities worldwide.
- Nine brands from seven European countries belong to the company: Volkswagen, Audi, SEAT, Skoda,

Volkswagen commercial vehicles, Bentley, Bugatti, Lamborghini and Scania.

- Volkswagen aims to become the most environmentally friendly auto manufacturer in the world by 2018. An effective energy-management system helps to achieve this goal. Environment policy is strategically integrated into all processes in the technical development of the brand. The controlling authority TÜV Nordcert supervises this.





Volkswagen's climatic wind tunnel in Wolfsburg, Germany, is the largest wind tunnel in Europe. In the 38-square-metre nozzle, the air velocity is boosted up to 200 km/h.

HEAT EXCHANGERS CONTRIBUTE TO WIND TUNNEL EFFICIENCY

Of the 11 Alfa Laval heat exchangers deployed in Volkswagen's climatic wind tunnels, four are part of the cooling unit, three are used for heating, two for free cooling (cooling without a chiller) and two for coupling two chillers. The chillers shift heat between different temperature levels. While total power of all Alfa Laval heat exchangers used at the wind tunnel is 20 megawatts, the ones used for the cooling unit produce 9.4 MW, whereas the ones for heating generate 4.2 MW.

Both tunnels at Volkswagen are equipped with heat exchangers for free cooling. Its precondition is a difference of at least 12 degrees Celsius between the temperature in the testing system and the temperature outside. Half of the time, the testing systems can be operated by free cooling, which makes the system very energy efficient.

"It is my personal goal to make the facilities more and more efficient year by year," says Ulrich Eikmeier, senior engineer at the Volkswagen wind tunnel. "This means that we use free cooling as much as possible and turn on the chiller as little as possible."

Due to the heat exchangers, heat energy flows by itself and does not require a chiller, as long as the difference between inside and outside temperatures is large enough. Using chillers is much more expensive than free cooling.

The refrigerant in both cooling units is ammonia, which is the most environmentally friendly substance in case of a spill. If a heat exchanger breaks down, it can be replaced by a chiller. So the systems are semi-redundant to guarantee high facility availability.

"We chose Alfa Laval's heat exchangers because I don't know a manufacturer with a better reputation," Eikmeier says. "Moreover, our maintenance department recommended them because of their reliability and high quality. After we had bought them, we were given good advice. I am very satisfied with the detailed computer analysis program."

Even the chiller is equipped with an Alfa Laval heat exchanger.

Besides the deployment in the climatic wind tunnels, heat exchangers can also be used for the cooling of lube oil and metal and for the cleaning of facilities.

Nuclear power plant trusts Alfa Laval for cooling

When the first nuclear power plant in the United Arab Emirates (UAE) opens in 2017, it will use Alfa Laval heat exchangers for its various cooling applications.

Alfa Laval recently won the order from Korean Electric Power Corporation (KEPCO), one of world's leading nuclear suppliers, to deliver heat exchangers for the Braka nuclear power plant outside Abu Dhabi in the UAE. The order is worth about SEK 60 million. Deliveries are scheduled to start in 2013 and be completed in 2018.

"It is a prestigious project," says Lars Renström, president and CEO of the Alfa Laval Group, explaining that a contributing factor to gaining the contract was Alfa Laval's strong local presence in South Korea. "We see it as a confirmation of our strong position in the global heat exchanger market," he says.

The Braka nuclear power plant will include four 1,400 megawatt reactors. The first is scheduled to be operational in 2017; the others are scheduled to be operational in 2020. KEPCO will design, build and help operate the nuclear power plant.



Cellulosic ethanol goes commercial

The first commercial-scale cellulosic ethanol plant is scheduled to open in 2013 in Hugoton, Kansas, in the United States, and Alfa Laval heat exchangers will be part of the plant setup. The ethanol producer recently ordered 31 Alfa Laval heat exchangers for the plant, covering all the needs for plate heat exchangers in the plant's production of ethanol.

The bioethanol plant will produce 20 MG (76,000 cubic metres) per year of ethanol made from cellulosic materials such as straw, wood and bagasse. Alfa Laval has previously supplied equipment to several cellulosic ethanol pilot- and demonstration-scale plants around the world and also has vast experience in commercial-scale ethanol production from sugar and starch.

82
different nationalities were employed in Alfa Laval in 2010, serving customers in 100 countries.



Meeting India's boom in baby food

Increased living standards in India are driving the demand for prepared food applications. Recently a food processing company in India ordered a complete processing line from Alfa Laval to use for the manufacture of baby food.

The processing line includes a variety of Alfa Laval products such as heat exchangers and a large amount of flow equipment for mixing, heating and cooling operations. The order is valued at about SEK 100 million (almost EUR 9 million).

DID YOU KNOW THAT...

...the installed base of Alfa Laval compact heat exchangers in energy-intensive industries saves more than 10 million tonnes of CO₂ emissions per year compared with traditional shell-and-tube heat exchangers.

STEAMY EXPANSION IN WEST AFRICA

Fresh water, and lots of it, is needed to produce steam for methanol production at a plant in Equatorial Guinea. With water in short supply, the plant owner relies on Alfa Laval's Multi-Effect Plate desalination units to solve the problem.

FOUR QUESTIONS FOR NICK LATTIMORE, technical manager at the Atlantic Methanol Production Company (AMPCO), which recently invested in a new unit.

What is the purpose of the Alfa Laval Multi-Effect Plate (MEP) desalination units at AMPCO's methanol plant?

"Since supplies of fresh water are limited at AMPCO's plant site in Equatorial Guinea, we use the Alfa Laval MEP desalination units to turn seawater into fresh water. The primary purpose of this fresh-water output is to make steam, which is integral to the methanol process. High-pressure steam is one raw material in the production of synthesis gas, which in turn is converted to methanol. Some of the freshwater is also used as potable water for the site personnel as well as for the expatriate personnel residential areas."

What is your impression of the Alfa Laval MEP desalination units?

"We're satisfied with all the units, particularly the new desalination unit [the MEP-3-1363, installed in 2010]. The operating cost and reliability have been good. Our satisfaction with the two original Alfa Laval units [installed in 1999] was the primary driver for us in choosing Alfa Laval again, although we did investigate other suppliers and technologies."

How has the MEP unit helped AMPCO plant operations?

"One of the deciding factors for the installation of the third Alfa Laval unit was the beneficial effects on the plant's steam balance. The improved steam balance added flexibility to plant operations. For example, we're able to operate the steam turbine drivers harder to make more horsepower, or to operate steam turbines instead of electric motor drivers, adding to the plant's operating reliability."

Alfa Laval made some improvements to the most recent desalination unit to enable higher production of the unit. How is that working out?

"AMPCO participated with Alfa Laval throughout the design process to make improvements based on our experiences with the two original units. Although the new unit has only been in service for a short while, the changes appear to be beneficial. So far, the new unit seems to hold its production rate better, indicating less fouling of the heat exchanger plates."

CARI SIMMONS



Oceans of challenge



Clean water.

Today, more than one billion people lack access to clean water. If we fail to conserve this life-giving resource, the numbers suffering from thirst will increase dramatically.

At Alfa Laval we are deeply involved in this challenge. We convert seawater to fresh-water. We cool and heat water. We clean waste water. Our high-performance decanters play a key role on the global stage. Installed in their thousands throughout the world, they clean a volume of waste water from a population equalling that of the entire USA. And each year we install new decanters with sufficient capacity to match the needs of everyone in Sweden!



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