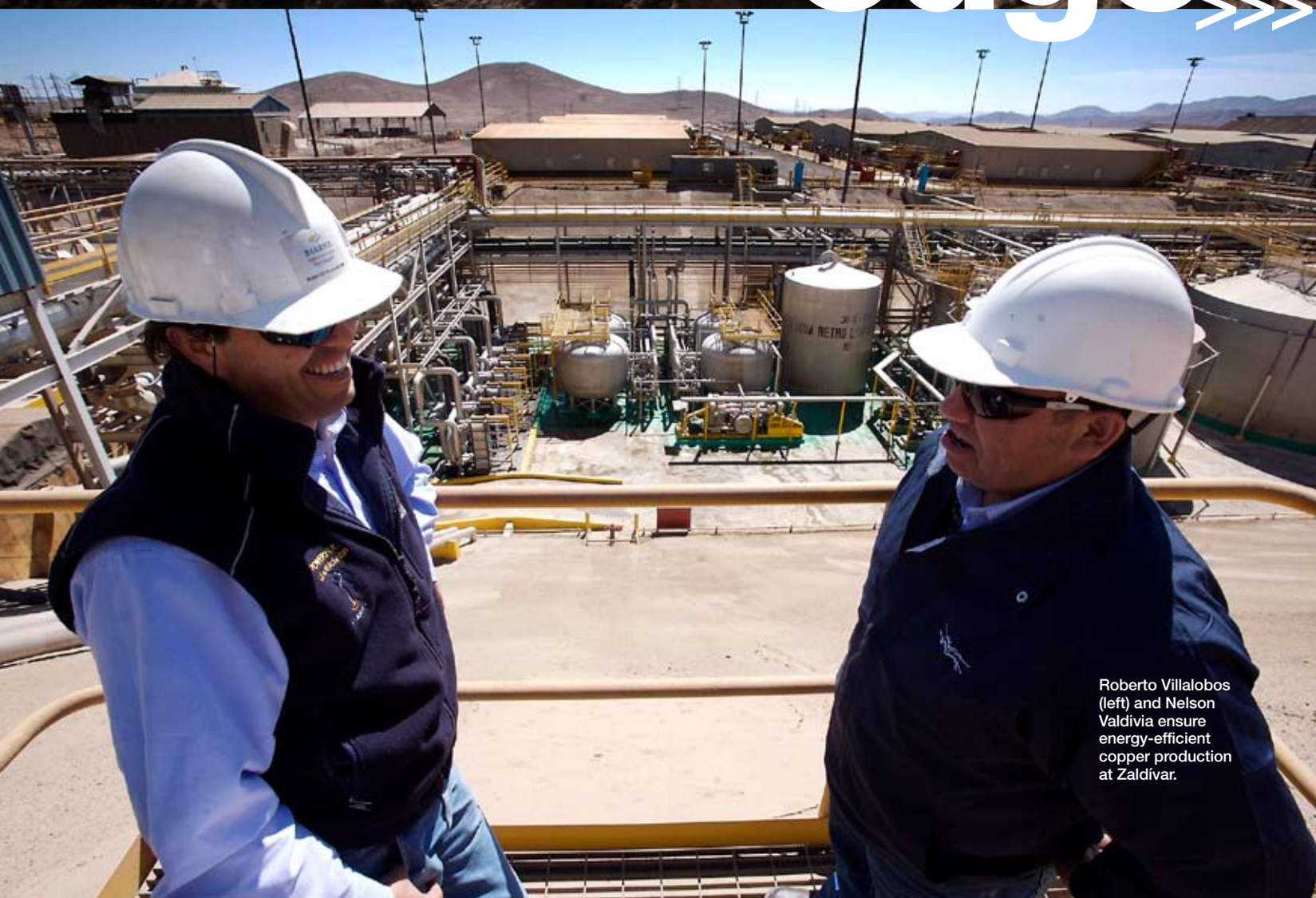
Barrick's Zaldívar copper mine in northern Chile was a pioneer in heat recovery when it first invested in the technology more than a decade ago. The solution is now paying dividends.

TEXT & PHOTO: **CHRISTIAN PEÑA**

At the leading edge >>>



Roberto Villalobos (left) and Nelson Valdivia ensure energy-efficient copper production at Zaldívar.

Zaldívar is an open-pit copper mine that stretches over 1,240 hectares.

THE ATACAMA DESERT IN NORTHERN CHILE is one of the driest places on earth, with an average rainfall of just one millimetre per year. It is also one of the richest mineral areas in the world and home to many of the largest copper mines. Copper, known as "the Chilean wage," is the driving force behind Chile's economy, and 50 percent of the world's copper is mined here.

One of the copper mines in this barren desert is the Zaldívar mine, located 3,300 metres above sea level, 1,400 kilometres north of Santiago and 175 kilometres east of the port city Antofagasta. It is owned and operated by Barrick Gold Corporation, a leading mining company that operates 27 gold and copper mines worldwide and has several projects in development.

Opened in 1995, Zaldívar is Barrick's largest copper mine, employing almost 750 people. It uses conventional methods of open-pit mining to produce pure cathode copper. At a crushing plant the ore goes through three stages of crushing and stacking. This is followed by a heap-leach operation in which the copper is dissolved using chemical and bacteriological agents. The dissolved copper is then concentrated and purified in the leach solutions at a solvent extraction plant. Finally, an electrowinning plant produces high-grade, high-quality cathode copper.

From the beginning Zaldívar's electrowinning plant had the capacity to produce 125,000 tonnes of cathode copper annually. A few years ago, the plant was modified to raise that to 150,000 tonnes per year, 20 percent more than the original design capacity. The increase was accomplished by increasing the flow-rate capacity of the equipment. In 2007 Zaldívar produced 143,000 tonnes of copper. Most of the processed cathode copper is shipped off to Japan, China and the United States.

This past year has been one of the most challenging to date, as the increasing cost of petrol has had a domino effect on other production costs, such as materials, chemicals, transport and supplies. Due to the increasing fuel costs and the growing pressure to reduce CO_2 emissions, Barrick, like many other companies, is forced to find ways of keeping its operating costs down and becoming more efficient.

Robert Mayne-Nicholls, recently appointed general manager of Barrick Zaldívar, explains: "We want to be the most efficient company in terms of energy, without affecting production. At Zaldívar we have been able to achieve this by working with Alfa Laval's technology."

BARRICK ZALDÍVAR'S COOPERATION with Alfa Laval began as the mine went into operation in 1995. At the time Barrick adopted a plate heat-recovery solution for the electrowinning plant at Zaldívar and invested in 16 gasketed plate heat exchangers from Alfa Laval to use in the copper-extraction process.

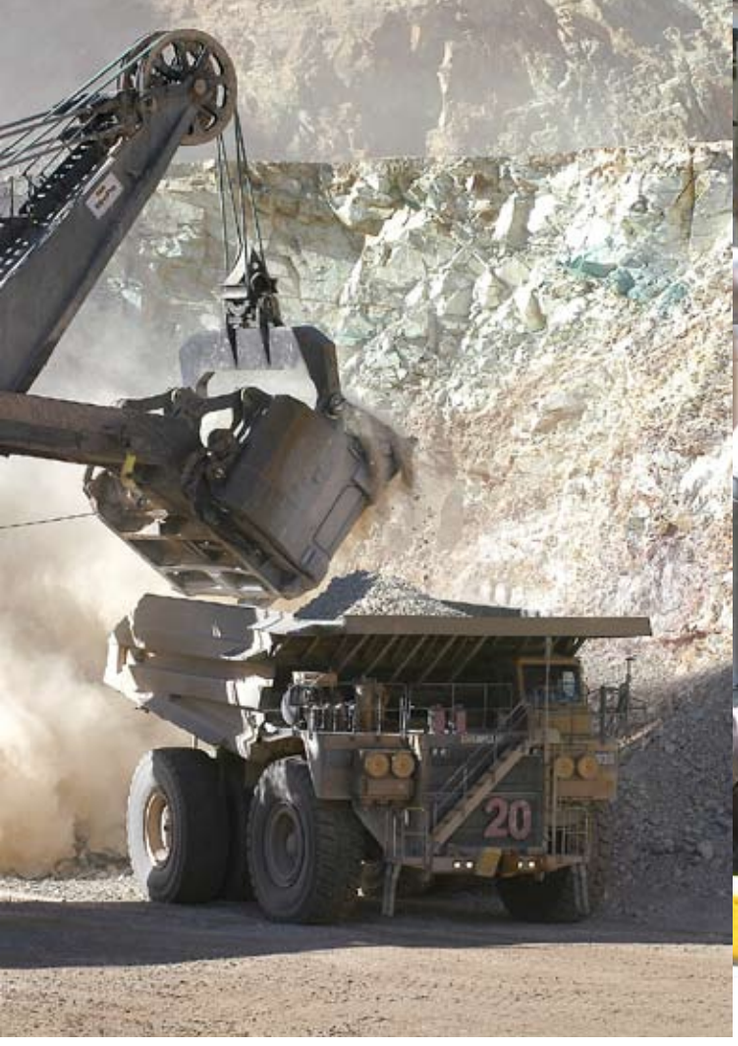
The units were installed in four parallel production lines, recovering a total of 48 megawatts of energy.

"When we began to use Alfa Laval's plate heat exchangers

▸ Facts

BARRICK AND ZALDÍVAR

- Barrick operates 27 mines and has exploration and development projects located across five continents.
- At the end of 2007 Barrick had 124.6 million ounces of proven and probable gold reserves, 6.2 billion pounds of copper reserves and 1.03 billion ounces of contained silver within gold reserves.
- Zaldívar is an open-pit, heap-leach copper mine in northern Chile stretching over 1,240 hectares at an average elevation of 3,300 metres.
- Zaldívar employs 750 people.



Zaldívar uses 16 Alfa Laval plate heat exchangers to recover 48 megawatts of heat.

"We want to be the most efficient company in terms of energy, without affecting production. At Zaldívar we have been able to achieve this by working with Alfa Laval's technology."

ROBERT MAYNE-NICHOLLS, *general manager of Barrick Zaldívar*

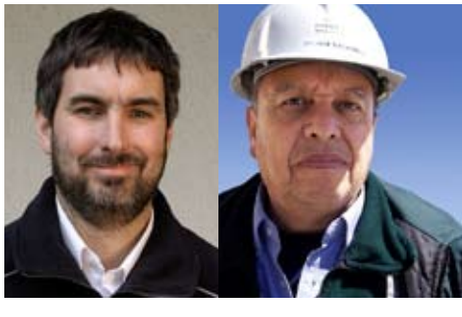
it was a real revolution," says Nelson Valdivia, energy and water-efficiency advisor at Zaldívar. "They changed everything because of their compact size and their fast heat-transfer rate. The benefits of our investment in this technology are even clearer today."

Ruben Arriagada, sales engineer at Alfa Laval in Chile, says Zaldívar was a true pioneer. "Zaldívar was one of the first plants to start using this method," he says. "They invested in heat-recovery technology before it was as necessary as it is now. If Zaldívar hadn't made that investment back then, their costs today would be a lot higher.

"There is a also a space-saving benefit, as the plate heat exchangers take up a fraction of the space that traditional shell-and-tube heat exchangers do," he continues. "They would have taken up a whole football field."

Easy maintenance and installation are other advantages of the Alfa Laval equipment. Visual inspections of the heat exchangers are made every day, and maintenance is carried out yearly. "When we need minor adjustments they are dealt with on site, but when major parts such as the frames begin to wear out we call Alfa Laval for their technical support and service," says Roberto Villalobos, Barrick Zaldívar's maintenance supervisor and plant manager.

ALTHOUGH THE RICH electrolyte solution is extremely corrosive to the equipment, Zaldívar hasn't had to change a single plate since 1995. The hardiness of the plates is due to their copper sulphate content combined with the customized design of the heat exchangers, which helps to minimize the corrosiveness.



Robert Mayne-Nicholls (left) and Nelson Valdivia of Barrick Zaldívar.

In addition, Alfa Laval's heat exchangers are reliable when the natural elements play up. On 14 November 2007, a massive earthquake struck the mining regions in northern Chile, causing a massive blackout and a 10-hour production loss at Zaldívar.

When the power returned, Valdivia verified that the Alfa Laval equipment was still sound. "Chile and the mining regions are in a seismic zone, and plant foundations in Chile are reinforced to cope with these earthquakes," he says. "Amazingly, the heat exchangers kept working as if nothing had happened."

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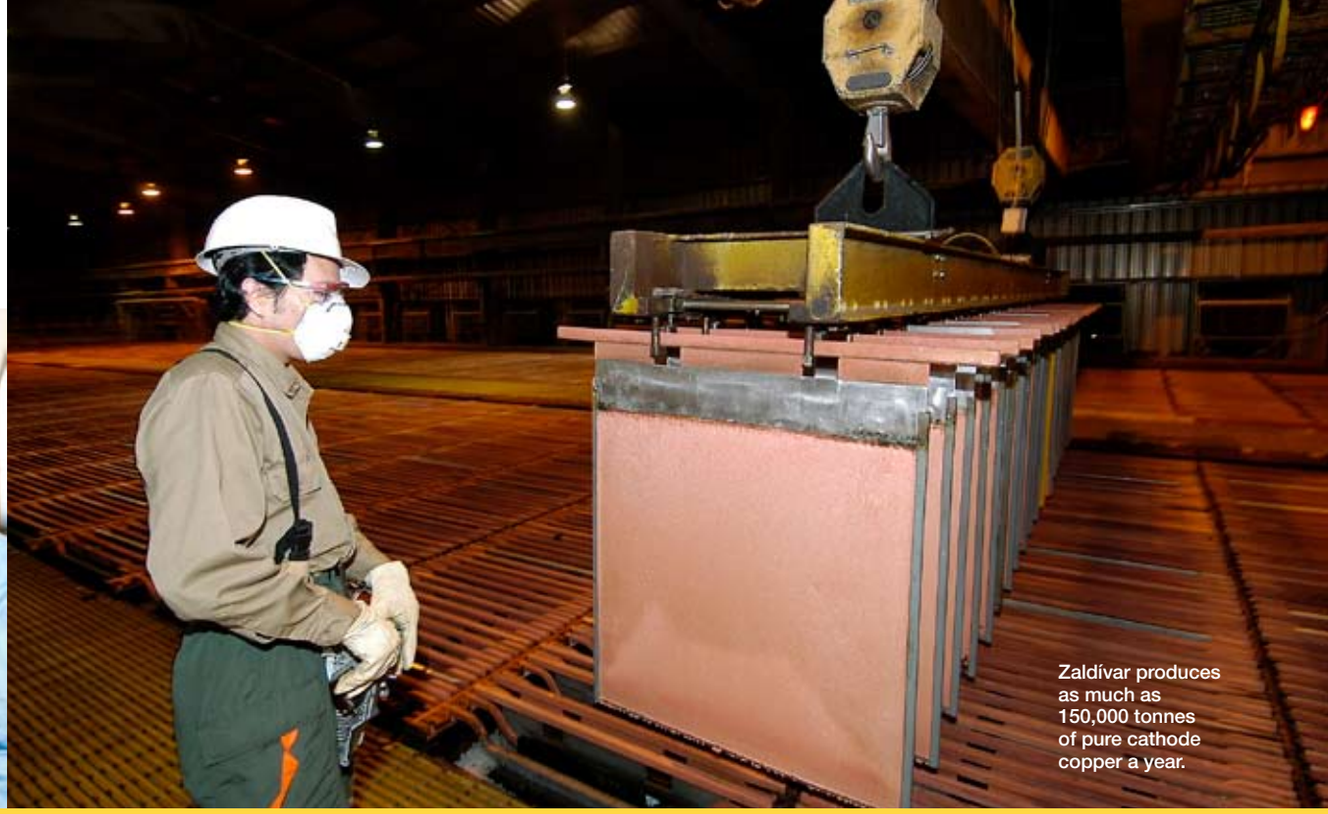
Ruben Arriagada, sales engineer at Alfa Laval in Chile.



Zaldívar produces as much as 150,000 tonnes of pure cathode copper a year.

▸▸ www.alfalaval.com/here/coppermine/zaldivar

>>> Valdivia was already well acquainted with Alfa Laval when he started at Zaldívar six years ago. "I had previous experience working successfully with Alfa Laval at another plant in Chile," he says. "Alfa Laval is well known throughout the mining industry for their proven energy recovery."

Alfa Laval's Ruben Arriagada visits the Zaldívar mine regularly. "I want to ensure that we deliver the best energy recovery possible," he says.

The need for energy efficiency is greater than ever, as energy costs continue to increase. Mayne-Nicholls says the next three years are going to be an energy challenge for all industries, including mining. Zaldívar's energy recovery goals are part of a vision that entails lowering the overall energy use and harmful emissions while keeping the production pace intact.

"Working with Alfa Laval's technology is a win-win situation," Mayne-Nicholls says. "Their plate heat recovery helps us achieve those goals."

But there is still more to accomplish. "We find ourselves in a situation where industries worldwide have to minimize their energy consumption," Mayne-Nicholls says, "and we are always open to new technologies to increase our energy efficiency even further."

Zaldívar and Alfa Laval are now looking into future ways to collaborate on energy recovery and to lower the overall costs. ■

▸ Heat recovery in copper production

A winning process

– Heat recovery cuts costs and CO_2 emissions

Zaldívar uses 16 Alfa Laval plate heat exchangers to recover heat in electrowinning, the final step in the copper-extraction process.

After the ore has been crushed it is leached with sulphuric acid, which dissolves the copper in the ore. The solution is washed with an organic solvent to extract impurities. After washing, the organic solvent is removed and recycled back to the washing section. The remaining solution, which consists of copper and acid, is called "rich electrolyte."

The rich electrolyte is placed in tanks, and an electric current is applied through two electrodes – a positive anode and a negative cathode. Copper is attracted by the electric current and is deposited on the cathode. The remaining solution, which is lean in copper content, is recycled back to the leaching step. On its way back, the lean electrolyte preheats the rich electrolyte, using Alfa Laval's heat exchangers.

Zaldívar uses four lines with four Alfa Laval MX25 plate heat exchangers in each. In addition, Zaldívar has an Alfa Laval M10 heat exchanger that heats the rich electrolyte with water at the end of the process. The heat exchangers are in operation 24 hours a day.

"The units have been operating without any major problems since we began using them in 1995."

"The units are very reliable," says Zaldívar Maintenance Manager Roberto Villalobos. "They have been operating without any major problems since we began using them in 1995."

Thanks to the heat exchanger solution, Zaldívar recovers 48 megawatts of heat. This translates into cost savings of about 4.6 million US dollar per year. It also cuts the plant's CO_2 emissions by almost 66 tonnes per year. Furthermore, the plate heat exchangers take up much less space than traditional shell-and-tube heat exchangers.

Roberto Villalobos, maintenance manager at Zaldívar.

The units are designed to make physical maintenance as straightforward as possible. The 16 units operate in four production lines and hang on a carrying bar, supported by a guiding bar. "This makes my job easy," says Villalobos. "Since only one heat exchanger at a time needs to be stopped, it doesn't affect the overall production significantly." ■