

Process upgrade yields sweet savings for sugar refinery



Replacing a sugar purification process that ran with little change for almost 120 years has reaped savings in labour, gas and water use and reduced discharges of wastewater, heat and air pollution at Auckland's Chelsea sugar refinery. ▶

NEW ZEALAND SUGAR COMPANY LTD
ENGINEERING MANAGER GRANT RITCHIE (LEFT)
AND PROJECT DESIGN ENGINEER
GERHARD VAN NIEKERK.

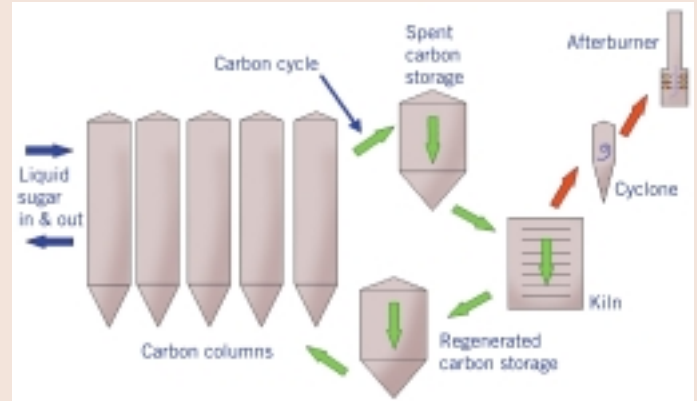
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The decolourisation plant

Each carbon column is used in sequence. As the carbon's surface becomes fully coated with the impurities that colour the sugar, the spent carbon leaves the column to be burnt in the gas-fired kiln, driving off the impurities.

The regenerated carbon is stored in a closed process and added as required. Dust is fed into a cyclone which mixes it with water mist and air. Dirty water is siphoned off into a waste water tank to capture the carbon. Heat and particles pass to the afterburner before discharge.



The Chelsea sugar refinery is an Auckland landmark, its salmon-coloured buildings sited in their own private harbourfront parkland near the Harbour Bridge.

The Victorian buildings are a heritage asset, but this is no abandoned factory. It's a working food processing plant with an assortment of equipment spanning three centuries.

Until February 2003 the carbon decolourisation process, which removes the colour from dissolved

sugar, ran just as it did in 1884 – with the purifying “bone char” regenerated in a dark, satanic kiln building, but fuelled by gas rather than the coal that grimy men shovelled continuously into the fires in the early days.

The brick building, with its nineteenth century cast-iron furnaces and venerable pressure vessels, has a Historic Places Trust Category A listing, so when the New Zealand Sugar Company Ltd wanted to improve the process they couldn't just knock it down and rebuild on the same spot.

They had to erect the new vessels and kiln nearby,

which made for some challenging pipework design.

The new process forces sugar liquor through granulated activated carbon in five 62 kilolitre pressurised stainless steel vessels, to remove impurities.

The activated carbon is made from coal. Previously, bone char (charred bones) was used.

The activated carbon is extremely porous. It has a surface area of 1000 square kilometres per cubic metre – 160 tonnes has a surface area equivalent to the total area of the South Island.

It is too expensive to be used fresh each time, so the trapped organic coloured materials are burnt off to regenerate the carbon in a kiln that operates at up to 950°C.

The previous eight kiln stacks have been replaced by one kiln, which has a standby diesel-powered fan to take over if there's a power cut. At any time, one of the five columns is out of service, while its carbon is being regenerated.

Chelsea sugar refinery

The sugar refinery is 50% owned by CSR Limited and 25% each by Queensland's Mackay Sugar Co-operative and Man Group plc.

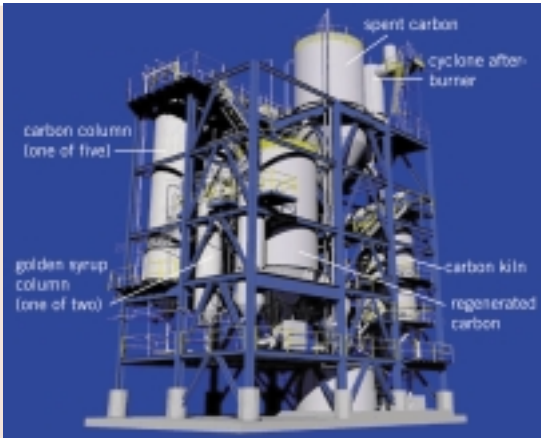
It takes raw sugar from Queensland and refines it into 120 products, including mixtures with milk products for export to Asia and the Pacific.

It markets around 220,000 tonnes of sugar products a year and has been operating continuously on the same site since 1884. Its exports generate 25% of the company's revenue and have doubled in the last five years.

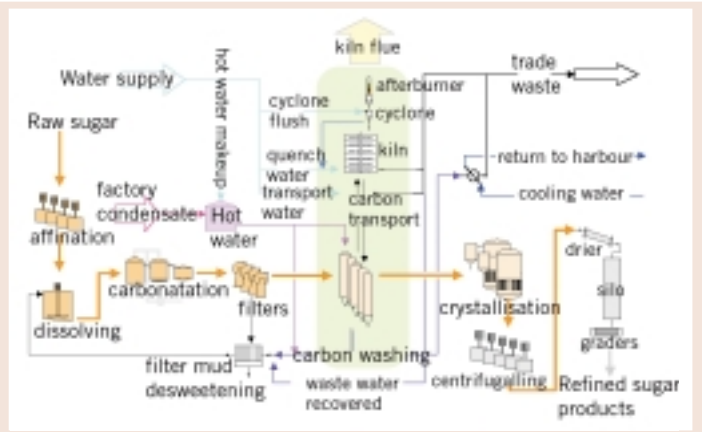


UNTIL THE **CARBON DECOLOURISATION PLANT** WAS OPENED IN **FEBRUARY 2003** (SILVER EQUIPMENT AT RIGHT), **CHELSEA SUGAR REFINERY'S DECOLOURISATION PROCESS** HAD OPERATED IN **MUCH THE SAME WAY AS IT DID IN 1884** IN THE BUILDING AT THE CENTRE OF THE PHOTO (ABOVE LEFT).

“The plant is repaying its \$7 million cost in just 3.8 years.”



LEFT:
COMPUTER
RENDERING
OF THE
NEW PLANT.
RIGHT:
SUGAR
REFINING –
SHOWING
ENVIRON-
MENTAL
FACTORS



“The plant’s wastewater reduction has cut by 8% the amount North Shore City’s treatment plant must deal with.”

Multiple benefits

The decolourisation plant is repaying its \$7 million cost in just 3.8 years.

The new process has valuable benefits. It has halved its natural gas usage and reduced greenhouse gas emissions. Only half the previous amount of potable water is needed and it generates 60% less trade waste. Although the electrical supply has gone from 200 Amps to 300 Amps, the reduction in gas use means overall energy consumption has dropped. This is what won a merit commendation in IPENZ’s 2003 Arthur Mead Environmental Award.

One of the main reasons for replacing the old decolourisation plant was concern about the sheer hard labour required to deal with the gritty bone char, in unpleasant conditions. The plant was expensive to run and needed constant maintenance. Sections were often out of service due to breakdown and it was running far beyond its design capacity.

Says project manager Gerhard van Niekerk: “We realised we had to do something to the plant.”

The new plant is fully automated, with a Siemens S7 400 control system using fourth generation PLC controls linked through a Citect SCADA (Supervisory Control and Data Acquisition) system to a central control room with easy-to-read computer graphics and a screen displaying video from a camera mounted above the plant. It is well endowed with safety features.

Other similar plants use manual arrangements for filling the vessels with carbon from the top. Says van Niekerk: “It was complicated to get the design correct to avoid bacterial growth, but we achieved an unmanned design which is totally automatic. We’ve taken a second-hand plant and gone for state of the art control equipment to make it a state of the art plant.”

It has been designed for expansion, with structural steel already in place ready to add three more columns, and pumps and valves sized to accommodate more capacity in the next 10 years.

Before and after

	Old plant	New plant
Natural gas usage	75 GJ/year	38 GJ/year
Water supply	308 m ³ /day	215 m ³ /day (estimate)
Cooling water	2000 m ³ /day	40 m ³ /day
Cooling water energy	42 GJ/day	0.84 GJ/day
Trade waste	360 m ³ /day	53 m ³ /day
Flue gas emissions	250 m ³ /min	132 m ³ /min
PM ₁₀ emissions	30-35 g/m ³	2-4 g/m ³

Greenhouse gas emissions

NZ Sugar had already achieved the 13% greenhouse gas emission reduction promised in its voluntary agreement with the Government. The new plant reduces emissions further.

Water

The new plant allows 182 m³ of wastewater to be recovered daily. This did not happen before. The plant’s wastewater reduction has cut by 8% the amount of wastewater North Shore City’s treatment plant must deal with.

The refinery is North Shore’s largest single user of potable water, consuming 1.5% of the city’s supply. Any reduction reduces the council’s infrastructural capital requirements.

The previous saltwater cooling requirement of 2000 m³ a day was equivalent to the volume of an Olympic swimming pool.

Always on the lookout

The engineering division has two maintenance engineers and six staff in the resource development team, whose job it is to look at new projects. Says van Niekerk: "We've got to look at productivity and generate projects that are economically viable for our investors to put money into."

Projects are evaluated and ranked according to their payback time and various benefits.

Chelsea looked at alternative decolourisation processes such as iodisation and others involving settling ponds, "But they were not environmentally friendly enough," says van Niekerk.

"In our asset management we have to constantly look at energy consumption, wastage and environmental impact.

"We have a stream of projects we investigate to see if we can get a good return. This one shows it's a fallacy that if you have to spend money to be more environmentally friendly there's no return."

Eliminating bottlenecks

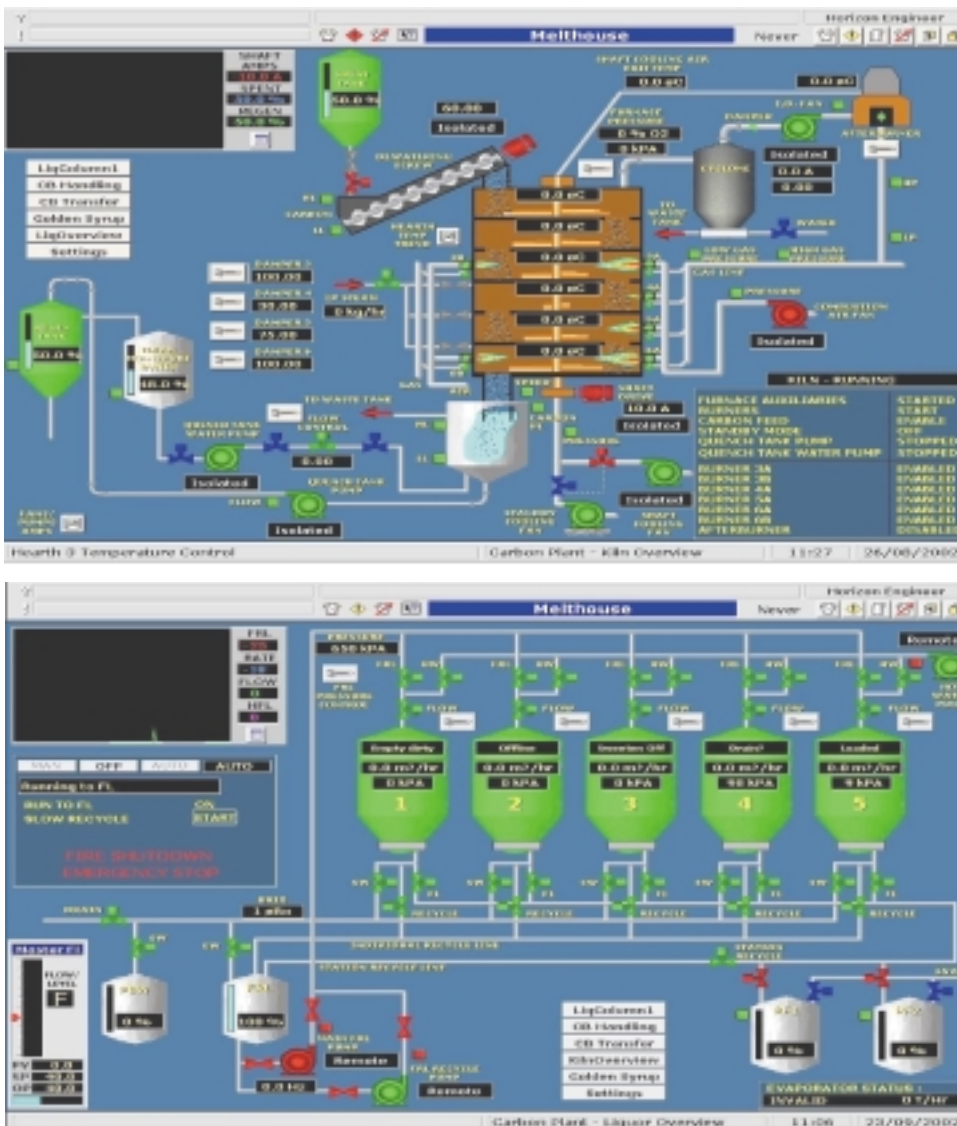
Van Niekerk says some manufacturers operate on the basis that their plant has a planned lifetime of 30 years, after which it is completely replaced.

At Chelsea they believe in working with what they've got and eliminating bottlenecks. With every improvement, they try to anticipate ancillary issues such as health and safety considerations and design accordingly rather than installing new equipment then tweaking it and patching up problem areas.

Previous improvements at the refinery include upgrading the two main steam-generating boilers to run on natural gas instead of fuel oil; and new economiser units to recover waste heat from the steam system.

The refinery has recently upgraded its evaporator plant with gleaming new pressure vessels and controls, with vastly improved water recycling and the largest heat exchanger in the Southern Hemisphere – but that's another story.

Advanced controls



TOP: THE CONTROL SCREEN SHOWS A SCHEMATIC DIAGRAM OF THE KILN.
BELOW: THE FIVE CARBON COLUMNS. A **SIEMENS PLC** AND **CITECT SCADA** SYSTEM CONTROLS ALL ASPECTS OF THE PLANT'S OPERATIONS. THE OPERATING SEQUENCES AND SCREENS WERE DESIGNED IN-HOUSE WITH OVERSEAS ASSISTANCE, AND BENCH-TESTED AT HORIZON TECHNOLOGY. THE CONTROL SYSTEM IS **POWER CUT-PROOF** – NO DATA WOULD BE LOST AND THE SYSTEM WOULD RESTORE TO ITS PREVIOUS STATE AFTER A POWER CUT.

CREDITS

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