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SUNKIST SHOWPLACE FOR CHENG CYCLE

Cover photo: Two unit Cheng Cycle installation at Sunkist Growers

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First industrial Cheng Cycle for Sunkist fruit processing plant

By Irwin Stambler

Sunkist Growers wanted a cogeneration facility that would save on energy costs, yet be able to follow the tremendous swings in power demand common in food processing. They found it in a 12-MW Cheng Cycle plant.

The first application of Cheng Cycle technology to an industrial cogeneration facility, along with a smaller installation completed last year at San Jose State University in California, is a strong signal that this innovative approach to cogeneration has come of age.

Simply, the Cheng Cycle, devised by Dah Yu Cheng, a one-time University of Santa Clara researcher and founder of International Power Technology of Sunnyvale, Calif., employs precisely controlled steam injection to boost cogeneration output and fuel efficiency. A Cheng Cycle heat-recovery steam generator injects superheated steam into a turbine combustion system to increase overall turbine mass loadings without raising inlet temperatures. "If properly implemented," Cheng notes, "this concept could provide power gains of 70% or more by raising turbine mass flow."

A Cheng Cycle was chosen for the 12-MW facility at Sunkist Growers' Ontario, Calif., plant, according to Lee Kosla, vice president of IPT, because it is particularly attractive for food processing operations, where greatly fluctuating steam demands typically occur. These same conditions, he says, tend not to favor the use of conventional gas-turbine cogeneration.

Sunkist's cogeneration facility is leased by IPT's wholly owned subsidiary, Ontario Cogeneration Inc. The subsidiary arranged financing for the installation of the plant and will operate it. "If for some reason the facility can't deliver any energy, we're not obliged to pay," says Vincent Benandillo, energy coordinator for Sunkist. "So IPT has the incentive to make the system work."

Load-following system

Sunkist had studied cogeneration for some time. "It seemed the ideal situation," Benandillo says. "We have a tremendous steam load but also an electrical requirement of 30-40 million kWh per year." Steam usage at the plant annually is in the 300-450 million-lb. range, with the amount needed at any time dependent upon the amount of fruit to be processed. In a single day, he adds, Sunkist's steam load can go from 20,000 lb/hr up to 80,000 lb/hr, posing the problem of how to size a cogeneration facility. "Most of the time you would take the low end, so the gas turbine would always be under a constant load," he says. "But then you can't take advantage of the times when the steam demand is much higher than the turbine capacity." Further, he says, "We shut down on weekends, and we operate on a seasonal basis. We have a low-fruit season, where steam loads are low, and a high-fruit season of 6-7 months a year, when steam demands are high." Because of these cyclic requirements, reasoned Benandillo, the economics for conventional turbine systems became marginal. "We would have been looking at a payback of five to six years. So I didn't recommend cogeneration until I heard about the Cheng Cycle."

'If for some reason the facility can't deliver energy, we're not obliged to pay'

The most attractive feature of the Cheng Cycle, says Benandillo, is the system's ability to follow the thermal load of the plant. This capability is obtained by injecting excess steam from the heat-recovery boilers back into the gas turbine to produce more electricity. "Even when the plant has no steam requirement," he adds, "the Cheng Cycle allows recycling all the steam back to the turbine, which runs at full load to produce more electricity."

Benandillo discussed the applica-

tion of the Cheng Cycle with Ebasco Services, which had originally suggested such an approach, and with IPT. "We plugged the capabilities of a proposed system into the plant requirments. It looked promising, so we went through a detailed analysis of the economics." The result: A Cheng Cycle would offer Sunkist a three-year payback, compared with six or seven years for a conventional facility. Such a project would cost about $13 million, including cost of a high-pressure gas pipeline and other facilities necessary to tie into the Southern California Edison grid.

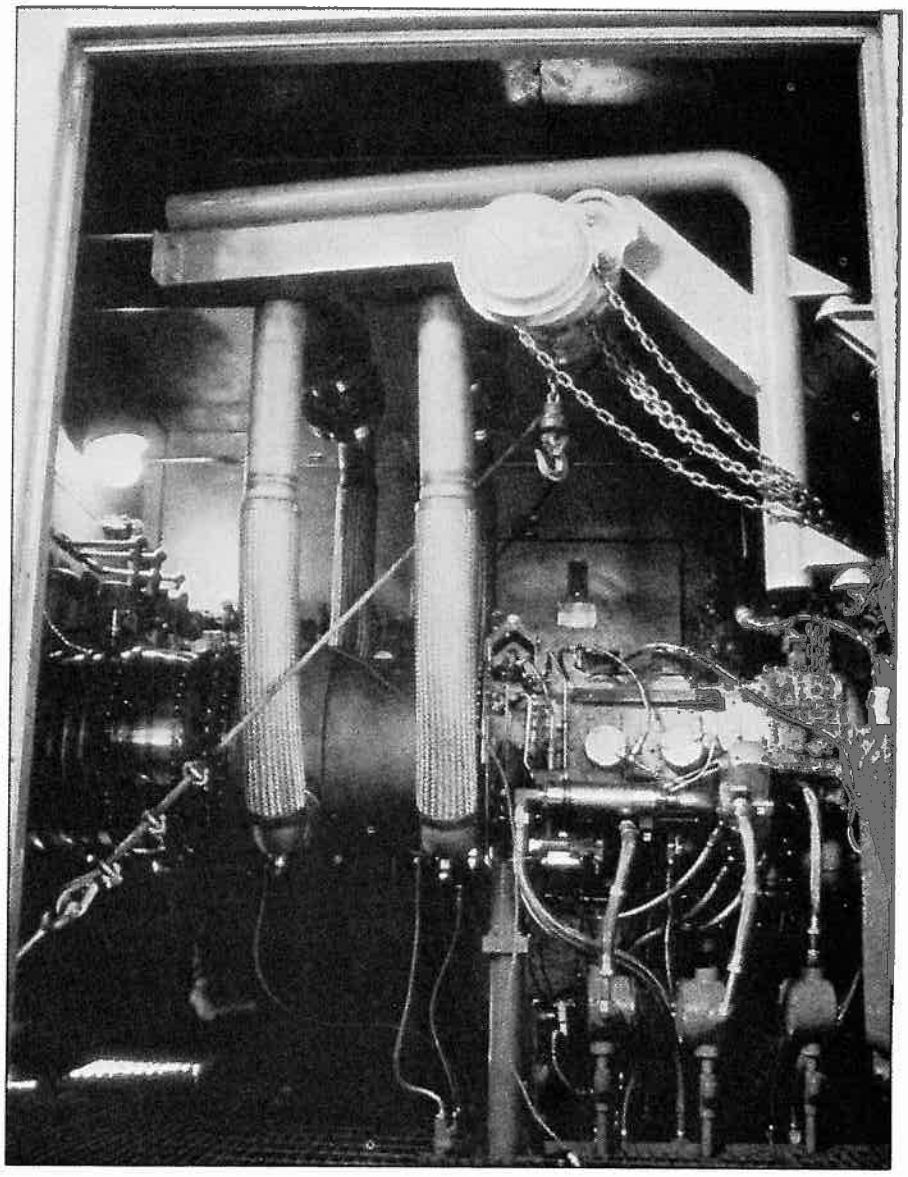
To meet the maximum anticipated plant steam demand of 80,000 lb/hr, the design called for using two General Motors Allison 501-KH gas turbines (the San Jose plant had just one) in conjunction with Deltak waste-heat boilers and Coen duct burners. Each turbine/HRSG system can generate 20,000 lb of steam/hr without using the duct burners. With the burners, each system can deliver 40,000 lb/hr of steam. When increased electrical output is desired, says IPT's Kosla, superheated steam is injected into the combustion chamber at 185 psi and 900F. Turbine modifications to accomodate this process were made by Allison, which also guarantees and warrants that part of the system, Kosla adds.

On-line computer

The key part of the system is the control technology developed by IPT. It uses an on-line computer to determine, in real time, the most economical way to run the system. The computer takes into consideration demand, the cost of fuel, and the requirements of different energy streams. Further, the computer analyzes three revenue streams: the sale of energy, the sale of electricity to Sunkist, and the sale of excess energy to Southern California Edison.

The equipment was in place by the end of November and running by the end of the year. The only loose end was the lack of an operating permit from the South Coast Air Quality Management District. For a time, Sunkist was affected, though really only as an innocent bystander, by a controversy over whether SCAQMD would require all new cogenerators to use selective catalytic reduction as the best available control technology for NOx.

"We had submitted our application for the permit at the end of 1983, and a month later, at the end of January, SCAQMD told us it was complete," says Benandillo. Under existing rules, if there were no negative comments about the project after six months the permit should have been forthcoming, but other projects were involved in the SCR discussion, causing the state agency to delay granting any permits.



Superheated steam at 185 psi and 900°F can be injected into the combustion section of the gas turbine through stainless steel manifolds (above) to increase gas turbine power output by as much as 70% — from a nominal base load output of 3500 kW to 6000 kW with steam injection — without burning any additional fuel.

"However, we had several things in our favor," says Benandillo. "One was that IPT was able to demonstrate that SCR should not be considered best available control technology for Cheng Cycle systems. The other was that we could provide adequate offsets." In November, 1984, the agency told Sunkist it would not require SCR for the Ontario project. That was sufficient to induce Southern California Gas Co. to start installing the two-mile, high-pressure pipeline, which it had hesitated to do before.

Cutting energy costs

The reason Sunkist got involved in the cogeneration program at all was its desire to cut energy costs. "With the new installation, we probably will reduce those by about 10%," says Benandillo. "It's not a tremendous reduction, but it's substantial enough to justify the risks we're taking." While Sunkist is not paying for the equipment, he says, "we have operation risks because we can't afford shutdowns. If we shut down for even a couple of hours, the packing houses start backing up."