Engine Drives Are Fueling the Future of Food Processing

Engine Refrigeration Compressor Drive Demonstrates Energy Saving Benefits

A Single Natural Gas Engine-Driven Ammonia Compressor Proves Worth for California Food Processor

Aquamar is a food processing facility that produces “imitation crab meat.” The ammonia refrigeration system at this plant has been recently updated to meet additional cooling loads and to include a Caterpillar engine-driven compressor with heat recovery.

The engine compressor system utilizes a plate frame heat exchanger to recover heat from the engine jacket water. In order to maximize the heat recovery potential, the heat exchanger is located between the engine and the radiator located on the roof. This provides the highest temperature glycol for heat recovery purposes.

One engine-driven compressor generates over $60,000 in annual operating savings providing the facility with a two-year payback.

Economics

Three different operating patterns (6, 16, and 24-hours of engine operation) were evaluated at the Southern California Edison TOU8 large service time of use electricity rate. Only the GN-10 core service gas rate was used to determine gas consumption costs. The total (including transportation) price for gas was set at $0.40, $0.50, and $0.60/therm to bound the range of commodity prices the facility might expect to see in the future.

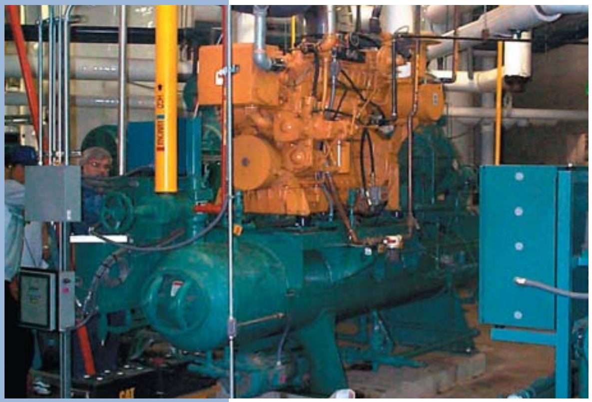
Net savings includes all heat recovery contributions and deductions for maintenance at a rate of 1.2¢/bHp-hour. Annual heat recovery utilization (percent of maximum possible jacket water energy recovered) was 28% for the 24-hour case, and proportionally less for the other operating scenarios. It is clear from this assessment that 24 hour per day operation is the most cost effective operating mode under the current electric rate tariff.

The incremental cost of the industrial engine operating at 1,800 rpm and the larger sized screw compressor to operate at 1,800 rpm without a gearbox versus an electric motor is $125,000. This provides Aquamar with approximately a two year payback assuming they purchase gas at $0.50/therm under their current 24 hour per day operating mode.

Aquamar

The two-stage ammonia refrigeration system at Aquamar includes three electric compressors and one new natural gas engine driven compressor:

- 150 HP high side electric motor-driven compressor (+15 °F suction)
- 100 HP booster electric motor-driven compressor for the blast freezer (-60 °F suction)
- 125 HP single stage electric motor-driven compressor for the refrigerated warehouse (-30 °F suction)
- 220 HP high stage engine-driven compressor (+15 °F suction)



The system was recently modified to handle the increased medium temperature chilled water loads. At the same time an engine-driven compressor was added on the high side of the system. Medium temperature loads include two new chiller plate-frame heat exchangers that provide chilled water for cooling baths that cool the packaged crab meat product before it is packaged or run through the blast freezer. Both of the low temperature loads have flash tanks with liquid-overfeed pumps.

The engine-driven compressor operated typically from 6:00 AM to 6:00-8:00 PM Monday through Saturday. The high side electric compressor (on the same +15 °F suction header) was observed to operate during off-peak hours and all day on Sunday. The -30 °F suction electric compressor operates independently of the high side compressors keeping the warehouse cold. The -60 °F suction booster compressor followed the operation of the high side compressors which is dictated by the production schedule. The facility displayed a very flat load profile.

The Bottom Line is Clear

Operating Hours	$0.40 / therm	$0.50 / therm	$0.60 / therm
24	$74,375	$63,706	$53,037
16	$49,997	$44,588	$39,178
6	$29,207	$27,127	$25,047

Capital cost differential - $125,000

Payback at 24 hours/day and $0.50 / therm gas is ~ 2 years

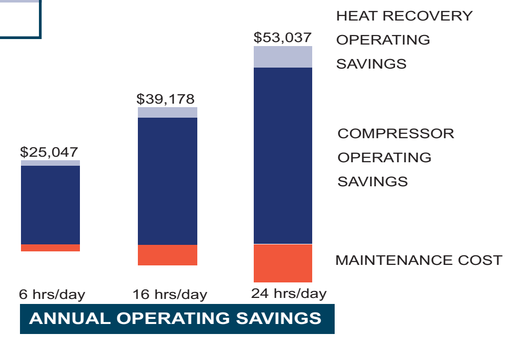
Heat Recovery Technology

The engine compressor system utilizes a plate frame heat exchanger to recover heat from the engine jacket water. In order to maximize the heat recovery potential, the heat exchanger is located between the engine and the radiator located on the roof. This provides the highest temperature glycol for heat recovery purposes.

The gas engine is supplying 190 °F glycol to the heat exchanger, and providing a 90-110 °F temperature increase to the makeup water system. The typical makeup water flow rate is 3.5 gpm.

Engine Loading	100 %
Fuel Input - HHV	1,705,974BTUh
Jacket Water Heat Available	580,080 BTUh
Heat Available Fraction	34 %
Average Recovered Heat Utilized in the Process	162,422 BTUh
Average Heat Utilization Fraction of Heat Available	28 %

The predominant energy savings at the Aquamar facility is through the engine shaft power. Increasing the heat recovery at this site could be achieved by adding a heat recovery steam generator (HRSG) which would reduce gas input to the boiler an additional 7%.



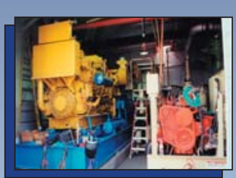
Gas Technology
Fueling the Food Industry

150 HP standard engine-driven screw compressor product line

Standard brine chillers from 50 to 1,000 HP

Industrial custom engine driven compressor sets up to 5,000 HP

Dehumidifiers ranging from 1,000 scfm to 50,000 scfm



Industrial air compressors up to 750 cfm

Engine-driven onsite electric power generation in sizes up to 5 MW

Turbine-driven onsite electric power generation in sizes up to 30 kW to 15 MW

Combined heat and power systems providing electric or shaft power and thermal heat recovery

Fueling the Future of Industry

Energy Efficiency, Emissions and the Future of Energy Decisions

The electric power industry is in transition with the intended outcome leading to competition in a formerly restricted and regulated environment. In time, numerous benefits can be expected from a competitive electricity market; however, the transition will require rethinking electric delivery system design to accommodate the nation's future economic, environmental and reliability needs.

Combined heat and power "CHP" systems (either direct drive systems with heat recovery like Aquamar or onsite electric generation systems with heat recovery) have the potential to eliminate costly transmission and distribution bottlenecks, reduce electric peak demand, improve power reliability and power quality. Technology exists today that can be integrated into successful CHP systems. Smaller sized and advanced CHP systems are on the horizon.

Be sure to consult your local gas utility for economics of refrigeration systems, CHP systems and other natural gas based industrial products in your area as rates vary widely across the nation.

In the future, when peak demand is expected to rise, when improved integrated devices are made and when CO_2 emission reductions are valued, then even with low electric rates gas engine driven compressors with heat recovery systems will have vastly improved pay backs.

For further information contact

Industrial Center Inc..

The Industrial Center supports the commercial introduction of new technologies to help build value-added markets for natural gas in North America. The Industrial Center and its members identify, evaluate and prioritize industrial markets and products for the opportunities they offer.

The Industrial Center then coordinates market development programs to move specific products from R&D success to market acceptance and ultimate commercial success. The goal of each program is to achieve stand-alone sales for each supported technology within 5 years of its first market demonstration.

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