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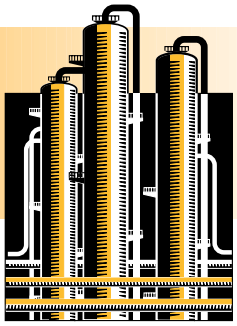
Project Fact Sheet



Dual-Function Absorption Cycle Uses Low-Level Refinery Heat

Benefits

- Could save 154 billion Btu of electricity per installation annually
- Could save the petroleum industry 8.5 trillion Btu annually by 2010
- Produces interchangeable power and/or refrigeration to meet refinery needs
- Uses very low-level waste heat
- Operates as a high-efficiency cycle at low cost
- Generates power for internal refinery needs and exports surplus energy to the grid
- Allows year-round use of waste heat and equipment

Applications

The dual-function absorption cycle is applicable to all 165 U.S. petroleum refineries, with each refinery accommodating multiple absorption cycles. Other prospective markets for the technology include the chemical and forest products industries, which also produce waste heat and use refrigeration and electricity.

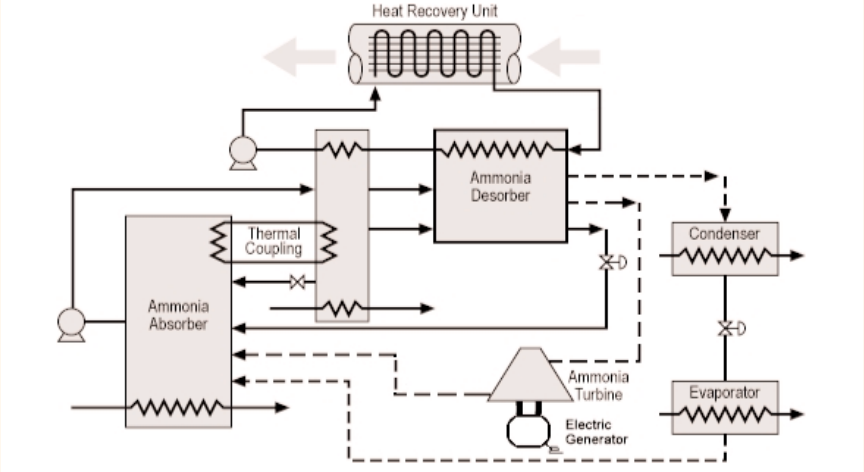
An Ammonia-Water Absorption Cycle Produces Power and/or Refrigeration in Refineries

The refining of petroleum produces a great deal of waste heat that largely is unused because demands for low-level waste heat are limited. Meanwhile, petroleum companies are seeking technologies that will increase energy efficiency and reduce emissions of greenhouse gases. Although several technologies for converting waste heat exist, they do not economically extract the available quantities of low-temperature heat and turn it into useful high-value products.

Existing organic-Rankine cycles yield low energy-conversion efficiency from low-temperature heat and are expensive at small scale. Another existing conversion technology uses ammonia-water mixtures in a process that involves total evaporation, superheating, and vapor condensation. However, this process also has drawbacks including the difficulty of a total evaporation step and the lack of pure ammonia vapor that could be used to coproduce refrigeration.

A new technology applies advancements in absorption-refrigeration technology to produce either refrigeration or power from low-level waste heat sources. The innovative process allows the waste heat produced by refineries to provide all necessary refrigeration; excess waste heat capacity can be converted to electrical power.

Schematic of the Dual-Function Absorption Cycle



This new technology, developed by the Energy Concepts Company, uses an ammonia- water absorption cycle to convert low-level waste heat to electric power or refrigeration.

Project Description

Goal: Produce a preliminary engineering design and cost estimate for the dual-function absorption cycle and validate the performance-critical components for commercially scaled applications.

The dual-function absorption cycle converts waste heat that is 250°F to 650°F to electric power and/or refrigeration. A closed-flow loop with a transfer fluid collects waste heat from several sources into a centralized absorption cycle. Power is produced when high-pressure ammonia vapor drives a turbine. In the refrigeration mode, high-pressure ammonia vapor flows to a condenser, and the condensate is expanded into an evaporator to produce refrigeration. In either case, the low-pressure vapor then flows to the absorber, and the resulting weak solution is pumped to the recuperator and then to the desorber to complete the cycle. The recuperation system is an innovation that extracts more waste heat than other processes.

The dual-function absorption cycle uses the same equipment interchangeably for power production and refrigeration, either separately or simultaneously. Refrigeration is a higher-value product than power, but refineries have more waste heat than is required to fulfill their refrigeration needs. The dual-function equipment allows the excess waste heat to be used for internal refinery power needs or exported to the power grid.

Energy Concepts Company is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the U.S. Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Identify a process unit with high potential both for waste-heat recovery and for refrigeration and/or power use.
- Perform thermodynamic analysis of the cycle to determine optimum parameters and sizing of major components.
- Test a prototype absorber for temperature performance and design the ammonia-turbine.
- Design and analyze the details of prototype unit components.
- Estimate installation costs.

Economics and Commercial Potential

The dual-function absorption cycle can economically convert about 18% percent of refinery waste heat to electricity or refrigeration. A typical refinery produces total waste heat of 127,000 Btu per barrel or 21% of total energy consumption. The dual-function absorption cycle could recover about two-thirds of this 7 trillion Btu per year to generate 26 MWe of power. This power would supply about one-half the electric demand of a typical refinery. Each refinery will require from 2 to 5 dual-function absorption units to use its waste heat, so the U.S. market is estimated at 600 installations.

This technology could save 154 billion Btu of electricity per installed unit each year. First sales for the technology are expected by 2003. Based on 10% market penetration by 2010, annual savings could be 8.5 trillion Btu with 55 units in operation at refineries. Market penetration of 35% by 2020 could save 30 trillion Btu from 192 operating units.

Industry of the Future—Petroleum

Petroleum is one of nine energy- and waste-intensive industries that is participating with the U.S. Department of Energy's (DOE) Office of Industrial Technologies' Industries of the Future initiative. Using an industry-defined vision of the petroleum industry in the year 2020, the industry and DOE are using this strategy to build collaborations to develop and deploy technologies crucial to the industry's future.

OIT Petroleum Industry Team Leader: Jim Quinn (202) 586-5725.

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

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Order# I-PE-821
September 2001