

Evaluations are continuing at the Hoffman-LaRoche pharmaceutical plant where this system was installed and is operating successfully. Four units are presently operating, saving 1.93 trillion Btu per year. At \$4 per million Btu, this is equal to cost savings of \$7.7 million annually. Estimated energy savings in the year 2010 due to this technology are 171 trillion Btu per year.

Energy Analysis and Diagnostic Centers

Large numbers of small and medium-size manufacturers lack the technical resources to perform thorough energy audits of their plants. DOE has sponsored a program to offer, at no direct cost to these manufacturers, plant energy analyses performed by engineering faculty and students from U.S. universities. The program has grown from its experimental beginnings in 1976 to include 13 participating universities located across the nation. To date, the Energy Analysis and Diagnostic Centers (EADCs) have performed over 2000 plant audits. Frequently recommended measures include the use of lower wattage lamps; insulating bare storage tanks, vessels, and lines; adjusting burners; and installing compressor air intakes in the coolest locations. From 55 to 75 percent of the recommended measures have been implemented, generally those involving smaller capital cost. Currently, the energy savings due to the EADC program are approximately 13.5 trillion Btu per year, worth about \$45 million.

Boiler Workshops

Steam boilers are the most prevalent energy conversion technology in industry. Boilers are used in every industrial and commercial sector to produce process steam, hot water, and building heat. Even small efficiency improvements in the operation of these boilers can save large amounts of fuel. DOE developed a national program of energy-efficiency information and instruction for boiler operators to

promote more cost-effective and efficient maintenance and operating practices. Under this program, university faculty members and boiler technology specialists taught well-attended courses all over the country. Many local and industrial organizations followed through and expanded on the pilot DOE program by continuing the courses with their own funding. These workshop courses for boiler operators are still held periodically in many areas of the United States. The energy savings due directly to this DOE project completed in 1987 are estimated at 2.8 trillion Btu per year.

Brayton-Cycle Solvent Recovery

In 1980, approximately 19.3 million tons of volatile organic solvents were lost as waste emissions from industrial processes of the petroleum, organic chemicals, paint, adhesive, printing, and dry-cleaning industries. Under a DOE contract, Garrett AiResearch has developed a Brayton-cycle heat pump designed to recover volatile organic solvents from waste vapors. The inherent cooling and heating capabilities of a Brayton-cycle heat pump provide an economical, energy-efficient solvent-recovery system in which solvent is recovered by condensation. With this system, solvent-laden gas enters the Brayton-cycle compressor, where part of the heat of compression drives the turbines, augmenting the electrical energy supplied to the motor-driven compressor. The rest of the heat of compression is returned, via a regenerator, for reuse in the industrial process. Solvent precipitation begins in the condenser and continues as the gas mixture expands through the turbine. Expansion of the gas causes further condensation of the solvent, which is collected in a coalesce separator. The first installation of the Brayton-cycle solvent-recovery system by the 3M Company at its magnetic-tape production facility in Hutchinson, Minnesota is estimated to save 38 billion Btu annually. By ensuring a consistent solvent quality, the system also improves productivity in the tape-making process.