USING AIR CONDITIONING ENERGY FOR ALL IT'S WORTH

Operating cost reductions in the new U.S. Department of Labor Building earned the author a Presidential letter from the White House, citing him for contributing to energy conservation and more economic government. Almost any building manager with a central cooling plant can do it, but savings will vary with machine loading and local energy costs.

The cost of central air conditioning has become an increasing financial burden on building operating budgets. Magnified by the soaring cost of energy, the problem can no longer be ignored. Although progress has been made in eliminating waste and optimizing use of conditioned air, more areas of cost cutting should be explored.

In searching for ways to reduce building operating costs and energy consumption in the new U.S. Department of Labor Building, managed by General Services Administration, we discovered a simple method of improving heat transfer which reduces electrical consumption from 0.89 kw/ton to 0.64 kw/ton.

The central cooling plant which services the six-story Department of Labor Building and the new, five-story U.S. Tax Court consists of an open recirculation system providing cooling water to three 1500-ton hermetically sealed centrifugal machines and one 1000-ton open centrifugal machine. Cooling plant design calls for two of the 1500-ton machines to serve the 1,725,000 sq. ft. Department of Labor Building and the 1000-ton machine to serve the 132,600 sq. ft. Tax Court Building. The third 1500-ton refrigeration machine provides standby service. Beneficial occupancy of these two buildings was completed in March, 1975.

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Dollars down the tube

To compensate for fouling of heat transfer surfaces in refrigeration machines and resultant loss of cooling capacity, designers have traditionally provided extra machine capacity and manufacturers have provided an allowance for fouling. Although this permits machines to operate longer between condenser cleanings, the burden of operating machines in fouled condition results in an undetected excess expenditure of energy.

Foulants such as scale, corrosion products, algae, silts, sludges and petroleum products, adhere to heat transfer surfaces, gradually building up and increasing insulating properties, and thereby increasing resistance to heat transfer. This requires the refrigeration machine to work harder to drive rejected heat into the cooling water. The process is normally tolerated until the refrigeration machine can no longer produce required cooling capacity to adequately cool the facility. The machine is then shut down, its condenser opened, tubes cleaned mechanically/chemically and it is then returned to service.

Fouling has been termed the major unresolved problem in heat transfer by the Heat Transfer Research Institute. It is also an expensive waste of energy. So, we decided to investigate a recently developed method of continually removing foulants from the water side surfaces of the condenser tubes in refrigeration machines.

We found some installations successfully employing the method since 1969 and studied other installations made within the last two years. The technique was developed to overcome the normal buildup of foulants which occurs in condensers of virtually all refrigeration machines, including those with some of the most sophisticated water treatment chemicals and control systems.

The author describes the program which represented the single greatest saving of 14 PBS employees, whose combined special efforts to conserve energy and reduce costs resulted in a saving of over $294,000. Mr. Petritsch was Buildings Manager, North Area Office, Washington, D.C., at the time the installation was made and performance data monitored. He recently transferred to Region 9 (San Francisco).

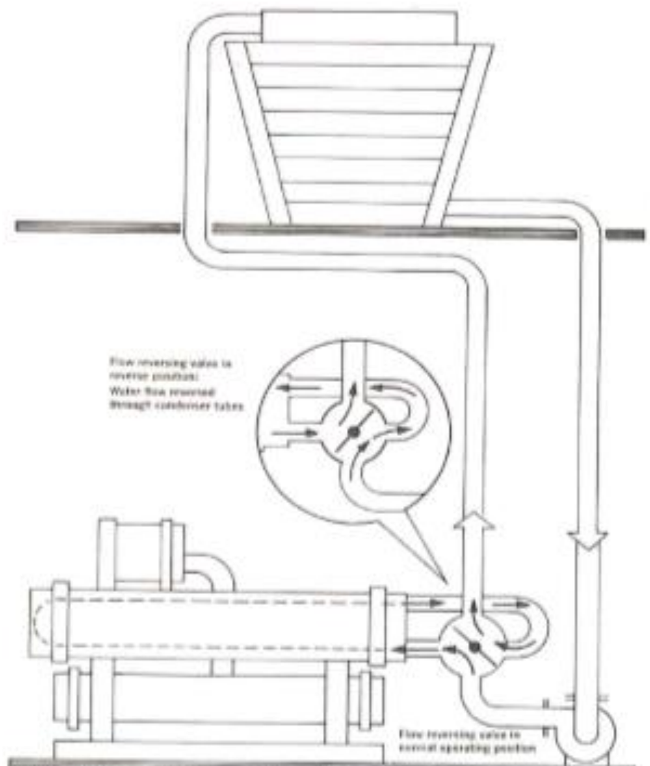
Simple, but automatic

The system consists of a set of two baskets and one brush for each condenser tube and a flow reversing valve. A basket is mounted at each end of the condenser tube to house the brush at the downstream end of the tube, and to permit full condenser tube flow without measurable pressure drop.

The brush is propelled through the tube by reversing the direction of condenser water flow. Flow reversal is accomplished by means of an automatic flow reversing valve incorporated in the condenser water piping system. The valve is usually pneumatically actuated and controlled by a timer which normally cycles the brushes every eight hours. (Each tube is brushed twice during each cycle.) A five-year brush life is predicted, but some in service that long show negligible wear.

AUTOMATIC VALVE in condenser piping system cycles brushes every eight hours. Flow reversal is followed one minute later by a second reversal which returns flow to forward direction.

UNDER GSA MANAGEMENT, the new U.S. Department of Labor Building and the new U.S. Tax Court Building are both cooled by centrifugal machines that are "cleaning up" on energy savings.



Flow diagram depicts flow reversing valve operation

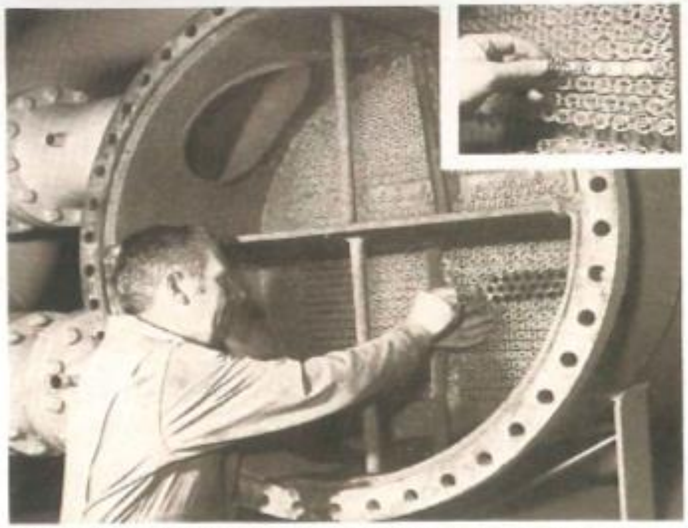
Our investigation revealed energy savings at existing installations ranging from 10 to 35%. Also, little operator attention is required because of the simplicity of the system and its automatic features. Our economic evaluation indicated a payback of less than one year. Therefore, we decided to initially procure one system for installation on one of the 1500-ton machines (machine #3) and monitor its performance. Purchase price for the installed system was $22,185.

Proving out performance data

After completion of one cooling season, the condenser was cleaned (December, 1975). An acid solution was circulated through the tubes to soften the heavy scale buildup, and softened material was then flushed out with the help of a "jiffy gun."

Late in January, 1976, the flow reversing valve was installed, and lastly, the baskets and brushes. The refrigeration machine with brush system activated was placed in service on February 20, 1976. Using precision test instrumentation prior to and subsequent to installation of the brush cleaning system, we acquired performance data which is detailed in Figure 1.

We obtained comparative operating costs with and without the brush cleaning system by extending indicated power consumption rates with contemplated machine loading and existing electric utility rates. We arrived at a cost of $82,080 per year with the brush cleaning system, compared to $114,142 per year without the system. The difference indicates an operating cost reduction of $32,062 per year due to energy savings alone. This does not include additional savings realized due to elimination of periodic manual condenser tube cleaning. Our premise on which a one-year payout for the capital investment in the system was anticipated is now being substantiated. □



BRUSHES IN EACH CONDENSER TUBE are slightly larger than the inside diameter of the tube to give surfaces of entire tube length a positive scrub-down. Brushes are of nylon bristles with corrosion-resistant support wires and nose cones; polypropylene baskets house brushes and maintain full condenser tube flow.

FIGURE 1

PERFORMANCE DATA — REFRIGERATION MACHINE #3
U. S. Department of Labor Building

	Without Brush System June 11, 1975	With Brush System May 11, 1976
Condenser water inlet temperature	81.0° F.	76.8° F
Condensor water outlet temperature	90.0° F.	85.7° F
Condenser water flow rate	4300 gpm	4400 gpm
Chilled water inlet temperature	49.5° F.	50.9° F.
Chilled water outlet temperature	42.0° F.	41.0° F.
Chilled water flow rate	3700 gpm	3400 gpm
Compressor amps	145	125
Compressor volts	4160	4160
Refrigeration produced	1152 tons	1402 tons
Power required	1023 kw	901 kw
Rate of power consumption	0.89 kw/ton	0.64 kw/ton

COMPARATIVE OPERATING COSTS

Assuming the machine will be used 3,000 hours per year with an average machine load of 75% at the present electric rate of $0.038/kwh, results are as follows:

Without brush cleaning system:
1500 tons x 75% x 0.89 kw/ton x 3000 hours/year x $0.038/kwh — $114,142 per year

With brush cleaning system:
1500 tons x 75% x 0.64 kw/ton x 3000 hours/year x $0.038/kwh — $82,080 per year

OPERATING COST REDUCTION PER YEAR: $32,062