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Energy Management in Institutional Facilities

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ENERGY MANAGEMENT IN INSTITUTIONAL FACILITIES

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Insitutional buildings present a challenge for energy conservation because their operation is year-round, seven-day-a-week, twenty-four per day. In this paper, the author examines year-round heat rejection sources and shows how an energy reclaim system that reuses cooling system waste heat for preheating service hot water proves effective for successful energy management.

GENERAL

During the past decade, the consumption, conservation, and selection of energy, has been the biggest concern of architects, engineers, and designers of institutional facilities. By studying the rate of consumption of fossil fuels (natural gas, oil, and coal) and comparing it with their rate of discovery, economical extraction, and environmental impact, it is readily evident that prudent management of energy offers the only hope of averting total disaster in this century.

Our domestic reserves of petroleum and natural gas, which provide roughly two-thirds of our energy supplies, can sustain current consumption (and wastage) rates only a few more decades. Our research for new energy sources, including nuclear fusion, geothermal, tidal energy, solar energy, hydrogen, etc. is slow, and there is a long lead time before these new sources can be economically utilized. As a net consequence, we are importing huge amounts of crude oil from foreign countries and are at their mercy.

EFFECTIVE YEAR-ROUND

Institutional facilities consume large amounts of energy for space heating, cooling, and service hot water. The need for space heating and/or cooling and service hot water in institutional buildings is twenty-four hours a day, seven days a week. During summer months, a "conventional" air-conditioning system removes heat from the building and rejects it to the atmosphere via condensers. Service hot water needs in the summer months are sometimes higher than in winter months because of additional shower loads. The optimum use of energy would be to reuse the cooling system waste heat for preheating the service hot water.

BUILDINGS & CREDITS

During the design of two correctional facilities, in Hillsboro and Centralia, Illinois, this principle of energy conservation was very effectively utilized. Each correctional facility included a multi-function building containing kitchen, warehouse, dining, maintenance shops, laundry, commissary and barber shop. This portion of the correctional facility was designed by Phillips Swager Associates, Architects, and Beling Consultants, Inc., Peoria, Illinois. Construction for these facilities is being financed by the Capital Development Board of the State of Illinois.

SYSTEM

The dining facility and a portion of the cooling facility were air conditioned. To reject the waste heat, a closed circuit condenser was utilized. This evaporative cooler serves the water-cooled condensers for kitchen freezers and coolers, in addition to water-cooled condensers for the air-conditioning system. To make a cost effective system, a portion of waste heat was injected into the space while the remaining portion of rejected heat was used to preheat the service hot water. Because kitchen freezers and coolers operate in the winter months too, the energy recovery system should prove effective year-round. Let me point out that year-round heat rejection sources, such as these freezers and coolers, make a heat reclaim system particularly attractive and economical.

PIPING SCHEMATIC

Fig. 1 depicts a piping schematic indicating how the waste energy is utilized for space heating and preheating of service hot water, thus reducing overall energy consumption of this institutional facility. A three-way modulating automatic control valve mixes the water cooled by the evaporative cooler and return water returning back to oondensers. When space and service water do not require heat, the evaporative cooler cools the condenser loop water so that water-cooled condensers for freezers, coolers, and the air-conditioning system may operate properly. During in-between weather and summer weather, when return air temperature is higher than the incoming loop water temperature, a two-position diverting-type automatic control valve bypasses the loop water. A proper mixture of glycol solution is recommended for this type of system.

Fig. 2 shows how piping schemicatic of Fig. 1 was transformed into working design for these institutional facilities. Presently, the systems based on this working design are under construction.

In order to control the initial cost of this project, air conditioning of the dining facility was bid as a separate alternate. Energy recovery was also bid as a separate alternate using a small service water preheat exchanger. In the event the air conditioning alternate was accepted, the service water preheat exchanger was changed to a larger size.

SYSTEM CHARACTERISTICS & PAYBACK ANALYSIS

Table 1 shows system characteristics used in this project. The system depicted in Figure 1, 2 and Table 1 looks very simple and practical. But is it cost effective? Here's a closer look at the economics of this project. Looking at the Table 2, it is evident that payback is between 0.94 years to 6.9 years, depending upon which option is considered. These payback figures are based on simple payback, i.e., initial cost of the project divided by first year's energy savings. Energy savings have been calculated based on an electric rate, including demand charges, of 3.5¢ per KWH. If the cost of energy is increased at current inflationary rates, actual payback will be sooner. After bidding this project, Option #1 (with payback of 0.94 years) was accepted and awarded to the Contractor.

CONCLUSIONS

Waste energy reclaim from air conditioning, freezers and coolers in an institutional building is very practical. The payback for this energy recovery system will be quicker as the cost of electricity (or other prime fuel) goes up. Waste energy reclaim systems help to save energy and dollars, while at the same time do not add any pollution to our environment. Procedures used in preheating service hot water with waste energy are identical to the procedures when solar energy is utilized to preheat service hot water. The energy reclaim system discussed in this article would definitely reduce total energy consumption with a very good payback in any institutional building where there is a sizable load of freezers/coolers and/or air conditioning and simultaneous need for service hot water. There are many, many such sources of energy in our institutional and industrial facilities that are presently untapped and which can be very economically reclaimed with the present day technology.

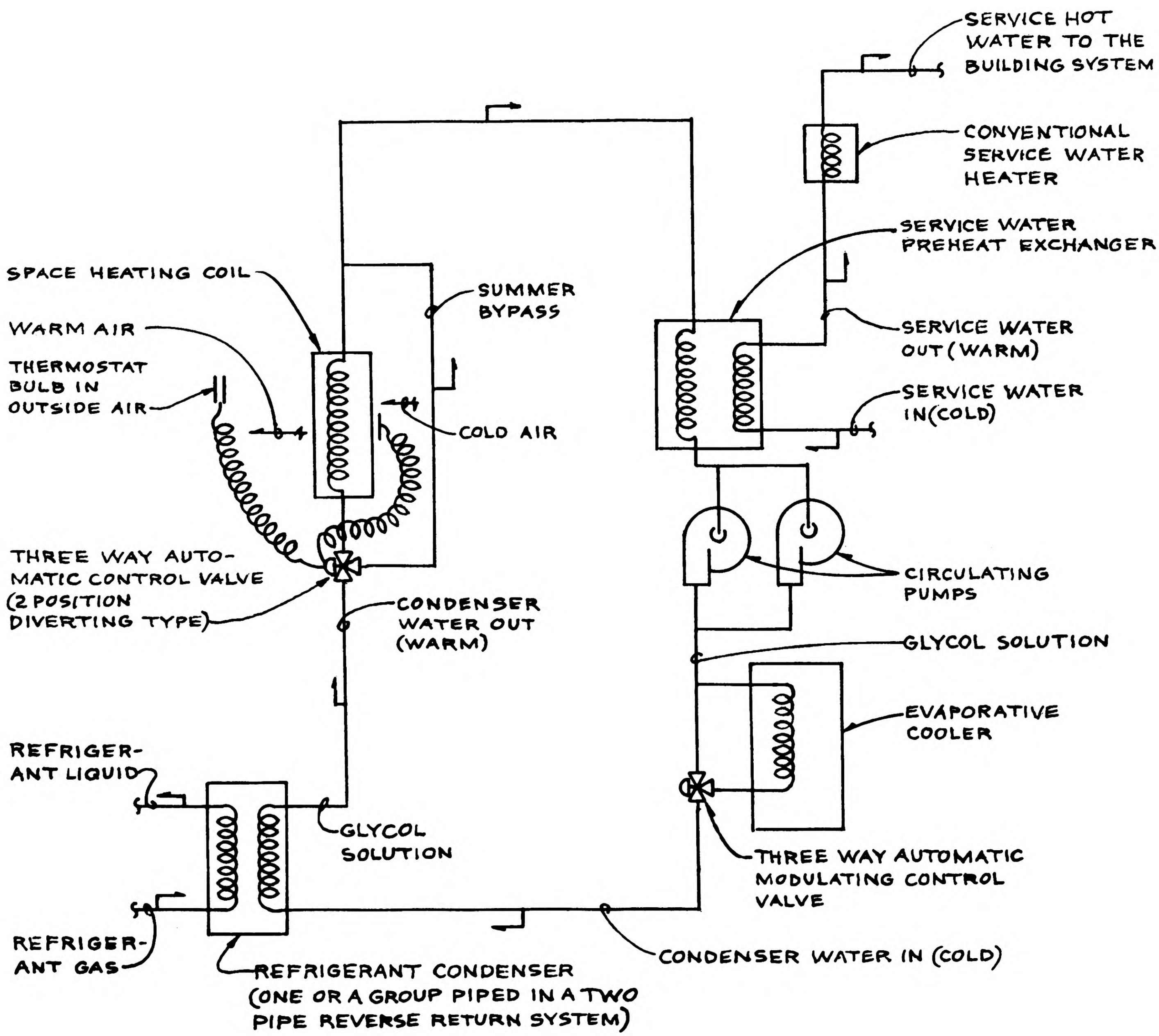
TABLE 1 - SYSTEMS CHARACTERISTICS

Total KW for all freezers	16.5
Tota KW for all coolers	18.0
No. of hours freezers/coolers operate (average)	18 hr out of 24
KW input to the space air-conditioning compressor	71.3
Rate of heat of rejection for coolers	125%
Rate of heat of rejection for freezers	130%
Rate of heat or rejection for air-conditioning compressor	115%
Service water preheated from 50 F to 70 F in GPH	1,500
Estimate of monthly service hot water usage in gallons	270,000

TABLE 2 - PAYBACK PERIODS FOR ENERGY RECLAIM SYSTEMS*

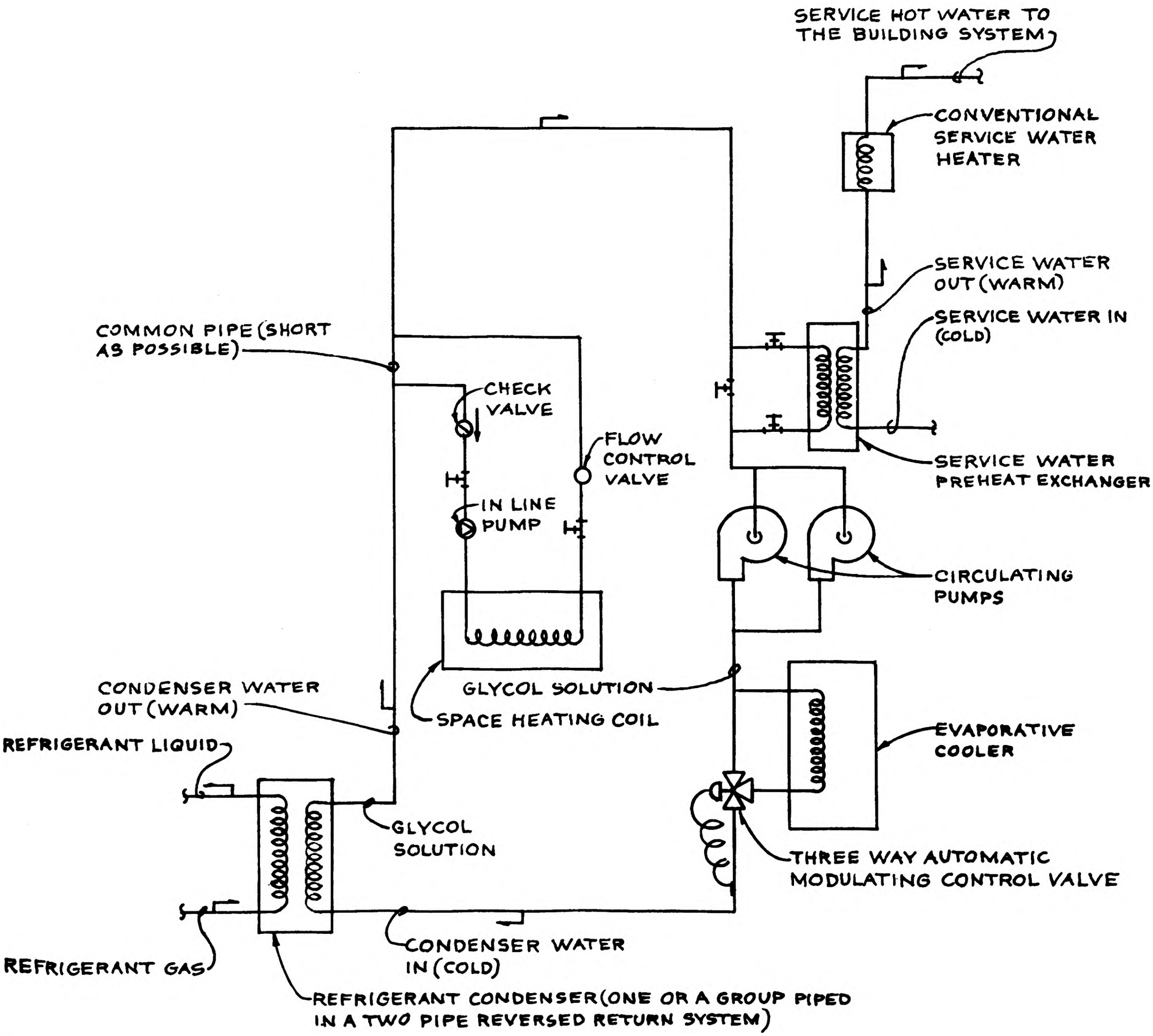
Payback for energy reclaim system (using small service water preheat exchanger and no space heating)	0.94 year
Payback for energy reclaim system (using small service water preheat exchanger and space heat)	3.9 year
Payback for energy reclaim system (using large service water preheat exchanger and space heat)	4.7 year
Payback for energy reclaim system (using service water heat exchanger, no freezers & coolers & no space heat)	6.9 year

*Payback figures shown are simple payback based on an electrical rate, including demand charges, of 3.5¢ per KWH. If the cost of energy is increased at current inflationary rates, actual payback will be sooner.



ENERGY RECLAIM SYSTEM-PIPING SCHEMATIC

FIG. 1



ENERGY RECLAIM SYSTEM-PIPING SCHEMATIC

FIG. 2

BIOGRAPHY

Raj Kumar received his B.S. degree in Mechanical Engineering in 1968. Then he came to Manhattan, Kansas and received his M.S. degree in Industrial Engineering in 1970. He is a registered Professional Engineer in the State of Illinois.

Presently, he is the Head of Department of HVAC Engineering and Environmental Engineering at Beling Consultants, Inc., Peoria, Illinois. He is engaged in design and construction supervision of Mechanical and Electrical Systems for commercial, industrial and institutional facilities with heavy emphasis on Energy Conservation. He is also experienced in EPA work for air and water pollution.

He is an active member of ASHRAE, Peoria Area Chamber of Commerce, ISPE, NSPE and AIA. He is a past President of ASHRAE.