TABLE 3
Calculated Results

TIME PERIOD	q_i (kW)	q_i (kW)	η (%)	U_c (W/m²·K)	U_i (W/m²·K)
10:00 12:00	1.45	0.263	18	20.6	15.2
12:00 1:00	1.05	0.524	50	28.1	38.6
1:00 3:00	1.20	0.262	22	33.8	15.7
3:00 5:00	1.14	0.262	23	18.0	12.9

$$U_c = \frac{q_i}{A_c(\Delta T)_{LM}} = \frac{1.45 \times 10^3 W}{2.38 m^2} \times \frac{ln \frac{16.7}{47.3}}{(16.7 - 47.3) K} = 20.6 \frac{W}{m^2 \cdot K}$$

$$U_t = \frac{q_t}{A_t(\Delta T)_{LM}} = \frac{2.63 \times 10^2 W}{1.86 m^2} \times \frac{ln \frac{0.7}{37.7}}{(0.7 - 37.7) K} = 9.8 \frac{W}{m^2 \cdot K}$$

Results for all time periods are shown in Table 3.

Sizing requirements for obtaining 0.189m³ (50 gal) of water at 50° which is initially at 15°C are shown below.

It is assumed that the actual time period for heat transfer is 8 hours. This assumption is due to the fact that the sun did not set until 7 pm and the collector surface was still quite hot at 5 pm.

$$q_t = mC_p\left(\frac{\Delta T}{\Delta t}\right)_t = 0.189 m^3 \times 99.64 \frac{kg}{m^3} \times 4.183 \times 10^3 \frac{J}{kg \cdot K} \times \frac{35K}{8 \text{ hrs}} \times \frac{1 \text{ hr}}{3600s} = 9.57 \times 10^2 W$$

$$q_i = \frac{q_t}{\eta} = \frac{9.57 \times 10^2 W}{0.251} = 3.81 \times 10^3 W$$

Assuming that the heat transfer rate is directly proportional to surface area

$$q \alpha A$$

$$A_t = \frac{957W}{300W}(1.86m^2) = 5.93m^2$$

$$A_c = \frac{3.81 \times 10^3 W}{1.23 \times 10^3 W}(2.38m^2) = 7.37m^2$$

The average value of q_t is 300W and the average value of q_i is 1230W for the calculated results.

CONCLUSIONS

A laboratory experiment to demonstrate the feasibility of using solar energy to heat has been discussed. The working fluid is moved by natural convection so no pumps are required. The experiment exposed students to the principles of solar energy and natural convection. The experiment also demonstrated the use of solar energy to heat water. Students used data obtained in the experiment to do preliminary design calculations to size equipment for a domestic hot water installation.

The experimental apparatus is simple in design and operation. The students can take data quickly and easily. The experiment also performed as desired (it works) so students can see the performance. □

REFERENCES

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In Memoriam

Ralph E. Peck

Ralph E. Peck, professor emeritus of chemical engineering at the Illinois Institute of Technology, died November 6, 1982, at the age of 71.

Dr. Peck began at the institute in 1939 and was chairman of the chemical engineering department from 1953 to 1967. He was internationally recognized as an expert in drying, and was active as a consultant for industry and government. He taught in Israel, Brazil, Algeria and Korea, and established a department of chemical engineering at India's University of Punjab.

Dr. Peck was involved in peace and nuclear arms freeze organizations and was sometimes called on by the U.S. government to disarm chemical gas weapons.

He was a member of the Ethical Humanist Society of Chicago. He was honored for teaching excellence from the institute and from ASEE and was a fellow of the AIChE. An annual Ralph Peck lectureship was established in 1973 at Illinois Institute of Technology.

His work after his retirement in 1977 led to his invention of a process for removing sulfur oxide gases from burning coal and converting them to high-grade fertilization. □