SECTION IX

Liquid and two-phase thermal fluid systems (hydronics, steam, and refrigerants)

Liquid and two-phase thermal fluid systems are fundamentally energy transport systems. Their basic role in the overall building environmental system is to receive energy from the available source in the thermal form, and by undergoing either a sensible or latent change, convey it to some point of use, and there dissipate it for whatever intended purpose. The reader may naturally assume that the intended purpose is to heat or cool the space, but this is neither the only use nor the most likely. Other uses of thermal fluids include driving power machinery such as turbines and steam engines, motivating absorption refrigeration, and control heat (such as is required in reheat and dual stream systems).

Most textbooks and other publications classify the materials of this chapter as "steam, hot water, and chilled water systems." The reason for reaching toward a more fundamental classification of this grouping of subsystems relates to an extremely important concept. That is, that many areas of technology cease advancing because of artificial boundries drawn about them for the sole purpose of identification. These boundaries tend to place a constraint upon the practitioners in the respective fields. One example of this observation is the chapter entitled "Vapor Lock in Refrigeration Systems." Although this phenomenon had not (to the best of the author's knowledge) been published prior to the publication of this original article, it is quite a common consideration in hydronic system design.

Steam heating systems serve as the classical example of this observation.

When technology in single-phase fluid systems (hydronics) advanced to the stage that their use solved the load control shortcomings of steam radiation systems, steam was replaced by water as the primary radiation-type heating system in commercial and institutional buildings. As a result, all development in two-phase heat transport technology apparently ceased. Yet the advantages of the latent heat exchange and transport concept remain to be developed.

There are numerous concepts in load control of two-phase systems that should be researched. Such research, for example, could provide a method (or methods) for retrofitting existing steam radiation systems for energy conservation. The simple reference of two-phase systems as "steam" systems tends to outrule other fluids that might be used in two-phase systems. One use of such fluids other than steam is in solar heat collection systems. There are major problems with single-phase systems in solar collection that might be avoided by the use of two-phase systems. Two such problems are those of freezing and reverse losses. The three most common solutions to the freeze prevention problem are: (1) install the system in a climate where the temperature never drops below 32 F, (2) drain the outdoor system down when the outdoor temperature drops below 32 F *and* the solar heat does not offset the temperature depression, and (3) add an ethelene glycol (antifreeze) solution to the water. All three of these solutions present either problems that result in significantly increased cost or limit the practicability of solar source heat systems. If, on the other hand, a commercially available refrigerant were used to transfer the heat from the outdoor solar collector to an indoor load device the "collection" problem would be greatly simplified, and it is likely that the cost could be significantly reduced.

There are numerous other examples of the opportunities in expanding the technology of heat transfer fluid systems if the artificial constraints of "steam and water" are removed. The chapter "Preheating Outdoor Air with Transfer Fluid Systems" is another example of some ideas that might be developed.

The chapter entitled "Hydronic Systems Overview" includes no new or imaginative technical information; it was written with the intention of presenting the known state of the art in a new perspective. The concept of the hydraulic analysis and thermal analysis has been used as an instructional tool, and once considered it tends to reveal many new avenues of understanding in the technology of hydronic systems.

There are two chapters on the "Integrated Decentralized Chilled Water Systems," one on the pure concept and the other a case history discussion of a system that was planned at the time the chapter first appeared as a magazine article. Since that time the system has been installed, and the performance has exceeded that anticipated. This type of system does not account for a very large share of the larger campus type of systems as of this date. However, with increasing costs of investment funds and energy, and a populace tending toward an acceptance of higher summer dew point temperatures, this concept could well move into a position of being a common alternative to the central plant. (Some current development work is being done on decentralizing but integrating heating systems in a somewhat similar manner.)

The chapter on steam, like that on hydronics, is simply a new perspective of an existing technology. Since this material was initially published, many of the concepts presented in this chapter have been investigated in the laboratory and in actual field installations. As a result, it appears that the old technology of "steam" has gotten a slight nudge forward. Given the inertia that this field appears to possess, this may be enough to get it rolling again.

To conclude, the intermediate fluid systems have been the bulwark of the contemporary large heating and cooling systems. The development of their technology was rapid and almost spontaneous. Now, in retrospect we might consider if we have derived the most out of our thermal fluid technology, or if there is room (or, indeed, need) for significant improvement. If we recognize that this need for improvement exists, this recognition, of itself, will motivate the advances in the state of the art.