ORNL MARK V HEAT PUMP DESIGN MODEL

SUMMARY OF CHANGES FROM VERSION 95b TO 95d

May 1996

HEAT EXCHANGER CALCULATIONS:

The results of the heat exchanger geometry calculations are now printed in the standard output (LPRINT=1). This output gives such heat exchanger characteristic parameters as air flow / frontal area ratio, air-to-refrigerant area ratio, and refrigerant and air-side total area.

The logic in the heat exchanger routines was modified to better handle poor evaporating and condensing guesses and cases where the heat exchanger ambient temperatures for the condenser were below those for the evaporator. An earlier attempt at eliminating these problems caused new difficulties.

THERMODYNAMIC PROPERTIES:

We corrected an error in the third significant digit of one R-134a coefficient identified by a user (the corrected A_3 value is 0.086308... instead of 0.086083...). Also the equation-of-state coefficients for R-134a, R-32, 143a, 123,124, and R-410A were updated to the official values in Allied's GENIE program (dated 6/94). We now use a slightly different J value for Martin-Hou (Allied) representations than for the Downing (DuPont) representations.

Equations were revised in subroutine SPFHT for calculating C_P and C_V from the Martin-Hou equation-of-state coefficients.

FLOW CONTROL OPTIONS AND CORRELATIONS:

The short-tube-orifice model now has specific correlations for R-22, R-12, and R-134a and covers two-phase inlet conditions. Orifice length and chamfer depth are new optional inputs. The number of parallel orifices can now be specified.

The capillary tube model no longer requires that the flow factor be input from values read off an ASHRAE chart. The user specifies tube ID and optionally tube length (otherwise 80 inches is assumed). Corrections for non-critical flow conditions based on additional ASHRAE charts are now included. In the flow-control-autosize-mode (IREFC=0), the required cap tube diameter will be calculated based on a default or user-specified cap tube length.

For the TXV model, the user can now select from ten Sporlan TXV distributor nozzle sizes and five distributor tube sizes (instead of the previously fixed sizes). The TXV model also is now operational with two-phase inlet refrigerant.

Default flow-control sizing parameters:

All the default capillary, short-tube-orifice, and TXV operation parameters (including the number of capillary or short-tube orifices in parallel) that were previously set inside the code (for use in flow control autosizing calculations) can now be changed in the user input.

SUMMARY OF CHANGES FROM VERSION 95b TO 95d (continued):

The comments in sample file FLDVDEF.DAT show how the default flow control parameters can be changed. Further description is also provided on the updated pages of the input description.

The sample INPUT files related to the new flow control features are:

FLDVDEF.DAT	--	a flow control sizing calculation with 1 cap tube and 1 orifice
FLDVSIZE.DAT	--	a flow control sizing calculation with 2 cap tubes and 2 orifices
FLDVCAP.DAT	--	specifying the calculated capillary tube size from the above autosizing run
FLDVORIF.DAT	--	specifying the calculated orifice size and # from the above autosizing run
FLDVTXV.DAT	--	specifying the calculated TXV size from the above autosizing run
FLDVORCH.DAT	--	specifying the calculated orifice size, #, and charge from the above autosizing run

More details of the flow control changes:

The Mark V Heat Pump Model was modified to incorporate improved short-tube-orifice equations from Texas A&M (Kim and O'Neal 1994). The new equations cover R-22 in the two-phase inlet region to 6% inlet quality (with linear extrapolations added by ORNL beyond that) while the previously used Mei correlation is valid only for subcooled inlet conditions. For R-134a, a quality range up to 10% quality is correlated.

This version also lets one specify the length of the orifice-tube (as opposed to the 0.5 inch length that the Mei correlation was based on) and any chamfering that the orifice inlet may have -- as opposed to a sharp orifice. A plot is included showing how the model performs for different operating conditions. Refrigerant-specific equations are used for R-22, R-12, and R-134a. For other refrigerants, R-22 correlations are assumed.

For the capillary tube model, we have included some curve fit equations also from Texas A&M (Penson and O'Neal 1988) to calculate the flow factor from the ASHRAE chart given the length and diameter of the cap tubes. We also included their curve fit equations for the ASHRAE correction factor for the effect of different suction pressures. The capillary tube equations were developed for R-12 and R-22 but are used here for other refrigerants in lieu of refrigerant-specific correlations.

References:

Kim, Youngchan, 1993, *Two-Phase Flow of HCFC-22 and HFC-134a Through Short-Tube Orifices*, Ph.D. Dissertation, Texas A&M University, May.

Kim, Y and O'Neal, D.L, 1994, "Two-Phase Flow of R-22 Through Short-Tube Orifices", *ASHRAE Transactions*, V.100, Pt. 1.

Kim, Y and O'Neal, D.L, 1994, "Two-Phase Flow of HFC-134a and CFC-12 Through Short-Tube Orifices", *ASHRAE Transactions*, V.100, Pt. 2.

Penson, S. B, 1988, *Development of a Room Air Conditioner Design Model*, Master's Thesis, Texas A&M University, May.

O'Neal, D. L. and Penson, S. B, 1988, An Analysis of Efficiency Improvements In Room Air Conditioners, ESL/88-04, Texas A&M University, November.

Figure 1. Predictions of Short-Tube-Orifice Correlations
Over a Range of Inlet Refrigerant Quality and Subcooling Levels