Refrigerator and Freezer Design and Code
Science Simulations For A Physical Science Laboratory

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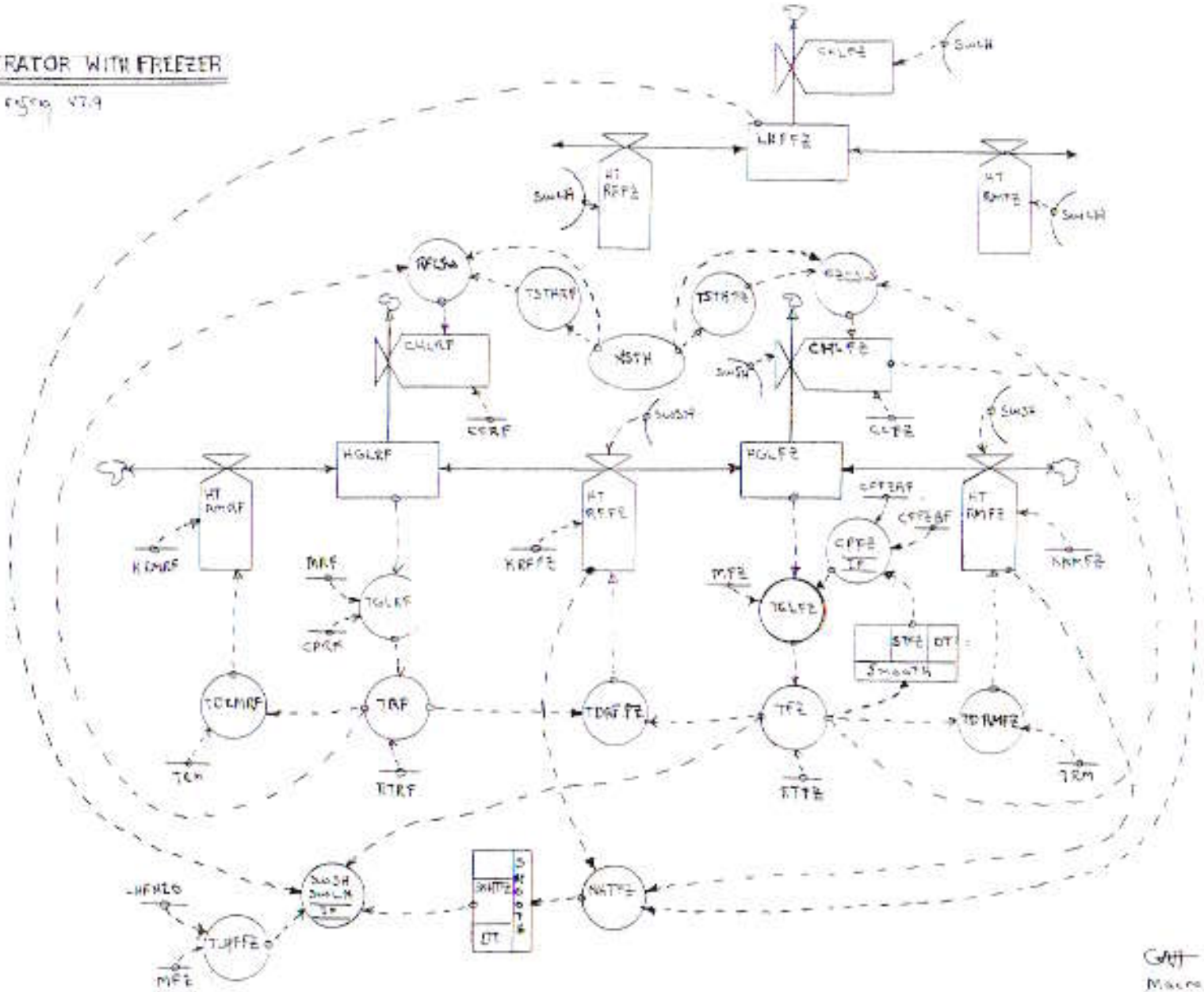
REFRIGERATOR WITH FREEZER

see refrig V7.9



GMT 1/15/89
Micro Systems Inc

```
0100 //program refrig v7.9 1/26/89
0110 initialize'display
0120 done:=FALSE
0130 clock'running:=TRUE
0140 initialize'constants
0150 calculate'rates
0160
0170 REPEAT
0171
0180   IF KEY$()"" THEN
0181     PRINT AT 20,1: "enter new thermostat setting: "
0182     INPUT AT 20,30,1: "": nsth
0183   ENDIF
0190   IF clock'running THEN update'experiment
0200
0210 UNTIL done
0220
0230 END
0240
0250 PROC initialize'constants //v1.0 1/25/89
0260   nsth:=0 //numerical setting of the      rmostat (dimensionless)
0270   // numerical   freezer    refrig
0280   // setting     temp       temp
0290   //             (F)        (F)
0300   //
0310   //    0        off        off
0320   //    1         12         40
0330   //    2         10         39
0340   //    3          8         38
0350   //    4          6         37
0360   //    5          4         36
0370   //    6          2         35
0380   //    7          0         34
0390   //    8         -2         33
0400   //    9         -4         32
0410   //
0420   cpfzbf:=.5 //specific heat mass in freezer below 32 F (BTU/(lb F))
0430   cpfzaf:=1 //specific heat mass in freezer above 32 F (BTU/(lb F))
0440   cprf:=1 //specific heat of mass in refrigerator (BTU/(lb F))
0450
0460   ccrf:=3.75 // cooling capacity of refrigerator (BTU/min)
0470   ccfz:=3.75 // cooling capacity of freezer (BTU/min)
0480
0490   mfz:=10 //mass in freezer (lb)
0500   mrf:=50 //mass in refrigerator (lb)
0510
0520   trm:=68 //temperature of room (F)
0530   itmfz:=0 //initial temperature of   mass in freezer (F)
0540   tfz:=itmfz //temperature of freezer (F)
0550   itmrf:=32 //initial temperature of mass in refrigerator
0560   trf:=itmrf //temperature of refrigerator (F)
0570
0580   rtfz:=32 //reference temperature of mass in freezer (F)
0590   rtrf:=32 //reference temperature of mass in refrigerator (F)
0600
0610   lhfh20:=144 //latent heat of fusion of water (BTU/lb)
0620        closed  door
0630   kmrf:=.05595 //thermal conductance, room to refrig (BTU/(min F))
0640   kmfz:=.02818 //thermal conductance, room to freezer (BTU/(min F))
0650   krfz:=7.625e-03 //thermal conductance, refrig to freezer (BTU/(min F))
0660
0670   // initialize control variables
0680   simtime:=0 // simulation elapsed time (min)
0690   dt:=1 // integration interval (min)
0700
0710   // initialize calculated constants
0720
0730   tlhffz:=lhfh20*mfz // total potential latent heat freezer contents (BTU)
0740
0750
0760   // initialize levels
0770   hglfz:=cpfz(itmfz)*mfz*(itmfz-rtfz) //heat gain or loss mass in fz (BTU)
0780   hglrf:=cprf*mrf*(itmrf-rtrf) //heat gain or loss mass in rf (BTU)
0790   IF itmfz)=32 THEN
0800     lhffz:=tlhffz
0810   ELSE
0820     lhffz:=0
0830   ENDIF
0840
0850   // initialize smoothing delays
```

open door

.3568 btu/(min °F) open

.1798 btu/(min °F) open

```
0860
0870   stfz:=itmfz //smoothed temperature of freezer
0880   snhtfz:=krffz*(itmrf-itmfz)+krmfz*(trm-itmfz)-ccfz*fzcsw(nsth)
0890   //smoothed net heat transfer to freezer
0900 ENDPROC initialize'constants
0910
0920 FUNC fzcsw(nsth) // freezer cooling switch v1.0  1/25/89
0930   IF nsth=0 THEN
0940     RETURN 0
0950   ELSE
0960     tsthfz:=-2*nsth+14
0970     IF tsthfz)=tfz THEN
0980       RETURN 0
0990     ELSE
1000       RETURN 1
1010     ENDIF
1020   ENDIF
1030 ENDFUNC fzcsw
1040
1050 FUNC rfcsw(nsth) // refrig cooling switch v1.0 1/26/89
1060   IF nsth=0 THEN
1070     RETURN 0
1080   ELSE
1090     tsthrf:=-nsth+41
1100     IF tsthrf)=trf THEN
1110       RETURN 0
1120     ELSE
1130       RETURN 1
1140     ENDIF
1150   ENDIF
1160 ENDFUNC rfcsw
1170
1180 FUNC cpfz(smoothed'freezer'temp) //v1.0 1/26/89
1190   //calculate specific heat for mass in freezer as function of state
1200   IF smoothed'freezer'temp)=32 THEN
1210     RETURN cpfzaf
1220   ELSE
1230     RETURN cpfzbf
1240   ENDIF
1250 ENDFUNC cpfz
1260
1270
1280 PROC calculate'rates //v1.0 1/26/89
1290   tglrf:=hglrf/(cprf*mrf)
1300   //     temp gain or loss of rf (F)
1310   tglfz:=hglfz/(cpfz(stfz)*mfz)
1320   //     temp gain or loss of fz (F)
1330   trf:=trf+tglrf
1340   //     temp of refrigerator (F)
1350   tfz:=tfz-tglfz
1360   //     temp of freezer (F)
1370   stfz:=tfz
1380   //     smoothed temp of freezer (F)
1390   tdrmrf:=trm-trf
1400   //     temp difference room to rf (F)
1410   tdrmfz:=trm-tfz
1420   //     temp difference room to fz (F)
1430   tdrffz:=trf-tfz
1440   //     temp difference rf to fz (F)
1450
1460   //calculate heat transfer
1470
1480   htrmrf:=krmrf*tdrmrf
1490   //     heat transfer rm to rf (BTU/min)
1500   htrmfz:=krmfz*tdrmfz
1510   //     heat transfer rm to fz (BTU/min)
1520   htrffz:=krffz*tdrffz
1530   //     heat transfer rf to fz (BTU/min)
1540   chlrf:=ccrf*rfcsw(nsth)
1550   //     cooling heat loss for rf (BTU/min)
1560   chlfz:=ccfz*fzcsw(nsth)
1570   //     cooling heat loss for fz (BTU/min)
1580   nhtfz:=htrffz+htrmfz-chlfz
1590   //     net heat transfer for fz (BTU/min)
1600   snhtfz:=nhtfz
1610   //     smoothed net heat transfer for fz (BTU/min)
1620
1630   set'switches //for sensible or latent heat flow
1640
1650 ENDPROC calculate'rates
```

```
1660
1670 PROC set'switches //v1.0 1/26/89
1680
1690   IF (snhtfz)0) AND THEN (tfz)=32) AND THEN (lhffz(tlhffz) THEN
1700     swlh:=1
1710     swsh:=0
1720   ELIF (snhtfz(0) AND THEN (tfz(=32) AND THEN (lhffz)0) THEN
1730     swlh:=1
1740     swsh:=0
1750   ELSE
1760     swlh:=0
1770     swsh:=1
1780   ENDIF
1790 ENDPROC set'switches
1800
1810 PROC update'experiment //v1.0 1/26/89
1820   //update'clocktime
1830   //IF simtime(=clocktime THEN
1840   display'exp'results
1850   //display'simtime
1860   calculate'levels
1870   calculate'rates
1880   simtime:=simtime+dt
1890   //ENDIF
1900 ENDPROC update'experiment
1910
1920 PROC update'clocktime //v1.0 1/26/89
1930   now:=TIME
1940   elapsed'time:=now-earlier
1950   clocktime:=clocktime+elapsed'time
1960   earlier:=now
1970
1980 ENDPROC update'clocktime
1990
2000 PROC display'exp'results //v1.0 1/26/89
2005   PRINT AT 2,20:
2010   PRINT USING "time : ####   therm : #": simtime,nsth
2015   PRINT
2020   PRINT USING "trf  :  -##.#": trf
2025   PRINT
2030   PRINT USING "tfz  :  -##.#": tfz
2040   PRINT
2050   PRINT USING "hglrf:-####.": hglrf
2060   PRINT
2070   PRINT USING "hglfz:-####.": hglfz
2080   PRINT
2085   PRINT USING "lhffz:-####.": lhffz
2090 ENDPROC display'exp'results
2100
2110 PROC calculate'levels //v1.0 1/26/89
2120
2130   hglrf:=hglrf+dt*(htrmrf-htrffz-chlrf)
2140   //     heat gain or loss by rf (BTU)
2150   hglfz:=hglfz+dt*(htrffz+htrmfz-chlfz)*swsh
2160   //     heat gain or loss by fz (BTU)
2170   lhffz:=lhffz+dt*(htrffz+htrmfz-chlfz)*swlh
2180   //     latent heat (of fusion) of contents of freezer (BTU)
2190
2200 ENDPROC calculate'levels
2210
2220
2230 PROC initialize'display
2240   USE system
2250   PAGE
2260   textcolors(14,15,11)
2270 ENDPROC initialize'display
2280
```