Chemical Engineering 512

Nuclear Reactor Transient Modeling

Lecture 18

Advanced Control Variables

Spiritual Thought

D&C 121:41-42

41 No power or influence can or ought to be maintained by virtue of the priesthood, only by persuasion, by long-suffering, by gentleness and meekness, and by love unfeigned;

42 By kindness, and pure knowledge, which shall greatly enlarge the soul without hypocrisy, and without guile–”

Practice Problem 1

- You have a fuel rod, component 1112 (joined to a pipe, volume 112) which represents the hottest rod in the core (center rod).
- There are 15 axial nodes to this heat structure, all producing power
- There are 10 radial nodes; from inside to outside, 7 are fuel, 1 is gap, and 2 are clad.
- Write a control variable (shortest possible) that will return:
  1. Peak fuel temperature (named pfuel)
  2. Peak clad temperature (named PCT)

- 2050010 pct stdfnctn 1.0 0.0 1
  0
- 2050010 max httemp 111200109 httemp 111200209
  1 httemp 111200309
- 2050010 httemp 111200409 httemp 111200509
  2 httemp 111200609
- 2050010 httemp 111200709 httemp 111200809
  3 httemp 111200909
- 2050010 httemp 111201009 httemp 111201109
  4 httemp 111201209
- 2050010 httemp 111201309 httemp 111201409
  5 httemp 111201509
- *
- 2050011 pfuel stdfnctn 1.0 0.0 1
  0
- 2050011 max httemp 111200101 httemp 111200201
  1 httemp 111200301
- 2050011 httemp 111200401 httemp 111200501
  2 httemp 111200601
- 2050011 httemp 111200701 httemp 111200801
  3 httemp 111200901
- 2050011 httemp 111201001 httemp 111201101
  4 httemp 111201201
- 2050011 httemp 111201301 httemp 111201401
  5 httemp 111201501

Practice Problem 2

- You have a decay heat removal heat exchanger that is cooling your core during an accident. The primary coolant pipe is 430, while the secondary side pipe is 540. The heat structure is 1430.

- Each pipe component has 40 axial nodes, while 1430 has 3 radial node.

- Develop a single control variable, 2050440, that will return the heat exchanger power in MW. Please name this variable htrecpow.

- The initial value for this control variable should be -1224.762, though you should also have RELAP calculate an initial value, in case this has changed.

```
   *ctlvar name     type     factor     init   f c     min     max
 2050440     htrecpow sum       1.0e-06  -1224.762 1
*           0
```

*ctlvar	a1	v1	p1	a2	v2	p2	a0
20504401	0.0	1.0	q	430010000	1.0	q	430020000
20504402		1.0	q	430030000	1.0	q	430040000
20504403		1.0	q	430050000	1.0	q	430060000
20504404		1.0	q	430070000	1.0	q	430080000
20504405		1.0	q	430090000	1.0	q	430100000
20504406		1.0	q	430110000	1.0	q	430120000
20504407		1.0	q	430130000	1.0	q	430140000
20504408		1.0	q	430150000	1.0	q	430160000
+		1.0	q	430170000	1.0	q	430180000
+		1.0	q	430190000	1.0	q	430200000
+		1.0	q	430210000	1.0	q	430220000
+		1.0	q	430230000	1.0	q	430240000
+		1.0	q	430250000	1.0	q	430260000
+		1.0	q	430270000	1.0	q	430280000
+		1.0	q	430290000	1.0	q	430300000
+		1.0	q	430310000	1.0	q	430320000
+		1.0	q	430330000	1.0	q	430340000
+		1.0	q	430350000	1.0	q	430360000
+		1.0	q	430370000	1.0	q	430380000
+		1.0	q	430390000	1.0	q	430400000

Practice Problem 3

- You want to know how much power (in MW) is added to a water stream by a compressor (component 465)
- The volume before the compressor is 461010000, and the volume after is 470010000 (no change in elevation or velocity)
- Please provide a series of no less than 10 control variables that will calculate and then return the power delivered to the fluid in MW
- hint: cprtrq and cprvel provide the torque and velocity of a compressor, respectively
- Hint: mechanical energy balance…

*ctlvar name 20504690 h470

Solution 3

```
*ctlvar    name       type              init    f c    max
                      factor                    min
2050466      pv461      div          12820.44 1
0                       1.0
*
*ctlvar    v1              p1              p2
                                  v2
2050466   rho       461010000       461010000
1                                 p
*
*ctlvar    name       type              init    f c    max
                      factor                    min
2050467      h461       sum          306540.  1
0                       1.0
*
*ctlvar   a0    a1   v1     p1                    a2   v2      p2
  20504671      0.0   1.0  ug 461010000   1.0  cntrlvar  466
*
   *ctlvar     nametype    factor    init   f c     min     max
20504680    pv470             div     1.0      27982.14 1
*
*ctlvar    v1      p1       v2       p2
20504681   rho     470010000  p       470010000
```

```
        type    factor   init   f c     min     max
          sum      1.0              327204.  1
*ctlvar       a0          v1       p1          a2     v2         p2
              a1
20504691        0.0    1.0  ug       470010000        1.0  cntrlvar  46

*
*ctlvar        name     type      factor       init     f c      min      ma

20504700      dh         sum       1.0        20663.75 1
*

 *ctlvar   a0    a1   v1     p1        a2   v2       p2
  20504701        0.0   1.0  cntrlvar 469  1.0  cntrlvar  467
                                *
 *ctlvar    name    type    factor   init   f c    min    max
 20504710    qmc-hyd  mult    1.e-6    35.0199  1
           *
 *ctlvar    v1      p1       v2       p2
 20504711   mflowj   465010000  cntrlvar  470
 *
 *ctlvar    name    type    factor   init   f c    min    max
 20504720    qmc-shf  mult    -1.e-6    35.06105 1
           *
 *ctlvar    v1      p1       v2              p2
  20504721    cprtrq   465    cprvel    465
```