KALIMER-600 IHTS

Design and Structural Evaluation of KALIMER-600 IHTS Piping System

,

150

KALIMER-600 (IHTS)

. 2- 3-

. ASME-NH

IHTS

- .

0.5Hz
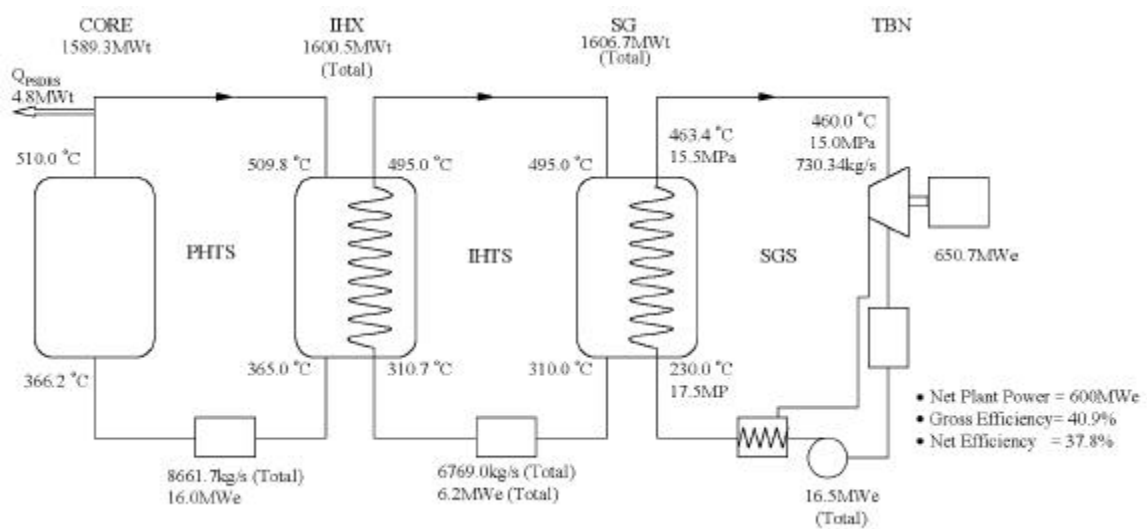
. ANSYS 6.1 .

Abstract

The design for arranging main components and piping system of intermediate heat transport system(IHTS) of KALIMER-600 with 2-loop and 3-loop was performed. Displacements, stresses were calculated for dead weight and thermal load under normal operation condition about 2-loop system and 3-loop system. Evaluation results of IHTS piping system by ASME-NH code showed that stress intensity and creep-fatigue damage were satisfied their limits. The natural frequencies of the two systems were calculated to check the dynamic characteristics related to the plant isolation frequency of 0.5Hz. ANSYS 6.1 structural analysis module was used of stress analysis and natural frequency calculation.

1.

KALIMER(Korea Advanced LIquid
MEtal Reactor)   (IHTS)
          (IHX)   (SG)   [1].   (500
   ),

                              .   loop   KALIMER-600 IHTS
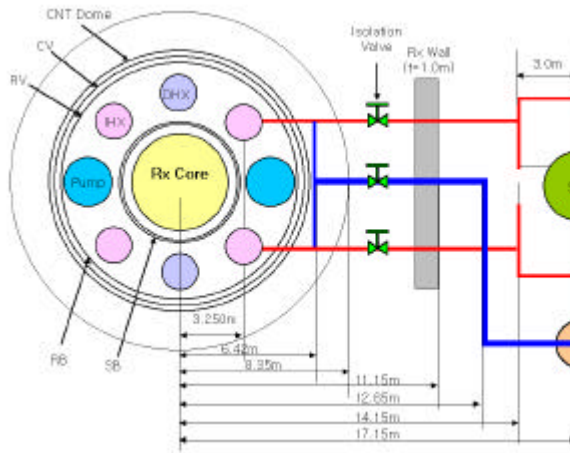   .

       KALIMER-600   loop   2-   (2-loop)   3-
      (3-loop)   .

                              .

                         .

                                                                                    ASME-NH,
RCC-MR,   BDS   ANSYS
             ASME-NH   [7].

2.

          1   KALIMER-600   [2].
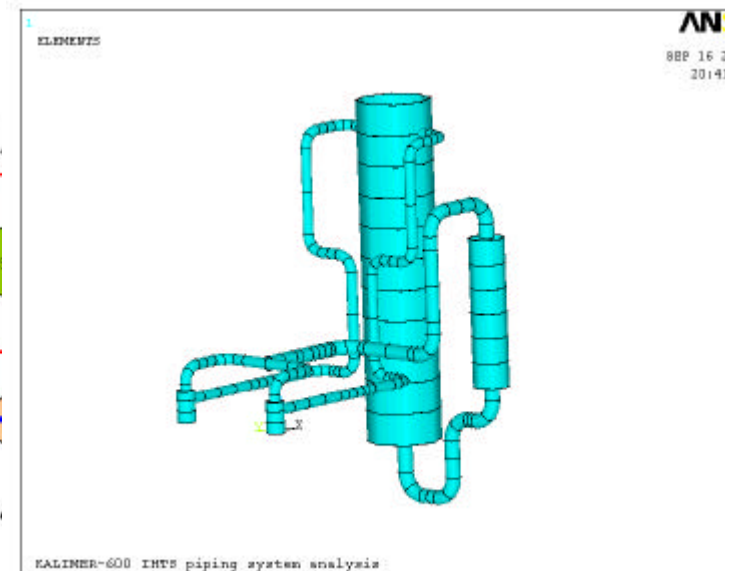   ,   ,
       IHX   495   ,   310.7   /   184.3
        .

1. KALMER-600

IHTS

IHX   SG   7m

7m   [3].

2   2-loop   3

. 2-loop   4   IHX   8

.   60   IHX   SG

.   SG

. SG   84.5   2

. 2   IHX

Tee   2

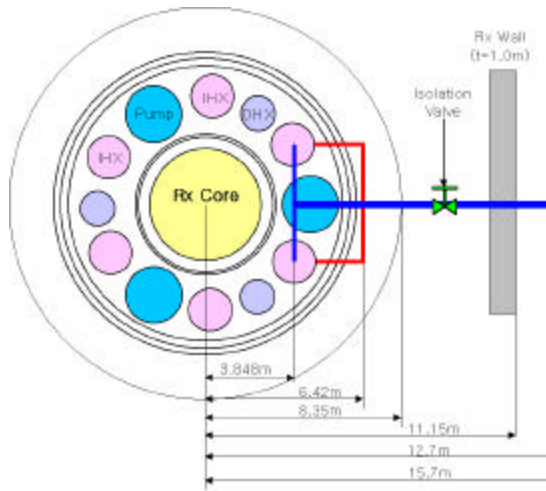. Loop   131.67m   51.43m,

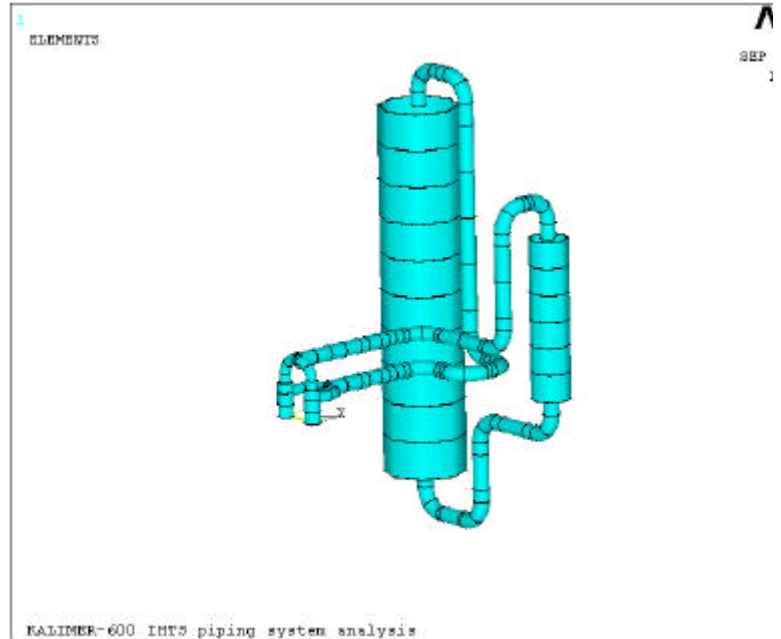80.24m   .   IHX-SG   10.25m

9.7m   .

2. 2-loop system

3   3-loop   3

. 3-loop   6   IHX   15

. IHX   51.4   Tee

72.5   SG   . SG

2   2

. Loop   94.13m   83.69m,

10.44m   . Loop   2-loop   loop

2-loop   30m   . IHX-SG   7.75m

9.1m   .

3. 3-loop system

2-loop

loop   3 , 3-loop   loop   2   .

.   1.5

[6].   1   loop   IHTS

.   316 SS   .

1. KALIMER-600 IHTS

		2-loop	3-loop
Components	IHX (EA)	4	6
	SG (EA)	2	3
	Primary Pump (EA)	2	6
Large Bored Piping (Hot Leg/Cold Leg)	Outer Diameter (cm)	84.5	72.5
	Thickness (cm)	1.27	1.27
	Radius of Curvature (cm)	126.8	108.8
Small Bored Piping (Hot Leg/Cold Leg)	Outer Diameter (cm)	60	51.4
	Thickness (cm)	0.95	0.95
	Radius of Curvature (cm)	92.9	77.1
Horizontal distance of IHX-SG (m)		13.90	11.21
Total length of IHTS Piping System (m)		125.67	94.13

hanger support   rigid support   rigid

support   hanger
support   [4].   spring hanger
                              rigid support   . 2-loop   hanger support
hot leg, cold leg, suction leg   4   , 2   , 1   3-loop
3   , 2   , 1   . SG   2

     .

3.

3.1
                              ANSYS   [6]   .   PIPE 16
                  PIPE 18   . 2-loop   3-loop
                        210   , 160   156   , 120   .
                                                                                  [1].

· Refueling Interval : 18 Months
· Plant Capacity Factor : 85%
· Total Operating Time : 30 Years
·   495   refueling   IHTS   200

          30   ,   1.5   20
                                        11,169   .
                                                                  .
hanger support   rigid support   . Rigid support
              4Hz   . SG   2
                                        .
                  1   .
                  2   .   906   /   .

2.

Temperature ( )	Elastic Modulus (GPa)	Thermal Expansion (m/m)	Poisson Ratio (-)	Density (/)
204	182.69	17.91E-6	0.280	7,932
315	174.42	18.92E-6	0.288	7,910
426	166.15	19.76E-6	0.297	7,889
538	157.18	20.52E-6	0.305	7,803

3.2

. 4 5 2-loop 3-loop

. 2-loop 163 MPa 3-loop

236 MPa . 2-loop 3-loop

10.16 12.55 . PRISM 28cm

[7].

3.3 ASME-NH

ASME section III, subsection NH .

.

3Sm . 2-loop 3-loop

163 MPa, 236 MPa 320.6

MPa . 0.076%, 0.12%

.

ASME-NH -

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$$\sum_{k=1}^{q} \left(\frac{\Delta t}{T_d} \right)_k + \sum_{j=1}^{p} \left(\frac{n}{N_d} \right)_j \leq D$$

,

D : total creep-fatigue damage

p : number of different cycle types

$(n)_j$: number of applied repetitions of cycle type, j

$(N_d)_j$: number of design allowable cycles for cycle type, j

q : number of time intervals for the creep damage calculation

$(\Delta t)_k$: duration of the time interval

$(T_d)_k$: allowable time duration determined from the stress-to-rupture curves

T_d N_d ASME-NH

11,169 , 20 . -

8 .

4.

Loop   3   .
                                                        0.5 Hz   4.0 Hz
   [5].   3   1   2-loop   5.07
Hz   3-loop   5.66 Hz   .
                                                              .   3-loop   2-loop
                                                                    .   6   7   loop
                    1   2   .

3. Loop

		2-Loop System	3-Loop System
	Mode 1	5.07	5.66
	Mode 2	5.55	8.73
	Mode 3	5.62	10.02
	Mode 4	5.63	10.66
Natural Frequency	Mode 5	6.83	11.62
(Hz)	Mode 6	6.84	14.57
	Mode 7	9.74	15.73
	Mode 8	9.85	18.80
	Mode 9	9.86	19.75
	Mode 10	11.12	21.12

5.

        KALIMER-600   2-loop   system   3-loop
system   IHTS
                                    . 2-loop   3-loop
                                                          3Sm   50.8%, 79.5%
                                    . ASME-NH   -
                          .   0.5 Hz
                                    .   KALIMER-600 IHTS
              loop
              .

                                                                                    .

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[1]   ,   , MS420-WR-02 Rev.A/2003, 2003.

[2]   , KALIMER-600   , KALIMER   (IOC-FS-013-200
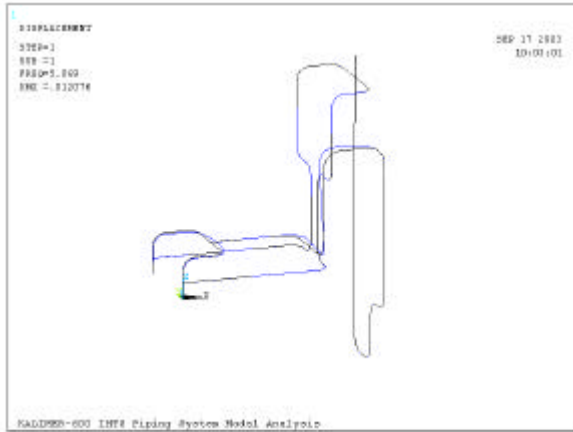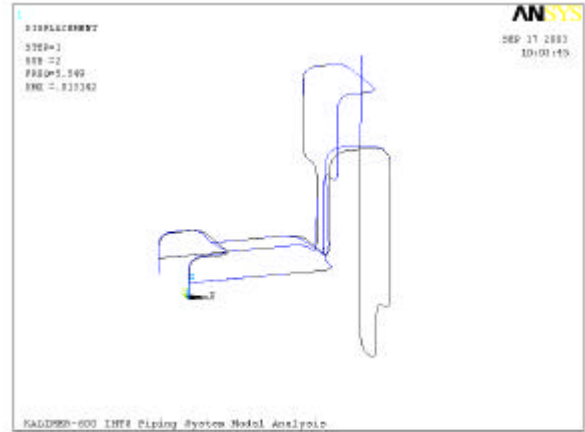   3),   , 2003.

[3]   , NSSS   IHTS   , KALIMER
             (IOC-FS-007-2001),   , 2001.

[4] PRISM Preliminary Safety Information Document, GE, 1987.

[5]   ,   , "   IHTS   ", 2003
                    ,   , 2003.

[6] ANSYS Analysis Guide, Release 6.1

[7]   ,   ,   , "   KALIMER   ",
    '99   ,   , 1999.

[8] ASME B&PV Code, Section III, Division 1, Subsection NH, 2001.
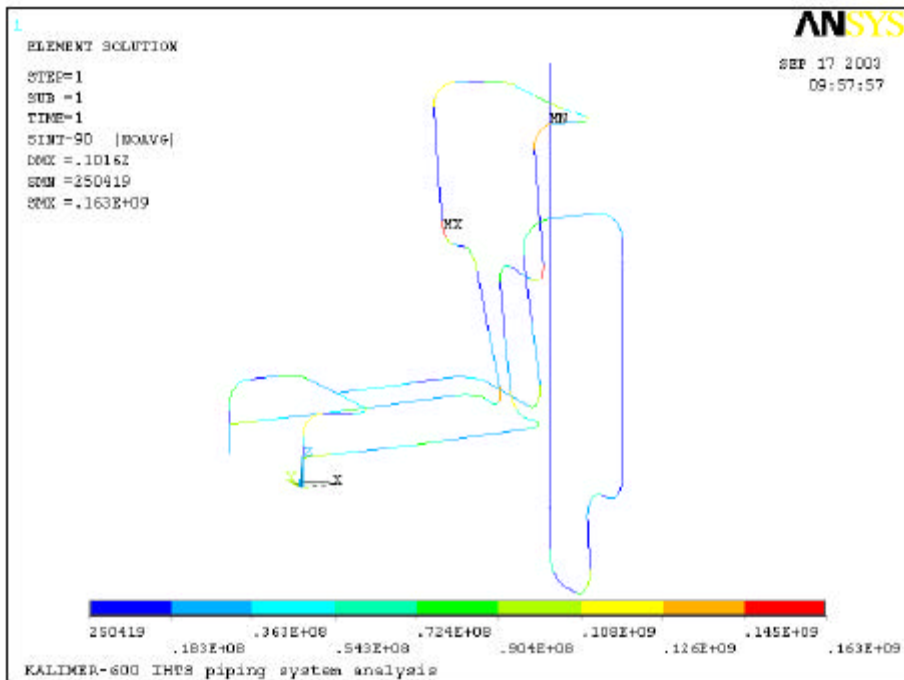
4. 2-Loop System
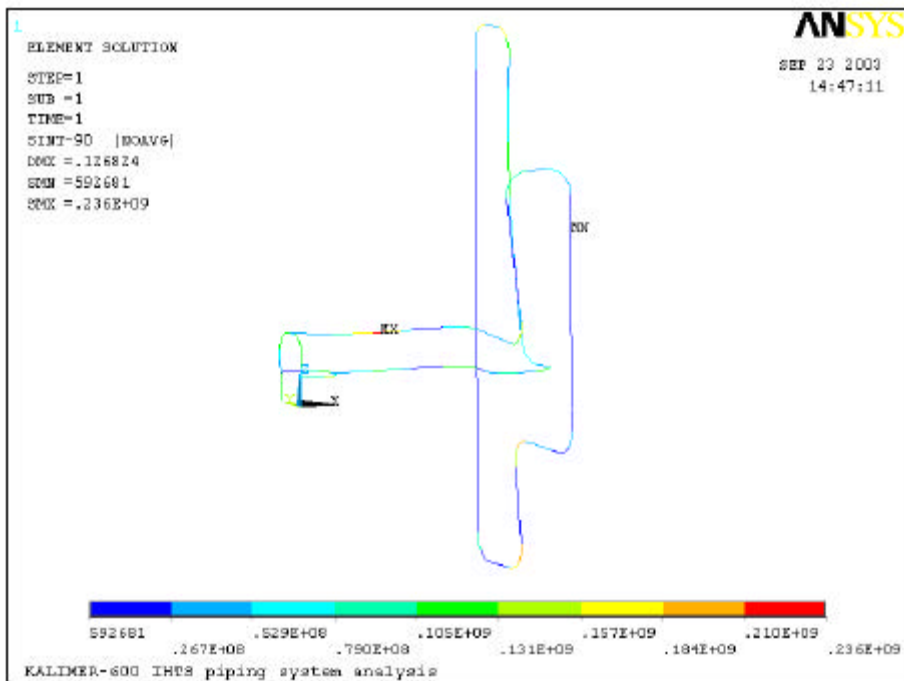
5. 3-Loop System

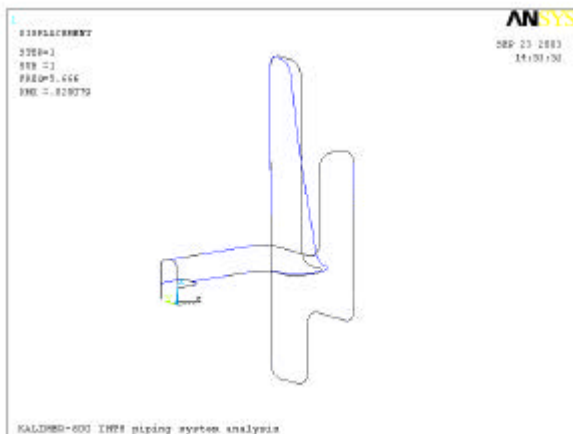1   (5.07 Hz)   2   (5.55 Hz)
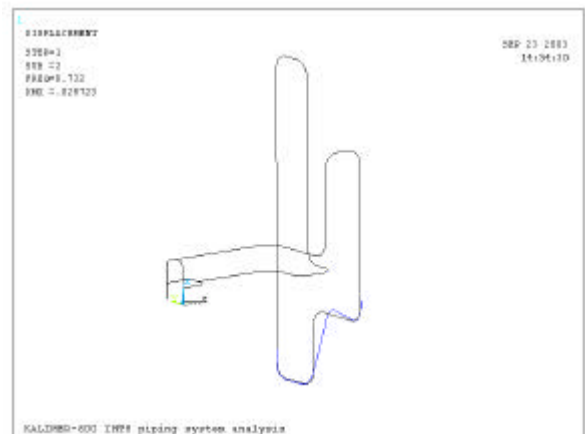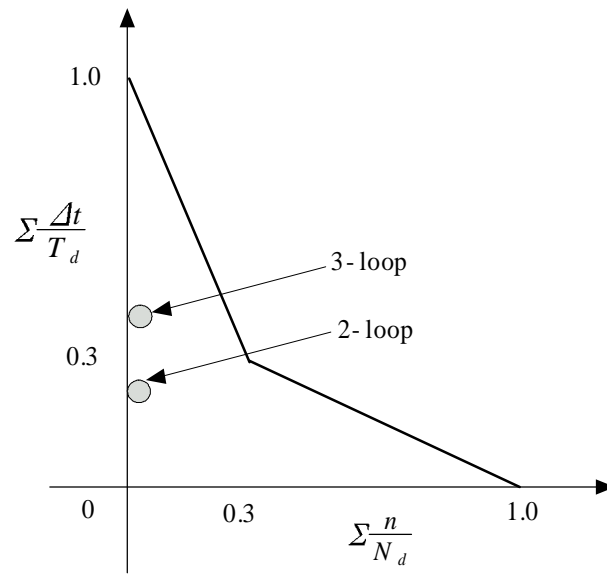
6. 2-Loop System

1   (5.66 Hz)   2   (8.73 Hz)

7. 3-Loop System

8.   -