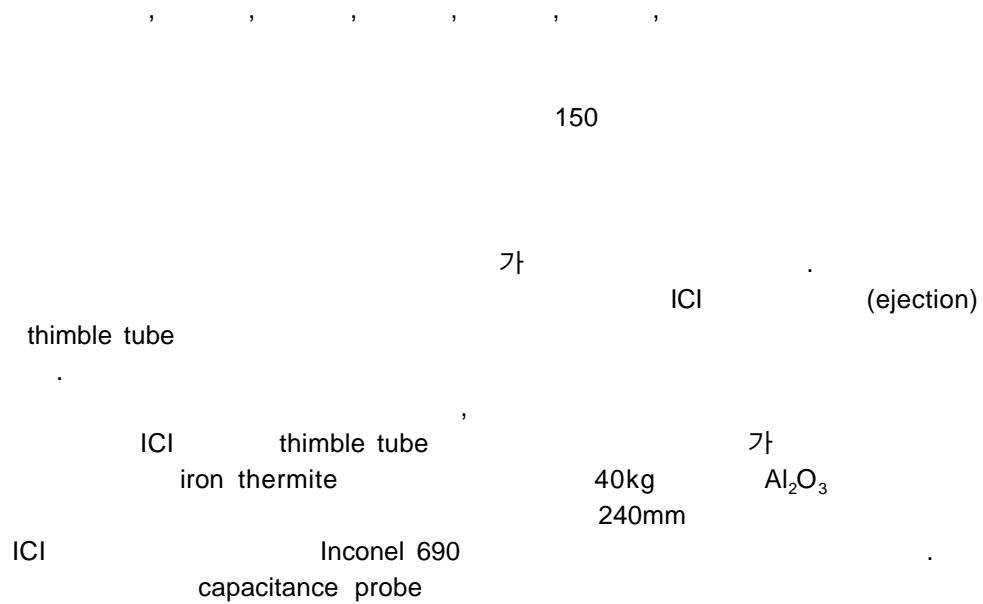


A Preliminary Experimental Study on the Integrity of the Lower Head Penetration in KNGR during a Severe Accident



ABSTRACT

A series of experiments are being performed on the integrity of a lower head penetration in KNGR (Korean Next Generation Reactor) during a severe accident. The failure of the lower head penetration may cause the release of radioactive materials to outside of the reactor pressure vessel through the melting of the support welding ejecting the ICI nozzle and ingress of the melt through the thimble tube. Since the external vessel cooling will be applied in KNGR to mitigate a severe accident, the experiments with the external vessel cooling have to be carried out. However, an experiment without the external vessel cooling and the water between the ICI nozzle and the thimble tube has been carried out so far as a preliminary and base case experiment. 40kg of high temperature Al_2O_3 melt separated from 80kg of iron thermite was used as a simulant of molten core material, and a circular flat plate with 240mm in diameter and the same thickness as the reactor lower head was used as a mockup of the lower head vessel. The ICI nozzle was fabricated with real material, Inconel 690, and with real size. The data obtained from the experiment are the displacement of the lower head mockup and the temperature histories in it and they will be used as the base case data in the future.

1.

가
jet impingement

(penetration)
thimble tube

ICI(In-Core Instrumentation)

(ejection)

. TMI-2

thimble tube

(10m)

[1].

[2,3].

Loviisa

AP 600

[4,5],

[6].

FAI

[7].

SNL

LHF(Lower Head Failure)

[8]

PSI

CORVIS

[9]

가

FAI

thimble tube

ICI

thimble tube

ICI

thimble tube

ICI

thimble tube

2.

1

thermite

, thermite

ICI

thimble tube

2

(KNGR : Korean Next Generation

Reactor)[10]

SA508, Grade 3, Class 1

165mm

가

가

34mm

MgO

20mm

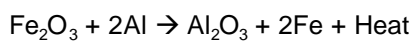
1 240mm
 가
 가
 76.2mm ICI 1
 Inconel 690
 가
 ICI
 150mm
 (EniCrFe-7)
 thimble tube 가

10m 790mm
 가
 ICI thimble tube
 가 가

2 K 가
 4 15mm
 2mm , ICI 4
 50mm thimble tube 6 가
 50mm
 C 100mm
 K

capacitance thimble tube

Thermite iron thermite
 iron thermite



Thermite 3 : 1 igniter 가
 1 : 1 2400K [1].
 Igniter Sigmund Cohn Corp. Pyrofuse™ wire 가
 650°C 2800°C iron thermite 가
 thermite
 100K

가 , 100K thermite
80kg iron thermite 40 kg
thermite
40kg ICI
base case [11].
base case

3.

40kg 5.8
가 thermite 가
10kg
3
4 가 25 가 25mm 가
가 ICI 가
가 K
ICI 5 6
가 가
thermal attack
가 ICI
3 ICI
가
ICI 10kg
ICI

ICI

Thimble tube

3

가 75

7

가 125

3

가 125

50

thimble tube

8

thimble tube

thimble tube

ICI

9 C

1700°C

MgO가 heat sink

thermite

thermite

가

10

13

가

9

LHV_10

LHV_10

가

1

가 가

14

15

14

가

(LHV_10

),

15

14

가

가

1.3MW/m²

15

0.45MW/m²

4.

ICI

thimble tube

가

ICI

thimble tube

가

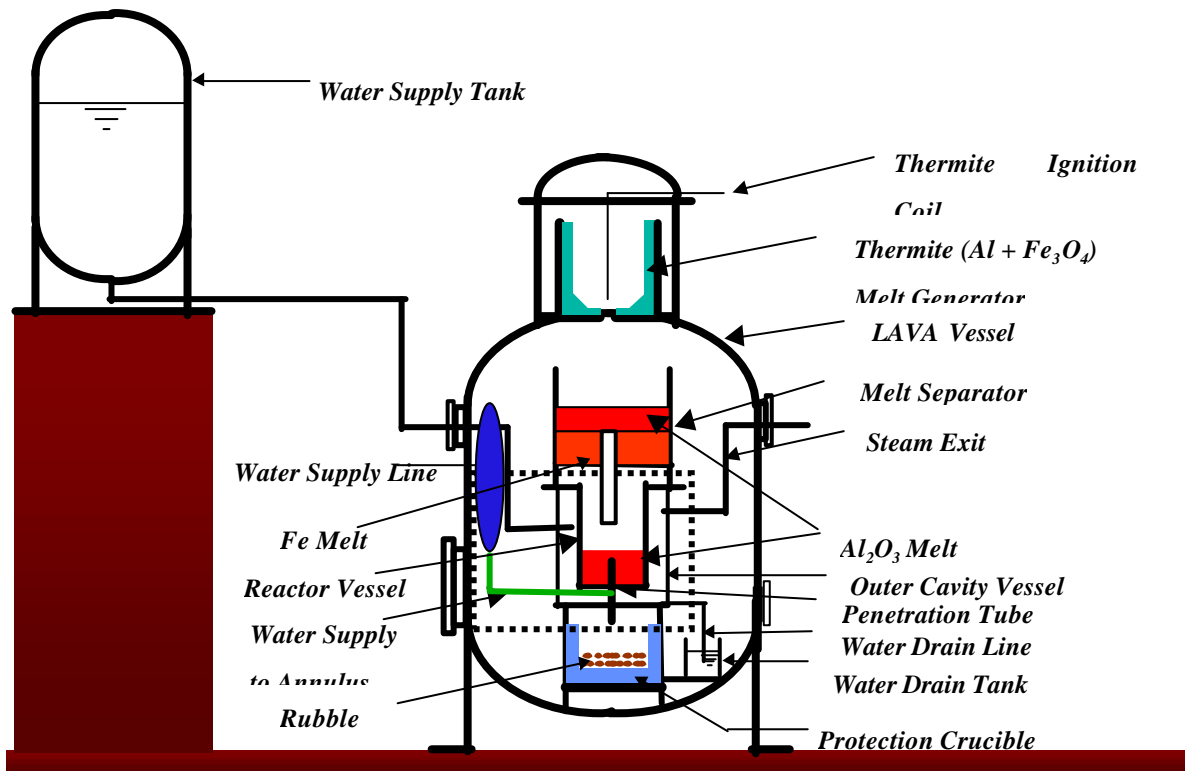
가 . 가
, thimble tube .
가 , 가
가 ,
thermite

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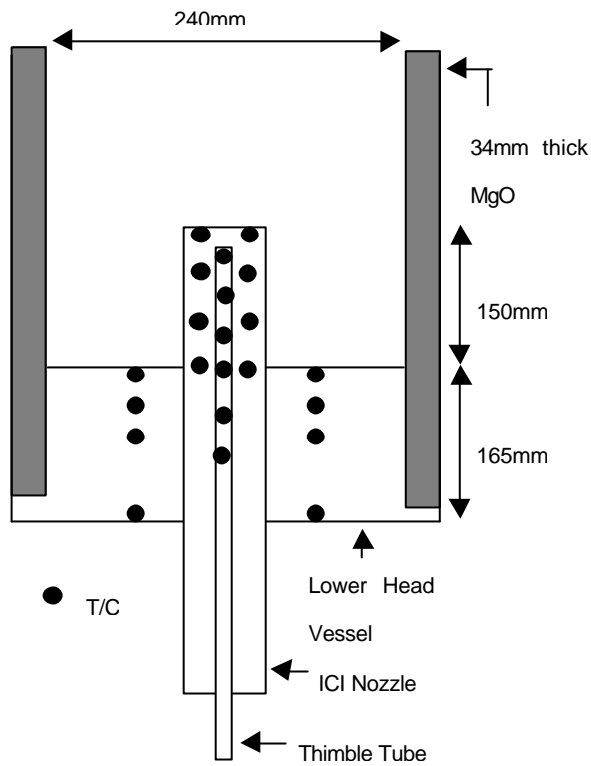
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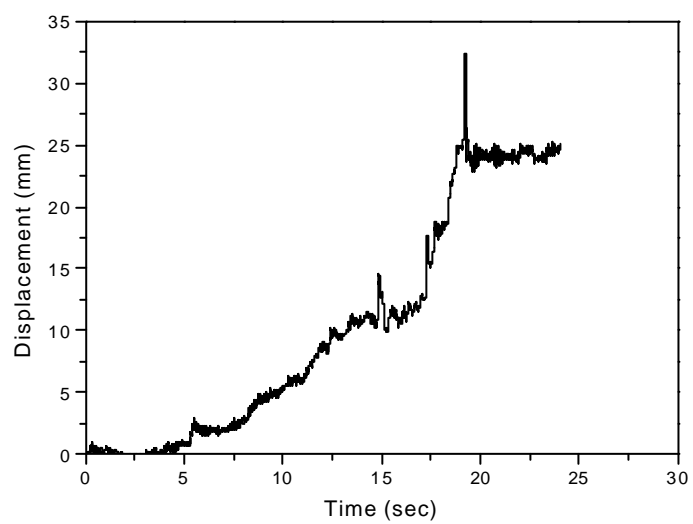
1.



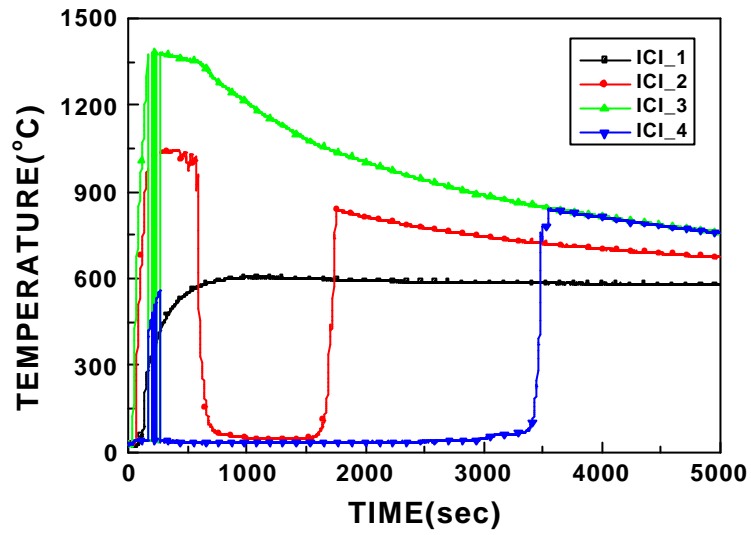
2.



3.

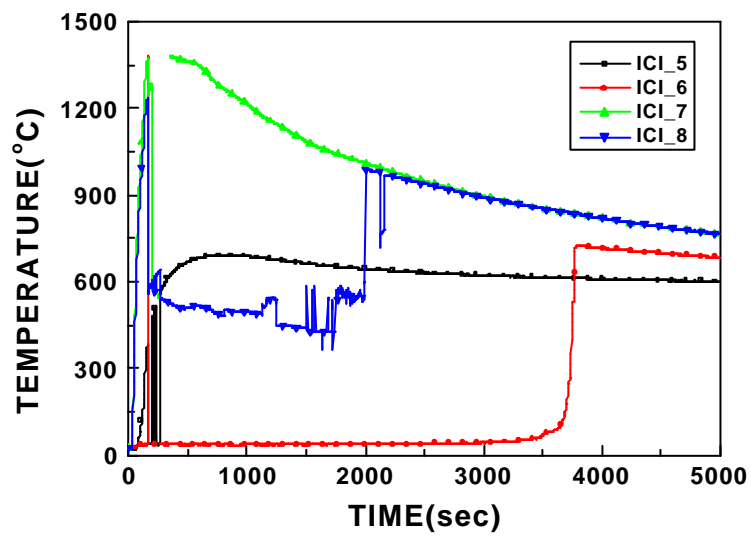


4.



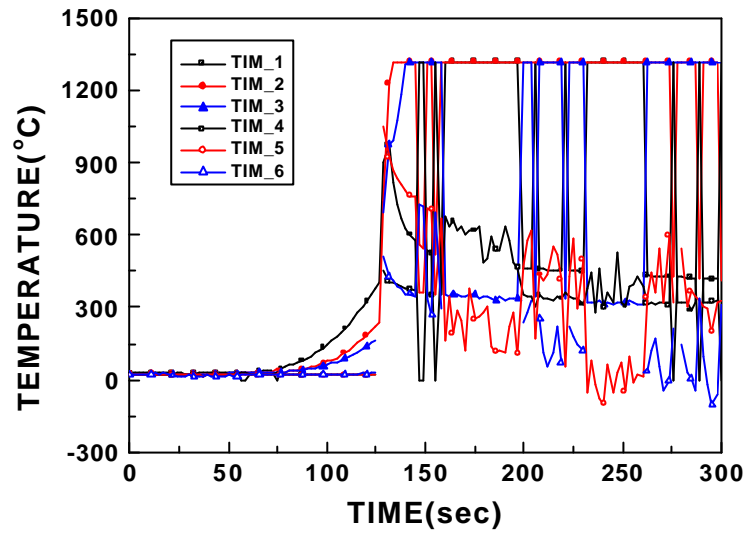
5. ICI

(1)



6. ICI

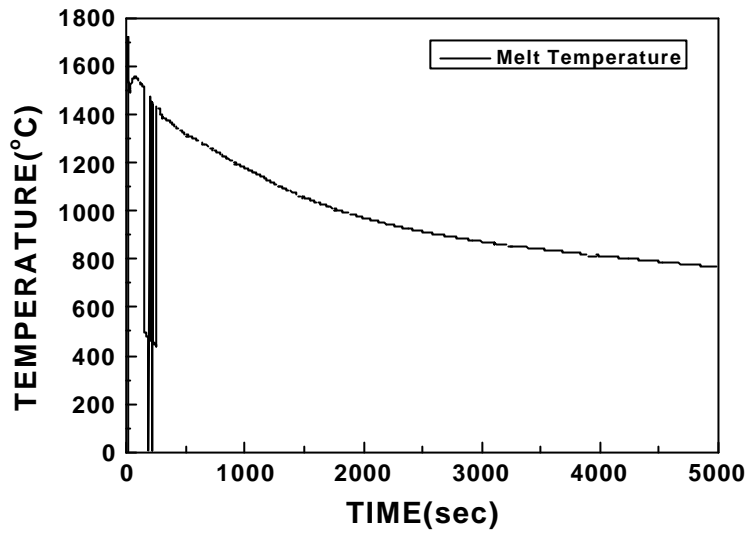
(2)



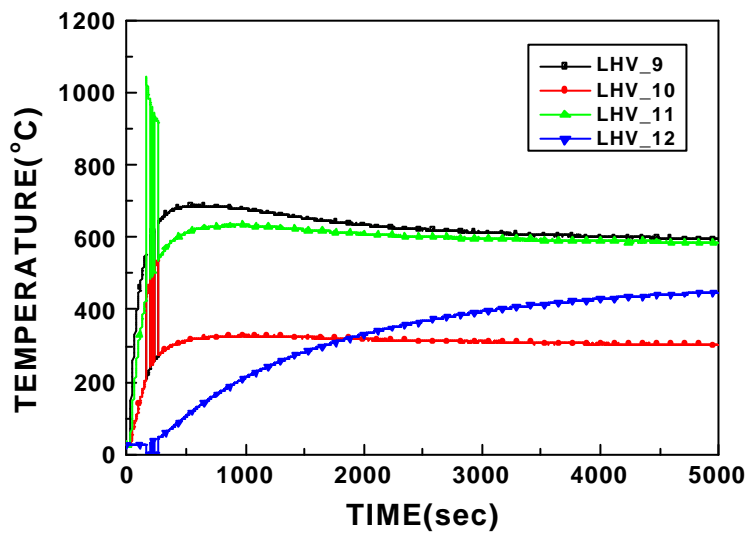
7. Thimble tube



8. thimble tube

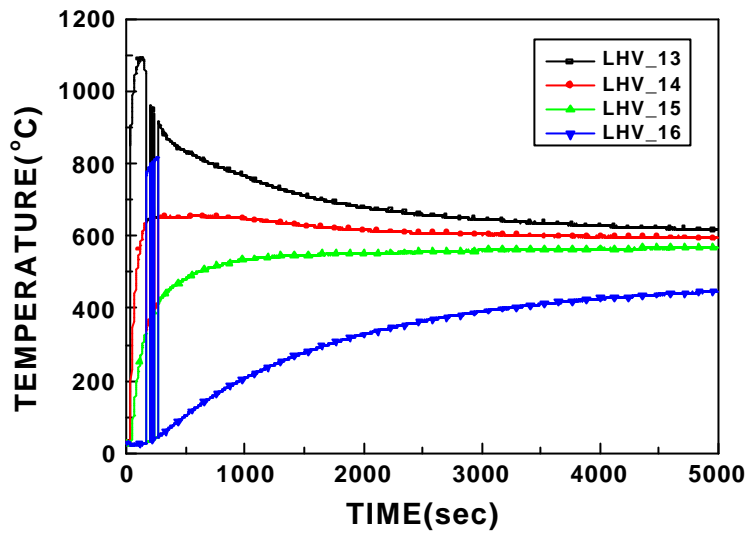


9.



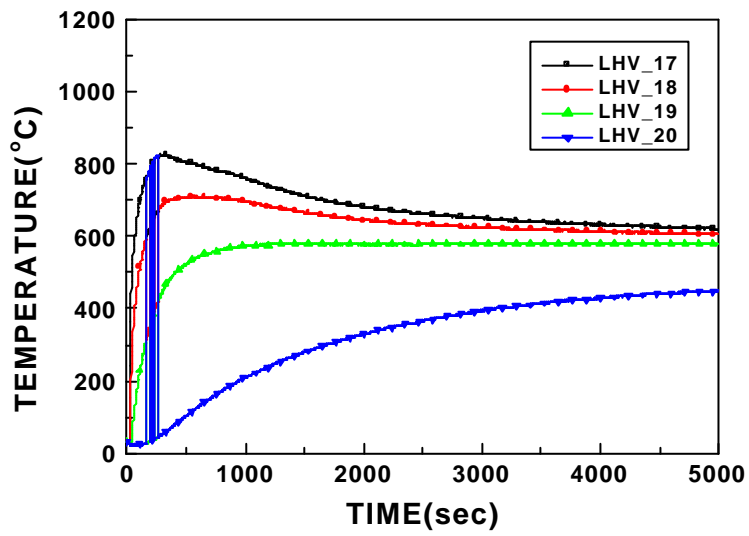
10.

(1)



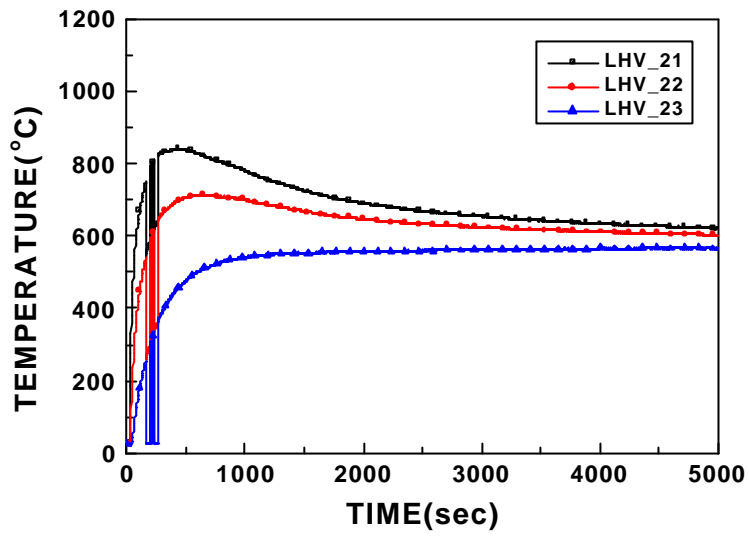
11.

(2)



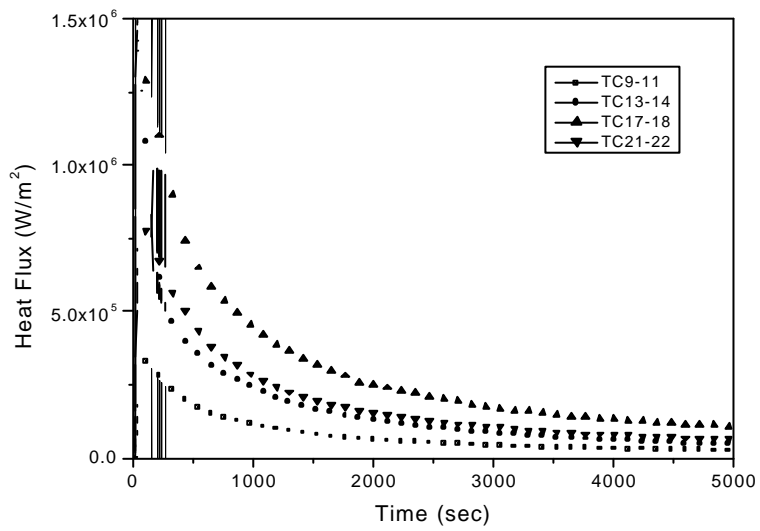
12.

(3)



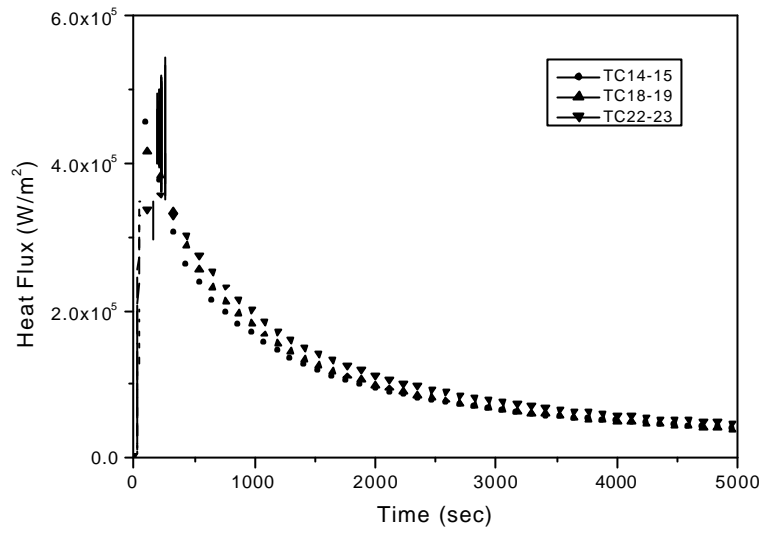
13.

(4)



14.

(1)



15.

(2)