Pretest studies of PARAMETER SF4 scenario with ICARE/CATHARE V2

(stand alone version ICARE2 V3.mod1.1-rev2)

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Background

Previous experience

- Development of air oxidation model for ICARE2
- Simulations of PARAMETER SF2 and SF3 experiments with SA ICARE2 and ICARE/CATHARE codes

Current application

Pretest examination of PARAMETER SF4 Scenario with on the basis of previous studies (input decks, model application)

Key items of test scenario

Steam inlet

p = 3 bar T = 750 K

flow = 0.0 g/s from 0 - 1500 s

3.5 g/s from 2000 - 16000 s

0.0 g/s after 16000 s

Ar inlet

p = 3 bar T = 750 K

flow = 2.0 g/s from 0 - 17060 s

0.0 g/s after 17060 s

Air flow

p = 3 bar T = 300 K

flow = 0.5 g/s from 16000 - 17060 s

External conditions on SS body t

p = 3 bar T = 300 K

external condition

Electrical power

time (s)	power (W)	
0.0	1.0	
100.0	2000.0	
2500.0	2000.0	
3500.0	2000.0	
6000.0	8400.0	(beginning of plateau)
8000.0	8800.0	(~ 1450 K)
14000.0	8800.0	
14003.0	5500.0	(~1173 K)
17060.0	5500.0	
17063.0	1.0	
18000.0	1.0	

External resistance

Equal to 4.0 Ohm (as for SF3)

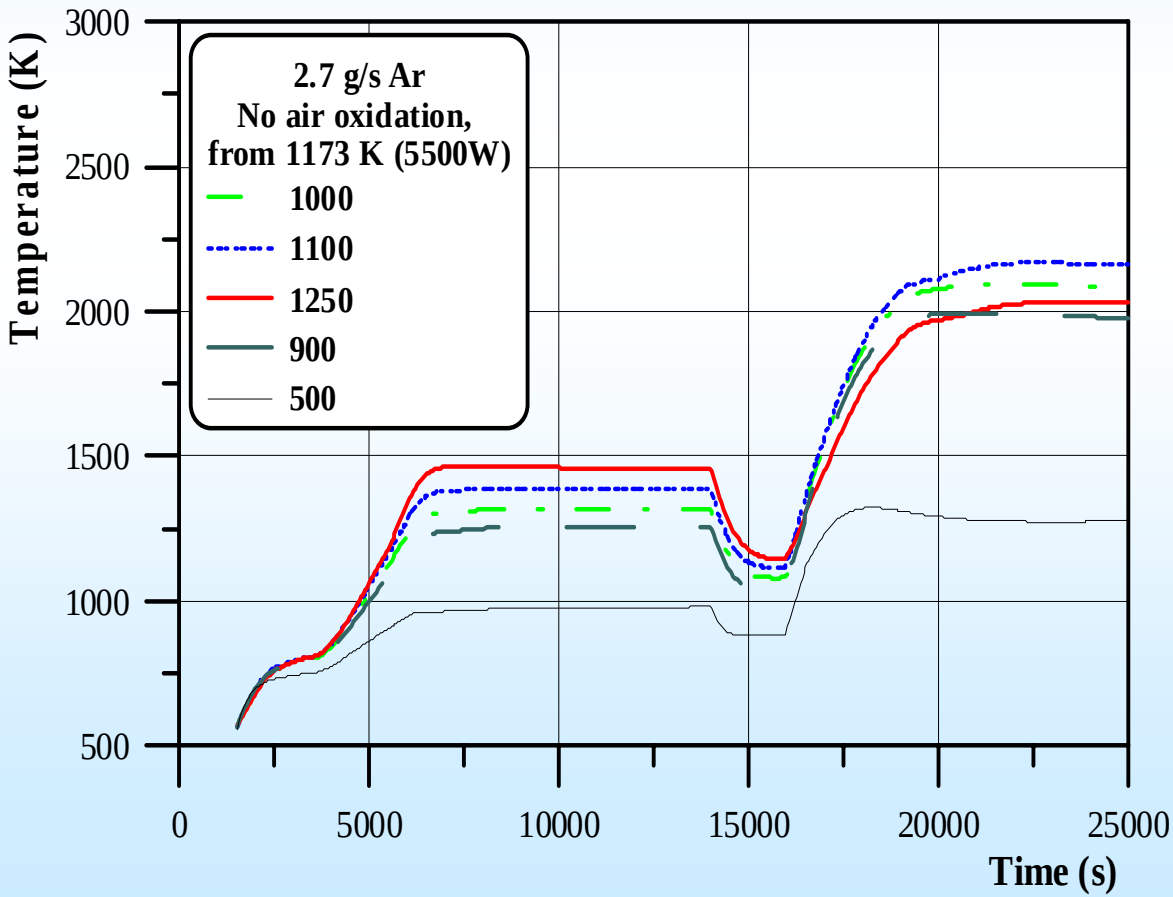
Similar to PSI one

Longer duration of preoxidation phase (14000 seconds)

Studies without air oxidation (SA ICARE2 code version)

SF3 input deck + accident scenario

Temperatures of second ring (heated) at different elevations



Conclusions

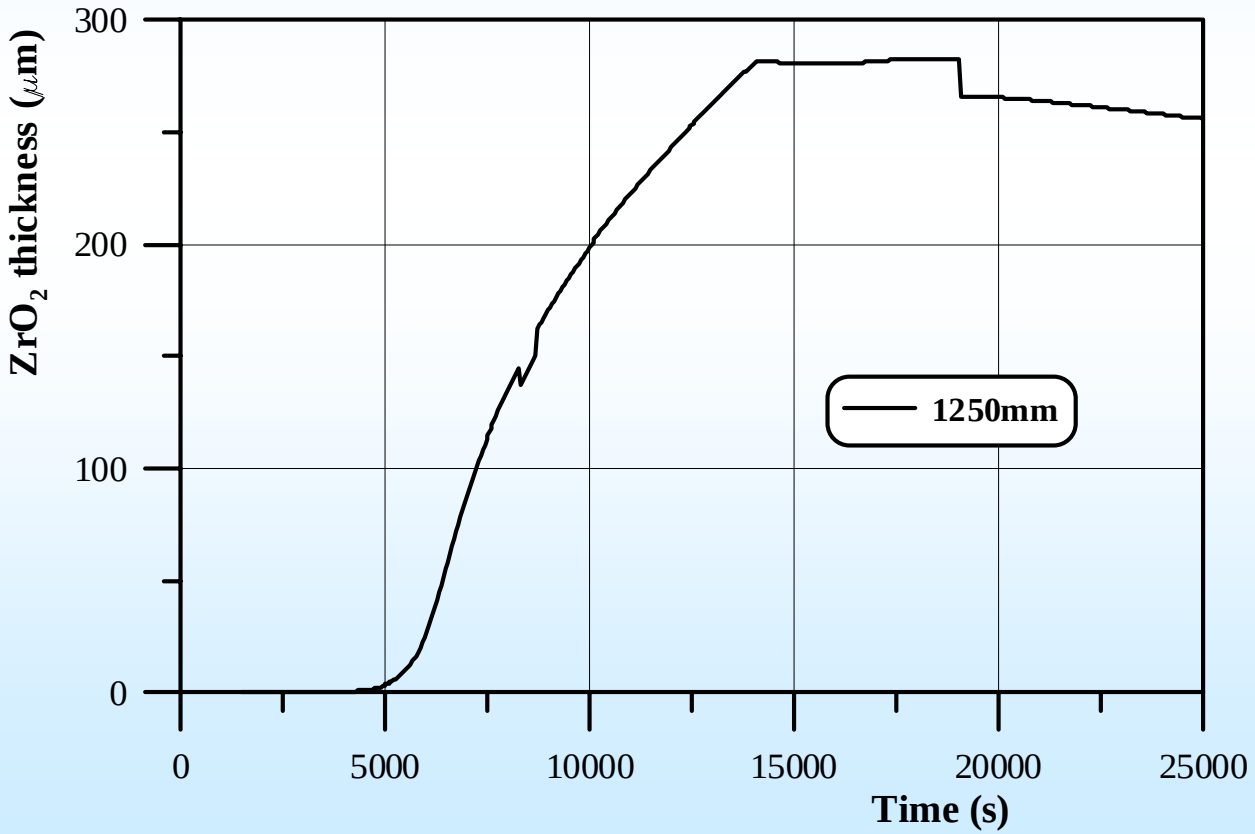
Air oxidation model switch off

- When steam is switch off then the temperature increases up to 2100 K in 2000 seconds
- The hottest zone is shifted to lower elevations
- Maximum temperatures can be obtained at 1100 mm due to low coolant flow

Studies without air oxidation (SA ICARE2 code version)

SF3 input deck + accident scenario

Evolution of zirconia thickness (Air oxidation model switch off)



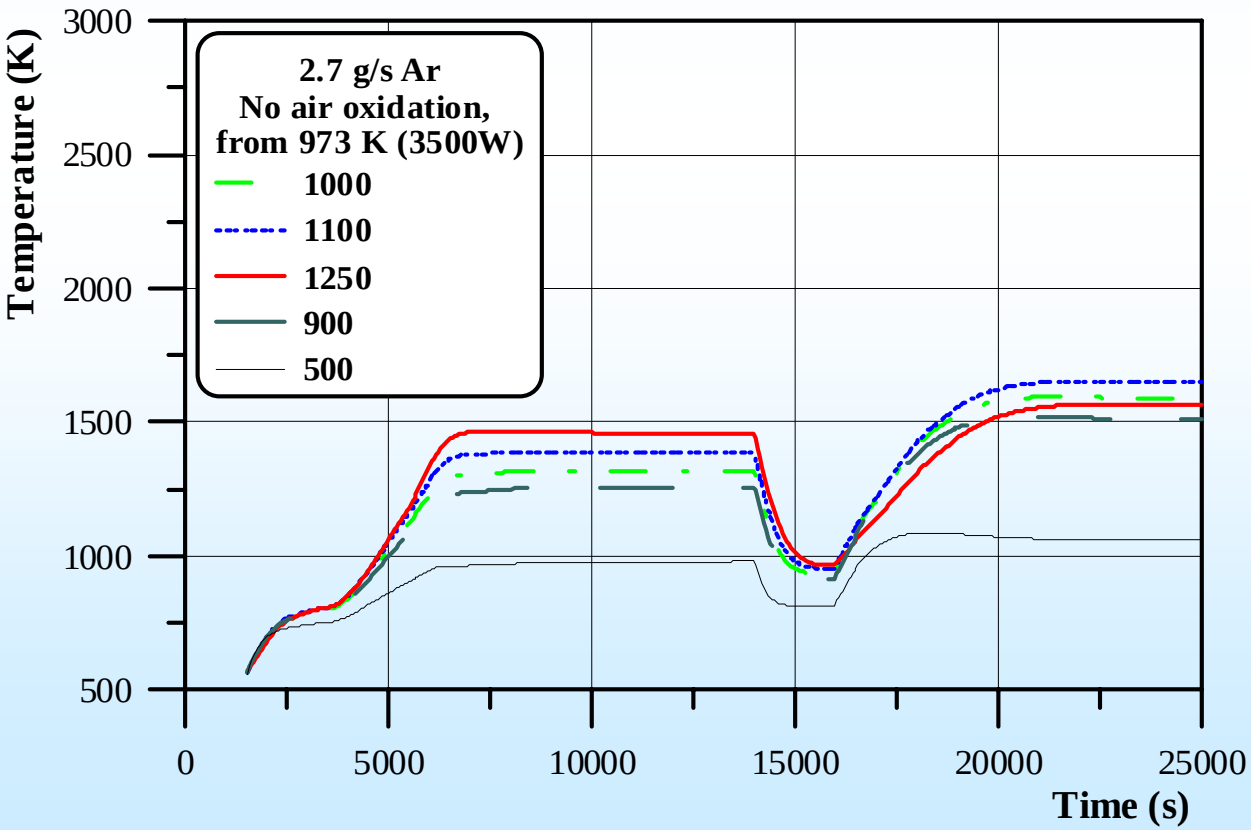
Conclusions

With best-fit correlations in ICARE/CATHARE desirable thickness (~280 μm) is reached approximately at 14000 seconds

Studies without air oxidation (SA ICARE2 code version)

SF3 input deck + accident scenario + low initial temperature (Variant II)

Temperatures of second ring (heated) at different elevations



Conclusions

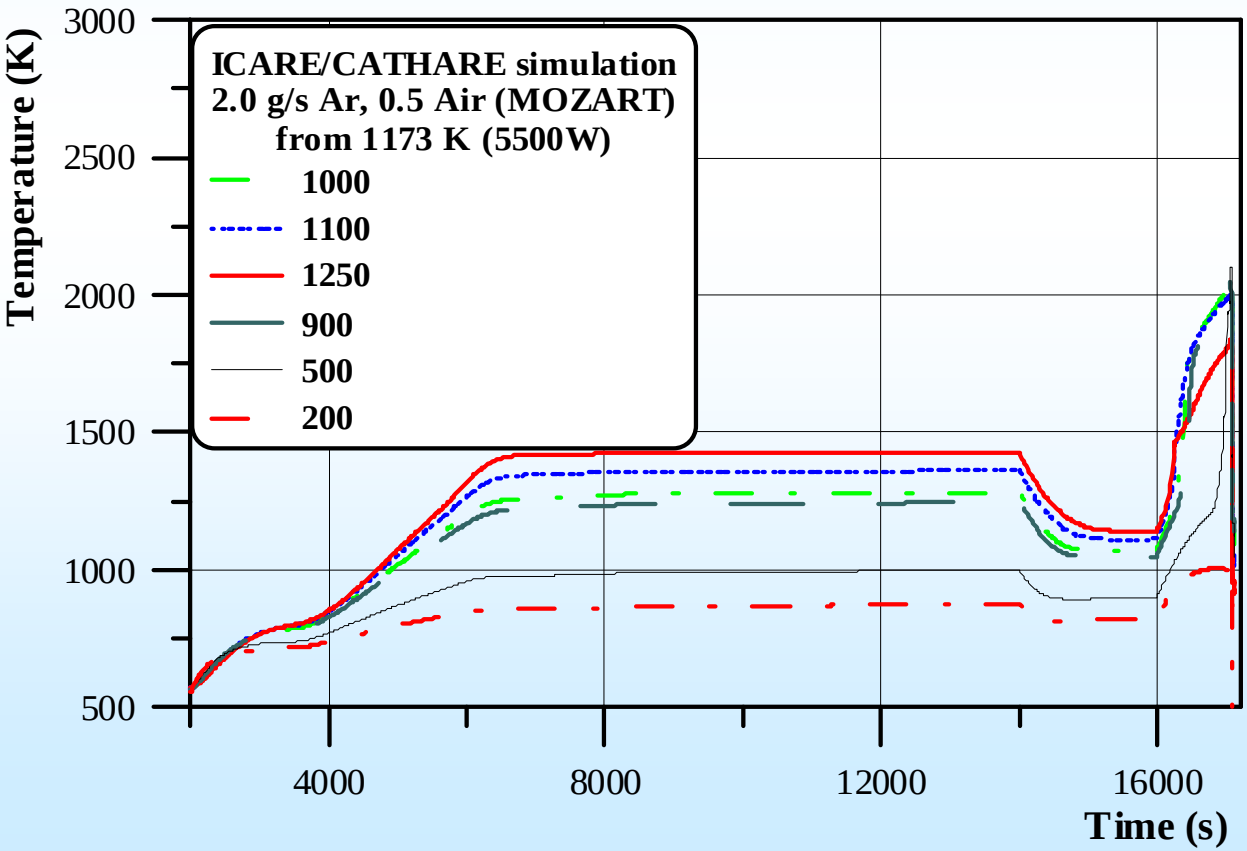
Air oxidation model switch off

- At low electrical powers (973 K) the temperatures of air injection phase may be too low for intensive air oxidation reaction
- Temperatures at air injection phase are very sensitive to variation of electrical power

Air oxidation studies (ICARE/CATHARE)

SF3 input deck + accident scenario

Temperatures of second ring (heated) at different elevations



Conclusions

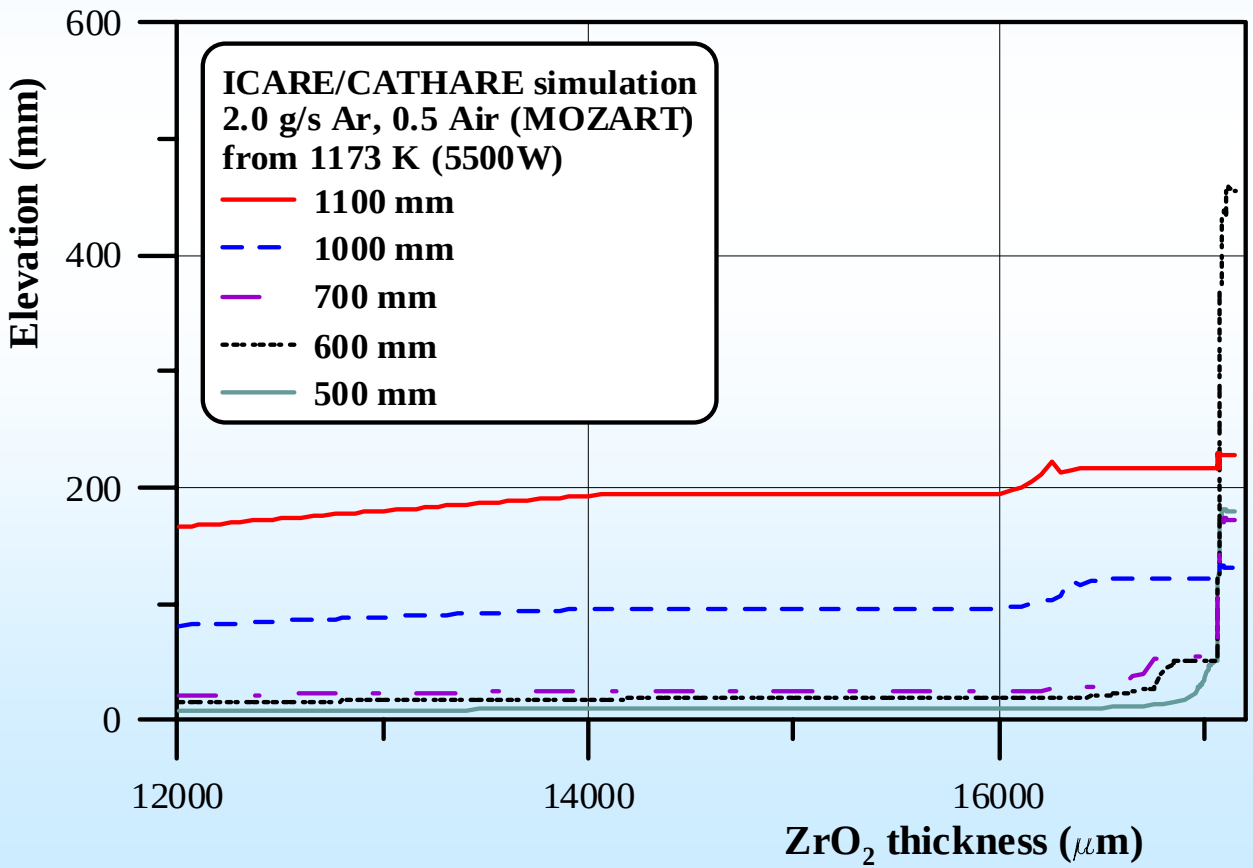
Air ingress – 0.5 g

- Air oxidation reaction firstly started at hottest elevations
- Peak of the air oxidation in simulation was shifted to much lower region (between 500 and 600 mm) - starvation conditions
- Before quenching temperature rate growth was up to 6K/s

Air oxidation studies (ICARE/CATHARE)

SF3 input deck + accident scenario

Oxide layer thickness at different elevations



Conclusions

Air ingress – 0.5 g

- Predicted oxide scale thickness - relatively small increase at initially heated zone (900 – 1300 mm)
- Sharp increase at 550 mm with maximum value of 460 μm.
- Initial ZrO_2 thickness in sharp escalation zone ~ 50 μm
- 1060 seconds of air oxidation lead to melting at 550 mm => decrease of exposition interval to 900 seconds (common presentation)

Summary

Examination with ICARE/CATHARE allowed to obtain following results

Air oxidation model switch off

- When steam is switch off then the temperature increases up to 2100 K in 2000 seconds
- The hottest zone is shifted to lower elevations
- Maximum temperatures can be obtained at 1100 mm due to low coolant flow
- At low electrical powers (973 K) the temperatures of air injection phase may be too low for intensive air oxidation reaction
- Temperatures at air injection phase are very sensitive to variation of electrical power

Air oxidation model switch on

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It should be accounted that ICARE/CATHARE air oxidation model was verified at lower temperatures (T < 1500 K) and at higher temperatures can have large uncertainty in kinetics