A Review of Core Catchers for Advanced Reactors

Samyak Munot  
*Homi Bhabha National Institute, samyakm@barc.gov.in*

A. K. Nayak  
*Bhaba Atomic Research Center, arunths@barc.gov.in*

Follow this and additional works at: [https://newprairiepress.org/asemot](https://newprairiepress.org/asemot)

Part of the [Mechanical Engineering Commons](https://newprairiepress.org), and the [Nuclear Engineering Commons](https://newprairiepress.org)

**Recommended Citation**


This Poster is brought to you for free and open access by the Conferences at New Prairie Press. It has been accepted for inclusion in Symposium on Advanced Sensors and Modeling Techniques for Nuclear Reactor Safety by an authorized administrator of New Prairie Press. For more information, please contact cads@k-state.edu.
A REVIEW OF CORE CATCHERS FOR ADVANCED NUCLEAR REACTORS

Samyak Mannot $^{a,b}$ and A.K. Naya $^{a,b}$

$^a$Tata Elxsi, India
$^b$Reactor Engineering Division, Bhabha Atomic Research Centre, Trombay, Mumbai-400085, India

BACKGROUND

1. Core melting during severe accident scenario is one of the major concerns due to its radioactivity, chemical reactivity and temperature.
2. Coolability and stabilization of corium are the major objectives for severe accident management in nuclear reactors to prevent failure of reactor pressure vessel.
3. Effective accident management is the major objectives for severe accident management in nuclear reactors to prevent failure of reactor pressure vessel.

DESIGN OBJECTIVE

- Relocation of the solid and liquid parts of the melt, core fragments and structural materials of the reactor i.e. Corium
- Maximum transfer of heat removal from the molten corium to cooling water
- Limiting the spreading of the molten materials beyond the boundary of the design
- Maintain the sub-critical conditions of the corium during the severe accident management
- Minimizes the exposure of structure, such as hydrogen, release to prevent the increase of pressure in the containment and avoid the steam explosion scenarios
- Limiting the stress to a permissible level on the structural material
- Minimizes the intervention from the operational staff
- Able to cool the molten corium for a long period of time and should be able to protect the structural materials from destruction during this period

SPECIAL MATERIAL

- To reduce the temperature level in the final melt by endothermic interaction between the corium melt and the sacrificial material.
- To reduce the specific volumetric heat release and the heat flow rate over the melt boundaries due to melting of sacrificial material in the corium.
- Due to a change in the density of the oxide components an inverse stratification of the oxide and metallic layers occurs, with the upward radiation of the oxide layer.
- To exclude second criticality of the mixture due to high absorbing properties of the sacrificial material (addition of neutron poison)
- The release of gases and aerosols is reduced.

TYPES OF CORE CATCHERS

1. The ex-vessel corium catcher for VVER consisted of a big crucible located in the reactor pit beneath the RPV.
2. In case of a RPV failure, the corium will be collected in the crucible which is cooled externally by flooding of the reactor pit by passive water injection.
3. The crucible is partly filled with sacrificial material (a mixture of sintered iron oxide and alumina) which melts and mixes with the corium, reducing the power density in the melt and yielding heat fluxes at the surface of the crucible below the critical heat flux which can be removed by the external cooling

CONCLUSIONS

- Core Catchers are Proprietary
- Core Catchers are divided into two categories depending on the location of its placement, viz., In-vessel (placed in inside the Reactor Pressure Vessel) and Ex-vessel (placed in side the containment but outside the Reactor Pressure Vessel).
- Although bottom flooding is an effective strategy to ensure melt coolability, there is a possibility of rapid containment pressurisation due to prompt quenching of melt and associated steam formation. Hence, the strategy of top flooding and side indirect cooling of core catcher can be incorporated.
- Sacrificial Material is completely soluble in molten corium.
- Combination of Iron Oxide and Aluminium Oxide is most suitable material for Sacrificial Material.
- Use of Sacrificial Material will prevent the metal water reaction and generation of non-condensable gases, hence depressurisation of the containment.
- The phenomenology of melt inversion will lead to entrapment of the radioactive nuclides in core catcher it, thus ensuring the safety of the environment.

SHORTCOMINGS

- Mechanism of Interaction of Corium With Sacrificial Material
- Understanding the phenomenology of thermal ablation of oxide sacrificial material with the molten corium and kinetics of chemical interactions
- Understanding the phenomena of melt inversion during operation of core catcher
- Spreading of Melt In The Core Catcher
- Understanding the spreading and distribution of flux at various locations of core catcher and Optimization of the arrangement of the bricks based on the understanding