KNS Virtual Autumn Meeting 2020, December 16-18.

Effects of interference grid on melt jet breakup and particle size distribution: MATE-MM-1 & 2 test cases (20A-428)

Mayank Modak[a], Hyun Sun Park[a]*, Evidente Ralph Carlo[a], Woo Hyun Jung[a], Yu Jung Choi[b], Mi Ro Seo[b]

[a]Division of Advanced Nuclear Engineering, POSTECH, Pohang, Gyeongbuk 37673, Republic of Korea
[b]Korea Hydro and Nuclear Power Co., Ltd., 1655, Bulguk-ro, Gyeongju-si, 38120 Gyeongbuk, Republic of Korea

INTRODUCTION

- In case of severe accidents in light water reactors (LWRs), the coolability of relocated corium from the reactor vessel is a significant safety issue. The failure in cooling and stabilizing of the molten core in the containment vessel can threaten the integrity of the containment boundary.
- Earlier, Jung et al. (2019) experimentally investigated the jet breakup length and jet diameter during molten fuel-coolant interaction.
- Current study is an extension to the previous work of Jung et al. (2019) in which, first systematic experimental research was conducted to study the particle size distribution and agglomerated debris using an interference grid for melt jet fragmentation.
- The MATE (Melt jet breakup Analysis with Thermal Effect) experimental facility was modified with a jet breakup device.

METHODOLOGY

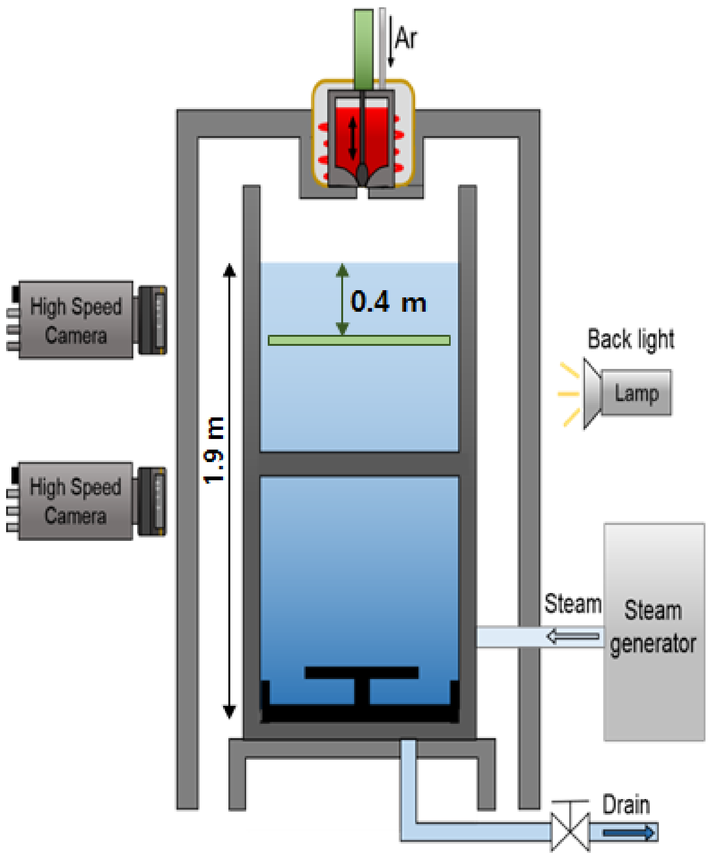

Fig. 1: Schematic design of MATE facility

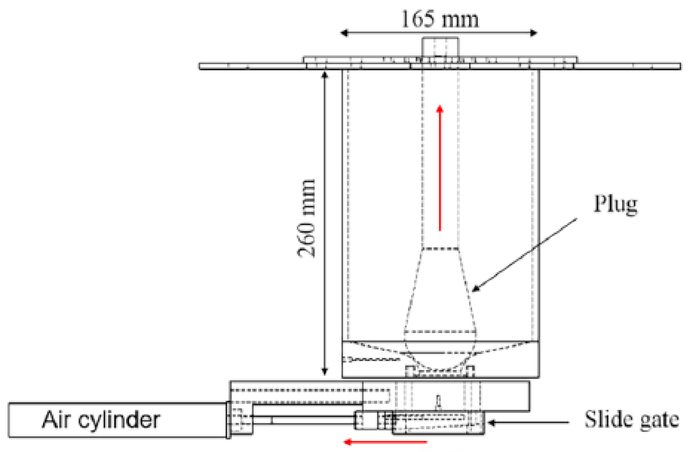

Fig. 2: Nozzle opening system plug and slide gate system

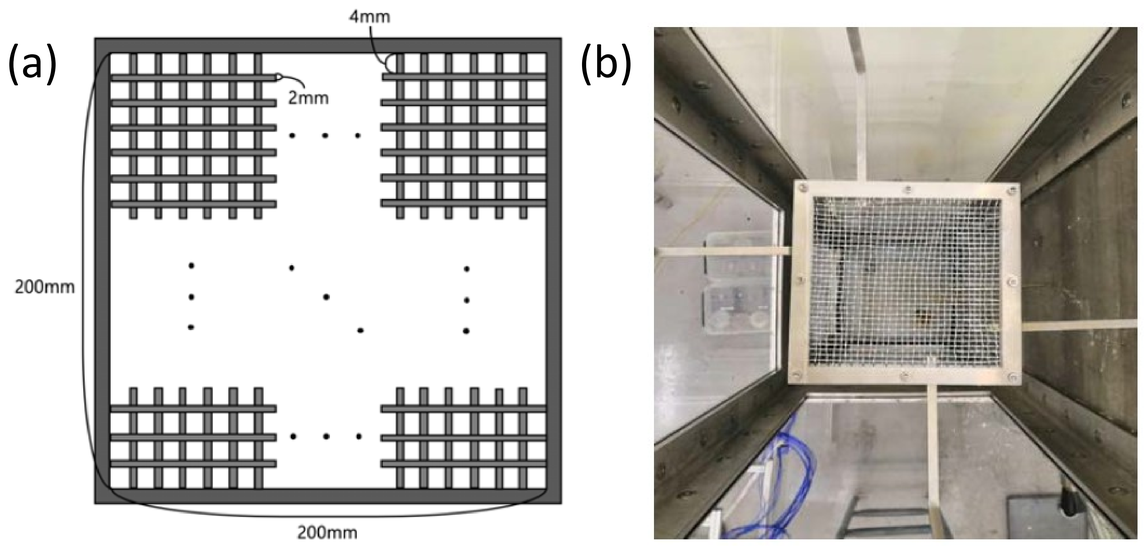

Fig. 3: (a) Mesh grid specification (b) mounting of grid in MATE tank

Table 1: Test cases for QPC tests

Test case	Grid position (cm)	Pressure (bar)	Nozzle dia. (mm)	Melt Mass	Water Temperature
MM-1	15	2	14	4 kg	Saturated
MM-2	45	2	14	10.4 kg	Saturated

RESULTS

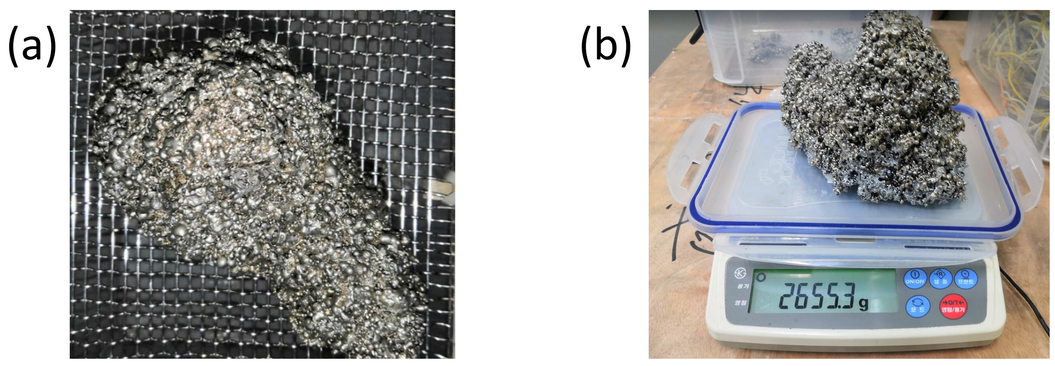

Fig. 4: (a) Agglomerated debris cake formation: Failed MATE MM - 1 tests (b) weight of MATE MM – 1 cake

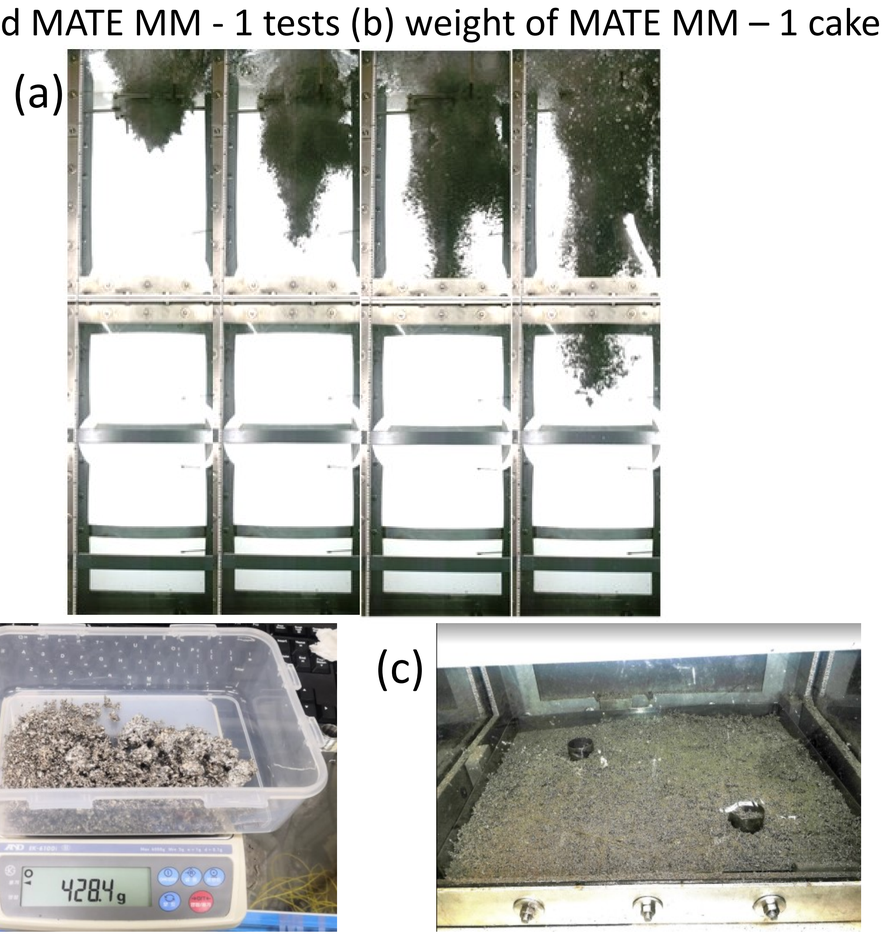

Fig. 5: Snapshots of melt jet progression during MATE-MM-2 (b) weight of the melt particles deposited over the grid (c) spreading pattern in the tank bottom

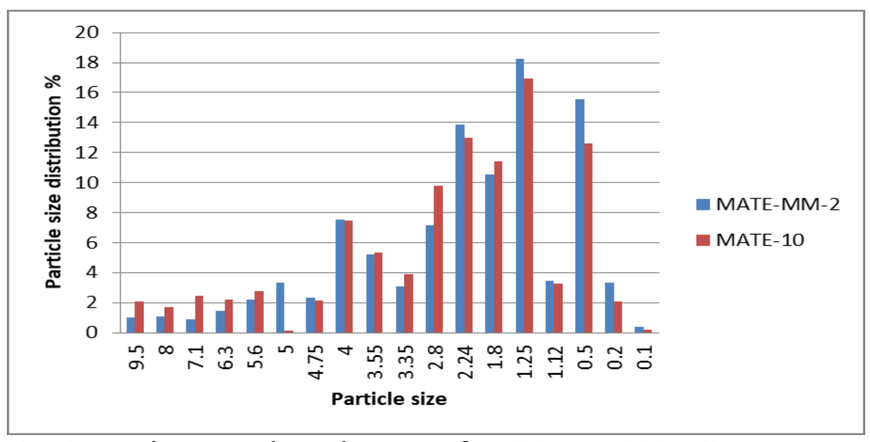

Fig. 6: Particle size distribution for MATE-MM-2 test case

CONCLUSION & PLAN FOR FUTURE

- The MATE-MM tests provide first systematic experimental data about the particle size distribution and agglomerated debris using an interference grid for melt jet fragmentation.
- One of the main findings in the MATE-MM tests is that fraction of agglomerated debris above 5 mm reduced greatly. While a very small fraction of debris particles were found deposited over the grid.
- Also the fraction of agglomerated debris particles has been significantly reduced compared to previous work at similar pool depth due to the use of interference grid.

REFERENCE

1. Jung, W.H., Park, H.S., Moriyama, K., Kim, M.H., 2019. Analysis of experimental uncertainties in jet breakup length and jet diameter during molten fuel-coolant interaction. 344, 183–194.
2. Jung, W.H., Park, H.S, Oh, J.H., Hwang, B., Lee, M., Kim, M.H., 2020, Minimum diameter limit of particle size distribution and its effect on coolability of debris bed. Nucl. Eng. Des., 110606.

ACKNOWLEDGEMENT

This work was supported by KOREA HYDRO & NUCLEAR POWER CO., LTD (No. 2018-RFP-Safety-5)

*Corresponding author: hejsunny@postech.ac.kr