

## Multi-Region and Multi-Component Thermal Fluid Analysis of Hydrothermal Oxidative Decomposition Reactor

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**Key Words:** *Polychlorinated Biphenyl, Hydrothermal Destruction Reactor, Multi-Region Analysis, OpenFOAM*

Hydrothermal oxidative decomposition is one of methods for detoxification of polychlorinated biphenyls (PCBs,  $C_{12}H_{(10-n)}Cl_n$ ), which are decomposed into water ( $H_2O$ ), carbon dioxide ( $CO_2$ ) and sodium chloride ( $NaCl$ ) by dechlorination with sodium carbonate ( $Na_2CO_3$ ) and oxidative decomposition with liquid oxygen ( $O_2$ ) under high temperature 370 °C and high pressure 26.5 MPa [1]. In these reactor vessels, wall thinning due to corrosion was observed on bottom inner wall. At present, the reactors have been safely maintained and operated by adding a bottom partition to prevent chemical sinking and supplying hot water to the reactor vessel bottom to control the temperature. Thermal fluid analysis of the hydrothermal oxidative destruction reactors is necessary to clarify the corrosion mechanism.

A finite volume analysis solver chtMultiRegionTwoPhaseEulerFoam of OpenFOAM [2] is used to perform a multi-regionally coupled analysis of the internal fluid flow and heat conduction in the reactor vessel considering the conjugate heat transfer on the solid-liquid interface. The internal fluid is two-component fluid, PCB and water, with different densities without chemical reaction. Advection equation for the volume fraction of two fluids, compressible Navier-Stokes equation with gravity term, and energy equation are staggeringly solved for unsteady thermal fluid analysis. The Reynolds-averaged Navier-Stokes equations based on the standard  $k-\epsilon$  model are used for turbulent flow analysis. Temperature dependent thermo-physical properties of PCB and water such as specific heat, thermal conductivity and viscosity, and equation of state of density, are employed as polynomial equation of temperature.

As a result of the analysis, the density difference flow of the two fluids was confirmed. To evaluate the integrity of the hydrothermal oxidative destruction reactor vessel, corrosion risk was evaluated based on the results obtained from the analysis such as temperature, volume fraction of PCB and wall shear stress on the solid-liquid interface.

### REFERENCES

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