Hybrid MPS and Eulerian computational approach for high-density hydrogen leakage with crack propagation in pressure vessel

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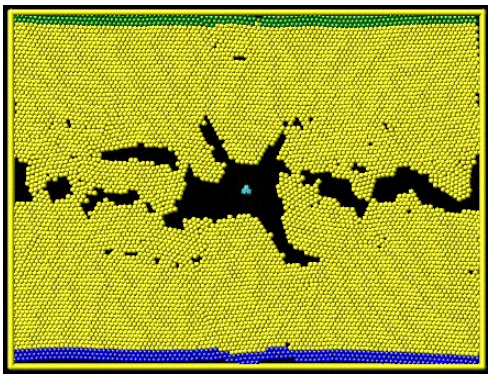
Abstract :

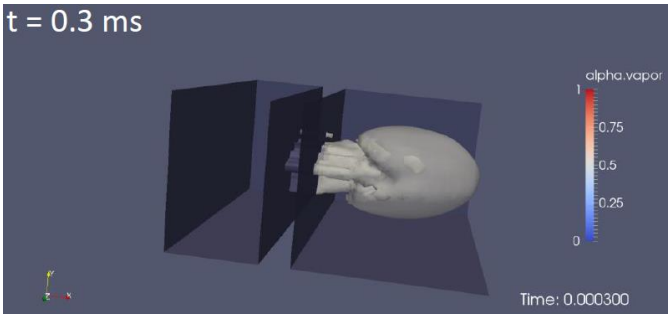
For hydrogen under the atmospheric pressure, energy generation rate per volume is less than that of fossil fuel such as gasoline. Therefore, it is necessary to develop the technique that high compression method of hydrogen to the high density fuel, and to develop the high density pressure vessels, high rate absorption method to metallic alloys for hydrogen storage. The present studies are made using mainly advanced supercomputing techniques. This research aims to develop and provide useful information to predict computationally the crack propagation and hydrogen leakage phenomena of pressure vessel as an important energy assessment vector.

Hybrid MPS and Eulerian computational approach

Hydrogen filling pressure to the fuel cell vehicles will be highly pressurized up to 70MPa in near future. Therefore, it is necessary to develop high-density hydrogen storage method, filling method, and the safety management procedure. Our new approach of the fluid-material coupled supercomputing for 70MPa highly compressed hydrogen (CH_2) and high-speed H_2 filling technology is possible to investigate both the pressure vessel's crack propagation and H_2 leakage flow characteristics under the same time in 70MPa high-pressure and high-speed H_2 filling condition. Figure 1 shows the computational prediction result of hydrogen embrittlement problems such as corrosion, cracking and leakage phenomena.



(a) Crack propagation analysis by MPS



(b) Hydrogen leakage simulation accompany with tank crack propagation using hybrid MPS and Eulerian VOF method

Figure 1 Hybrid MPS and Eulerian VOF computational approach for high-density hydrogen leakage accompany with crack propagation in pressure vessel.