Numerical analysis of cryogenic preparation of methane and hydrogen

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In this study, heat and mass transfer phenomenon during the production of methane solid tubes produced at low temperature is analyzed by using finite element method (Fig. 1). Through the numerical simulations and phase diagram analysis, a possible phase transition path is proposed to explain how to prepare solid tubes by using liquid methane under vacuum conditions. In a low-pressure environment, prepared solid methane tubes are sublimated because their saturated vapor pressure is higher than the ambient pressure. Thermal radiation and sublimation can affect the temperature and diameter of the solid tube. Different values of the sticking coefficient of sublimation and the emissivity of the radiation are used and compared in the calculations (Fig. 2). Since the tube is exposed to the vacuum, the diameter of the tube gradually decreases and the tube will finally disappear through the sublimation. Therefore, the expected length of the solid tube under different conditions also have been calculated. The analysis is further applied to the case of the production of hydrogen tubes. Several reasons are proposed to explain why the hydrogen tube production failed and the methane succeeded in the experiments.

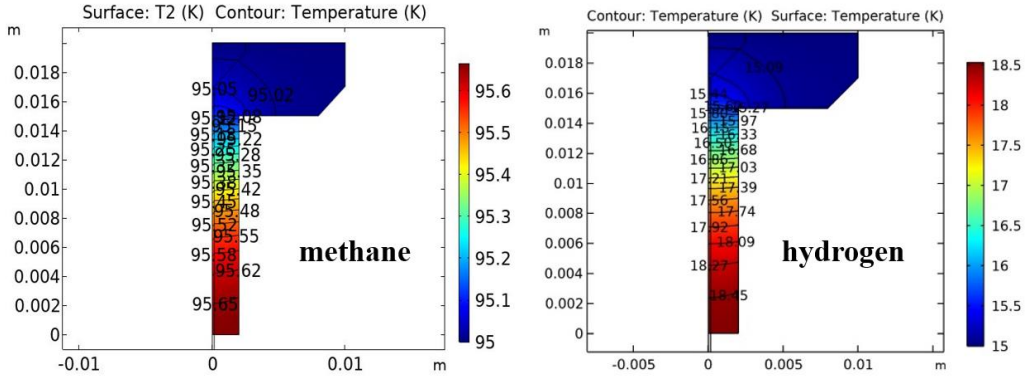

Fig.1 Temperature distribution in the pressurized nozzle for methane and hydrogen preparation

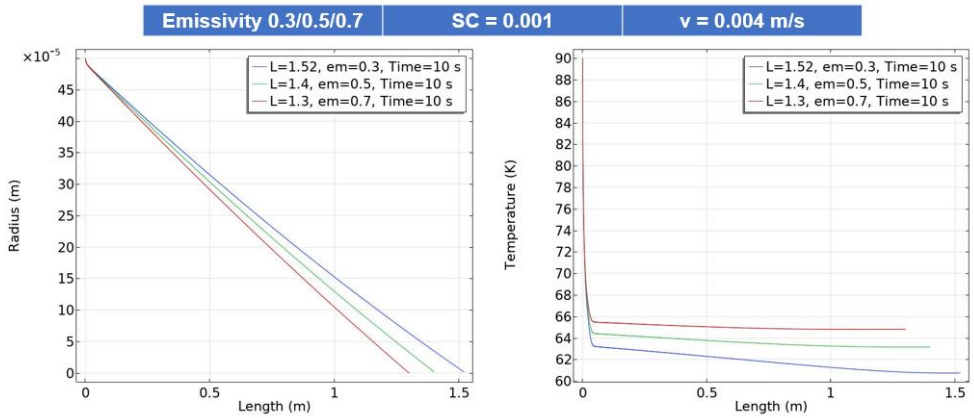

Fig.2 The radius and temperature of the tubes as a function of the emissivity of the radiation.