



Dynamic modeling of hydrogen desorption from a metal hydride tank using the electrical fluidic analogy

Djafar Chabane, Fabien Harel, Abdesslem Djerdir, Denis Candusso, Omar Elkedim, Nouredine Fenineche

► To cite this version:

Djafar Chabane, Fabien Harel, Abdesslem Djerdir, Denis Candusso, Omar Elkedim, et al.. Dynamic modeling of hydrogen desorption from a metal hydride tank using the electrical fluidic analogy. WHEC 2016, World Hydrogen Energy Conference, Jun 2016, Saragosse, Spain. WHEC 2016, World Hydrogen Energy Conference, 1 p, 2016. <hal-01366243>

HAL Id: hal-01366243

<https://hal.archives-ouvertes.fr/hal-01366243>

Submitted on 14 Sep 2016

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Dynamic modeling of hydrogen desorption from a metal hydride tank using the electrical fluidic analogy

FR CNRS 3539

FCLAB

D. CHABANE^{1,2}, F. HAREL^{1,6}, A. DJERDIR^{1,2}, D. CANDUSSO^{1,5}, O. EL-KEDIM^{1,4}, N. FENINECHE^{1,3}

¹FCLAB Fédération de recherche (FR CNRS 3539), 90010 Belfort Cedex

²IRTES-SET, UTBM, 90000 Belfort CEDEX

³IRTES-LERMPS, UTBM, 90010 Belfort cedex, France

⁴FEMTO-ST, MN2S department, UTBM, 90010, Belfort, cedex, France

⁵Université de Lyon, IFSTTAR / AME / LTE, 25 avenue François Mitterrand, Case 24, Cité des mob F-69675 Bron cedex, France.

⁶IFSTTAR / COSYS / SATIE (UMR CNRS 8029), 25 allée des marronniers, 78000 Versailles Satory, France.

djafar.chabane@utbm.fr



The current work presents a modeling study of the thermal behavior during discharge of a hydride hydrogen tank. In a thermal coupling between a fuel cell and its associated hydride hydrogen tank, the hydrogen desorption kinetics depends on temperature, nature of the hydride, the tank design, but also on the hydrogen demand from the fuel cell in terms of mass flow and pressure. The objective of the study is to demonstrate the dynamic response of hydrogen discharge from a metal hydride tank by using the fluidic electrical analogy.

Model

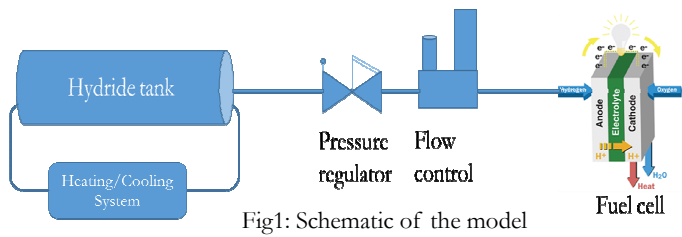


Fig1: Schematic of the model

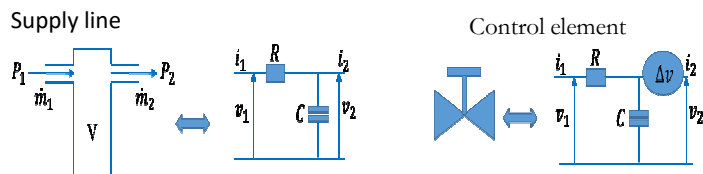
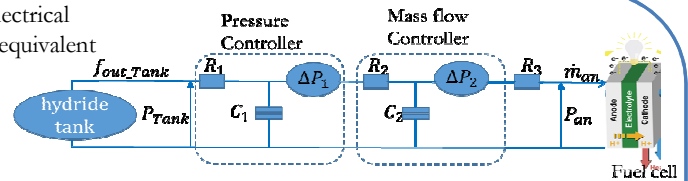


Fig2: Electrical fluidic analogy

Fig3: Electrical model equivalent



$$(\rho C p)_e \frac{dT}{dt} = \dot{m} \Delta H + Q \quad Q = \frac{\dot{m}_w c_{p,w}}{V_{MH}} (T_{w,in} - T_{MH})(1 - e^{-\alpha})$$

$$\varepsilon \frac{\partial \rho_g}{\partial t} = -\dot{m}$$

$$\alpha = U \pi D L / \dot{m}_w c_{p,w}$$

$$(1 - \varepsilon) \frac{\partial \rho_s}{\partial t} = \dot{m}$$

$$T_{w,out} = T_{MH} + (T_{w,in} - T_{MH})e^{-\alpha}$$

$$\dot{m} = C_d \exp\left(-\frac{E_d}{RT}\right) \left(\frac{P_g - P_{eq}}{P_{eq}}\right) (\rho_s - \rho_0)$$

Results

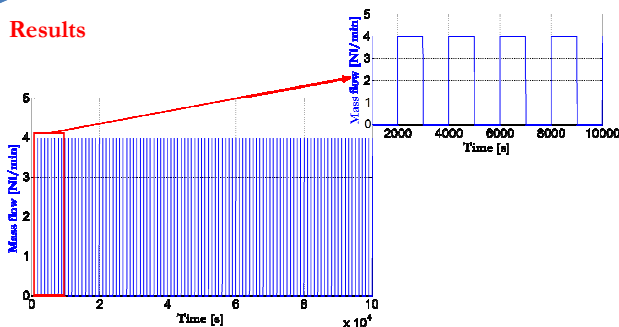


Fig4: Flow demanded by fuel cell

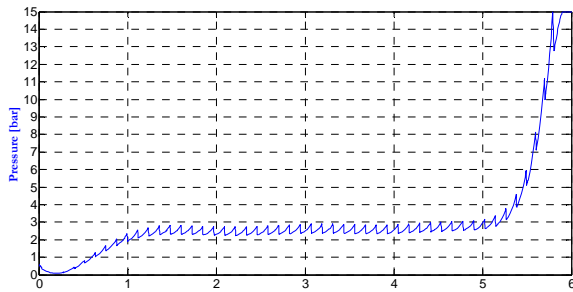


Fig5: Pressure composition temperature (PCT)

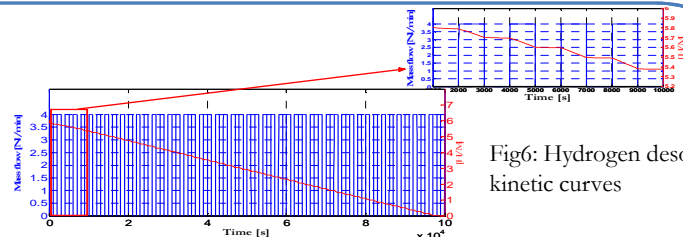


Fig6: Hydrogen desorption kinetic curves

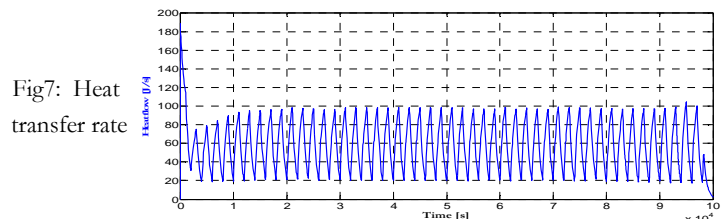


Fig7: Heat transfer rate

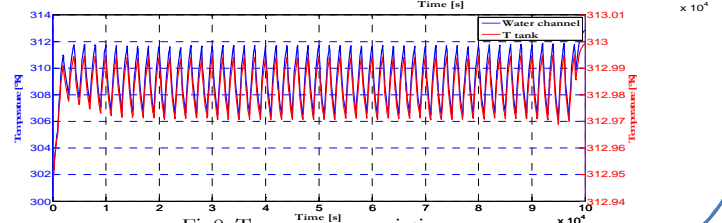


Fig8: Temperature variation

The future work will demonstrate more characteristics of hydrogen supply for various operational demands of a fuel cell system with an enhanced simulation accuracy using higher-dimensional models. Also, the dynamics of fuel cell system performances will be explored with the goal of enhancing the control strategies of hydrogen supply with optimizing control parameters