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# Advanced thermal management of metal hydride reactors: a numerical study on optimized fin geometries

<sup>1</sup>Oussama Rejeb <sup>1</sup>, Christophe Vial <sup>1</sup>, Abdelmajid Jemni <sup>2</sup>, Tarik Kousksou <sup>3</sup>, Nouredine Fenineche <sup>4</sup>, Maamar Bettayeb <sup>5,6</sup>, Chaouki Ghenai <sup>7,8 \*</sup>

1. Université Clermont Auvergne, Clermont Auvergne INP, CNRS, Institut Pascal, F-63000, Clermont-Ferrand, France
2. Université de Monastir, Ecole Nationale d'Ingénieurs de Monastir (ENIM), LESTE, LR99ES31, 5000, Monastir, Tunisia.
3. Laboratoire SIAME, Université de Pau et des Pays de L'Adour/E2S UPPA, EA4581, 64000 Pau, France
4. ICB-PMDM UMR 6303, CNRS, Université Bourgogne Franche-Comté, UTBM, Belfort, F-90010, France
5. Department of Electrical Engineering, University of Sharjah, Sharjah, United Arab Emirates.
6. Center of Excellence in Intelligent Engineering Systems (CEIES), King Abdulaziz University, Jeddah, Saudi Arabia.
7. Department of Sustainable and Renewable Energy Engineering, College of Engineering, University of Sharjah, Sharjah, United Arab Emirates
8. Sustainable Energy Development Research Group, Research Institute for Science and Engineering (RISE), University of Sharjah, P.O. Box 27272, Sharjah, United Arab Emirates.



## Context

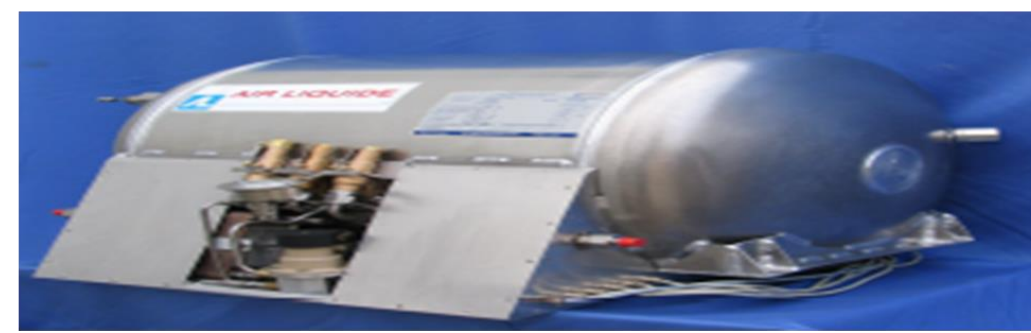
### Hydrogen Storage Mode

#### Compressed



High-pressure

#### Liquefied



High energy (Cryogenic)  
needed

#### Solid (Hydride)

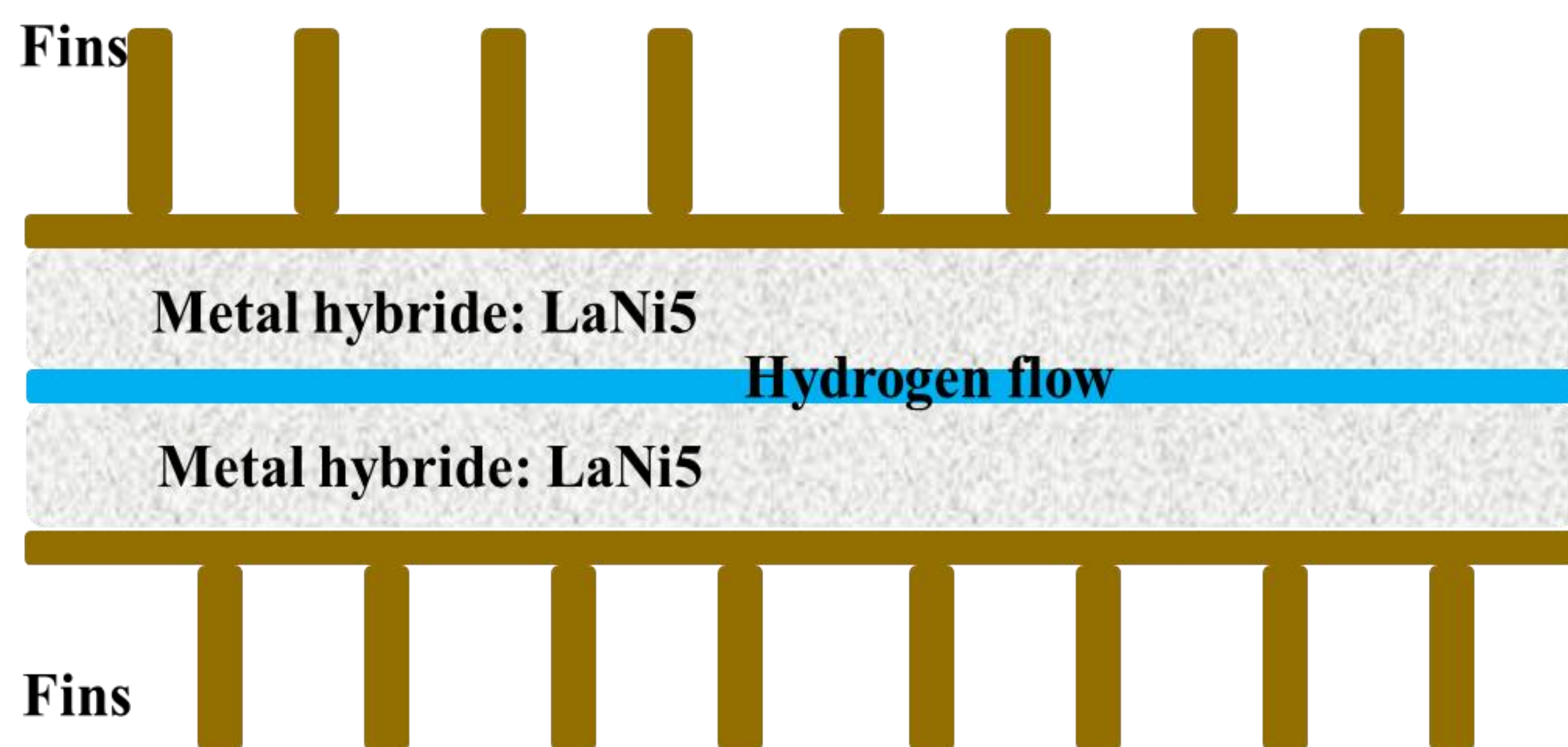


Thermal management  
needed

## Contribution

- ❖ **Safe Hydrogen Storage:** Solid storage ensures safety.
- ❖ **Passive Thermal Management:** Effective heat regulation.
- ❖ **Optimized Fin Geometries:** Different fin shapes for better heat transfer.
- ❖ **Developed a Dynamic Model for the LaNi5 material with a cylindrical reactor coupled with fins.**

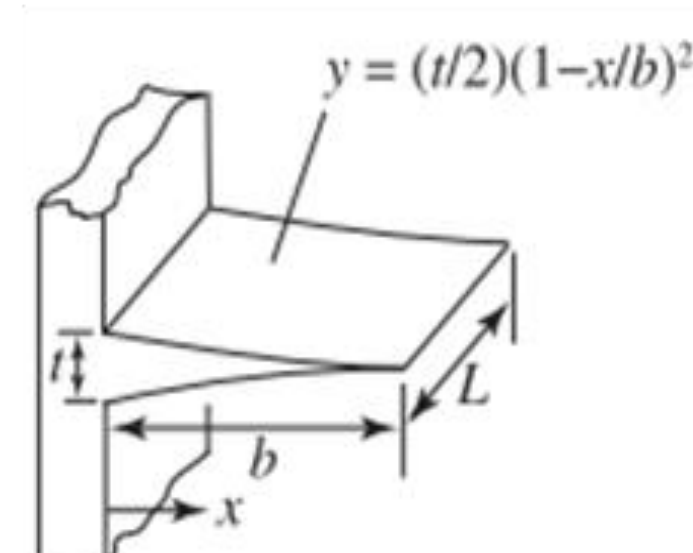
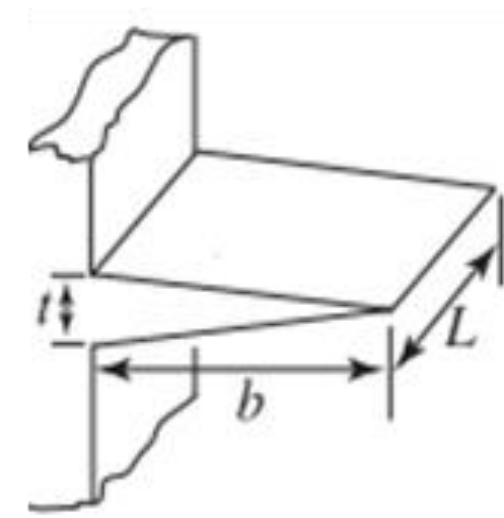
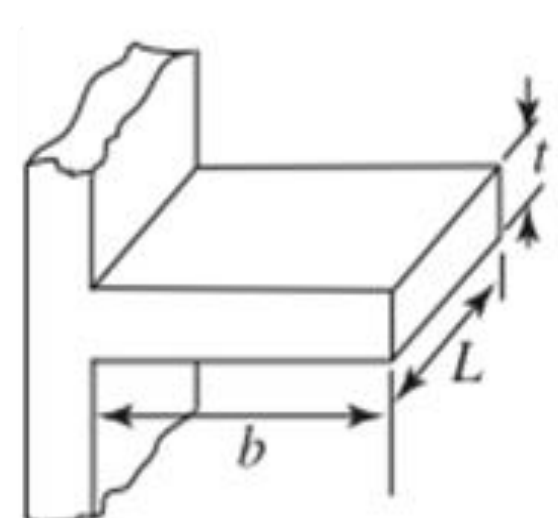
## System Description



(a) Rectangular Fins

(b) Triangular Fins

(a) Rectangular Fins



LaNi5 cylindrical reactor coupled with fins

## Mathematical Part

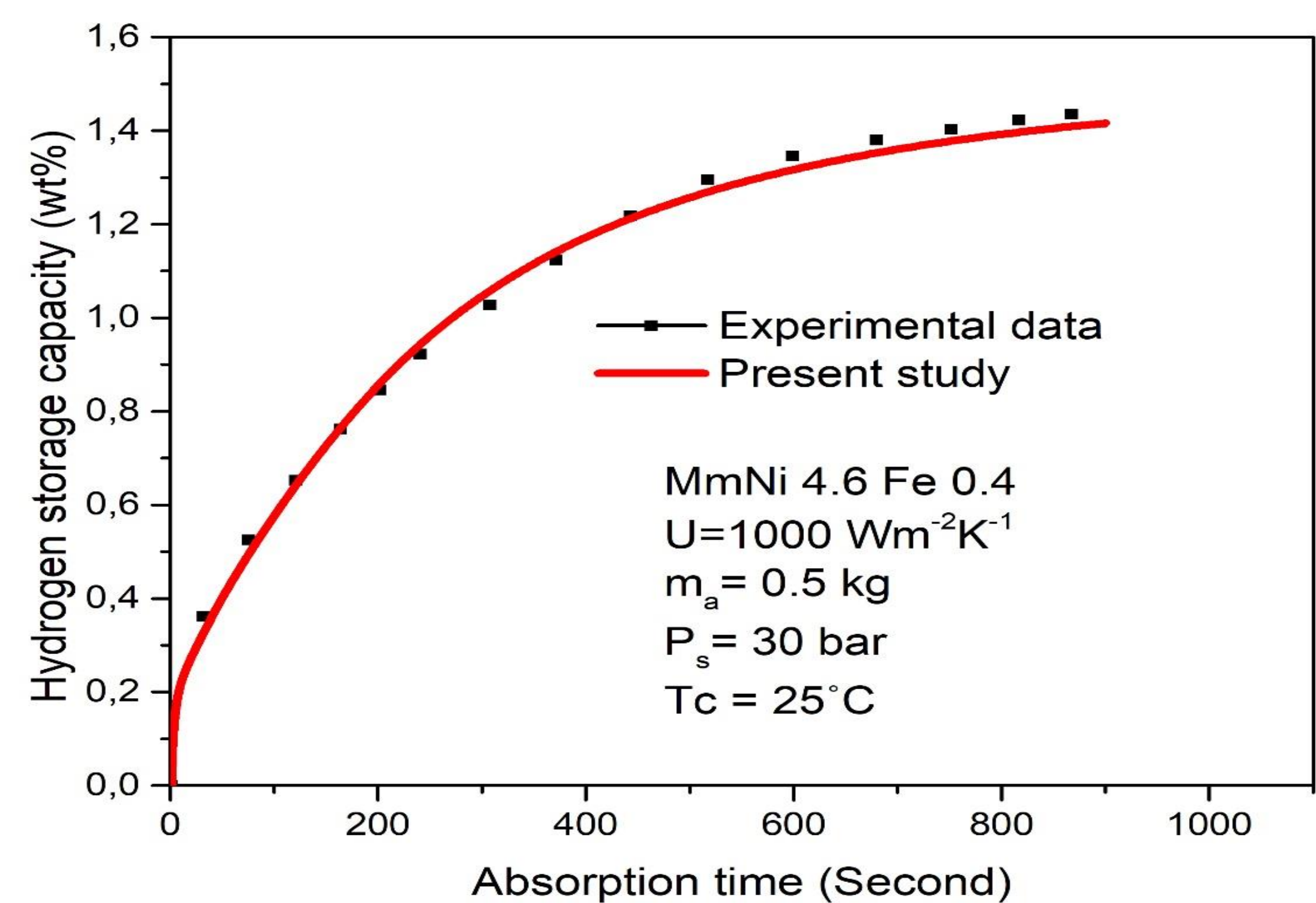
### Kinetics Reaction

$$\frac{dX_{abs}}{dt} = Cst_{abs} \ln\left(\frac{P}{P_{eq,abs}}\right) \exp\left(\frac{-E_{act}}{RT_{abs}}\right) (X_{lim,abs} - X_{abs})$$

### Energy equation

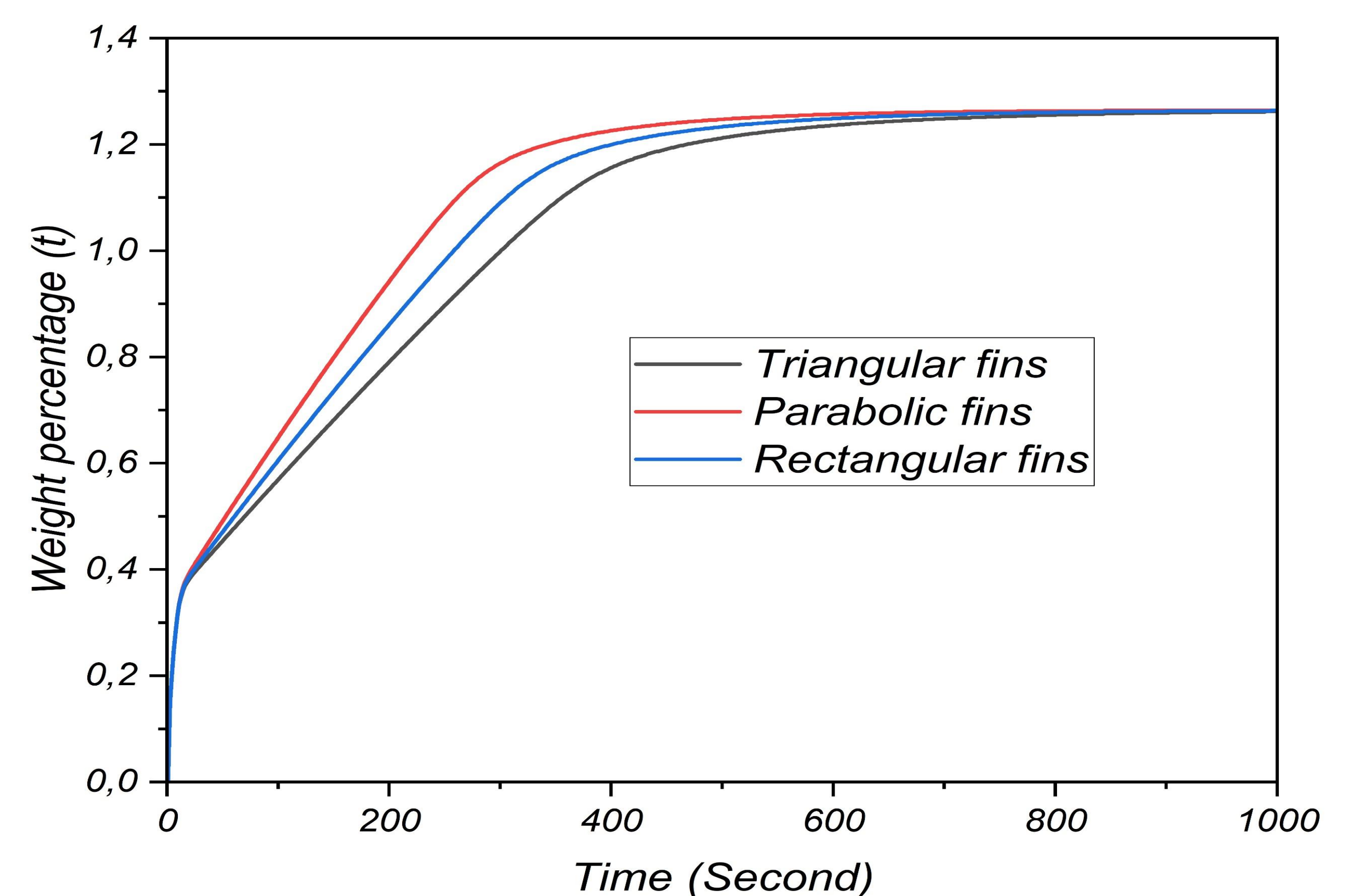
$$(C_{p,can}m_{can} + C_{p,MH}m_{MH}) \frac{dT_{abs}}{dt} = -Cst_X \frac{\Delta H}{MW_{H_2}} \frac{dX_{abs}}{dt} - A\eta_{0,fin}h_{air}(T_{ex} - T_{abs})$$

## Validation



Validation: Comparing the results provided by the numerical model with experimental data available in the literature.

## Results



The variation in hydrogen storage capacity (%wt) for parabolic fins, rectangular fins, and triangular fins.

## Conclusions

**Model Development:** A lumped transient model for a finned LaNi5 cylindrical reactor integrates kinetics, energy, and mass transfer.

**Thermal Control:** Parabolic fins outperform rectangular and triangular designs, reducing the charging time.

**Efficiency Boost:** Fins enhance the reliability of metal hydride hydrogen storage, supporting sustainable energy solutions.