



***Post-doctoral fellow in thermal/energy/materials engineering  
(18 months)***

**« Heat exchanger design based on raw earth materials:  
application to the data centres cooling »**

**Education and abilities**

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- PhD in thermal/energy/materials engineering
- Skills : fluid mechanics, heat and mass transfer
- Interest in experimental techniques applied to fluids and civil engineering materials
- Some knowledge in the modelling tools of heat and moisture transfer in capillary medium would be a plus

**Context and issues**

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Energy saving in datacentre is one of the major challenge for the 21<sup>th</sup> century [1]. The raw earth constructions are recognized to deliver a high level of thermal inertia performance. This ability is imputed to the hygrothermal behaviour of these hygroscopic building materials. The use of raw earth applied to the data centre cooling is the main objective of this experimental project. Previously, the heat and moisture exchanges need to be characterized at the scale of a bed packed composed of earth materials. Consequently, the design of an earth block mounted at upper scale will provide the evidence in terms of energy benefits.

**Position summary**

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This 18 months postdoctoral position is funded by an ADEME (French Energy Agency) research program and involves three different partners (APL, IFSTTAR, Makjo). In collaboration with these partners, the heat exchanger based on earth elements will be scaled from physical boundary conditions found in the data centres. The experimental work will be carried out from two facilities:

- At the scale of a bed packed of earth elements, the influence of geometrical parameters of the heat exchanger (shape factor, porosity and areas of exchange) on the thermo-hydric kinetics under controlled conditions will be determined. Alternations of cool and warm air flows will mimic the day/night cycles.
- At the scale of a mini data centre, the demonstrator based on earthen heat exchanger will be designed according to the results established in bed packed.

At the end of the postdoctoral work, modelling tools established from the experimental campaigns will be able to assess the energetic efficiency of the earthen heat exchanger devoted to the data centre. This assessment will be conducted according to performance indicators used for the data centre sector. The postdoctoral fellow will also be involved in the scientific valorisation of this work (scientific publication and congress).

**Location and environment**

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The applicant will be employed by IFSTTAR and will join the laboratory « *Aggregates and materials processing laboratory (GPEM)* » close to Nantes (Allée des Ponts et Chaussées, Bâtiment Féret, CS4, 44344 Bouguenais (<http://www.gpem.ifsttar.fr/>)). The research group is currently developing modelling and experimental tools devoted to the energy efficiency of materials processing [2-5] such as those used in building earth materials [6-8].

## Period

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Start date: 1<sup>st</sup> semester 2018

End date: 2<sup>nd</sup>e semester 2019

Duration: 18 months

## Salary

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Gross monthly salary: 2350 €

## Contacts

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## Application

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Please, send the following documents to [florian.huchet@ifsttar.fr](mailto:florian.huchet@ifsttar.fr) and [lauredan.leguen@ifsttar.fr](mailto:lauredan.leguen@ifsttar.fr)

- a detailed curriculum vitae including the scientific production.

- a covering letter showing the relevance of your professional project with the present one.

- a copy of the PhD diploma\*

## References

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[1] A. Almoli, A. Thompson, N. Kapur, J. Summer, H. Thompson, G. Hannah, "Computational fluid dynamic investigation of liquid rack cooling in data centres, **Applied Energy**, 89 1, 150-155 (2012).

[2] Le Guen L., Piton M., Hénault Q., Huchet F., Richard P., Heat Convection and radiation in flighted rotary kiln : a minimal model, **Canadian Journal of Chemical Engineering**, 95, 100-110 (2017).

[3] Piton M., Huchet F., Le Corre O., Le Guen L., Cazacliu B., A coupled thermal-granular model in flights rotary kiln: Industrial validation and process design, **Applied Thermal Engineering**, 75, 1011-1021 (2015).

[4] Leguen L., Huchet F., Dumoulin J., Wall Heat transfer correlation for rotary kilns with secondary air flow and recycled materials inlet, **Experimental Thermal and Fluid Science**, 54, 110-116 (2014).

[5] Huchet F., Richard P., Joniot J., Le Guen L., Heat transfer rate within non-spherical thick grains, **Conference Powder and Grains**, Montpellier 1-7 july 2017.

[6] T. Vincelas, T. Colinart, E. Hamard, A. Hellouin de Ménibus, T. Lecompte, H. Lenormand, Light earth performances for thermal insulation: application to Earth-Hemp, in: **2nd Int. Conf. Bio-Based Build. Mater. 1st Conf. Ecol. Valoris. Granul. Fibrous Mater.**, Clermont-Ferrand (France), 2017: pp. 1-7.

[7] E. Hamard, B. Cazacliu, A. Razakamanantsoa, J.-C. Morel, Cob, a vernacular earth construction process in the context of modern sustainable building, **Building & Environment**, 16, 103-119 (2016). doi:10.1016/j.buildenv.2016.06.009.

[8] E. Hamard, J.-C. Morel, F. Salgado, A. Marcom, N. Meunier, A procedure to assess the suitability of plaster to protect vernacular earthen architecture, **Journal of Cultural Heritage**, 14, 109-115 (2013). doi:10.1016/j.culher.2012.04.005.

\*The applicant should have obtained his diploma since at least 3 years (September 2014). The maternity leave is not accounted in that period.