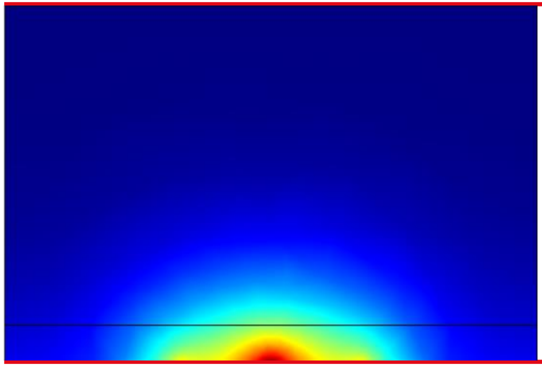

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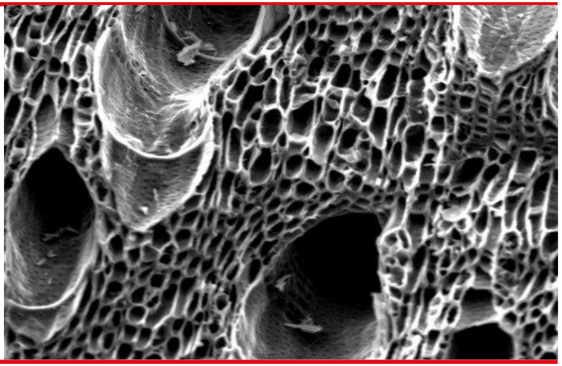

Determination of Load Dependent Thermal Conductivity of Porous Adsorbents

O. Kraft[1], J. Gaiser[1], M. Stripf[1], U.Hesse[2]

[1]University of Applied Sciences Karlsruhe

[2]TU Dresden

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GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

FORSCHUNG AN FACHHOCHSCHULEN

Adsorption

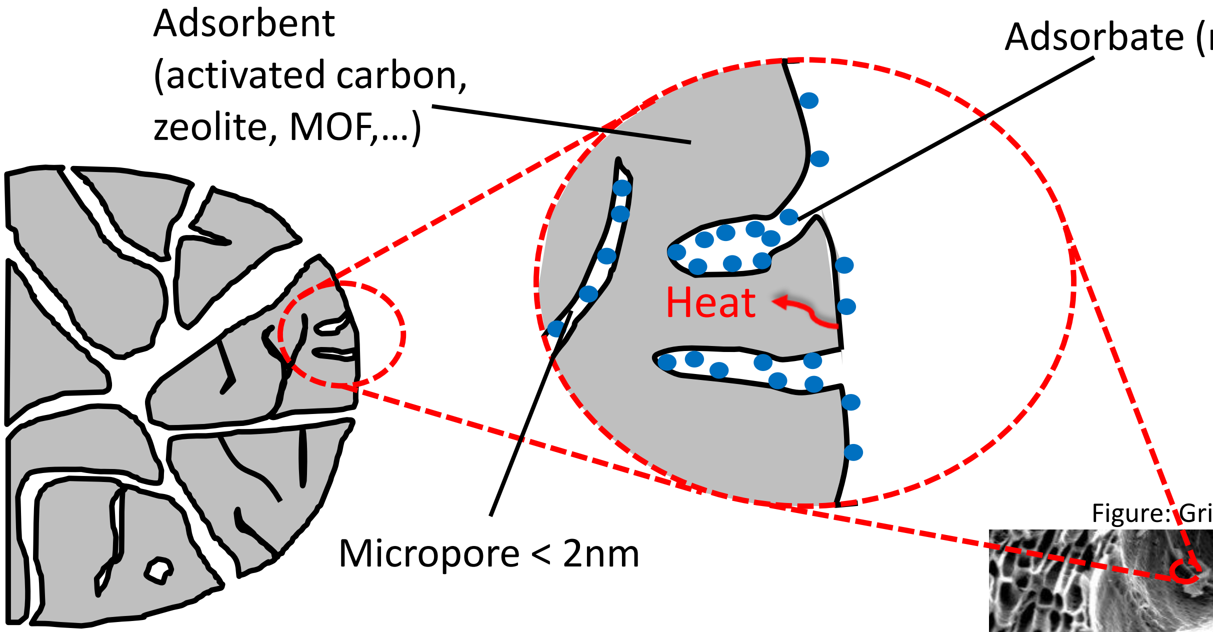
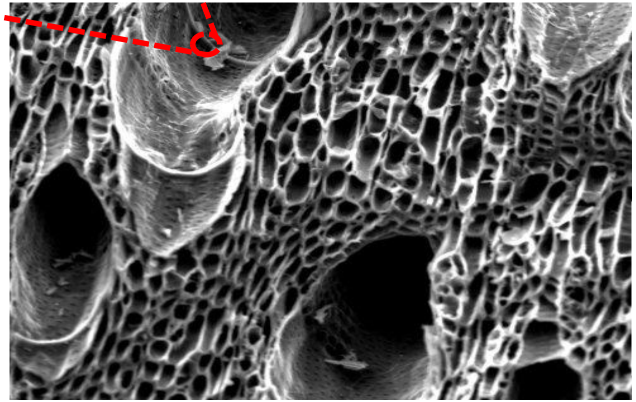


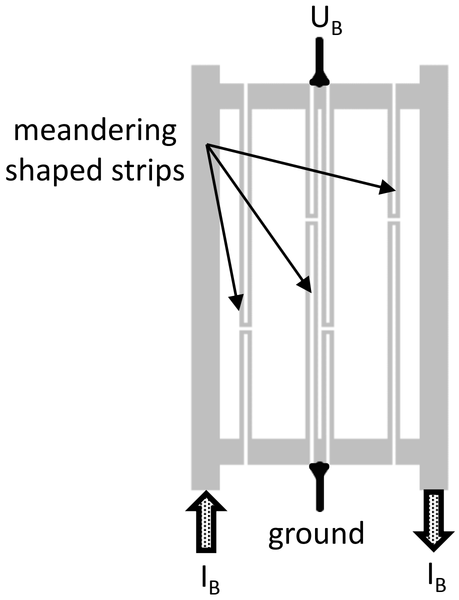
Figure: Grit Kalies, University of Leipzig

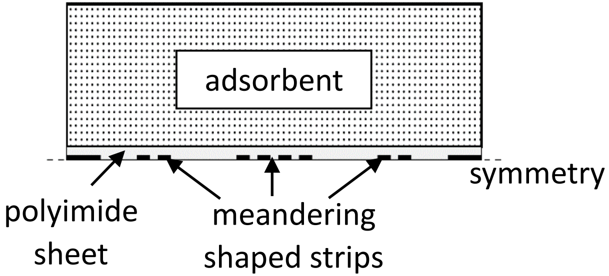


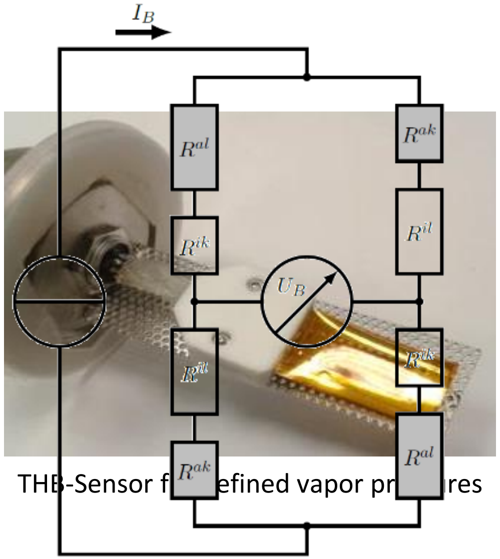
- Regenerative filters
- Purification of liquids and vapors
- Heat storage, Heat pumps

Principle of Transient Hot Bridge Technique

- Structured nickel film between two polyimid sheets
- Sensor clamped between two equivalent specimen







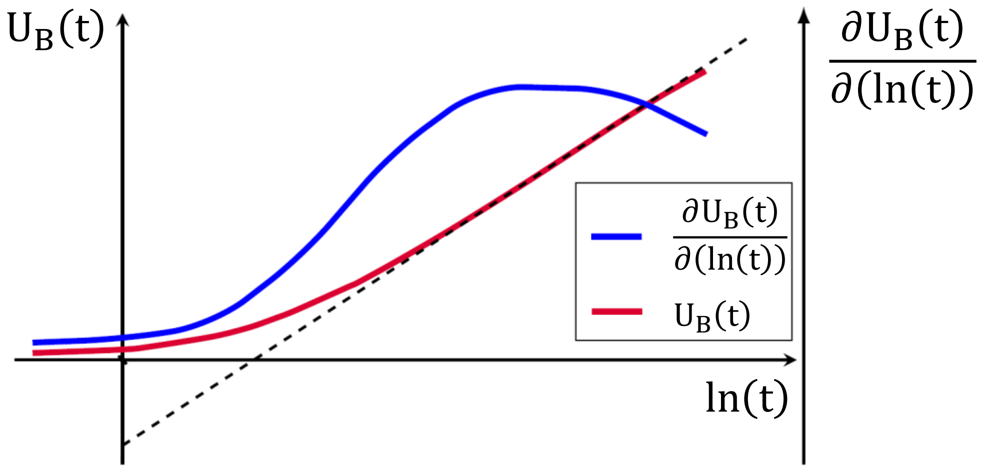
Wheatstone Bridge

Analytical Evaluation

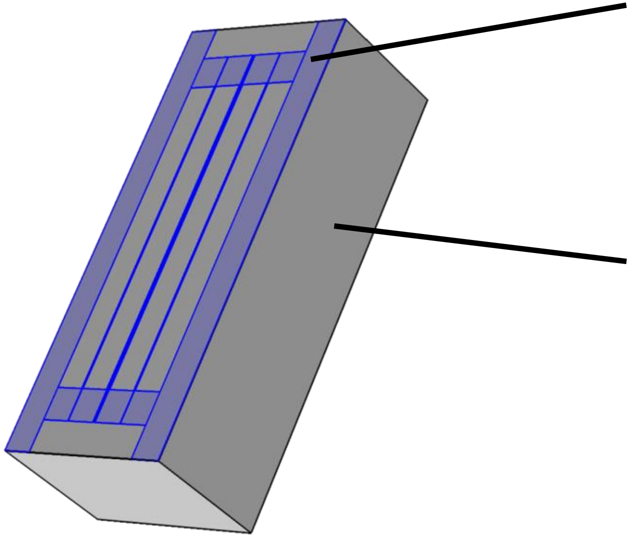
Assumptions:

- Thickness of the sensor is negligible
- Sensor hot strips correspond to infinitly long flat heat sources
- Infinitly large samples with homogeonous material properties

$$k_{Specimen} = \frac{\alpha R_0^2 I_B^3}{32\pi \left(\frac{\partial U_B(t)}{\partial(\ln(t))}\right)_{max} L_s}$$



3D-COMSOL-Model



Geometry of sensor and specimen

Sensor-Physics:

- Heat Transfer in Solids
- Constant Current

Specimen-Physics:

- Heat Transfer in Porous Media
- Transport of Diluted Species in Porous Media
- Partial Differential Equation for Adsorption Process

Physics

Sensor

Heat Transfer in Solids	$\frac{\partial T}{\partial t} = \frac{1}{\rho c_p} \cdot \left(\nabla(k \nabla T)\right)$
Constant Current	$\nabla\left(-\sigma \nabla V + \frac{I_B}{d_{HS} \cdot b_{HS}}\right) = 0$

Specimen

Transport of Dissoluted Species in Porous Media	$\frac{\partial c}{\partial t} = \nabla(D \nabla c) - \frac{\rho_{Adb,dry}}{\epsilon \cdot M} \frac{\partial X_{ges}}{\partial t}$
Partial Differential Equation (Adsorption, multistage)	$\frac{\partial X_{ges}}{\partial t} = \sum_{i=0}^{n} \left(\xi_i \cdot ksAp_i \cdot (X_{GG} - X_i)\right)$

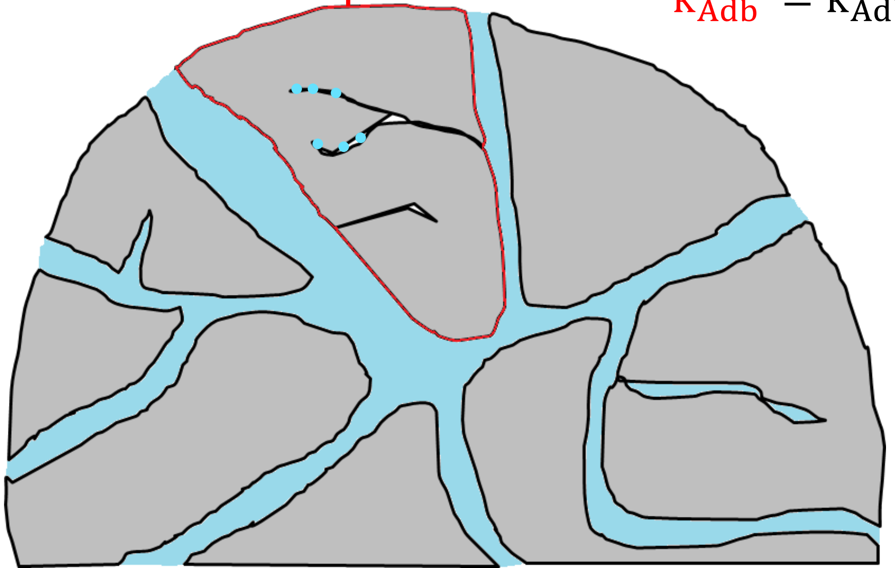
Physics

Heat Transfer Porous Media

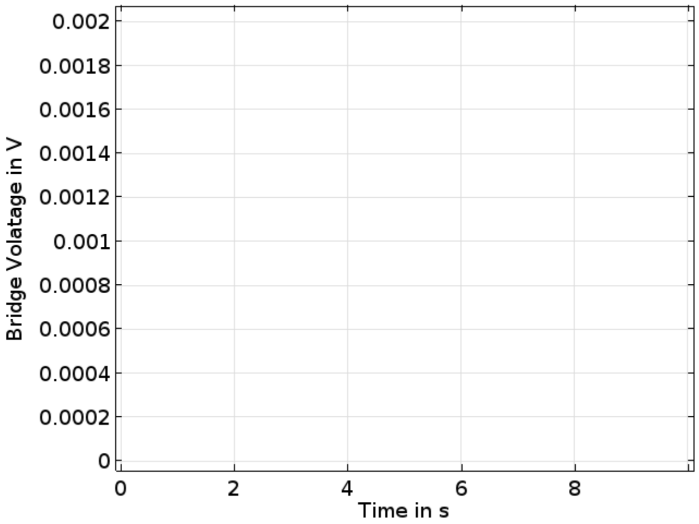
$$\frac{\partial T}{\partial t} = \frac{1}{(\rho c_p)_{eff}} \cdot \left(\nabla (k_{eff} \nabla T) + (\rho_v c_{p,v} \mathbf{u}) \nabla T + \frac{h_{ad}}{c_{p,Adb}(X_{ges}, T)} \frac{\partial X_{ges}}{\partial t} \right)$$

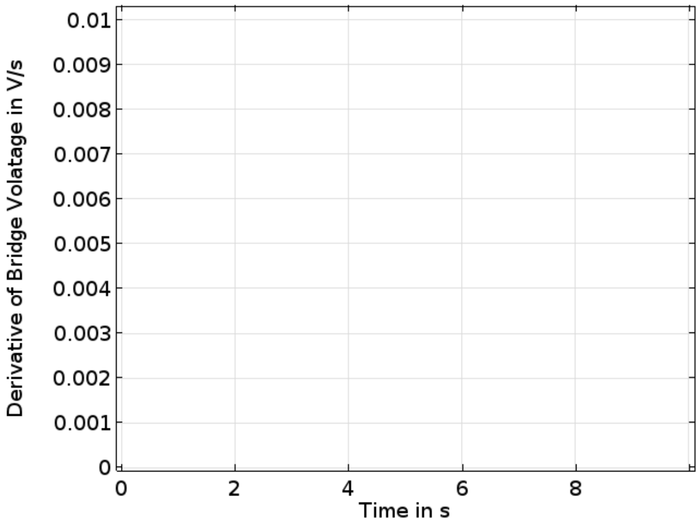
$$k_{eff} = \epsilon \cdot k_{Adb}(X_{ges}, T) + (1 - \epsilon) \cdot k_v(T)$$

$$k_{Adb} = k_{Adb,dry} + f(X_{ges}, k_{Fluid})$$

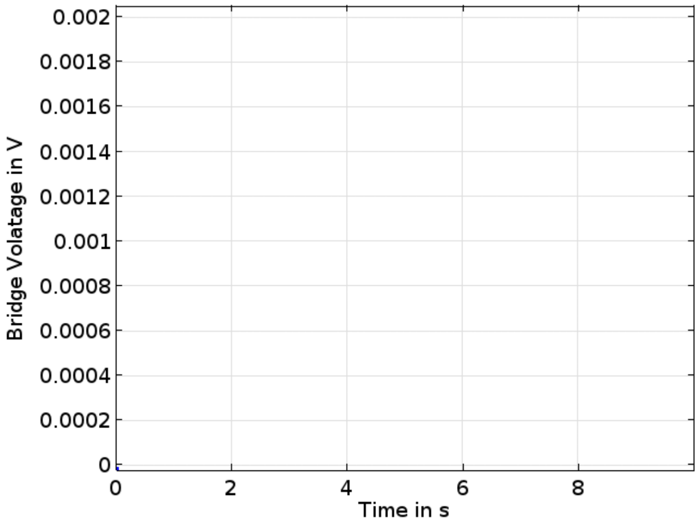


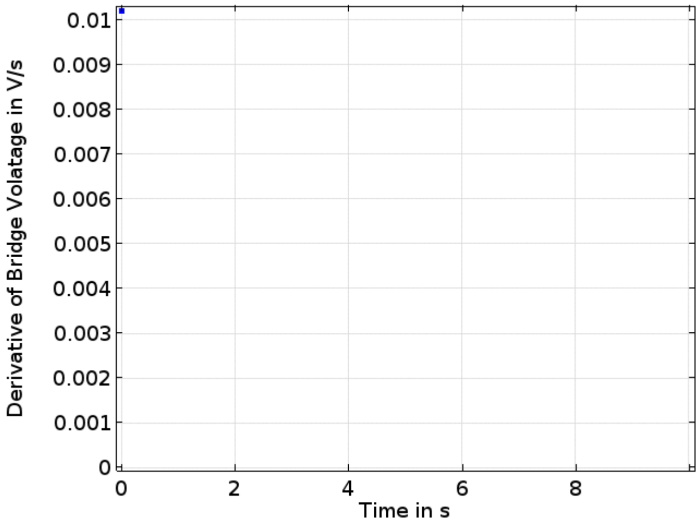
3D-COMSOL-Model





3D-COMSOL-Model





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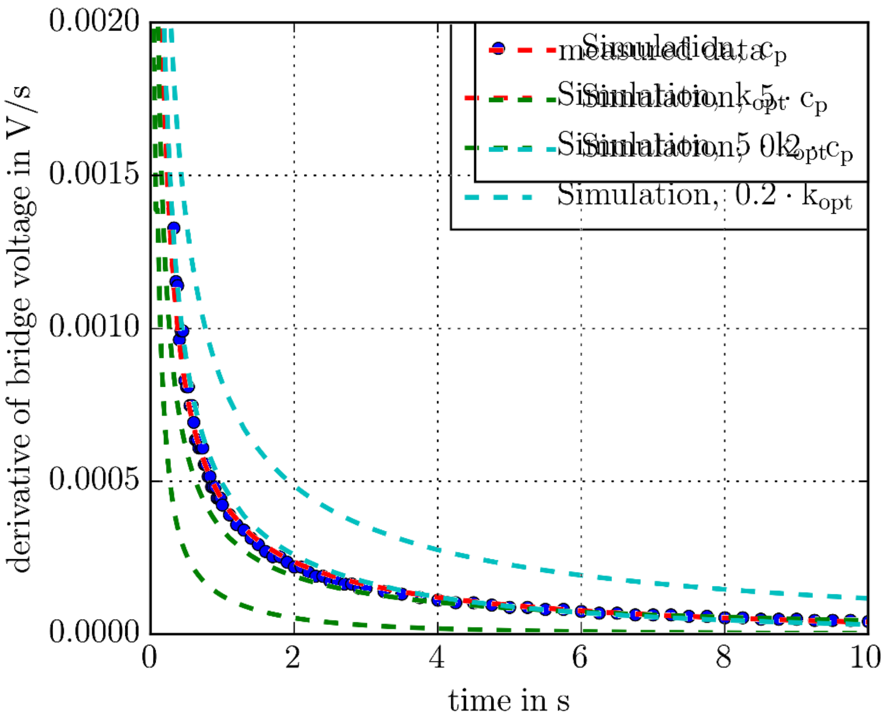
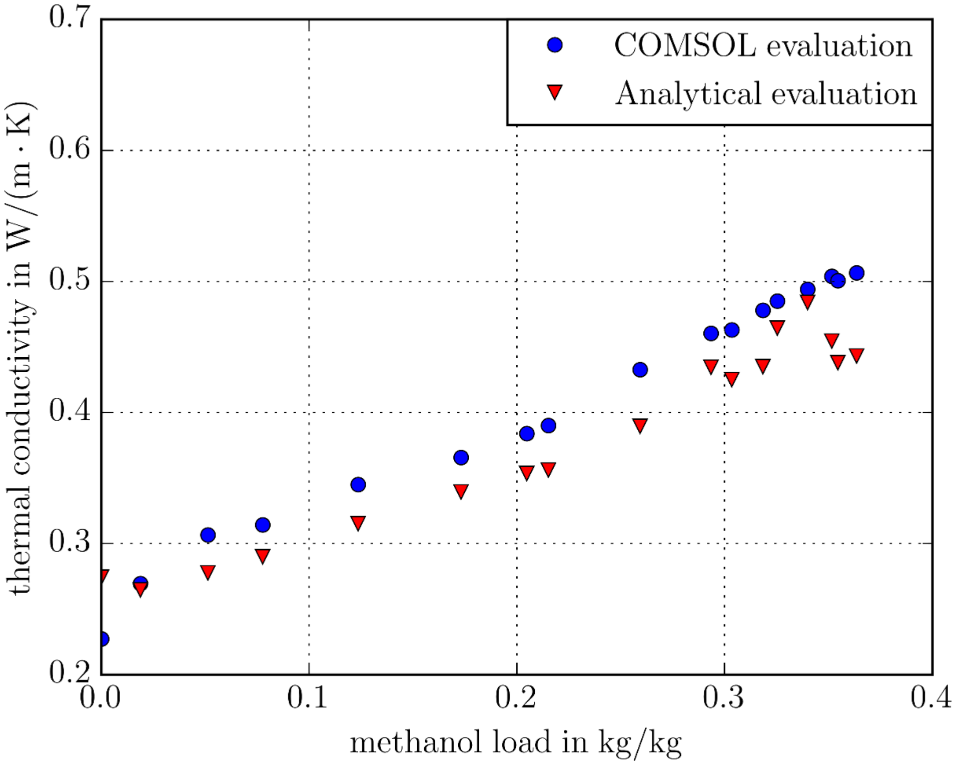
Use of Application Builder



- Automated evaluation of the load-dependent thermal conductivity
- Implementation of an optimization algorithm

Results



- No influence of the adsorption kinetics on the evaluation results
- COMSOL evaluation possible with low currents

Outlook

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- Determination of load dependent specific heat capacity
  ➔ separation of solid and adsorbate heat capacity
- Determination heat capacity and thermal conductivity of specimen with
  ➔ optimized heat transfer with high conductive additives

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Backup

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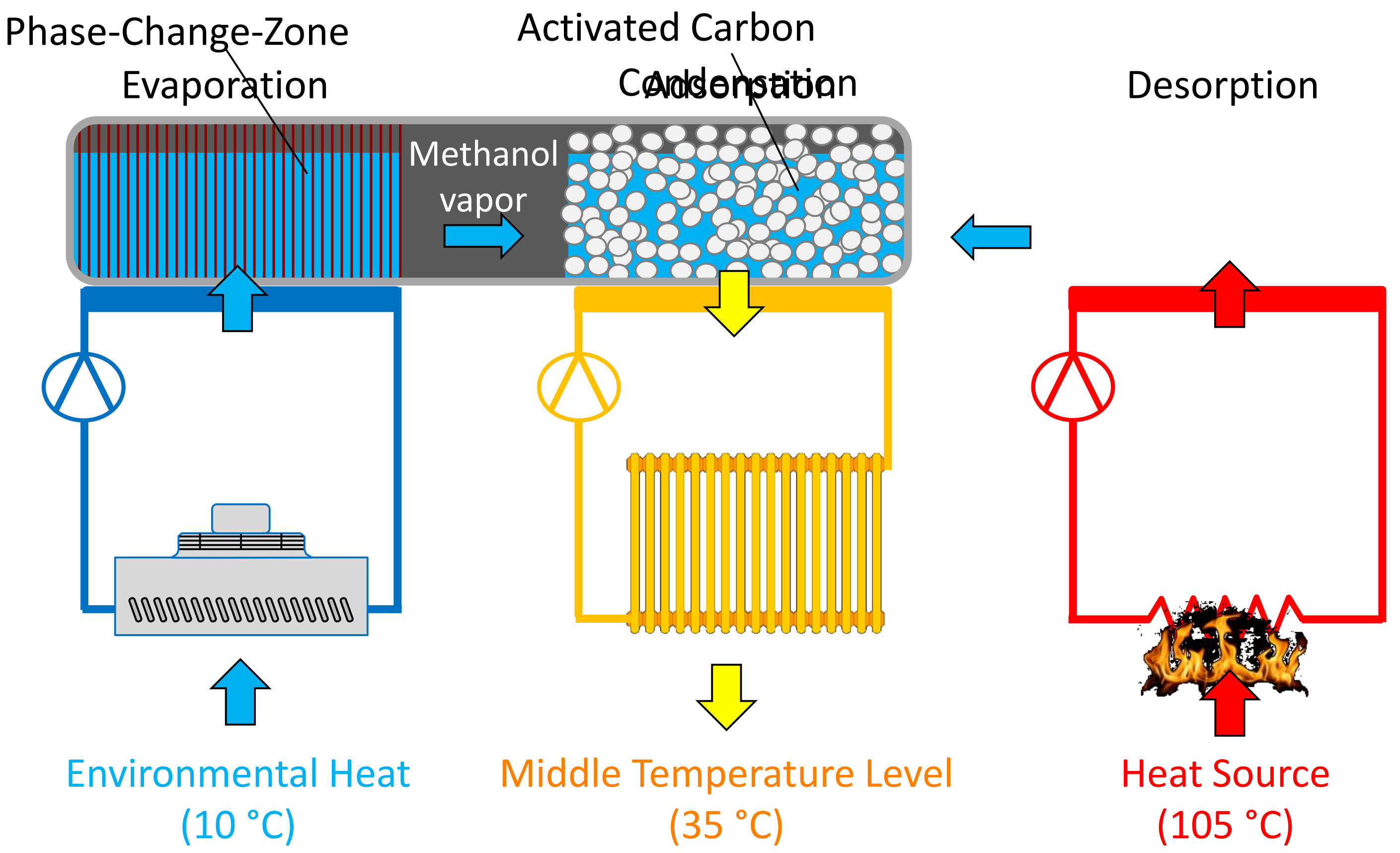
Principle of adsorption heat pump



Principle of adsorption heat pump

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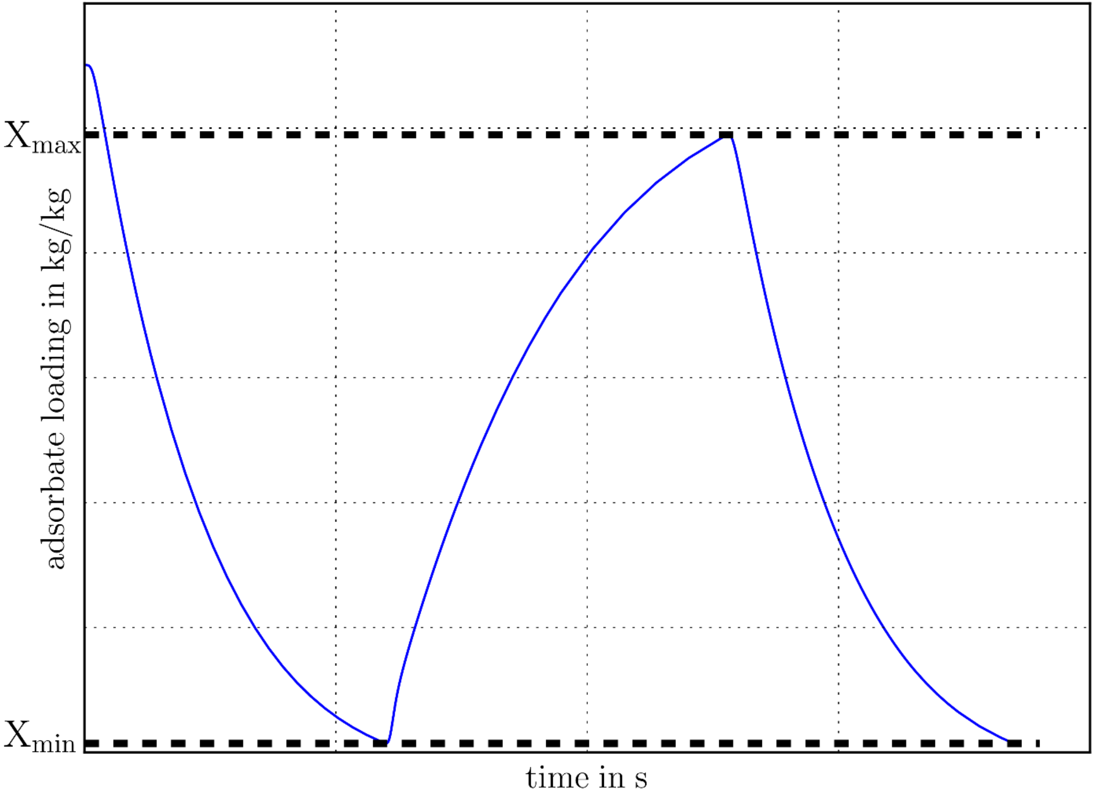

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