Heat Flow Meter Measurement of the Thermal Conductivity and Contact Resistance of FAM AQSOA-Z02 Pellets between Aluminum Plates

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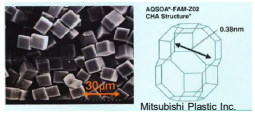
Introduction

- **AQSOA™-FAM-Z02** is a zeolite adsorbent with thermodynamic properties suitable for **adsorption chillers** and **desiccant air-conditioners**.

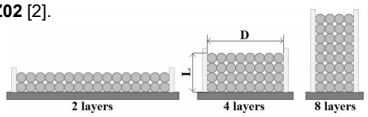


- **Poor mass and heat transfer** in adsorption systems makes research on the uptake and thermal conductivity of great importance.
- **Freni et al.** studied coated and granular FAM-Z02 [1]. The **loose grain FAM-Z02** showed **higher volumetric power,** which makes it suitable for **storage applications**.

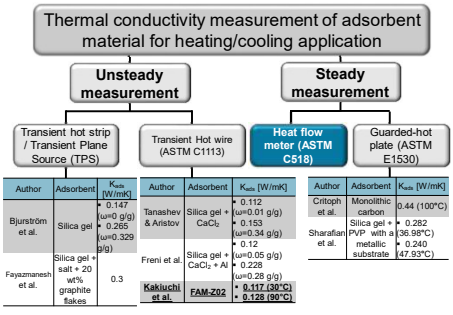
Blank HEX	Coated HEX	Granular HEX
Size [mm] 235x157x22 Metal mass [kg] 0.51 Volume [dm³] 1 HT Area [m²] 0.94	Ads. weight [kg] 0.084 M_{metal}/M_{ads} [kg/kg] 6 Coating thk. [mm] 0.1	Ads. weight [kg] 0.260 M_{metal}/M_{ads} [kg/kg] 1.96 Grain size [mm] 0.6-0.7

Note: T_{evap}=15°C, T_{cond}=T_{ads}=28°C, T_{des}=90°C, t_{cycle}=5 min	Differential water loading wt%	Mass specific cooling power [W/kg$_{ads}$]	Volumetric specific cooling power [kW/m³]	Cooling COP
Coated adsorber	17.6	675	**93**	0.24
Granular adsorber	8	498	**212**	0.4

- **Aristov et al.** studied the sorption kinetics of **multiple layers (N=2,4 and 8) of loose grain FAM-Z02** [2].



- **Literature Review on Thermal Conductivity Measurement of Adsorbent**



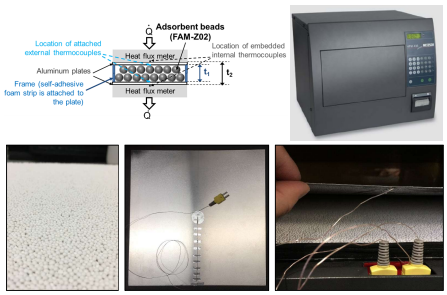
Author	Adsorbent	K_{ads} [W/mK]
Bjurström et al.	Silica gel	• 0.147 (ω=0 g/g) • 0.265 (ω=0.329 g/g)
Fayazmanesh et al.	Silica gel + salt + 20 wt% graphite flakes	0.3

Author	Adsorbent	K_{ads} [W/mK]
Tanashev & Aristov	Silica gel + $CaCl_2$	• 0.112 (ω=0.01 g/g) • 0.153 (ω=0.34 g/g)
Freni et al.	Silica gel + $CaCl_2$ + Al	• 0.12 (ω=0.05 g/g) • 0.228 (ω=0.28 g/g)
Kakiuchi et al.	FAM-Z02	• 0.117 (30°C) • 0.128 (90°C)

Author	Adsorbent	K_{ads} [W/mK]
Critoph et al.	Monolithic carbon	0.44 (100°C)
Sharafian et al.	Silica gel + PVP with a metallic substrate	• 0.282 (36.98°C) • 0.240 (47.93°C)

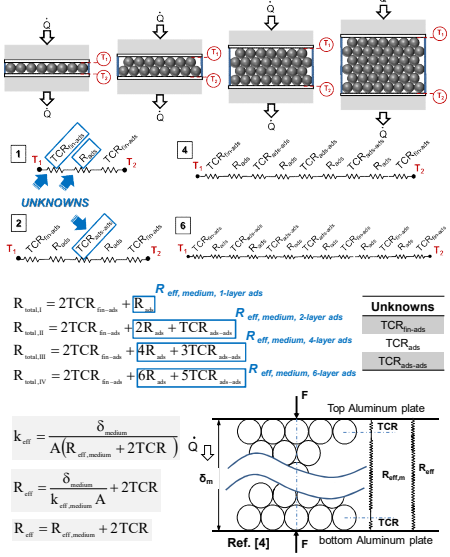
Experimental study

- **Heat flow meter 436/3/1E (ASTM C518)**



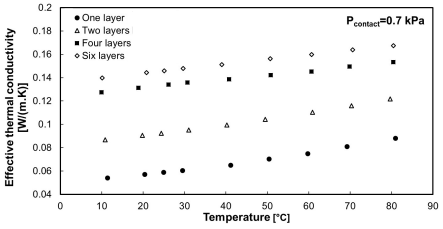
Experimental study

- **Humidity control is not provided with this experimental apparatus. Although, FAM-Z02 almost achieves its maximum uptake at T=25˚C, RH=30% [3].**
- **TCR measurement for 1, 2, 4, and 6 layers of FAM-Z02**

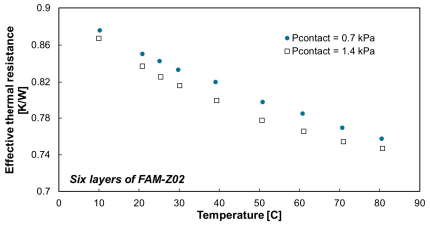


Results

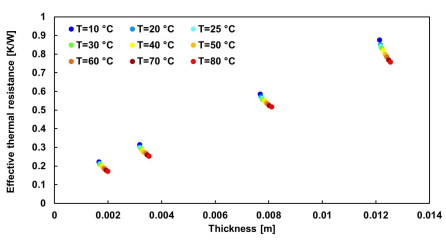
- Effective medium thermal conductivity increases with increasing temperature and increasing number of adsorbent layers.



- Effective medium thermal resistance decreases with increasing contact pressure.

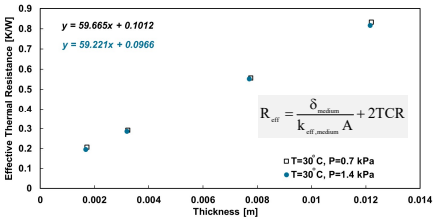


- Effective medium thermal resistance increases with the total thickness of the adsorbent.



Results

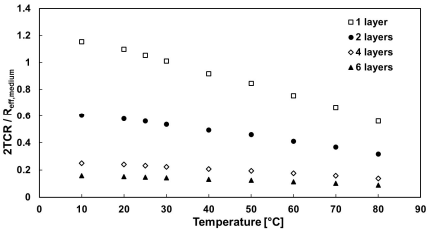
- **Effective Medium Thermal Conductivity and TCR**



T[°C] \ P[kPa]	$k_{eff,medium}$ [W/(m·K)] 0.7	$k_{eff,medium}$ [W/(m·K)] 1.4	TCR [K/W] 0.7	TCR [K/W] 1.4
10	0.1729	0.1711	0.0583	0.0544
20	0.1774	0.1773	0.0549	0.0520
25	0.1789	0.1799	0.0528	0.0502
30	0.1804	0.1818	0.0506	0.0483
40	0.1822	0.1853	0.0467	0.0459
50	0.1866	0.1907	0.0433	0.0437
60	0.1885	0.1926	0.0391	0.0400
70	0.1915	0.1952	0.0351	0.0363
80	0.1930	0.1960	0.0304	0.0317

TCR [K/W] = -4.86E-7 T² - 3.51E-4 T + 0.0618 (P=0.7 kPa)
TCR [K/W] = -1.31E-6 T² - 1.96E-4 T + 0.0561 (P=1.4 kPa)

- **Thermal contact resistance compared to the resistance of medium is significant and should be considered in adsorption studies.**



Conclusion

- The measured thermal conductivity of FAM-Z02 is in the agreement with the reported values in the literature.
- Thermal conductivity and thermal resistance of FAM-Z02 for different numbers of layers and various temperatures are reported.
- TCR is a significant amount compared to the resistance of the medium, especially for fewer layers of adsorbent and lower temperatures. For example, $2TCR/R_{medium}$ is 53% for 2 layers of FAM-Z02 and temperature of 30°C.

References

[1] A. Freni, L. Bonaccorsi, L. Calabrese, A. Caprì, A. Frazzica, Appli. Therm. Eng. 82 (2015) 1-7.

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[3] M.J. Goldsworthy, Micropor. Mesopor. Mat. 196 (2014) 59–67.

[4] M. Bahrami, M.M. Yovanovich, J.R. Culham, Int. J. Heat Mass Trans. 49 (2006) 3691–3701.

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