



Development of Micro-fin Adsorption Equipment for Adsorption Heat Pump

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Environment

*Hybrid and electric vehicle components,
gasoline engine management system,
diesel engine management system,
starter, alternator, radiator, etc.*

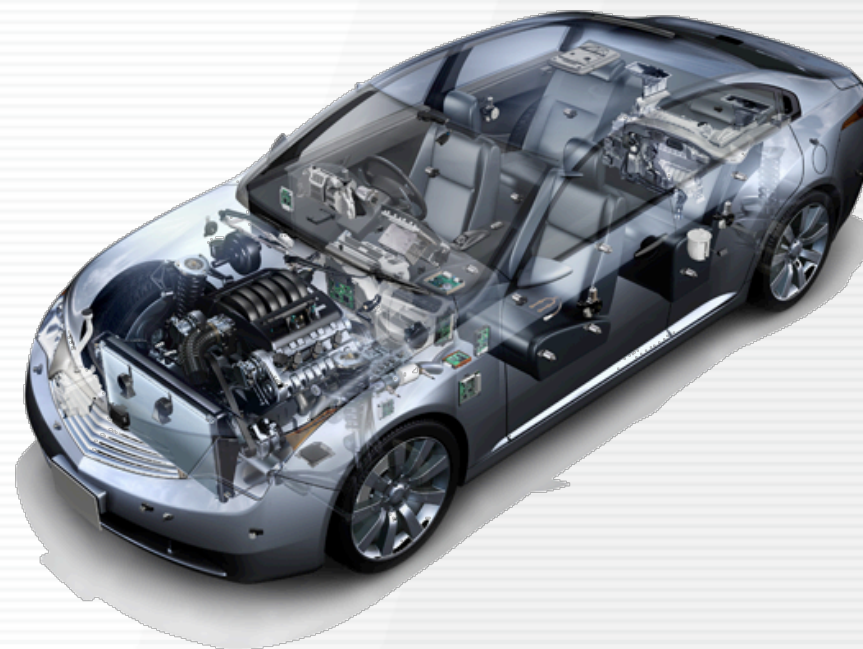
Comfort & Convenience

*Car air-conditioning system,
air conditioner for buses, air purifier,*

*Car navigation system,
electronic toll collection system (ETC),
remote security system,
remote touch controller, smart key,
advanced vehicle operation system (AVOS), etc.*

Safety

*Sensing technologies for driving assist systems,
actuator & computer for antilock brake system (ABS) /
electronic stability control (ESC),
adaptive front-lighting system (AFS),
airbag sensors & electronic control units,
periphery monitoring system, instrument cluster,
rain sensor for automatic windshield wiper, etc.*



■ Home Equipment



■ Heating and Cooling Equipment



■ Auto ID Data Capture Devices



DENSO Global Site



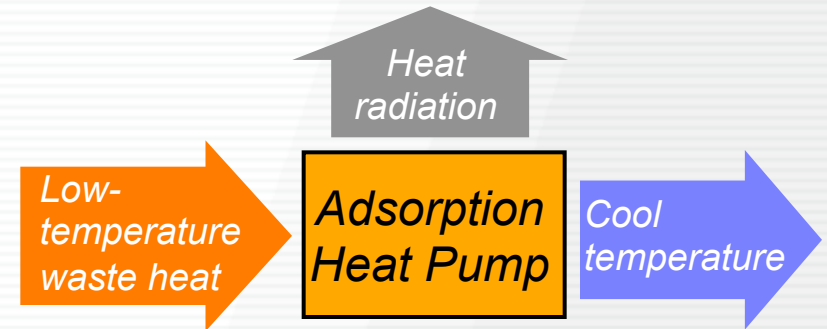
■ Factory Automation Products



◆ Advantage

Adsorption Heat Pump


- can provide cool temperature from low-temperature waste heat below 100°C
- is an eco-friendly system, using water as refrigerant; zeolite or silica gel as adsorbent
- uses less electricity (one-quarter of water-cooled chiller), because it doesn't have a compressor



◆ Application field


Current

Limited to large industrial refrigerator



Downsizing
Price reduction

Applicable in many areas including transportation and consumer(civilian) use

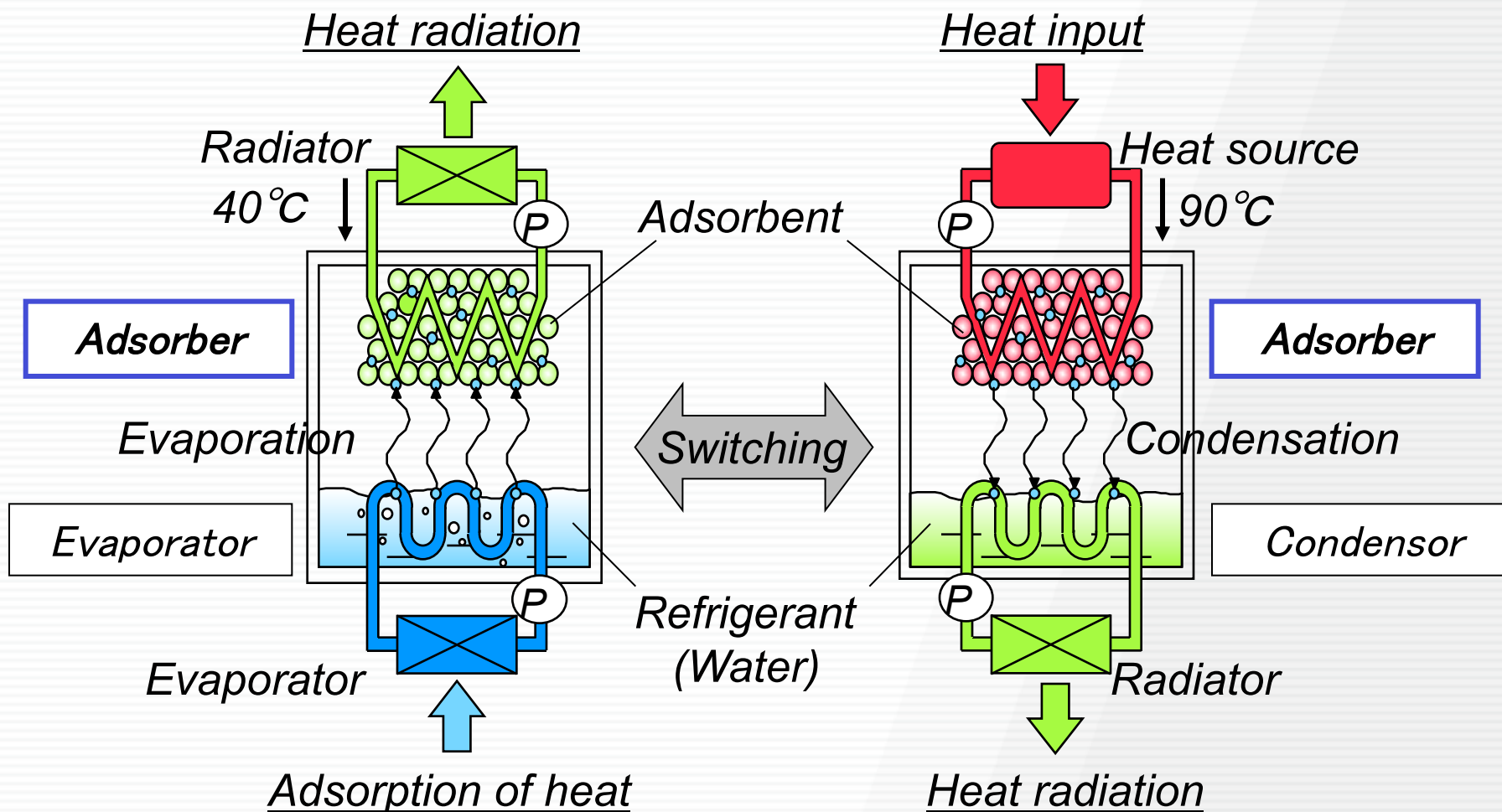


Principles of an Adsorption Heat Pump

Cooling by using both 90 degree celsius and 40 degree celsius

Adsorption mode

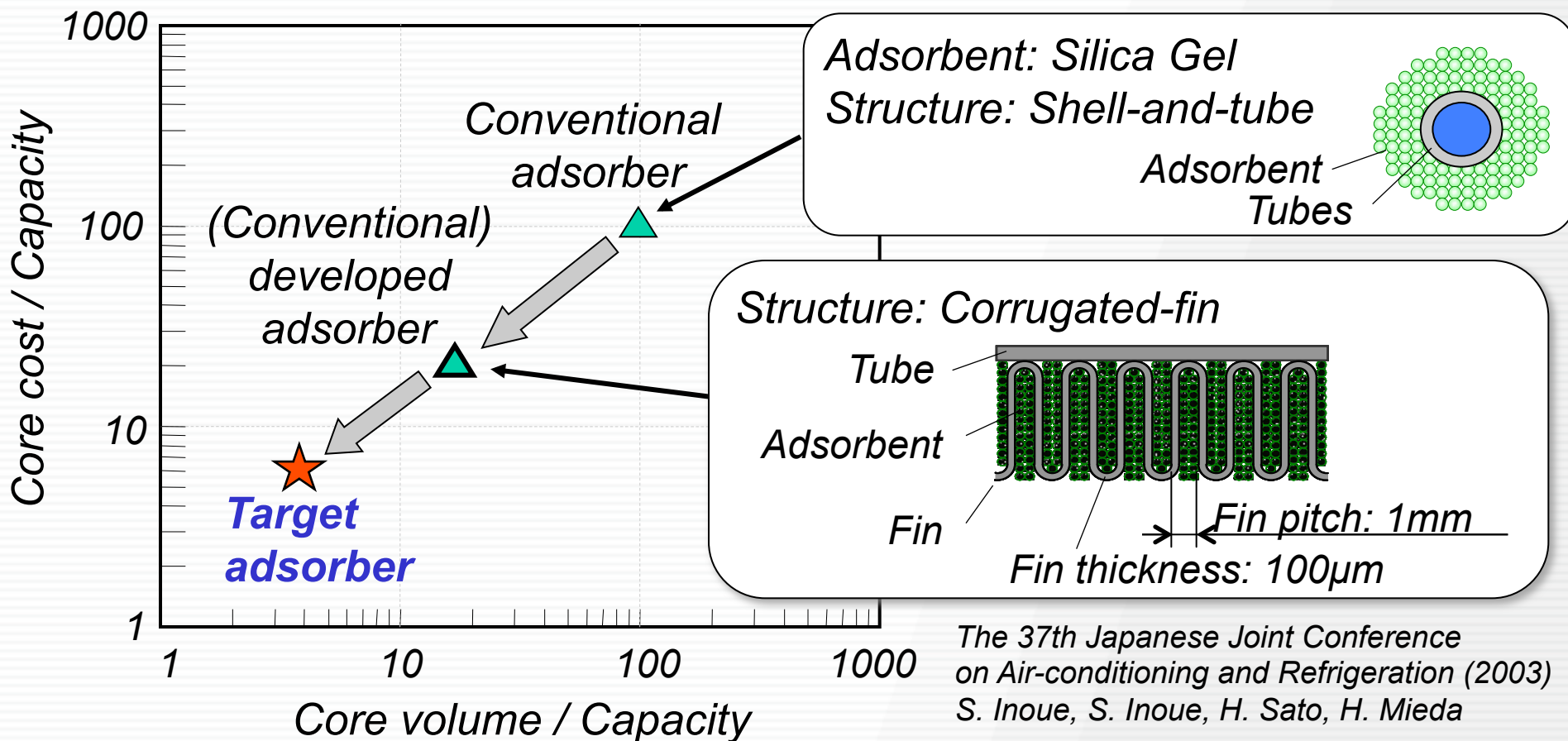
Desorption mode



Issue and Target of Adsorption Heat Pump

Current Issue : large in size and high production costs

Target : Develop compact adsorber for consumer(civilian) use



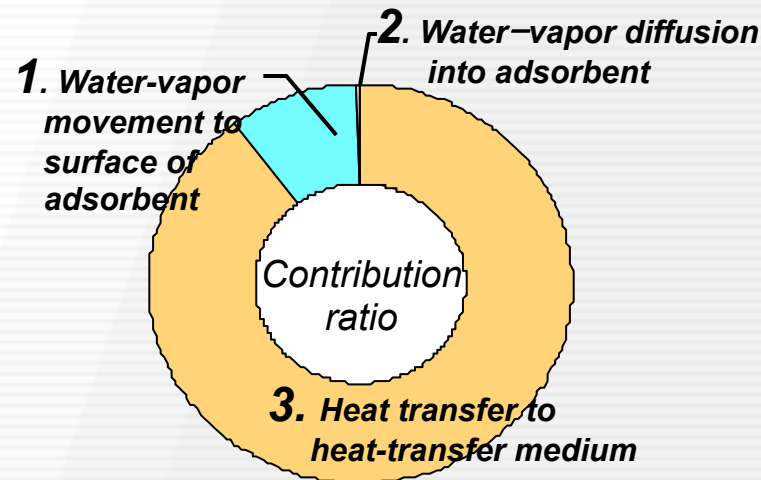
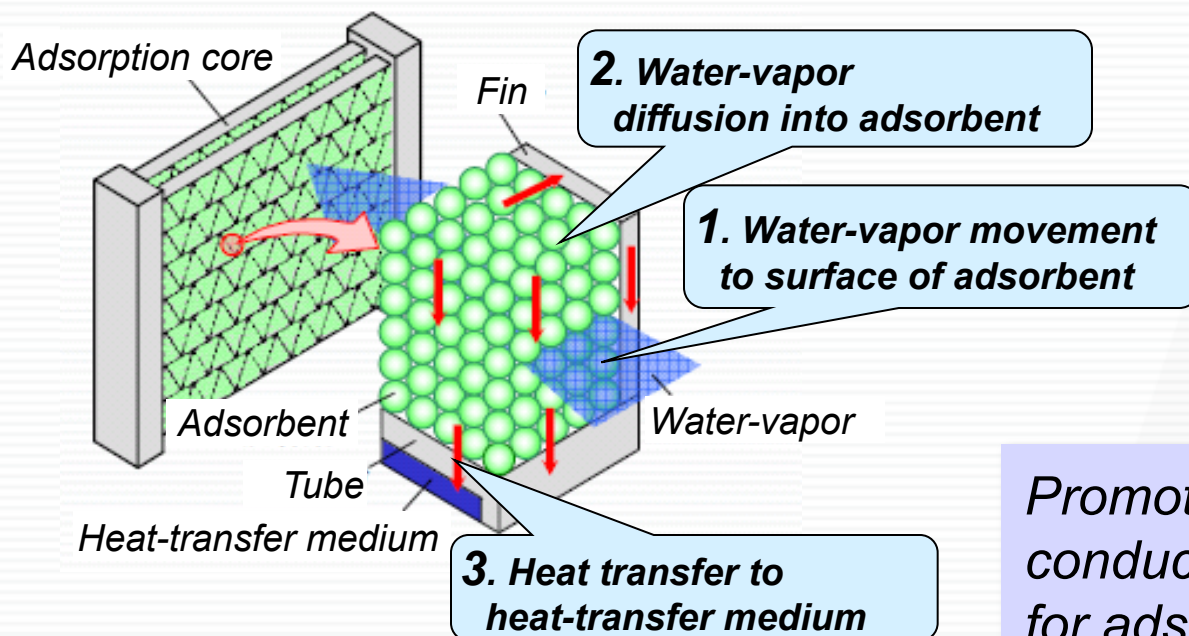
◆ Performance of Adsorption Heat Pump

Cooling performance $Q = H_L \cdot G \cdot \Delta C \cdot \underline{V}$
Adsorption rate

- H_L : Water latent heat
- G : Amount of adsorbent
- ΔC : Moisture adsorption capacity of adsorbent
- V : Adsorption rate

For downsizing and enhancing performance, adsorption rate improvement is necessary

◆ Predominant factor of adsorption rate

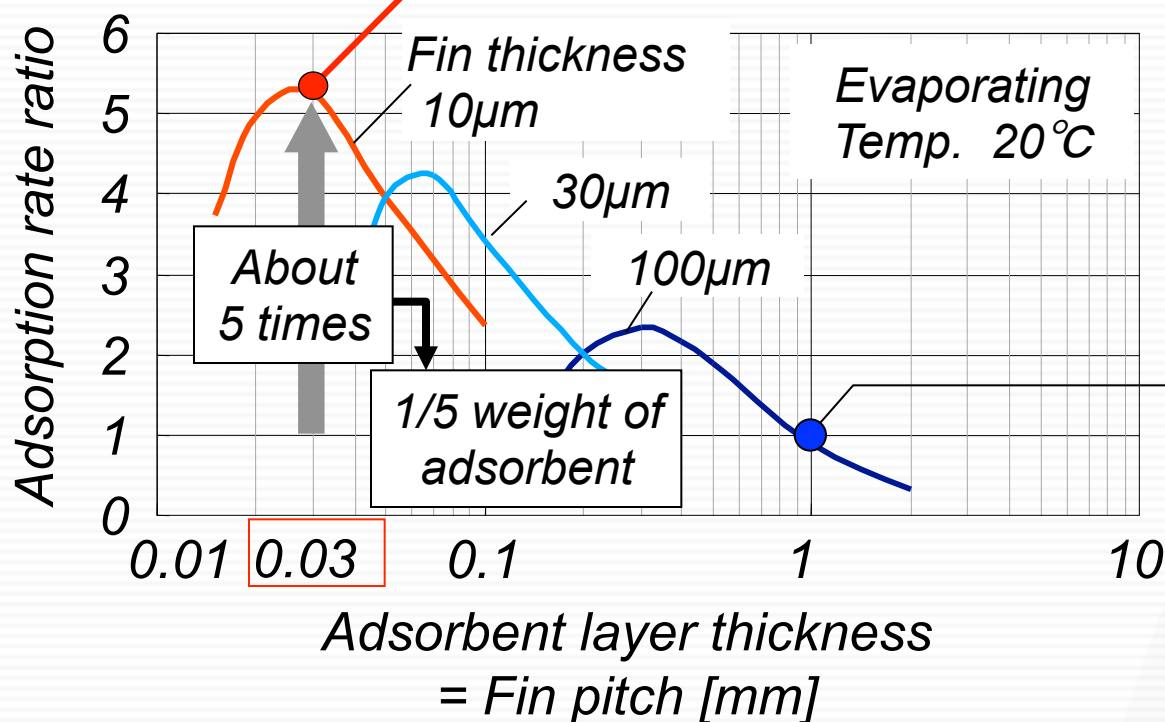


Promoting heat transfer in low thermal conductive adsorbent layer is a key for adsorption rate improvement

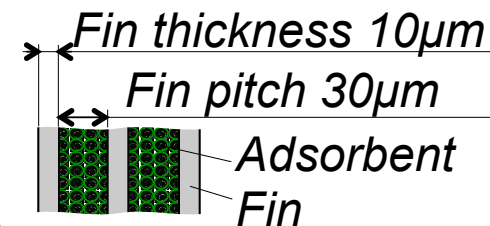
Method to Increase the Adsorption Rate

We improve heat transfer by thinning the adsorbent layer.

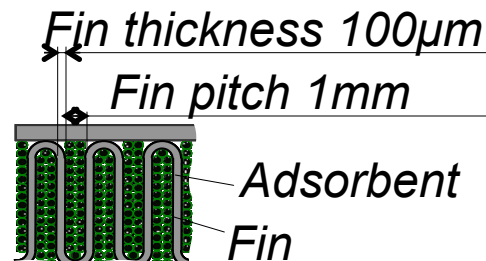
◆ Simulation result



Ideal structure
(Micro-fin)



Conventional structure
(Machined-fin)

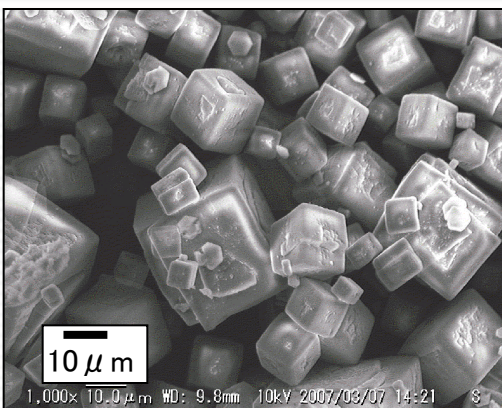


Adsorption rate improves drastically by forming the Micro-fin.
But, it is difficult to manufacture it by mechanical processes.

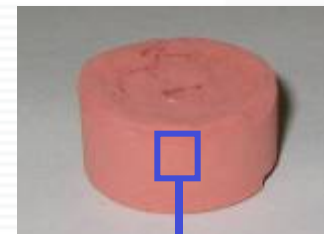
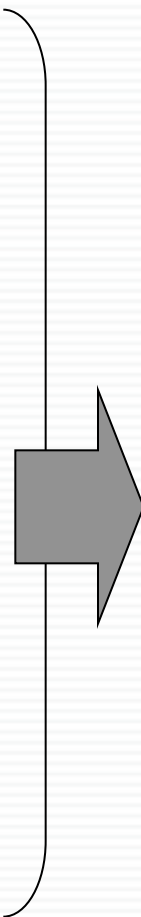
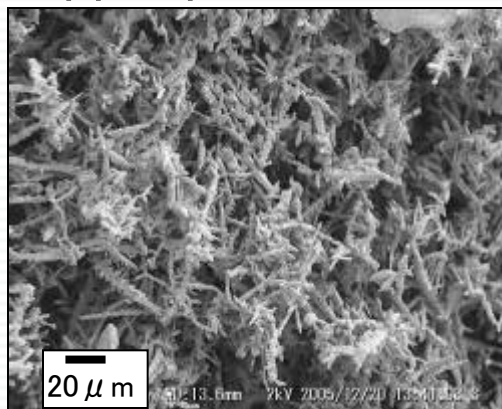
Manufacturing process of Micro-fin

We adopt copper powder of several tens micrometers as fins.

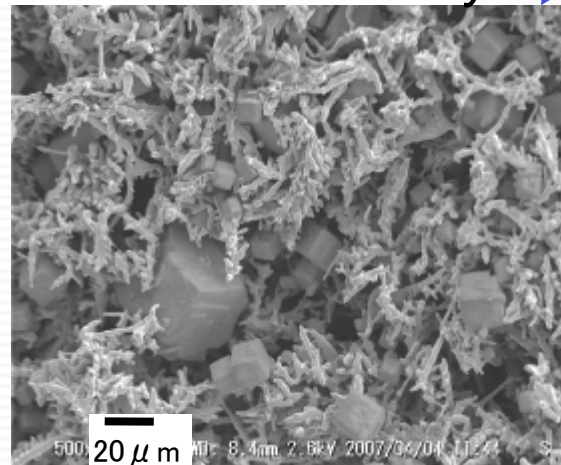
Adsorbent



Electrolytic copper powder



Mixed sintered body

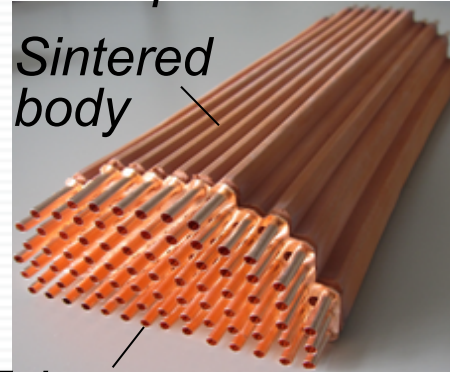


We developed several tens micrometer-size Micro-fin structure with adsorbent/copper powder mixed sintered body.

Micro-fin Adsorber

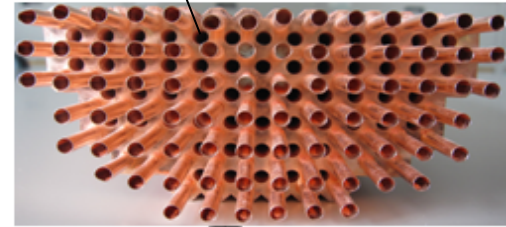


Adsorption core



Sintered body

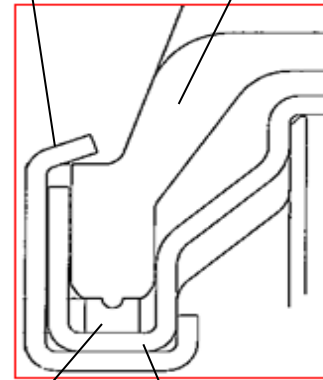
Vapor passages



Tubes

Caulking plate

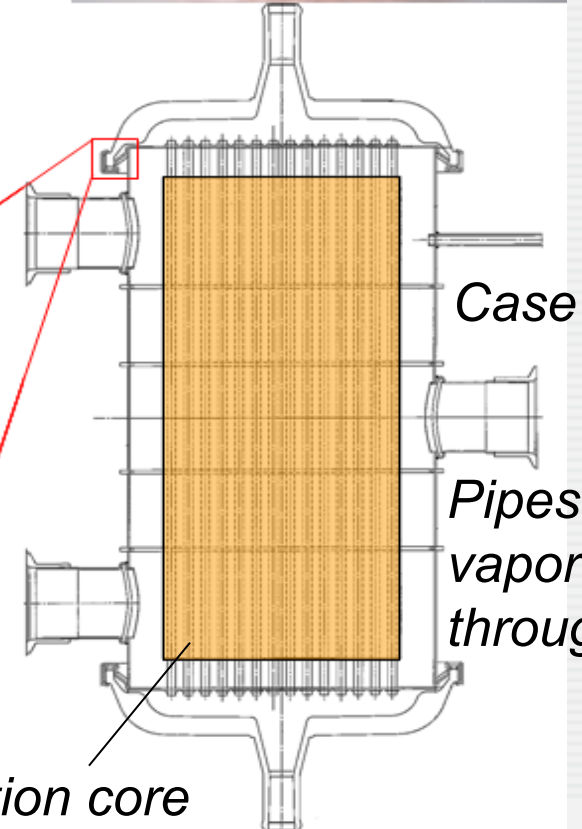
Plastic tank



Packing

Header plate

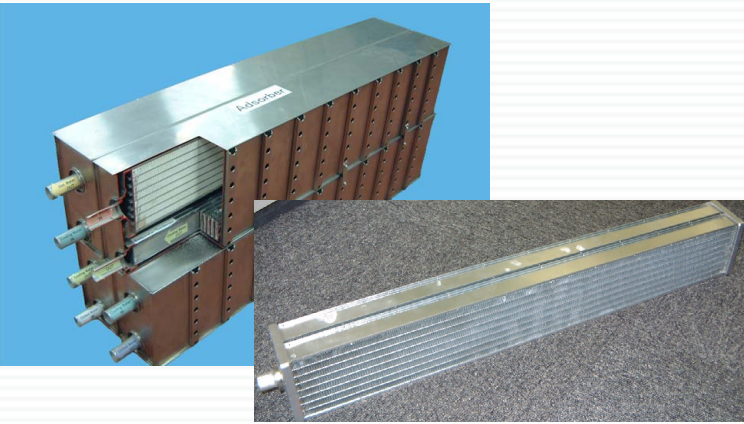
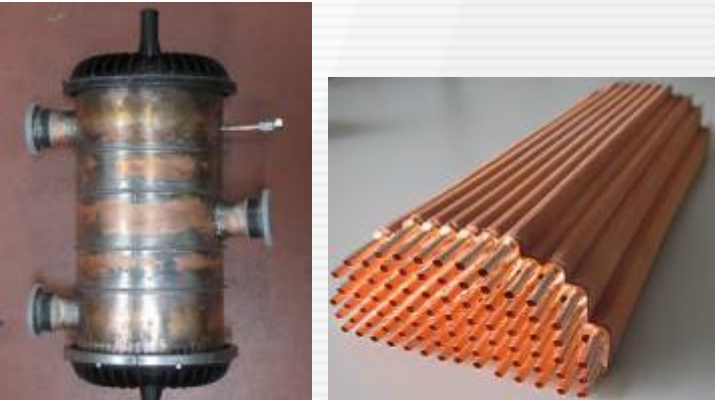
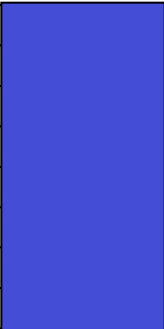

Adsorption core



Case

Pipes which vapor flows through

Achievement of the Downsized Adsorber

	<p><i>Conventinal Technology</i> <i>Corrugated-fin Adsorber</i></p>	<p><i>Developed Technology</i> <i>Micro-fin Adsorber</i></p>
<p><i>Pictures</i></p>	 <p><i>Adsorption core</i></p>	 <p><i>Adsorption core</i></p>
<p><i>Core Volume</i></p>		<p><i>1/4</i></p>  <p><i>Target</i></p>

Micro-fin adsorber is quarter as small as the conventional one.

- ◆ *We developed micro-fin adsorber which adsorbent/copper powder mixed sintered body.*
- ◆ *The dimension of the micro-fin adsorber is quarter as small as the conventional one with corrugated-fin and the adsorbent.*
- ◆ *With this adsorber, we will advance development of compact adsorption heat pump and propose it to wide field of application.*
- ◆ *This study was one of NEDO projects to develop the innovative technology of the energy-saving (2011).*



solutions for asia

natural refrigerants

3-5 February 2015 in Tokyo

Thank you very much!