Measurement of the heat transfer characteristics of high speed rotating heat pipe

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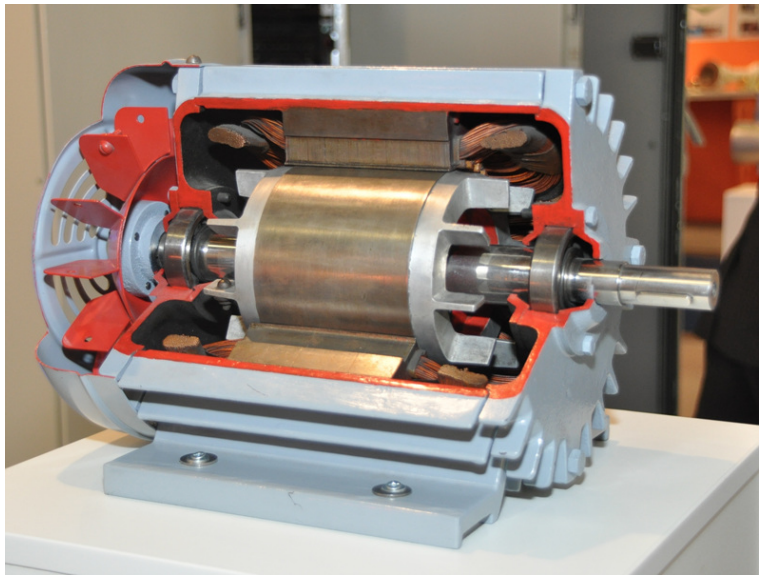
How to cool the high speed motor…



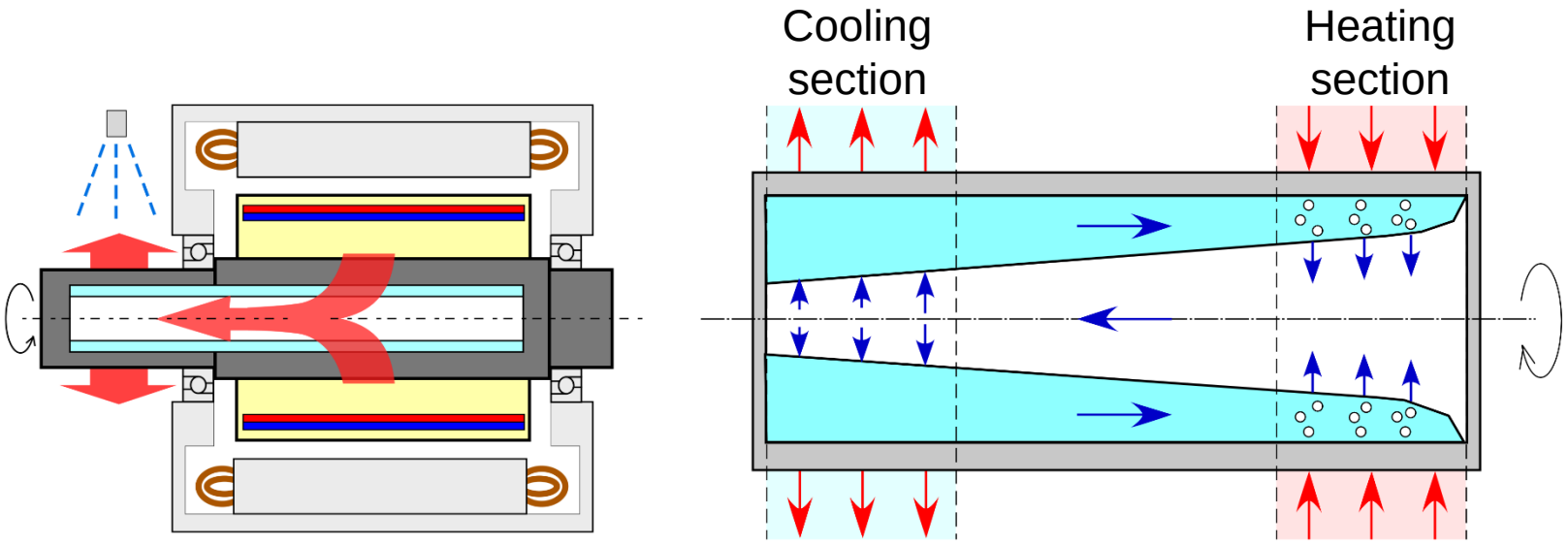
"Rotterdam Ahoy Europort 2011 (14)" by S.J. de Waard
http://commons.wikimedia.org/wiki/File:Rotterdam_Ahoy_Europort_2011_(14).JPG

- High temperature causes thermal demagnetization of the rotor.
- Cooling from the outside is difficult.

=> Direct cooling inside the shaft is needed

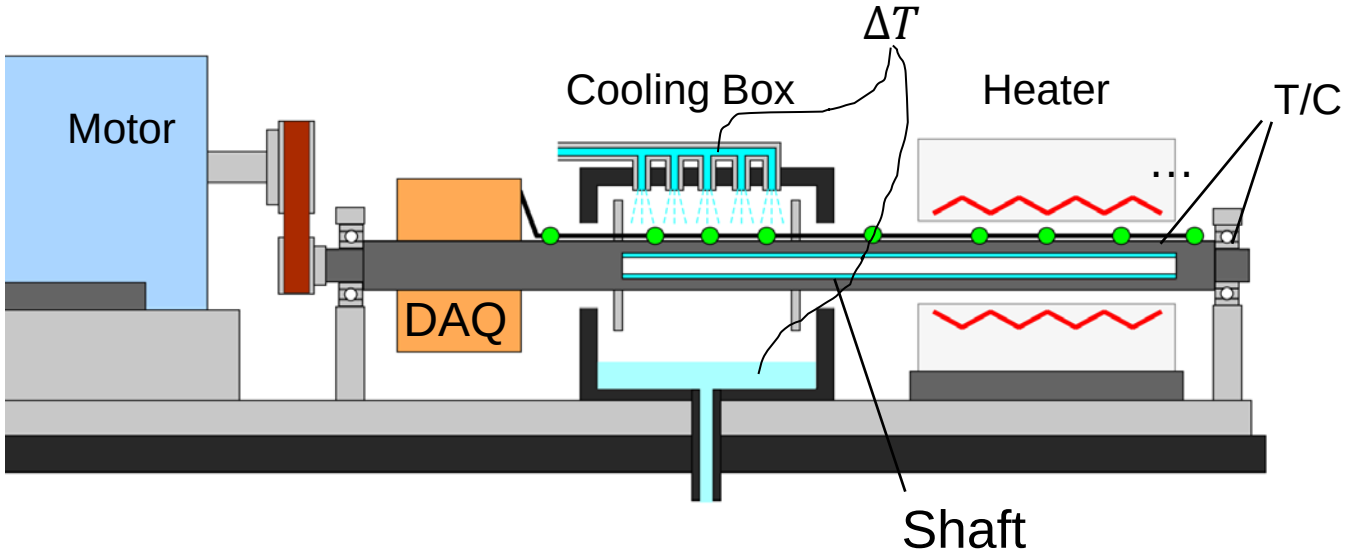
Rotating Heat Pipe (RHP)

- Working Principle



- Heat is transported by phase change of fluids.
- We want to see the heat transfer characteristics of RHP at high rotating speed.

Experimental Setup



- RHP: Hollow S45C shaft partially filled with ethanol
- To be measured:
  - Temperature distribution of the shaft
  - Amount of cooling by the RHP

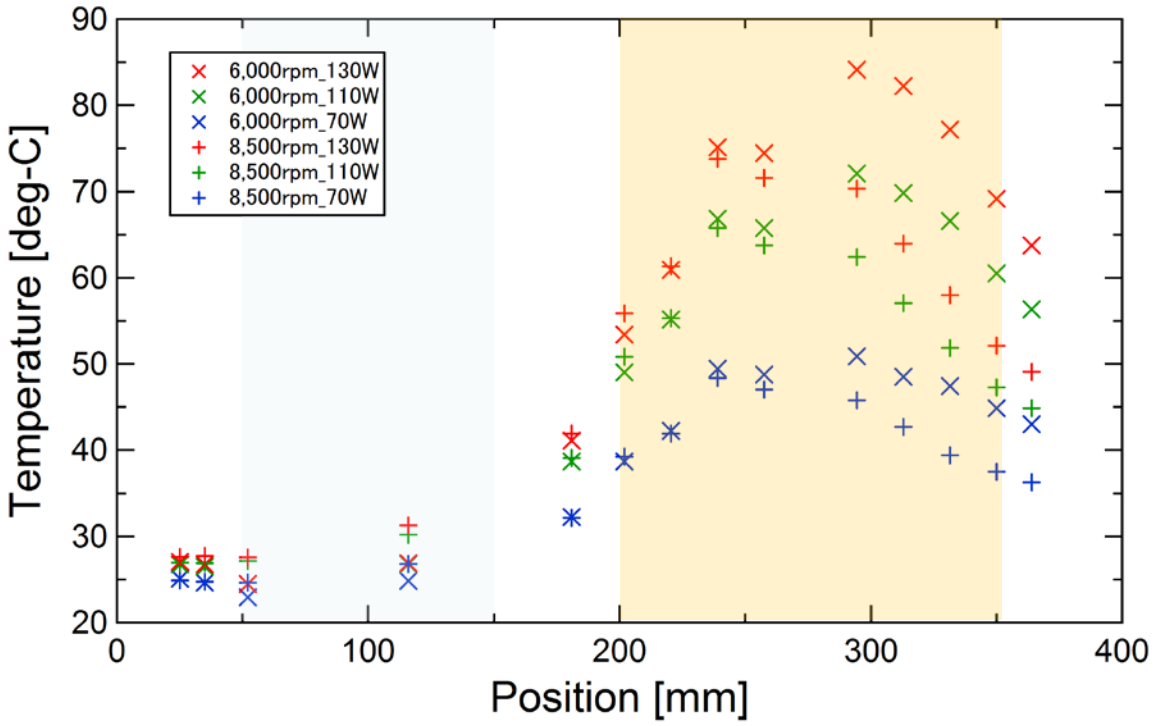
$$Q_{tr} = \dot{m} c_p \Delta T$$

$\dot{m}$: Flow rate of water
c_p : Specific heat of water
ΔT : Temperature difference

Experiment

Rotating speed	6000, 8500 rpm
Heater power	70, 110, 130 W
Cooling water flow rate	0.7 L/min

Temperature distribution

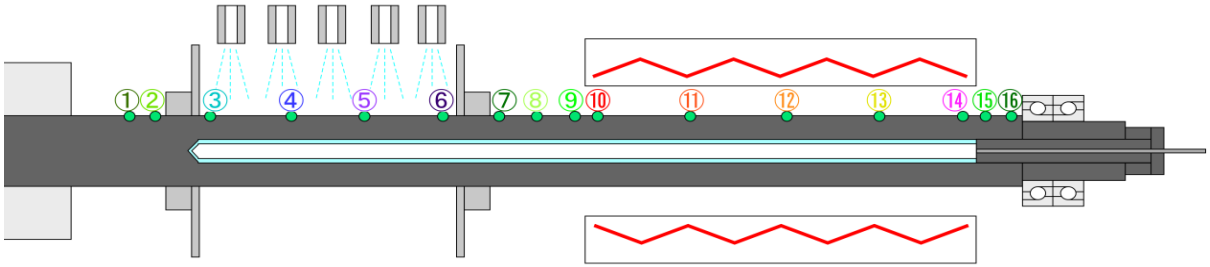


Rotating speed ↑

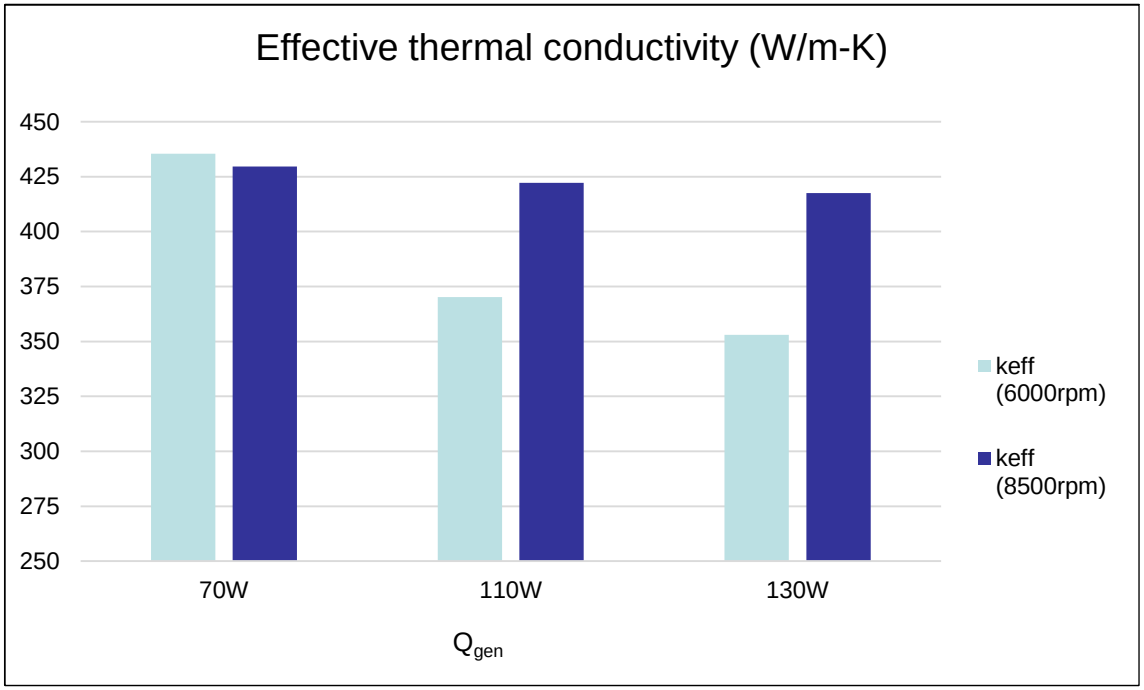
(Centrifugal force ↑)

⇒ Max. temperature ↓

⇒ Uniform temperature distribution



Heat transfer performance



$$k_{eff} = \frac{Q_{tr} L_{eff}}{A(T_h - T_c)}$$

T_c, T_h : Temperature of heating/cooling section

L_{eff} : Effective length between heating and cooling section

A : cross sectional area of the shaft

$k_{S45C} = 50 W/m \cdot K$

Life in Japan