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In IT industry, cooler modules' capability under forced convection condition – thermal resistance is crucial for products' performance and long-term reliability. Furthermore, thermal resistance (R) and air flow rate (Q) are close to each other. In this experiment, we focus on studying each parameter that might affect RQ. For instance, we check the relation of input electrical & heating power, measure working temperature by applying Fourier's Law, and get standard air flow rate by following AMCA 210 standard, etc.

Long Win's Educational Facilities for Thermal & Flow

LW-9344 Cooler Module's RQ Performance Measurement

Experimental items

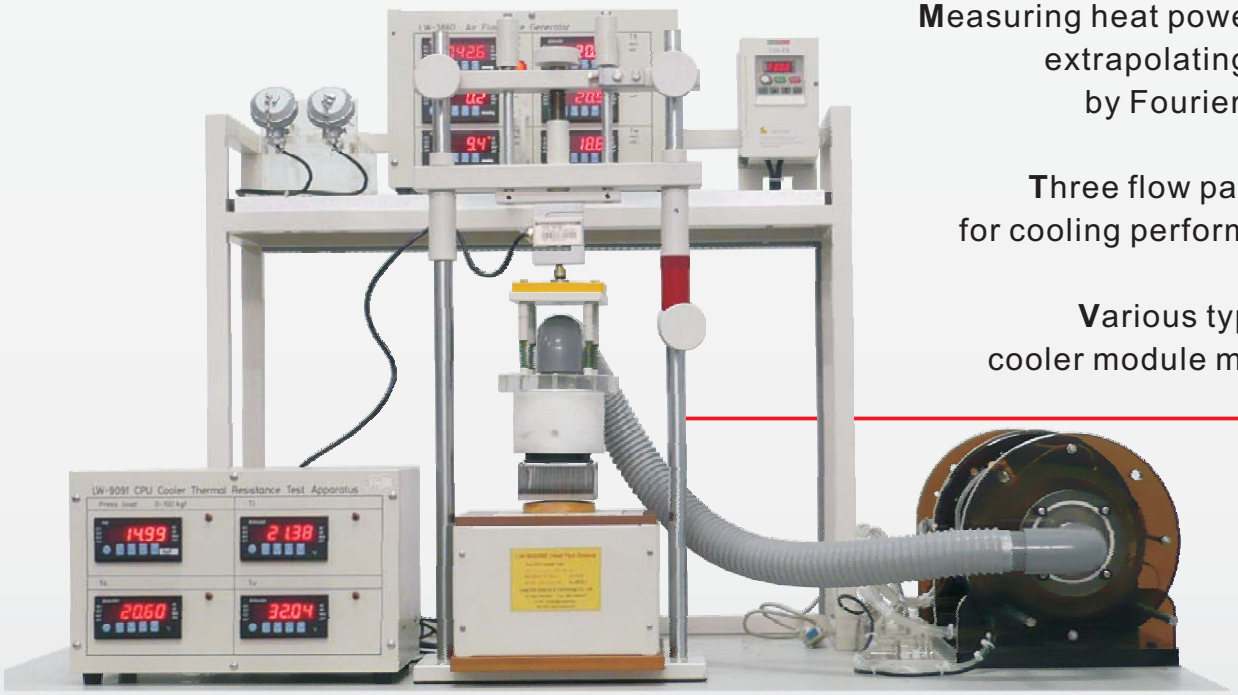
Standard flow rate generation and theory validation

The correlation of thermal resistance (R) and air flow rate (Q)

Measuring heat power and extrapolating T_{case} by Fourier's law

Three flow patterns for cooling performance

Various types of cooler module models



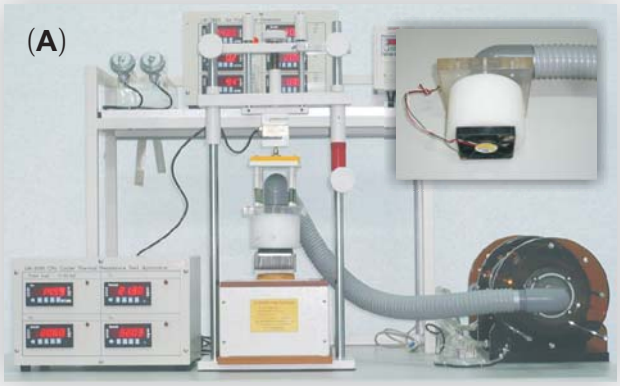
Features

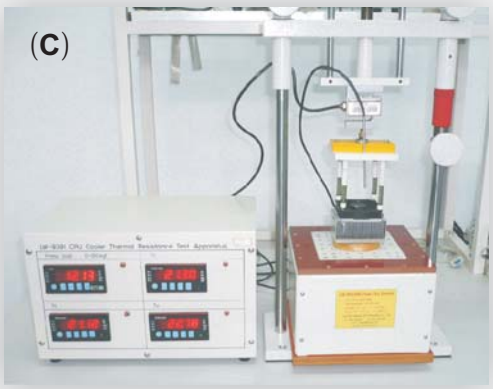
Standard flow rate generator and a set of exchangeable nozzles meeting AMCA 210-99 Standard. By cooperating with digit display meters of parameters, the system can provide a flow rate criterion in fluid mechanics laboratory.

The device can control press load on forced convection device.

Heat flux source simulates CPU die and provides adjustable heating power. The working temperature of die (T_{case}) can be calculated by Fourier's law through accurate temperature measurement of the device.

3 Flow Patterns of Forced Convection



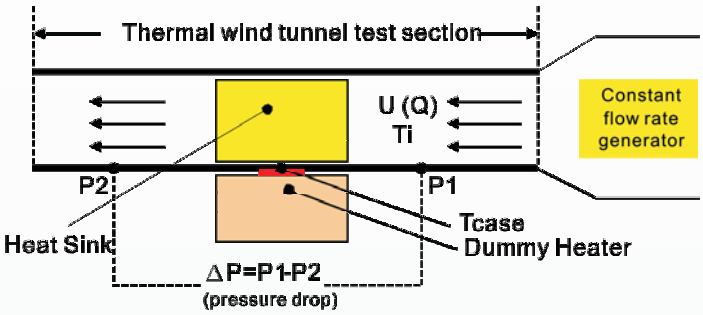


(A) Cooling performance test by providing forced wind with standard flow rate.

(B) Cooling performance test of wind-tunnel type by providing forced wind with standard flow rate.

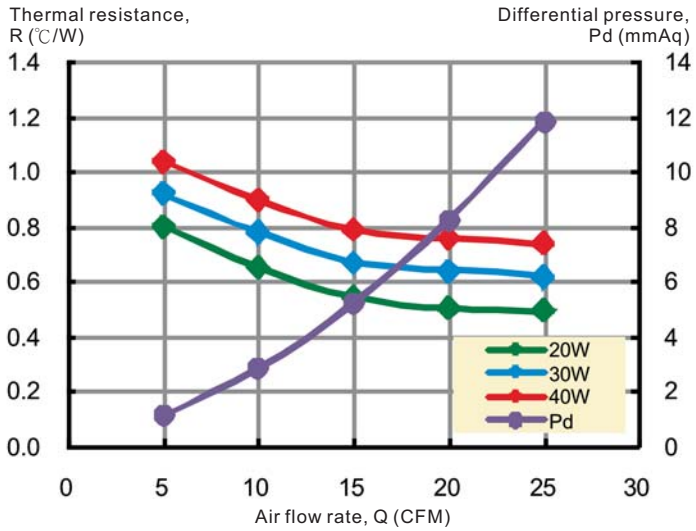
(C) Cooling performance test imposed by a fan.

Applications



Thermal resistance calculation:

$$R = \frac{Tcase - Ti}{Power} (°C/W)$$



The main purpose is to study the correlation between **cooling performance** and **air flow rate** while the cooling module is under following controlled conditions:

1. Flow pattern

2. Working Temperature

Specifications

Flow rate generator	According to	AMCA 210-99 Standard, Figure 15.	
	Flow rate range	2.31 ~ 85.9 CFM (0.065 ~ 2.41 CMM)	
	Accuracy	3%	
	Common chamber	150 mm in inner diameter	
	Measuring parameters	a. Dry-bulb temperature (Td)	d. Atmospheric pressure (Pb)
		b. Wet-bulb temperature (Tw)	e. Chamber static pressure (Ps)
		c. Chamber temperature (Tc)	f. Differential pressure of nozzle (P_{56})
Digit differential pressure meter	Accuracy of pressure transducer	0.25%	
	Range	0 ~ 127 mmAq	
Press load apparatus	Range	4 ~ 50 kgf, manual setting	
	Max. loading/unloading displacement	50 mm/150 mm	
Heat flux source	Ambient temperature (Ta) measurement	1 point of T-type sensor, with a digit display	
	Meter bar temperature measurement	3 points of PT-100 sensor, with a digit display	
	Die working temperature (T_{case})	According to Fourier's Law	
	Max. heating power	180 W	
	Max. TI value	< 180 ℃	
	Heat flux die dimension	31 x 31 mm, or other customized sizes	
Fan for forced convection	Control device	by a 90 W power supply	
	RPM measurement	FG signal and a digit display	
Overall size	With an operation table,	1.2 (L) × 0.7 (D) × 1.6 (H) m	
Power source	AC220V, 5 Amp, 50/60 Hz, single phase.		

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