Application Note

Refractory Brick Thermal Conductivity Measurement

Industry	:	Ceramic
Instrument	:	Quick Thermal Conductivity Meter
Measurement method	:	Hot wire comparative method
Standard	:	

1. Scope

Refractories are materials that can withstand high temperatures.
Regular refractories can be approximately classified into two types: those that have been molded and sintered beforehand (bricks and plates), and others called monolithic refractories (powdered or clay-like) that are applied on site.

Regular refractories are further classified as refractory bricks and refractory insulation bricks, according to their degree of thermal conductivity.

In this study, we will introduce the results of measuring the refractory bricks with low thermal conductivity using the Quick Thermal Conductivity Meter.

2. Precautions

Avoid trapping air between the sample and the probe when setting.
If pockets of air exist, they will affect the thermal conductivity measurement result.

・Prepare a flat specimen with no irregularities or undulations on the sample surface.

・If there is dust on the sample surface or probe, wipe it off.

For the amount of heat applied to the sample, determine the heater current value so that the temperature rise during measurement is 5 to 20 °C.

Set the heater current value from [HEATER] on the main unit and select the heater current value to be used according to the sample. Excessive heating may cause breakage of samples and references. Refer to the instruction manual for current value guidelines.

Measure the sample by allowing it to fully conform to the measurement environmental temperature.

3. Apparatus

Main unit	:	Quick Thermal Conductivity Meter (Normal Measurement)
Probe	:	PD-13N(Insulated moisture-proof probe)

4. Procedure

1) Place the probe on the sample.
2) Apply constant power (calories) to the heater and at the same time record the change in temperature rise to obtain the thermal conductivity.

NOTE: Refer to the instruction manual for details.

5. Example

- Measurement principle-

Our Quick Thermal Conductivity Meter is a thermal conductivity meter that can perform simple and quick measurement with excellent operability. Measurement begins when the probe is pressed (Fig. 1) against a sample surface of uniform temperature, and the operation can be completed in just 60 seconds.

The probe consists of a linear heating element and a thermocouple, and as the constant power (calories) is continuously applied to the heater, the temperature of the heater rises exponentially. When the time axis uses a logarithmic scale, the temperature rise curve becomes a straight line (Fig. 2).

The slope of this straight line increases with lower sample thermal conductivity, and if the sample has high thermal conductivity, the slope decreases. In other words, the thermal conductivity of the sample can be obtained from the slope of the temperature rise graph in which the horizontal time axis has a logarithmic scale.

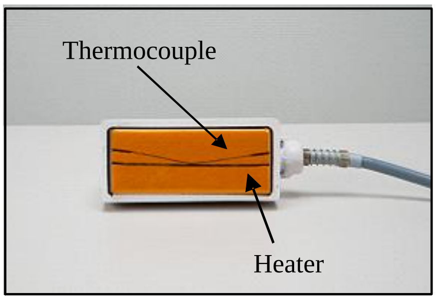


Fig1.Probe

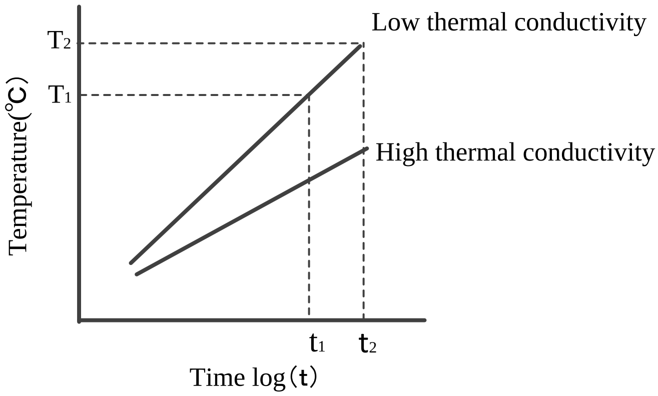


Fig 2.log(t)vsTemp. graph

-Measurement conditions-

○Ambient condition : 23℃
○Heater current value : 1.0A
○Measurement time : 60 seconds

- Measurement results-

These are the measurement results for the thermal conductivity of refractory brick.
For the measurements, we attached the probe to the sample and then removed the probe on each iteration.
Measurement was performed three times.
Table 1 shows average value, standard deviation and relative standard deviation.

Table 1. Measurement result table for refractory bricks

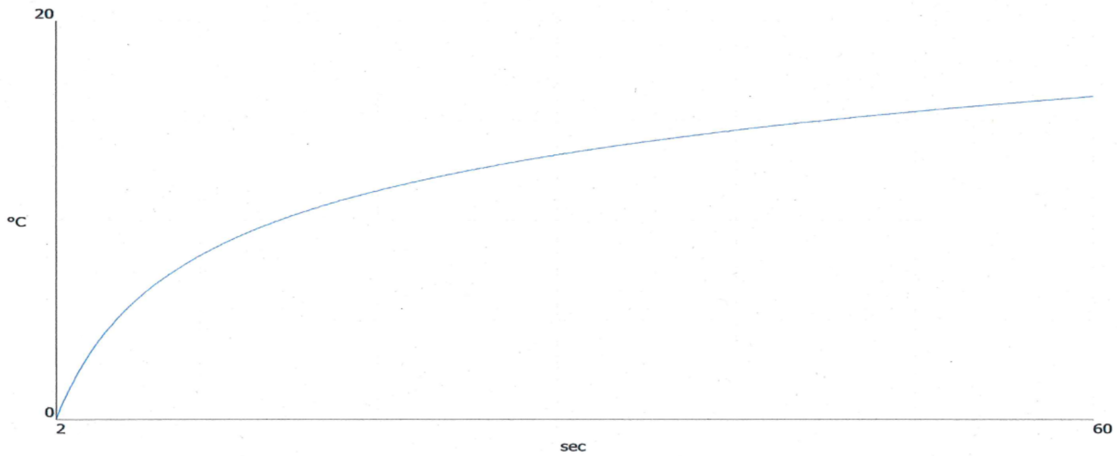
	Refractory brick	
	Refractory brick 1	Refractory brick 2
Thermal conductivity λ (W/(m K))	0.1337	0.1284
	0.1357	0.1278
	0.1351	0.1279
Mean value	0.1348	0.1280
Standard deviation	0.0010	0.0003
RSD (%)	0.76	0.25

-Measurement example-

Model:	QTM-710		Print: 2017/04/26 15:28
Serial:	22660002		Page: 1/1

Operator:	User	Date:	2017/03/27 15:35
Sample No:	01-001	Sample ID:	RENGA1
Meas.Mode:	Normal Measurement		
Probe Unit:	PD-13N		
Probe No:	22870006		
Probe Const:	Main		
λ :	0.1337 [W/(m K)]		

dT:	16.20	[°C]	
T0:	23.8	[°C]	
T1:	37.1	[°C]	
T2:	40.0	[°C]	
Tm:	31.9	[°C]	(T0+T2)/2
I:	1.0	[A]	
Stab:	Fine		



6. Summary

Good accuracy was confirmed in which relative standard deviation of refractory bricks was 1% or less.

Although refractory brick 1 and refractory brick 2 are the same material, it can be confirmed that there is a slight difference in thermal conductivity.

The difference in thermal conductivity between the two refractory bricks is presumed to be involved by the brick surface condition, as the difference in the polished states of the two brick surfaces can be visually observed.

For other refractory bricks, high thermal conductivity types are also available besides the low thermal conductivity type, which may need to characterize them separately. In such cases please consult us as necessary.

7. References

None.