



# KERONE

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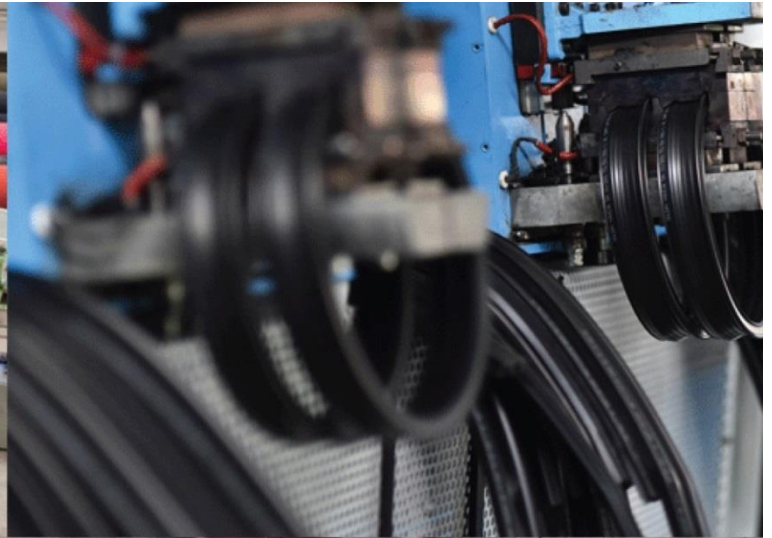


ELECTRO MAGNETIC innovative technologies

Kerone Research & Development Centre (KRDC),

B/47, Addl. MIDC. Anand Nagar, Ambernath (East), Thane- 421 506, India

Tel- +91-251-2620542/43/44/45/46. Email-[info@kerone.com](mailto:info@kerone.com) [www.kerone.com](http://www.kerone.com)



**Batch Microwave + Convection Heat Treatment  
For Curing of Composite Material**

ISO 9001-2008 | ISO 9001-2015 | EMS 14001 | OHSAS 18001

In Association with SVCH-Technology, Moscow (Russia)



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Customer :	M/s. ACME, Hadapsar, Pune
Process :	Batch Microwave + Convection Heat Treatment for Curing of Composite Material

**TEST REPORT No: 47/KRDC/LAB/61 Mum 02/11/2021**

Date Sample reception : 27/08/2021

ID : 47/LAB/61

**SAMPLE DESCRIPTION:**

Sampling : As Requested

Sample Condition : Acceptable

Quantity : 1 Kg

Samples opening date : 28/10/2021

Product : Composite Material

Requirement : Final moisture must be 0.4%

Start Date test : 01/11/2021

End Date test : 03/11/2021

**LABORATORY EXPERIMENTAL SET UP:**



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#### LAB BATCH MICROWAVE+CONVECTION HEATING SYSTEM SPECIFICATIONS:

<b>Microwave Power</b>	2 KW (CW)
<b>Frequency</b>	2450 MHz $\pm$ 50
<b>Convective Power</b>	3.5 KW ( airflow 350 l/min at 20°C )
<b>Microwave Exposure Zone (Cavity)</b>	1 Cubic meter
<b>Mode Stirrer</b>	One
<b>Thermal Monitoring System</b>	Single Channel Fiber Optic: Range -40 to 250°C
<b>Exhaust Power</b>	1 HP
<b>Tray size (width*height*depth)</b>	450*950*50 mm

#### ENVIRONMENT-LABORATORY AMBIENT CONDITIONS:

<b>Temperature (°C)</b>	26°C ( $\pm$ 5°C)
<b>Humidity (%)</b>	$\leq$ 70% RH
<b>Pressure (kN/m<sup>2</sup> or kPa)</b>	Not recorded

**Note for recommendation:** Environmental conditions have a direct impact on test results. Accuracy and consistency of test data are affected by the laboratory conditions.






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## EQUIPMENTS USED:

Name of Equipment	Picture of Equipment	Specifications
Compact Thermal Imaging Camera		<b>Model:</b> FLIR E-30 <b>Resolution:</b> 160 x 120 IR Thermal <b>sensitivity of 0.10°C</b>
Moisture Analyzer		<b>Make:</b> Axis Balance <b>Description:</b> <b>Moisture range:</b> 1%(sample 0.02/0.05g), 0.1% (Sample 0.5/5g), 0.01%(Sample>5g)
Thermo Hygrometer		<b>Model No:</b> HTC-2 <b>Temperature accuracy:</b> $\pm 1^{\circ}\text{C}$ ( $1.8^{\circ}\text{F}$ ) <b>Temperature resolution:</b> $0.1^{\circ}\text{C}$ ( $0.2^{\circ}\text{F}$ ) <b>Humidity range:</b> 10%~99% RH <b>Humidity accuracy:</b> $\pm 5\%$ RH <b>Humidity resolution:</b> 1% RH

## SAMPLE PREPARATION AND METHOD/PROCEDURE:

The experiment has been performed on Composite material to speed up the curing rate. For this experimental run, given sample has been filled in a plastic mould and later over turned on a crucible to form a cake. It is then placed in MW+ Convection heating system with suitable parameters. Observations are made after decided time period on the basis of Product temperature, Texture, change in Weight & moisture of the product.

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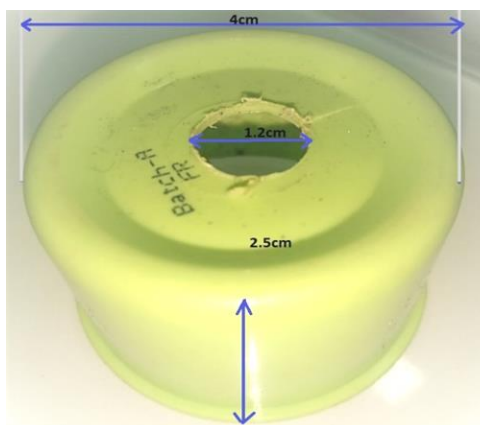
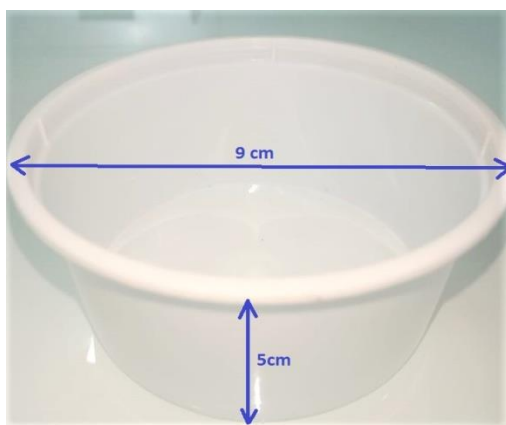


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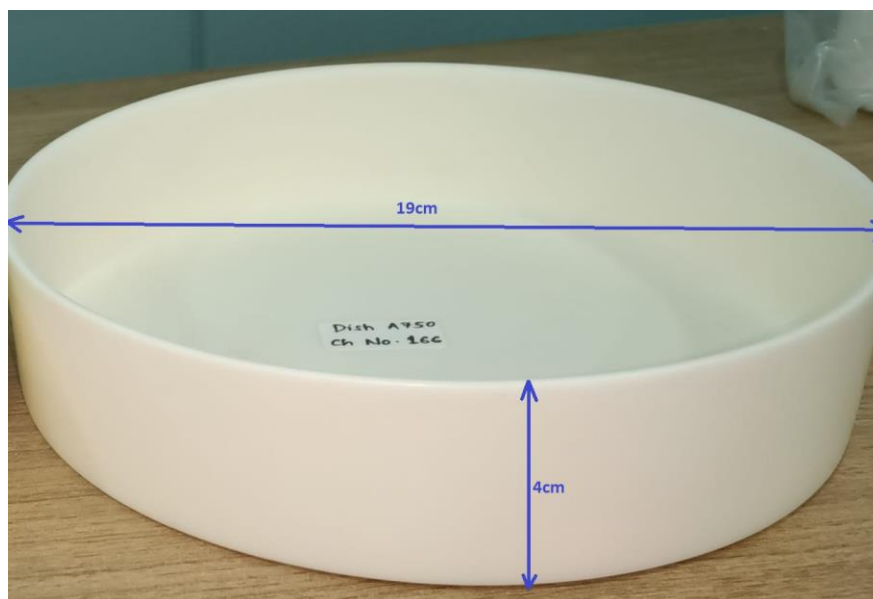
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### PLASTIC MOULD-



### CRUCIBLE-



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## ANALYTICAL RESULTS:

### TRIAL-1:

Initial Wt. of Product: 345g

Initial moisture of Product: 9.6 %

Magnetron Power: 1.8 KW

Convection Heater- 180°C

Fan speed: 70%

Cycles	Cycle Time (min)	Product Temperature	Product Weight (g)	Product Weight Loss (%)
C1	4 min	(170-180) °C	307g	11.01%

Total cycle time: 4 min

Final Wt. of Product: 307 g

Final moisture of Product: 0.4%

### TRIAL-2:

Initial Wt. of Product: 332g

Initial moisture of Product: 9.6 %

Magnetron Power: 1.8 KW

Convection Heater- 190°C

Fan speed: 70%

Cycles	Cycle Time (min)	Product Temperature	Product Weight (g)	Product Weight Loss (%)
C1	7 min	(180-195) °C	294g	11.44%

Total cycle time: 7 min

Final Wt. of Product: 294 g

Final moisture of Product: 0.3%



### BEFORE AND AFTER PICTURES OF TREATED SPECIMEN SAMPLE:



### TRIAL-3:

Initial Wt. of Product: 45g

Initial moisture of Product: 9.6 %

Magnetron Power: 1.8 KW

Convection Heater- 180°C

Fan speed: 70%

Cycles	Cycle Time (min)	Product Temperature	Product Weight (g)	Product Weight Loss (%)
C1	4 min	(180-200) °C	38g	15.55%

Total cycle time: 4 min

Final Wt. of Product: 38 g

Final moisture of Product: 0.4%



#### **TRIAL-4:**

Initial Wt. of Product: 45g

Initial moisture of Product: 10.0 %

Magnetron Power: 1.4 KW

Convection Heater- (80-120) °C

Fan speed: 70%

Cycles	Cycle Time (min)	Set Convection Temp. (°C)	Product Temperature	Product Weight (g)	Product Weight Loss (%)
C1	5 min	120°C	(150-160) °C	40g	11.11%
C2	3 min	80°C	(180-200) °C	38g	5.0%
C3	3 min	60°C	(160-175) °C	36g	5.26%

Total cycle time: 11 min

Final Wt. of Product: 36 g

Final moisture of Product: 0.4%

#### **BEFORE AND AFTER PICTURES OF TREATED SPECIMEN SAMPLE:**







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## THERMAL ANALYSIS REPORTS:

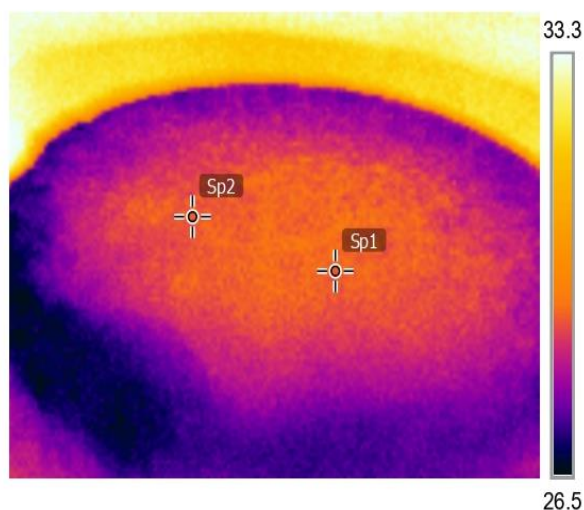
### BEFORE TREATMENT-

#### Measurements

Sp1	29.0 °C
Sp2	29.2 °C

#### Parameters

Emissivity	0.95
Refl. temp.	20 °C



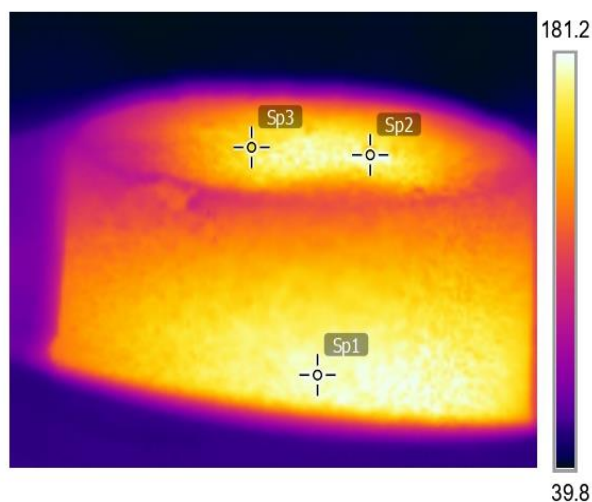
### During Trial -1:

#### Measurements

Sp1	178.8 °C
Sp2	179.6 °C
Sp3	164.2 °C

#### Parameters

Emissivity	0.95
Refl. temp.	20 °C



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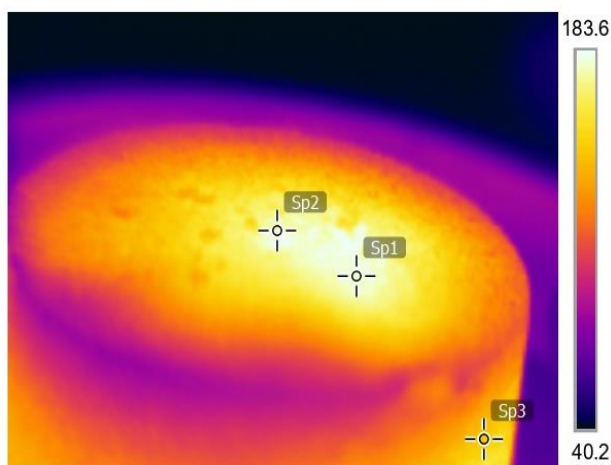
### During Trial -2:

#### Measurements

Sp1	180.0 °C
Sp2	182.0 °C
Sp3	152.7 °C

#### Parameters

Emissivity	0.95
Refl. temp.	20 °C



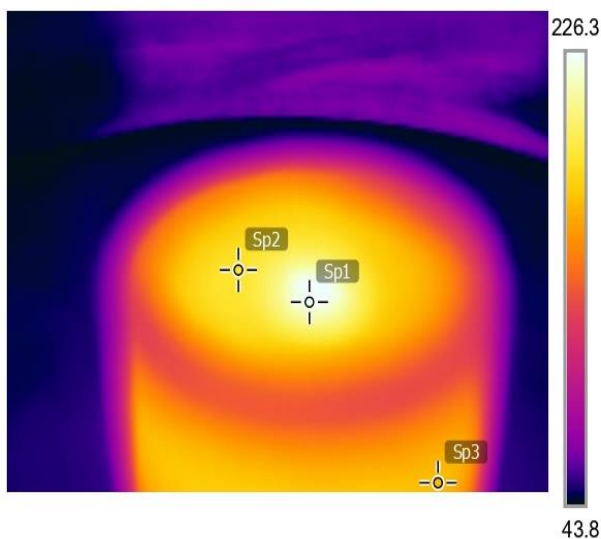
### During Trial -3:

#### Measurements

Sp1	223.9 °C
Sp2	193.6 °C
Sp3	178.3 °C

#### Parameters

Emissivity	0.95
Refl. temp.	20 °C





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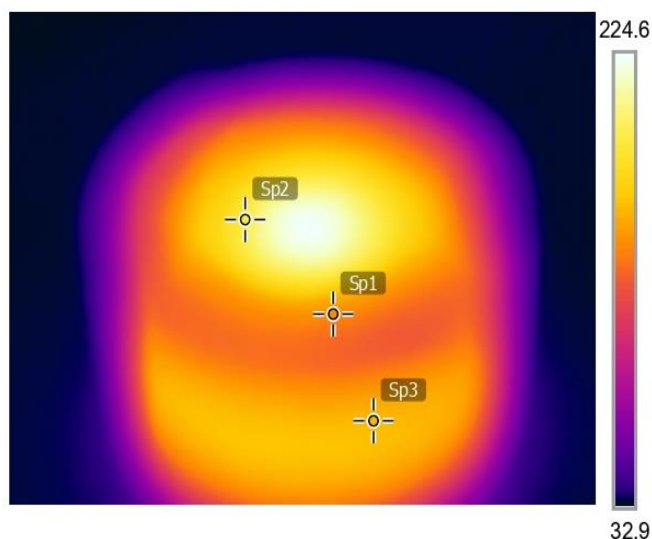
#### During Trial -4:

##### Measurements

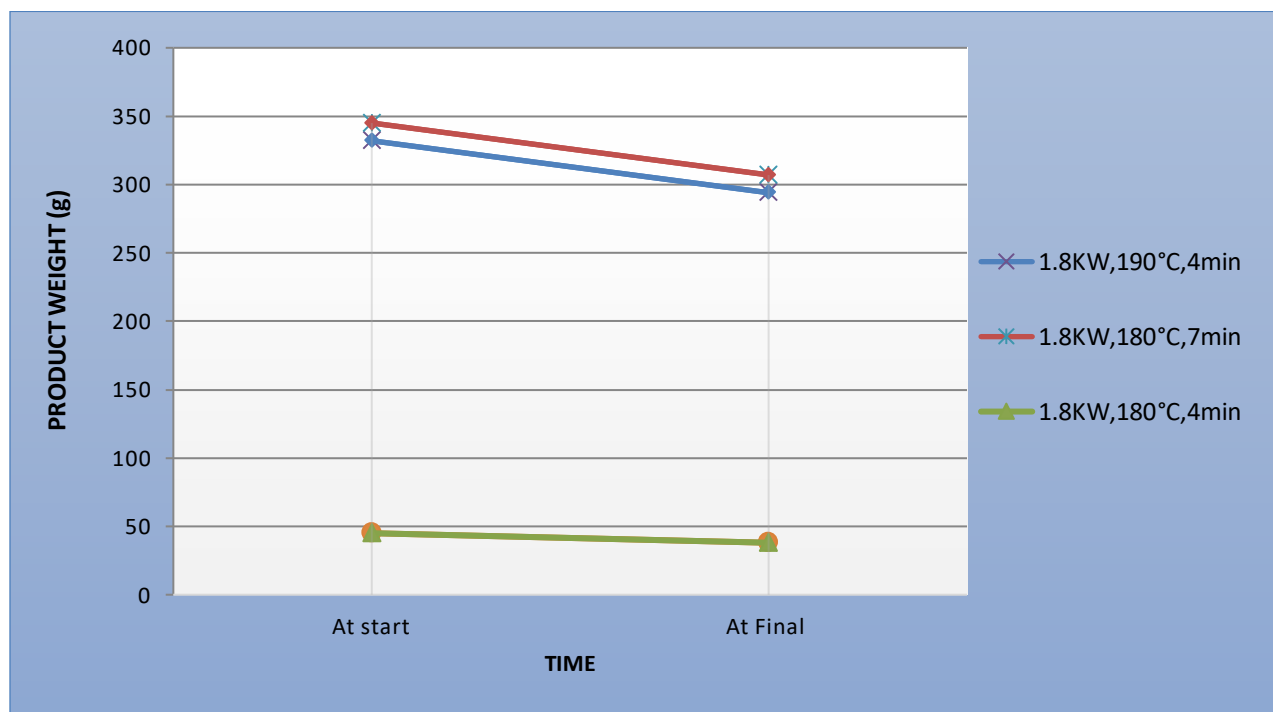
Sp1	160.3 °C
Sp2	198.8 °C
Sp3	174.4 °C

##### Parameters

Emissivity	0.95
Refl. temp.	20 °C



#### GRAPHICAL REPRESENTATION:



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## MOISTURE ANALYSIS REPORTS:

Drying started		Drying started		Drying started		Drying started	
Date : 1-11-2021		Date : 1-11-2021		Date : 1-11-2021		Date : 1-11-2021	
Time :12:24:33		Time :14:27:35		Time :12:24:33		Time :13:58:01	
Model:AGS200		Model:AGS200		Model:AGS200		Model:AGS200	
Serial number : 138		Serial number : 138		Serial number : 138		Serial number : 138	
Drying parameters		Drying parameters		Drying parameters		Drying parameters	
Product :		Product :		Product :		Product :	
Drying temperature : 120.0 °C		Drying temperature : 120.0 °C		Drying temperature : 120.0 °C		Drying temperature : 120.0 °C	
Drying profile : standard		Drying profile : standard		Drying profile : standard		Drying profile : standard	
Mode : Short mode		Mode : Short mode		Mode : Short mode		Mode : Short mode	
Calculation : ((m0-m)/m0)*100%		Calculation : ((m0-m)/m0)*100%		Calculation : ((m0-m)/m0)*100%		Calculation : ((m0-m)/m0)*100%	
Finished : 3 samples		Finished : 3 samples		Finished : 3 samples		Finished : 3 samples	
Initial weight : 2.311 g		Initial weight : 1.156 g		Initial weight : 2.311 g		Initial weight : 1.455 g	
Final weight : 2.088 g		Final weight : 1.151 g		Final weight : 2.088 g		Final weight : 1.450 g	
Drying time : 00:02:20s		Drying time : 00:00:50s		Drying time : 00:02:20s		Drying time : 00:01:20s	
Sampling interval : 10 sec		Sampling interval : 10 sec		Sampling interval : 10 sec		Sampling interval : 10 sec	
Moisture : 9.6 %		Moisture : 0.4 %		Moisture : 9.6 %		Moisture : 0.3 %	
NOTE Initial moisture		NOTE final moisture of Composite material (Trial 1)		NOTE Initial moisture		NOTE final moisture of Composite material (Trial-2)	
The analysis performed by:		The analysis performed by:		The analysis performed by:		The analysis performed by:	
Signature: <i>Komal</i>		Signature: <i>Komal</i>		Signature: <i>Komal</i>		Signature: <i>Komal</i>	

**TRIAL-1**

**TRIAL-2**

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Drying started		Drying started	
Date : 1-11-2021		Date : 3-11-2021	
Time : 12:24:33		Time : 16:38:31	
Model: AGS200		Model: AGS200	
Serial number : 138		Serial number : 138	
Drying parameters		Drying parameters	
Product :		Product :	
Drying temperature : 120.0 °C		Drying temperature : 80.0 °C	
Drying profile : standard		Drying profile : standard	
Mode : Short mode		Mode : Short mode	
Calculation : $((m_0-m)/m_0)*100\%$		Calculation : $((m_0-m)/m_0)*100\%$	
Finished : 3 samples		Finished : 3 samples	
Initial weight : 2.311 g		Initial weight : 0.913 g	
Final weight : 2.088 g		Final weight : 0.909 g	
Drying time : 00:02:20s		Drying time : 00:01:42s	
Sampling interval : 10 sec		Sampling interval : 20 sec	
Moisture : 9.6 %		Moisture : 0.4 %	
NOTE Initial moisture		NOTE final moisture of composite material.	
The analysis performed by:		The analysis performed by:	
Signature: <i>Homal</i>		Signature: <i>Homal</i>	

**TRIAL-3**

Drying started		Drying started	
Date : 8-11-2021		Date : 8-11-2021	
Time : 11:43:14		Time : 11:36:43	
Model: AGS200		Model: AGS200	
Serial number : 138		Serial number : 138	
Drying parameters		Drying parameters	
Product :		Product :	
Drying temperature : 120.0 °C		Drying temperature : 120.0 °C	
Drying profile : standard		Drying profile : standard	
Mode : Short mode		Mode : Short mode	
Calculation : $((m_0-m)/m_0)*100\%$		Calculation : $((m_0-m)/m_0)*100\%$	
Finished : 3 samples		Finished : 3 samples	
Initial weight : 1.376 g		Initial weight : 0.993 g	
Final weight : 1.239 g		Final weight : 0.989 g	
Drying time : 00:02:20s		Drying time : 00:01:40s	
Sampling interval : 20 sec		Sampling interval : 20 sec	
Moisture : 10.0 %		Moisture : 0.4 %	
NOTE Initial moisture.		NOTE final moisture.	
The analysis performed by:		The analysis performed by:	
Signature: <i>Homal</i>		Signature: <i>Homal</i>	

**TRIAL-4**

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### **OBSERVATION:**

The Composite material containing metallic aluminium, alcohol and moisture has been treated under the Microwave + Convection heating system with the aim of curing it. The heating rate is found to be increasing with respect to increase in time. It has been found that the product's weight decreases with respect to increase in setting temperature. As per physical investigation, it has been observed that the product becomes hard on drying.

A handwritten signature in blue ink that reads "Komal".

**Ms. Komal Ingle**  
**(Tested By)**