EXPERIMENT 7
EXHAUST GAS RECIRCULATION DRYING

I. INTRODUCTION

One of the most common method for separating water from a wet material is drying with hot air (drying agent).

When the wet material is contacted to hot air, water on the surface of the material will evaporate and diffuse into the air. Then there will appear the difference of moisture between the surface and inside the material and thus diffuse from the inside of the material to the surface of the material.

Thus, the moisture separation process of the material consists of two stages:

+ Stage one: mainly disperses free moisture from the wet material surface into the environment. The drying rate (more moisture per unit surface per unit time) is constant and do not depend on the moisture content of the material if the drying conditions are not changed. This stage is called the "constant-rate drying" stage.

+ Stage two: When the moisture of the material is less than the critical moisture, the amount of moisture inside the material transferred to the surface of the material is less than the amount of moisture that can evaporate on the surface of the material, the drying rate starts to decrease. The “reduction-rate drying” continues until the moisture content of the material reaches equilibrium.

Representing the change in moisture content of the material over time, the curve is called a "drying curve" (see Figure 1).

If we show the relationship between the drying rate and the moisture content of the material, we get a curve called the "drying rate curve" (see Figure 2).

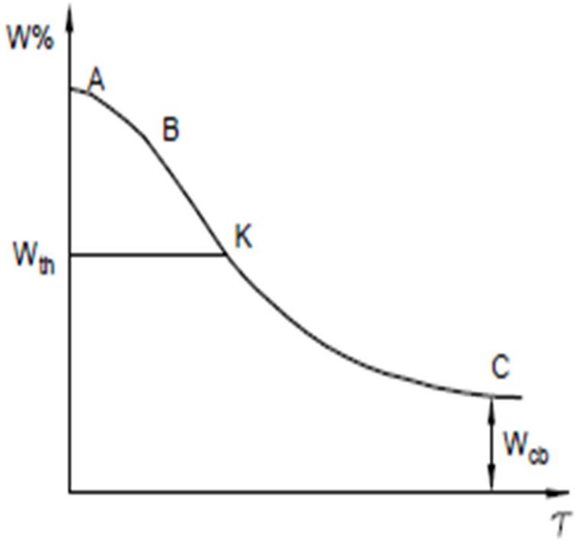

Figure 1. Drying curve

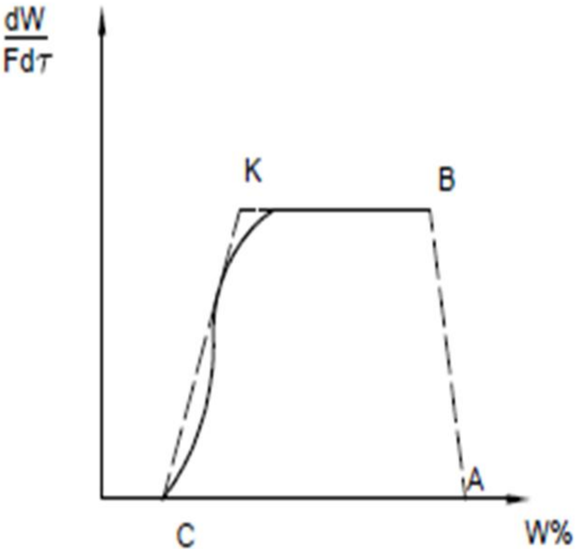

Figure 2. Rate drying curve

II. EXPERIMENT PURPOSES

1. Get familiar with and know how to operate the hot air drying system with exhaust gas recirculation.

2. Determine the relationship between the moisture content of the material and the drying time (drying curve).

3. Determine the relationship between the drying speed and the material moisture content (drying rate curve).
4. Calculate drying time according to formula and compare with actual drying time.

III. EXPERIMENT SYSTEM

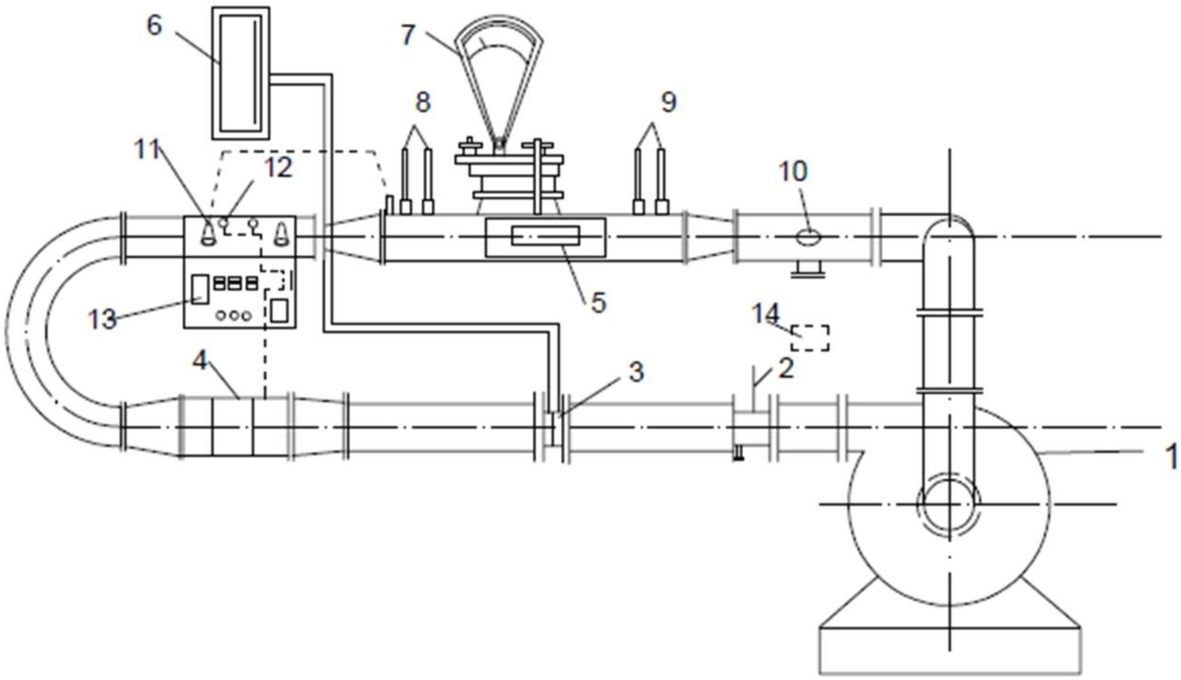

Figure 3. Experiment system

1. Fan	7. Scale
2, 10. Air doors	8,9. Hygrometer
3. Plate	11. Relays
4. Electric calorifier	12. Light
5. Drying chamber	13. Breaker
6. Flow meter	14. Humidity control unit

Operation:

The outside air is exhausted by fan 1 through door 10 and then heated in electric calorifier 4. Controlled air temperature by contact thermometer system and relay 11. Humidity of the air before and after the drying chamber is determined with a hygrometer 8 and 9. The wet material is placed in the trays placed in a frame of the drying chamber. The frame is hung on the scale 7. Observe the change in the mass of the drying material on the needle of the scale. Adjust the exhaust air volume with plate 3 and flowmeter 6.

IV. EXPERIMENT STEPS

1. Material soak: requires no stirring, no loss.
2. Observe and check the experimental system according to the diagram
3. Fill the hygrometer with water and prepare the measuring instruments: the thermometer and hygrometer.
4. Turn on the fan and close the circuit breaker to increase heat for the calorifier.
5. Wait until the drying air temperature (drying agent) stabilizes to put the material in and read the readings on the scale.

6. Every 5 minutes (from the time the material was added), read and write the number on the scale again. Do this until the reading on the scale has remained constant for three measurements, stop the experiment.
7. Turn off the circuit breaker, turn off the fan, take out the tray to observe the material (take care not to lose material). Record the obtained data in the "experiment record" and report to the supervisor. Clean up the lab area before leaving. (Note: must turn off the circuit breaker of the calorifier first, then after a while then turn off the fan).

V. CALCULATION

1. The initial amount of moisture is present in the material: g = Gư – GK, g (12-1)

Where:

Gư : Mass of wet material, g

GK : Mass of absolute dry material, g

2. Mass of evaporated water : ΔWi = Gi – Gi-1, g (12-2)

Gi, Gi-1: mass of material corresponding to time i and i-1

3. Mass The amount of moisture contained in the material: W' = g -Σ ΔWi, g (12-3)

4. The percentage mass of moisture in the material is calculated as an absolute dry material:

$$W = \frac{W'.100}{G_K}, \quad \% \qquad (12\text{-}4)$$

5. The drying time of constant-rate drying stage:

$$\tau_d = \frac{1}{K} \cdot \frac{W_d - W_{th}}{W_{th} - W_{cb}} \qquad (12\text{-}5)$$

Where :

K : constant velocity of the drying process, 1/s

Wd, Wth, Wcb : Initial moisture content, critical moisture content and equilibrium moisture content of material, calculated as absolute dry material.

6. The drying time of the reduction-rate drying stage:

$$\tau_g = \frac{2,3}{K} \lg \frac{W_{th} - W_{cb}}{W_c - W_{cb}} \qquad (12\text{-}6)$$

Where:

Wc: final moisture content of material, calculated as absolute dry material

7. Draw a drying curve and a drying rate curve

8. Comment on experiment results

EXPERIMENTAL DATA SHEET AND CALCULATION RESULTS

Test	Time τ (min)	$\Delta\tau$ (min)	Thermometer				Scale G (g)	Calculation parameters			
			Before drying chamber		After drying chamber						
			Dry thermometer (K)	Wet thermometer (Ư)	Dry thermometer (K)	Wet thermometer (Ư)		Evaporated moisture ΔW_i (g)	Moisture in the material W' (g)	Moisture in the material according to the absolute dry material W%	Drying rate $\Delta W_i/\Delta\tau$
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
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