# Limestone Calcination: Equilibrium $CO_2$ Pressure and Temperature

Equilibrium $CO_2$ pressure over $CaCO_3$ at a bed temperature, and the lowest temperature for calcination at a $CO_2$ partial pressure (Basu Eq. 5.7).

**Method:** Basu; Circulating Fluidized Bed Boilers: Design; ...

## Input parameters

Unit system: SI

| Parameter | Value | Unit |
|---|---|---|
| Bed temperature | 850.00 | °C |
| $CO_2$ partial pressure in the furnace | 15.000 | kPa |

## Calculated results

| Parameter | Value | Unit |
|---|---|---|
| Equilibrium $CO_2$ pressure at T | 48.335 | kPa |
| Equilibrium calcination temperature at p_$CO_2$ | 777.78 | °C |
| Driving ratio (> 1: calcines) | 3.2223 | |

### Notes for this case

- Limestone calcines at this temperature: the equilibrium $CO_2$ pressure is above the partial pressure (calcination needs at least 778 °C).
- Pressurised beds and oxy-fuel firing raise $CO_2$ partial pressure; limestone then reacts uncalcined (direct sulfation).

## Formula and method

$$P_e = 1.2 \times 10^7 \exp\left(-\frac{E}{RT}\right) \text{ bar}, \quad T_e = \frac{-E}{R \ln(p_{CO_2}/1.2 \times 10^7)}$$

### Variables

| | | |
|---|---|---|
| $T$ | Bed temperature | K |
| $p_{CO_2}$ | $CO_2$ partial pressure in the furnace | Pa |
| $P_e$ | Equilibrium $CO_2$ pressure at T | Pa |
| $T_e$ | Equilibrium calcination temperature at p_$CO_2$ | K |
| $P_e/p_{CO_2}$ | Driving ratio (> 1: calcines) | - |

### Method and standards

Basu's Eq. (5.7), with E = 159 000 kJ/kmol and R = 8.314 kJ/(kmol·K) as given with it; the pressure in bar is converted to pascals. A note says whether the limestone calcines (ratio above 1).

### Assumptions and limits

- Equilibrium only; kinetics ignored.

### References

- Basu
- Circulating Fluidized Bed Boilers: Design
- Operation and Maintenance (Springer, 2015)
- ch. 5
- Eq. (5.7) (Stanton 1983): $P_e = 1.2 \times 10^7 \exp(-E/RT)$ bar
- E = 159 000 kJ/kmol

## Report details

| | |
|---|---|
| Report reference | FCC-BZG2-CWCQ (the same inputs always give the same reference) |
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| Release checks | 2 reference cases of this calculator, computed independently, are checked on every release |

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

### This calculator online

https://calc.firecad.com/boilers-power-plant/fluidised-bed/limestone-calcination-equilibrium

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.