EXAMPLES
1. GAS/SOLID INTERACTIONS

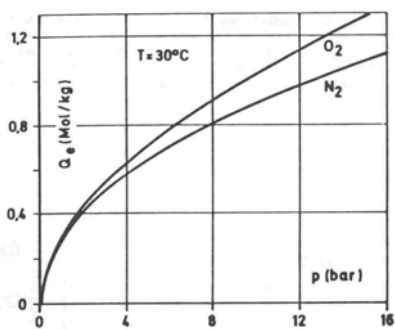63

DIFFERENT DYNAMIC BEHAVIOUS
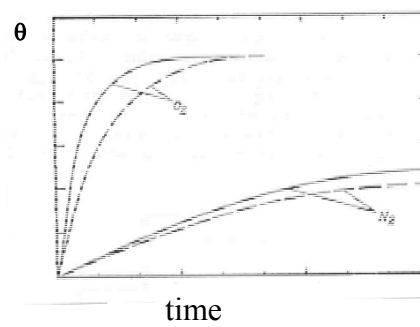
$$n^s = f(p,E,T,t)$$

O_2 0,28 nm N_2 0,32 nm
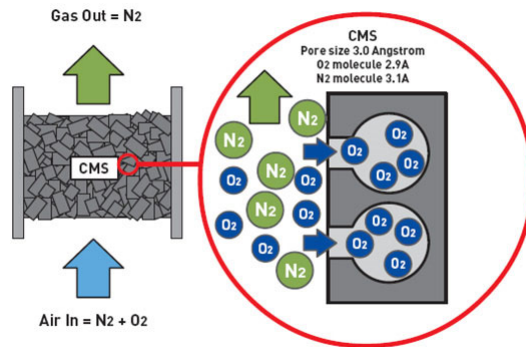
equilibrium   dynamic
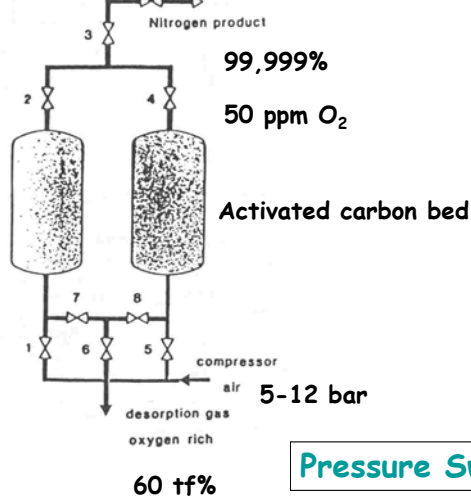

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Path of air components in a porous carbon bed:

Gas Out = N2

CMS
Pore size 3.0 Angstrom
O2 molecule 2.9A
N2 molecule 3.1A

CMS

Air In = N2 + O2

Molecular sieve effect

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$n^s = f(p, E, T, t)$

Separation of air, biogas, CO_2/CO, etc.

Nitrogen product

isobars

99,999%

50 ppm O_2

Activated carbon bed

Adsorbed amount

p increases

Temperature

compressor

air **5-12 bar**

desorption gas

oxygen rich

60 tf%

Pressure Swing Adsorption, PSA

Cycles last for a few minutes
66
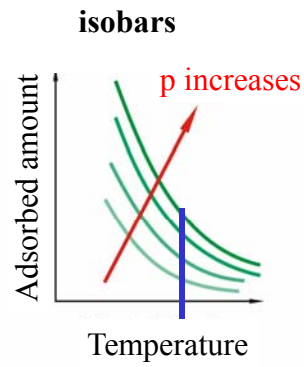
In case of vapours:

$n^s = f(p, E, T, t)$

Temperature Swing Adsorption, TSA

$T_1 < T_2$

T_1

T_2

n_i

c_i or p_i
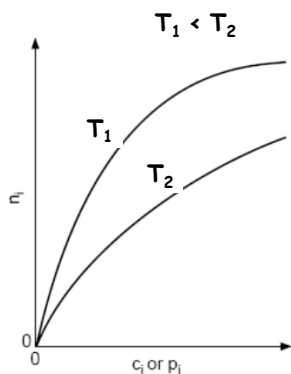
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Increasing concentration of green house gases in the atmosphere

Antropogenic
Natural

global warming   3 °C/40 year

$T_1 < T_2$

T_1

T_2

n^s

p

GWP (global warming potential)
$CH_4 : CO_2$ 23:1

Western Siberia
„permafrost" soil 10^6 km^2
    30 - 40 cm peat
    20 - 40 m loes
$(A_S \approx 10$ m^2/g$)$

$7 \cdot 10^{10}$ ton methane in form of
clathrates ($4CH_4 \cdot 23H_2O$)

Methane Hydrate pressure-temperature phase diagram

120000

100000

80000

Pressure (kilo-Pascals) →

Methane
Hydrate
& Ice

60000

Methane
Hydrate
In Water

40000

Methane
Gas
in Water

20000

0

-15 -14 -12 -9 -6 -3   2   8 10 12 15 16 17 18 19 21 23 26 28 30 33

Temperature (^{0}C) →