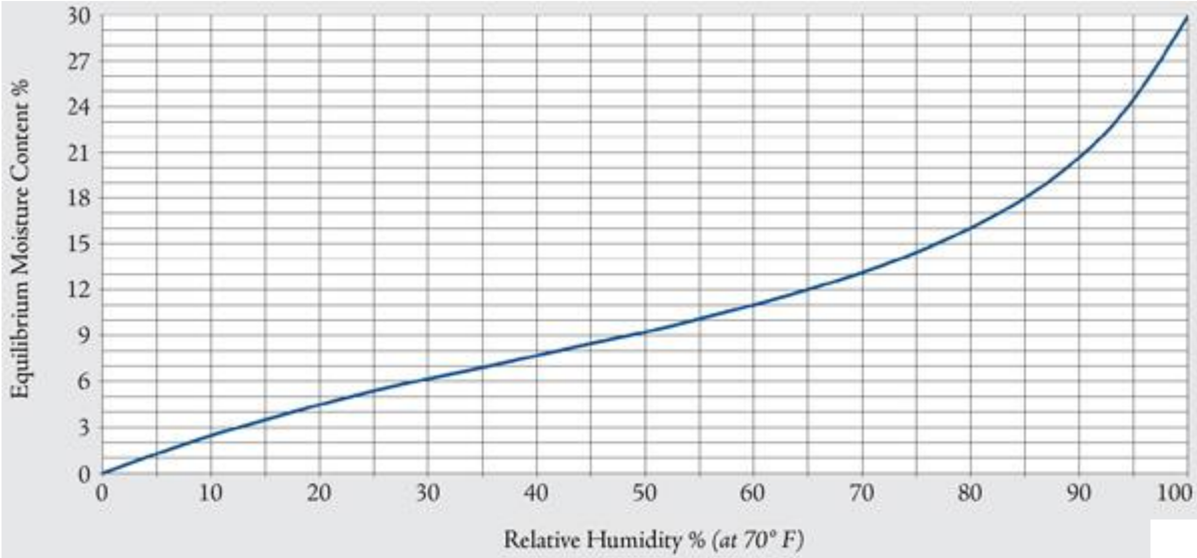
ESERCIZIO 3

Del sapone umido viene posto a contatto con aria alle condizioni costanti di 75°C ed 1 atm. La distribuzione all'equilibrio dell'umidità è:

%W/W umidità sapone	0	2.40	3.76	4.76	6.10	7.83	9.90	12.63	15.40	19.02
P_{H2O} in aria, mm Hg	0	9.66	19.2	28.4	37.2	46.4	55.0	63.2	71.9	79.5



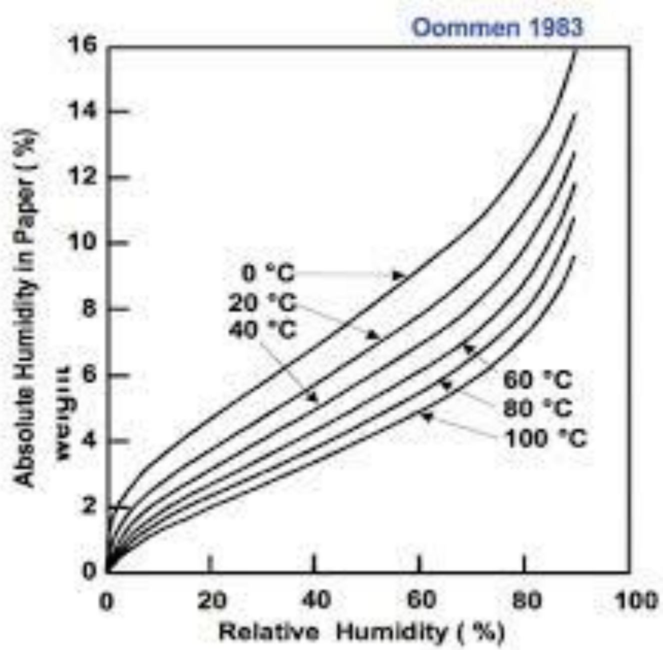
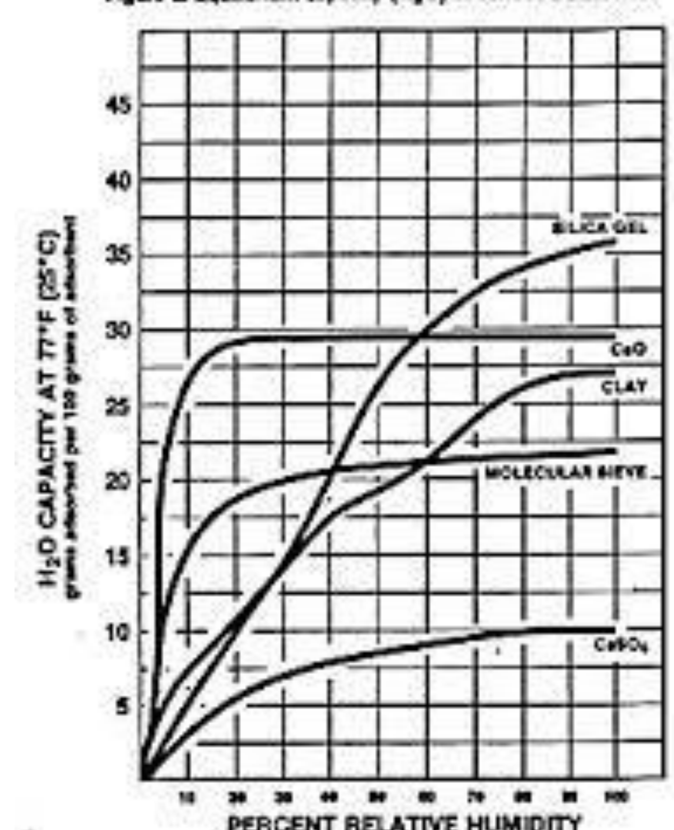
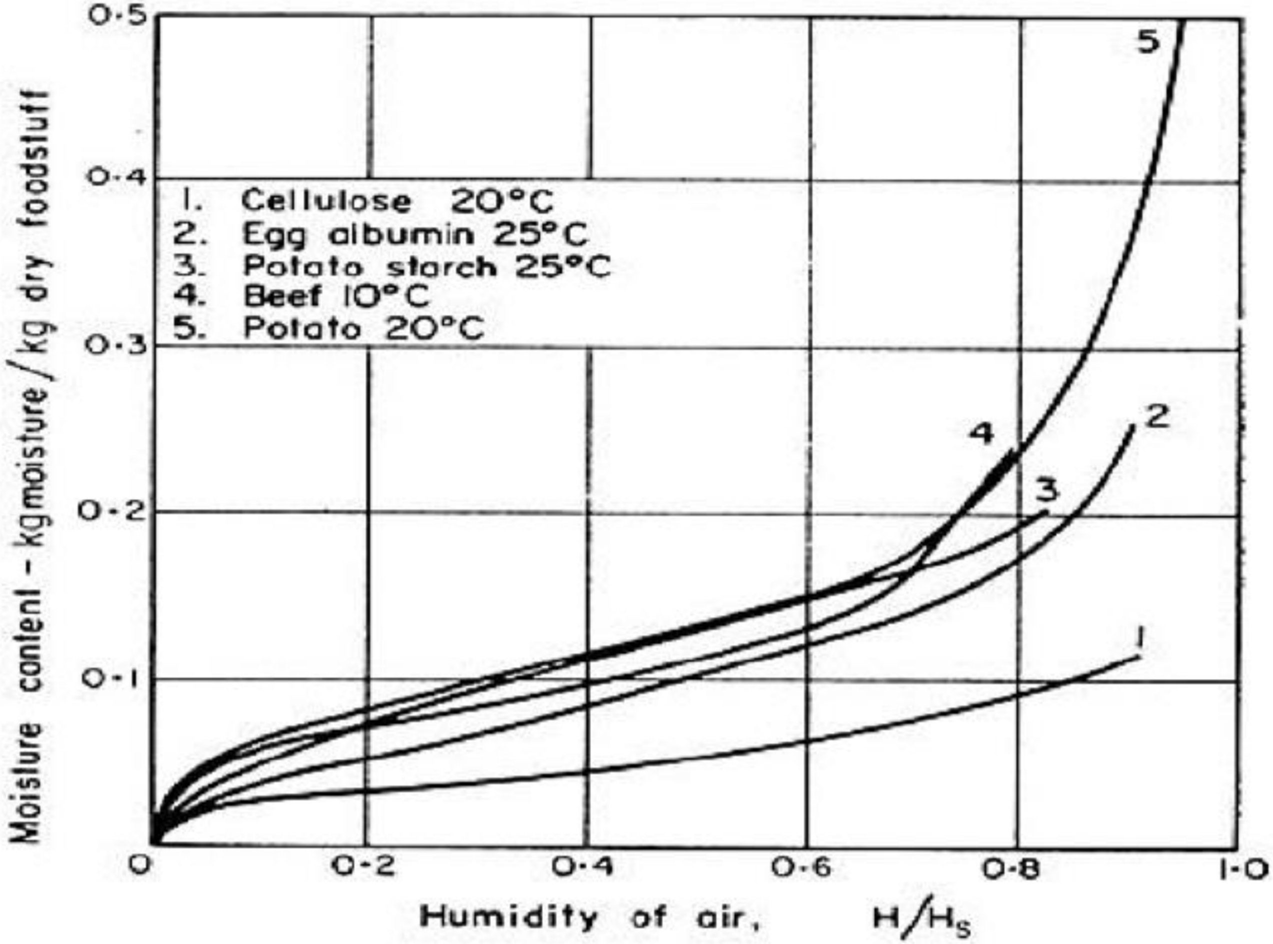


Figure 2: Equilibrium capacity (H_2O) of various adsorbents.

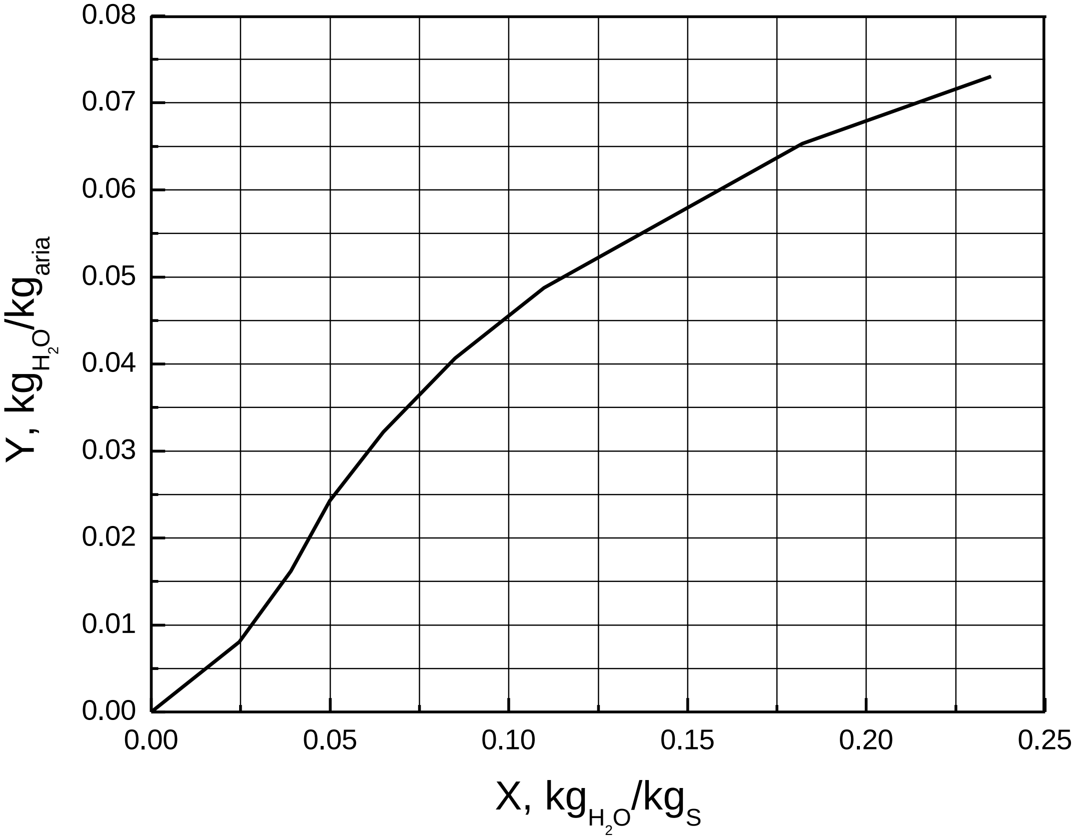




Moisture content - kg moisture / kg dry foodstuff
0·5
0·4
0·3
0·2
0·1
0
0·2
0·4
0·6
0·8
1·0
Humidity of air, H/Hs
1. Cellulose 20°C
2. Egg albumin 25°C
3. Potato starch 25°C
4. Beef 10°C
5. Potato 20°C
1
2
3
4
5

T = 75 °C; P_{TOT} = 1 atm

%W/W umidità sapone	0	2.40	3.76	4.76	6.10	7.83	9.90	12.63	15.40	19.02
P_{H2O} in aria, mm Hg	0	9.66	19.2	28.4	37.2	46.4	55.0	63.2	71.9	79.5



% W/W umidità sapone	0	2.40	3.76	4.76	6.10	7.83	9.90	12.63	15.40	19.02
P_{H2O} in aria, mm Hg	0	9.66	19.2	28.4	37.2	46.4	55.0	63.2	71.9	79.5

$$UM = \frac{\% w/w}{100} = \frac{M_{H_2O}}{M_{H_2O} + M_S} \Rightarrow \frac{M_{H_2O}}{M_S} = \frac{UM}{1 - UM} = X$$

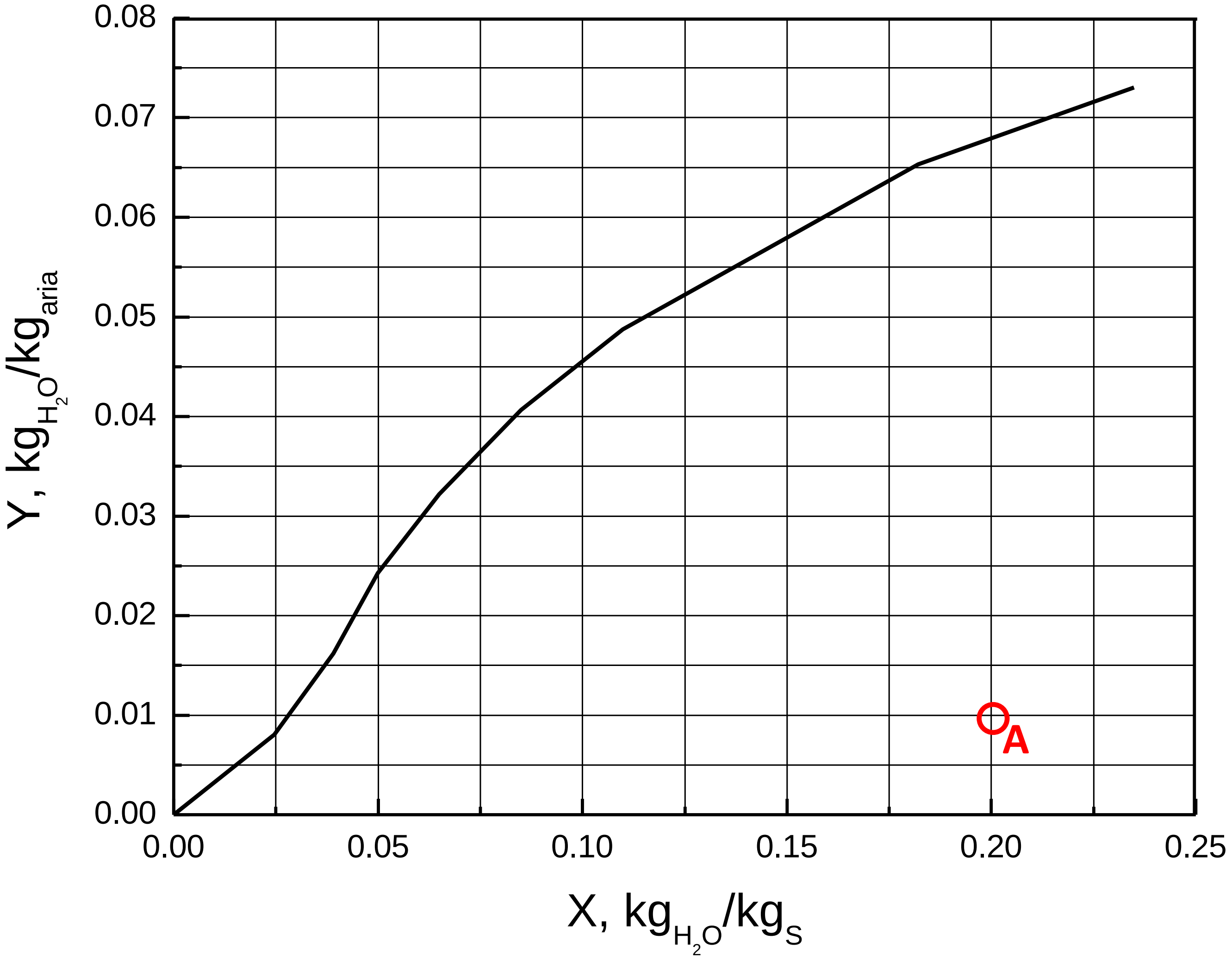
$$y_{H_2O} = \frac{p_{H_2O}}{p_{TOT}} = \frac{n_{H_2O}}{n_{H_2O} + n_{aria}} \Rightarrow \frac{n_{H_2O}}{n_{aria}} = \frac{\frac{p_{H_2O}}{p_{TOT}}}{1 - \frac{p_{H_2O}}{p_{TOT}}} = \frac{p_{H_2O}}{p_{TOT} - p_{H_2O}}$$

$$Y = \frac{PM_{H_2O}}{PM_{aria}} \frac{p_{H_2O}}{p_{TOT} - p_{H_2O}}$$

a) 10 kg di sapone umido al 16.7% sono posti in un recipiente con 10 m^3 di aria di umidità iniziale 12 mm Hg. Quando il sapone raggiunge l'umidità del 13.0%, l'aria viene rimpiazzata con altra delle stesse condizioni iniziali e si attende l'equilibrio. Quale sarà l'umidità residua del sapone?

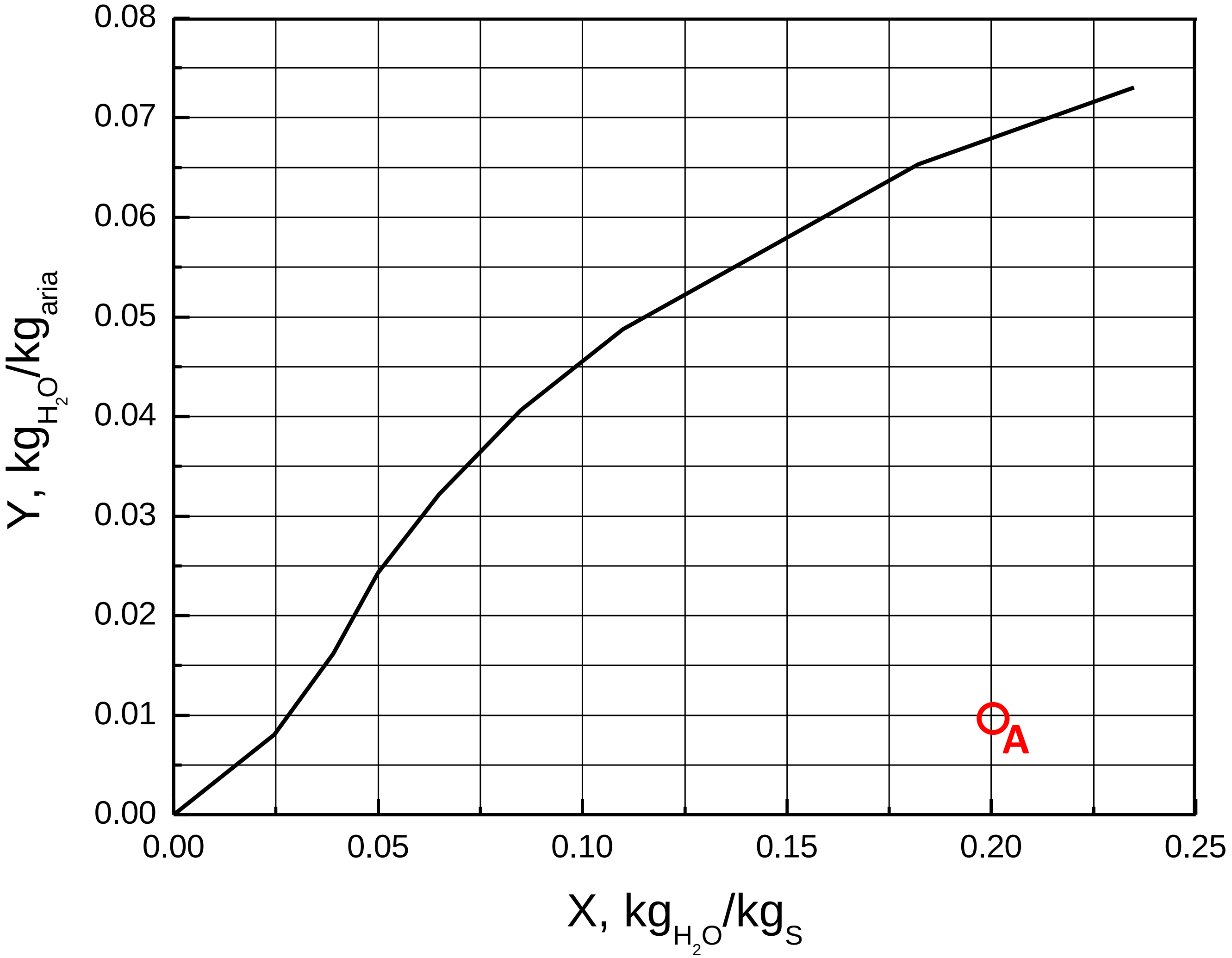
$$x_A = \frac{0.167}{1 - 0.167} = 0.20$$

$$y_A = \frac{18}{28.8}\frac{12}{760 - 12} = 0.010$$

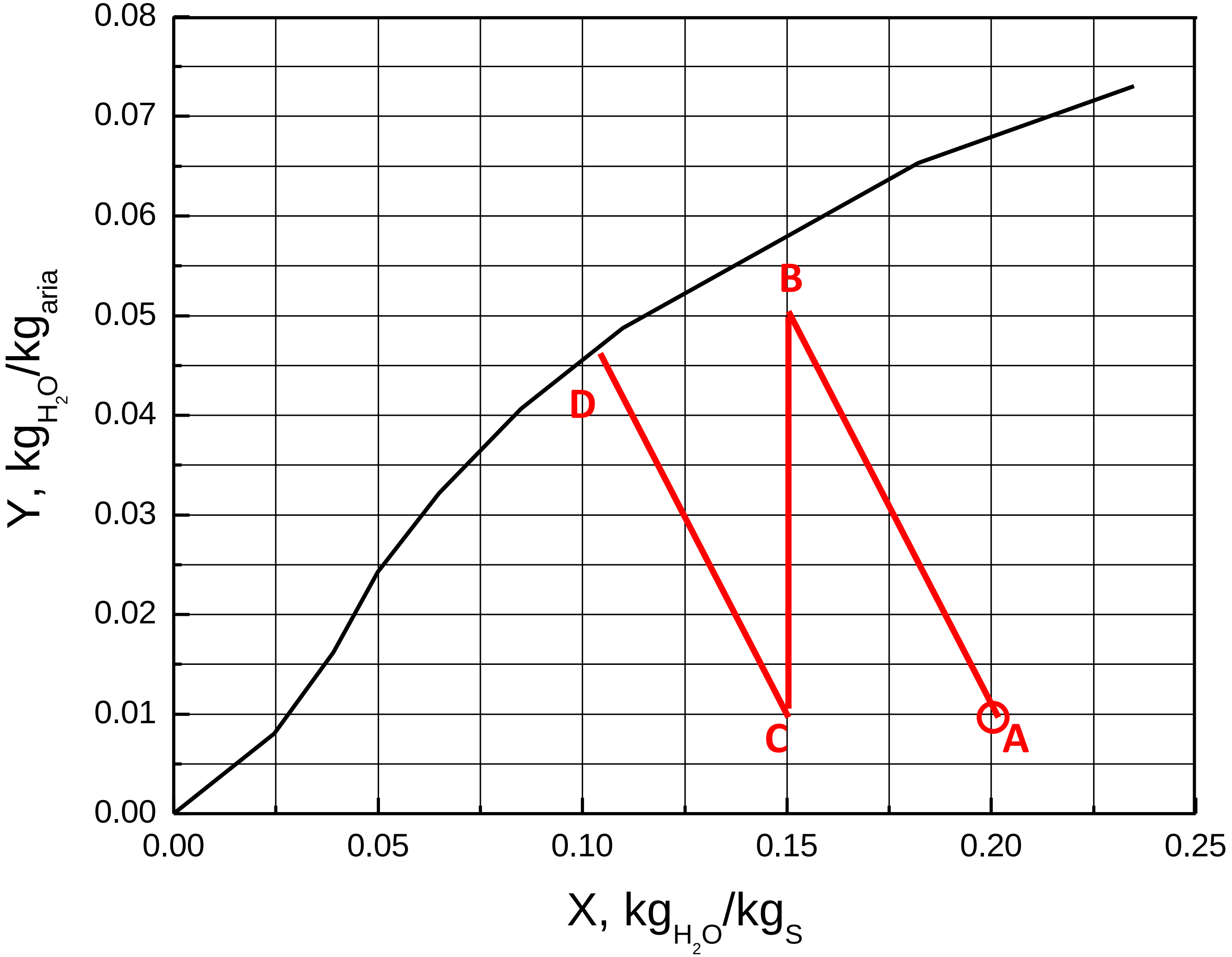


$$M_S = 10(1 - 0.167) = 8.33\text{kg}$$

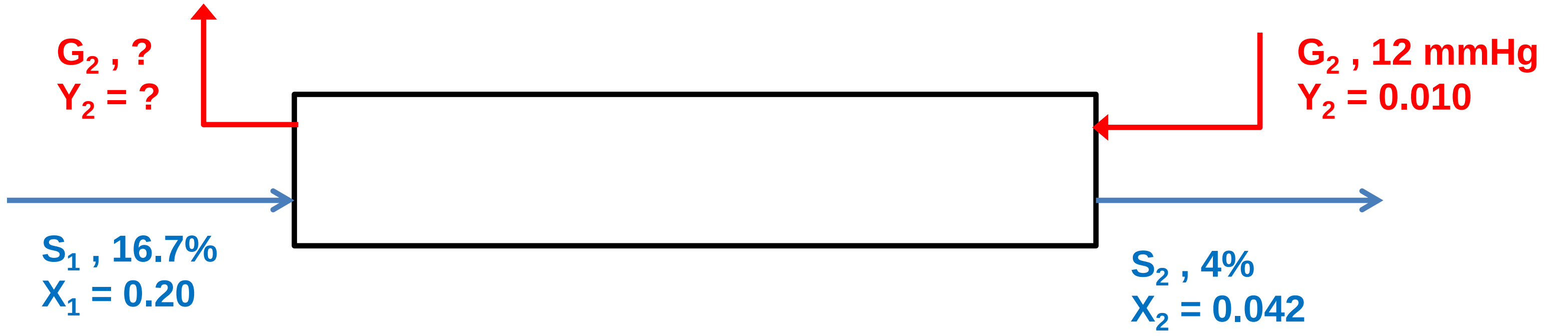
$$M_G = \left(\frac{1 \times 10}{0.082 \times 348}\right)\left(\frac{760 - 12}{760}\right)(28.8) = 9.93\text{kg}$$



$$M_G\left(Y - Y_A\right) = M_S\left(X_A - X\right) \qquad Y = -\left(\frac{M_S}{M_G}\right)X + \left(\frac{M_S}{M_G}\right)X_A + Y_A \qquad -\frac{M_S}{M_G} = -0.839$$

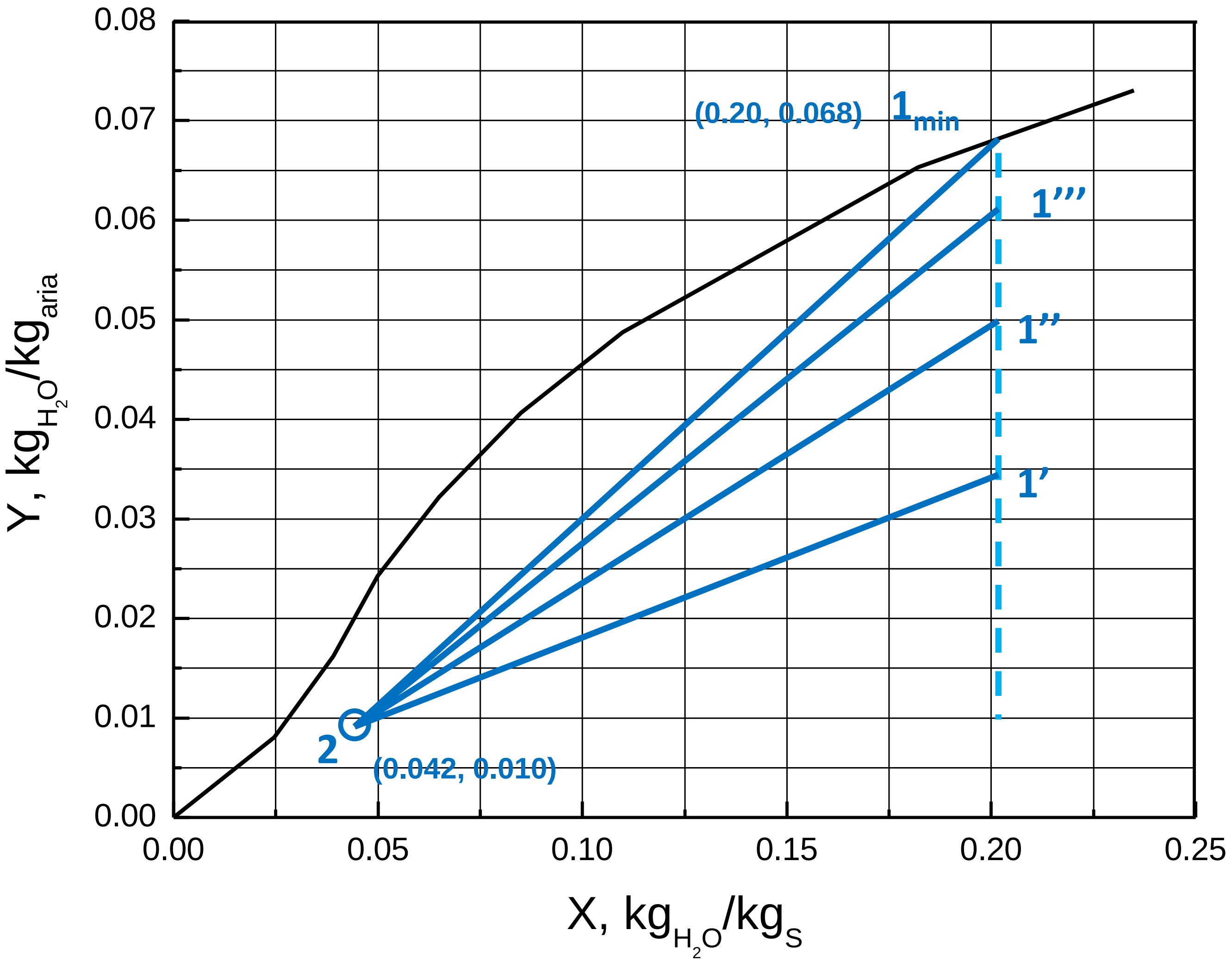


b) Si vuole essiccare il sapone dal 16.7% al 4% in un processo continuo in controcorrente con aria di umidità 12 mm Hg. Qual è la portata d'aria minima richiesta per trattare 1 kg/h di sapone?



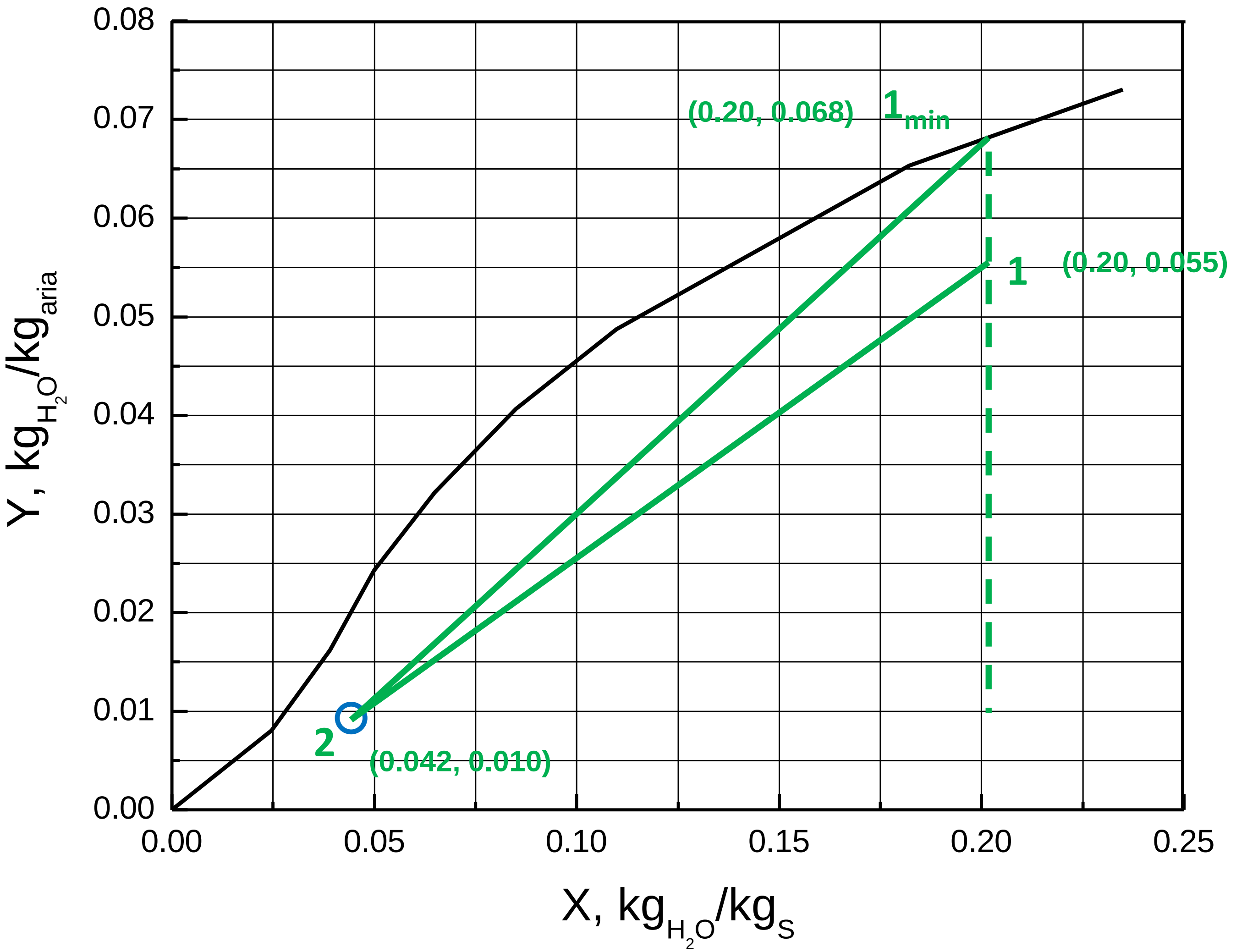
$$M_S\left(X - X_2\right) = M_G\left(Y - Y_2\right)$$

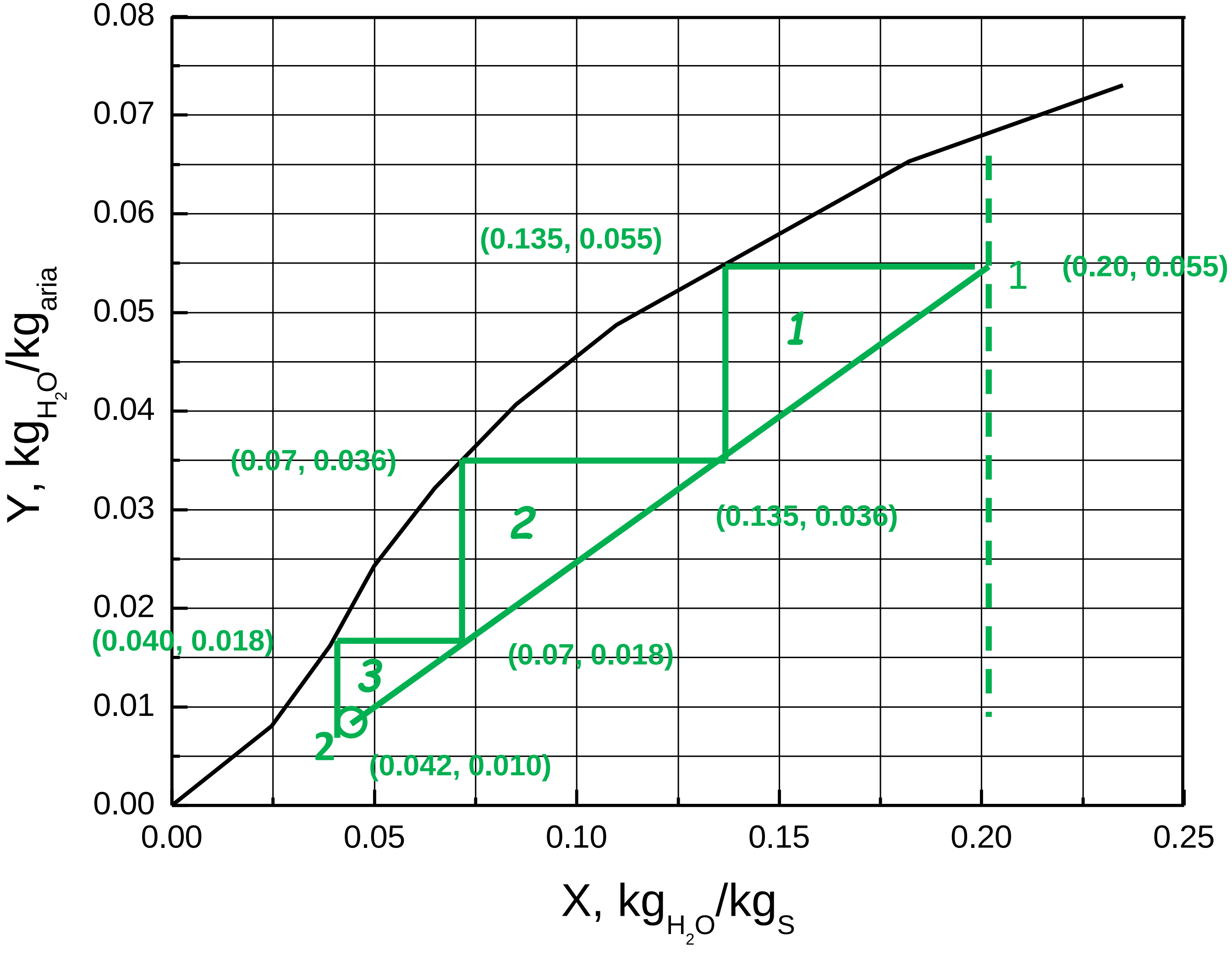
$$Y = \left(\frac{M_S}{M_G}\right)X + Y_2 - \left(\frac{M_S}{M_G}\right)X_2$$



C) Se si impiega una portata maggiore del 30% rispetto al valore di b), quale sarà l'umidità dell'aria in uscita dall'impianto? A quanti stadi di equilibrio sarà equivalente il processo?

$$\frac{M_S}{M_G} = \frac{(0.068 - 0.010)}{(0.20 - 0.042)} = 0.367$$





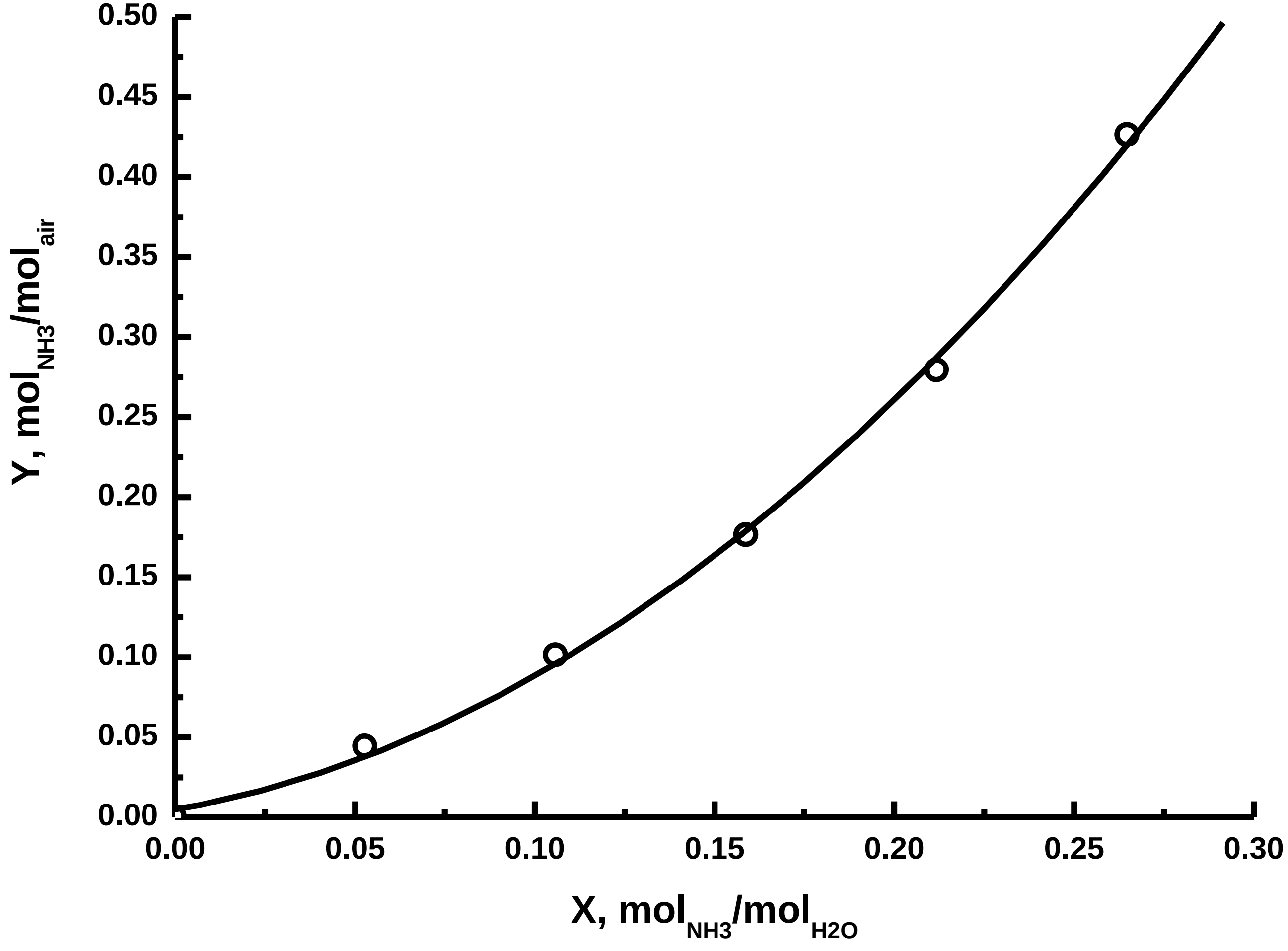
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.00
0.05
0.10
0.15
0.20
0.25
Y, kg_{H_2O}/kg_{aria}
X, kg_{H_2O}/kg_S
(0.135, 0.055)
(0.20, 0.055)
1
1
(0.07, 0.036)
2
(0.135, 0.036)
(0.040, 0.018)
3
(0.07, 0.018)
2
(0.042, 0.010)

ESERCIZIO 4

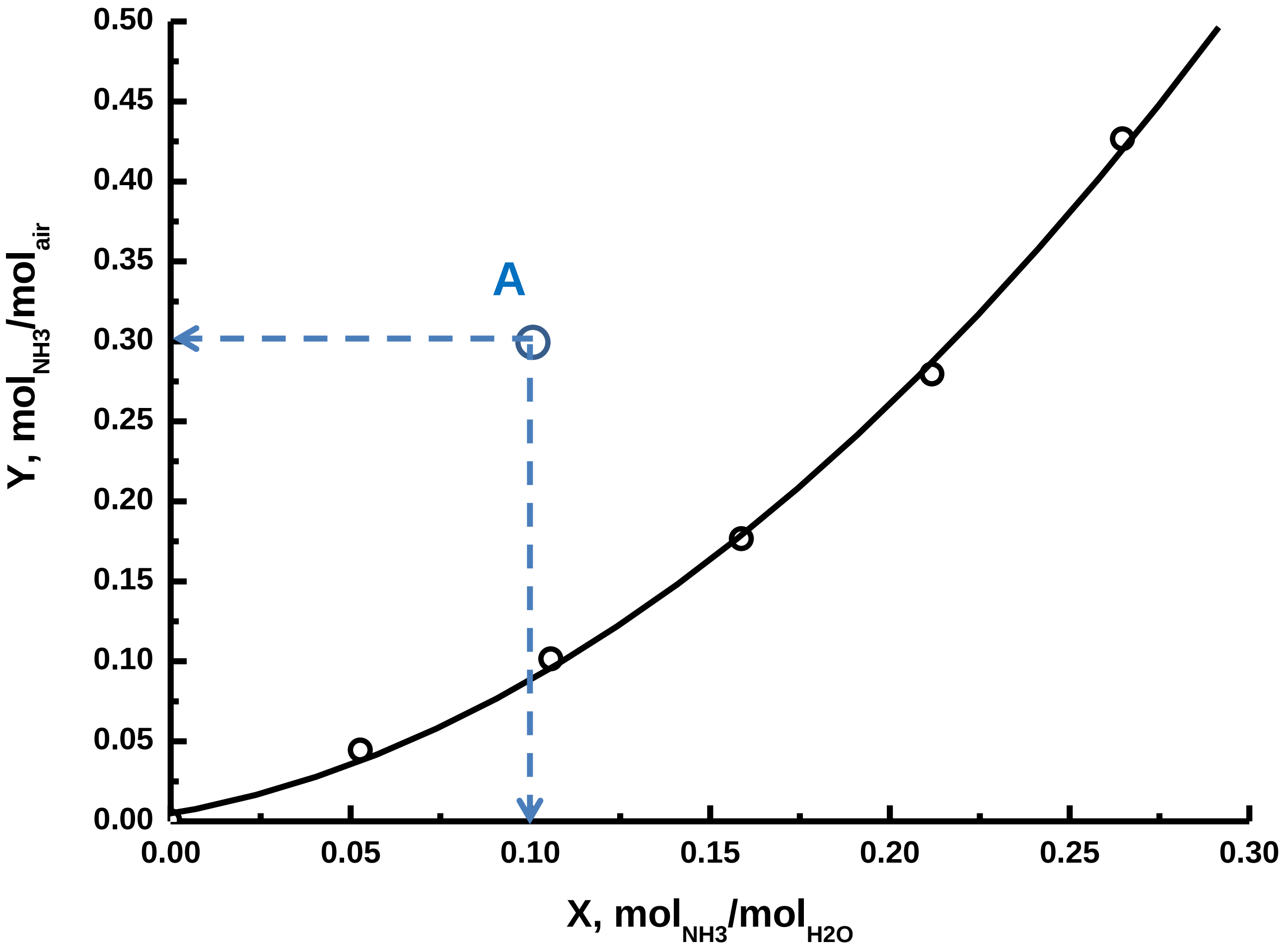
The partial pressure of ammonia (A) in air–ammonia mixtures in equilibrium with their aqueous solutions at 20 °C is given in the above table. Using these data, and neglecting the vapor pressure of water and the solubility of air in water, construct an equilibrium diagram at 101 kPa using mole ratios Y_A (mol NH_3/mol air) and X_A (mol NH_3/mol H_2O as coordinates. Henceforth, the subscript A is dropped. If 10 mol of gas of $Y = 0.3$ are contacted with 10 mol of solution of $X = 0.1$, what are the compositions of the resulting phases?

NH_3 Partial Pressure, kPa	g NH_3/g H_2O	Y, mol NH_3/mol	X, mol NH_3/mol
4.23	0.05	0.044	0.053
9.28	0.10	0.101	0.106
15.2	0.15	0.176	0.159
22.1	0.20	0.279	0.212
30.3	0.25	0.426	0.265

Using these data, and neglecting the vapor pressure of water and the solubility of air in water, construct an equilibrium diagram at 101 kPa using mole ratios Y_A (mol NH_3/mol air) and X_A (mol NH_3/mol H_2O as coordinates.



If 10 mol of gas of Y = 0.3 are contacted with 10 mol of solution of X = 0.1, what are the compositions of the resulting phases?



$$Y = -\left(\frac{n_L}{n_G}\right)X + \left(\frac{n_L}{n_G}\right)X_0 + Y_0$$

$$-\frac{n_L}{n_G} = -\frac{10}{10} = -1$$