Processos de Separação

Extracção Líquido – Líquido / Liquid – Liquid Extraction

1.

Pretende-se extrair o ácido acético contido em 800g de uma solução aquosa com 55% (percentagem mássica de ácido acético) (T = 20ºC), adicionando-se 400g de éter isopropílico, sem variação de temperatura.

a) Determinar as composições e massas das fases em equilíbrio, depois da adição do éter;

b) Para a remoção do ácido ainda existente na fase refinada obtida da operação anterior, adiciona-se éter isopropílico na proporção de 1:1. Determine as composições e as massas das novas fases em equilíbrio.

The aim is to extract the acetic acid contained in 800g of an aqueous solution with 55% (mass percentage of acetic acid) (T = 20ºC), by adding 400g of isopropyl ether without varying the temperature.

a) Determine the compositions and masses of the phases in equilibrium, after the addition of ether;

b) To remove the acid still present in the raffinate phase obtained from the previous operation, isopropyl ether is again added in a 1:1 ratio. Determine the compositions and masses of the new phases at equilibrium.

Experimental data:

For the isopropyl ether – water – acetic acid ternary system, the conjugated phases have the following compositions at 20 ºC:

Organic phase			Aqueous phase		
Isopropyl ether	Acetic acid	water	Isopropyl ether	Acetic acid	water
98.80	0.00	1.20	0.80	0.00	99.20
87.50	10.00	2.50	1.70	5.00	93.30
76.20	20.00	3.80	2.10	10.00	87.90
60.00	30.00	10.00	2.50	15.00	82.50
39.00	41.50	19.50	3.30	25.00	71.70
27.50	45.00	27.50	3.50	30.00	66.50
19.70	46.80	33.50	4.20	35.00	60.80
13.00	46.00	41.00	5.60	40.00	54.40

2.

Pretende-se recuperar acetona de uma solução aquosa a 30 ºC usando acetato de etilo, $CH_3COOCH_2CH_3$, como solvente.

A corrente de alimentação, contendo 25 % de acetona e 75 % de água, entra na base da coluna de extracção a um caudal de 250 kg/h. O solvente, puro, entra no topo a um caudal de 97 kg/h. Deseja-se um produto refinado com 10 % de acetona. Calcule:

a) A concentração e o caudal da corrente de extracto;

b) O número de andares de equilíbrio necessários para esta separação.

The aim is to recover acetone from an aqueous solution at 30 ºC using ethyl acetate, $CH_3COOCH_2CH_3$, as solvent.

The feed stream, containing 25% acetone and 75% water, enters the base of the extraction column at a flow rate of 250 kg/h. The pure solvent enters at the top of the column at a flow rate of 97 kg/h. A raffinate product with 10% acetone is desired. Calculate:

a) The concentration and flow rate of the extract stream;

b) The number of equilibrium stages required for this separation.

Experimental data:

Equilibrium data		
Ethyl acetate	Acetone	Water
7.4	0.0	92.6
8.0	7.6	84.4
9.9	16.1	74.0
11.9	21.1	67.0
13.6	24.3	62.1
15.5	27.0	57.5
17.4	29.2	53.4
19.2	31.1	49.7
24.0	33.8	42.2
25.5	34.6	39.9
29.0	36.0	35.0
36.7	37.0	26.3
44.4	36.1	19.5
47.6	35.0	17.4
55.0	32.0	13.0
62.5	27.5	10.0
70.0	22.4	7.6
77.0	17.0	6.0
83.7	11.2	5.1
96.5	0.0	3.5

Organic phase			Aqueous phase		
Ethyl acetate	Acetone	Water	Ethyl acetate	Acetone	Water
91.0	4.8	4.2	8.3	3.2	88.5
85.8	8.7	5.5	8.0	6.0	86.0
80.5	13.4	6.1	8.3	9.5	82.2
76.2	17.6	6.2	9.2	12.8	78.0
73.0	20.0	7.0	9.8	14.8	75.4
69.4	23.2	7.4	10.2	17.5	72.3
65.1	25.8	9.1	12.2	19.8	68.0
62.2	27.4	10.4	11.8	21.2	67.0
54.0	32.7	13.3	15.0	26.4	58.6

3.

Nicotina é extraída de uma solução aquosa usando querosene como solvente. A água e o querosene são imiscíveis.

a) Se tiver uma solução aquosa com 1% (percentagem mássica) de nicotina determine a percentagem de extracção usando 150 kg de solvente por cada 100 kg de alimentação;

b) Qual a percentagem de extracção se forem usados 3 andares de equilíbrio e 50 kg de solvente em cada.

Nicotine is extracted from an aqueous solution using kerosene as a solvent. Water and kerosene are immiscible.

a) If you have an aqueous solution with 1% (mass percentage) of nicotine, determine the extraction percentage using 150 kg of solvent per 100 kg of feed;

b) What is the extraction percentage if 3 equilibrium stages and 50 kg of fresh solvent are used in each stage.

Experimental data:

Equilibrium curve for the system nicotine – water - kerosene

x' (kg nicotine/kg water)	y' (kg nicotine/kg water)
0.0	0.0
0.00101	0.000807
0.00246	0.001961
0.00502	0.004560
0.00751	0.006860
0.00998	0.009130
0.02040	0.01870

4.

Se 1000 kg/h de uma solução aquosa contendo 1% de nicotina for contactada com querosene a 20 ºC para reduzir o teor em nicotina para 0.1% determine:

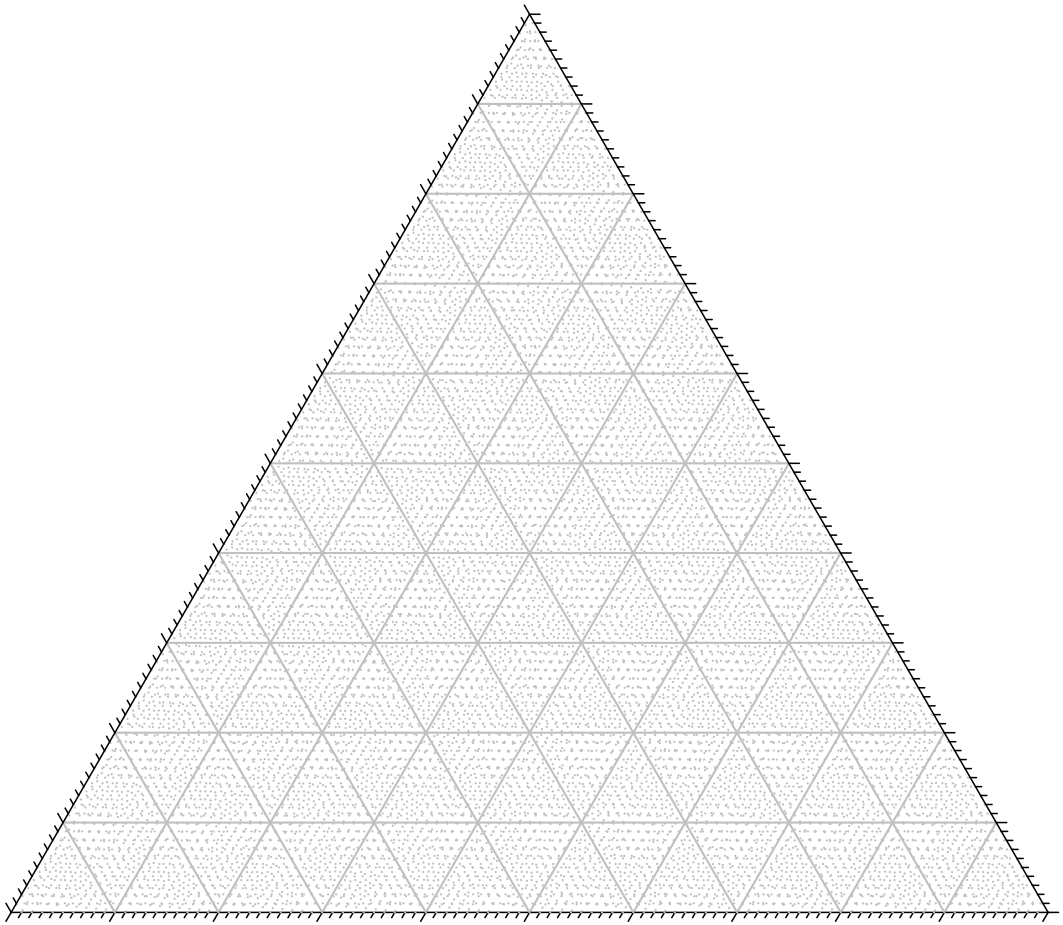
a) O caudal mínimo de solvente;

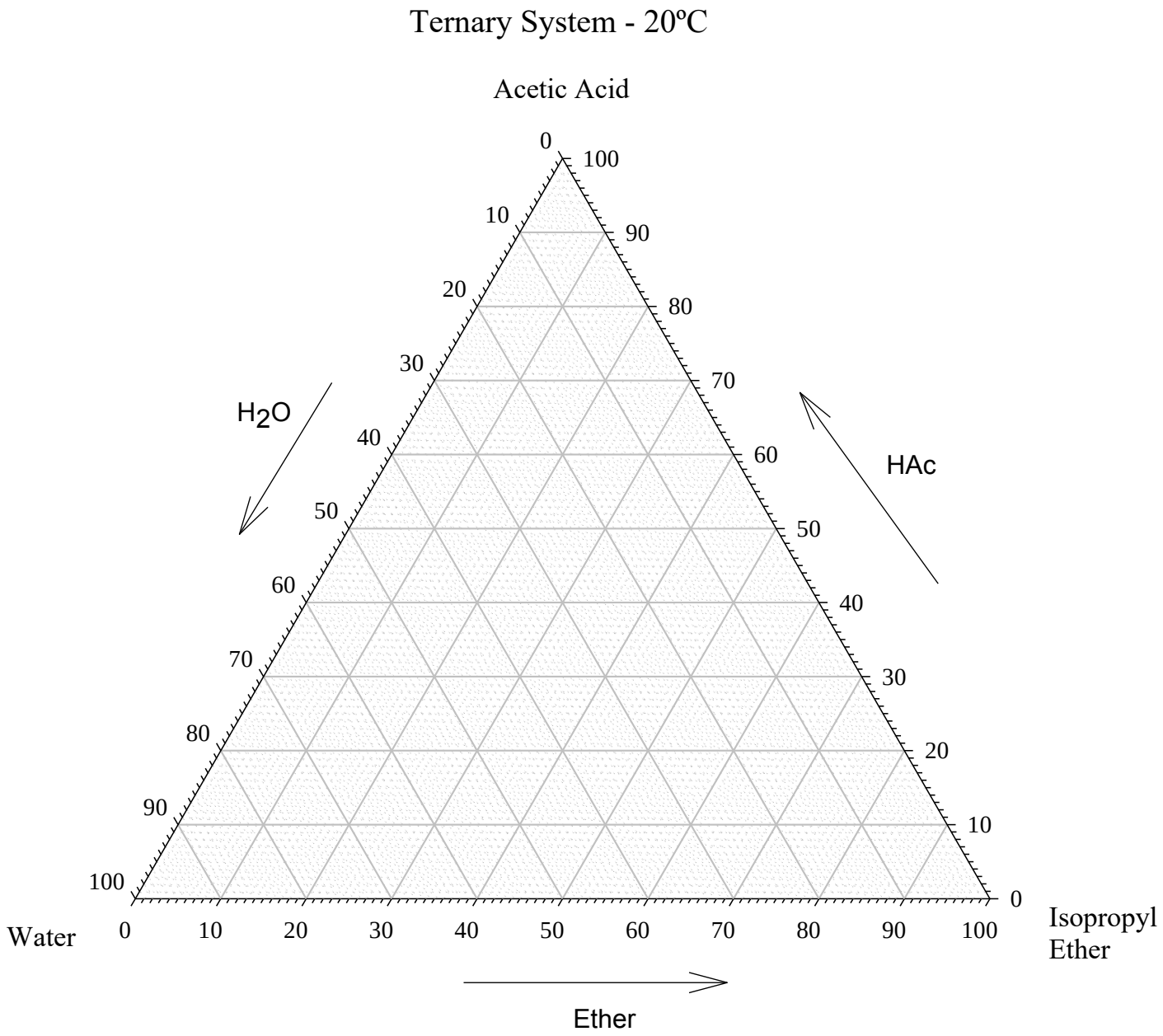
b) O número de andares necessários, se o caudal de solvente for de 1150 kg/h.

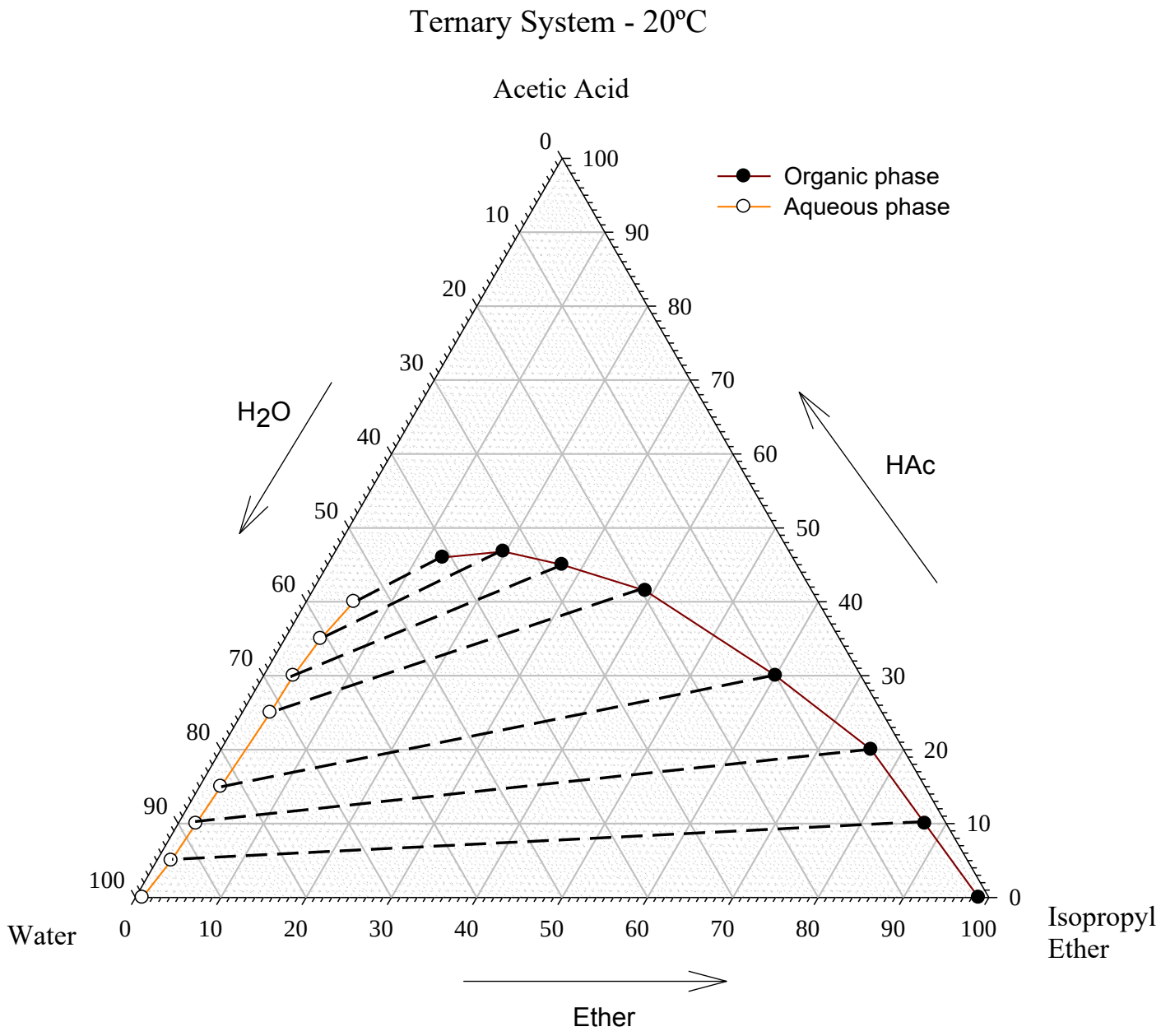
If 1000 kg/h of an aqueous solution containing 1% nicotine is contacted with kerosene at 20 ºC to reduce the nicotine content to 0.1% determine:

a) The minimum solvent flow rate;

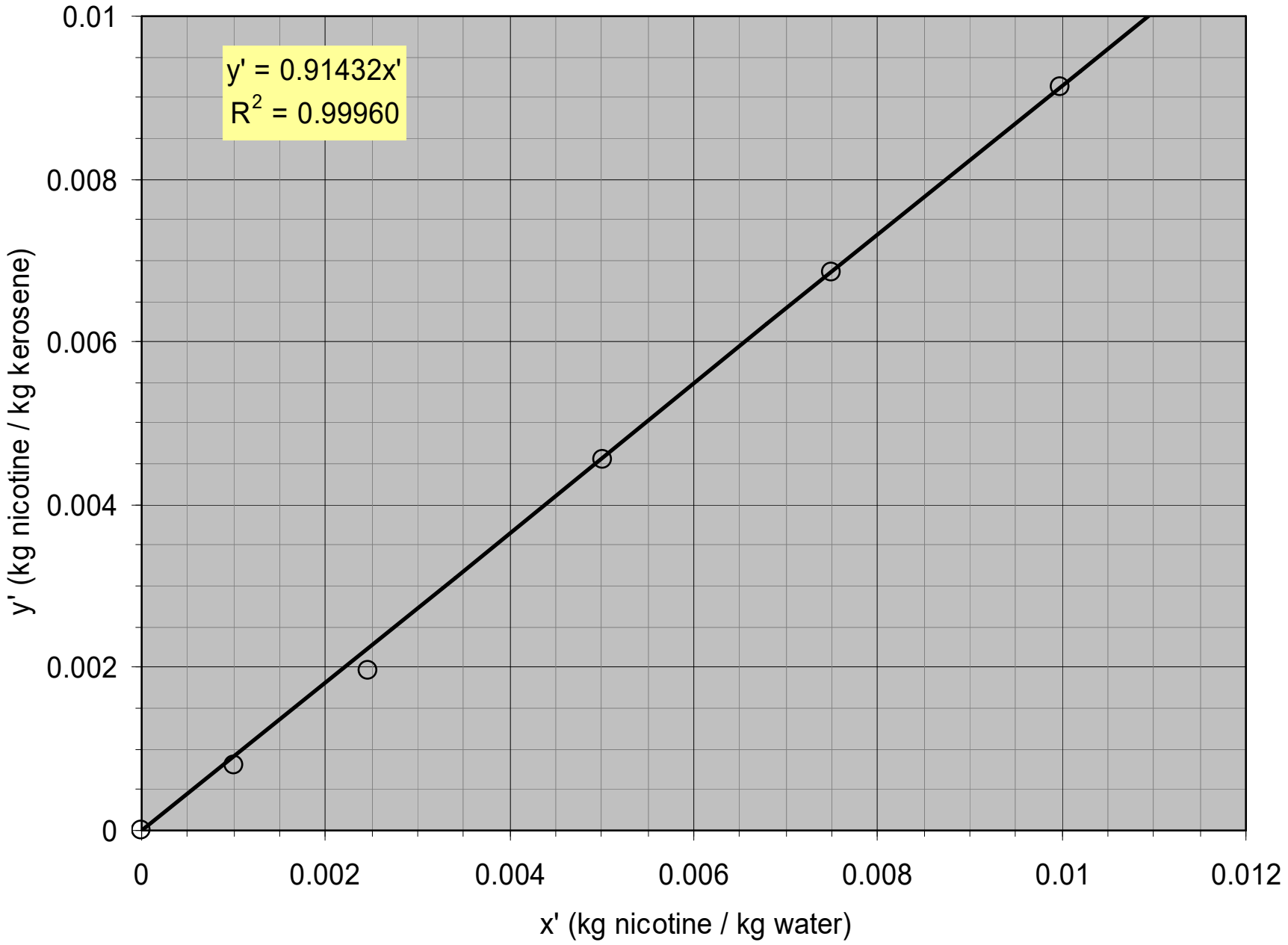
b) The number of stages required if the solvent flow rate is 1150 kg/h.



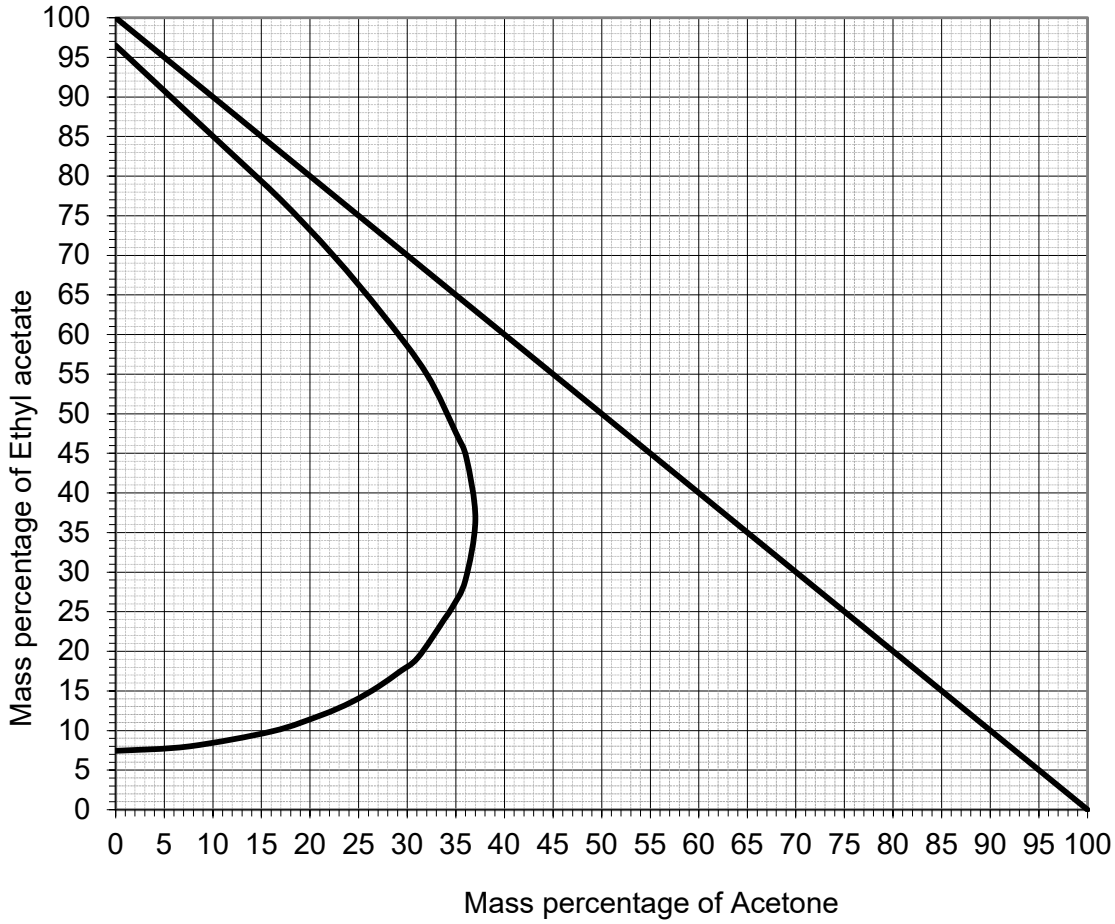

Ternary System - 20ºC
Acetic Acid
0
100
10
90
20
80
30
70
40
60
50
50
60
40
70
30
80
20
90
10
100
0
H_2O
HAc
Water
0 10 20 30 40 50 60 70 80 90 100
Isopropyl Ether
Ether


Ternary System - 20ºC
Acetic Acid
Organic phase
Aqueous phase
H2O
HAc
Water
Isopropyl Ether
Ether
0
10
20
30
40
50
60
70
80
90
100

Equilibrium diagram for the system:
Water, Kerosene, Nicotine



Equilibrium diagram for the system
Water, Acetone, Ethyl acetate



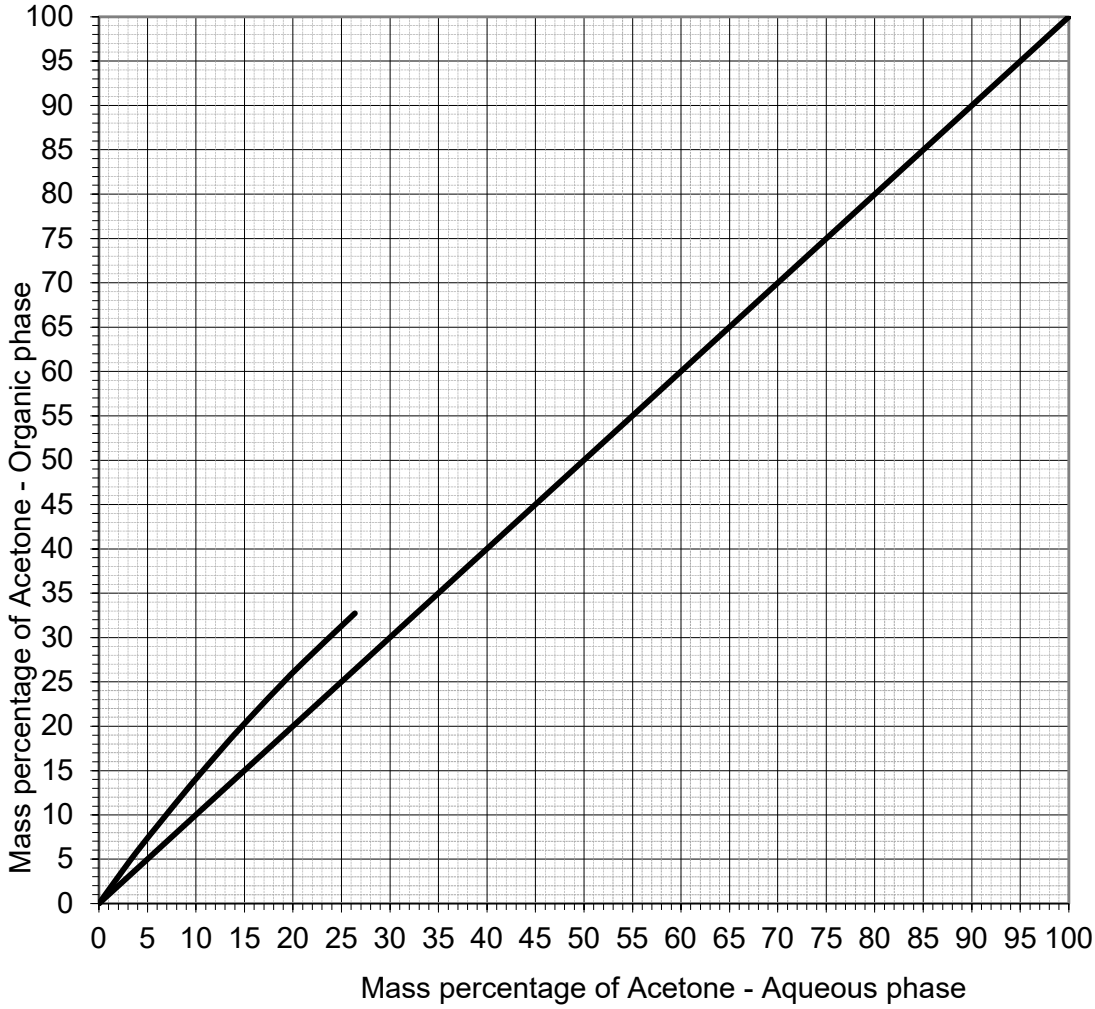


Diagrama de equilíbrio para o sistema
Água, Acetona, Acetato de etilo

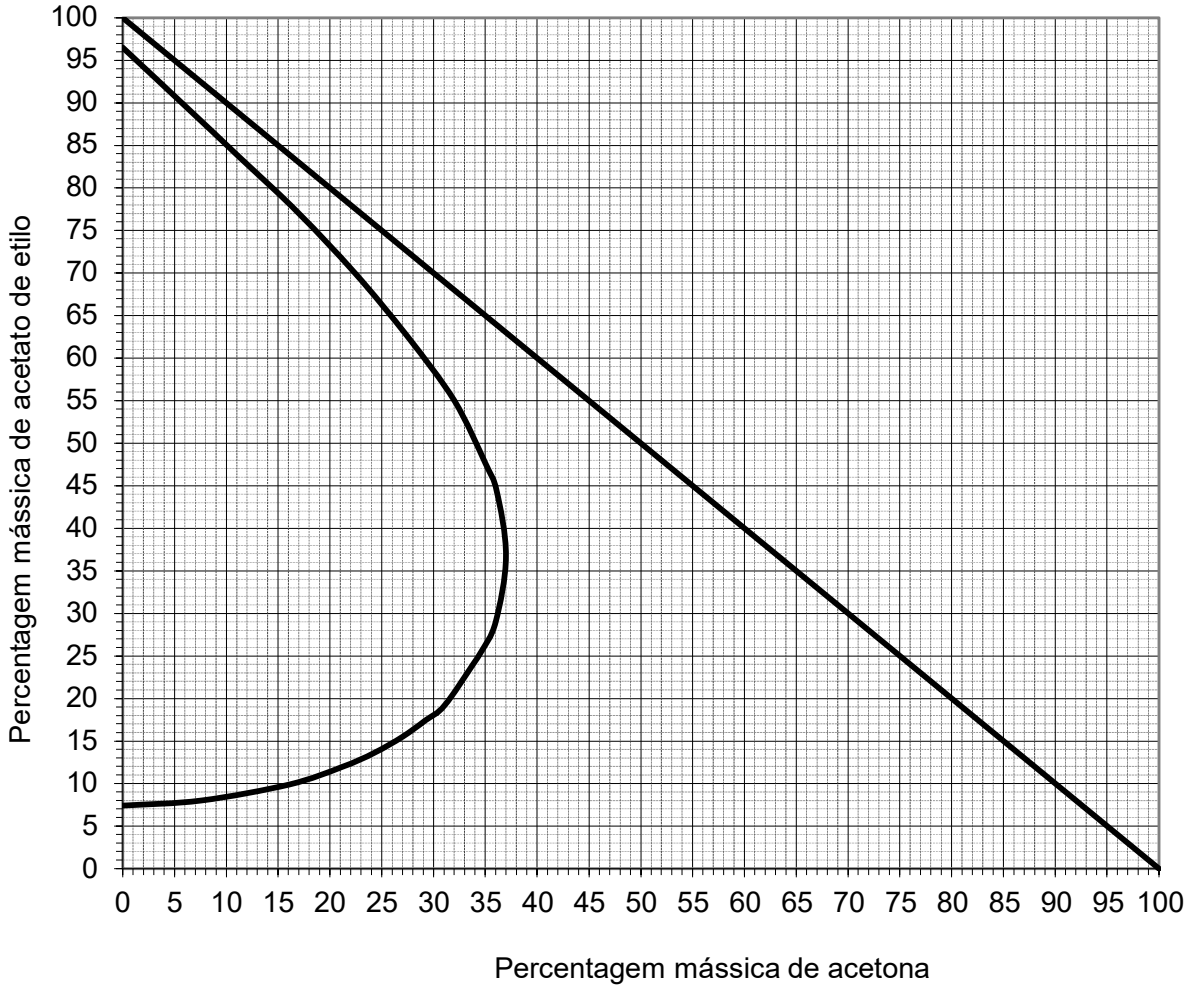


Diagrama de equilíbrio para o sistema
Água, Acetona, Acetato de etilo