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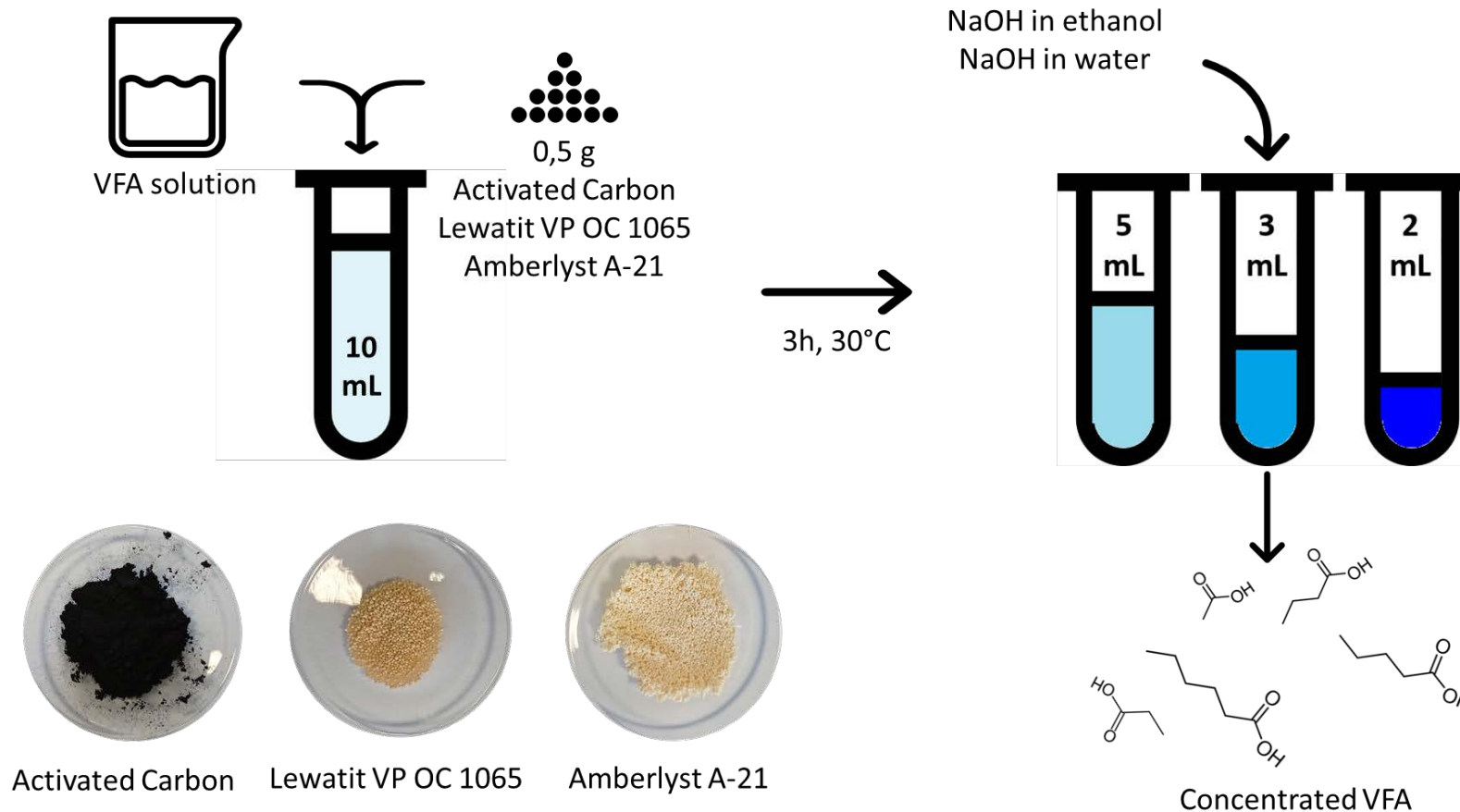
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VFA RECOVERY FROM ANAEROBIC
FERMENTATE: FOCUSING ON ADSORPTION
AND DESORPTION PERFORMANCES

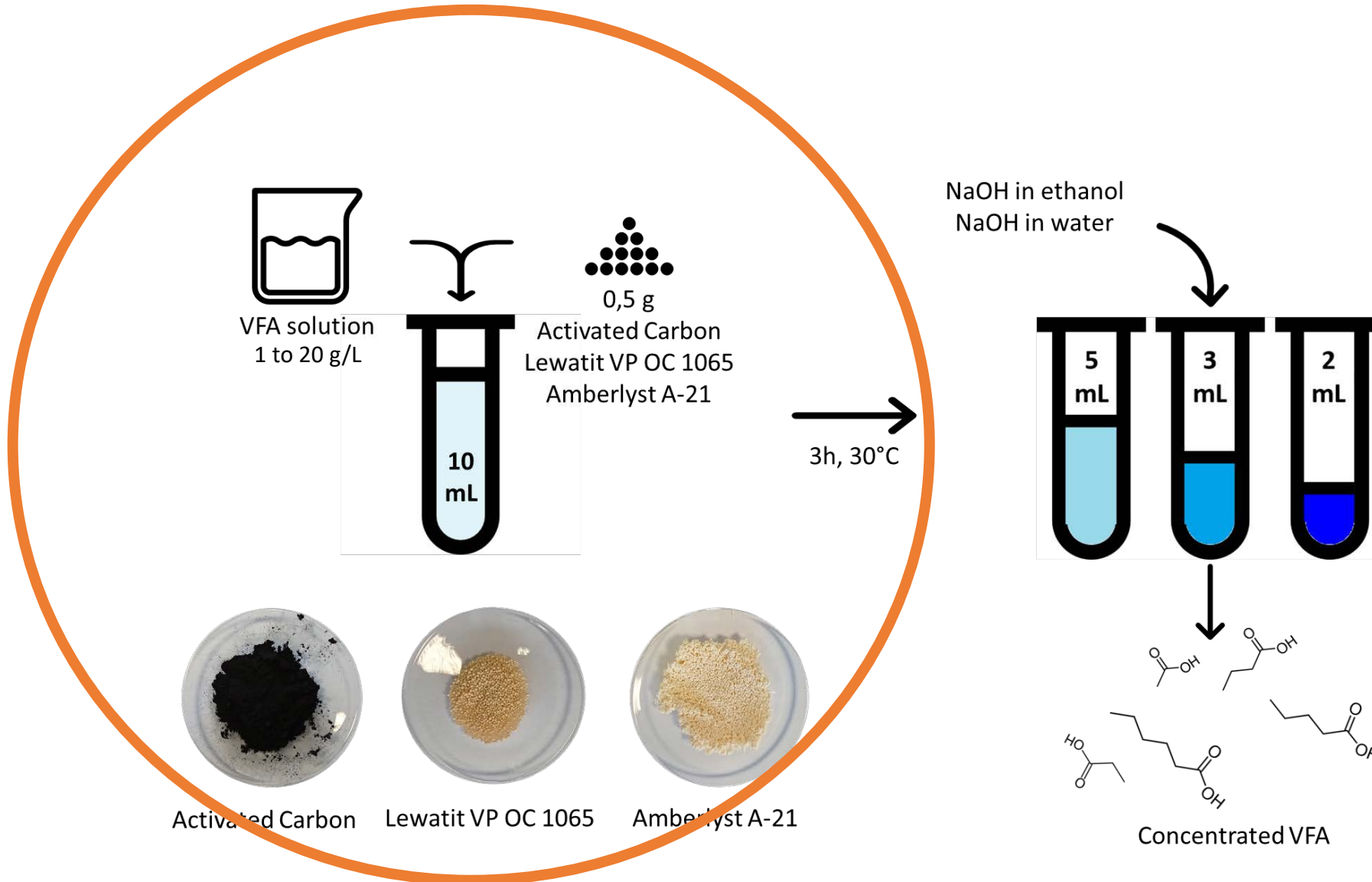
AIM OF THIS WORK

Aim of this work is the investigation on the conditions optimizing the purification and concentration of Volatile Fatty Acids from anaerobic fermentate by sequential adsorption/desorption operations.

The investigation has started studying the adsorption/desorption processes of synthetic VFA

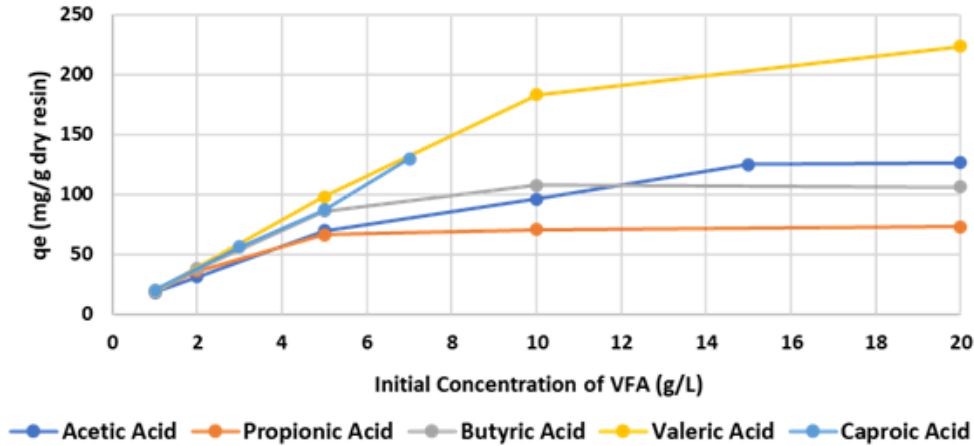


Adsorption of single synthetic VFA

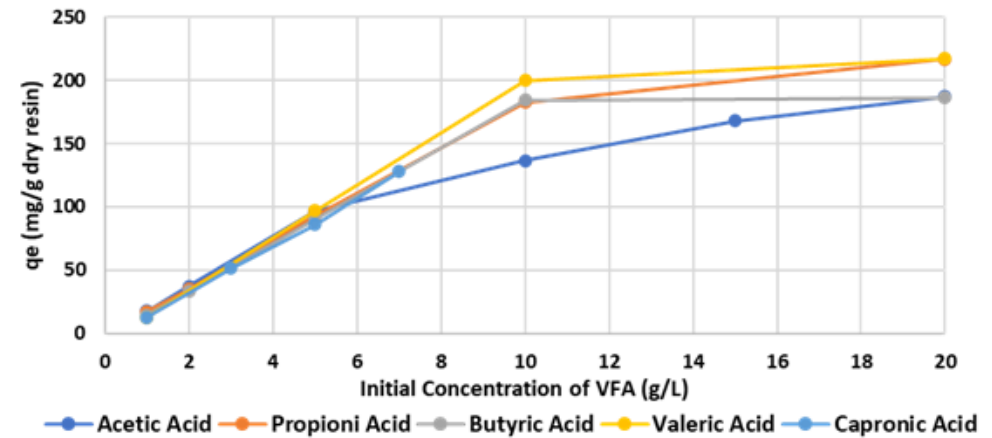


Adsorption on single VFA mix (1 to 20 g/L)

PAC Adsorption's Performance



Lewatit Adsorption's Performance



Amberlyst Adsorption's Performance

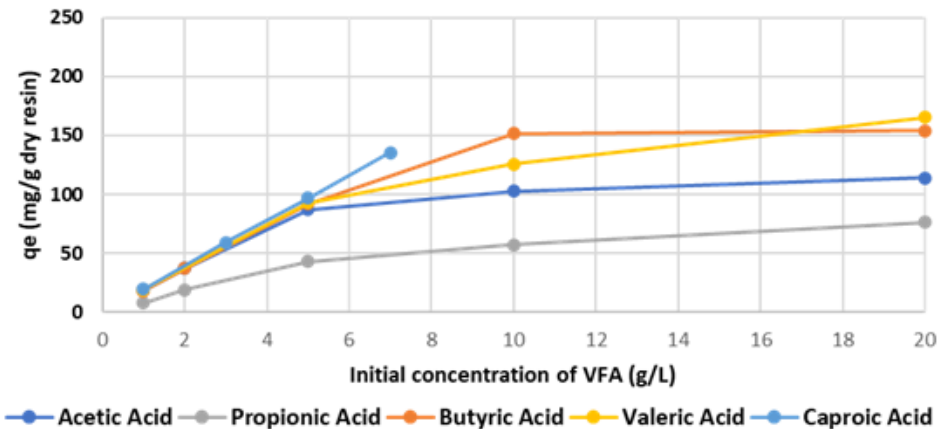


Figure 2. Specific adsorption capacity of the IEX matrices

2a. Specific adsorption on PAC

2b. Specific adsorption on lewatit

2c. Specific adsorption on amberlyst

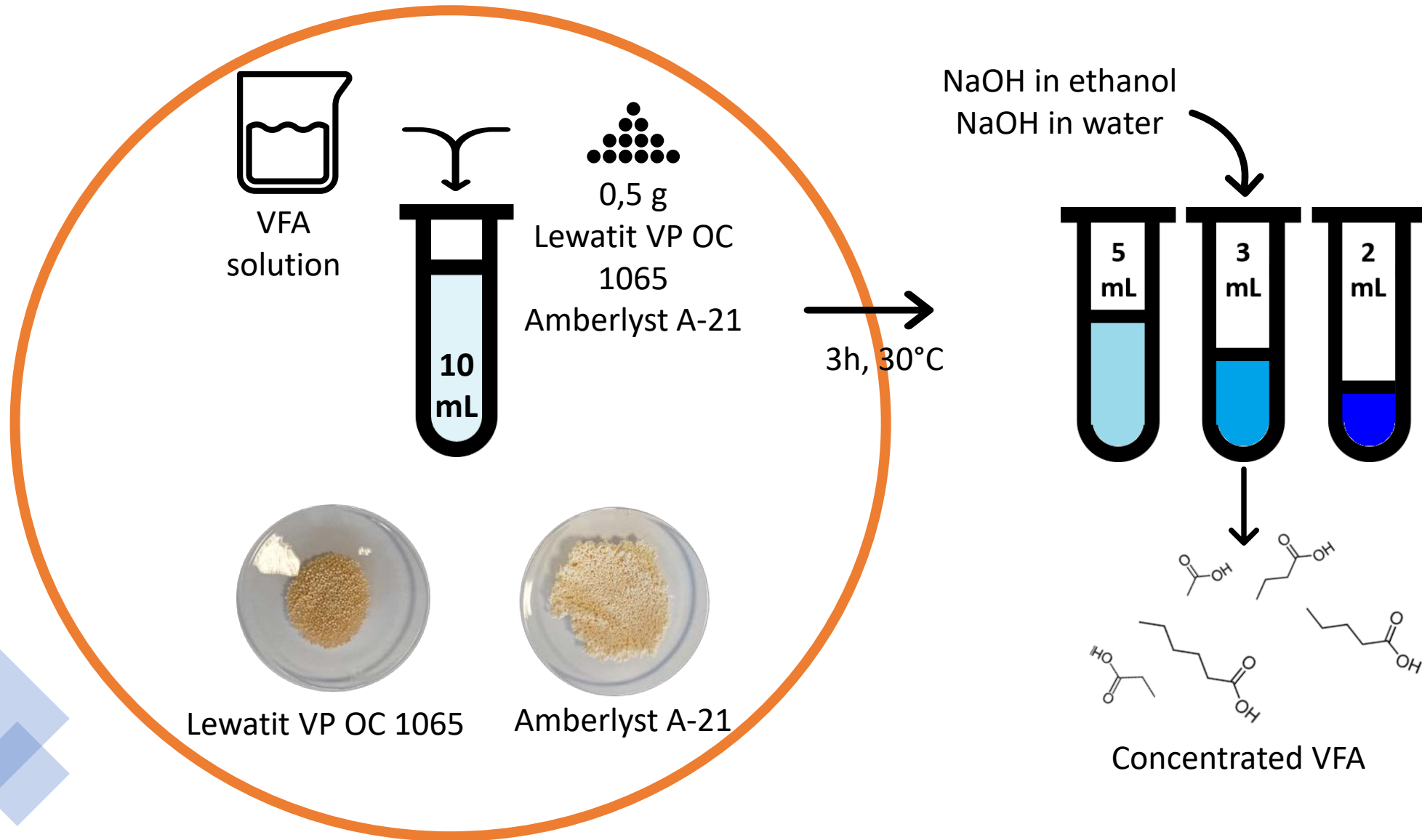
Specific capacity (q_e) and Langmuir's constant (b)

	PAC		Lewatit VC OP 1065		Amberlyst A 21	
	q_e (mg/g)	b (L/mg)	q_e (mg/g)	b (L/mg)	q_e (mg/g)	b (L/mg)
Acetic	153.76	11.66	182.20	24.12	114.91	23.44
Propionic	73.30	14.44	153.37	19.12	97.36	16.18
Butyric	107.96	16.86	207.55	27.81	146.92	23.39
Valeric	227.56	21.29	217.16	28.77	165.43	25.78

Physical properties of solid matrices

	PAC	Lewatit VP OC 1065	Amberlyst A-21
Chemical composition	Carbon	Styrene-divinylbenzene Primary amine (Benzyl amine)	Styrene-divinylbenzene Tertiary amine (Not specified in the technical sheet)
Particles size (mm)	0.001- 0.150	0.47 - 0.57	0.49 - 0.69
Approx pore volume (cm ³ /g)	0.65	0.27	0.10
Approx surface area (cm ² /g)	0.12	50.00	35.00

Adsorption of a synthetic VFA mixture



Adsorption Yields at 25 g/L VFA multi-solution

VFA	LEWATIT VP OC 1065	AMBERLYST A-21
	Adsorption Yield (%) from VFA Mixture tests	Adsorption Yield (%) from VFA Mixture tests
Acetic	26.21 ± 1.04	23.26 ± 2.93
Propionic	15.56 ± 0.48	16.42 ± 0.71
Butyric	18.90 ± 0.62	17.53 ± 0.39
Valeric	49.35 ± 2.59	23.63 ± 1.98
Caproic	74.20 ± 3.14	51.26 ± 2.03
Overall	40.85 ± 6.05	27.72 ± 5.83

- VFA mix composition: 5 g/L each VFA (C2 to C6) for a total of 25 gVFAs/L;
- After ~10 gVFAs/L the matrices saturates, thus leading to reduced yields;
- Lewatit VP OC 1065 has the best yields overall, as it has better Langmuir's constants and specific capacity than PAC and Amberlyst;
- Longer the chain, better the yields.

Chemical-Physical properties of VFAs

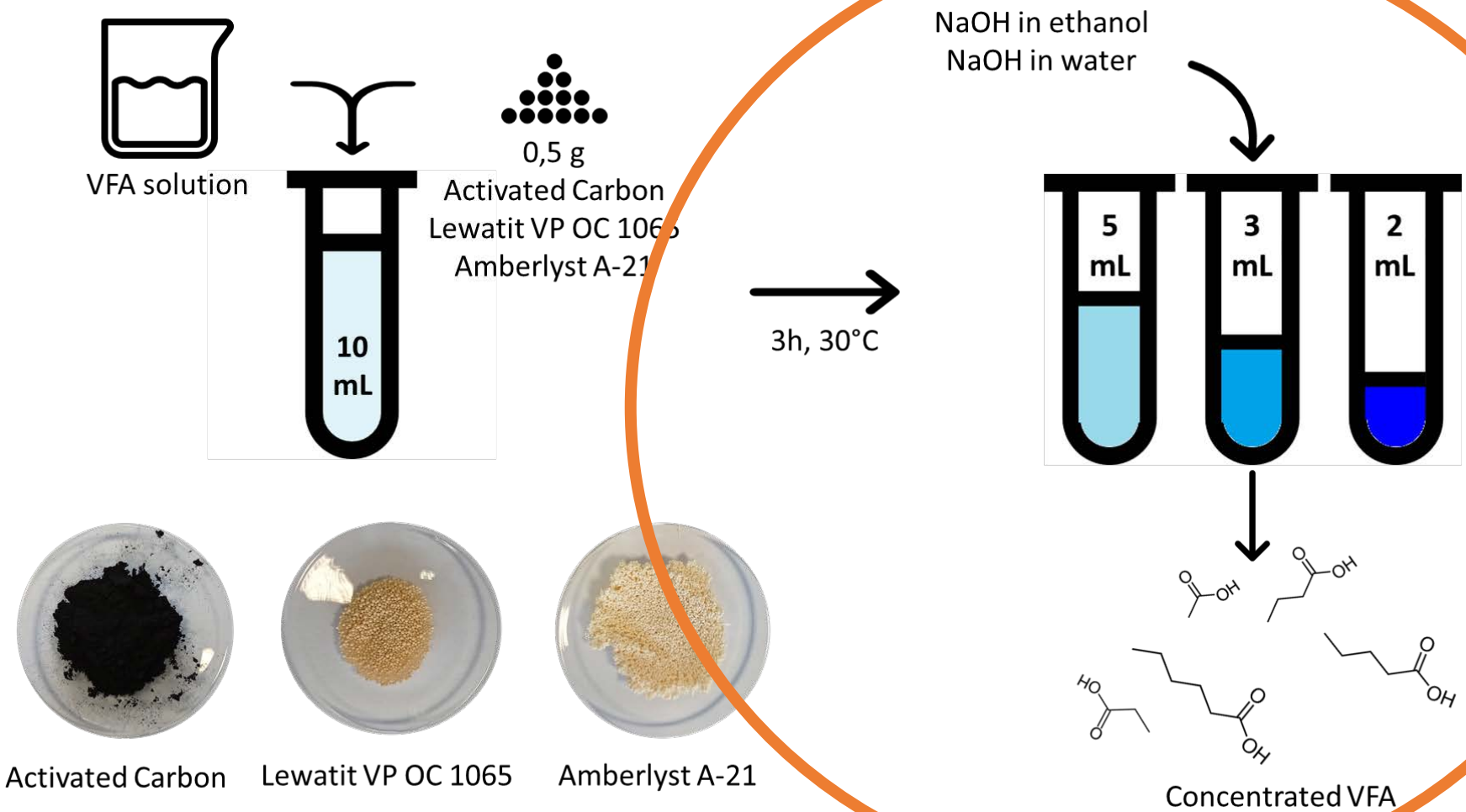
	Molecular formula	log Kow	Ka (at 25°C, 10⁻⁵)	pKa (at 25°C)	Vapor Pressure (at 20°C), Pa
Acetic Acid	C ₂ H ₄ O ₂	-0.20	1.76	4.74	1,540
Propionic Acid	C ₃ H ₆ O ₂	0.30	1.34	4.87	390
Butyric Acid	C ₄ H ₈ O ₂	0.79	1.54	4.82	57
Valeric Acid	C ₅ H ₁₀ O ₂	1.40	1.52	4.81	20
Caproic Acid	C ₆ H ₁₂ O ₂	1.90	1.31	4.88	27

- Valeric and Caproic Acids have the best log Kow values, indicating a high affinity for the resin;
- pKa values higher than the pH of solution (~3.50), indicates a physical-type adsorption.

Adsorption step highlights

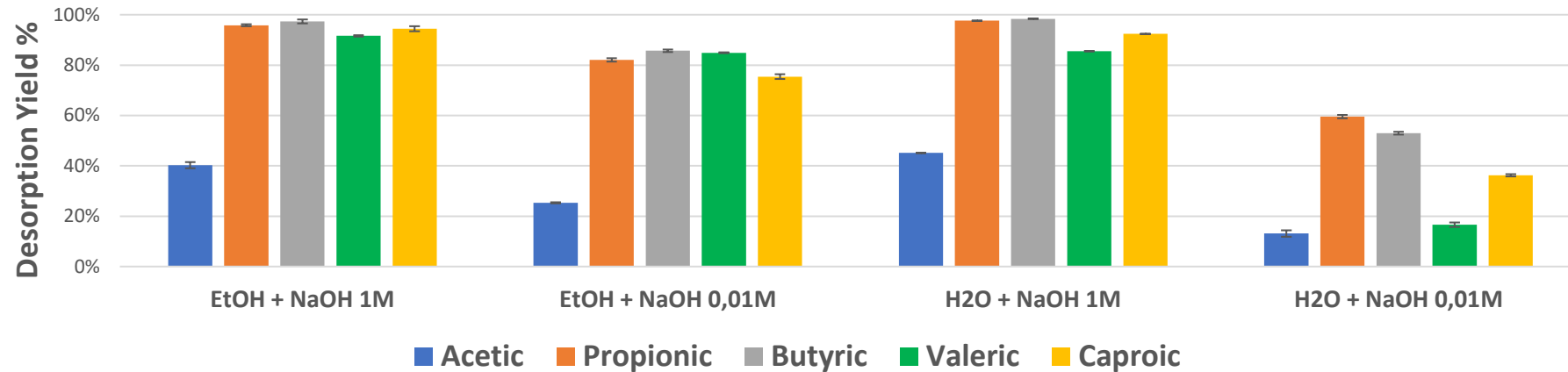
- Lewatit VP OC 1065 and Amberlyst A-21 showed the best performance on single and multi VFAs solutions;
- Powdered Activated Carbon was excluded from further trials for poor performance;
- On multi solution, longer chain VFAs are better adsorbed.

Desorption Step

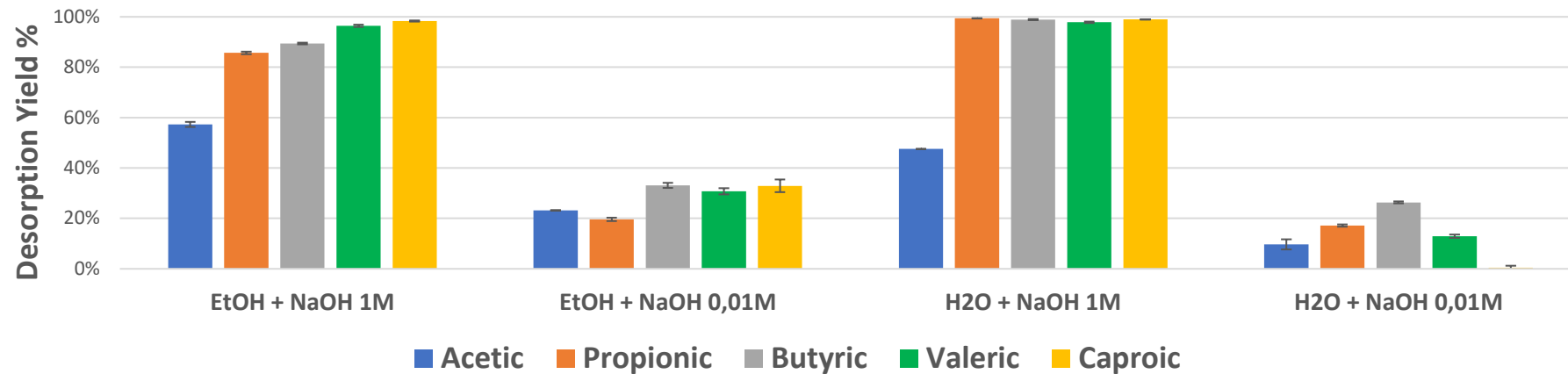


Desorption Step Yields at 5mL of desorbent

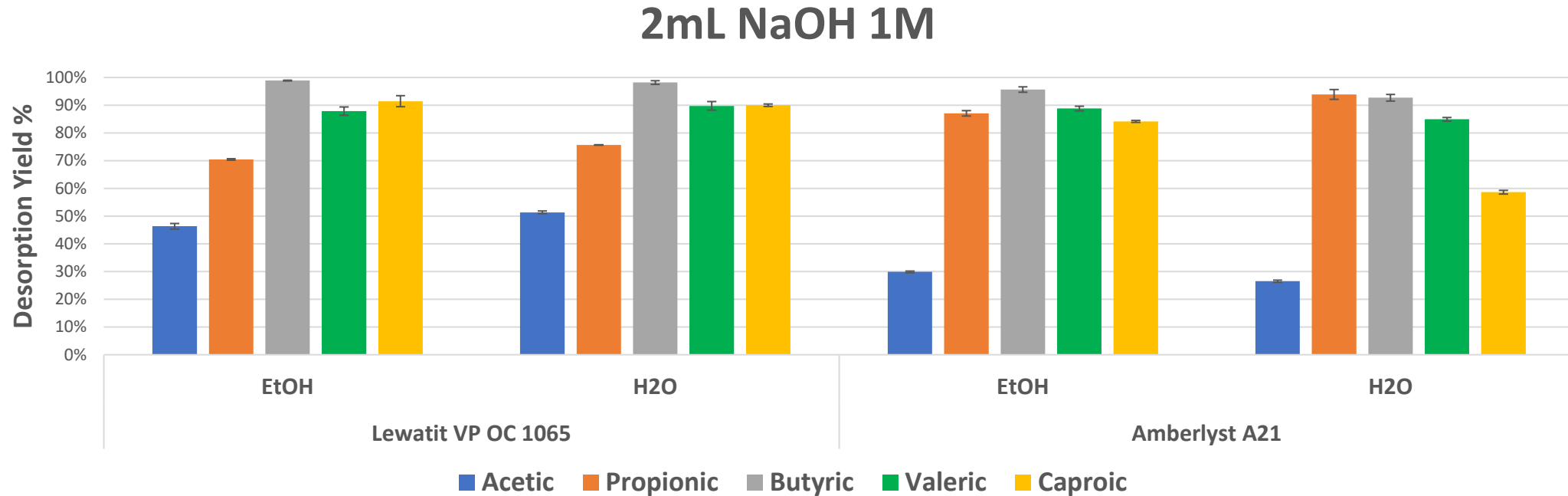
Amberlyst A-21



Lewatit VP OC 1065



Desorption Step Yield at 2mL of desorbent




- Desorption yields at 2 mL of desorbent are lower but consistent with the 5 mL desorption assay, at 1M NaOH;
- This allows to concentrate x5 the VFA volume: from 10 mL to 2 mL;
 - **VFAs concentration rises from 25 g/L to ~95 g/L.**

Adsorption and Desorptions overall results

- Best adsorption matrix: Lewatit VP OC 1065
- Best desorption conditions: 2 mL ethanol + NaOH 1M

On the next weeks, the best conditions will be applied on a real fermentate.



THANK YOU FOR THE
ATTENTION!