

# Transmembrane Chemical Absorption Process for Recovering Ammonia as an Organic Fertilizer Using Citric Acid as the Trapping Solution (Supplementary Information)

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**Table S1.** Ammonia distribution in the studied TMCA system configuration using sulfuric and citric acid as capturing solutions under different operational conditions

TS	pH	T	TAN <sub>o</sub> [mg]	Avg. TAN <sub>o</sub> [mg]	TAN <sub>f</sub> [mg]	Avg. TAN <sub>f</sub>	TAN <sub>p</sub> [mg]	Avg. Tan <sub>p</sub> [mg]
C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	10	22 °C	447,8	447,8	30,9	30,9	287,3	287,3
		40 °C	441,4	441	6,1	3,7	336,9	334,1
			441		1,2		331,2	
H <sub>2</sub> SO <sub>4</sub>	10	22 °C	445,4	445,4	11,7	11,7	359,4	359,4
		40 °C	437,4	437	1,5	1,5	427,7	403,8
			436,6		1,5		379,9	
C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	10,5	22 °C	435,0	435	22,2	22,2	351,3	351,3
		40 °C	436,6	435,8	0,8	1,1	320,3	344,0
			435,0		1,3		367,7	
H <sub>2</sub> SO <sub>4</sub>	10,5	22 °C	430,2	430,2	15,1	15,1	371,4	371,5
		40 °C	439,8	435	1,4	1,3	358,1	386,3
			430,2		1,0		414,4	

**Table S2.** Ammonia mass transfer in the studied TMCA system configuration using sulfuric and citric acid as capturing solutions under different operational conditions

	pH	T	J <sub>NH<sub>3</sub>, rem.</sub> [g·m <sup>-2</sup> ·d <sup>-1</sup> ]	Avg. J <sub>NH<sub>3</sub>, rem.</sub> [g·m <sup>-2</sup> ·d <sup>-1</sup> ]	J <sub>NH<sub>3</sub>, p</sub> [g·m <sup>-2</sup> ·d <sup>-1</sup> ]	Avg. J <sub>NH<sub>3</sub>, p</sub> [g·m <sup>-2</sup> ·d <sup>-1</sup> ]	NaOH [mL]	Avg. NaOH [mL]
C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	10	22 °C	21,4	21,4	4,0	4,0	6,4	8,01
		40 °C	22,4	22,5	4,7	4,6	7,2	
			22,6		4,6		7,0	
H <sub>2</sub> SO <sub>4</sub>	10	22 °C	21,6	21,6	5,0	5,0	8,0	
		40 °C	22,4	22,4	5,3	5,2	9,2	
			22,4		5,2		10,3	
C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	10,5	22 °C	21,7	21,7	4,9	4,9	9,2	10,19
		40 °C	22,4	22,3	4,4	4,8	9,3	
			22,3		5,1		9,7	
H <sub>2</sub> SO <sub>4</sub>	10,5	22 °C	21,3	21,3	5,1	5,1	12,2	
		40 °C	22,5	22,3	5,0	5,3	11,3	
			22,1		5,7		9,5	

Table S3. Operational expenses estimations

Pretreatment				
Parameter	Unit	Value	Value per kg of TAN	Reference
<b>Membrane</b>				
Membrane flux	$\text{L}\cdot\text{m}^{-2}\cdot\text{h}^{-1}$	25		
Membrane area	$\text{m}^2$	60	2,9	
<b>Pump</b>				
Head*	bar	5		
Nominal power	kW	8,25		
Operational level	% full capacity	80		
Operational time	$\text{h}\cdot\text{d}^{-1}$	24		
Pump energy consumption	$\text{kWh}\cdot\text{d}^{-1}$	158,4	7,5	
Energy price	$\text{€}\cdot\text{kWh}^{-1}$	0,3306		[1]
Energy cost	$\text{€}\cdot\text{d}^{-1}$	52,4	2,5	
TMCA				
Parameter	Unit	Value	Value per kg of N	Reference
<b>Circulation pump</b>				
Nominal power	kW	2,2		
Operational level	% full capacity	85		
Operational time	$\text{h}\cdot\text{d}^{-1}$	24		
Pump energy consumption	$\text{kWh}\cdot\text{d}^{-1}$	44,88	2,14	
Energy price	$\text{€}\cdot\text{kWh}^{-1}$	0,3306		[1]
Energy cost	$\text{€}\cdot\text{d}^{-1}$	14,8	0,7	
<b>Chemical consumption</b>				
NaOH 30% price	$\text{€}\cdot\text{kg}^{-1}$	0,77		[2]
NaOH 30% density	$\text{kg}\cdot\text{L}^{-1}$	1,36		
NaOH 30% requirement	$\text{L}\cdot\text{m}^{-3}$	8,01	0,38	
	$\text{kg}\cdot\text{m}^{-3}$	10,9	0,52	
	$\text{kg}\cdot\text{d}^{-1}$	381,3	18,16	
NaOH cost	$\text{€}\cdot\text{d}^{-1}$	293,6	14,0	
H <sub>2</sub> SO <sub>4</sub> 50% price	$\text{€}\cdot\text{kg}^{-1}$	0,48		[3]
H <sub>2</sub> SO <sub>4</sub> 50% consumption	H <sub>2</sub> SO <sub>4</sub> :TAN <sub>r</sub>	3,5		[4]
	$\text{kg}\cdot\text{d}^{-1}$	73,5		
H <sub>2</sub> SO <sub>4</sub> cost	$\text{€}\cdot\text{d}^{-1}$	35,3	1,7	
C <sub>6</sub> H <sub>8</sub> O <sub>7</sub> 50% price	$\text{€}\cdot\text{kg}^{-1}$	1,08		[5]
C <sub>6</sub> H <sub>8</sub> O <sub>7</sub> 50% consumption	$\text{kg}\cdot\text{d}^{-1}$	147	7	[5]
C <sub>6</sub> H <sub>8</sub> O <sub>7</sub> cost	$\text{€}\cdot\text{d}^{-1}$	158,8	7,6	

<b>Sales</b>				
<b>H<sub>2</sub>SO<sub>4</sub></b>				
Recovery efficiency	%	86,5		
Recovered TAN	kg·d <sup>-1</sup>	18,2		
Ammonium sulfate produced	kg·d <sup>-1</sup>	70,5		
Ammonium sulfate price	€·kg <sup>-1</sup>	0,43		[6]
<b>H<sub>2</sub>SO<sub>4</sub> sales</b>	<b>€·d<sup>-1</sup></b>	<b>30,3</b>	<b>1,4</b>	
<b>C<sub>6</sub>H<sub>8</sub>O<sub>7</sub></b>				
Recovery efficiency	%	75,8		
Recovered TAN	kg·d <sup>-1</sup>	15,9		
Ammonium citrate production	kg·d <sup>-1</sup>	195,70		
C <sub>6</sub> H <sub>11</sub> NO <sub>7</sub> price	€·kg <sup>-1</sup>	1,06		[5]
<b>C<sub>6</sub>H<sub>11</sub>NO<sub>7</sub> sales</b>	<b>€·d<sup>-1</sup></b>	<b>207,4</b>	<b>9,9</b>	

## References

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