SELECTIVE RECOVERY OF LITHIUM USING MEMBRANE TECHNOLOGY

ALTA 2019

24th Annual Event

Pan Pacific Hotel, Perth, Australia

18-25 May 2019

AMS TECHNOLOGIES
ADVANCED MEMBRANE SEPARATION

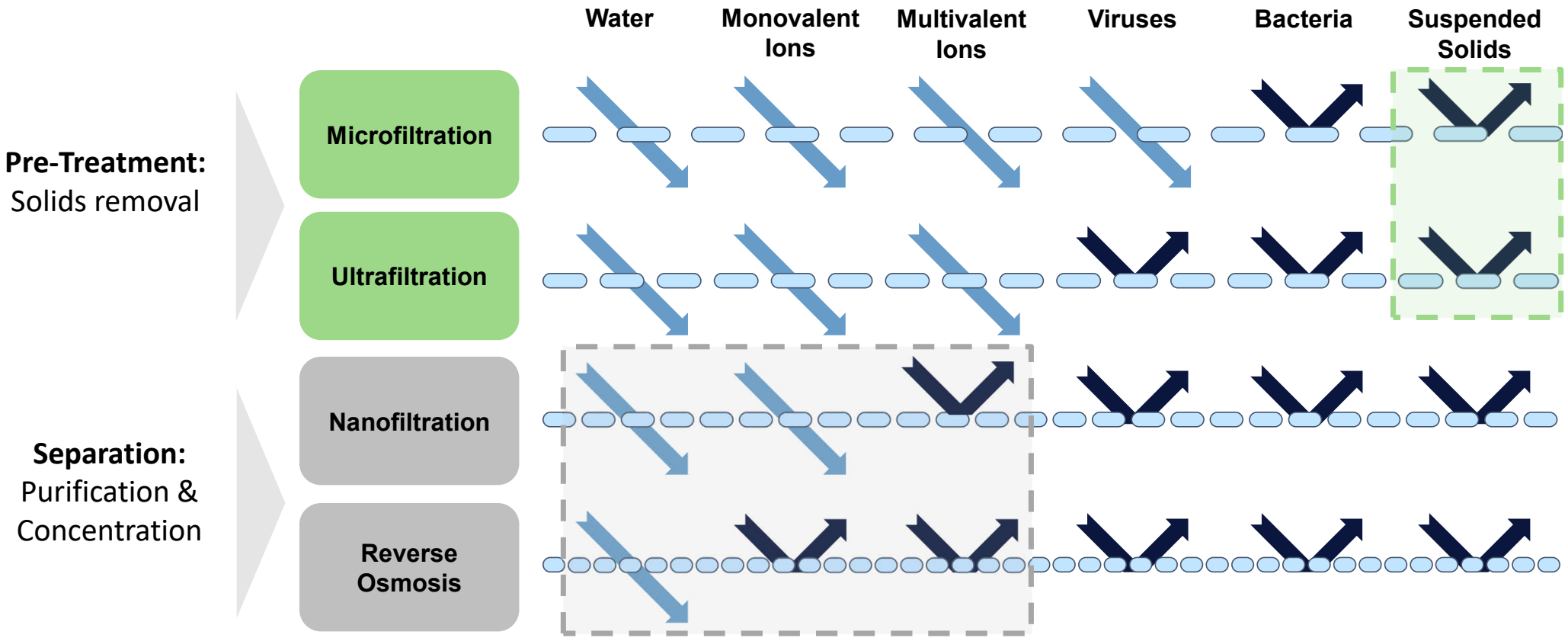
CHIMERICAL TECHNOLOGY

Implementation of membranes for separation, purification and concentration of lithium

INTRODUCTION

Membrane Rejection

Separation of components in solution based on size and charge



Membrane Separation

Various degrees of impurity separation

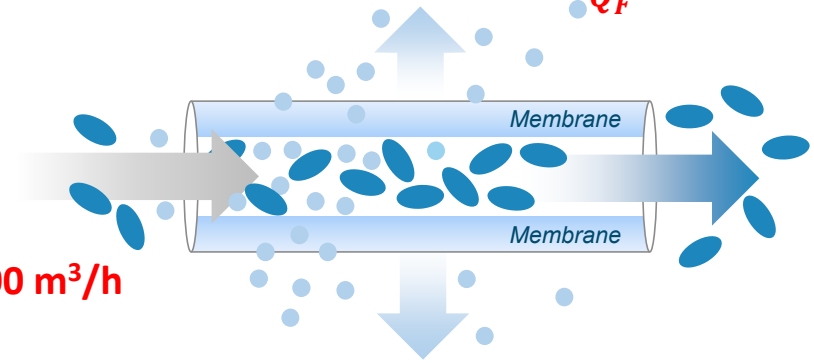
Microfiltration
+
Ultrafiltration
+
Nanofiltration
+
Reverse Osmosis

Membrane Process

Volumetric stream split and concentration

Copper / Cobalt electrolyte

80% Recovery = $\frac{Q_P}{Q_F}$



Feed

$Q_F = 100\ m^3/h$

Concentrate

$Q_C = 20\ m^3/h$

Permeate

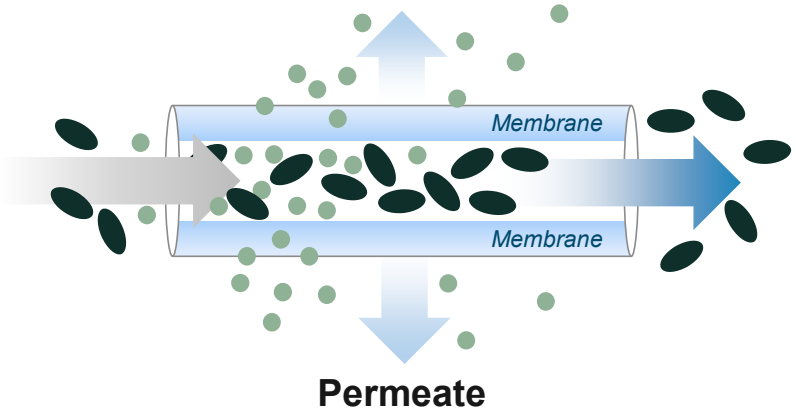
$Q_P = 80\ m^3/h$

- **Monovalent ions –** H^+, Na^+, Cl^-, Li^+…
- **Multivalent ions –** Mg^{2+}, $Fe^{2+/3+}$, Ca^{2+}…

Membrane Processes in Mining

Nickel tailings pond water

Nickel sulphate

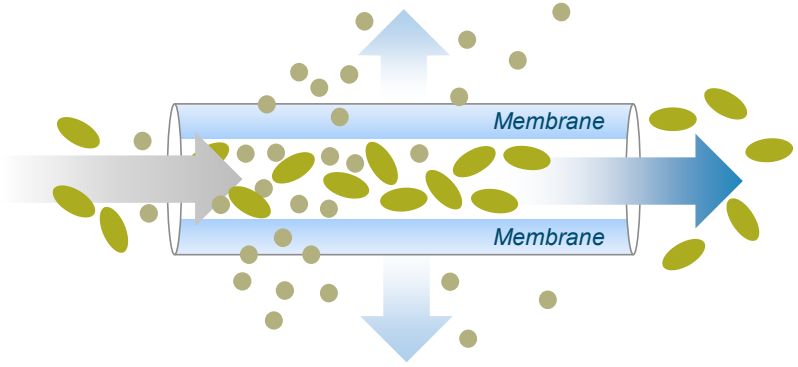


- **Monovalent ions –** H^+, Na^+, Cl^-, Li^+…
- **Multivalent ions –** Mg^{2+}, $Fe^{2+/3+}$, Ca^{2+}…

Membrane Processes in Mining

Concentrated uranium eluate stream

Uranium



- **Monovalent ions –** H^+, Na^+, Cl^-, Li^+…
- **Multivalent ions –** Mg^{2+}, $Fe^{2+/3+}$, Ca^{2+}…

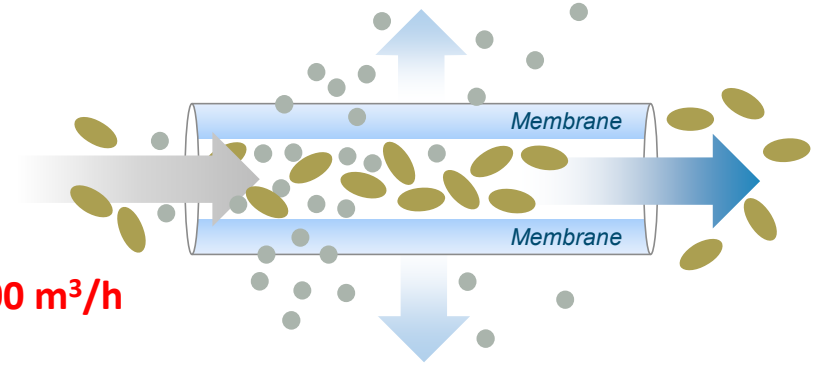
MEMBRANE PROCESSES IN MINING

Lithium separation from impurities

Lithium

Feed

$Q_F = 100\ m^3/h$



Concentrate

$Q_C = 20\ m^3/h$

Li^+
Na^+
K^+
H^+
Cl^-

Mg^{2+}
Ca^{2+}
Fe^{2+}
Fe^{3+}
Mn^{2+}
Al^{3+}

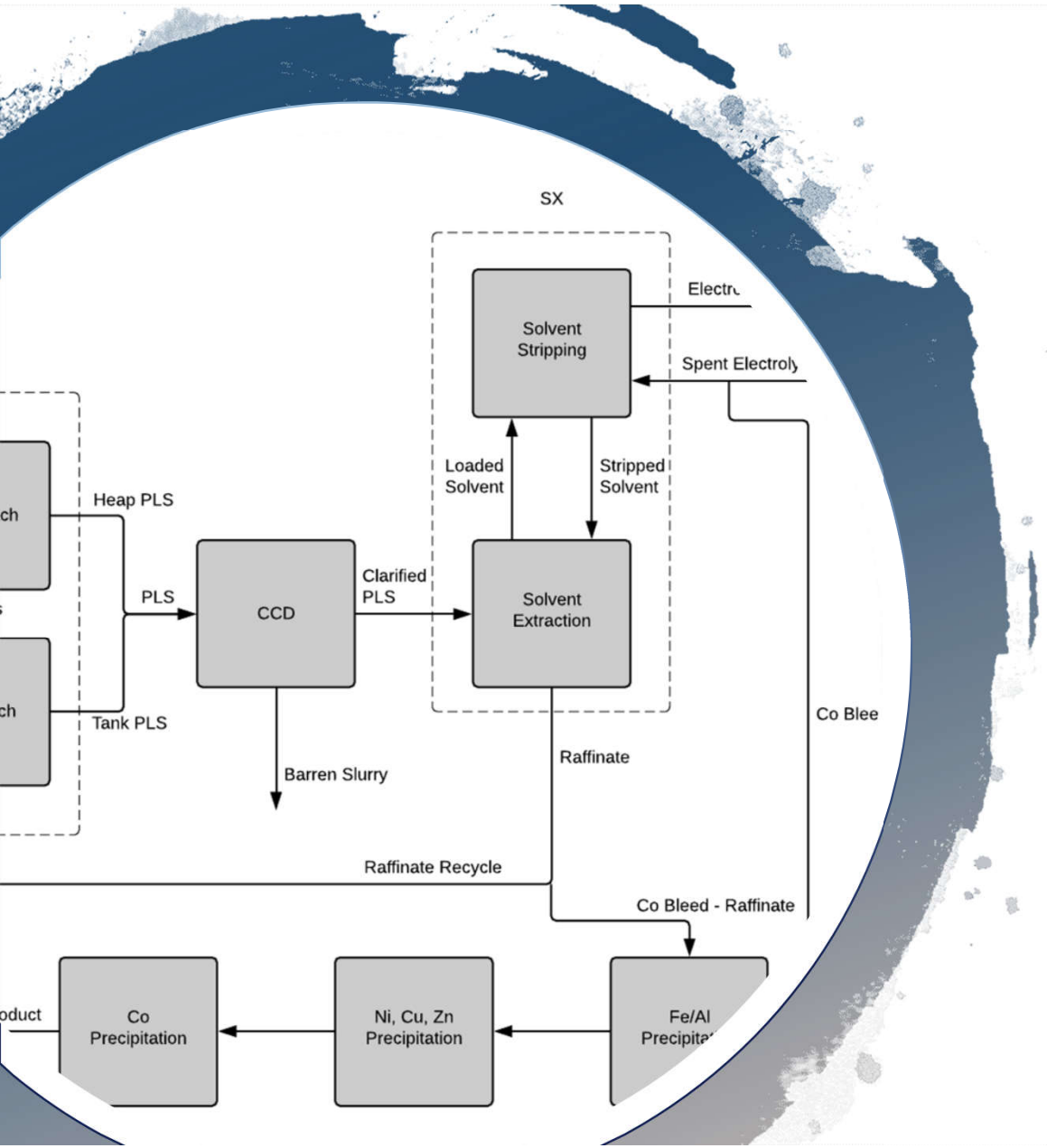
Permeate

$Q_P = 80\ m^3/h$

Li^+
Na^+
K^+
H^+
Cl^-

Li^+
Na^+
K^+
H^+
Cl^-

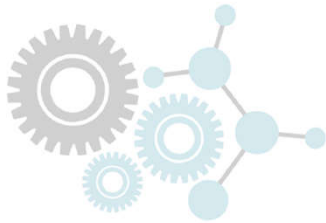
Mg^{2+}
Ca^{2+}
Fe^{2+}
Fe^{3+}
Mn^{2+}
Al^{3+}



Unit processes for membrane systems used in both lithium brine and hard-rock ore processing

SYSTEM DESIGN AND STUDIES

Membrane System Design



Design considerations

- High solids content
- High acidity, salinity, TDS
- Large volumes
- High concentration of impurities
- High temperature > 40°C
  (hard-rock ores)

PRETREATMENT

✓ Ceramic MF and UF membranes

PURIFICATION

✓ Acid-stable NF membranes

CONCENTRATION

✓ RO / IX systems

PRETREATMENT

Solids removal using micro- and ultrafiltration membranes

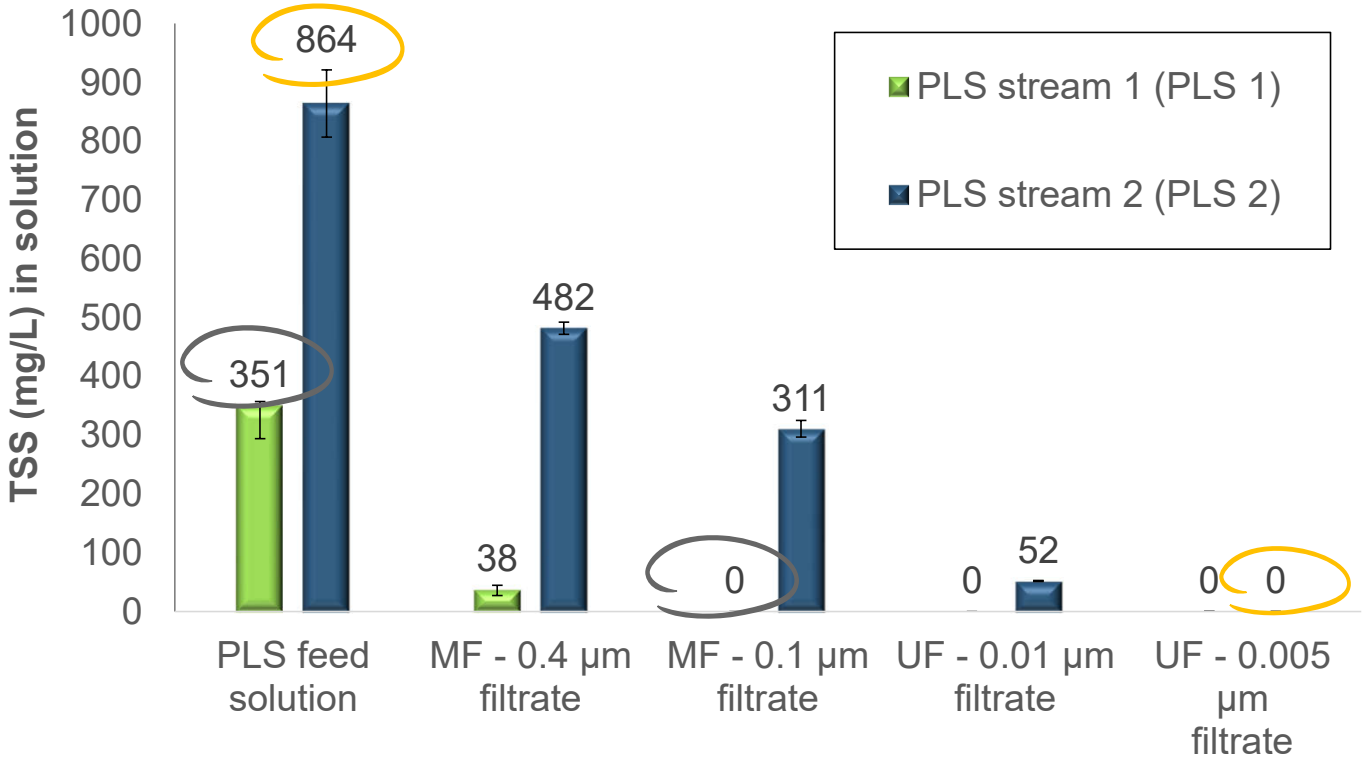
Li Solution:
Leach solution from 2 x hard-rock ores post solid-liquid separation

Microfiltration

MF pore size:	0.4 µm, 0.1 µm
Test pressure:	3 bar
Temperature:	28 °C

Ultrafiltration

UF pore size:	0.01 µm, 0.005 µm
Test pressure:	12 bar
Temperature:	28 °C



PURIFICATION

Nanofiltration Membranes for Lithium Brine processing

Li Solution:
Synthetic solution simulating
Li brine

Nanofiltration

Membrane: AMS A-3012
NF pore size: 200 Da
Test pressure: 40 bar
Temperature: 28 °C

Global multivalent impurity rej:
> 98 %

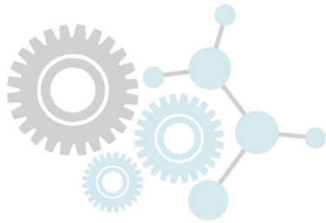
Lithium mass recovery:
71.4 %

Description	Units	Case 1				Case 2			
		Feed	Perm	*Conc	Rej	Feed	Perm	*Conc	Rej
PARAMETERS									
Volume	*(% feed)*	100	25	75	-	100	28	72	-
pH	-	1.5	1.1	2.3	-	1.1	0.8	1.6	-
COMPONENTS									
Al	*(mg/L)*	2 653	48	10 469	*98.2%*	1 917	12	6 817	*99.4%*
Ca	*(mg/L)*	542	17	2 118	*96.9%*	113	2	399	*98.5%*
Fe	*(mg/L)*	5 209	68	20 633	*98.7%*	3 251	42	11 502	*98.7%*
K	*(mg/L)*	2 112	2 025	2 372	*4.1%*	4 315	4 177	4 670	*3.2%*
Li	*(mg/L)*	380	375	394	*1.2%*	1 153	1 135	1 200	*1.6%*
Mg	*(mg/L)*	7 230	86.8	28 660	*98.8%*	11 946	83.6	42 449	*99.3%*
Mn	*(mg/L)*	206	2	817	*98.8%*	18	1	63	*97.2%*
Na	*(mg/L)*	1 827	1 778	1 975	*2.7%*	2 819	2 726	3 058	*3.3%*
H_2SO_4 (free)	*(mg/L)*	18 520	17 631	21 187	*4.8%*	27 651	26 213	31 348	*5.2%*

PURIFICATION

Nanofiltration Membranes for Hard-rock ore processing

Li Solution:
Leach solution from Zimbabwean petalite ore



Nanofiltration

Membrane: AMS A-3011
NF pore size: 100 Da
Test pressure: 60 bar
Temperature: 42 °C

Global multivalent impurity rej:
> 99 %

Lithium mass recovery:
81.7 %

Description	Units	Case 3			
		Feed	Perm	*Conc	Rej
PARAMETERS					
Volume	% feed	100	15	85	-
pH	-	0.95	-	-	-
COMPONENTS					
Al		10.0	0.1	66.2	*99.1%*
Ca		145	1.2	960	*99.2%*
Fe		38.0	0.1	253	*99.7%*
K		451	431	563	*4.4%*
Li		5717	5 494	6 980	*3.9%*
Mg		12.0	0.0	79.7	*99.6%*
Na		1422	1 348	1 841	*5.2%*

CONCENTRATION

Implementing RO membranes or IX for further processing

Purified lithium stream now mostly contains monovalent impurities:

- Sodium (Na^+)
- Potassium (K^+)

Ion Exchange

- Already present in most Li flow sheets
- Higher efficiency in purified stream
- Better resin selectivity
- Up to 30 x Li concentration factor

Reverse Osmosis

- Only applicable if pH 2-11
- Remove water from Li solution
- Up to 5 x Li concentration factor

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THANK YOU

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