

Enrichment of REE Elements from Geothermal Produced Water Using MF/NF. Mohammad A. Hossain Mentor: Lucy M. Camacho, Ph.D.

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Physical appearance of some REE's







Applications







What is a produced water?

Produced water is a term used in the oil industry to describe **water** that is **produced** as a byproduct along with the oil and gas.



Importance: Improves the inflow revenue into oil and gas sector which could be considered as an additional income for oil and Gas Company.



Concentrate Concentrate









MF Process



Filtered Samples

NF Process



Final Diluted Samples Finally analyzed by ICPMS

Unfiltered Samples



Results (Ce):

Samples	Init. Conc.	Volume,ml	Time,min	% Retentation/e	Permeate Conc.,ppb	Salt passage	Salt rejection
P1F1	25	75	5	99.99	0.003569998	0.014279994	98.57
P2F1	25	81	5	99.99	0.003587586	0.014350345	98.56
P1F2	25	76	5	99.98	0.005258281	0.021033122	97.90
P2F2	25	41	3	99.96	0.010481425	0.041925699	95.81
P1RC	25	99	4	99.97	0.008740373	0.034961494	96.50
P2RC	25	67	4	99.91	0.022774422	0.09109769	90.89
P1F1	50	70	5	99.96	0.021244382	0.042488764	95.75
P2F1	50	72	5	99.93	0.037213235	0.07442647	92.56
P1F2	50	73	5	99.97	0.014315272	0.028630544	97.14
P2F2	50	74	4	99.98	0.010833152	0.021666305	97.83
P1RC	50	97	5	99.96	0.019731931	0.039463862	96.05
P2RC	50	49	2.5	100.00	0.001301377	0.002602754	99.74
P1F1	100	52	5	99.87	0.166963925	0.166963925	83.30
P2F1	100	40	5	99.86	0.172874199	0.172874199	82.71
P1F2	100	47	5	99.94	0.075606697	0.075606697	92.44
P2F2	100	76	5	99.96	0.052865853	0.052865853	94.71
P1RC	100	58	5	99.94	0.075378055	0.075378055	92.46
P2RC	100	46	3	99.94	0.074287604	0.074287604	92.57

0

Sample#	Init.(Feed)	time,min	Cum.time,	Pressure,	permeate.	permeate	QpCp(Ce)	QcCc(Ce)	QfCf(Ce)	Recovery,r
	Conc.ppb		min	psi	Collected	Cum.,vol,ml	ml*ppb/	ml*ppb/	ml*ppb/	
					vol.,ml		min	min	min	
1		5	5	68	75	75	0.05	28.42	28.47	0.23
2		5	10	68	81	156	0.06	21.13	21.19	0.20
3		5	15	62	76	232	0.08	4.95	5.03	0.64
4	25	3	18	62	41	273	0.14	111.35	111.49	0.04
7		5	5	68	70	70	0.30	18.92	19.22	0.3
8		5	10	68	72	142	0.54	3.08	3.61	0.76
9		5	15	62	73	215	0.21	13.64	13.85	0.3
10	50	4	19	62	74	289	0.20	32.20	32.40	0.1
13		5	5	68	52	52	1.74	6.59	8.32	0.8
14		5	10	68	40	92	1.38	14.80	16.18	0.6
15		5	15	62	47	139	0.71	47.39	48.10	0.10
16	100	5	20	62	76	215	0.80	83.12	83.92	0.0

REEs passage =	(permeate conc./feed conc.)*100						
REEs rejection =	(1-salt passa						
Flux =	Filtrate flow rate through membrane/surface area of membrane						
Recovery,r =	Qp/Qf						
Cc =	Cf*1/(1-r)						
Flow balance:	Qf=Qp+Qc						
Mass balance: QfCf=QpCp+		-QcCc					

Data from ICPMS analysis.

Mass balance.

Used equations.

Continued Results.....



Flux vs. Permeate and feed concentration.

Permeate flux vs. cum time Permeate REEs rejection vs. feed conc.



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