



Worldwide Pharmaceutical Sciences
Molecules to Market

Evaluation and Comparison of Tangential Flow Filtration Cassettes for Use in a Monoclonal Antibody Purification Process

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**IBC's 6th International Single-Use Applications for
Biopharmaceutical Manufacturing**

Pfizer Confidential

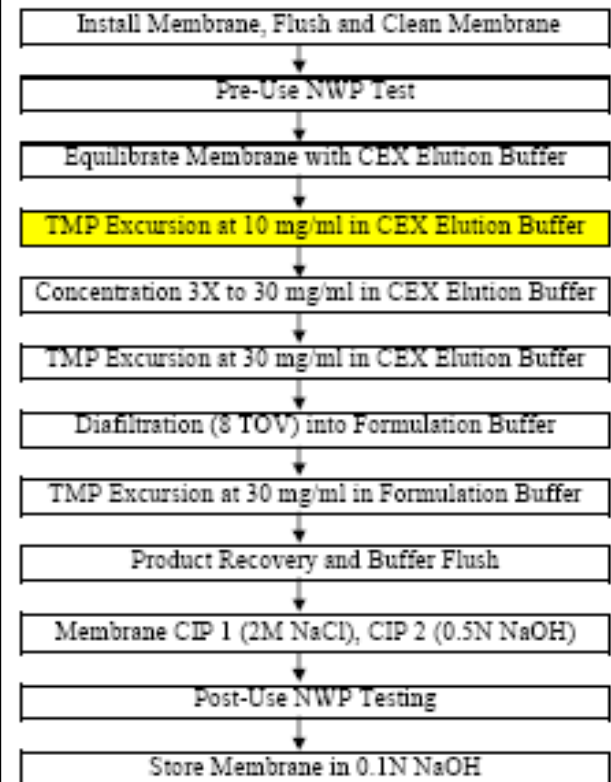
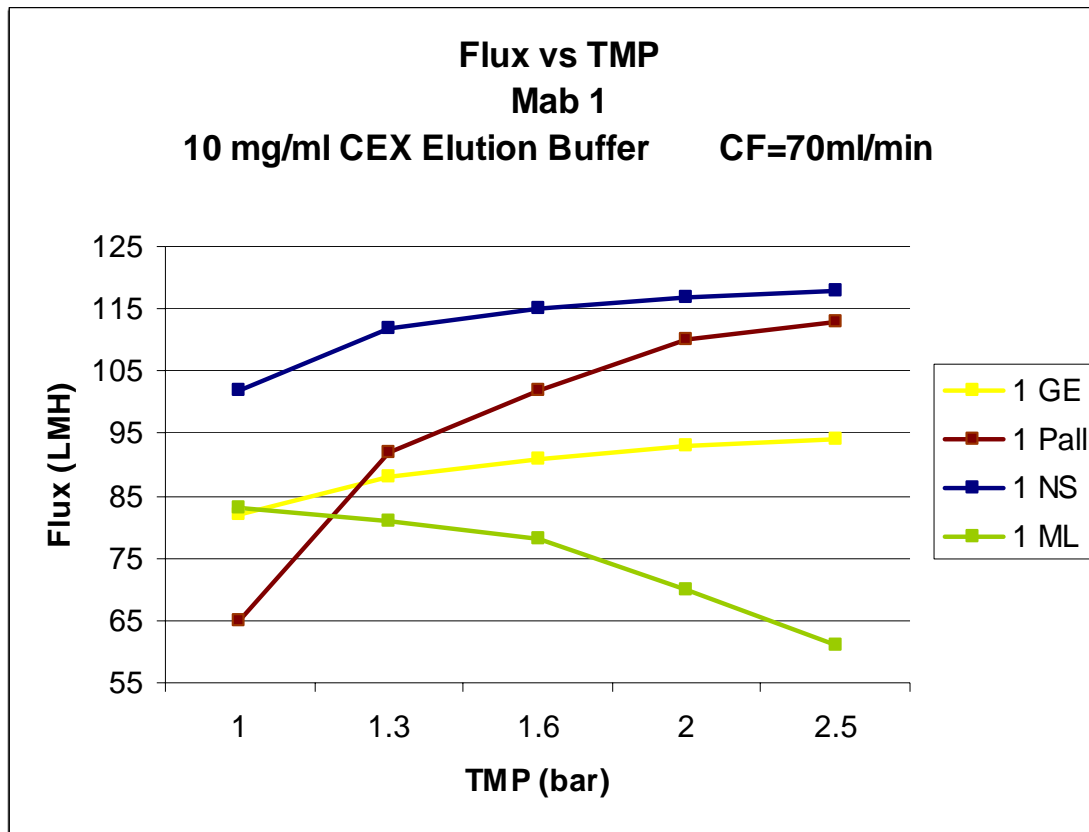


The Membranes Evaluated

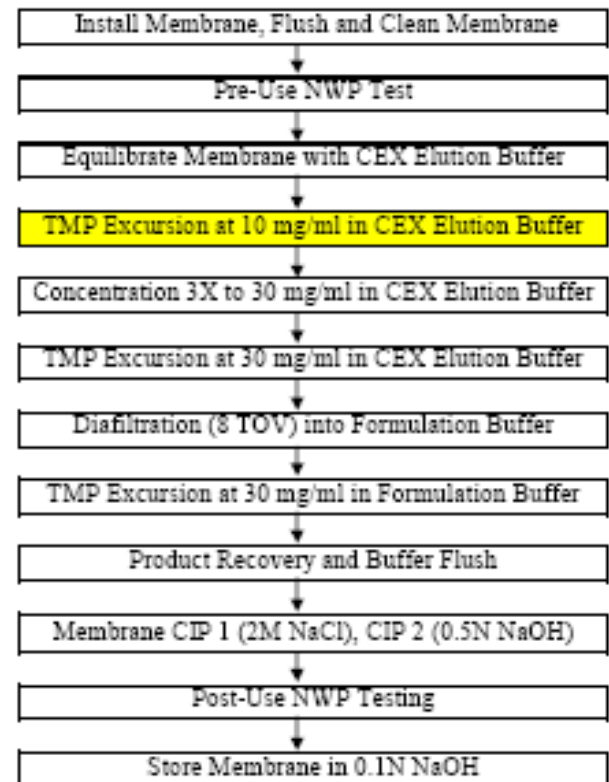
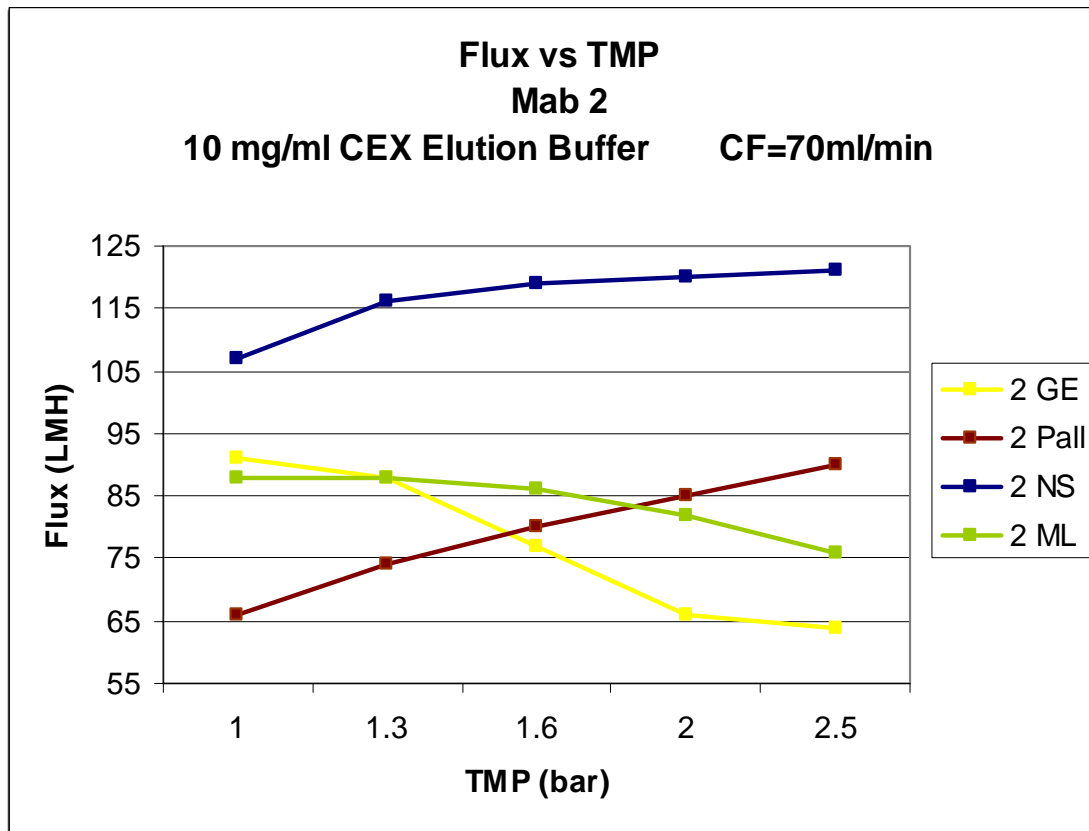
Membrane	Size (cm ²)	MWCO	Material	Holder	Cross Flow Rates (ml/min)	TMP's (bar)	Protein Load (g/m ²)
GE Kwick Lab Packet	100	50kD	PES	Kwick Lab Packet	60, 70, 80	1, 1.3, 1.6, 2.0, 2.5	300
Pall Centramate	100	50kD	PES	Kwick Lab Packet	60, 70, 80	1, 1.3, 1.6, 2.0, 2.5	300
NovaSep, SIUS	92.8	50kD	PES	Kwick Lab Packet	60, 70, 80	1, 1.3, 1.6, 2.0, 2.5	307
Millipore Pellicon 3	88	50kD	PES	Millipore Mini	40, 50, 60	1, 1.3, 1.6, 2.0, 2.5	341

- NovaSep SIUS Membrane is a **disposable**, single-use membrane

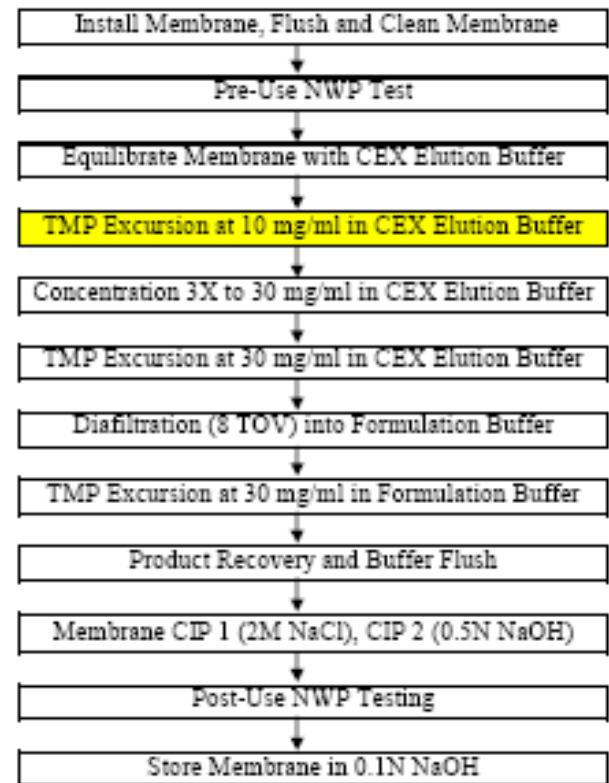
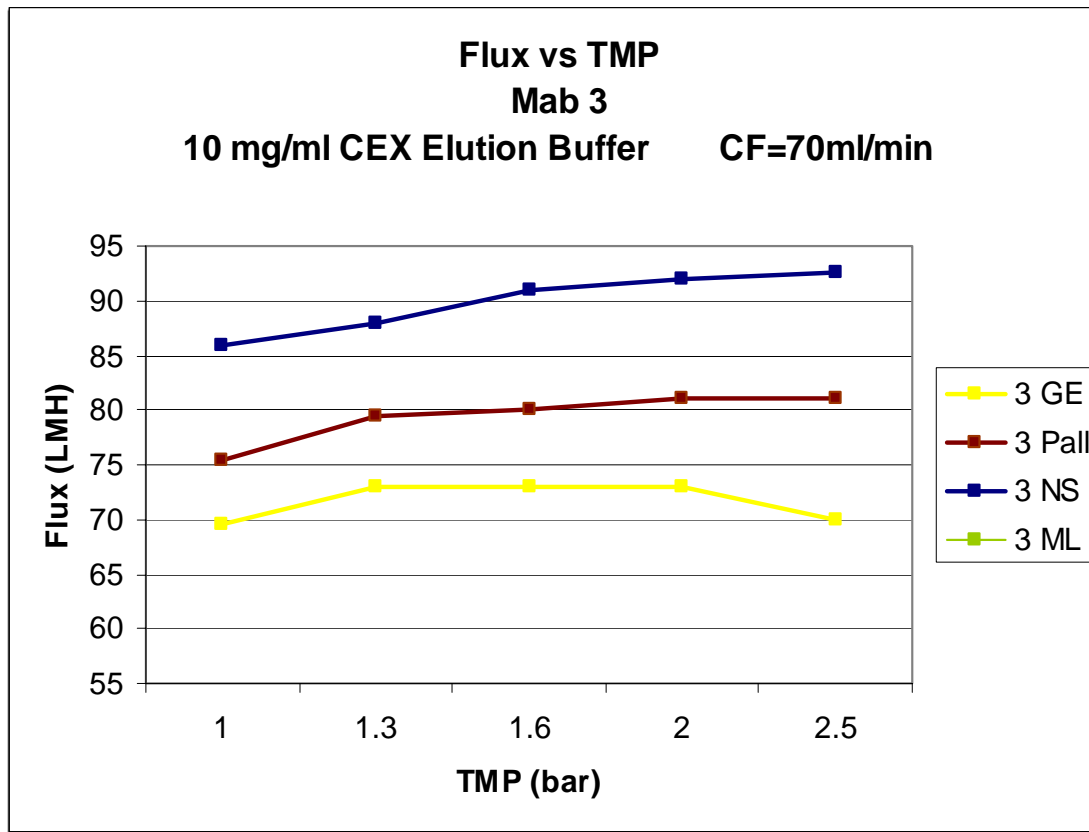
— GE — PALL — NOVASEP — MILLIPORE



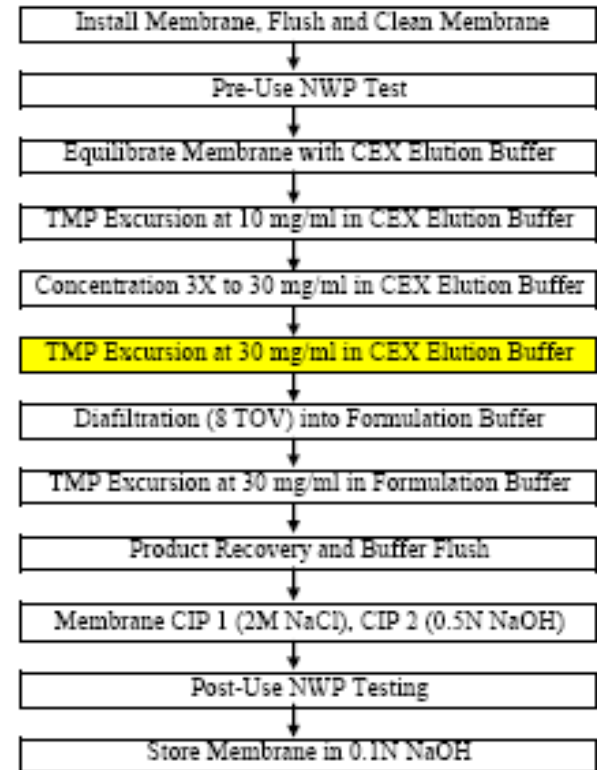
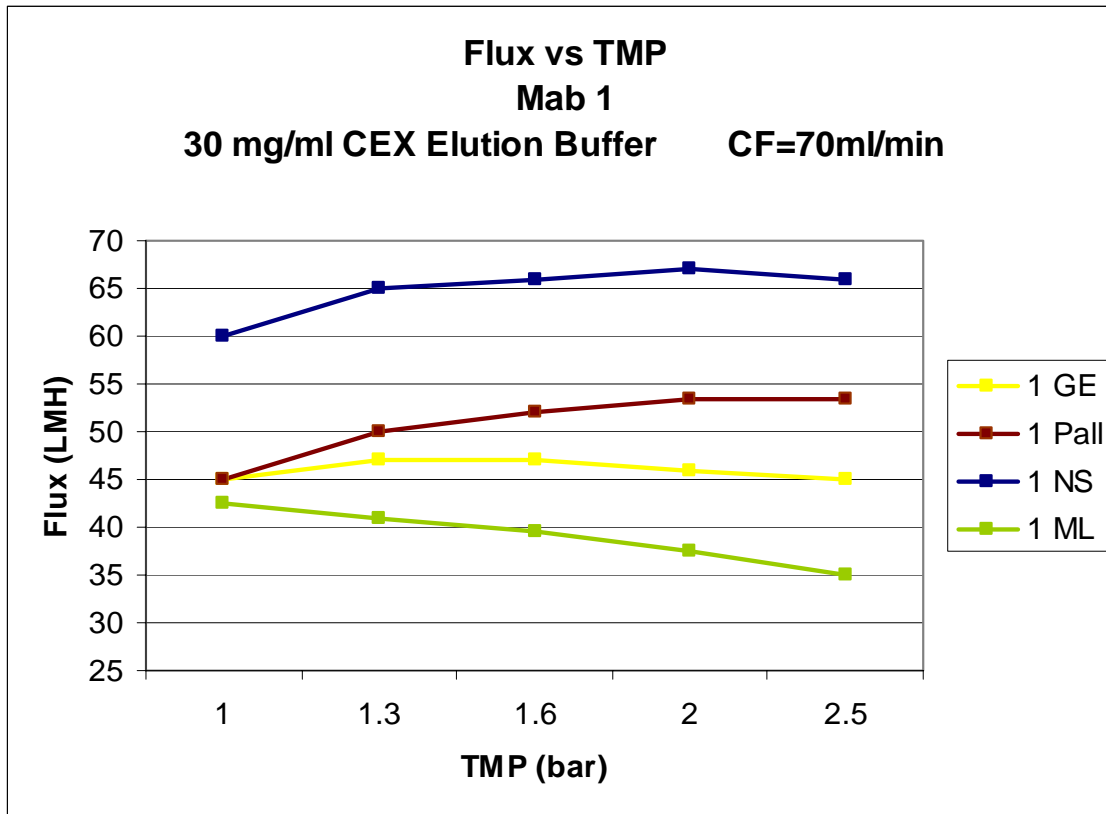
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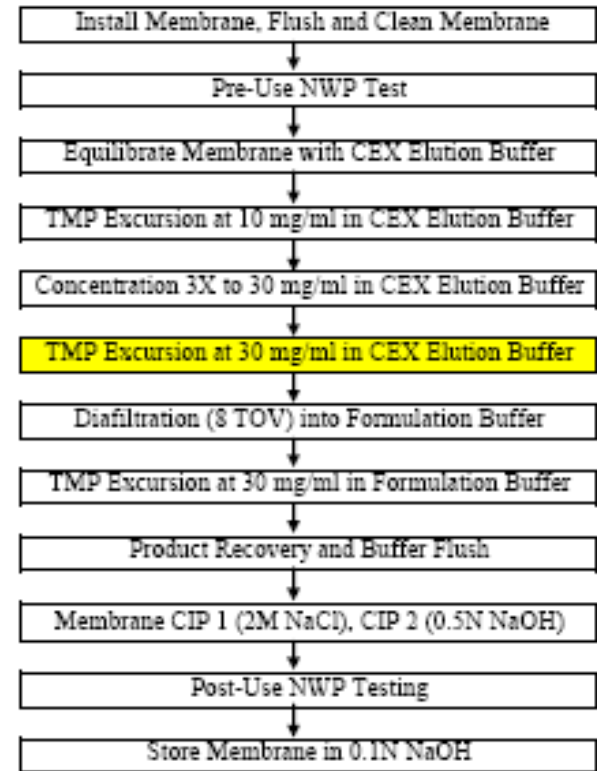
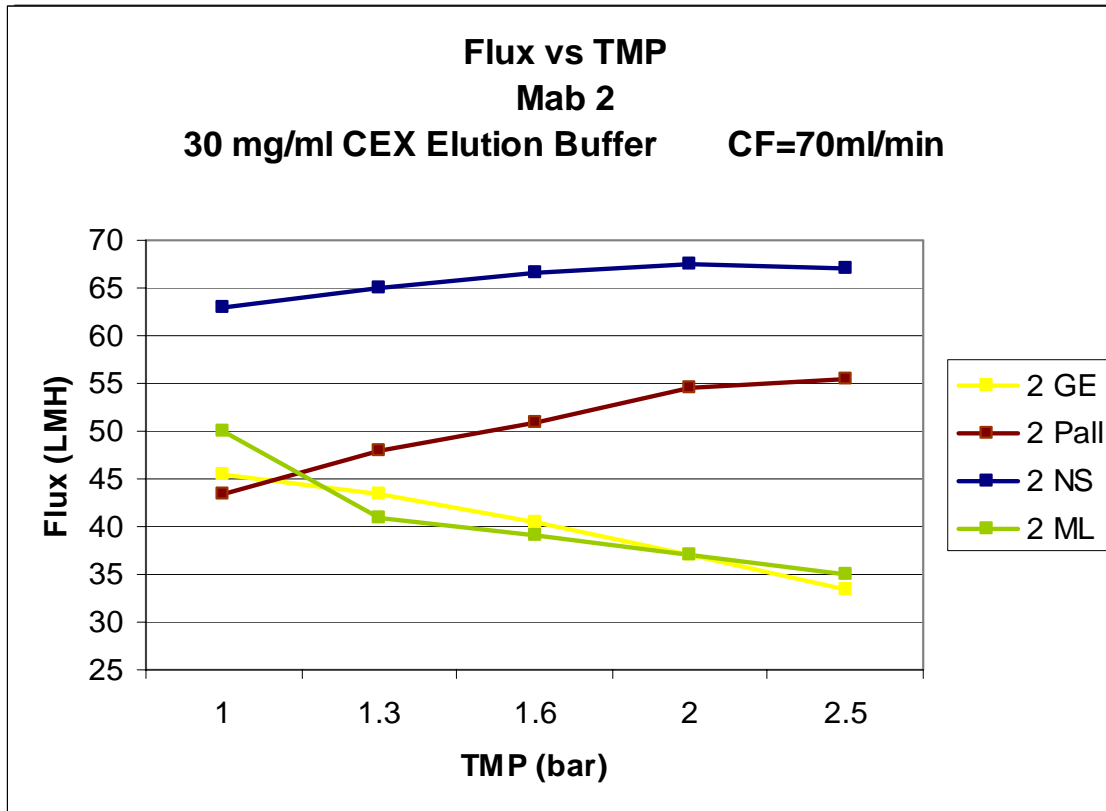


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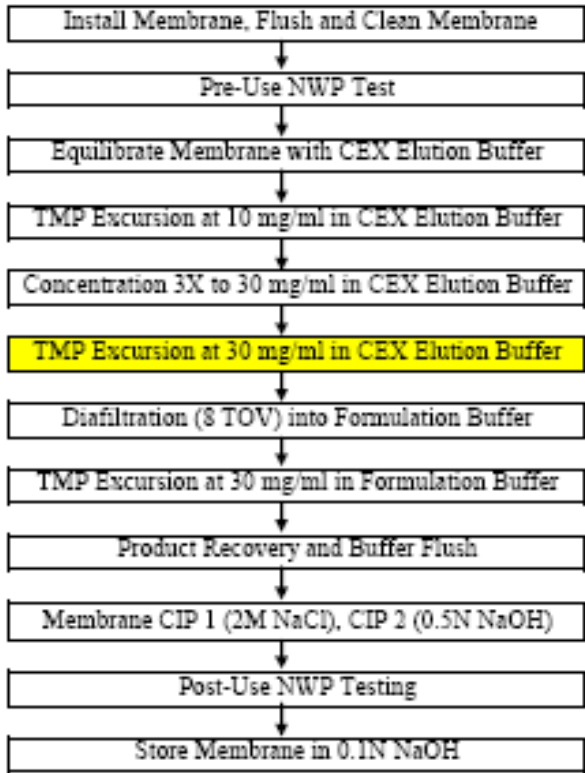
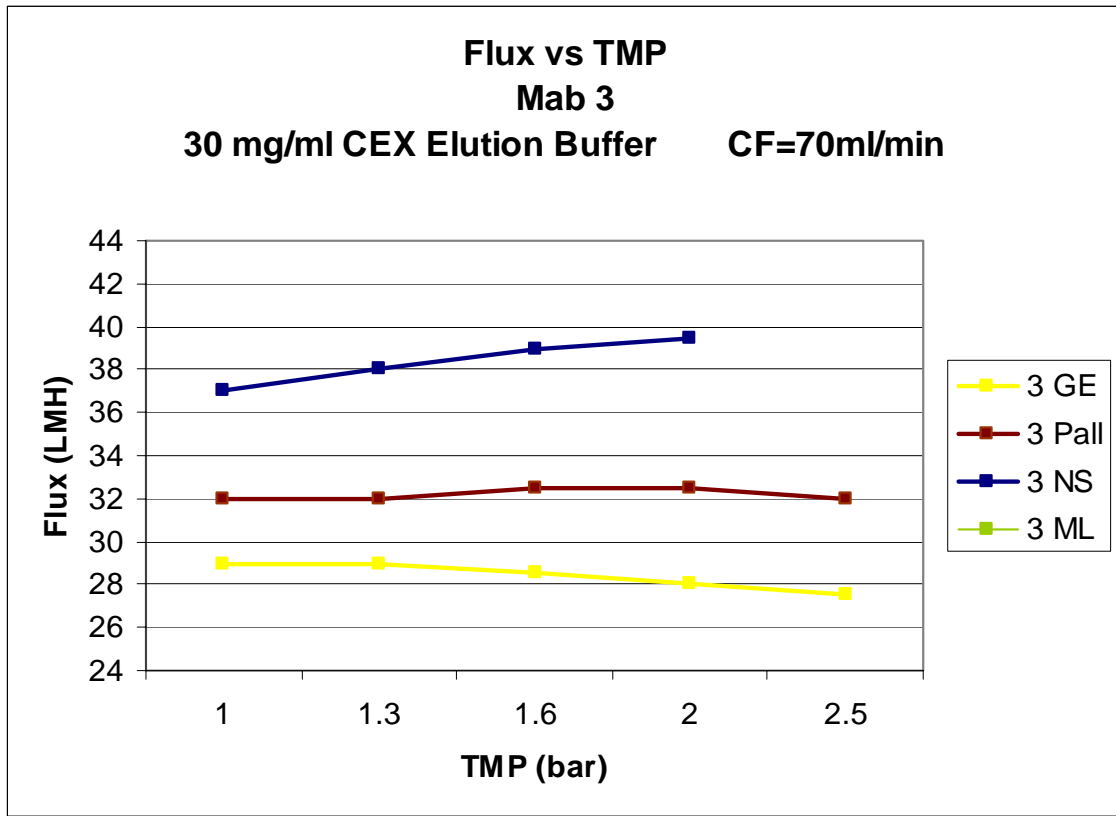
Note: Flux Decreases with Increasing Protein Concentration

— GE — PALL — NOVASEP — MILLIPORE



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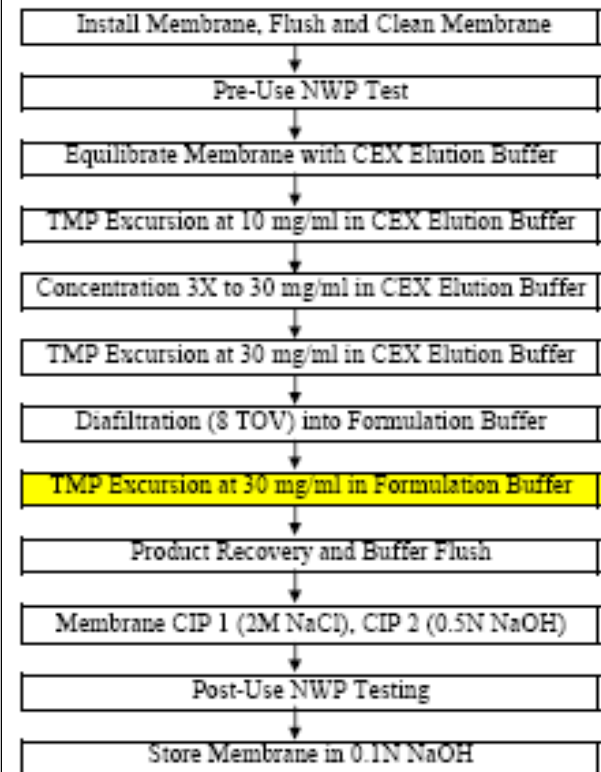
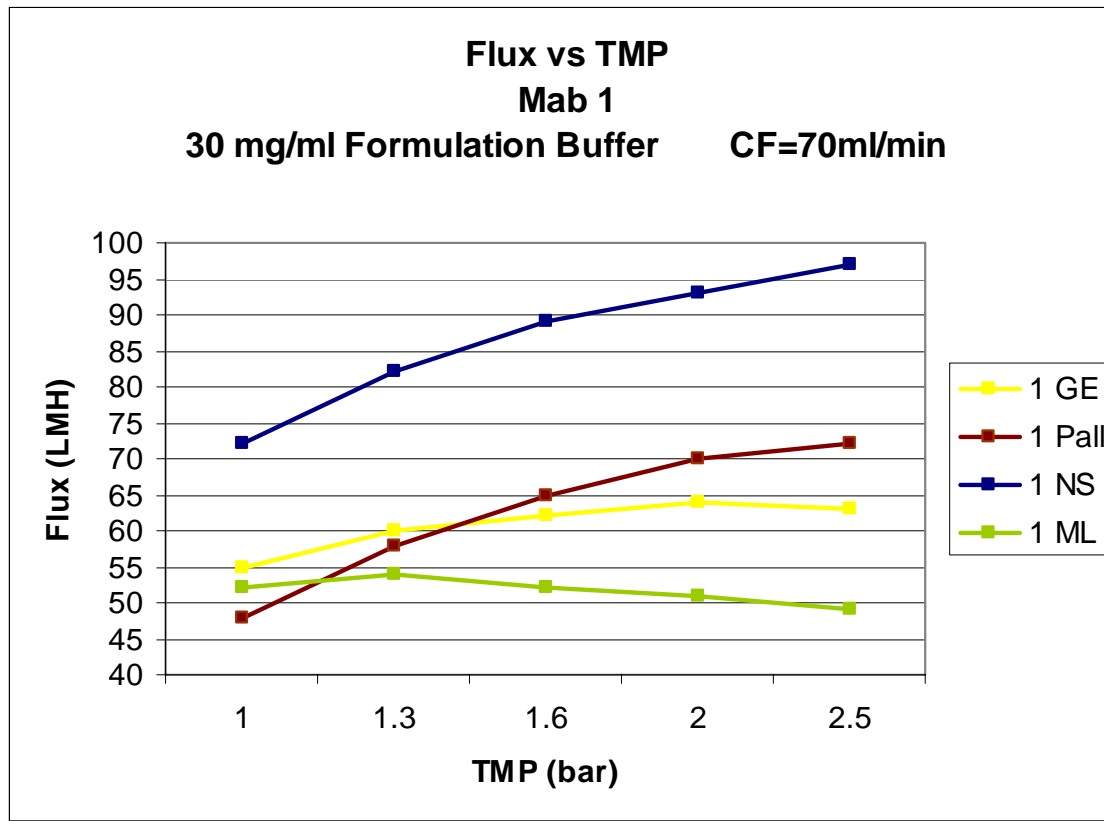
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Note: Flux Decreases with Increasing Protein Concentration

Membrane Comparison in Formulation Buffer at High mAb Concentration

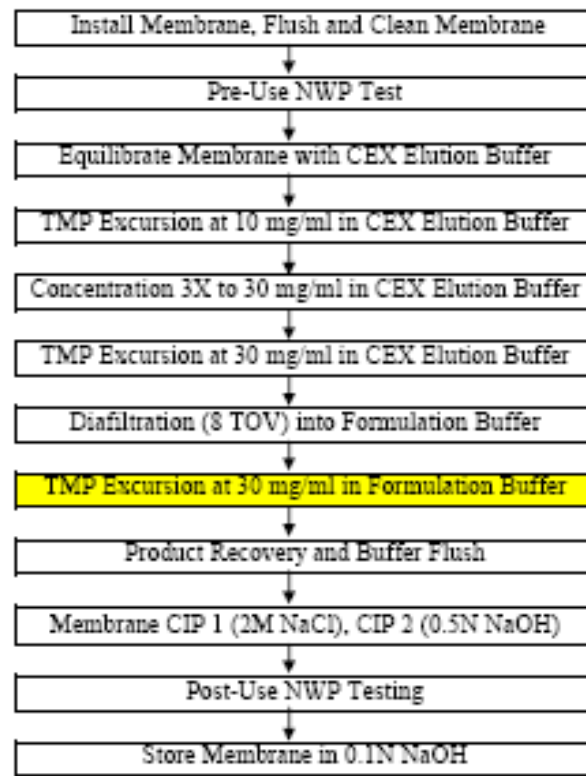
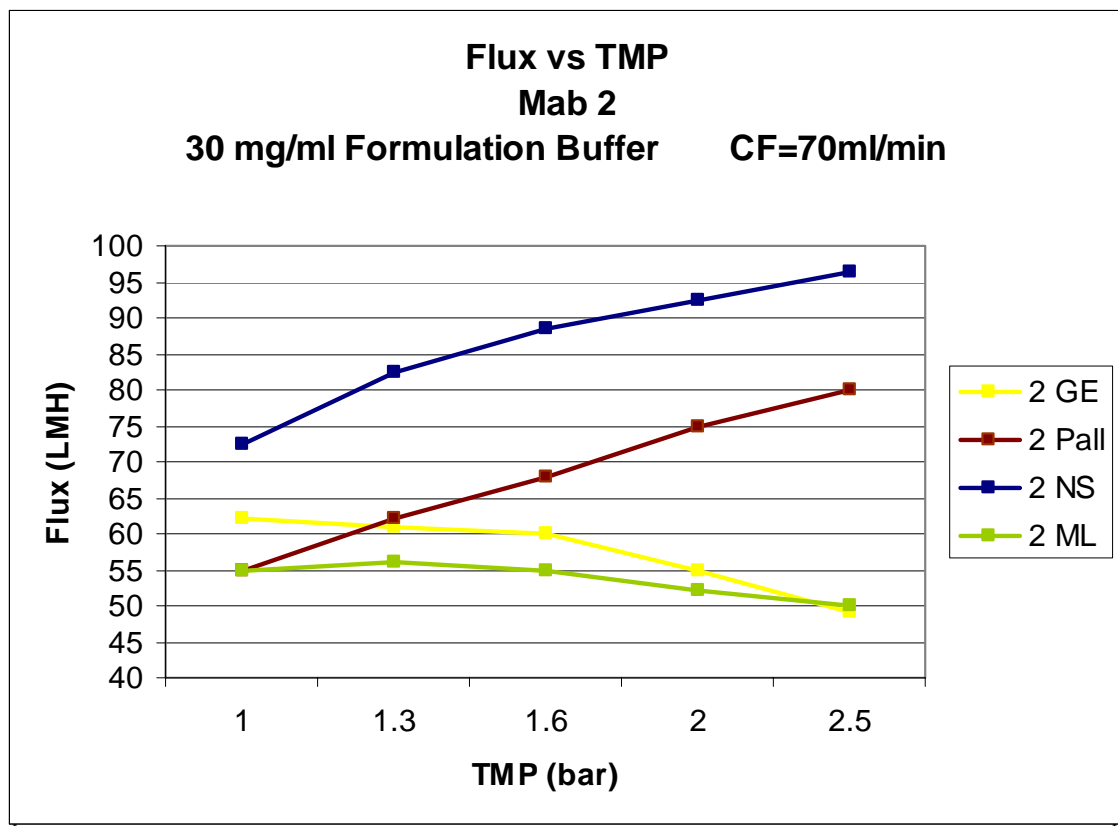
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Note: Flux is Recovered in Formulation Buffer

Membrane Comparison in Formulation Buffer at High mAb Concentration

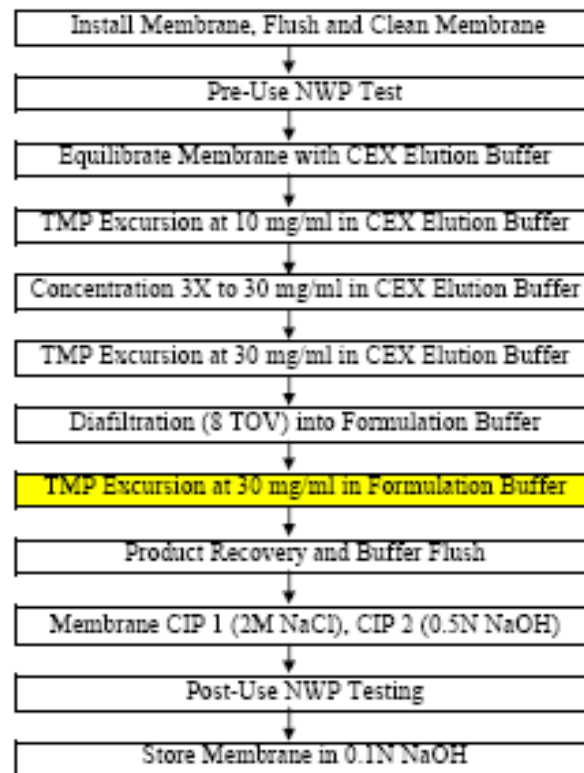
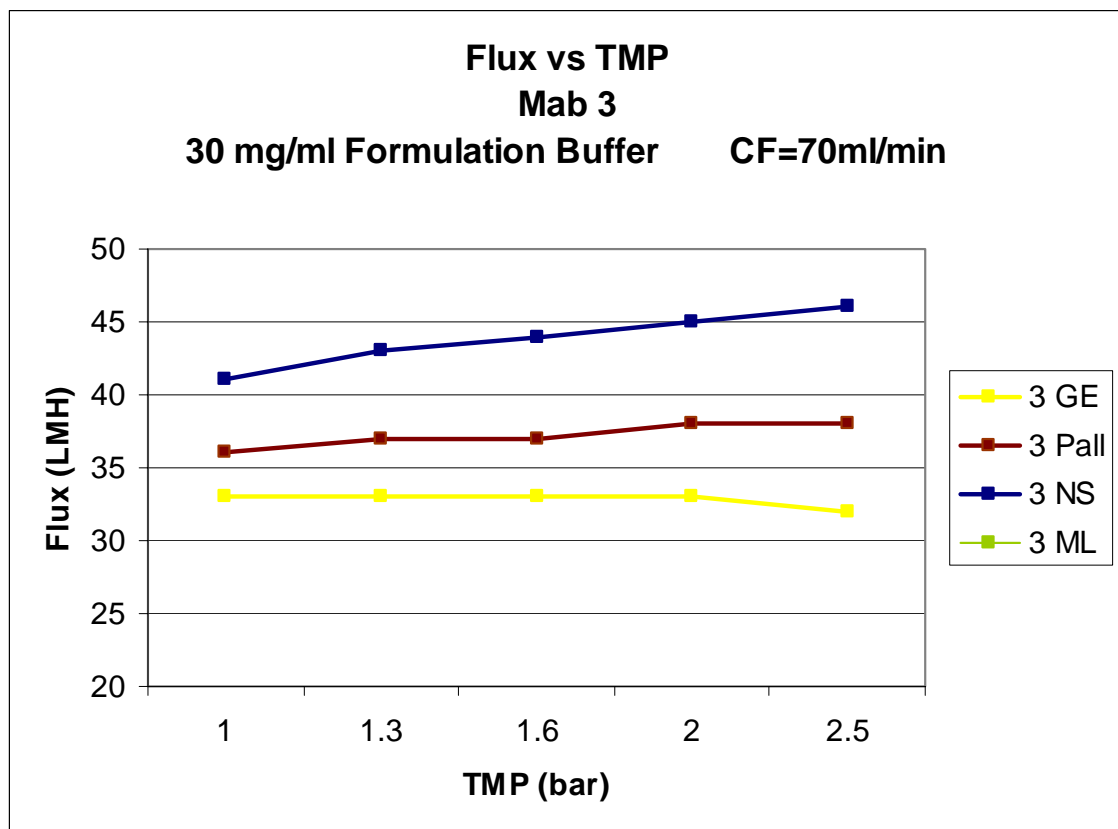
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Note: Flux is Recovered in Formulation Buffer

Membrane Comparison in Formulation Buffer at High mAb Concentration

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Note: Flux is Recovered in Formulation Buffer

Process Steps Average Flux

Process Step Membrane	Average Flux (LMH)											
	GE			Pall			NovaSep			Millipore		
mAb Number	1	2	3	1	2	3	1	2	3	1	2	3
Concentration (10 mg/ml to 30 mg/ml)	70	59	51	77	65	56	91	92	65	59	63	N/A
Diafiltration (30mg/ml in SP Elution Buffer to 30mg/ml in Formulation Buffer)	55	50	31	59	60	35	78	77	42	46	47	N/A

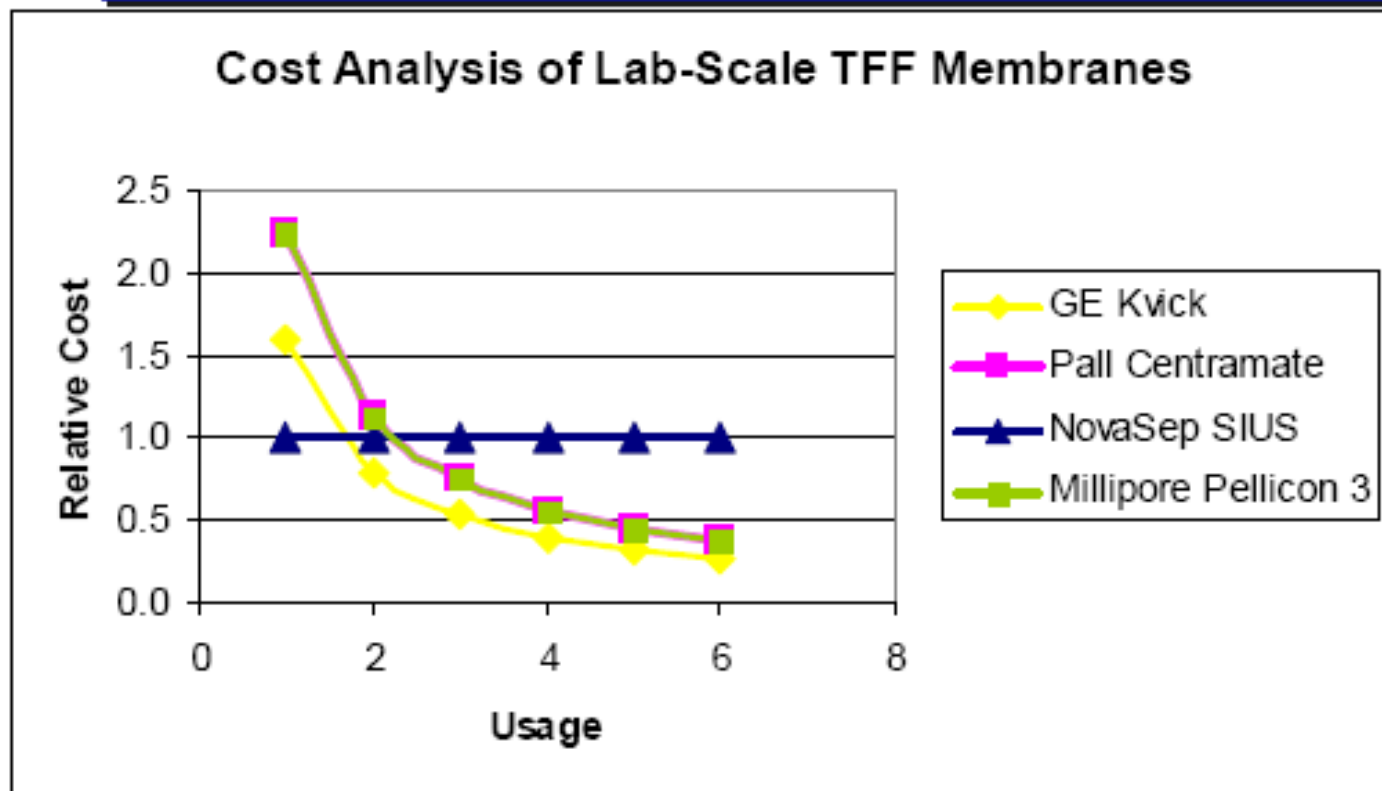
- NovaSep Membrane has highest average flux for all Mabs during both the concentration and diafiltration step
- Not all Mabs perform equally----Mab 3 performs poorly on all tested membranes.

Total Process Time Calculations

Process Step	Process Time (hours)											
	1	2	3	1	2	3	1	2	3	1	2	3
mAb Number												
Membrane	GE			Pall			NovaSep			Millipore		
Concentration (10 mg/ml to 30 mg/ml)	0.8	0.8	1.1	0.7	0.9	1.0	0.6	0.6	0.9	0.9	0.9	N/A
Diafiltration (30mg/ml in SP Elution Buffer to 30mg/ml in Formulation Buffer)	2.7	3.0	4.8	2.5	2.5	4.2	1.9	1.9	3.6	3.2	3.2	N/A
Total Process Time	3.5	3.8	5.9	3.3	3.4	5.2	2.5	2.6	4.4	4.2	4.1	

- **NovaSep resulted in the shortest concentration and diafiltration process time.**

Membrane Cost Analysis



- If membrane is needed for only one or two cycles, the NovaSep may be a cost effective membrane choice.
- Pall, GE, and Millipore Traditional reusable membranes would be the cost effective choice for multiple processing usage.

Conclusions

- NovaSep SIUS membrane has the highest flux performance at low and high protein concentrations; thus minimizing total process time for the UF/DF operation.
- NovaSep disposable SIUS membrane is an cost effective choice for short campaigns; however the cost impact diminishes as multiple uses are necessary.
- The Pall, GE, Millipore traditional membranes (non-disposable) become more cost effective with multiple uses.
- Pall Centramate membrane provides acceptable performance over the TMP range tested.
- Millipore and GE lab-scale membranes may result in a high protein wall concentration at the TMP ranges tested, as indicated by the flat TMP versus Flux curves, however this needs to be investigated. Additional work may be needed to optimize these membranes at lower TMP (<1 bar) ranges.