MEMBRANE TECHNOLOGY FOR SULPHURIC ACID RECOVERY

"The recovery of purified Sulphuric acid in hydrometallurgical processes using Nanofiltration membranes. A boost to your bottom line and a win for ESG"

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Introduction

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Omnia Group

Solution provider for chemical reagents

Expert metallurgy team

Market Facing

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Process and Project Development

Technology Provider for Membrane Technology

Customised Filtration Solution

Design and Fabrication

Agenda

01 Sulphuric Acid Market

02 Membrane Technology Principles

03 Case Study - Uranium (South U)

04 Conclusion

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SULPHURIC ACID MARKET

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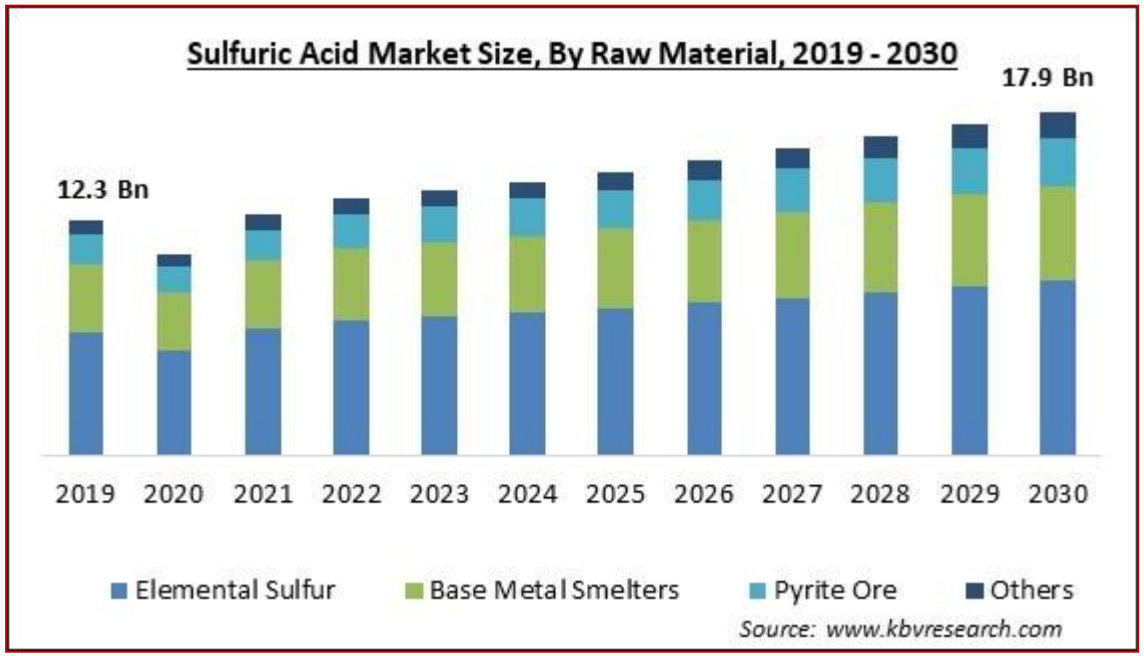
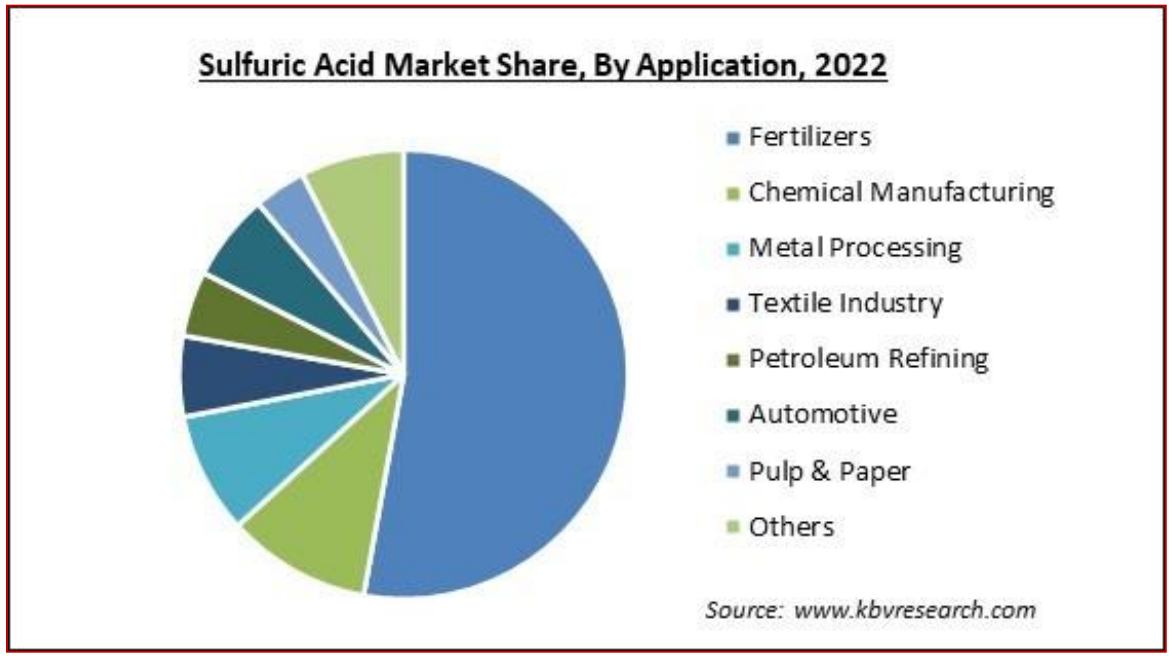
Sulphuric Acid Market





- US$ 18 Bn market - 3.9% CAGR growth
- Indicator of economic activity
- Phosphate fertilizer market is the largest demand driver
- Fundamental and critical product across the mining industry

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Sulphuric Acid Considerations

Production Method	Estimated Cost (Cost/ ton)	Sulphur Source Cost	CAPEX	Environmental Impact	Scalability
Sulphur Burn	Expensive	High ↗	Low ↘	Moderate ⟺	High ↗
Pyrite Roasting	Moderate	Medium ⟺	Medium ⟺	High ↗	Moderate ⟺
Smelter Off-Gas Capture	Cheap	Low ↘	High ↗	Low ↘	Limited to smelter scale ↘

- **Transport**
  - H_2SO_4 - Transport - $0.15 per km - $375 / MT
  - +/- 2.4MT GHG emissions per 2500km distance
- **ESG**
  - CO_2 emissions during production and transport
  - Waste production
- Significant cost contributor to operations

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MEMBRANE TECHNOLOGY
PRINCIPLES

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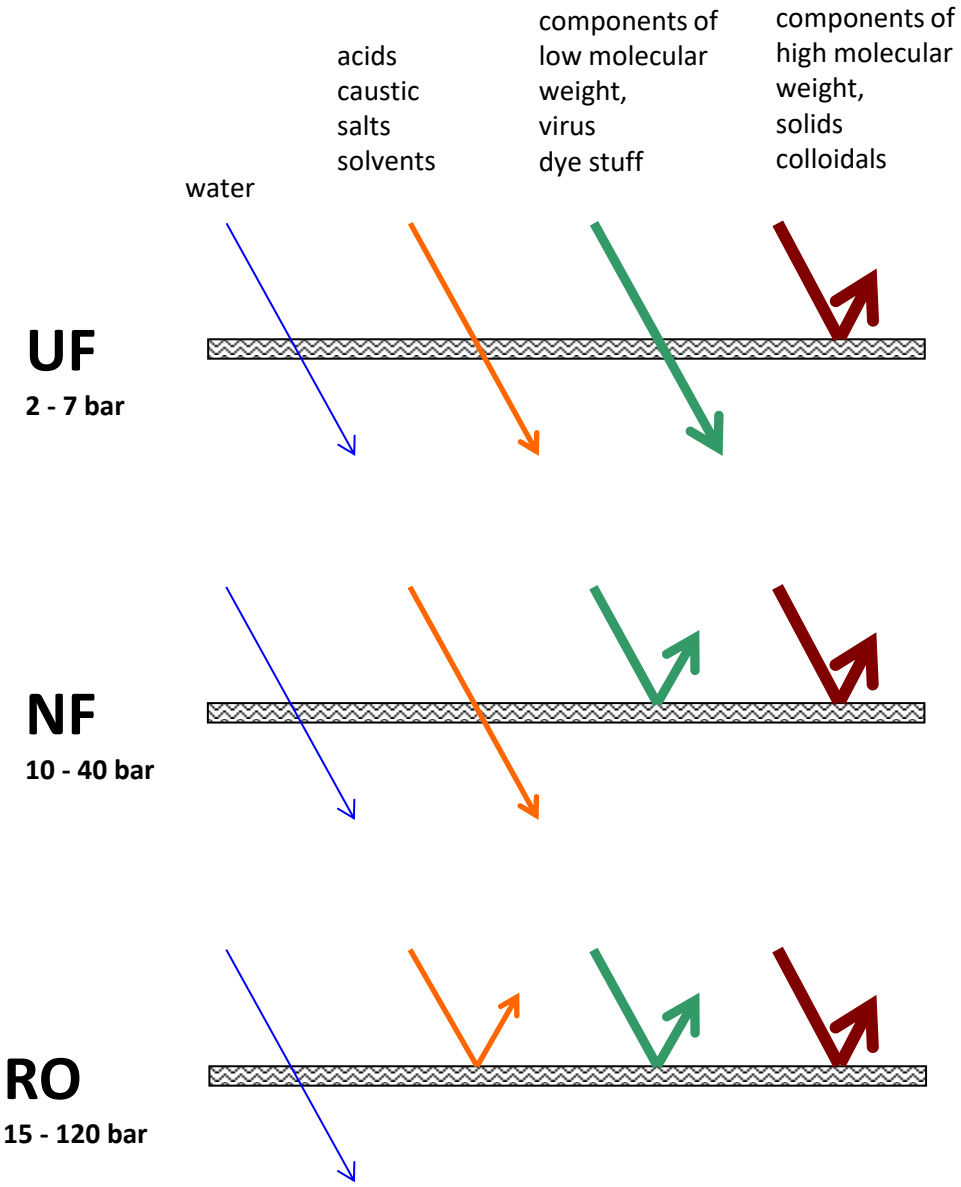
Membrane Principles

- NF uses crossflow filtration mechanism
- Not a pore size exclusion model but a charge exclusion rejection model
- Metals and Multivalent Acids - rejected
- Monovalent - permitted

$$H_2SO_{4(aq)} \rightleftharpoons H^+_{(aq)} + HSO^-_{4(aq)}$$
$$HSO^-_{4(aq)} \rightleftharpoons H^+_{(aq)} + SO^{2-}_{4(aq)}$$



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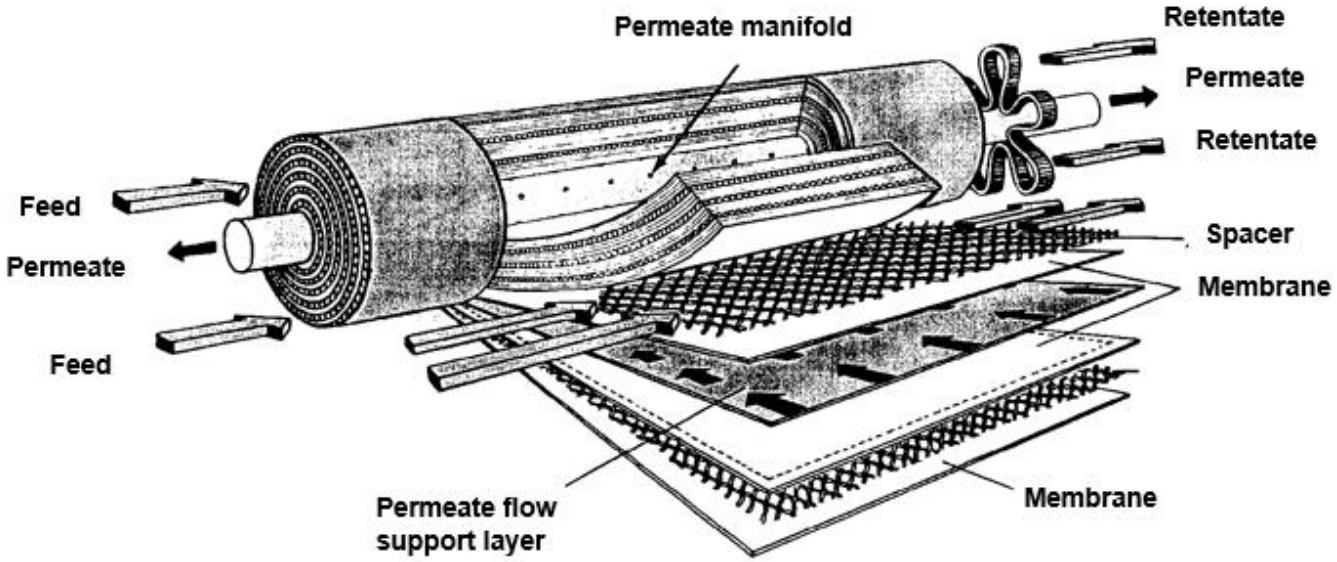
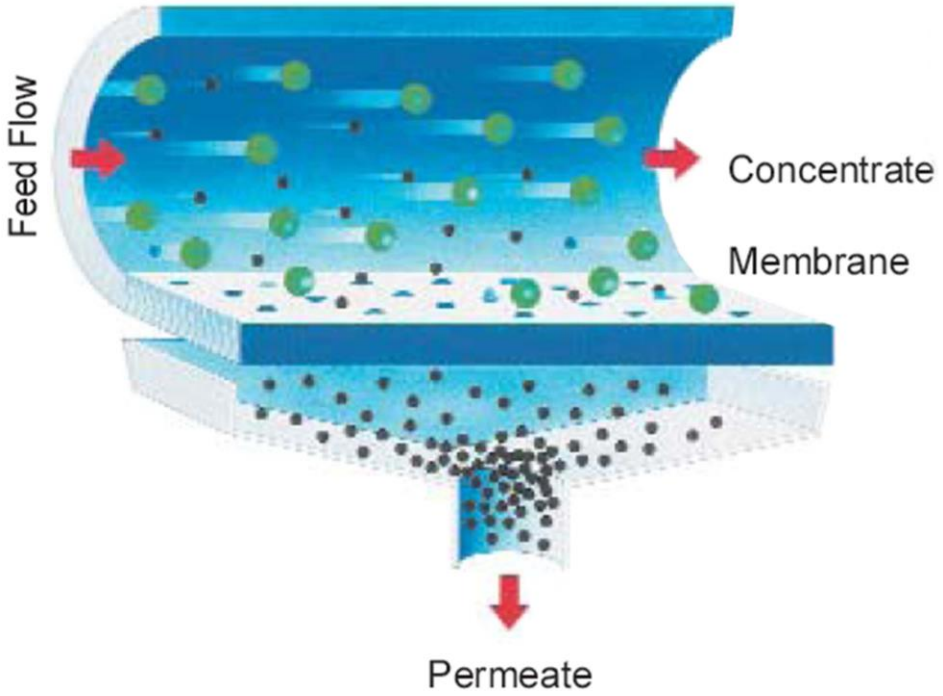
Membrane Mechanism

Flat sheet of the membrane is rolled into what we call a spiral wound module

Permeate stream: acid-rich, low-metal solution >the recovered sulphuric acid

Retentate/Concentrate: metal-rich waste > can be further processed or disposed off.





Benefits / Challenges

BENEFIT	DESCRIPTION
Selective Separation	Good separation between acid and divalent metals.
Compact Footprint	Small-scale modules available for retrofitting.

CHALLENGES	EXPLANATION
Limited to Dilute Streams	Best for ≤20% H_2SO_4; concentrated acids require dilution.
Membrane capability	Membrane fouling and replacement frequency

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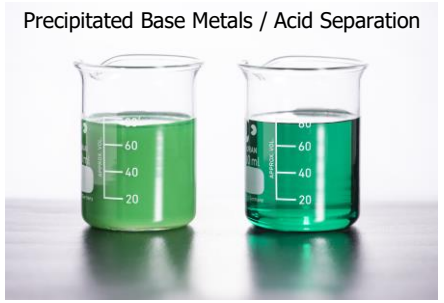
Applications

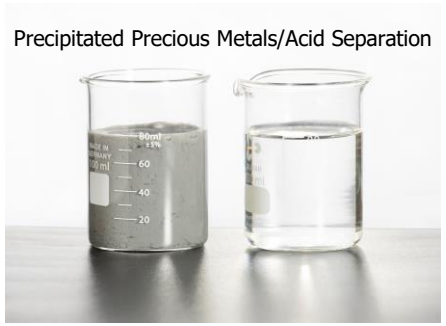
1. **Hydrometallurgy and Mining**:
   - Recovers H_2SO_4 from leachate or process solutions.
   - Reduces neutralization costs and improves water recycling.
   - Uranium - IX Eluate for concentration and acid recovery
2. **Steel Pickling Liquors** (acid + iron):
   - Separates H_2SO_4 from $FeSO_4$.
   - Reduces acid loss and allows iron recovery via crystallization.
3. **Battery Recycling / Spent Electrolytes**:
   - Separates sulphuric acid from metals like U, Pb, Cd, Ni
4. **Other potential**:
   - Pre-IX, pre-crystallization concentration.
   - Acid Mine Drainage

Dissolved Metals / Acid Separation

Precipitated Base Metals / Acid Separation



Precipitated Precious Metals/Acid Separation



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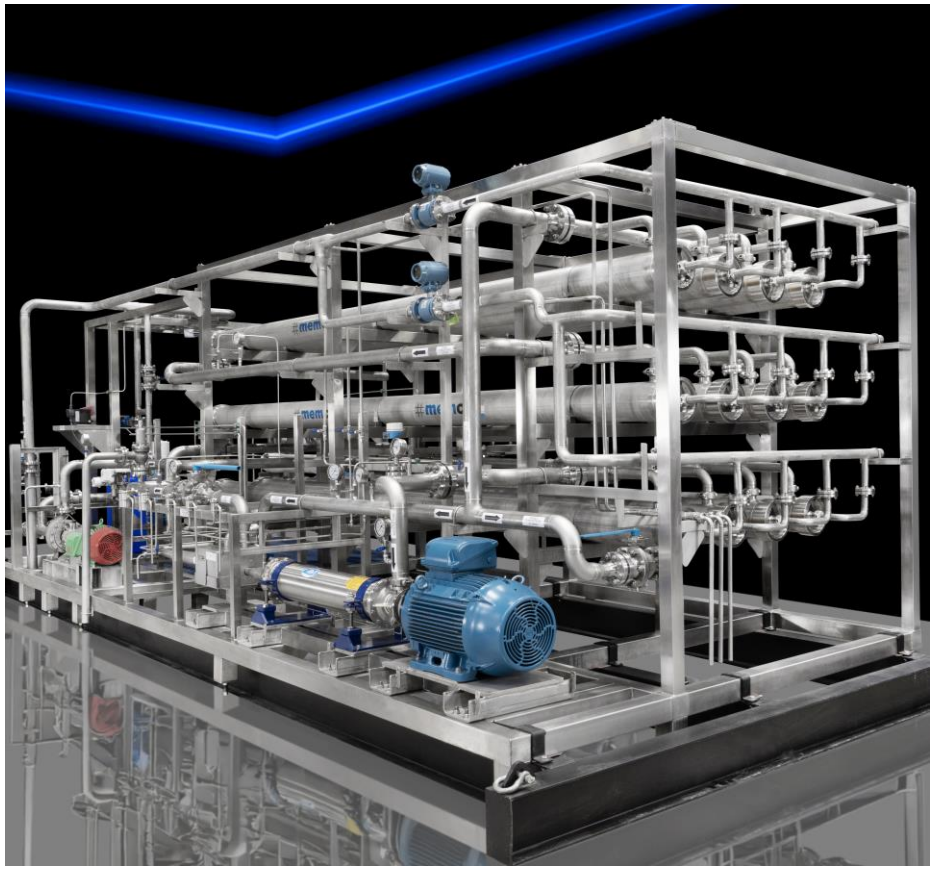
Project Development

Lab-scale NF plant

Pilot-scale NF plant

Commercial NF plant



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URANIUM CASE STUDY
TEST WORK
HARMONY - SOUTH U

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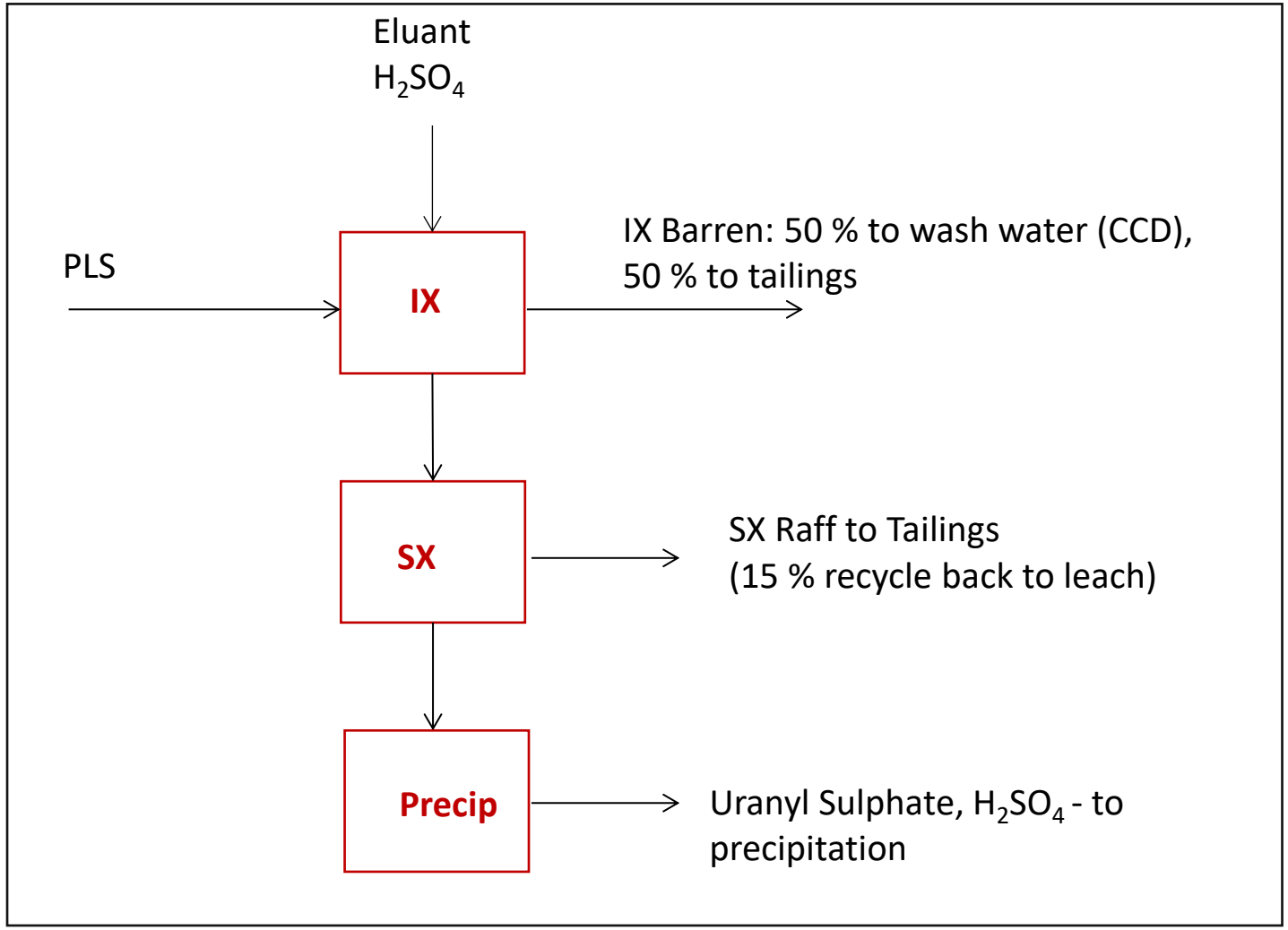
Uranium - IX Eluate

Current Flow Sheet



Before Implementation:

- Loss of Uranium
- Loss of H_2SO_4 reagent
- pH neutralization
- Loss of water

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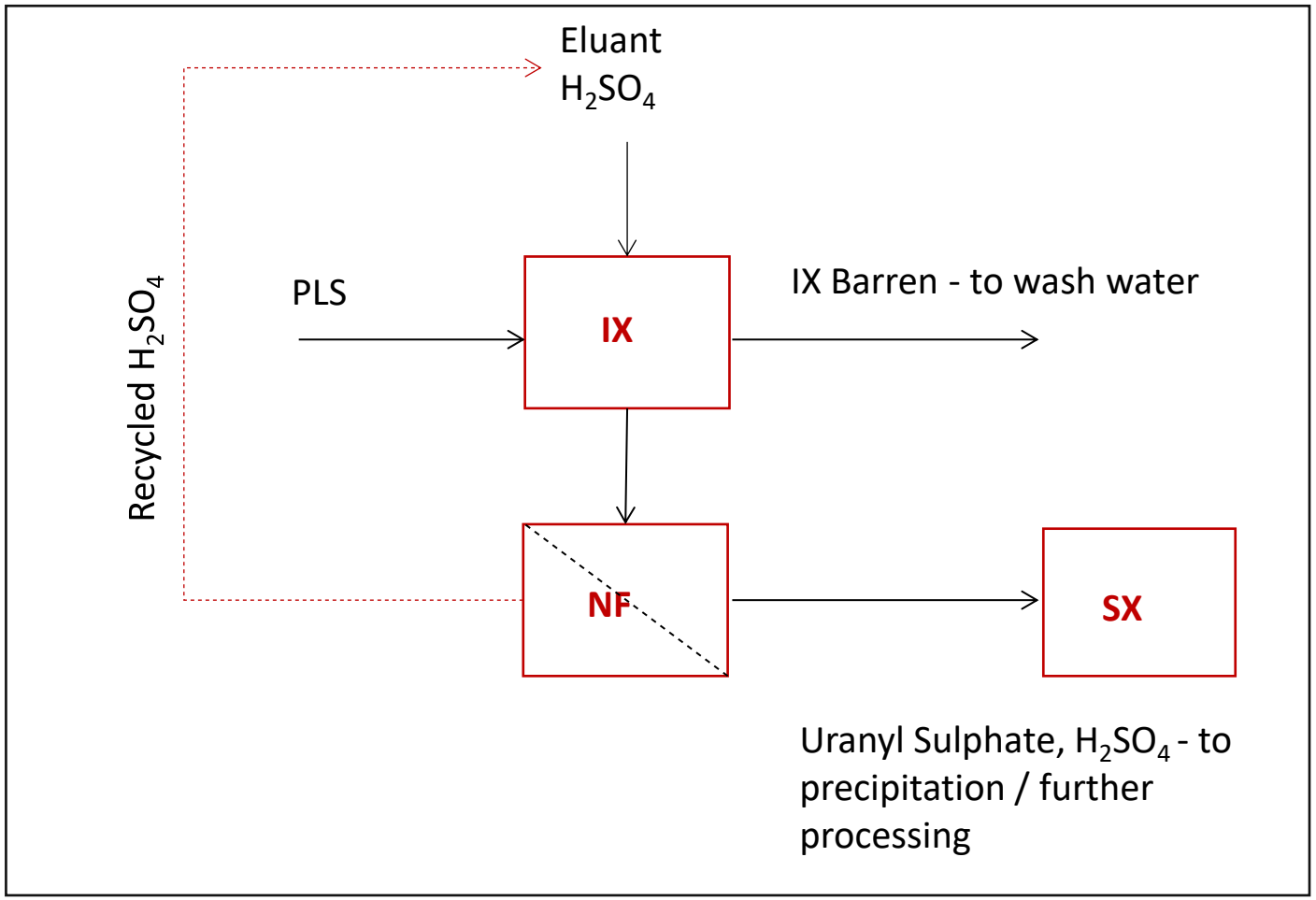
Uranium - IX Eluate

Proposed Solution



After Implementation:

- Recovery and re-use of Sulphuric Acid
- Concentration of IX Eluate
- Potential replacement / reduction of SX

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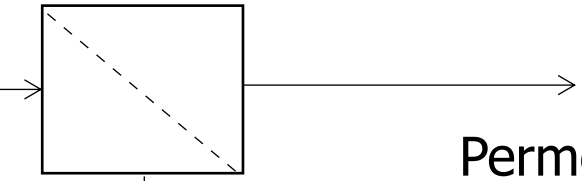
Test Work - Results

Harmony - South U
NF Membrane 1 – IX Eluate

NF Membrane – 1.5 VCF



Feed

pH	3.2
H2SO4 (g/L)	9.1
U3O8 (g/L)	1.98

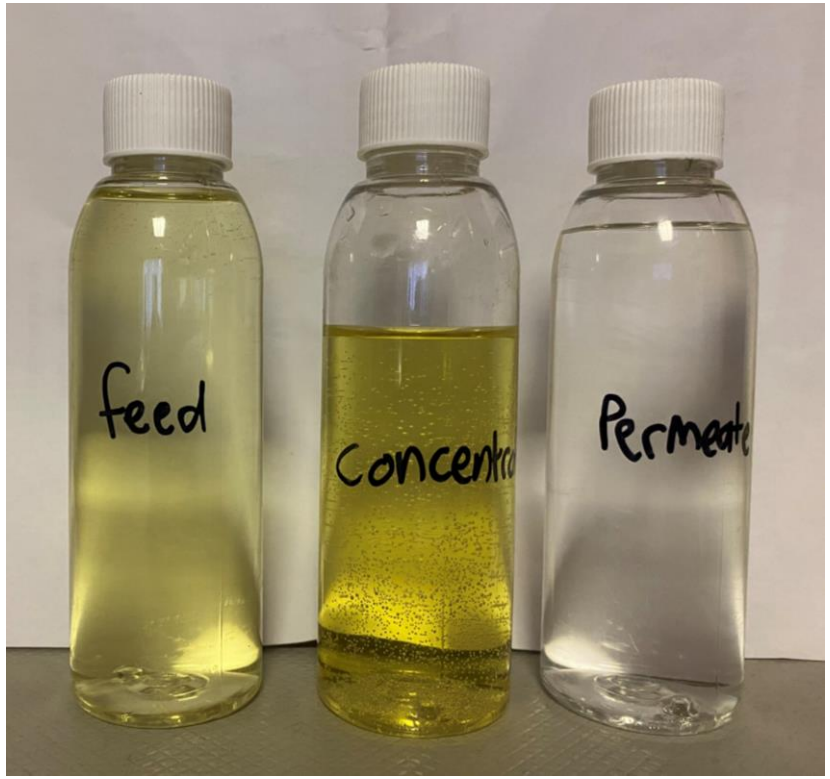
Permeate

pH	2.8
H2SO4 (g/L)	8.1
U3O8 (g/L)	0.057

Concentrate

pH	3.7
H2SO4 (g/L)	8.8
U3O8 (g/L)	6.07

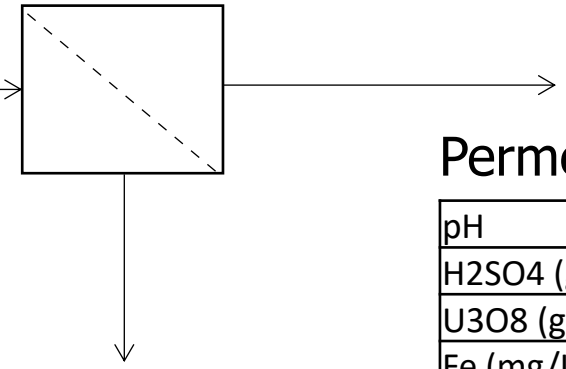
*Upgrade Uranium conc – 2nd stage



Test Work - Results

Harmony - South U
NF Membrane 2 – IX Eluate

NF Membrane – 7 VCF



Feed

pH	3.2
H2SO4 (g/L)	9.1
U3O8 (g/L)	1.98
Fe (mg/L)	720.16

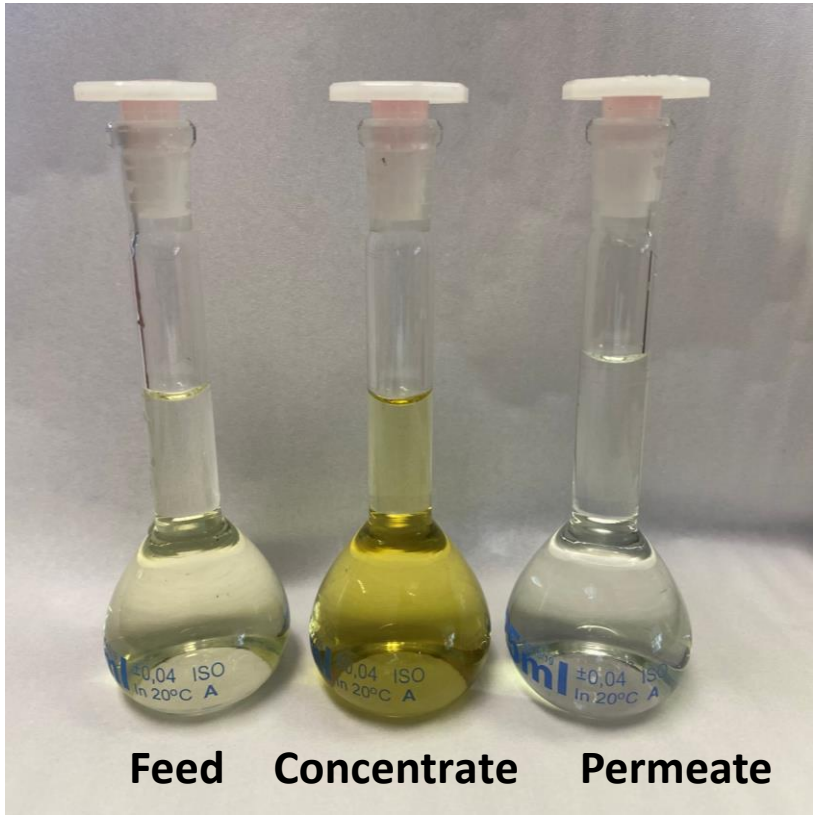
Concentrate

pH	2.9
H2SO4 (g/L)	9.1
U3O8 (g/L)	8.08
Fe (mg/L)	3805.05

Permeate

pH	3.1
H2SO4 (g/L)	8.3
U3O8 (g/L)	0.62
Fe (mg/L)	59.15

*Uranium slip – 2nd pass



Conclusion

- Exciting technology for the mining space
- Significant potential to recover and reuse Sulphuric acid
  - In excess of 30% tons per annum H_2SO_4
  - Millions of rands in OPEX savings
- Additional benefits downstream
  - Reduction in feed to SX
  - Potential replacement of SX
  - Reduction in neutralization costs – ESG savings
- Established technology in other industries
- Applicable to other metals and processes
- Applicable to other reagents (caustic / bicarb etc.)

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THANK YOU

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