

# Innovation for Sustainable Production

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Nanofiltration (NF) technology  
removes *non* biodegradable  
API's (active pharmaceutical ingredients)  
from  
aqueous & organic solvent mixtures

**Kamla Jevons & David Johnson**



## ***Industry drivers for change to current practice***

### **Organic solvent/aqueous + API contaminated streams**

- Corporate Environmental standards:
- Best practice low energy solutions
  - **EU initiatives to reduce CO<sub>2</sub> emissions**
  - **Climate change levy impact on cost of energy**
  - **IPPC**
- **COST OF OPERATIONS**
- Site production capacity increase



# Why alternative technology

**Established disposal  
route: thermal oxidation**

**Inefficient with high H<sub>2</sub>O content  
Existing capacity limit  
High Capital Investment  
Environmental issues**

**Active Pharmaceutical Ingredient (API)  
in process waste stream:  
>90% H<sub>2</sub>O + < 10% organic solvent +  
salts + API + by product**

**MEMBRANE FILTRATION  
SOLVENT STABLE MEMBRANE  
WITH >500 MW API  
REMOVABLE CAPABILITY**

**Reduce volume for thermal oxidation  
Filtered stream to chemical WWTP  
>98% reduction of API  
>70% reduction of volume  
Major capital & operating cost saving  
Environmental credits.**

## SelRO® - MPS-44 Spiral Membranes



- **Nanofiltration membrane ~ 250 NMWC**
- **Hydrophilic fine performance in aqueous streams**
- **Stable in organic solvents/aqueous mixture**
- **Reasonable operating range pH 4 to 10 and 40°C**
- **~25% rejection of NaCl**
- **~98% rejection of sucrose.**

# Process Stream Characterisation

**6 process steps producing  
different compositions &  
volumes**

<b>API ~720 Daltons:</b>	<b>concentration, solubility, analytical method</b>
<b>Solvent:</b>	<b>concentration</b>
<b>Monovalent salts:</b>	<b>type &amp; concentration</b>
<b>Multivalent salts:</b>	<b>type &amp; concentration</b>
<b>Water:</b>	<b>concentration</b>
<b>pH &amp; Temperature:</b>	<b>limits</b>
<b>Volume:</b>	<b>determine mixed stream volume</b>

# Process verification trials

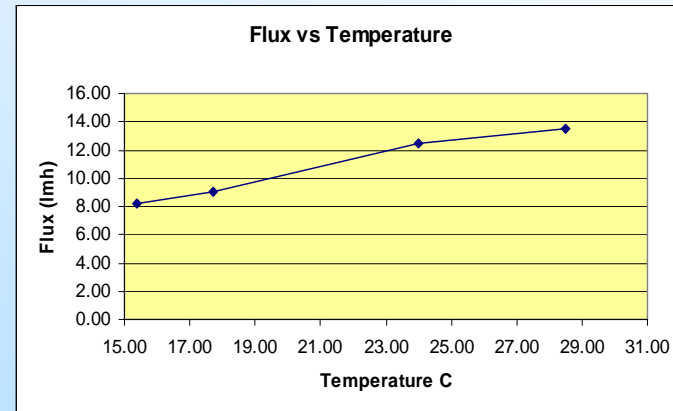
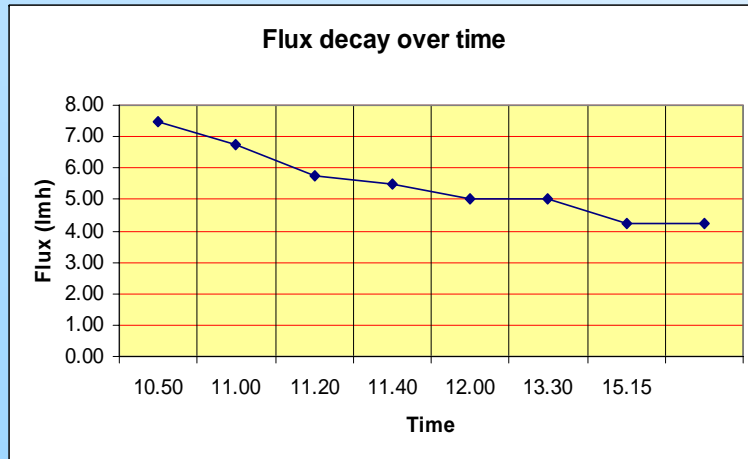
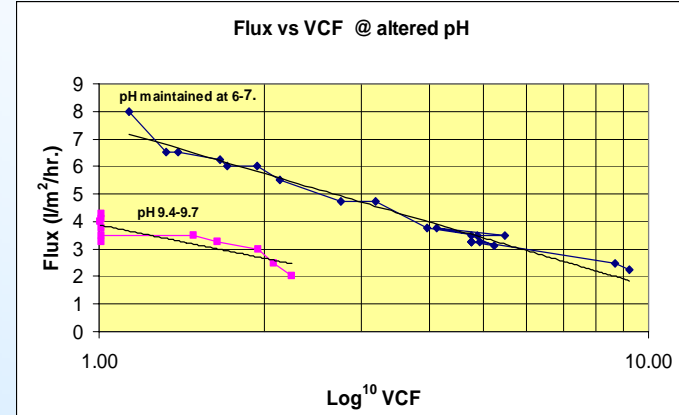
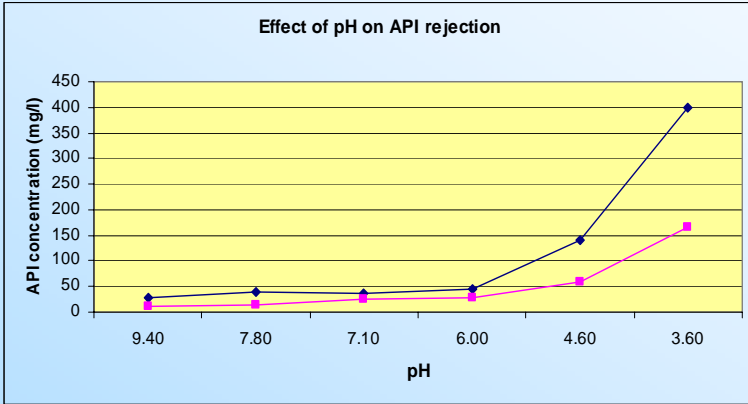
## PROOF OF CONCEPT

- API rejection 95 to 97%
- pH impacts on flux and rejection
- After 6 month soak test membrane retains rejection

## PILOT TRIALS

- 70% volume concentration achievable
  - >97% rejection of API First Pass
  - >95% rejection on Second Pass
  - pH impacts flux & rejection
  - Temp. impacts flux.
- Product solubility had a major impact on membrane performance

# Some basic effects



# Process Samples



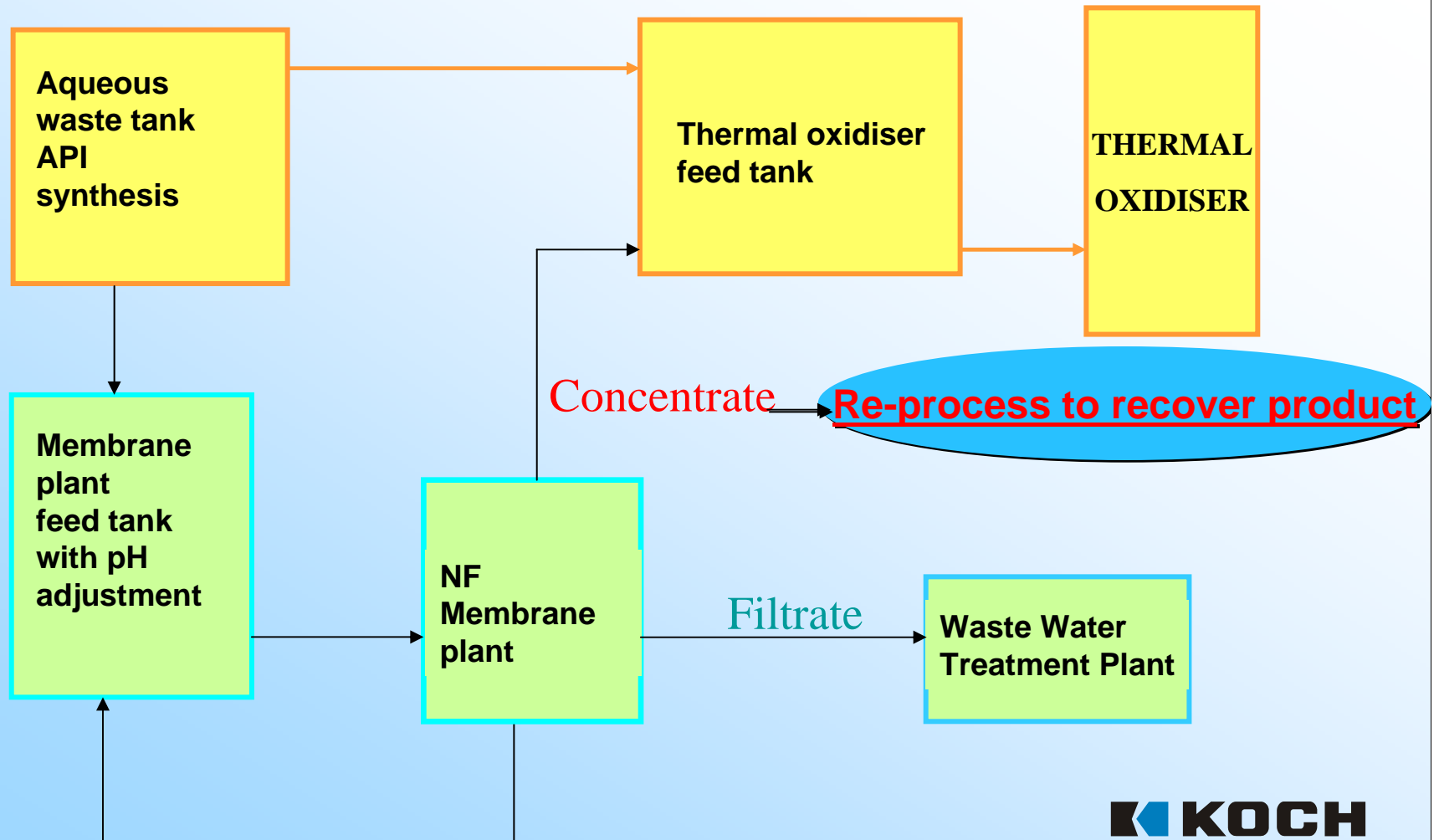
**FEED SAMPLE to NF**

**NF PERMEATE SAMPLE**





# Site Waste Stream Process Overview



**2 stage NF System: ATEX, cGMP validated, operating 35 bar.**

**Organic solvent stable materials of construction**



**KOCH**  
MEMBRANE SYSTEMS

# 2 years of of plant operation

- Plant commissioning and 1<sup>st</sup> Q operation:
  - Waste stream variability (different to trial phase material)
    - Developed a sticky residue blocking the membrane flow spacer:  
*50/50% organic solvent water rinse dissolved the residue.*
    - Membrane fouling decreased NF system capacity:  
*modified CIP clean –in –place regime.*
- Year 1 & 2 operation:
  - System capacity ~10% less than required
    - System designed to allow ~15% additional membrane area.
    - *Expansion in progress.*
  - *Membranes replaced after 9 months*
  - *First Pass NF consistently meets required permeate quality*





## Site benefits:

- Cost of offsite disposal (*due to thermal oxidiser upgrade*) more than covered the NF plant CAPEX.
- **NF installation will enable site expansion without additional thermal oxidiser installation.**
- SITE STANDARD API discharge limit can be met with first pass of the NF plant. *Second pass acting as a security.*
- **NF concentrated product could be recovered and reworked to enhance product yield.**





Thank you  
Kamla Jevons  
David Johnson

