

## Acid Concentration & Recovery Applications

Esmil and our Partners have conducted much research and gained vast experience in acid recovery and concentration across a range of industries. From bench scale studies right the way through to full scale plant operations we strive to offer BAT (Best Available Technology) using state of the art membrane separation technologies and other treatment processes.

### Industry Experience

- Organic Acids (Acetic acid/ Acrylic acid) removal / recovery
- Acid purification
- Nitric, Boric and Phosphoric acid Recovery
- Recognized licensed PTA membrane process for Acetic Acid Recovery

Membrane systems are ideal for the recovery of acid from a variety of industrial applications including radioactive solutions. Typical recovery and rejection rates are presented in the tables below:

### Sulphuric Acid Purification

Results generated on a 35% sulphuric acid feed stream. Metals recovered for re-use.

Components	Feed Conc.-mg/l	Rejection-%
<b>Copper</b>	2,880	82.0
<b>Iron</b>	1,640	99.6
<b>Lead</b>	20	90.0
<b>Zinc</b>	780	98.9
<b>Cadmium</b>	5,060	92.0
<b>Arsenic</b>	1,750	22.0
<b>Fluoride</b>	2,416	59.0
<b>Chloride</b>	569	33.3

### Boric Acid Purification

Results generated from a feed stream containing radio-nuclides. High degree of radionuclide rejection was achieved.

Components	Rejection-%
<b>Boric Acid</b>	3.0
<b>CO58</b>	84.5
<b>CO60</b>	87.9
<b>Sb124</b>	99.0

### Nitric Acid Purification

Acid recovery from 2N acid solution contaminated with 10,000 mg/l uranyl nitrate. 85% recovery achieved with less than 200 mg/l uranyl nitrate in the effluent.

Components	Pass-I		Pass-II	
	Feed Conc.-mg/l	Rejection-%	Feed Conc.-mg/l	Rejection-%
<b>HNO3</b>	2N	0	2N	0
<b>UO8NO3</b>	14,417	85	1,457	86

## Phosphoric Acid Purification

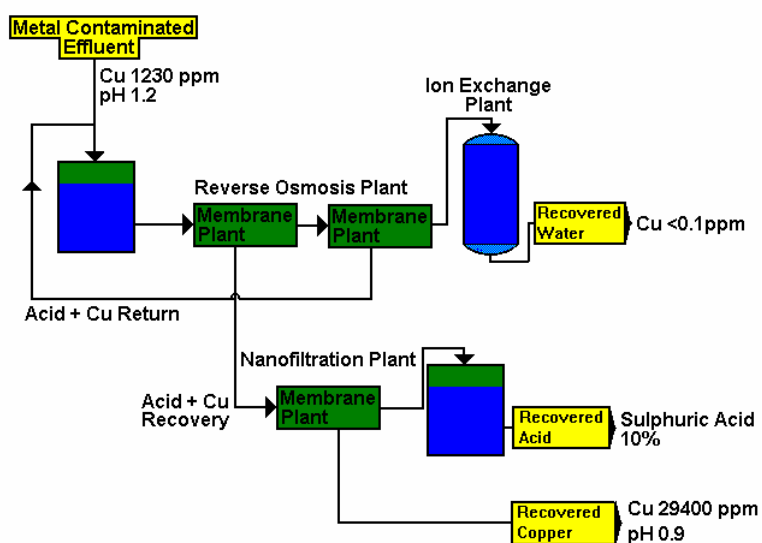
Phosphoric acid can be purified using the membranes. Typical contaminant rejections obtained on 25% phosphoric acid stream.

Components	Feed Conc.-mg/l	Rejection-%
<b>Sulphate</b>	15,300	99.4
<b>Aluminium</b>	3,300	99.9
<b>Iron</b>	2,800	99.9
<b>Magnesium</b>	2,800	98.8
<b>Vanadium</b>	600	99.9
<b>Cadmium</b>	68	93.5
<b>TOC</b>	245	60.0

## Industrial Applications

### Sulphuric acid

The manufacture of printed circuit boards (PCB) results in the generation of an effluent comprising dilute acid and trace metals, particularly copper. Effluent generated may be treated by a combination of reverse osmosis and Nanofiltration stages followed by an Ion exchange plant. The system was designed to optimise recovery of both residual copper and spent acid rinse waters



Cost benefit analysis of a similar recovery plant for a copper rod mill is described in the table below.

<b>Through-put</b>	<b>400 m<sup>3</sup>/day</b>
<b>Capital Cost</b>	<b>£1,100,000</b>
<b>Copper Sulphate Recovery</b>	<b>£917/day</b>
<b>Sodium Hydroxide Savings</b>	<b>£647/day</b>
<b>Polymer dosing savings</b>	<b>£88/day</b>
<b>Total Annual Savings (based on 340 days/year)</b>	<b>£561,680</b>
<b>Payback Period</b>	<b>2 years</b>

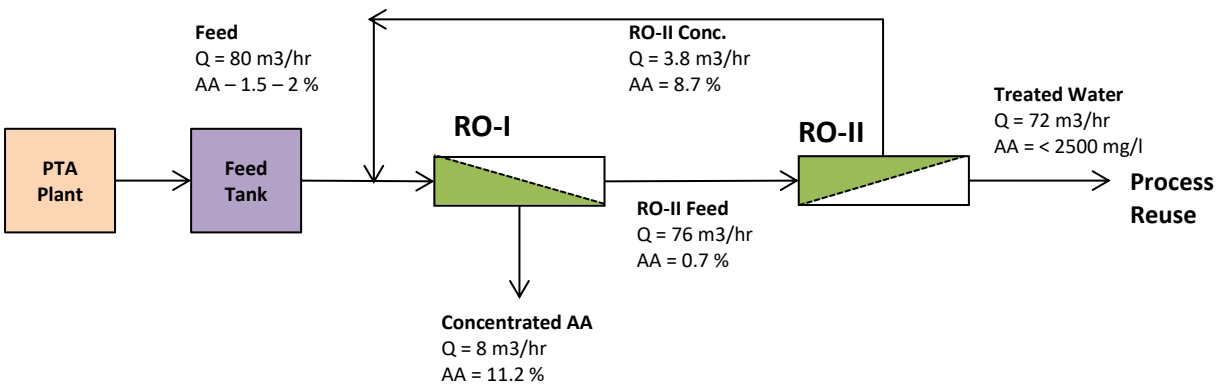
Both sulphuric acid recovery systems as describe above offered the following advantages:

- Rapid investment pay-back
- Copper Sulphate recovery
- Acid rinse water recovery
- Reduced environmental liability
- Reduced loading on Ion Exchange plant

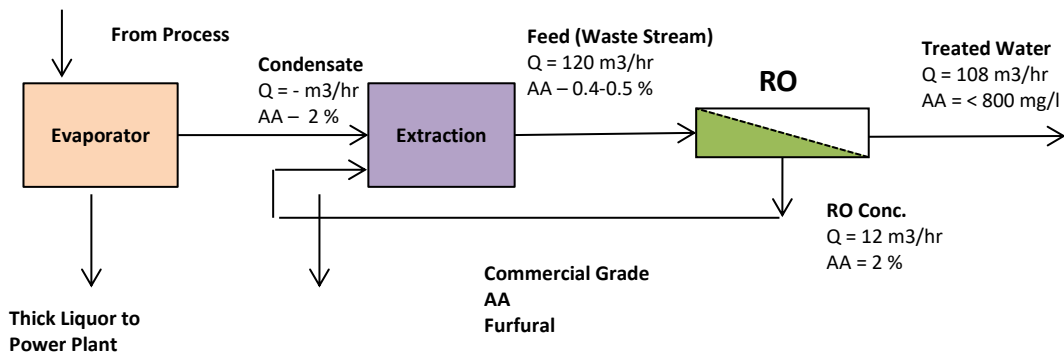
Acetic Acid

BP chemicals site was faced with the treatment of an aqueous effluent for the removal of Acetic Acid before discharge from site. Reverse Osmosis membranes were proposed for the separation and recovery of the Acetic Acid. The thin film composite polyamide membrane rejects Acetic Acid, whilst allowing water to pass through it; producing concentrated acetic acid and a treated water stream (permeate). This provides possibilities for re-using the recovered acid and treated water streams back in the site processes.

Purified Terephthalic Acid (PTA) manufacturing process produces 1.5 – 2% acetic acid as a by-product which makes the aqueous stream unsuitable for reuse. Acetic acid contributes very high COD load making downstream treatment non-feasible. Esmil membrane based process can concentrate Acetic acid to around 10-12 % and produce the treated water suitable for reuse or can be treated in downstream WWTP with ease.



Wood based fibre manufacturing process generate waste stream after the extraction stage which contains up to 0.5% acetic acid which adds huge COD load on downstream WWTP. Esmil membrane based process can concentrate Acetic acid to around 2 % which is added to the feed to extraction unit to enhance overall Acetic acid recovery.



Esmil Acetic Acid Recovery design uses specially developed and proven membrane technology to provide the following benefits:

- 90-95% feed recovery as treated water for reuse or further treatment.
- 95% acetic acid rejection below 20°C
- Robust and reliable automated plant.
- No chemical dosing requirement.



### **Acid Recovery Design Philosophy**

As no two processes are equal it is essential to follow a number of steps to ensure that your tailored Acetic acid recovery process performs as well and economically as possible to achieve your treatment goals.

- Laboratory tests
- Long term site pilot trial to allow for feed variation and data gathering
- Extensive plant design incorporating capital and operating expense calculations
- Build, Installation Supervision, Commissioning and Start-up assistance

### **References:**

- Toppan, PCB Manufacturing, USA - Sulphuric Acid Recovery
- Phelps Dodge, Copper Rod Mill, USA – Sulphuric Acid Recovery
- BP Chemicals UK – Acetic acid recovery
- PTA process licensor, Global – Acetic acid recovery

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