Metallurgical Processing of Manganese Nodules – Indian Perspective

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INDIAN POLYMETALLIC MANGANESE NODULE (PMN) PROGRAMME

- **26 January 1981, first nodule sample collected by Indian scientists in Indian Ocean**
- **December 1987, India registered as Pioneer Investor with mining sites allocated in the Indian Ocean**
- **PMN programme is managed by Ministry of Earth Sciences (MoES), New Delhi (previously Department of Ocean Development)**
- **MoES has divided the tasks under PMN programme into Survery & EIA, Mining and Metallurgy**
- **Various laboratories and institutes in India are working under the categories:**
  - **Survey & Exploration: National Institute of Oceanography, Goa and National Centre for Antarctic and Ocean Research, Goa**
  - **Mining: National Institute of Ocean Technology, Chennai**
  - **Metallurgy: Institute of Minerals and Materials Technology, Bhubaneswar**

SIGNIFICANCE OF NICKEL & COBALT

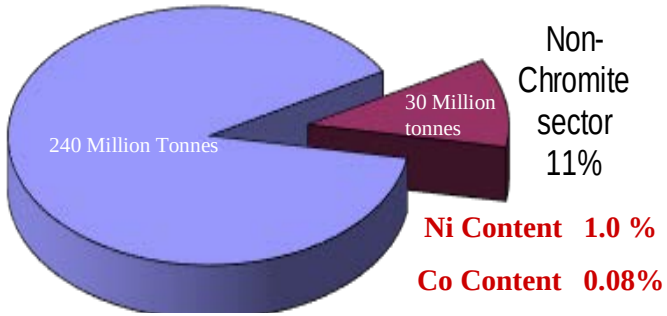
- The only available natural source of nickel (Ni: ~0.7%) of India present in Chromite Overburden (COB).
- Process developed by IMMT was tested in pilot scale (10 tpd COB) at IMMT, Bhubaneswar.

TOTAL RESERVES OF Ni ORE IN INDIA

Ni & Co content of existing COB dumps

Ni Content 0.7%

Co Content 0.05%



Ni Content 1.0 %

Co Content 0.08%

Typical composition of Polymetallic nodules	
Metal	**Composition**
Ni	1.1%
Co	0.1%
Cu	1%
Mn	23%
Fe	8%
Zn	0.1%

PMN Metallurgy Programme

PMN metallurgy programme in India started in 1987 through cooperative efforts of various national level agencies for three metals recovery

15 process routes were initially taken up for recovery of Cu, Ni and Co

After evaluation 3 processes shortlisted

Direct leaching process in ammoniacal medium

(Institute of Minerals and Materials Technology)

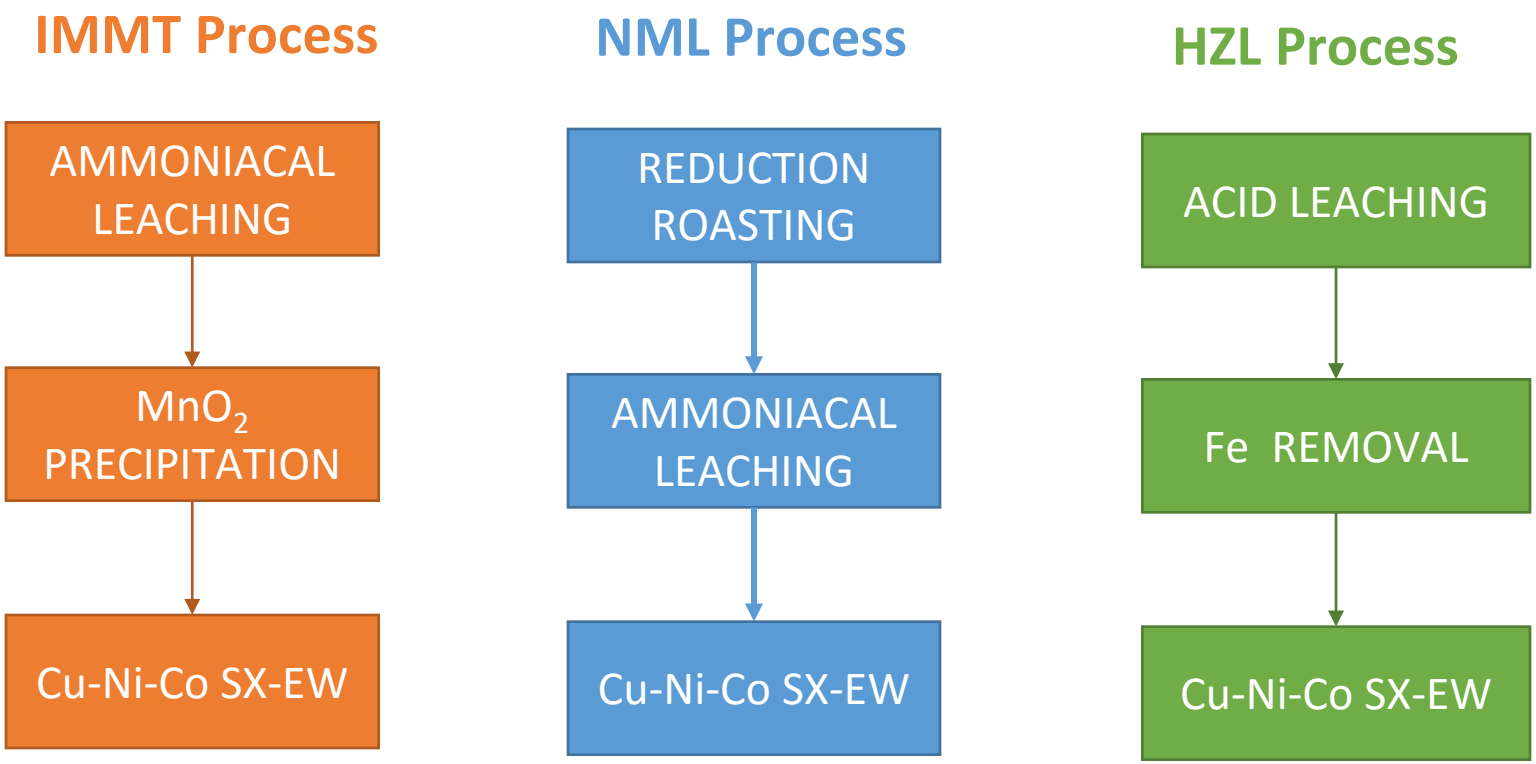
Reduction roasting and ammoniacal leaching

(National Metallurgical Laboratory)

Sulfuric acid leaching

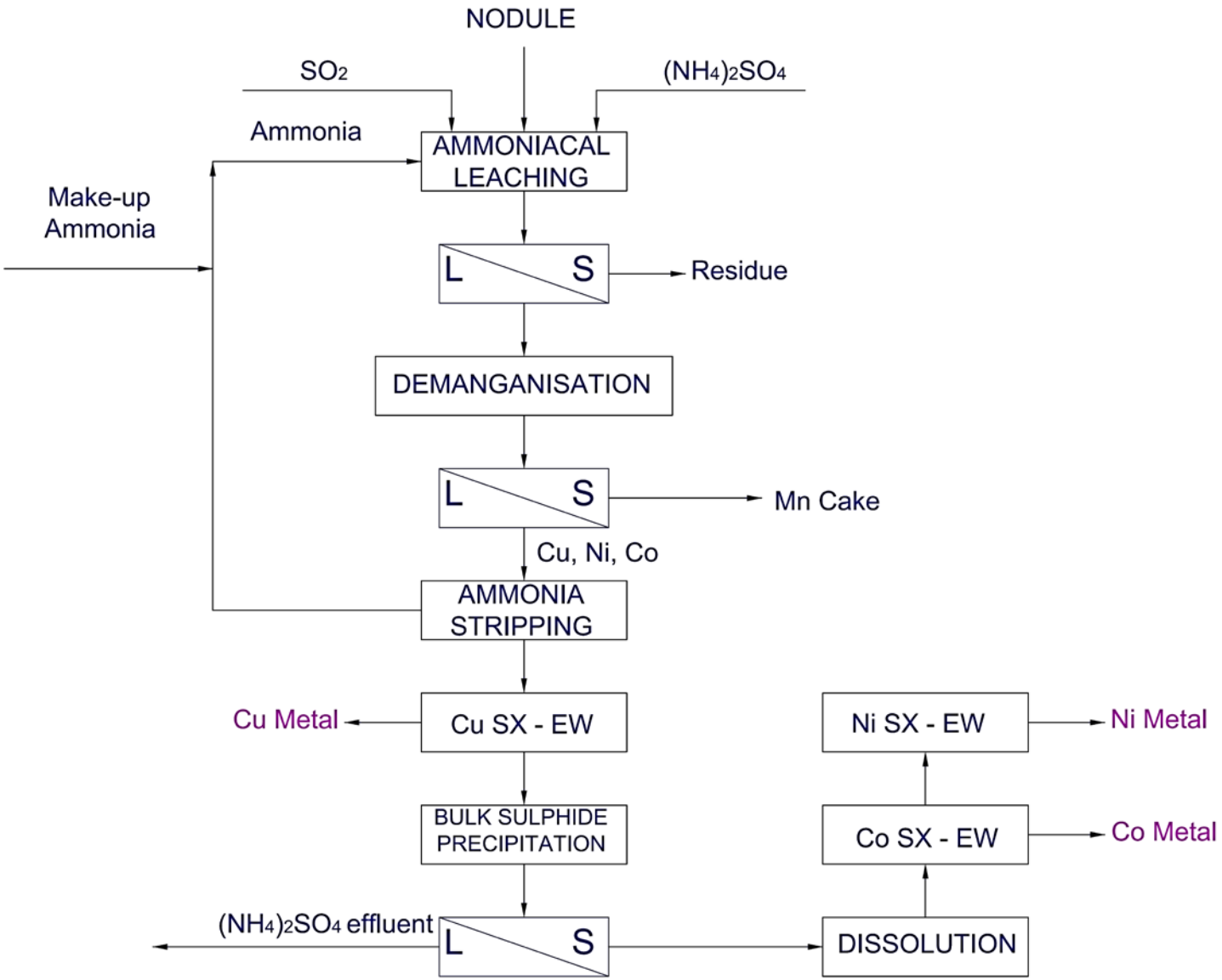
(Hindustan Zinc Limited)

SHORTLISTED PROCESSES



IMMT and NML demonstrated their respective processes at 100 kg scale

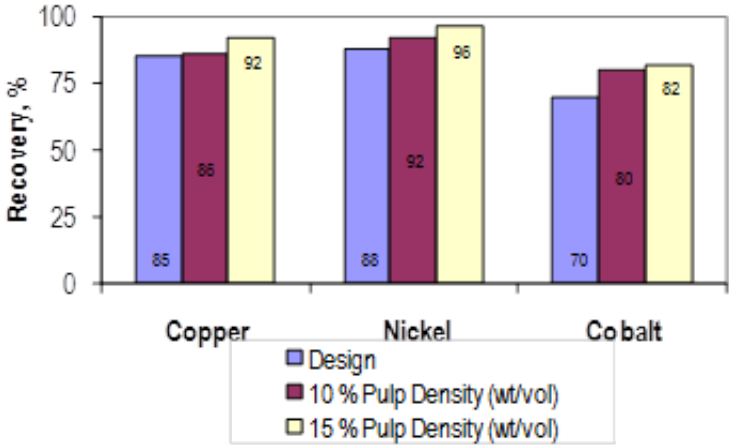
IMMT PROCESS

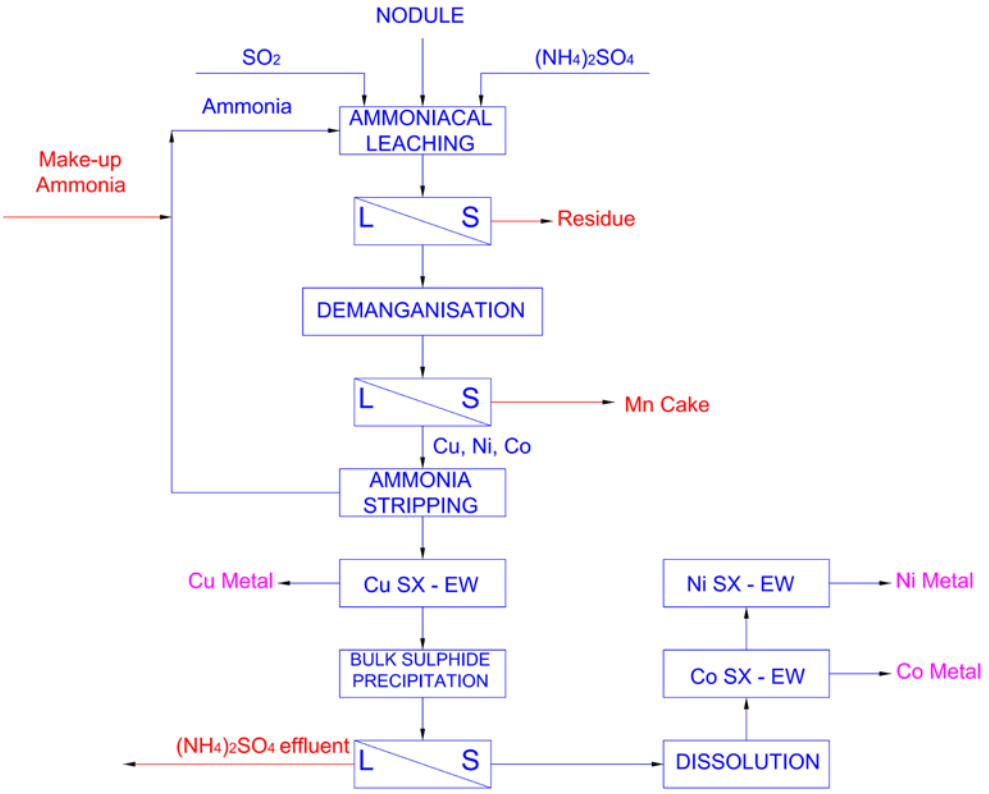


PILOT PLANT DEMONSTRATION

500 kg / day scale at technology demonstration pilot plant at HZL, for extraction of Cu, Ni and Co during 2002-2007.

RECOVERIES & IMPROVEMENTS

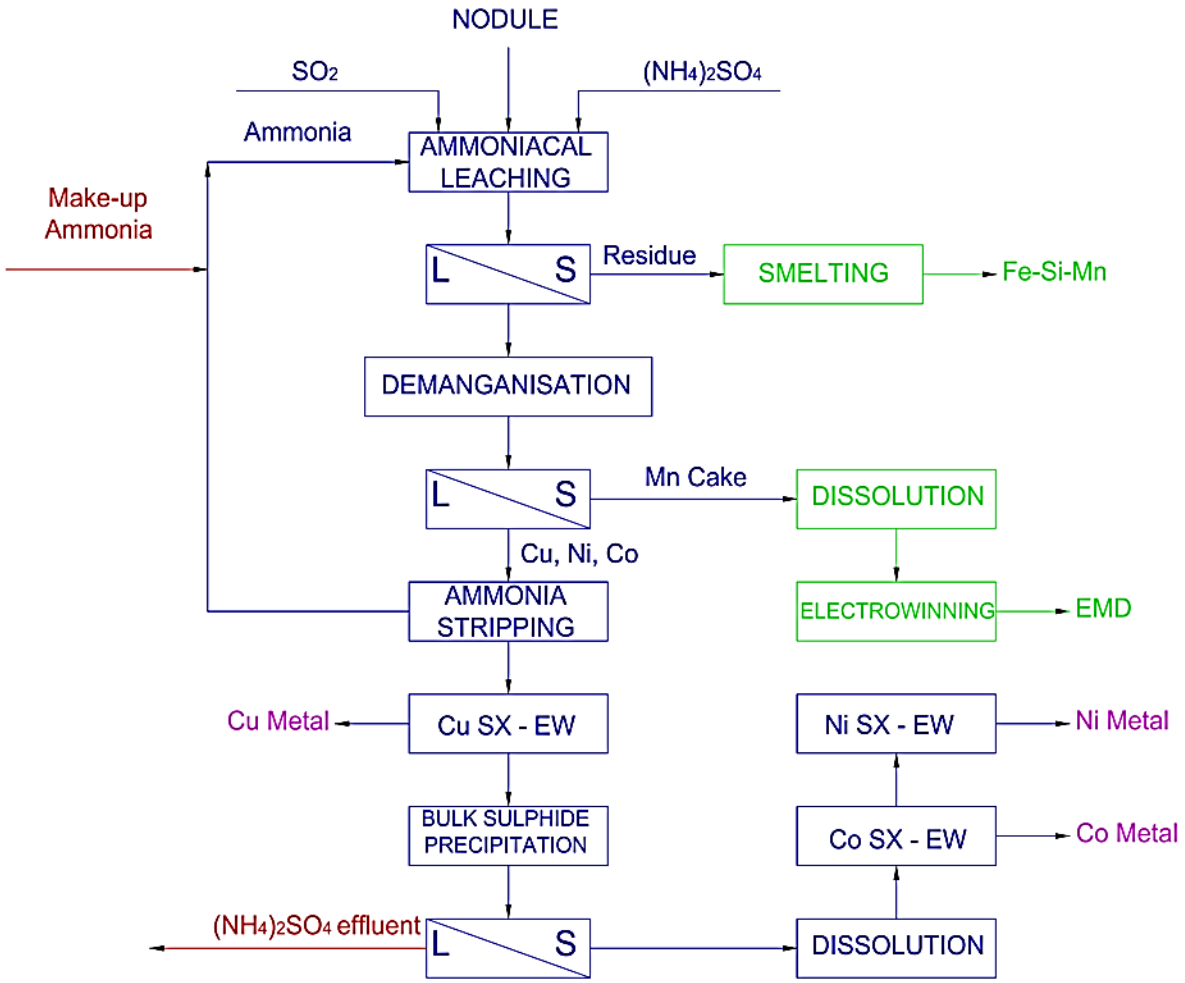




Opportunities for improvements:

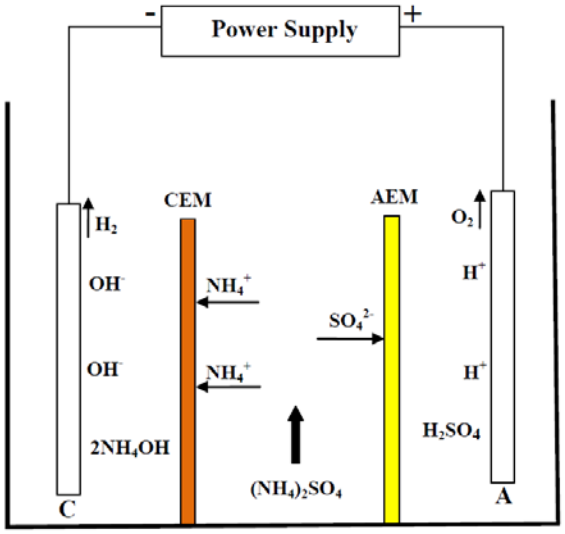
- Residue from leaching operation containing Mn and Fe
- Cake from demanganisation operation containing Mn
- Make-up ammonia requirement in the leaching operation
- Ammonium sulphate effluent

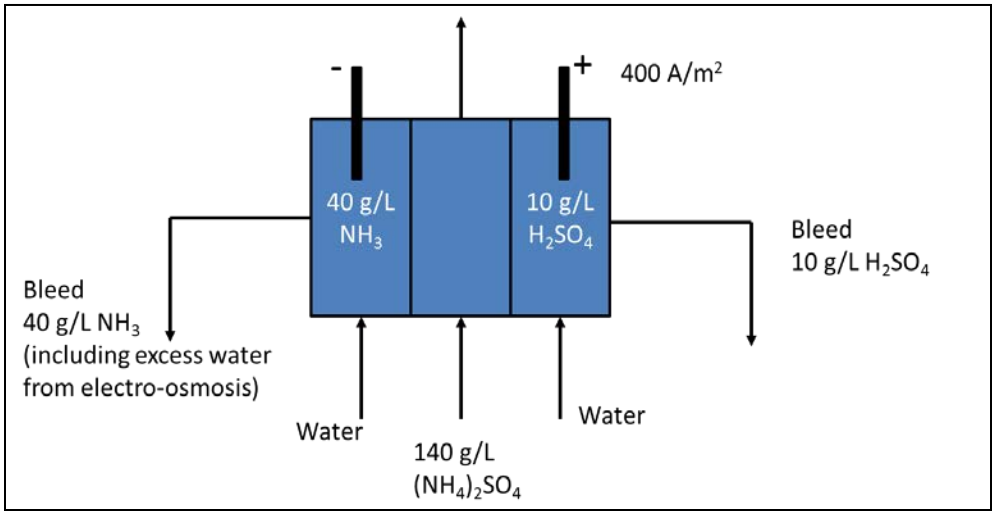
FOUR METALS RECOVERY



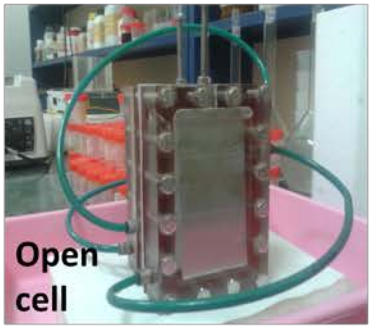
- Mn was recovered as Ferro silicomanganese from leach residue.
- A separate pilot plant was set up at NML to recover manganese as the fourth metal.
- However, the Mn content in the residue was low with accompanying high process energy consumption per unit weight of recovered manganese.
- Pilot scale demonstration carried out for EMD

AMMONIUM SULPHATE SPLITTING

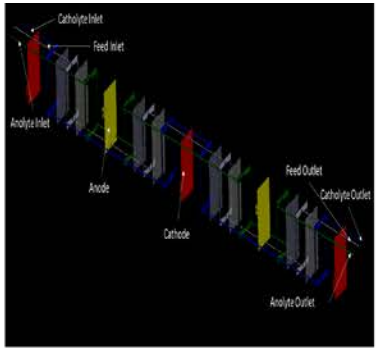




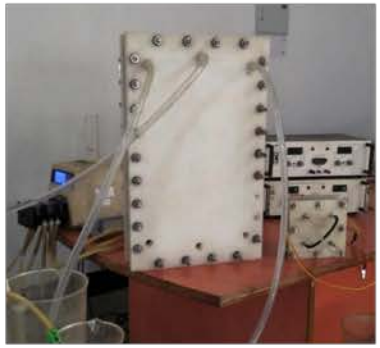
Optimized in lab scale and scaled up to 50 L/h feed



Development of salt splitting cell at lab scale of 6L/h capacity

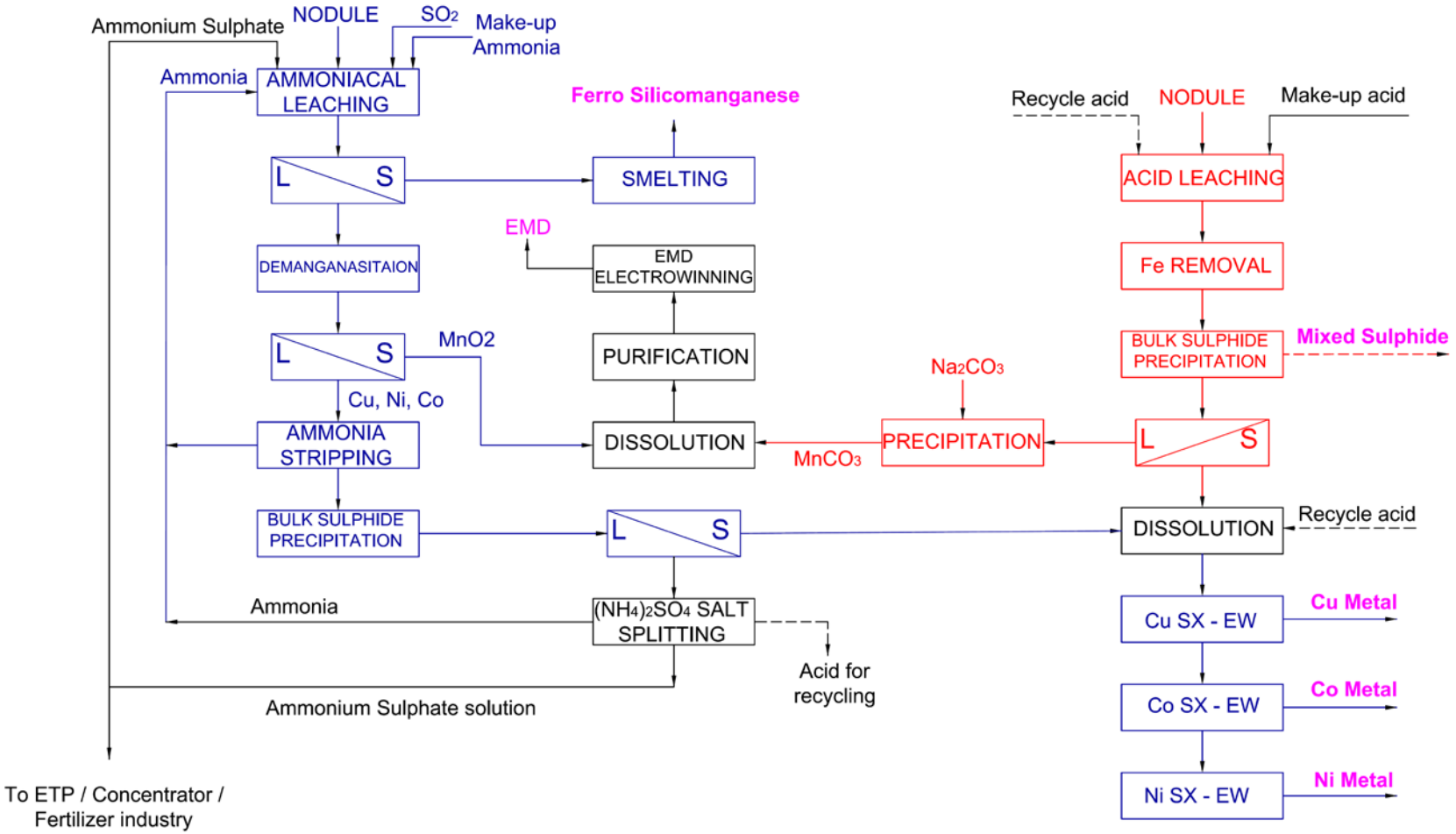


Design of Up-scaled salt splitting cell



Up-scaled cell of 50L/h capacity

INTEGRATED LEACHING PROCESS



Products:

Cu - Metal / mixed sulphide
Co - Metal / mixed sulphide
Ni - Metal / mixed sulphide
Mn - Ferro Silicomanganese & EMD
Fe - Ferro Silicomanganese

PRESENT FOCUS

- Improving Mn portfolio
  - Ferro Silicomanganese
  - EMD
  - $MnCO_3$
- Processing and recycling of effluents for reducing chemical consumption
- Efforts to address residue washing

ACKNOWLEDGEMENTS

- MoES, Govt. of India, for the PMN metallurgy programme
- Towards the workshop
  - Organizers
  - MoES
  - CSIR-IMMT

Thank you