SHORT COURSE

SX and its Application to Copper, Uranium and Nickel-Cobalt

Presented by

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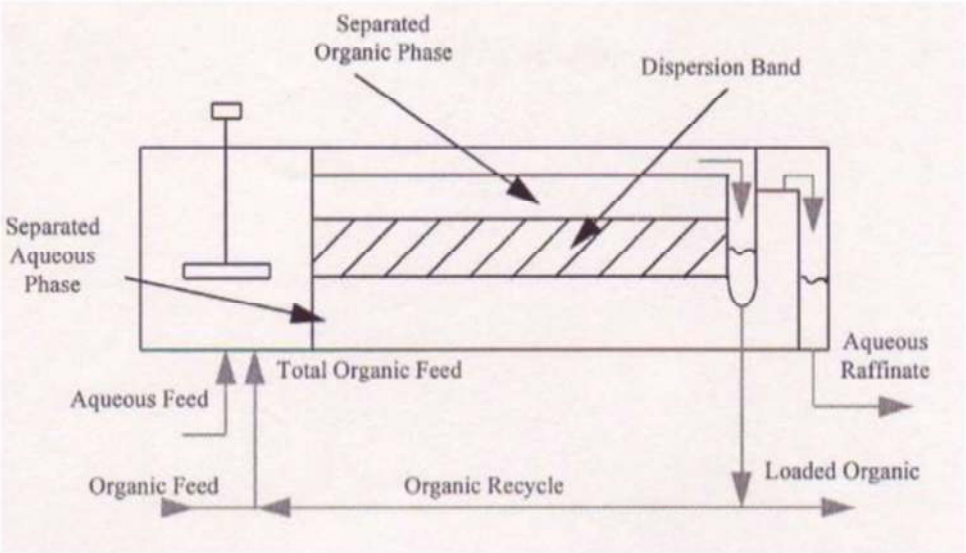
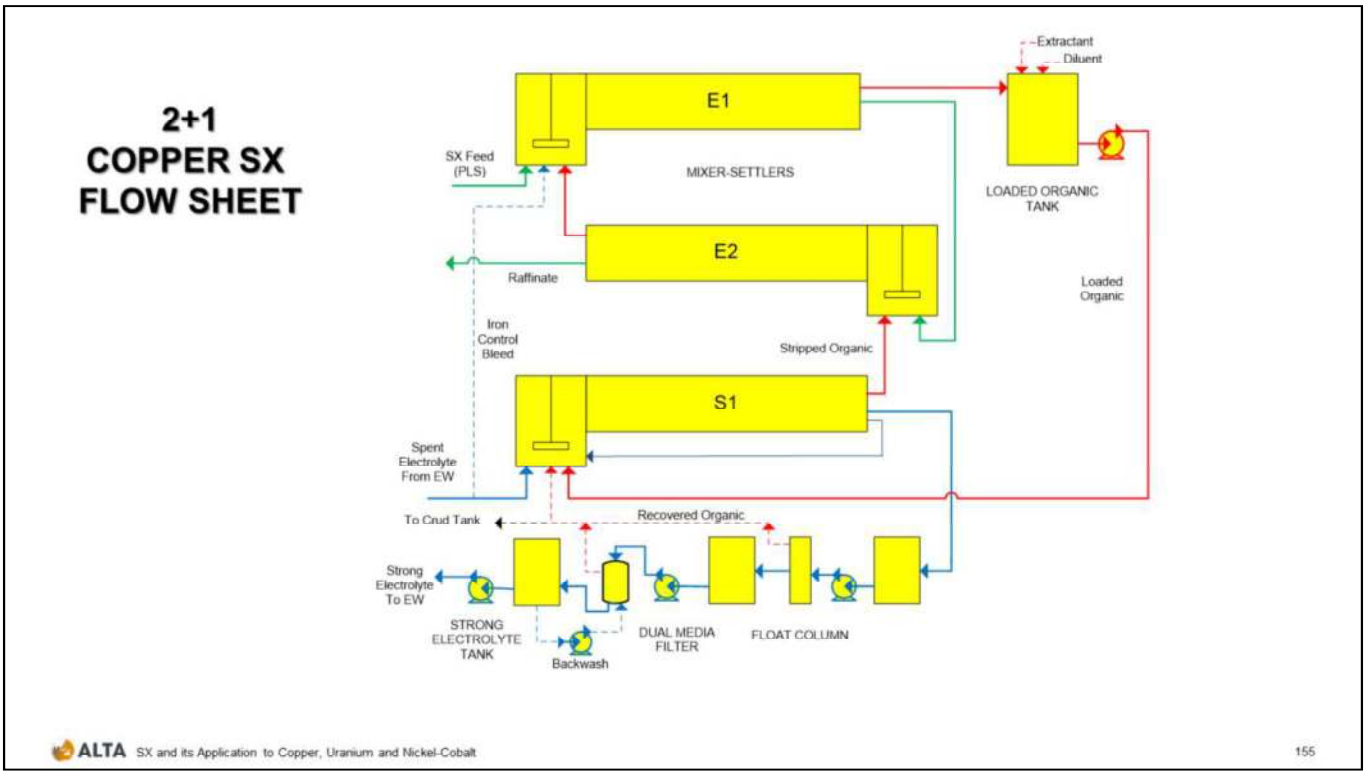
Notes

CONVENTIONAL MIXER-SETTLER WITH ORGANIC RECYCLE



Notes

1. Mixer-settlers were first used the in nuclear industry in the 1940s and 1950s for specialized applications including purification of uranium, reprocessing of fuels and separation of fission products. Reasons included low head room requirement which minimized the amount of shielding, simplicity and low maintenance. Typically, nuclear mixer-settlers involved consisted of partitioned “boxes” to avoid inter-stage piping with interstage flow by gravity. Use spread to uranium ore processing in the 1950s with the introduction of SX, and became the most widely used type of SX contactor. Since then mixer-settlers have been commonly used in copper, nickel-cobalt and other SX applications.
2. Organic and aqueous phases are contacted in mix boxes typically equipped with slow speed, large diameter, low shear pump-mix type agitators, which provide inter-stage pumping as well as mixing. Pump-mixers commonly have variable speed drives, and are designed to avoid fine droplet formation and air entrainment which hinder coalescence in the settlers. Auxiliary mix boxes and agitators can be used for large plants to reduce mixing inefficiencies which can occur with large single mix boxes, and to achieve a lower profile.
3. In the adjoining settler, the phases coalesce and separate by gravity, and are typically removed via separate weir boxes. The overall solution level is generally set by a fixed organic weir, while the thickness of the top organic layer is set by an adjustable aqueous weir or by an adjustable sleeve on the discharge pipe in the aqueous weir box.
4. The mix boxes can be operated either with the organic or the aqueous as the continuous phase depending on the properties of the organic and aqueous phases and the function of the particular stage in the circuit. An organic or aqueous recycle stream from the settler back to the mix boxes is commonly needed to maintain the phase ratio in the mix box suitable for the desired phase continuity.
5. Mix boxes can be cylindrical or “square”; settlers are generally rectangular (though circular settlers have been used).
6. Devices such as flow distributors, picket fences and various coalescence aids are installed in the settler to improve performance.
7. Phase separation rates in the settlers are relatively slow, and the specific flow is typically 2.5–5 m^3/h (of combined aqueous and organic) per m^2 of settler area, depending on the solution properties and the temperature.
8. Construction materials used include FRP, stainless steels, HDPE, wood, and concrete with various corrosion resistant linings.

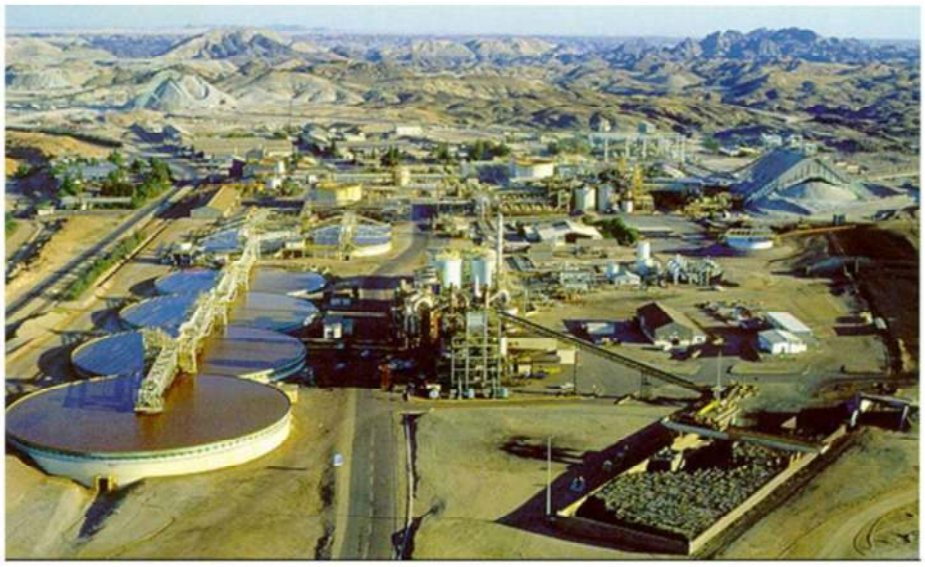


Notes

1. Flowsheet shows a simple single train 2 extraction stages + 1 strip stage flowsheet, typically suitable for relatively low grade solution from heap or dump leaching.
2. Multi-trains of mixer-settlers may be used for large plants and to reduce risk of total production loss due to fire.
3. More stages may be added for more concentrated solutions, such as from leaching of high grade ore or concentrates.
4. A float column followed by dual media filter is included for strong electrolyte.
5. No organic recovery step is included for the raffinate.
6. Conventional mixer-settlers with single stage mix-boxes are depicted. It is recognized that other types of units could be used, and that two or three stage mix boxes are common.
7. A small bleed stream is taken from the spent electrolyte returning from EW in order to control the level of iron and/or chloride in the EW circuit. The bleed is added to the first extraction stage to recover the copper content. The acid content flows through to the raffinate and forms part of the acid make-up to leach. If the acid cannot be accommodated in leach (e.g. in some sulphide leaching systems), it may be necessary to treat a raffinate bleed stream with limestone or other acid consumer to neutralize the acid and in some cases precipitate iron. In such cases, it may be necessary to incorporate a copper recovery step to avoid unacceptable copper loss from the bleed stream.

ROSSING URANIUM AGITATED ACID LEACH OPERATION, NAMIBIA

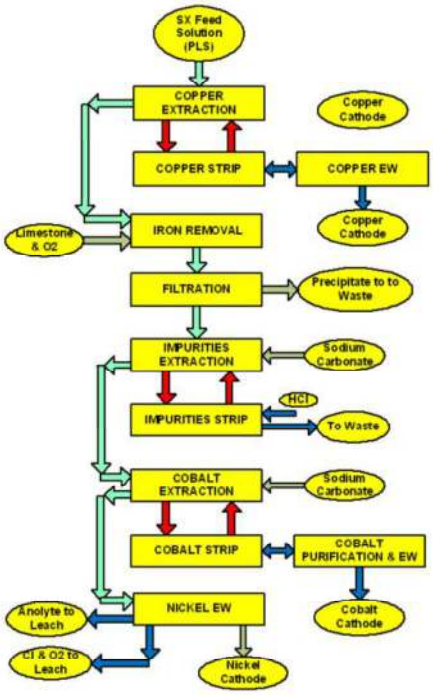
(Ref: Cognis presentation, ALTA 2009)



Notes

1. Rössing Uranium Limited is a member of the Rio group of companies.
2. Plant started up in 1976, and produces 4,000 tons per year of U_3O_8 from 13 million t/a of ore with a grade of about 0.03% U_3O_8.
3. Purchased by China National Uranium Company July 2019.

VOISEY'S BAY SX FLOWSHEET



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Notes

1. Reference: "Voisey's Bay Nickel Project Hydromet Demonstration Facility Business Opportunities Study", Gov. of Newfoundland and Labrador Dept. of Natural Resources, Sept. 2004, and US Patent 6,428,604, Aug. 6, 2002.
2. Copper is first recovered from the sulphate-chloride leach solution from pressure oxidation containing about 5 g/L Cu by conventional copper SX-EW (or alternatively by precipitation as copper sulphide).
3. Raffinate containing about 1 g/L Fe is neutralized with limestone under oxidizing conditions at 60-80oC to precipitate ferric hydroxide and gypsum.
4. Impurities such as zinc, lead, calcium, and residual copper and iron are then extracted using D2EHPA with pH control by an alkali such as soda ash or caustic. Loaded organic is stripped with HCl and the strip solution is sent to effluent neutralization.
5. Cobalt is selectively extracted from the purified solution using Cyanex 272, stripped with sulphuric acid solution and recovered by EW.
6. Sodium carbonate is used for pH control in impurities and cobalt SX.
7. Nickel is then recovered from the sulphate-chloride solution containing about 80 g/L Ni as cathode by EW The DSA anodes are enclosed in bags with a hood to capture oxygen and chlorine gas and anolyte solution which are recycled to the leach circuit.