LITHIUM BLACK POWDER RECYCLING

SOLVENT FREE TECHNOLOGY

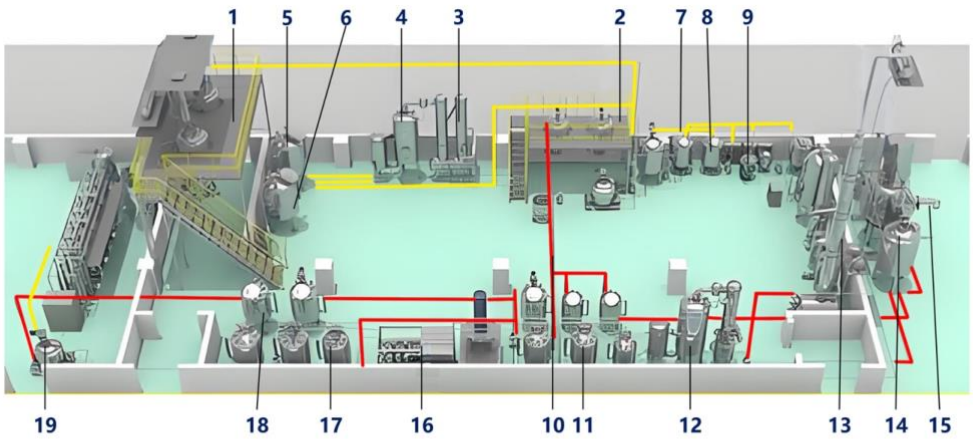
Solvent Extraction Free Hydrometallurgical Technology for Lithium Battery Black Powder

Non-Solvent Extraction Process

The non-solvent extraction hydrometallurgical process for lithium battery black powder uses waste battery black powder and waste cathode sheet powder as raw materials. It adopts an independently developed step-by-step leaching technology to obtain nickel-cobalt-manganese mixed solution, lithium sulfate solution, and anode graphite powder respectively.

After further purification, the anode graphite powder is used as a raw material for battery anode manufacturers. After impurity removal and purification, the nickel-cobalt-manganese solution yields battery-grade nickel-cobalt mixed salts; alternatively, the mixed salts can be further used to synthesize precursors for ternary lithium batteries.

After purification, the lithium sulfate solution undergoes evaporation and crystallization to produce battery-grade lithium hydroxide or undergoes carbonation and precipitation to obtain battery-grade lithium carbonate. Throughout the entire production process, the separation and high-value recovery of nickel, cobalt, manganese, and lithium are achieved without the use of solvent extraction technology.



Flowchart of UniRec Solvent Extraction-Free Wet Process:

1 Black Mass
2 Selective leaching
3 Li_2SO_4 solution
4 Precipitate
5 Purification
6 Battery-grade Li_2CO_3
7 Na_2SO_4 solution
8 Evaporative
9 Na_2SO_4
10 Leaching residue
11 Leaching
12 Mixed solution
13 Purification
14 Evaporative .
15 Ni/Co/Mn sulfate
16 Graphite residue
17 Purification
18 Dry
19 Regenerated graphite

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Advantages of Non-Solvent Extraction Process Technology

Our process is a non-solvent extraction hydrometallurgical method that uses new, independently developed techniques for leaching, purification, and recovering nickel, cobalt, manganese, and lithium. Unlike the traditional method, which relies on hydrogen peroxide leaching followed by solvent extraction for purification and separation, our technology offers several clear advantages:

1. No need for extractant procurement and low construction costs

Our process does not use extractants, which saves the cost of extractant procurement, reduces the requirements for the plant's fire protection rating and the plant construction cost, thereby lowering the overall construction investment of the hydrometallurgical plant. **When building hydrometallurgical recovery plants of the same size, our process allows you to save over 50% on investment costs.**

2. Shorter process flow

With our process, there is no need to separate nickel, cobalt, and manganese individually. This means we do not use extractants, resulting in a shorter process, less equipment, lower material use, and a higher recovery rate for metals. There is also no leftover extractant waste or need to remove oil from the solution. **Compared to traditional long-process hydrometallurgical extraction methods, our process is much shorter and can cut operating costs by 15–20%.**

3. Low pollution discharge

Advanced technology is utilised to monitor and regulate water-gas circulation and solid waste generation during the process. This includes reusing water and gas, as well as turning solid waste into useful materials. **As a result, almost 100% of all waste gas, wastewater, and solid residues from decommissioned lithium batteries are recycled,** making the process efficient and environmentally friendly.

4. High recovery rate

The recovery rates of nickel, cobalt, and manganese exceed 99%, and the recovery rate of lithium exceeds 95% (the lithium recovery rate of the extraction method is less than 90%).

5. High product quality and high added value

The output from our recycling are nickel-cobalt-manganese sulfates and battery-grade lithium salts, which can directly be used in the production of ternary precursors and cathode materials. These materials are further applied in manufacturing power batteries for new energy vehicles, lithium batteries for 3C products, energy storage batteries, and other products.

Output of the Non-Solvent Extraction Process

For every 1 ton of black powder processed, the element recovery rates, and main product outputs are detailed in the table below:

Element/Component	Recovery Rate (%)	Product	Output (Ton)
Total Nickel- Cobalt-Manganese (Ni+Co+Mn)	99.0	Nickel-Cobalt-Manganese Sulfate / Ternary Precursor	1.50 / 0.48
Lithium (Li)	95.0	Battery-Grade Lithium Carbonate / Battery-Grade Lithium Hydroxide	0.18 / 0.20
Graphite	98.0	Recycled Graphite Powder	0.39

Pollutant Discharge

Waste Gas

Nickel, cobalt, and manganese in the black powder are extracted using a dedicated reducing agent, with no waste gas generated. Only a small amount of acid mist-containing waste gas is produced, and all of it is recycled back to the system for reuse after spray absorption. The emission concentration fully complies with the atmospheric pollutant discharge standards.

Wastewater

Evaporative condensed water and washing water generated during the production process are recycled back to the water used in the front-end leaching process. The internal recycling of wastewater is realized throughout the entire production process; only a small amount of rinsing water and laboratory quality inspection wastewater are mixed, treated to meet discharge standards, and then discharged. The wastewater discharge volume is 2 cubic meters per day (m^3/d).

Solid Waste

After nickel, cobalt, manganese, and lithium are extracted from the black powder, graphite residue is produced. By utilizing the graphite residue resource recycling technology developed by the company, the production line can sell the recycled graphite resources as commodities after it is completed.