A closed-loop zero-liquid-discharge process for the precipitative separation of all valuable metals from waste lithium-ion batteries of mixed chemistries at room-temperature†

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Materials and Methods

A variety of used mobile batteries were gathered from a local recycling centre in Bhavnagar, Gujarat, India. These batteries were discharged and disassembled manually to separate cathode, anode, metal casings, and plastic separators. The whole cathode, which is aluminium foil with cathode active material, was heated in air at 450 °C for 5h to remove the binder. For leaching experiments, either the whole cathode (aluminium foil with active cathode material) or cathode powder was utilized separately. Acetic acid, hydrogen peroxide (35 % v/v), dimethylglyoxime, sodium sulfide, sodium hydroxide, and sodium carbonate, all chemicals of the analytical grade, were purchased from TCI Chemicals Pvt. Ltd.

Analytical methods

In this study, the concentration of metal ions in the leached liquor was analyzed using an ICP-MS Thermofisher icap Qnova series instrument. The morphologies of the recovered metal salts were characterized through scanning electron microscopy (SEM-Leo series 1420 VP). The FT-IR spectra of the samples with KBr pellets were measured using a Perkin-Elmer GX spectrophotometer, which was manufactured in the USA. Additionally, powder X-ray diffraction profiles were recorded at 2θ angles ranging from 10° to 80° using a MiniFlex-II (FD 41521) powder diffractometer from Rigaku, Japan. To ensure accuracy and minimize errors (within ± 5 %), all leaching experiments and subsequent downstream processing to recover metal ions through precipitation were repeated three times, and the average results were considered as the final results.

Experimental procedure:

Battery discharging & dismantling

The collected lithium-ion batteries (from mobile phones) were immersed in the NaCl solution (1 M) for 48 hrs to discharge the batteries. Then these batteries were washed with tap water, followed by deionized water, and dried in a vacuum oven at 70 °C for 12h. Batteries were dismantled manually to obtain cathode (aluminum foil with metal oxides, 34.28 %), anode (copper foil with graphite, 18.98 %), and separator (5.14 %), aside from the steel casing and other parts (42 %) (Fig. S1†).

Selective precipitative separation of metals from leached liquor of cathode material

Separation of Nickel:

After leaching, the metal-enriched liquor is used as the feed source for separation of the metal ions sequentially (Ni, Co, Al, Mn, Li) by selective chemical precipitation method. Initially, the filtered leached liquor having a pH of ~3.5 was used for the recovery of nickel as $Ni(DMG)_2$. In a typical precipitation method, DMG (dimethyl glyoxime) (2.24 g, 19.29 mmol) was dissolved in 100 mL water containing sodium hydroxide (0.77 g). This solution was added slowly with constant stirring into the above liquor (1 L) under warm conditions for 1h and the red precipitate was filtered, washed, and dried to obtain the $Ni(DMG)_2$ complex (2.64 g, yield = 99.32 %). Recovered $Ni(DMG)_2$ was characterized by elemental analysis; 32.9 % C (33), 4.80 % H (4.84), and 20.00 % N (19.38) found (calculated) are matched with the $Ni(DMG)_2$ complex with the formula $C_8H_{14}N_4NiO_4$. Powder XRD also confirms the pure form of $Ni(DMG)_2$ complex. ICP-MS analysis of the acid-digested solution indicates a purity of ~ 99 ± 0.26 %.

Separation of Cobalt:

The obtained filtrate after the recovery of nickel having a pH ~ 3.7 was used for the precipitation of cobalt as cobalt sulfide. In a typical precipitation method, sodium sulfide (6.65 g) was added under warm conditions, to obtain black precipitates of cobalt sulfide. The black precipitate thus obtained was centrifuged and finally collected by vacuum filtration followed by washing with hot water and drying in a vacuum oven at 70 °C to get Co_xS_y (7.43 g, yield = 99.77 %). The cobalt sulfide retrieved was determined to possess an amorphous structure initially. It was then subjected to calcination to enhance its crystallinity, resulting in the identification of Co_9S_8 species through powder XRD analysis. Additionally, it is characterized by EDX elemental mapping and ICP-MS results indicated the absence of other metallic impurities, demonstrating a purity of ~98 ± 0.56 %.

Recovery of excess lixiviant acetic acid:

The filtrate obtained from the above step after the recovery of cobalt was distilled under a vacuum at 120 °C to recover the unreacted acetic acid. Recovered acetic acid was titrated against 1N NaOH volumetrically and molarity was found to be ~1.72 M (800 Ml). The remaining residue was used further for the recovery of manganese and lithium.

Recovery of Manganese:

The residual part obtained from the above step was dissolved in 200 mL of water to get a clear solution. A saturated solution of sodium hydroxide was added to the above solution to raise the pH of the solution initially to ≥ 6 which gives small amount of $Al(OH)_3$, which was filtered and discarded. Then additional amount of NaOH was added to raise the pH of the solution ≥12 to precipitate out $Mn(OH)_2$ (1.70g). Al and Mn are not valuable products and can be separated together as a mixture (total: 2.97 g) by directly raising the pH of the solution ≥12 to reduce the number of steps. $Mn(OH)_2$ was characterized by PXRD, EDX, and ICP-MS analysis.

Recovery of Lithium:

The filtrate obtained from the above step after removal of manganese was used for the recovery of lithium as lithium carbonate or lithium phosphate from boiling solution. A little excess stoichiometric amount of a saturated solution of sodium carbonate was added to obtain white precipitates of Li_2CO_3 (3.91 g, yield = 85.40%). In separate experiments, the treatment with trisodium phosphate gives Li_3PO_4 (4.25 g, yield = 88.87 %). The above salts were characterized by PXRD, EDX, and ICP-MS analysis. The ICP-MS results of Li_2CO_3 revealed the absence of other metallic impurities, signifying a purity of 99 ± 0.24 %.

Recovery of the by-product Sodium acetate:

The filtrate obtained after lithium recovery was neutralized (pH ~7) with acetic acid. The neutralized filtrate was treated with activated charcoal powder (0.5 % w/v) and stirred vigorously for 30 minutes on a magnetic stirrer followed by filtration. The volume of the filtrate was reduced under a hot plate to obtain a saturated solution, which resulted in white crystalline sodium acetate (332.8 g) upon cooling. The obtained sodium acetate was analyzed by PXRD, EDX and ICP-MS analysis. The ICP-MS results revealed a purity of ~97±0.86 %. As the quantity of sodium acetate is in large excess compared to other salts, the remaining lithium and other unrecovered salts do not affect its purity drastically. Based on weight loss on drying indicates a mixture of sodium acetate trihydrate (65%) and sodium acetate (35%).

Metal leaching from spent anode material:

In this study, the spent anode material was initially calcined in a muffle furnace in an air atmosphere at 500 °C for 1 hour to volatilize the electrolyte and the binder (PAA), which decomposes when the temperature reaches approximately 400 °C. The recovered acetic acid

(1.7 M CH_3COOH) from cathode leached liquor was employed as a leachate to recycle lithium, graphite, and copper foil from the calcined anode materials. The calcined spent anode material was then treated with recovered acetic acid in a beaker. The reaction mixture was stirred with a mechanical stirrer at 500 rpm and a temperature of 75 °C for 100 minutes. Finally, the mother liquor was separated by vacuum filtration after completing the reaction. The graphite and copper foil solid residue was washed with plenty of distilled water. The blue colour of the filtrate showed that the copper acetate leached into the solution.

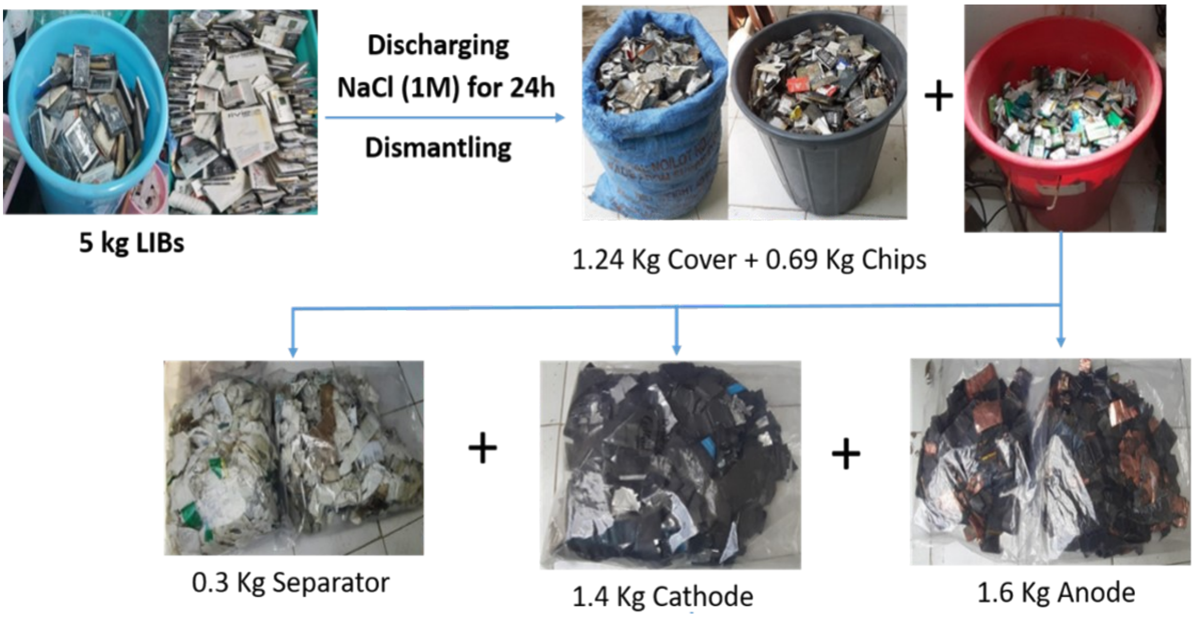

Fig. S1 The discharging and dismantling of mixed type mobile batteries.

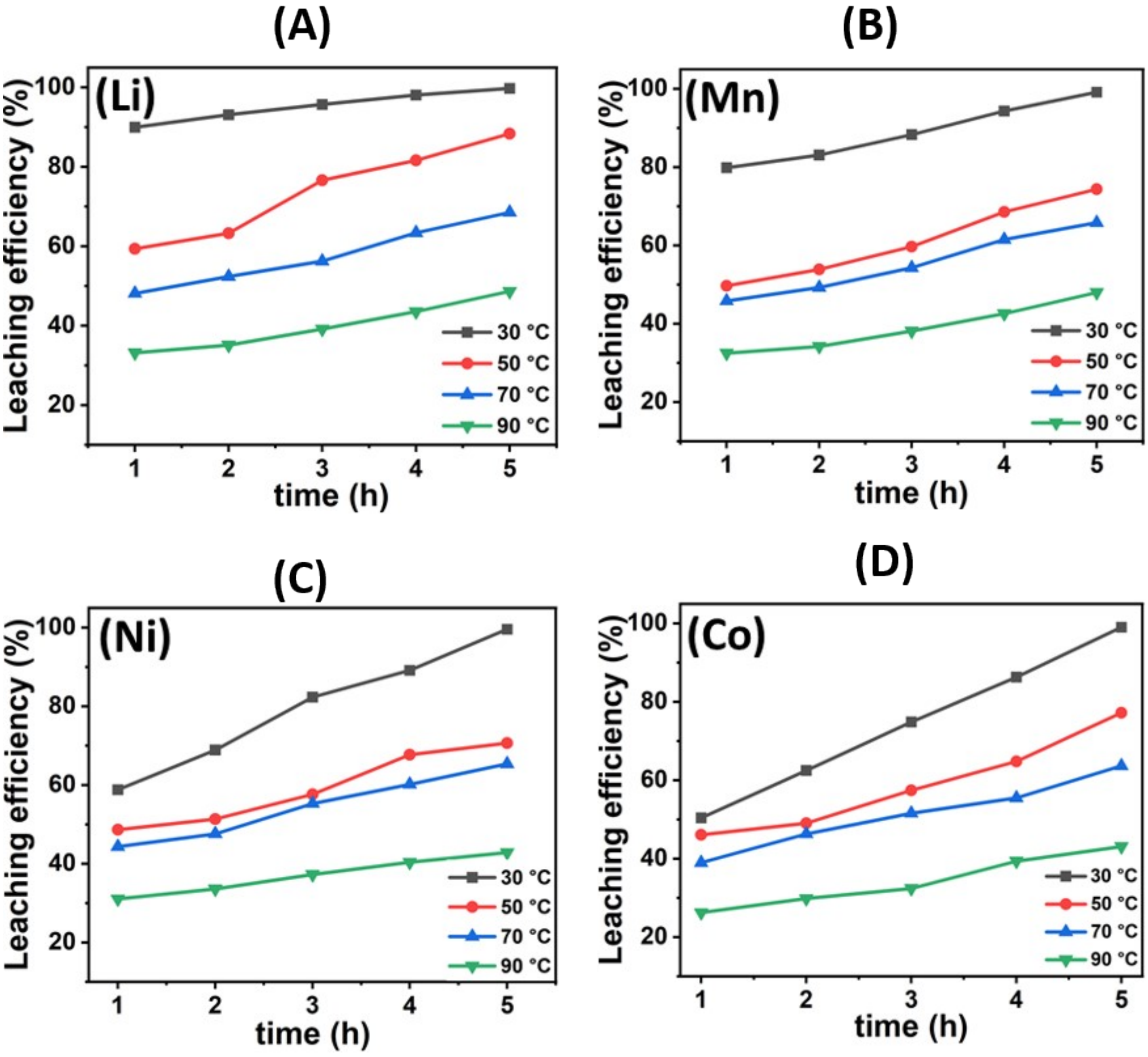

Fig. S2 Plot of leaching efficiency (%) versus time (h) at different temperatures under optimized conditions for Li (A), Mn (B), Ni (C) and Co (D).

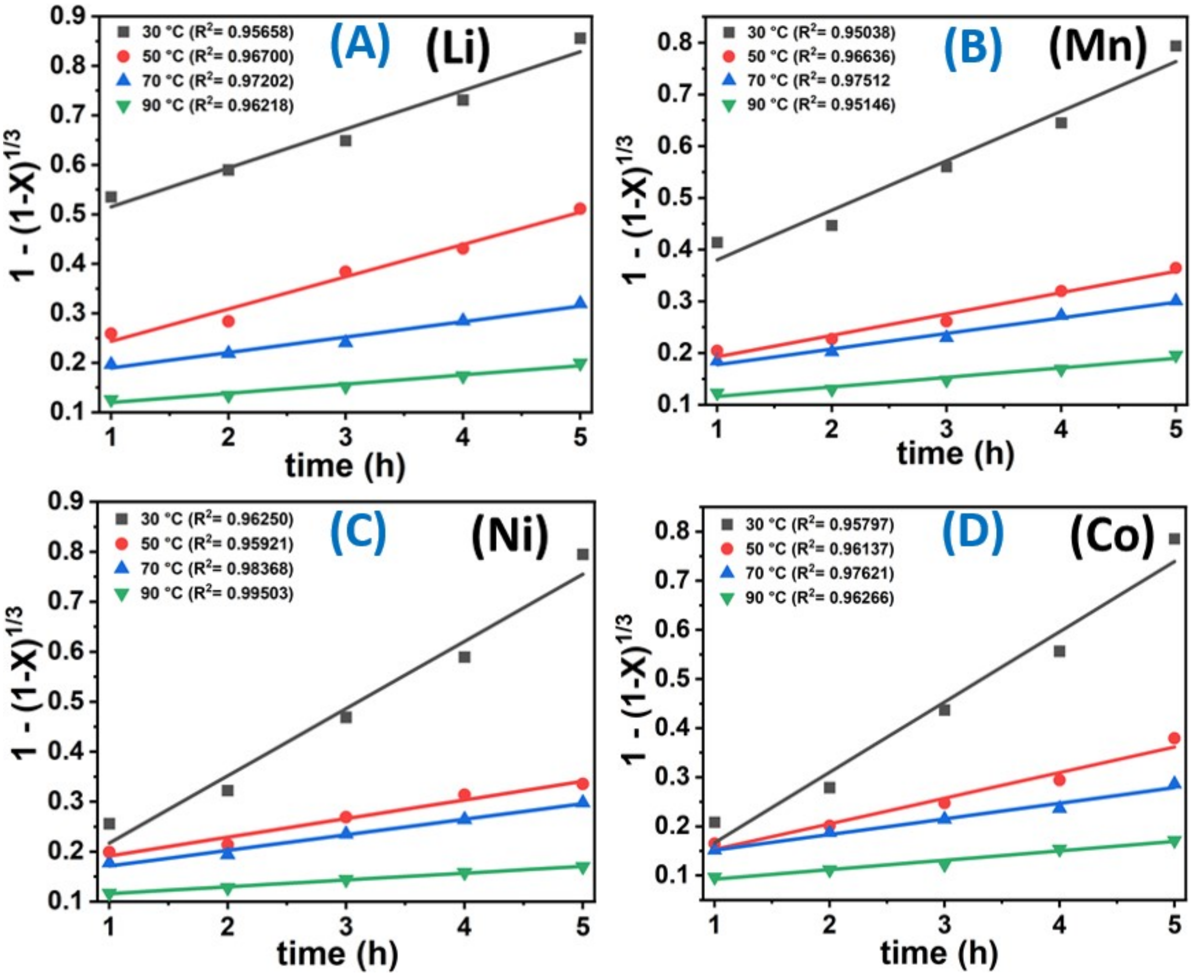

Fig. S3 Plot between 1- $(1\text{-}X)^{1/3}$ versus time (h) for Li, Mn, Ni and Co under optimized conditions (S/L ratio: 20 g/L; H_2O_2 conc: 5 %; Acetic acid conc: 4 M; time: 5 h) varying temperature.

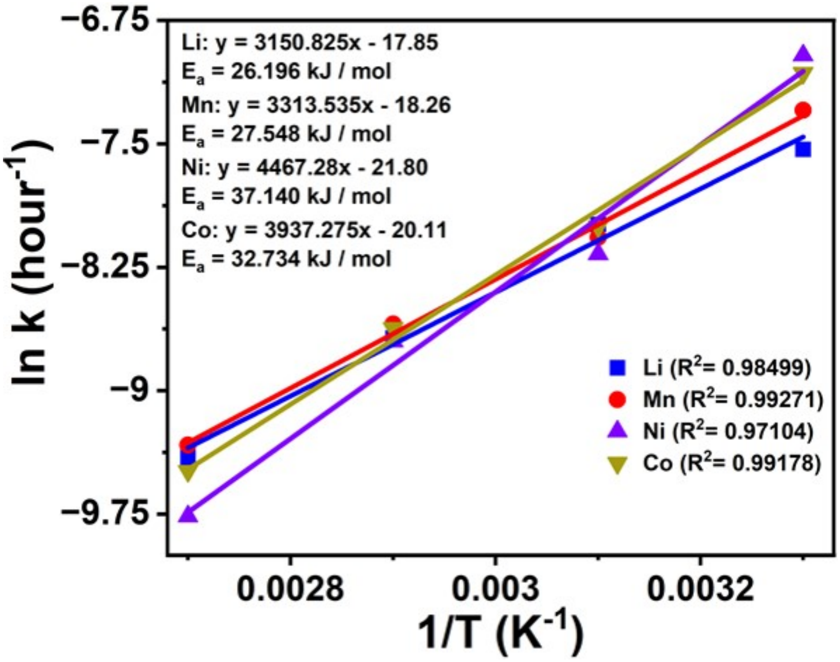

Fig. S4 Plot between ln k (h^{-1}) versus 1/T (K^{-1}).

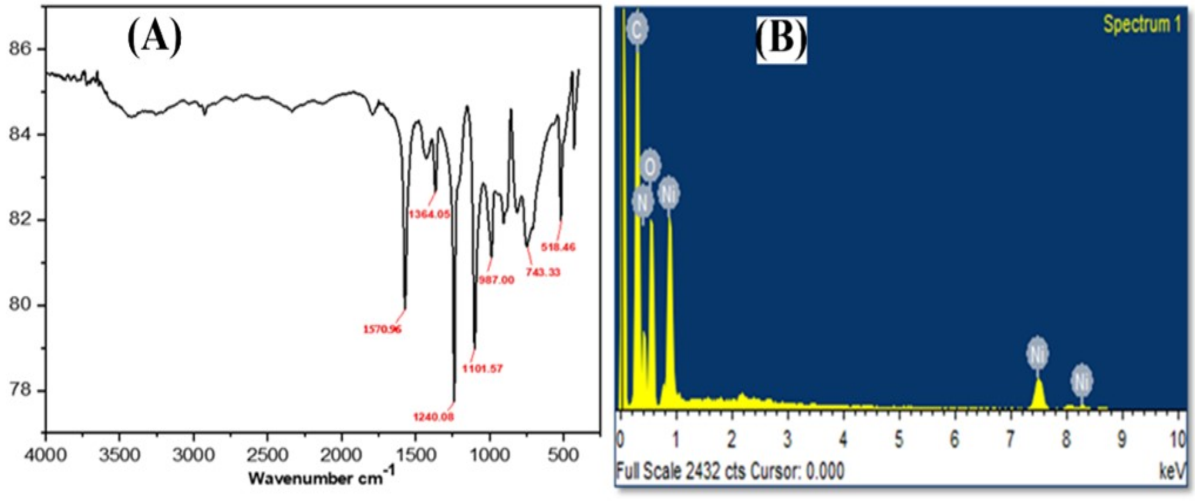

Fig. S5 The FT-IR (A) & EDX (B) characterization plots for recovered Ni(DMG)$_2$ complex.

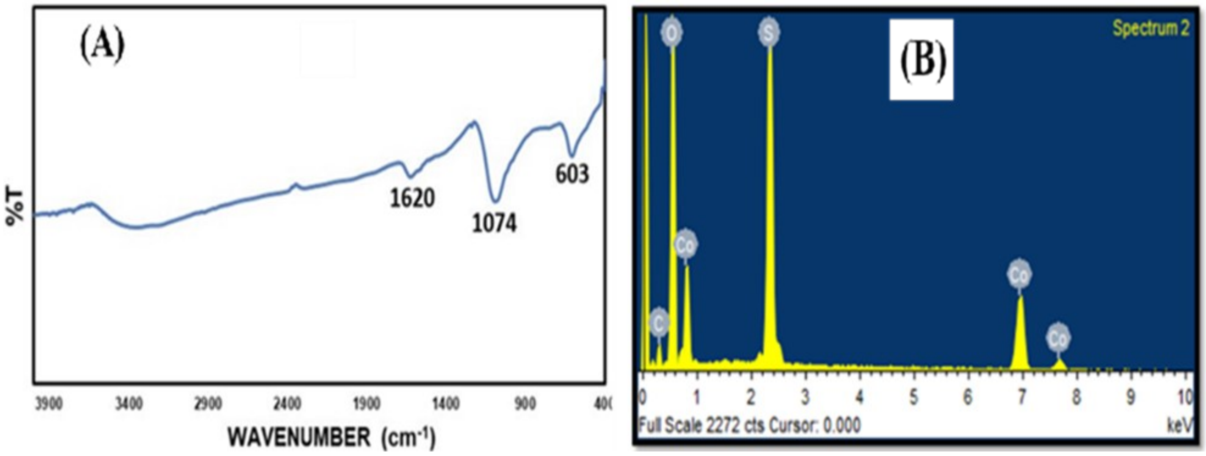

Fig. S6 The characterization plots for recovered for Co_9S_8 salt.

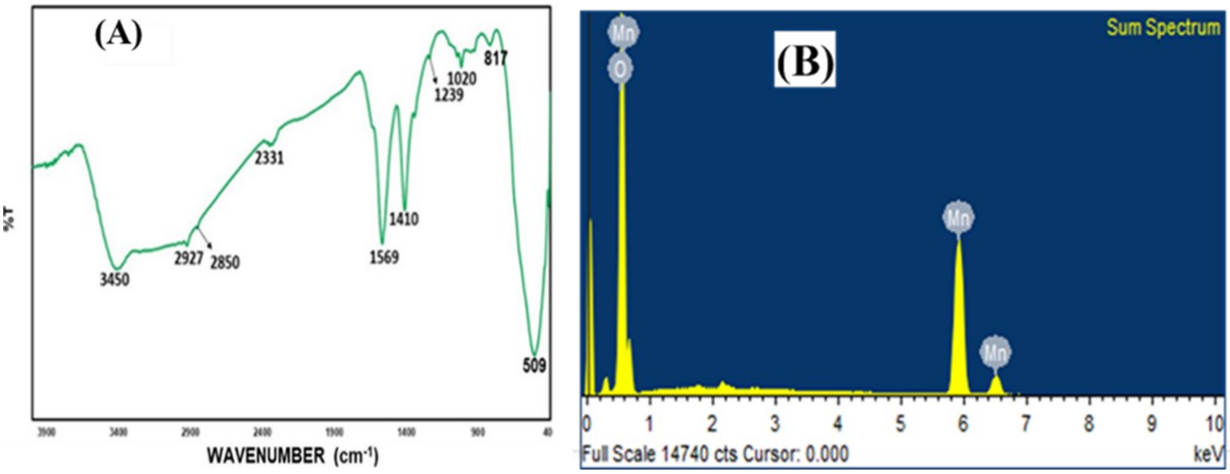

Fig. S7 The characterization plots for recovered $Mn(OH)_2$.

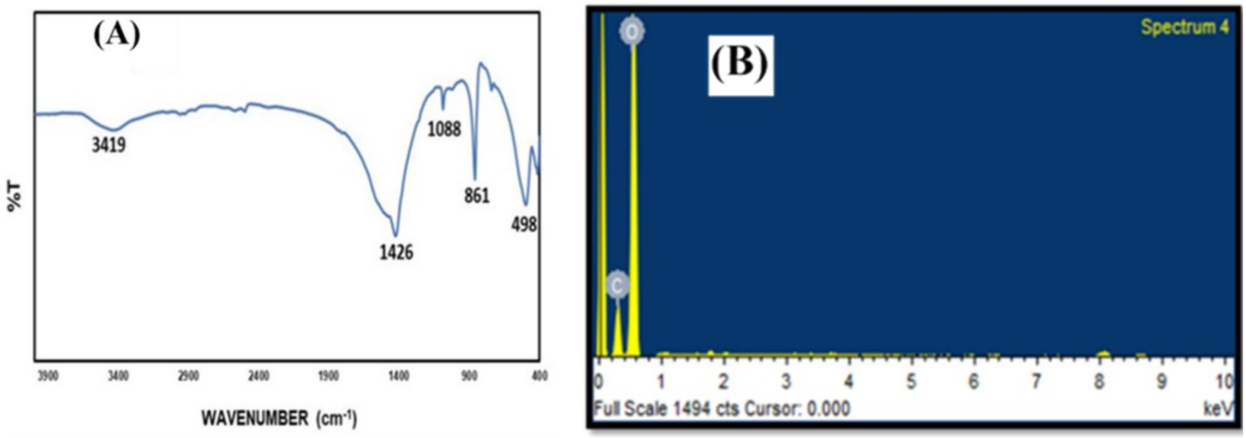

Fig. S8 The characterization plots for recovered Li_2CO_3.

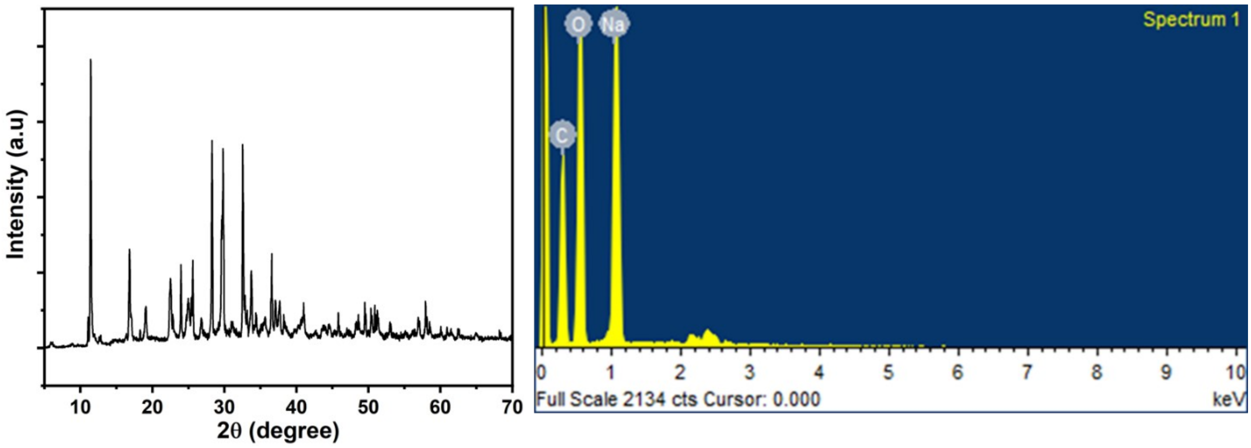

Fig. S9 The PXRD & EDX spectrum of recovered sodium acetate.

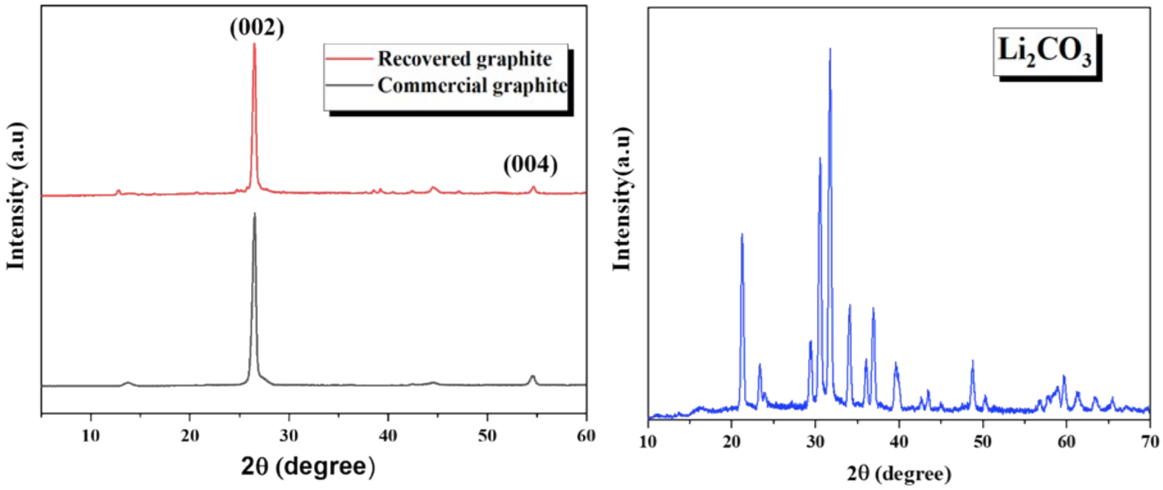

Fig. S10 (A) PXRD pattern of recovered graphite and (B) Li_2CO_3 from anode.

Table. S1 The leaching of metal ions from cathode material using various lixiviants.

S. No.	*Type of Battery*	*Acid/DES as leachant*	*Reducing agent*	*Reaction condition*	*Leaching efficiency*	*Metals Recovered*	*Ref.*
1	LCO/ NCM	ChCl:EG	-	100 mg NMC, 5 g ChCl:EG, 180 ºC, 24 h / 10 mg NMC, 5 g ChCl:EG, 180 ºC, 24 h	Li 89.8 %, Co 50.3 % / Li 53.6 %, Co 23.4 %,	Co only	6

					Ni 18.8, Mn 40.9 %		
2	NCM /LPF	Phosphoric acid	H_2O_2	3 M H_3PO_4, 6 % H_2O_2, 50 g/L S/L, 80 min, 70 ºC	Li 100 %, Co 96.3 %, Ni 95.5, Mn 98.8 %, Fe 2.70	-	14
3	LFP	Acetic acid	H_2O_2	0.8 M AcOH, 6 % H_2O_2, 120 g/L S/L, 30 min, 50 ºC	Li 94.08 %, Fe 5.5 %,	Li only	20
4	LCO	Sulfuric acid	H_2O_2	2 M H_2SO_4, 0.5 % H_2O_2, 20 g/L S/L, 20 min, 70 ºC	Li 99.1 %, Co 70 %	-	21
5	NCM	Mixed system	-	0.4 mol/L (HTTA), 0.4 mol/L (TOPO) and IL, O/A = 1/1, 20 min, 25 ◦C	Li 2.8 %, Co 99.5 %, Ni 99.6, Mn 99.8 %	-	22
6	NCM	Lactic acid	H_2O_2	1.5 M $C_3H_6O_3$, 6 % H_2O_2, 50 g/L S/L, 80 min, 70 ºC	Li 97.7 %, Co 98.9 %, Ni 98.2, Mn 98.4 %	-	23
7	NCM	Formic acid	H_2O_2	2 M HCOOH, 2 % H_2O_2, 50 g/L S/L, 120 min, 70 ºC	Li 98.2 %, Co 99.9 %,	Li only	27

					Ni 99.9, Mn 99.9 %		
8	LCO	Sulfuric acid	H_2O_2	3 M H_2SO_4, 1.6 mL/g H_2O_2, 7 mL/g L/S, 2.5 h, 70 ºC	Co 85.5 %	Co only	30
9	NCM	Sulfuric acid	H_2O_2	3 M H_2SO_4, 3 % H_2O_2, 7 20 g/L S/L, 60 min, 80 ºC	Li 99 %, Co 99 %, Ni 99, Mn 99 %	Li, Co, Ni, Mn	31
10	LCO	ChCl:LA	-	1:3 ChCl:LA , 1:100 S/L, 24 h, 90 ºC	Li 97.1 %, Co 95.2 %	Li and Co	36
11	LCO	PTSA-ChCl	-	PTSA·2H_2O·$ChCl_{DES,}$ 60 g/L S/L, 15 min, 90 ºC	Li 100 %, Co 100 %	Co only	37
12	LCO	nitrilotriacetic acid/ Adipic acid (AA)	Ascorbic acid	0.1 M AA, 0.02 M ascorbic acid, 0.2 g LCO, 20 min, 80 ºC	Li 92 %, Co 85 %,	Co only	44
13	LPF	Sulfuric acid	-	pH- 3.5, 10 g/mL S/L, 5 h, 25 ºC, air flow 600 mL/min	Li 99.3 %	Li only	45
14	NCM	Sulfuric acid	H_2O_2	1 M H_2SO_4, 0.62 wt % H_2O_2, 25 ml/g L/S, 60 min, 51 ºC	Li 99 %, Co 99 %, Ni 99, Mn 99 %	Li only	46
15	LCO/LMO	Acetic acid	H_2O_2	3 M $C_3H_6O_3$, 7.5 % H_2O_2, 20 g/L S/L, 40 min, 70 ºC	Li 99.9 %, Co 98.7 %, Mn 99.5 %	Li, Co, and Mn	47
16	LCO	Phosphoric	H_2O_2	0.7 M H_3PO_4, 7 %	Li 98.7	Li	50

		acid		H_2O_2, 30 mL/g L/S, 40 min, 40 ºC	%, Co 0.69 %,		
17	LCO	EDTA	-	0.8 M $C_{10}H_{16}N_2O_8$, 50 g/L S/L, 4 h, 90 ºC	Li 97.1 %, Co 93.5 %,	Li, Co	56
18	NCM	Acetic acid	H_2O_2	4 M AcOH, 5 % H_2O_2, 20 g/L S/L, 5 h, 30 ºC	Li 99.1 %, Co 98.1 %, Ni 98.3, Mn 99.5 %	Li, Co, Ni , Mn	This work

Table. S2 The leaching of metal ions from anode material using various lixiviants.

S. No.	***Type of material considered***	***Acid/ DES Leachant***	**Reducing agent**	***Reaction conditions***	***Leaching efficiency***	***Elements recovered***	***Ref***
1	Both cathode and anode	Acetic acid	H_2O_2	Pulp density 20 g/L, 3 M AcOH, 70 ˚C, 40 min	99.9 % Li	Li, graphite	47
2	LIB (Only anode)	HCl	H_2O_2	S/L ratio 1:50 g/mL, 90 min, 3M, 80 ˚C	99.4 % Li	Li, graphite	59
3	LIB (Only	aqueous		ultrasonic	>90.00%	Li,	S1

	cathode)	solutions		leaching	Li	graphite	
4		HCl, HNO_3			96.6 % Li, Cu (97.6%)	Li, Cu	S2
5	A mixture of cathode and anode	0.8 M acetic acid		70 ˚C	100 %	Li, Co	S3
6	A mixture of cathode and anode	2 M acetic acid	H_2O_2	70 ˚C, S/L ratio of 20 g/L, 30 min	98.56 % Li	Al, Co, Mn, Ni, Li	S4

Supporting Information References

S1 T. Ren, K. Lin, M. Zhao, B. Lai and J. Ruan, *ACS Sustain. Chem. Eng.*, 2024, **12**, 15240–15249.

S2 S. Agarwal, S. Dhiman and H. Gupta, *Environ. Sci. Pollut. Res.*, 2024, **31**, 34249–34257.

S3 S. Sahu and N. Devi, *RSC Adv.*, 2023, **13**, 7193–7205.

S4 K. Wang, G. Zhang and M. Luo, *Separations*, 2022, **9**, 259.

Mass balance & Economic viability calculations:

In our process, a 1 kg batch of whole cathode (including Al foil) is used for leaching, with a total of 50 L: 2.5 L of H_2O_2 and 47.5 L of 4M acetic acid. This leaching process allows for the concurrent leaching of metals while effectively separating the undissolved Al foil. The resulting leached liquor from the whole cathode is then processed in 1 L batches for the selective and sequential precipitation of metals. For every 1 kg of cathode, 3.6 kg of used LIBs, 1.15 kg of anode, 1.22 kg of external parts, and 0.2 kg of separator are processed.

In the material balance calculations, we assume that the input and output water are the same if collected, and thus H_2O_2 and water are not included in the calculations. It was observed that for an input of 17.382 kg, 17.52 kg of product was obtained. Economic evaluations were made based on the local market prices of some commodities and the price information from cited literature. Since no market price is available for Co_9S_8, we used the price for cobaltous sulphide as a reference. For $Ni(DMG)_2$, this material is recycled to recover $Ni(OH)_2$ and DMG, but we have excluded it from the cost calculation. Similarly, $Mn(OH)_2$ and $Al(OH)_3$, due to their lower economic value and small quantities, were not included in the cost calculation. The solid separator and external parts were also excluded from the cost evaluation. Based on the input cost of 218.46 USD, the output revenue amounts to 460.15 USD, yielding a net profit of 241.69 USD.

Table S3. Mass balance for processing of 3.6 Kg of used LIBs in our study.

Material balance for dismantling of 3.6 Kg battery to get 1 Kg cathode material			
INPUT MATERIALS	Weight (Kg)	**OUTPUT MATERIALS**	Weight (Kg)
Battery	3.6 Kg	Cathode	1 Kg
		Anode [0.544kg (Cu foil) + 0.520kg (C powder)]	1.15 kg
		Separator	0.21 kg
		External Parts	1.22 kg
Total	**3.6 kg**	**Total**	**3.58 kg**
Material balance for processing of 1 Kg cathode material for metal recovery			
INPUT MATERIALS	Weight	**OUTPUT MATERIALS**	Weight

	(Kg)		(Kg)
Cathode	1 Kg	Al foil Carbon residue	0.107 kg 0.069 Kg
4 M Acetic acid (47.5 L)	11.41 kg	Recovered Acetic Acid (1.72 M, 40 L)	4.12 Kg
35 wt % H_2O_2 (*Not considered for mass balance*)	2.5 L		
DMG	0.11 Kg	$Ni(DMG)_2$	0.13 Kg
Na_2S	0.332 Kg	Co_9S_8	0.372 Kg
NaOH (for neutralization & precipitation of Mn &Al	4.2 Kg	$Mn(OH)_2 + Al(OH)_3$	0.148 Kg
Na_2CO_3	0.330 Kg	Li_2CO_3	0.195 Kg
		NaOAC.3H_2O (65%)/NaOAC (35%)	16.64 Kg
Total	17.382 Kg		21.819 Kg
Total	**17.382 Kg**	Subtracting water content in NaOAC.3H_2O (4.3 Kg)	21.819 – 4.3 = **17.52 Kg**
Notes: H_2O_2 & Water is not considered for mass balance (The input water will same as output water if collected).			

Table S4. Economic evaluation for processing of 3.6 Kg of used LIBs in our study.

Cost calculation for Input Materials				
Input Material	**Quantity**	**Cost (USD/Kg)**	**Total Cost (USD)**	**Source of Values**
Battery	3.6 Kg	4	14.4	(Local market, India)
4M Acetic	47.5 L = 11.41	0.81 USD/Kg	9.24	Local market price (www.indiamart.com)

acid	Kg			
35 % H_2O_2	2.5 L	0.14 USD/L	0.35	*J. Hazard. Mater.*, 2024, **474**, 134794.
DMG	0.11 Kg	3 USD/Kg	0.33	Local market price (www.indiamart.com)
Na2S	0.332 Kg	0.80 USD/Kg	0.26	Local market price (www.indiamart.com)
NaOH	4.2 Kg	0.42 USD/Kg	1.76	*J. Hazard. Mater.*, 2024, **474**, 134794.
Na2CO3	0.33 Kg	0.37 USD/Kg	0.12	*J. Hazard. Mater.*, 2024, **474**, 134794.
Total input material cost			**26.46 USD**	
Operation cost for 3.Kg of spent LIBs that takes 2 days for complete separation				
Electricity (in KWH)	1170 kwH		112 USD	
Manpower	3	10 USD/Person/Day	60 USD	
Capital cost/per process			20 USD	
Total Cost (material + operation)			**218.46 USD**	
Cost calculation for Output Materials				
Output Material	Quantity	**Cost (USD/Kg)**	**Total Cost (USD)**	**Source of Values**
Al foil	0.107 Kg	2.19 USD/Kg	0.23	*J. Hazard. Mater.*, 2024, **474**, 134794.
Cu foil	0.544 Kg	8.15 USD/Kg	4.43	*J. Hazard. Mater.*, 2024, **474**, 134794.
Carbon powder	0.520 Kg	0.21 USD/Kg	0.11	*J. Hazard. Mater.*, 2024, **474**, 134794.
Recovered Acetic acid (1.72 M, 40L)	4.12 Kg	0.81 USD/Kg	3.33	Local market ((www.indiamart.com)
Co_9S_8	0.372 Kg	1163 USD/Kg	432 USD	**https://www.ibuychemikals.com/product/cobalt-(ii)-sulphide-cobaltous** **https://www.chemicalbook.com/Price/COBALT-SULFIDE.htm**
Li2CO3	0.195 Kg	17.5 USD/Kg	3.41 USD	*J. Hazard. Mater.*, 2024, **474**, 134794.
NaOAc	16.64 Kg	1 USD/Kg	16.64 USD	Local market (www.indiamart.com)
Total output material cost			**460.15 USD**	
NET Profit = Total output cost – Total input cost = 460.15 – 218.46 = 241.69 USD				

Co_9S_8: There is no market price available for Co_9S_8. So, we have considered price for cobaltous sulphide. $Ni(DMG)_2$: This material is recycled to recover $Ni(OH)_2$ & DMG. However, we have not considered in cost calculation. $Mn(OH)_2$ & $Al(OH)_3$: Considering less economic values and small amount not considered in cost calculation. Water: The quantity of input water will be same as output water if collected. So, we have not considered in cost calculation. Separator: Not considered in cost calculation External Parts: Not considered in cost calculation

Table. S5 A comprehensive analysis of mass balance & economic evaluation

INPUT MATERIALS		**Input Cost (USD)**	**OUTPUT MATERIALS**		**Output Cost (USD)**
Battery	3.6 Kg	14.4 USD (4 USD/Kg) (As per local market pricing)	Cathode	1 Kg	Used for metal recovery
			Anode [0.544kg (Cu foil) + 0.520kg (C powder)]	1.15 kg	[4.43 USD (Cu foil)+ 0.11USD (C powder)] = 4.54 USD [8.15 USD/Kg (Cu foil), 0.21 USD/kg (C powder)] (Pricing: *J. Hazard. Mater.*, 2024, **474**, 134794.)
			Separator	0.21 kg	--
			External Parts	1.22 kg	--
Total	3.6 kg	14.4 USD	Total	3.58 kg	4.54 USD
Downstream processing of obtained 1 kg cathode from 3.6 kg of used LIBS (Total volume 50 L)					
Cathode	1 Kg		Al foil Carbon residue	0.107 kg 0.069 Kg	0.23 USD [2.19/Kg] (Pricing: *J. Hazard. Mater.*, 2024, **474**, 134794) --
4 M Acetic acid (47.5 L)	11.41 kg	9.24 USD (0.81 USD/Kg)	Recovered Acetic Acid (1.72 M, 40 L)	4.12 Kg	3.33 USD (0.81USD/Kg) (local market)

35 wt % H_2O_2 (*Not for mass balance*)	2.5 L	0.35 USD (0.14 USD/L) (Pricing: *J. Hazard. Mater.*, 2024, **474**, 134794.)			---
DMG	0.11 Kg	0.33 USD (3 USD/Kg) (local market)	$Ni(DMG)_2$	0.13 Kg	--- Recycled
Na_2S	0.332 Kg	0.26 USD (0.80 USD/Kg) (local market)	Co_9S_8	0.372 Kg	432 USD **(1163 USD/Kg)** **(**There is no market price available for Co_9S_8. So, we have considered price for cobaltous sulphide) **https://www.ibuychemikals.com/product/cobalt-(ii)-sulphide-cobaltous** **https://www.chemicalbook.com/Price/COBALT-SULFIDE.htm**
NaOH (for neutralization & precipitation of Mn &Al	4.2 Kg	1.76 USD (0.42 USD /Kg) (Pricing: *J. Hazard. Mater.*, 2024, **474**, 134794)	$Mn(OH)_2 + Al(OH)_3$	0.148 Kg	--
Na_2CO_3	0.330 Kg	0.12 USD (0.37 USD/Kg) (Pricing: *J. Hazard. Mater.*,	Li_2CO_3	0.195 Kg	3.41 USD (17.5 USD/Kg) (Pricing: *J. Hazard. Mater.*, 2024, **474**,

		2024, **474**, 134794)			134794)
			$NaOAC.3H_2O$ (65%)/NaOAC (35%)	16.64 Kg	16.64 USD (1 USD/Kg) (Pricing: local market)
Total	17.382 Kg	**26.46 USD**		21.819 Kg	**460.15 USD**
Total	**17.382 Kg**		Subtracting water content in $NaOAC.3H_2O$ (4.3 Kg)	21.819 – 4.3 = **17.52 Kg**	
Operation cost for handling 3.6 Kg of sent LIBs in 2 days up to the end (up to recovery of sodium acetate)					
Electricity (in KWH)	1170 kwH	112 USD			
Manpower	3	60 USD			
Capital cost/per process		20 USD			
Total		**218.46 USD**	**NET Profit**: 460.15 - 218.46 = 241.69 USD		**460.15 USD**