

High-performance metal extraction diluents for lithium-ion battery recycling with sustainability benefits

With the continued growth in electric vehicle (EV) adoption, it's estimated that 2 million tons of lithium-ion batteries will be available for recycling by 2030¹. Recycling offers the potential to reduce the pollution threat posed by used EV batteries and improve EV economics by extracting valuable metals that can then be re-deployed.



Efficient recovery

Minimal diluent and extractant with consistent performance



Contributes to a safer working environment with lower environmental impact

150% higher occupational exposure limit and lower environmental impact than high flash kerosene³



Global scalability

Enabling quick global ramp up of operations and quality consistency

Solvent extraction is a highly effective approach for recovering metals from EV batteries, enabling ...

metal recovery rates of **90+%** with **95+%** purity².

High purity, quality consistency, improved safety and a global supply make Escaid™ diluents an excellent choice for solvent extraction processes⁴ when compared to high flash kerosene alternatives.

Escaid™ diluents are used for the solvent extraction of rare earth and noble metals including copper, nickel, cobalt, uranium and zinc. The Escaid portfolio features grades with narrow boiling ranges, low viscosities, high flash points, and low evaporation rates. Escaid products offer the right balance of good flow and phase separation with minimal diluent and extractant losses.⁵

Escaid diluents with low aromatic content and high flash points meet stringent environmental requirements, and can help to enhance worker safety due to the higher occupational exposure limit than kerosene-type aromatic-containing diluents.⁶

¹ Source: Bloomberg New Energy Finance (BNEF) – "Lithium-Ion Battery Recycling: 2 million tons by 2030". Jan 7th 2019.

² Recovery rate and purity dependent on system variables. Source: Chagnesa A, Pospiech B – "A brief review on hydrometallurgical technologies for recycling spent lithium-ion batteries". Journal of Chemical Technology and Biotechnology, 88: 1191-1199 (2013)

³ Compared to high flash kerosene. See "Improving worker safety and comfort" - Occupational Exposure Limit and "Lowering health and environmental risk" - Maximum Incremental Reactivity" tables in the back of this page.

⁴ Source: <https://www.exxonmobilchemical.com/en/solutions-by-industry/industrial-applications/metal-solvent-extraction>, "Selecting the right diluent" PDF

⁵ and ⁶ Source: <https://www.exxonmobilchemical.com/en/solutions-by-industry/industrial-applications/metal-solvent-extraction>, "High-performance diluents for metal extraction" PDF brochure

Range of solutions

ExxonMobil is a leading global supplier in the solvent extraction market, with a diluent product slate that enables custom solutions for optimized performance across a wide range of operating temperatures and conditions. Escaid™ 110 has been the diluent of choice in the solvent extraction market for decades, and is well-suited for EV battery recycling. Contact your ExxonMobil sales representative for more information on our products.

Key properties*	High-flash kerosene	Escaid 110 fluid ¹	Escaid 120 fluid ³
Distillation range (°C) ⁴	202-238	207 - 240	235 - 265
Aromatics content (% wt) ⁵	17	< 0.01	< 0.1
Viscosity at 25°C (cSt) ⁶	2.0	2.1	3.16
Flash point (°C) ⁷	78	82	103
Density at 15°C (kg/dm ³) ⁸	0.809	0.795	0.822
Occupational exposure limit ⁴ (mg/m ³) ⁹	52	1200	1200

Source: Data from tests performed by or on behalf of ExxonMobil.

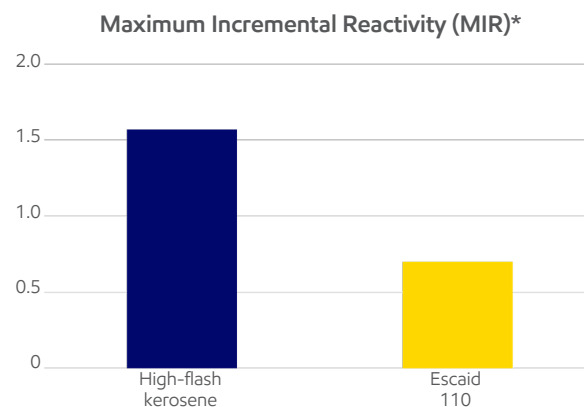
*All data provided are typical from latest FAAG: (1) Singapore typical; (2) Baytown typical; (3) Antwerp typical. Test methods: (4) Distillation Range: Method "ASTM D86" for all grades; (5) Aromatics content: GC1/HPLC for high-flash kerosene - Method "AMS 140.31" for Escaid 110 - Method "EM Test method UV1" for Escaid 120 and 120 ULA; (6) Viscosity at 25 C: Method "ASTM D445" for Escaid 110 - Method "ASTM D7042" for Escaid 120 and Escaid 120 ULA; (7) Flash Point: Methods "ASTM D93" for all grades; (8) Density at 15C: "ASTM D4052" for Escaid 110 and method "ISO 12185" for Escaid 120; (9) Source for Occupational Exposure Limits: RCP - TWA - ExxonMobil data. High-flash kerosene data are from published product datasheet.

Opportunity to lower health and environmental risk

Escaid 110 fluid presents fewer GHS hazards than high-flash kerosene, without compromising performance.

Property	Escaid 110	High-flash kerosene
Aromatics content (% wt) [UV]	< 0.01	17
Naphthalene content [GC]	< 1 ppm	< 3%
GHS hazard categories (health)	Aspiration Tox 1	Aspiration Tox 1 Carcinogen 2
GHS hazard categories (environment)	--	Aquatic Chronic 3
Aquatic toxicity - rainbow trout	LL ₅₀ > 1000 mg/l	LL ₅₀ > 41.4 mg/l

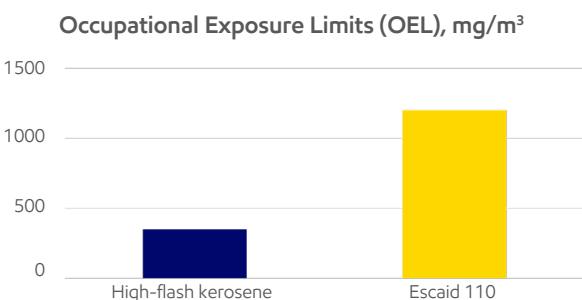
Source: Data from tests performed by or on behalf of ExxonMobil



*Grams of ozone formed/grams of VOC emitted (California Air Resources Board)
Source: Data from tests performed by or on behalf of ExxonMobil

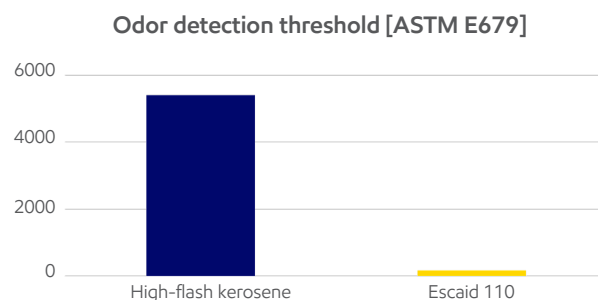
Opportunity to improve worker safety and comfort

Escaid 110 fluid has a higher OEL and a lower odor level, compared to high-flash kerosene.



- Lower health hazard (inhalation)
- Greater margin for safe use

Source: Data from tests performed by or on behalf of ExxonMobil



- Lower dilution ratio at which odor can no longer be detected

Source: St. Croix Sensory 2016

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