Benefits of GTL G80 Mining Diluent in Copper SX for Low- and High-Grade Copper Ore

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Also, in this presentation we may refer to Shell's "Net Carbon Intensity" (NCI), which includes Shell's carbon emissions from the production of our energy products, our suppliers' carbon emissions in supplying energy for that production and our customers' carbon emissions associated with their use of the energy products we sell. Shell's NCI also includes the emissions associated with the production and use of energy products produced by others which Shell purchases for resale. Shell only controls its own emissions. The use of the terms Shell's "Net Carbon Intensity" or NCI are for convenience only and not intended to suggest these emissions are those of Shell plc or its subsidiaries.

Shell's net-zero emissions target

Shell's operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, they reflect our Scope 1, Scope 2 and NCI targets over the next ten years. However, Shell's operating plans cannot reflect our 2050 net-zero emissions target, as this target is currently outside our planning period. In the future, as society moves towards net-zero emissions, we expect Shell's operating plans to reflect this movement. However, if society is not net zero in 2050, as of today, there would be significant risk that Shell may not meet this target.

Forward-Looking non-GAAP measures

This presentation may contain certain forward-looking non-GAAP measures such as **[cash capital expenditure]** and **[divestments]**. We are unable to provide a reconciliation of these forward-looking non-GAAP measures to the most comparable GAAP financial measures because certain information needed to reconcile those non-GAAP measures to the most comparable GAAP financial measures is dependent on future events some of which are outside the control of Shell, such as oil and gas prices, interest rates and exchange rates. Moreover, estimating such GAAP measures with the required precision necessary to provide a meaningful reconciliation is extremely difficult and could not be accomplished without unreasonable effort. Non-GAAP measures in respect of future periods which cannot be reconciled to the most comparable GAAP financial measure are calculated in a manner which is consistent with the accounting policies applied in Shell plc's consolidated financial statements.

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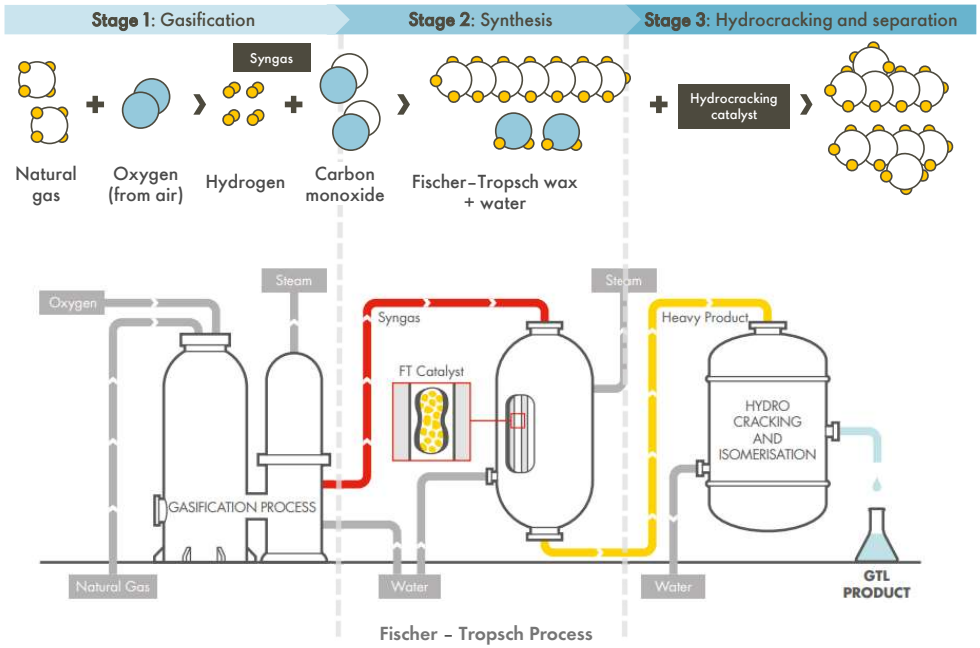
GTL Manufacturing

Best affordable synthetic available

The GTL process converts natural gas into oil products

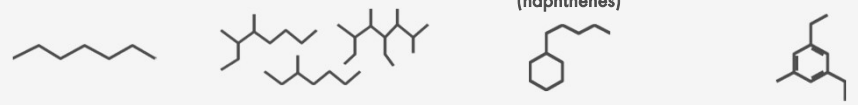


Unlike crude-oil derived products, GTL is synthetic, offering

- **enhanced quality, consistency and stability**
- **increased control** over the synthesising process – enabling, for example, more precise best ratios to be determined for desired applications
- **higher product purity**, resulting in lower emissions and better performance

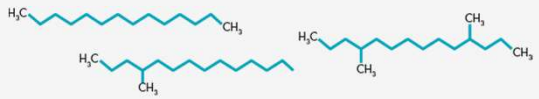
Crude oil derived solvents

Normal-paraffins | Iso-paraffins | Cyclo-paraffins (naphthenes) | Aromatics



Synthetic iso-paraffins

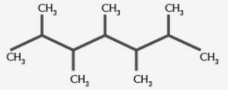
Shell GTL solvents



BI = Low

BI = Branching index (# branches / # all C atoms)

Conventional iso-paraffins
(Alkylates – Shellsol T / ShellSol TD)



BI = High

1–2% cyclo-paraffins

Why use Shell GTL?

Large product portfolio and reliable global supply chain

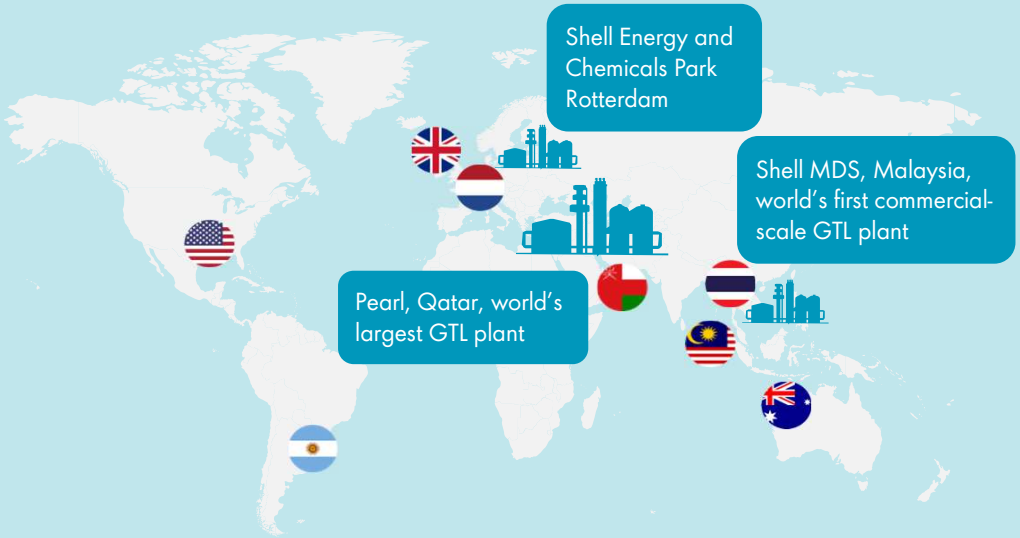
- **Meeting your requirements** through constant innovation and a wide range of performance fluids
- **Over 3500 GTL patents**

Property	G70	G80	G85	G100
Density, kg/m³	777	767	778	786
Distillation: Initial point, °C	177	200	198	237
Distillation: Dry point, °C	345	260	343	343
Flash point, °C	68	84	86	104
Aniline point, °C	95	87	95	98
Viscosity at 40°C , cSt	2.6	1.8	2.9	3.5
Aromatics, %	0.02	0.03	0.02	0.02

Global network of regional hubs for GTL solvents and fluids

Large distributor network with **strong** supply chain experience to get the product to your where and when you need it

Instant support through a strong customer service coverage globally



Shell GTL Solvents and Fluids in metal extraction

Journal of Sustainable Metallurgy (2023) 9:107–122
https://doi.org/10.1007/s40831-022-00629-2

RESEARCH ARTICLE

Conversion of Lithium Chloride into Lithium Hydroxide by Solvent Extraction

Viet Tu Nguyen[1] · Clio Deferm[1] · Ward Caytan[1] · Sofía Riaño[1] · Peter Tom Jones[2] · Koen Binnemans[1]

Journal of Sustainable Metallurgy (2020) 6:589–598
https://doi.org/10.1007/s40831-020-00294-3

RESEARCH ARTICLE

Ammoniacal Solvoleaching of Copper from High-Grade Chrysocolla

Lukas Gijsemans[1] · Joris Roosen[1] · Sofía Riaño[1] · Peter Tom Jones[2] · Koen Binnemans[1]

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Article

Solvent Extraction Process for Refining Cobalt and Nickel from a "Bulk Hydroxide Precipitate" Obtained by Bioleaching of Sulfidic Mine Tailings

Thomas Abo Atia,* Clio Deferm, Lieven Machiels, Mohammad Khoshkhoo, Sofia Riaño, and Koen Binnemans

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Recovery of cobalt from lithium-ion battery cathode material by combining solvoleaching and solvent extraction

Nand Peeters, Koen Binnemans and Sofía Riaño *

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Article

Solvometallurgical Process for the Recovery of Tungsten from Scheelite

Martina Orefice,*[,§] Viet Tu Nguyen,[§] Stijn Raiguel, Peter Tom Jones, and Koen Binnemans

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Separation of iron(III), zinc(II) and lead(II) from a choline chloride–ethylene glycol deep eutectic solvent by solvent extraction

Stylianos Spathariotis, †[a] Nand Peeters, †[b] Karl S. Ryder, [a] Andrew P. Abbott, [a] Koen Binnemans [b] and Sofía Riaño *[b]

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journal homepage: www.elsevier.com/locate/seppur

Check for updates

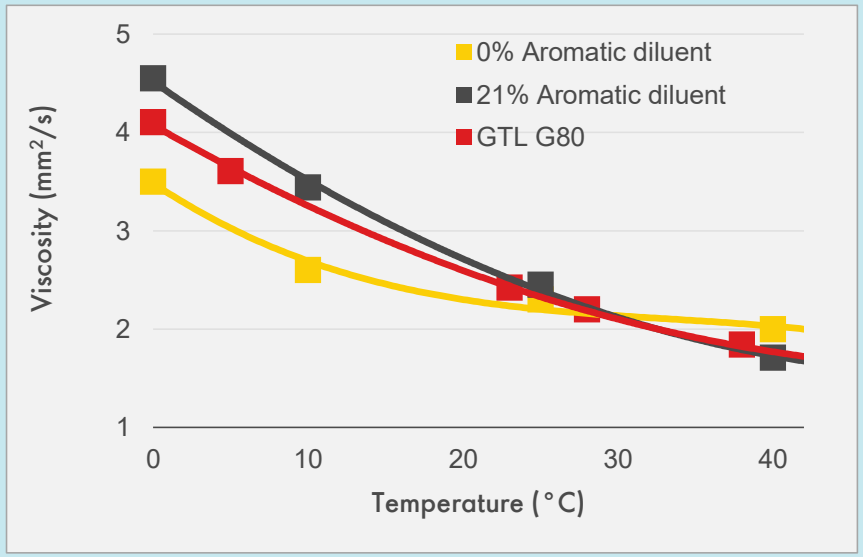
Separation of cobalt and nickel via solvent extraction with Cyanex-272: Batch experiments and comparison of mixer-settlers and an agitated column as contactors for continuous counter-current extraction

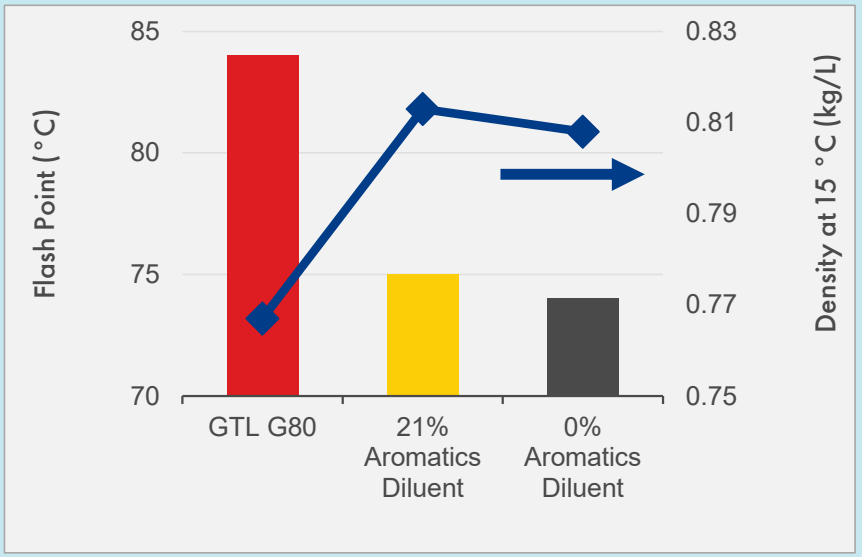
Isadora R. Rodrigues, Clio Deferm, Koen Binnemans, Sofía Riaño *
KU Leuven, Department of Chemistry, Celestijnenlaan 200F, P.O. Box 2404, B-3001 Leuven, Belgium

Shell GTL G80 vs competing diluents

Property	Method	Shell GTL Fluid G80	21% Aromatic Diluent	0% Aromatic Diluent
Initial Boiling Point, °C	ASTM D86	205	195	192
Final Boiling Point, °C	ASTM D86	265	245	250
Aromatics, %wt	GC	<0.04	19	0.8
Cycloparaffins, %wt	GC	<1	24	46
Flash point, °C	ASTM D93	84	75	74
Viscosity at 25°C, mm^2/s	ASTM D445	2.4	1.9	2.4
Color, Saybolt	ASTM D156	+30	+30	+30
Density at 15 °C, kg/l	ASTM D4052	0.767	0.811	0.808
Sulphur, ppm	ASTM 5453	<1	<5	<1
Vapour pressure at 20 °C, kPa	Calculated	0.01	0.013	0.016

Shell GTL G80 vs competing diluents

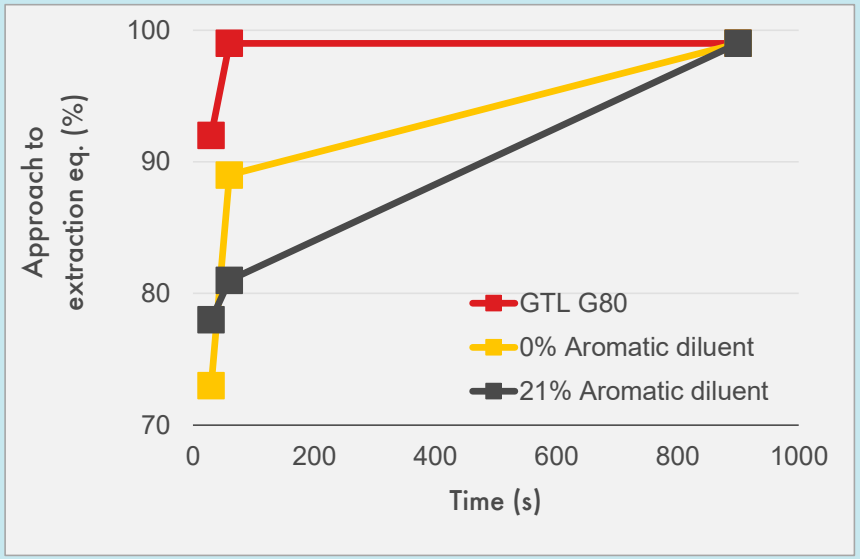


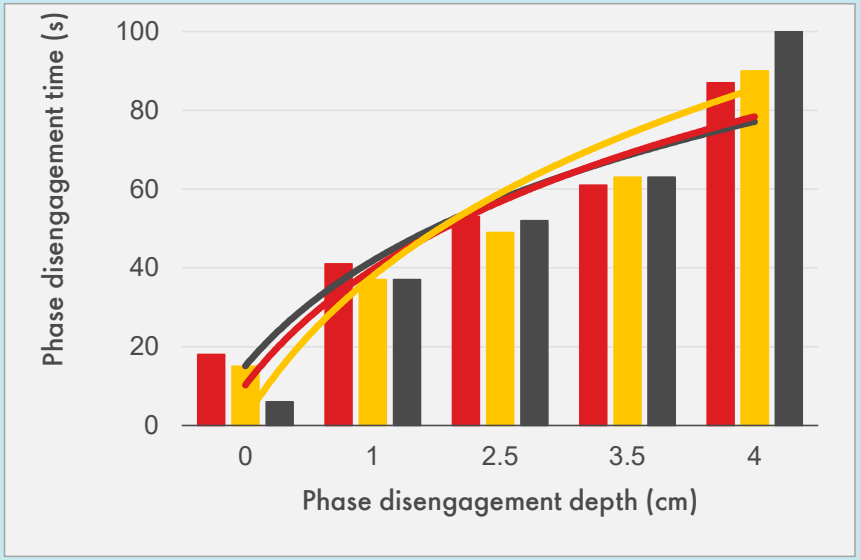


- Viscosity **below 4.0 mm²/s** in the 0 to 40 °C range
- Combined with **flash point above 83 °C and lower density**

Density and/or specific gravity measured following the ASTM D4052 method.
Viscosity measured according to the ASTM D445 method.
Flash point determined by the ASTM D93 method.

Accelerating solvent extraction with Shell GTL G80



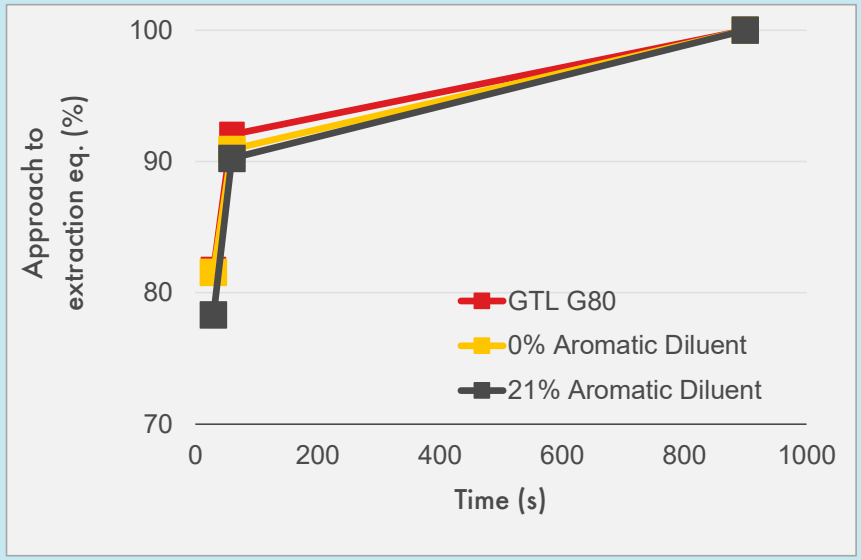


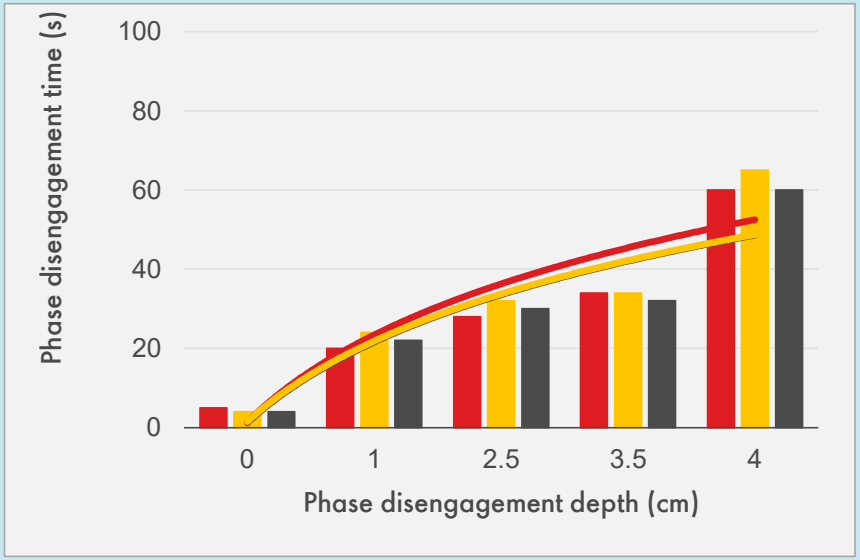
- **Up to 20% faster extraction kinetics****

Extraction tests of synthetic pregnant leach solution (PLS) with:
6.0 g/L Cu and 3.0 g/L Fe, pH = 2.0 (H_2SO_4).
10%vol of LIX® 984N[1] extractant,
O/A = 1, T = 25 °C

[1]LIX® is a brand of an extractant produced by BASF. [2]ACORGA® is a brand of an extractant produced by Syensqo.
Measured by or on behalf of Shell Global Solutions International B. V.
**Depending on extractant, ore and operational parameters.

Accelerating solvent extraction with Shell GTL G80





- **Faster stripping kinetics* ***
- **Low phase disengagement time**

Extraction tests of synthetic pregnant leach solution (PLS) with:
6.0 g/L Cu and 3.0 g/L Fe, pH = 2.0 (H_2SO_4).
10%vol of ACORGA® M5640[2] extractant,
O/A = 1, T = 25 °C

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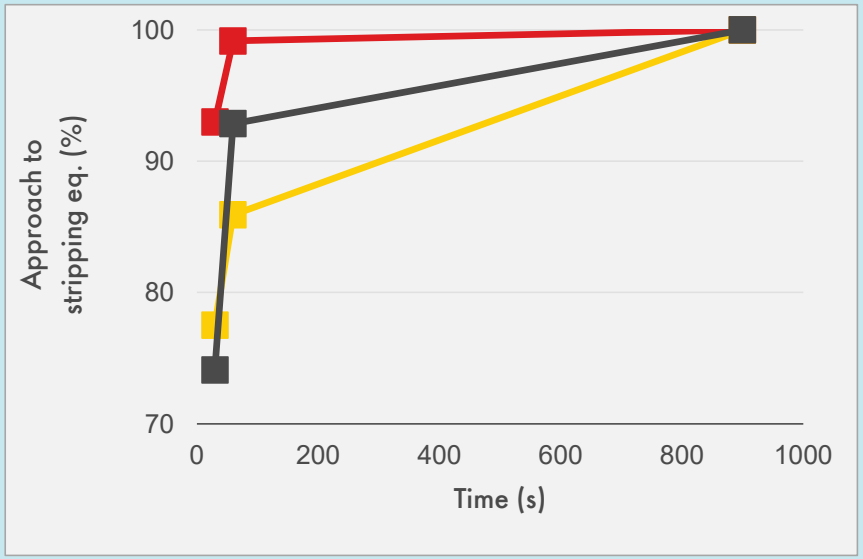
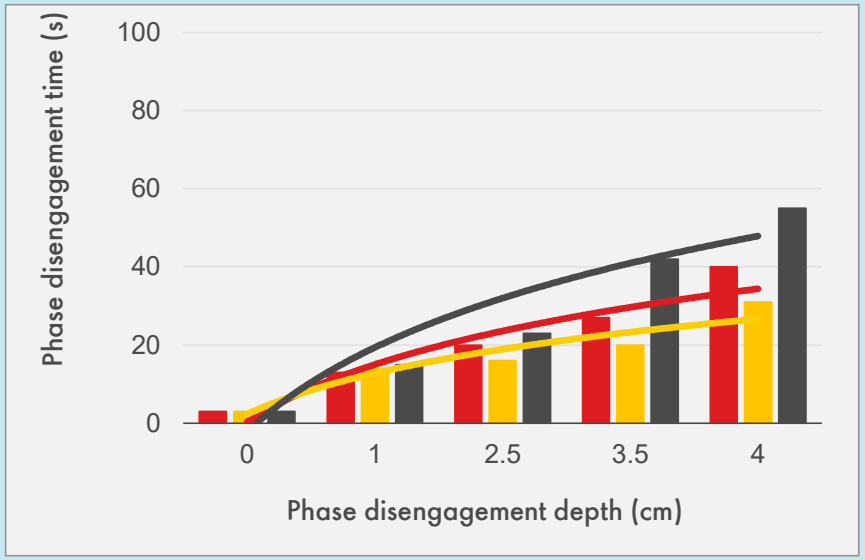
Accelerating solvent extraction with Shell GTL G80





- **Faster stripping kinetics****
- **Low phase disengagement time**

Stripping tests with simulated spent electrolyte and 10%vol LIX® 984N[1] :
35.0 g/L Cu and 160.0 g/L (H_2SO_4).
O/A = 1, T = 25 °C

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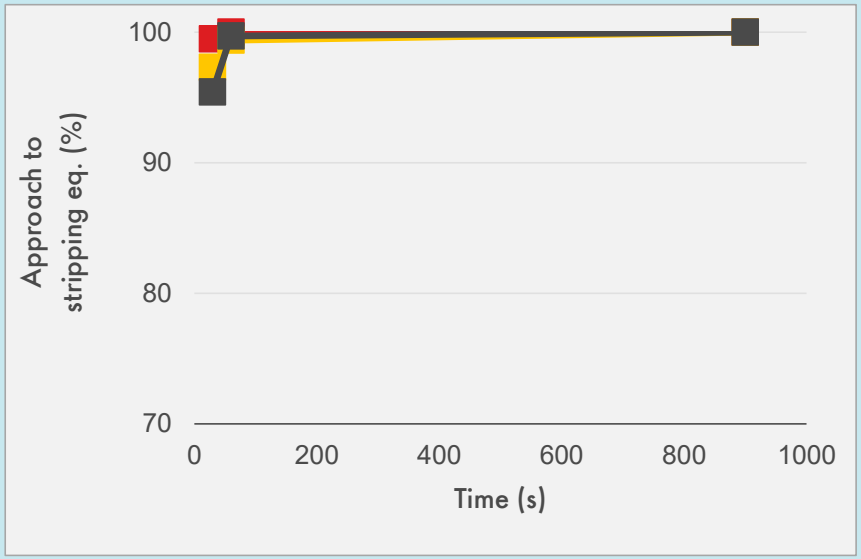
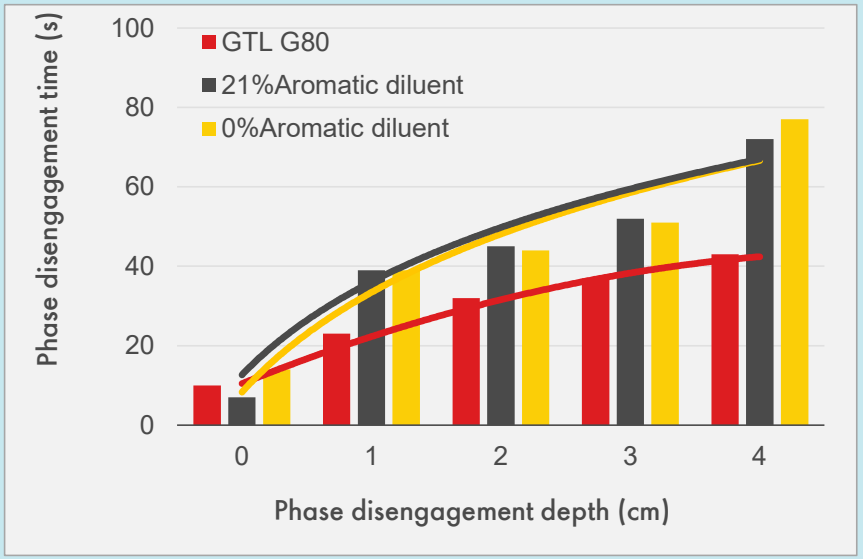
Accelerating solvent extraction with Shell GTL G80





- **Faster stripping kinetics* ***
- **Low phase disengagement time**

Stripping tests with simulated spent electrolyte and 10%vol ACORGA® M5640[2] :
30.0 g/L Cu and 150.0 g/L (H_2SO_4).
O/A = 1, T = 25 °C

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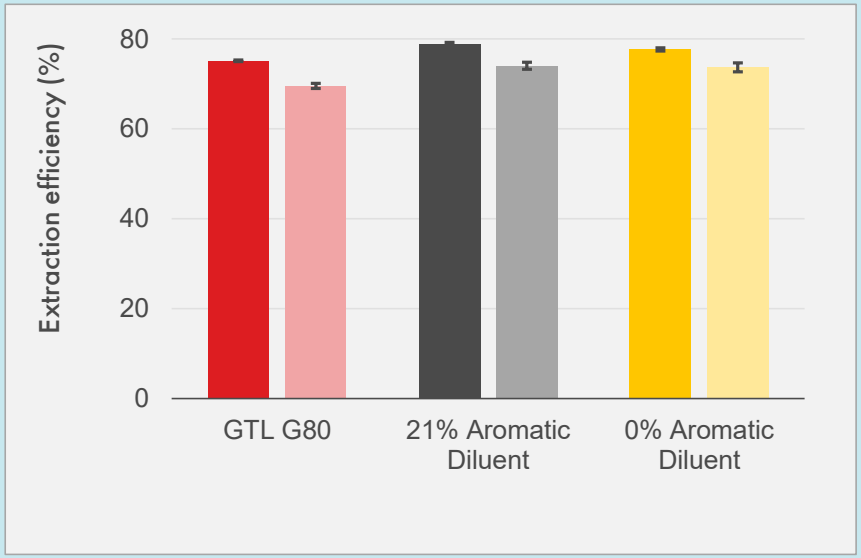
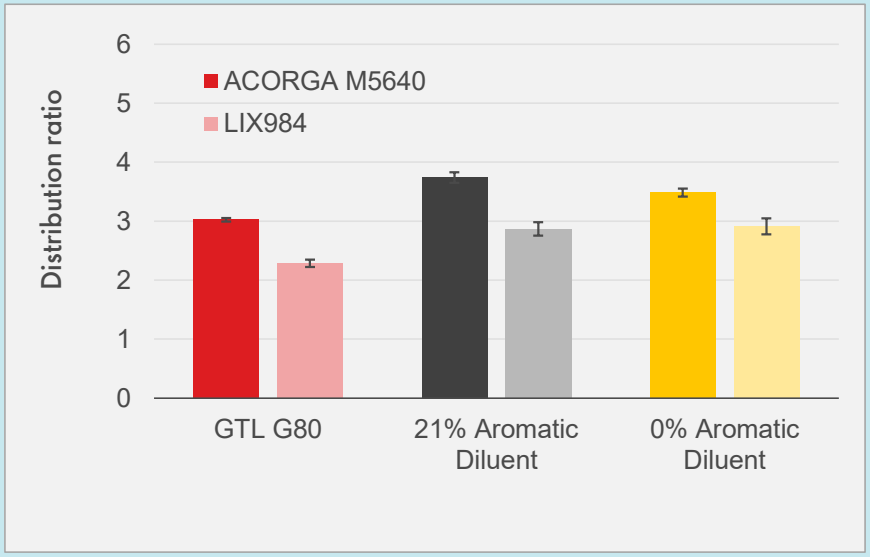
Extraction efficiency





Extraction of synthetic pregnant leach solution (PLS) with:
6.0 g/L Cu and 3.0 g/L Fe, pH = 2.0 (H_2SO_4).
10%vol of leading oxime type extractant,
O/A = 1, T = 25 °C

$$\text{Ext eff}(\%) = \frac{Cu_{org}(900s)}{Cu_{org}(900s) + Cu_{aq}(900s)} \qquad D = \frac{Cu_{org}(900s)}{Cu_{aq}(900s)}$$

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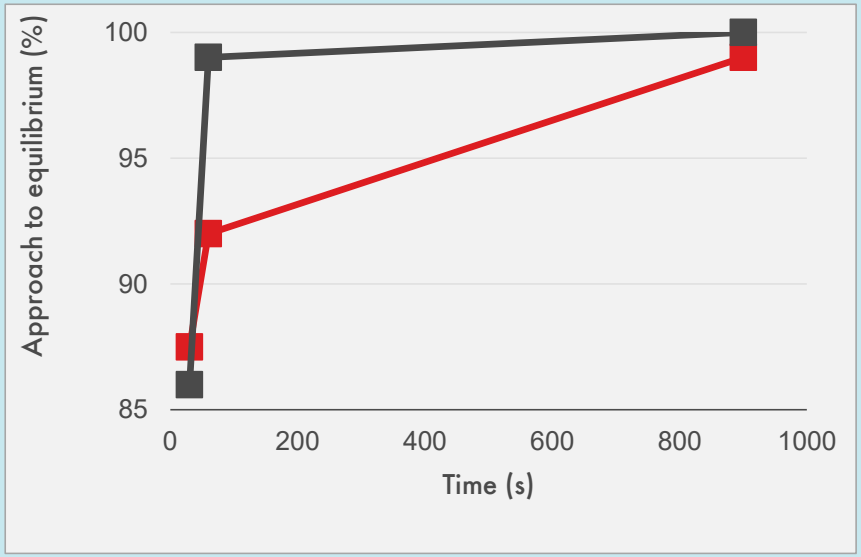
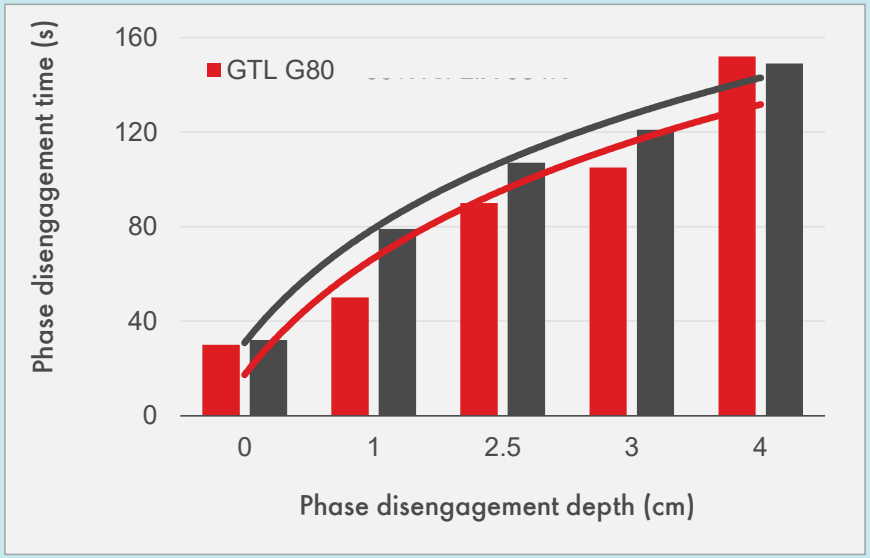
Performance with both low- and high-grade ores





- **Low phase disengagement proven across SX reagents and Cu concentrations in PLS**

Stripping tests with simulated spent electrolyte and 35%vol LIX® 984N[1] :
35.0 g/L Cu and 160.0 g/L (H_2SO_4).
O/A = 1, T = 25 °C

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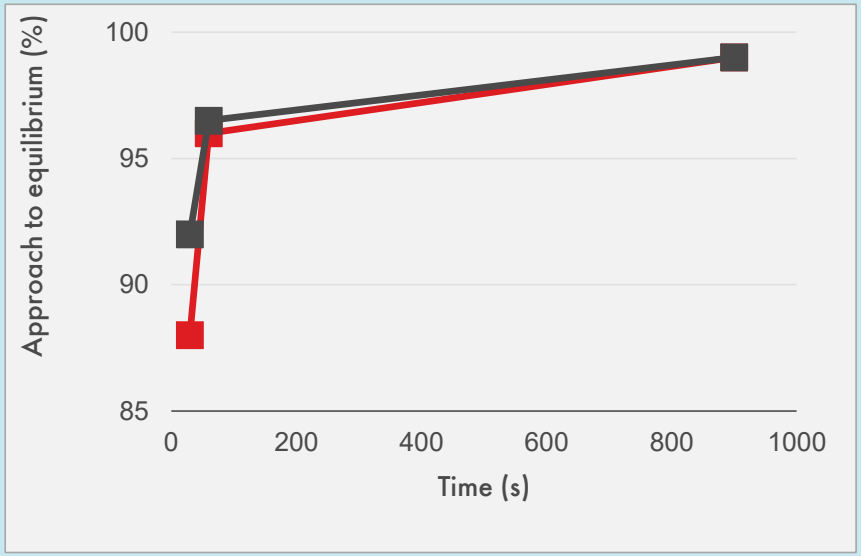
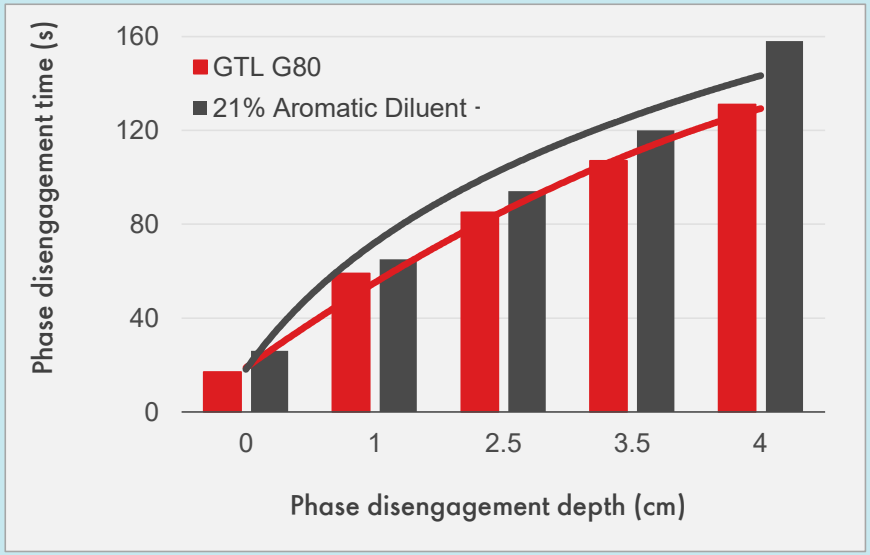
Performance with both low- and high-grade ores





- **Low phase disengagement proven across SX reagents and Cu concentrations in PLS**

Stripping tests with simulated spent electrolyte and 35%vol ACORGA® OPT5540[2] :
30.0 g/L Cu and 150.0 g/L (H_2SO_4).
O/A = 1, T = 25 °C

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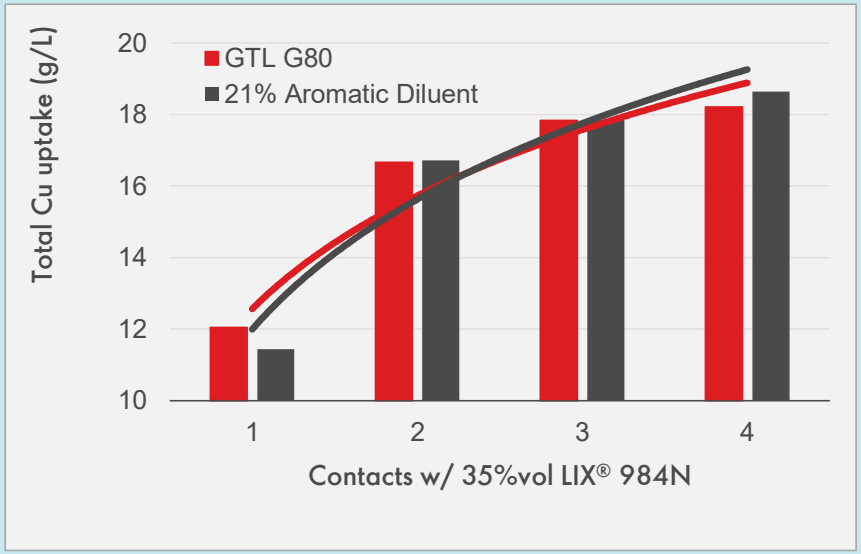
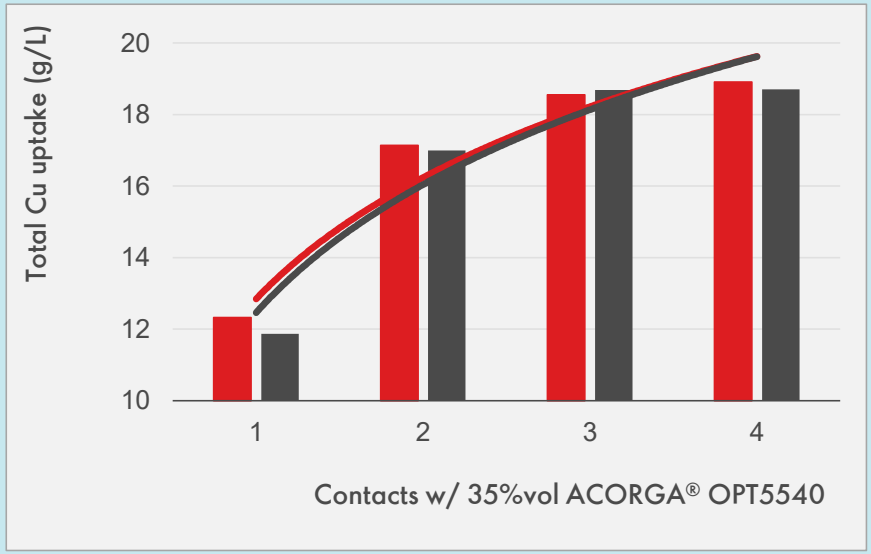
Copper uptake after multiple contacts





[A]Copper uptake of the organic phase measured after 900 seconds per contact by ICP-OES.
[B]Extraction tests of synthetic pregnant leach solution (PLS) with:
18.0 g/L Cu and 2.0 g/L Fe, pH = 2.0 (H_2SO_4).
35%vol of leading oxime extractant,
O/A = 1, T = 25 °C

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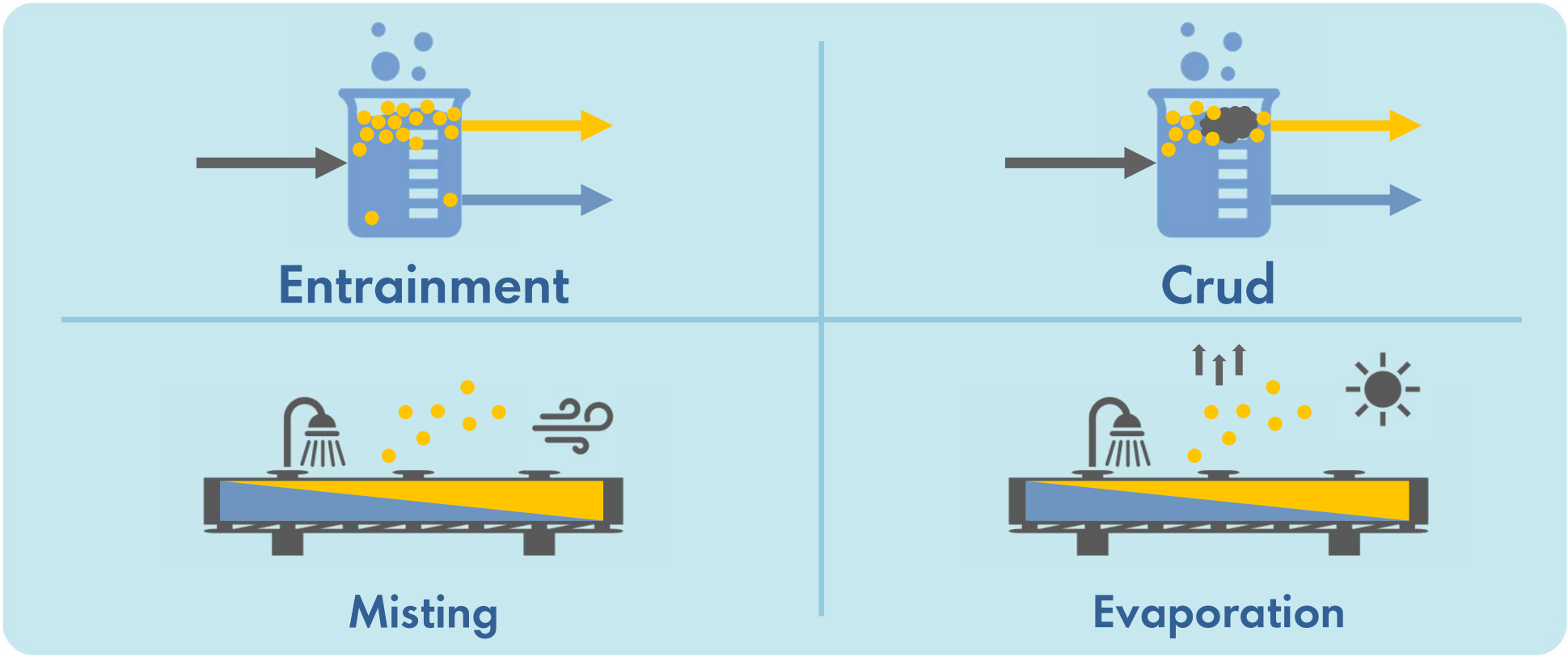
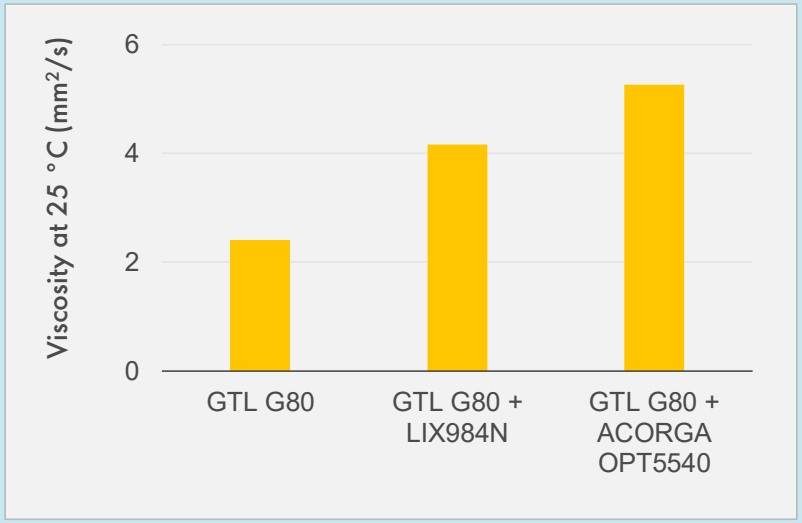
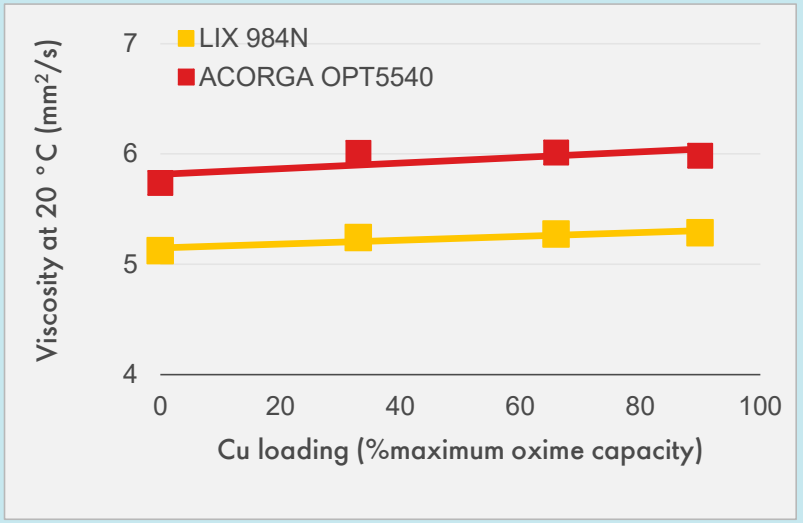
Diluent Losses in SX operations



Performance with both low- and high-grade ores



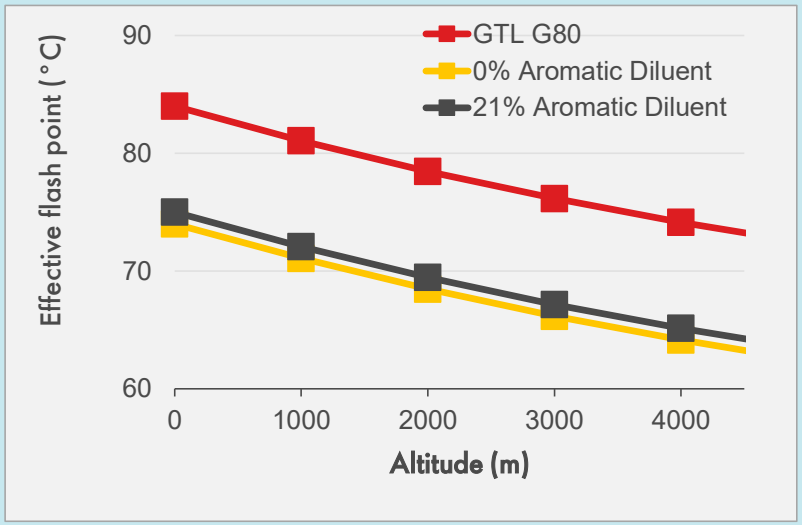


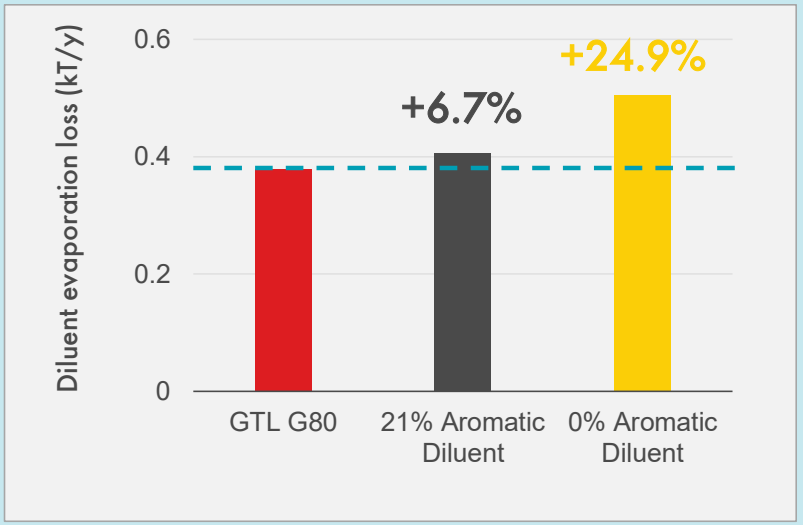
Viscosity performance at 35%vol extractant concentrations

Both at low- and high-grade copper loadings

[1]LIX® is a brand of an extractant produced by BASF. [2]ACORGA® is a brand of an extractant produced by Syensqo. Measured by or on behalf of Shell Global Solutions International B. V.
Viscosity determined as described in the ASTM D445 method at 20 °C with Ubbelohde viscometers.
Accelerated evaporation tests conducted in rotatory evaporator with reduced pressure under identical conditions.

Improved safety and reduced evaporation



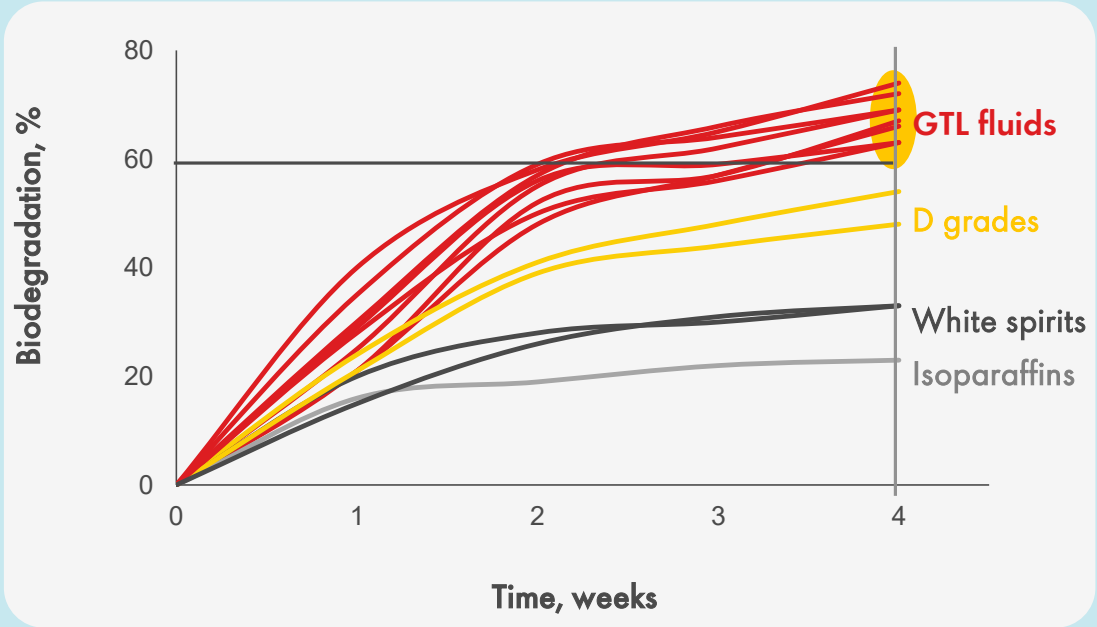


Better worker safety thanks to reduced risk of autoignition

Reduced evaporation leads to cost savings in diluent and extractant

Flash point determined according to ASTM D93. Model conditions of a selected location in the DRC (21 °C, 10 km/h wind, 25x25 m^2 mixer-settlers)
Flash point calculated as per: Yang et al. "Investigation on the dependence of flash point of diesel on the reduced pressure at high altitudes", *Fuel, [2016] 181, 836–842*
Evaporation as per: Mackay, D., Matsugu, R. S., "Evaporation rates of liquid hydrocarbon spills on land and water", *Canad. J. Chem. Eng. [1973], 51, 4, 434-439*

Excellent biodegradability



Reference: Christopher Hughes, Graham Whale (Shell), Chris Mead (Harlan Laboratories Ltd, Shardlow, UK), "Investigation into the biodegradability of hydrocarbons"

All Shell GTL Performance Fluids are **"Readily biodegradable" according to OECD 301F** (>60% biodegradation after 28 days) and have **very low eco-toxicities.**

Low toxicity and environmental impact

Property	Method	Shell GTL Fluid G80	21% Aromatic Diluent	0% Aromatic Diluent
GHS Labeling	(EC) No 1272/2008			
Toxicity to Aquatic Life		Non-toxic	Category 2, Toxic to aquatic life with long lasting effects	Non-toxic
Biodegradability	OECD 301F (in 28 days)	Readily biodegradable (>60%)	Biodegradable (<60%)	Readily biodegradable (>60%)
Components		C9-C16, n-alkanes, isoalkanes, < 2% aromatics	C12-C14, n-alkanes, isoalkanes, cyclics, aromatics (2-25%)	C12-C14, n-alkanes, isoalkanes, < 2% aromatics

Why use Shell GTL as a mining diluent?

Diluents play a critical role in the extraction of copper, nickel, cobalt, zinc and other metals

Environmental benefits

- Better anaerobic **biodegradability: >60%** degradation after 28 days*
- **Low aromatics** and polyaromatic hydrocarbons (PAH)
- **Non-ecotoxic** and non-phytotoxic
- High purity → **ensured quality** and stability

Health and safety benefits

- **Better worker safety**
- Low O_3 potential
- **Low misting** for less inhalation
- **Extremely low odour** and toxicity
- Non-skin sensitising and non-eye irritant

Technical benefits

- Carbon profile leads **to an optimal evaporation** profile with **low viscosity**
- Low density → **fast phase disengagement**
- Proven **Cu-Fe selectivity** and excellent stripping performance
- **High stability against oxidation** compared to aromatic diluents

**According to OECD 301F tests*

Shell GTL G80 helping customers succeed

- Over 20,000 tons of product sold of G80 mining diluent in South Africa and the Copperbelt
- Trials planned in Arizona at one of the largest mining groups in the Americas
- Trials planned with the biggest players in Chile and Peru

Shell GTL G80 Diluent

- Performance
- Supply
- Customer services
- Health and safety
- Environment
- Cost

For more information, please contact your local Shell representative or technical support team at www.shell.com