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NET ZERO

Technological Advancements in Purification,
Concentration and Recycle of Spent Sulfuric Acid

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How many lives are impacted each year by industrial pollution worldwide?



The number is staggering,
reminding us just how urgent
this issue is....

- 01** | Sulfuric Acid As Spent Acid - Purification & Concentration Processes
- 02** | Critical Minerals Technology Solutions – An overview
- 03** | Summary & Key Takeaways

The background of the slide is a landscape photograph. The top portion shows a bright, hazy sky over a distant horizon. The middle portion is a dark green horizontal bar containing the title text. The bottom portion shows a lush, green, hilly landscape with dense vegetation and trees, viewed from an elevated perspective.

Sulfuric Acid as Spent Acid: Purification & Concentration Processes

Sulfuric Acid As Spent Acid

Industries

- Titanium Dioxide Production
- Copper Refinery
- Aramid Fiber Manufacturing
- Explosives
- Nitrocellulose
- Chlorine Drying
- PV Production
- Lithium Extraction
- Dyes & Intermediates
- Pharma & Life Science
- Various Organic Chemicals



Challenges

- Environment Legislation
- Spent Acid Quality
- Acid Concentration
- Neutralization Expenses
- Operating & Personal Safety
- Construction Material Selection
- Organic Impurities Treatment
- Inorganic Impurities Treatment
- Production Loss Due To Disposal Issues
- Market Dependence & Price Fluctuation

Sulfuric Acid Concentration Technologies

Low Concentration

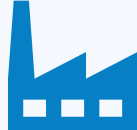
- Ecoplanning Technology For Concentration Up To **65%**
- Anti-corrosion Materials Selection Know-how
 - Graphite
 - RFP/PFA
 - PTFE-lined
 - Hastelloy
- Well Proven Evaporation Technologies With Maximum of Energy Recovery
- Crystallization & Valorization of Inorganic By-products



High Concentration

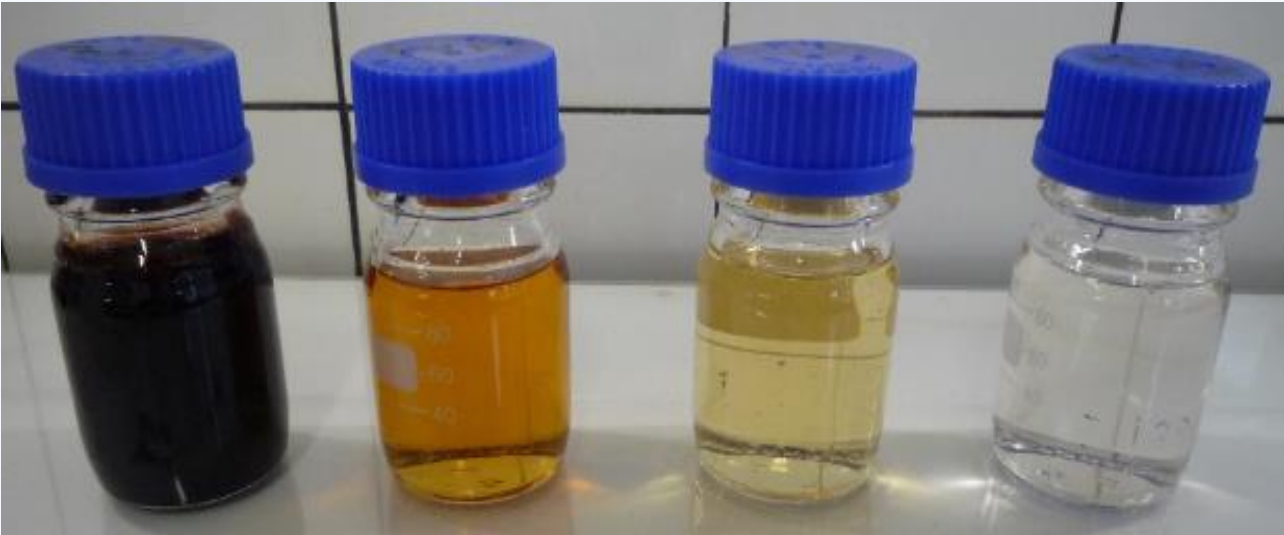
- Plinke Technology For Concentration Up To **98%**
- Anti-corrosion Materials Selection Know-how
 - Tantalum
 - Glass-lined
 - Silicon Carbide
 - Silicon Cast Iron
- Treatment Of Organic Impurities
- Patented Processes **SAC® DEN® SAVAPO®**
- **SAVACO®** Heat Exchanger For H₂SO₄ Up To **98%** For Temperatures Up To **250°C**

Spent Sulfuric Acid Properties



Production Process

- Identification of impurities
- Classification of Spent Acid
- Understanding of Process Requirement



Spent Acid

- Composition
- Concentration
- Flow Rate
- Temperature
- Pressure

Purified & Concentrated Acid

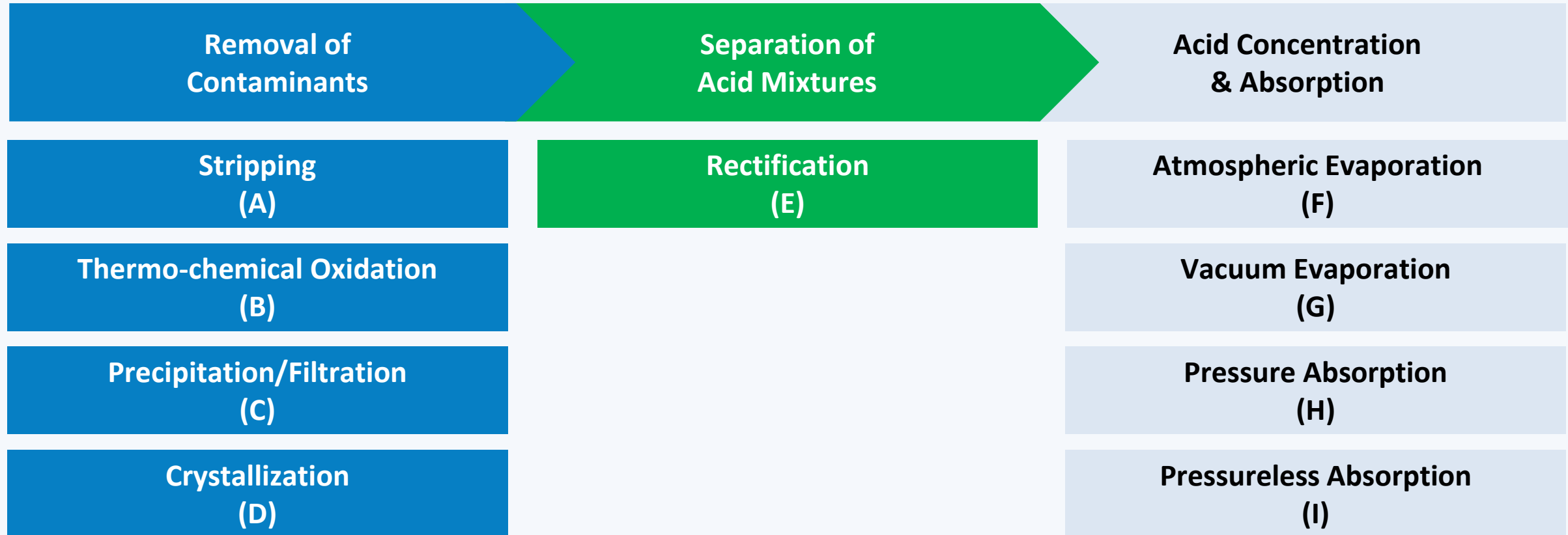
- Impurities Level
- Concentration
- Flow Rate
- Temperature
- Pressure



Modular Process Design



Sulfuric Acid Recovery/Recycling Configuration



From Spent To Purified Concentrated Sulfuric Acid



Spent Acid



Purified Concentrated Acid

Atmospheric Evaporation (F)

Vacuum Evaporation (G)

Precipitation/
Filtration (C)

Thermo-chemical Oxidation (B)

Thermo-chemical Oxidation (B)

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The background of the slide is a landscape photograph showing rolling green hills and a valley. A large, semi-transparent green banner is overlaid across the middle of the image, containing the text "KBR Experience". There are also smaller green geometric shapes in the top left and bottom right corners.

KBR Experience



Features

Capacity: 1 to 2484 MTPD*

>90 delivered plants

1957 – 2024

Purification and Concentration

↑ *At 100% Acid concentration

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Features

Sulfuric Acid concentration up to 98%

Plinke patented Heat exchanger

Special Heat Exchanger for H₂SO₄ from 94 upto 98 wt% for temperatures up to 250° C

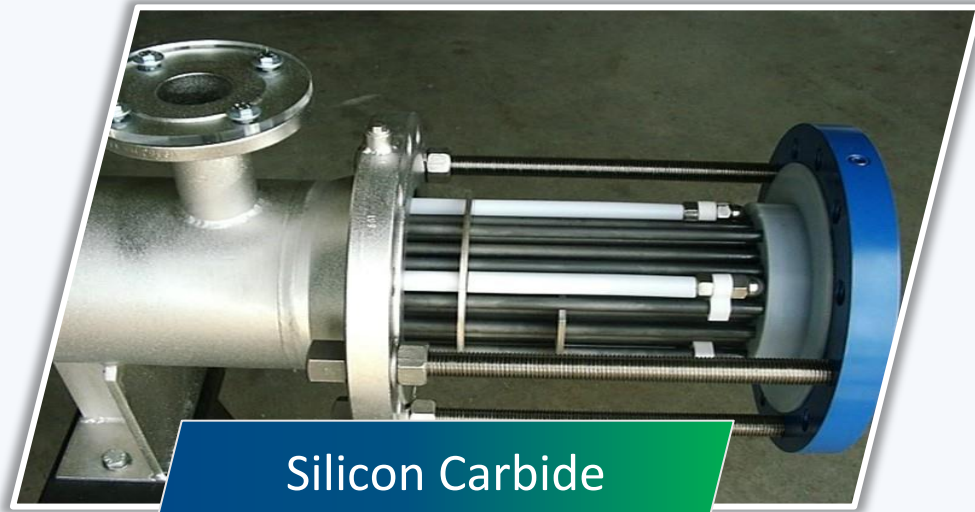
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KBR'S Expertise on Materials

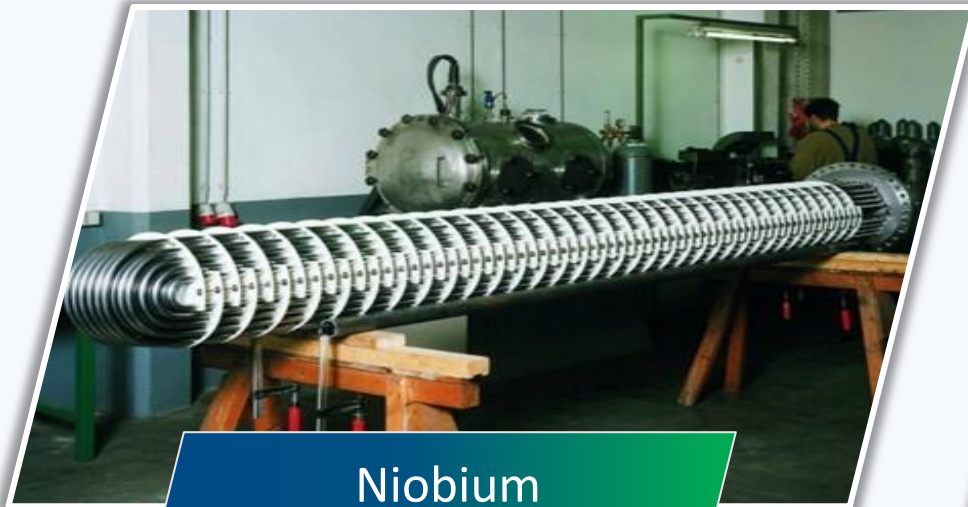
Equipment and Hardware: Materials of Construction



Stainless Steel



Silicon Carbide

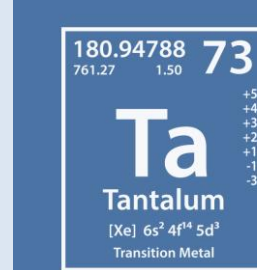
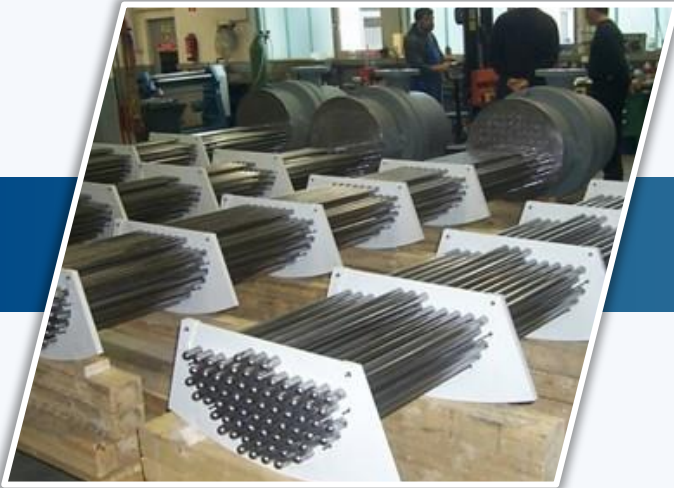


Niobium

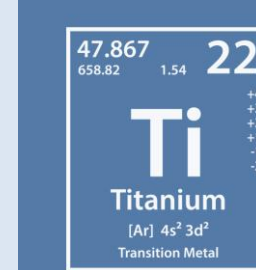


Graphite

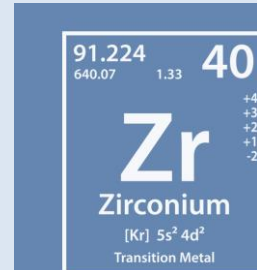
Equipment and Hardware: Materials of Construction



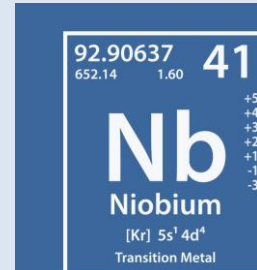
TANTALUM



TITANIUM

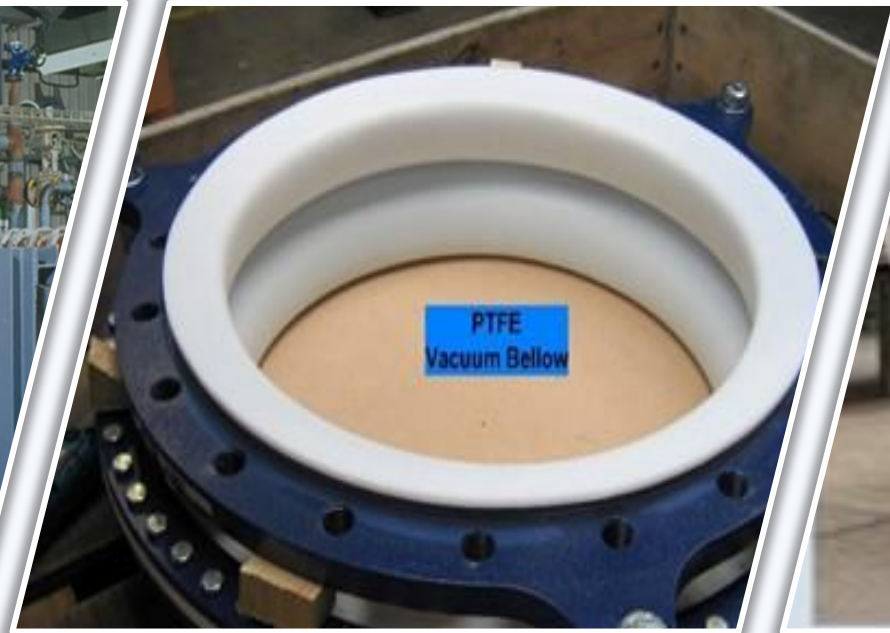


ZIRCONIUM



NIOBIUM

Equipment and Hardware: Materials of Construction



Glass lined steel

PTFE/PFA lined steel

Glass

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Equipment and Hardware: Materials of Construction



**Glass lined evaporators during operation
(insulated)**



**Glass lined evaporators during installation
(non-insulated)**

Equipment and Hardware: Materials of Construction



- Special heat exchanger for H_2SO_4 from 94 up to 98 wt% for temperatures up to 250°C
- Special alloy

The background of the slide is a landscape photograph showing rolling green hills and a forested area. A horizontal band of light blue and white sky is visible in the upper portion. Two dark green, semi-transparent geometric shapes are overlaid on the image: a trapezoidal shape on the left side and a larger, wider trapezoidal shape in the center that contains the title text.

KBR Critical Minerals: An overview

Critical Minerals: Mineral Acid Solutions

Mixed Acids

- Separation
- Purification
- Concentration

NO_x absorption

- Down to 20 ppm NO_x (with additional treatment)
- Using water and atmospheric air only
- Recovery of HNO₃
- Atmospheric or under pressure

Nitric Acid

- Up to 99% HNO₃ using
 - Magnesium Nitrate (MAGNAC®)
 - Sulfuric Acid (NACSAC®)
- Up to 68% HNO₃ by rectification (NAPC®)



Sulfuric Acid

- Pre-concentration atmospheric or at vacuum conditions
- Medium concentration up to 85% H₂SO₄ at vacuum conditions
- High concentration up to 98% H₂SO₄, at vacuum conditions and high temperature

Hydrochloric Acid

- Pre-concentration up to 24 % HCl
- Medium concentration up to 35 % HCl
- High concentration up to 100 % HCl
- Purification

Nitration of Benzene and Chlorobenzene

- With integrated energy recovery
- Minimized by-products
- Compact unit with integrated SAC®
- Use of weak nitric acid feedstock

Critical Minerals: Brine to Batteries



Direct Lithium Extraction



- KBR has entered an exclusive global alliance with GeoLith to license DLE Li-Capt® technology, unlocking new resources worldwide (geothermal, salars, oil field brines, battery recycling)
- DLE has transformed traditional processes, reducing **carbon, time, and costs**

Li-Capt®



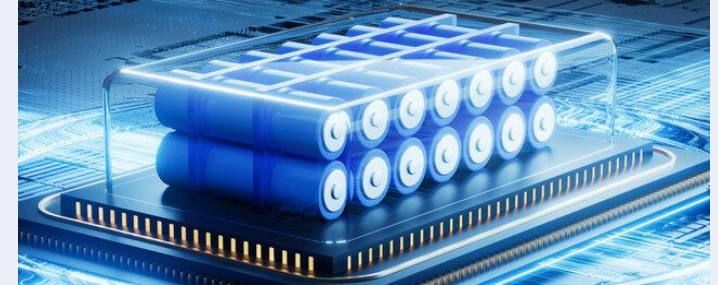
High-purity Lithium Production



- PureLiSM is KBR's refining and conversion technology that transforms a variety of lithium feedstocks into **battery-grade lithium carbonate** or **lithium hydroxide monohydrate**
- Enhanced process design guarantees **maximum lithium yield** with the **highest purity**
- Customized, proven process designs and solutions for different lithium feedstocks

PureLiSM

Lithium Sulfide Production



- KBR and ISU Specialty Chemical are **jointly developing** a fully integrated and proprietary technology for all-solid-state-batteries (ASSBs)
- The ongoing development focuses on optimizing the synthesis of **Li₂S** at commercial scale
- Sulfide-based solid electrolytes offer exciting possibilities for **safer and higher energy-density ASSBs**

PureLi2SSM

ISUSM SPECIALTY CHEMICAL

Li-Capt and PureLi is KBR's integrated solution to unlock the full potential of the world's lithium resources

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Business Scope



Technology Licensing

Basic Engineering Design

Detailed Engineering Design

Proprietary & Non-Proprietary Equipment

Erection, Commissioning and Start-up Services

Spare Parts Services

Technical Training

Studies & Revamping

Laboratory Tests & Piloting



Laboratory
Facilities



Lab Testing
Piloting



Engineering
Design

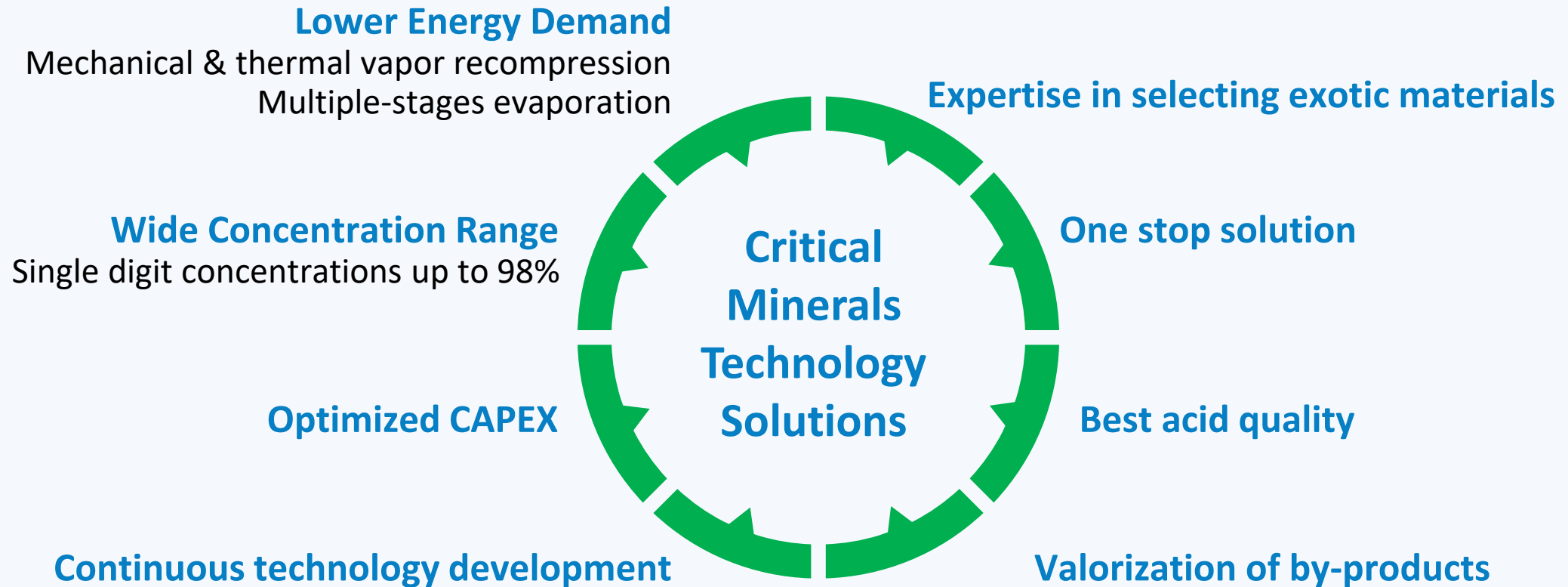


Commercial
Scale



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KBR Critical Minerals Technology Solutions – Why?



Summary & Takeaways



Sustainability

- Reduction of NO_x Emissions
- Reduction of Waste Water & Spent Acid Discharge
- Optimization Of CO₂ Footprint
- High Quality Process Condensate



Safety

- Selection of Anti-corrosion Material
- Customized Engineering Solution
- Continuous Training & Customer Support
- KBR Zero Harm Guidance



Profitability

- Valorization of By-products/Minerals
- Ensuring Product Quality
- Extending Customer's Products Portfolio
- Optimizing Plant's Operating Cost
- Minimizing Investment Costs

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HARM
COURAGE TO CARE

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Thank you

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