



April 24, 2024

Adiabatic Nitration of Benzene & Chlorobenzene

Technology Solutions - Inorganics
Bhavesh Shah



Delivering Solutions, Changing the World.SM



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Background - Inorganics Technology Solutions



Reactor - Adiabatic Nitration Process



NB Purification and Benzene Recovery Processes



Safety Features in KBR's Adiabatic Nitration Process



KBR Experience



Key material of construction of equipment



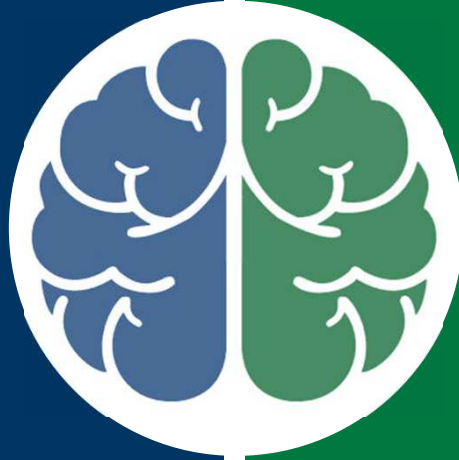
Summary – Key benefits of Adiabatic Nitration Process



BACKGROUND

ECOPLANNING

Over 150 Years Of Know-how
Evaporation & Crystallization
Acid Low-concentration Know-how
Zero Liquid Discharge Technologies
Treatment And Purification Of Minerals



PLINKE

World Leader In Acid Concentration
Treatment Of Organic Impurities
Acid High-concentration Know-how
Patented Processes & Equipment
Special Material Competence

750+

TECHNOLOGY REFERENCES
ALL AROUND THE WORLD

150+

YEARS OF
EXPERIENCE

40+

TECHNICAL
EXPERTS

20+

REGISTERED
PATENTS

2

LABORATORY
FACILITIES

Technology Portfolio & Its Applications



Main Products	Concentrated Nitric Acid (HNO_3)		Sodium Chlorate (NaClO_3)	Sulphuric Acid (H_2SO_4)	Metal Sulfates (CuSO_4 , NiSO_4 , ZnSO_4)
	Nitrobenzene (NB)	Nitrochlorobenzene (NCB)	Purified Phosphoric Acid (PPA)	Lithium (LiSO_4 , Li_2CO_3 , LiOH)	Hydrochloric Acid (HCl)

Treatment/Recycling of Waste Products	Recovery Of Chemicals From Boiler Ashes	Industry Sectors	Food & Fertilizers	Chemicals	Metallurgical	Explosives
	Spent & Waste Acid Recycling					
NO_x Conversion To Nitric Acid	Zero Liquid Discharge	Pulp & Paper	Pigment & Dye	Materials & Fibers	Refineries	
						

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



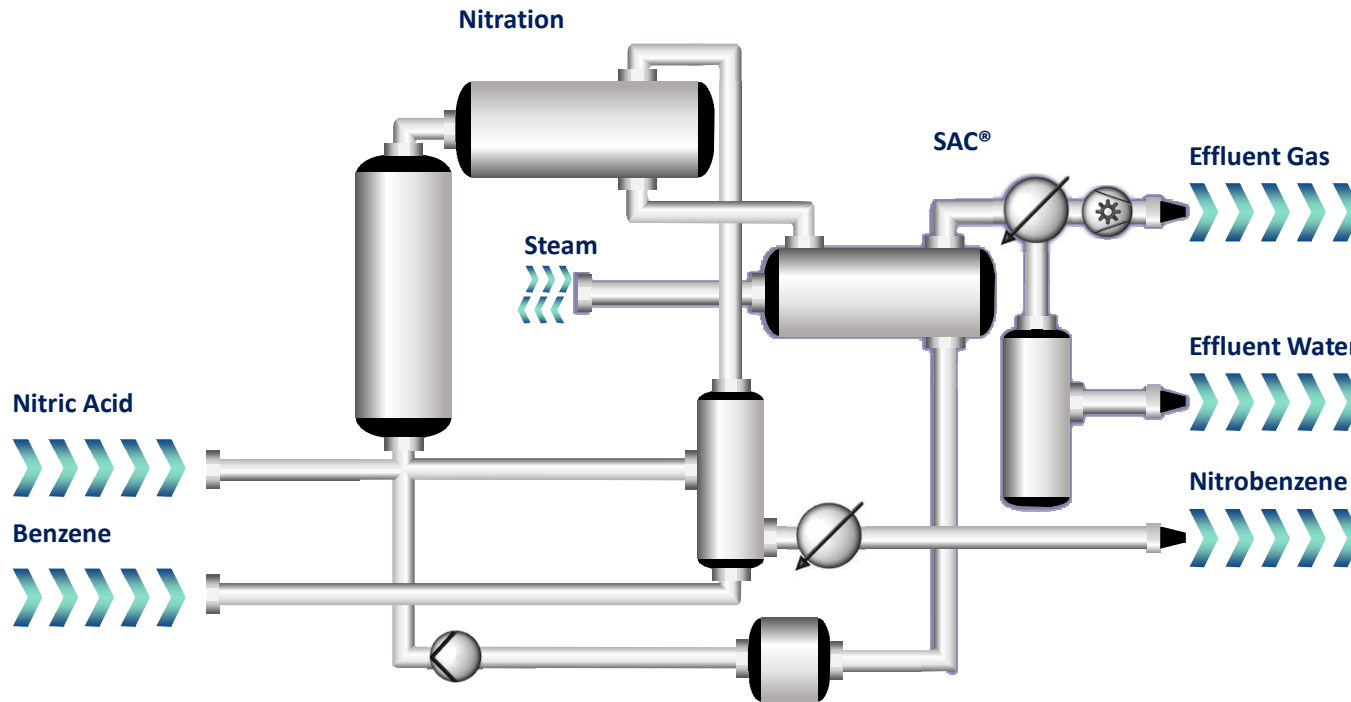
Commercial
Scale





ADIABATIC NITRATION OF BENZENE & CHLOROBENZENE

KBR's Adiabatic Process for Nitration of Benzene



KBR Adiabatic Process for Nitration of Benzene



KBR's Adiabatic Nitration of Benzene is a nitration process with integrated Acid re-concentration with the following main characteristics:

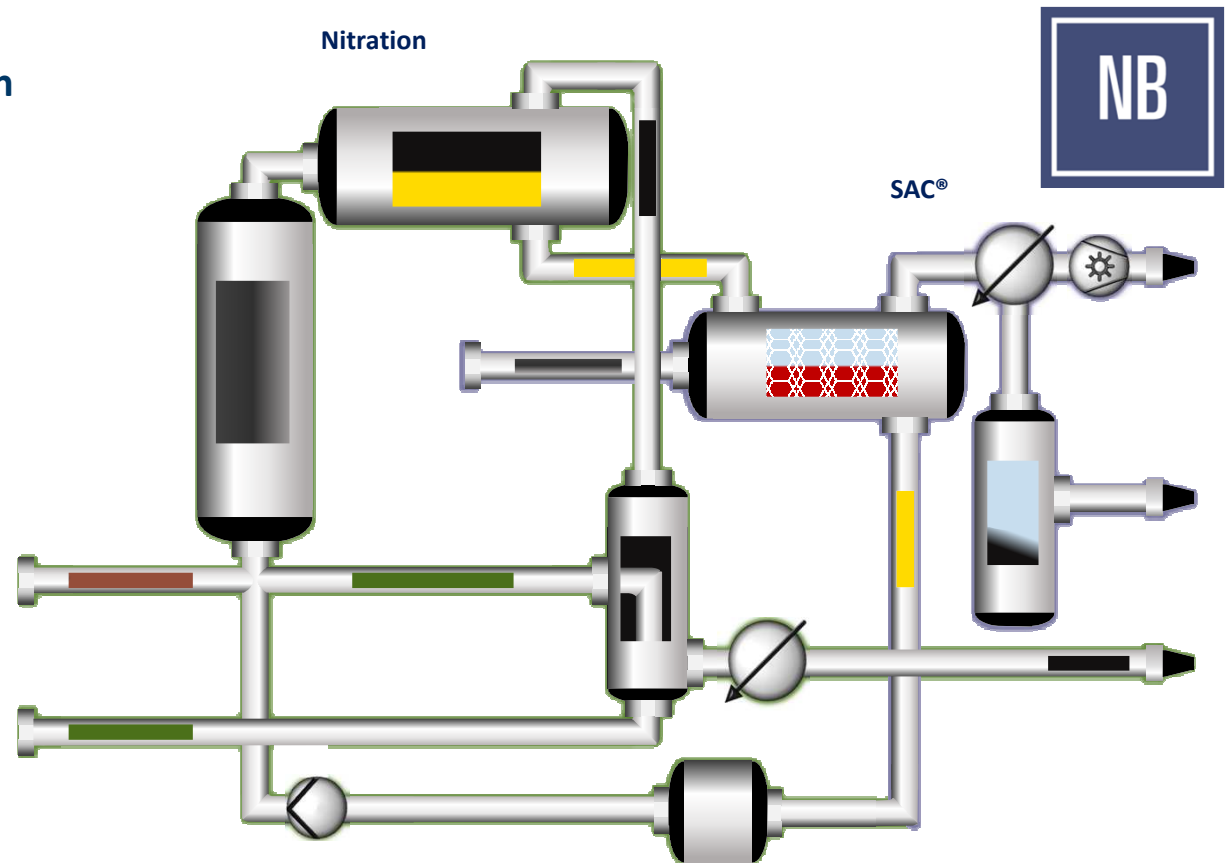
Minimized by-product formation

High efficient reactor without rotating inserts

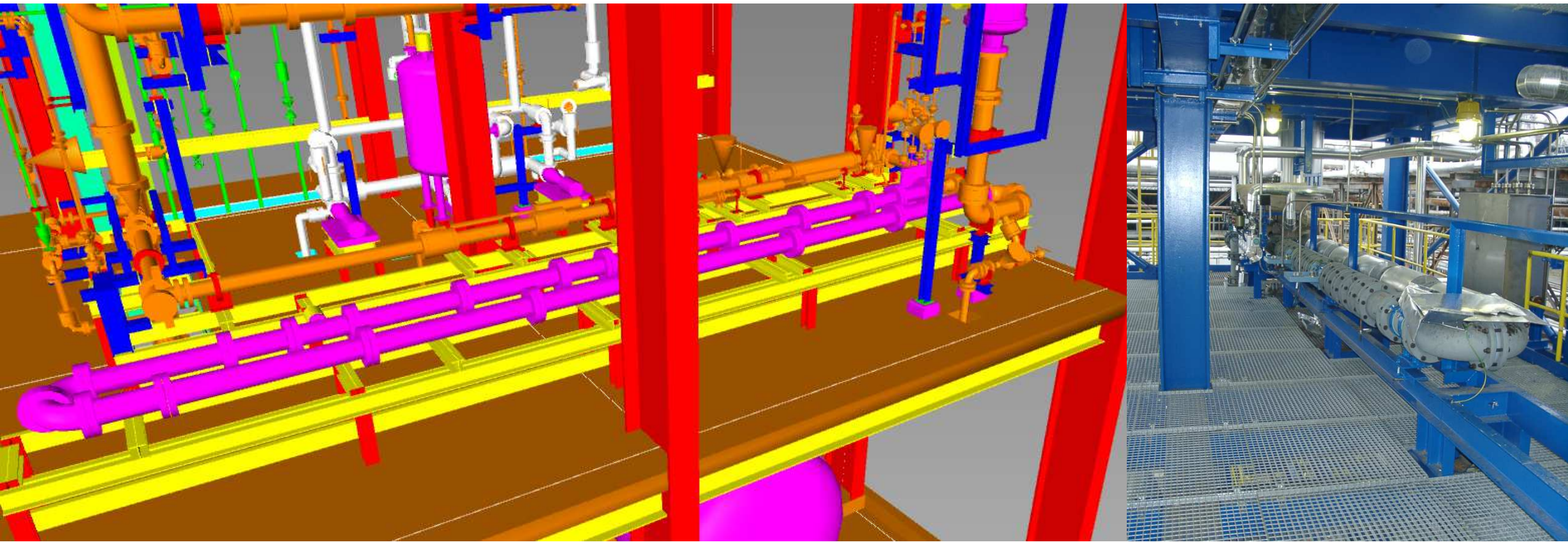
Optimized flow characteristics for best mass transfer

Controlled temperature increase

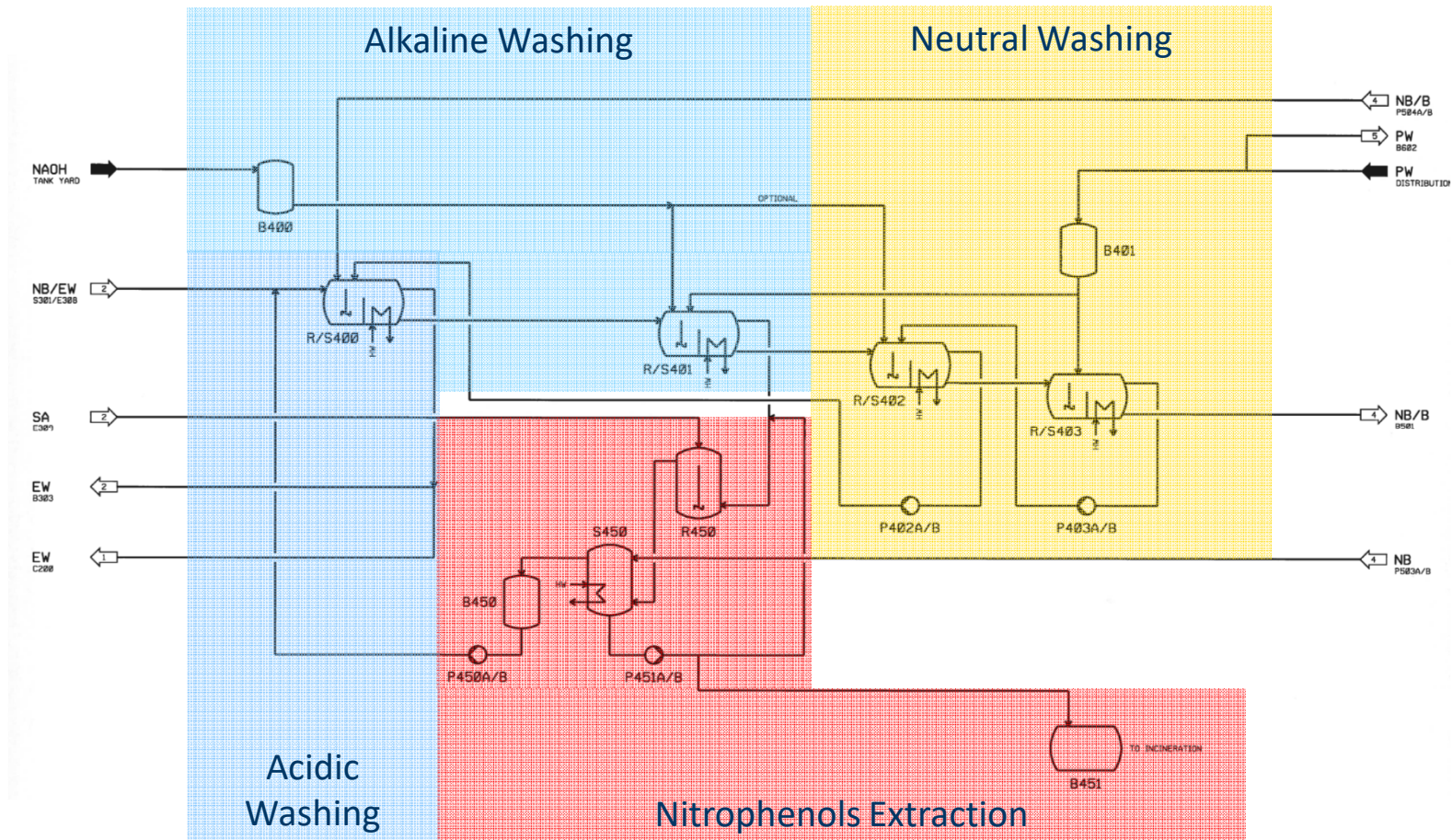
Integrated SAC[®] for maximum internal heat re-use



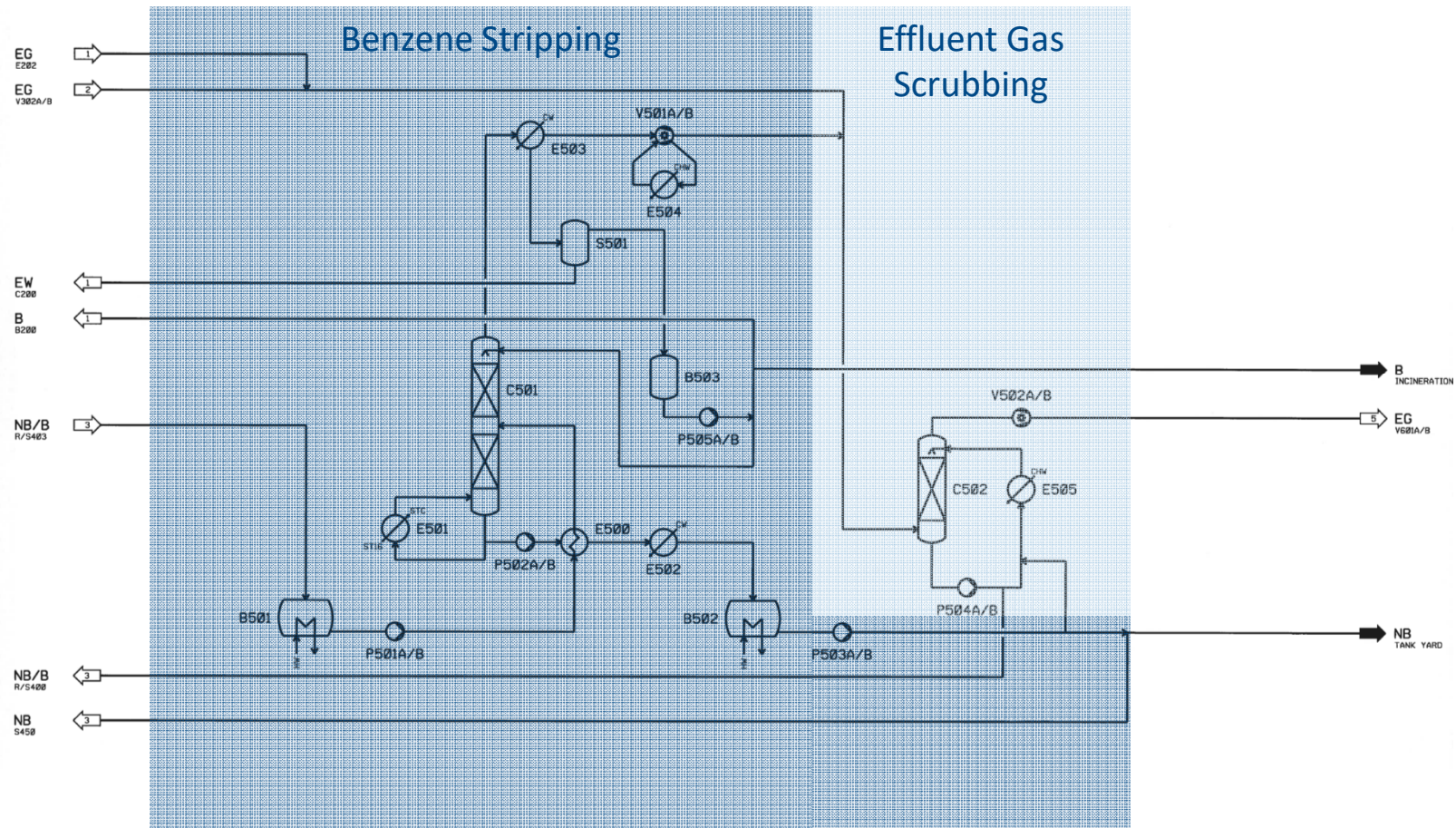
Main Reactor-Highest yield



Purification Process – Only NB



Benzene Stripping Process- Only NB





SAFETY FEATURES IN KBR'S ADIABATIC NITRATION PROCESS

Counter Measures to avoid Runaway Reactions

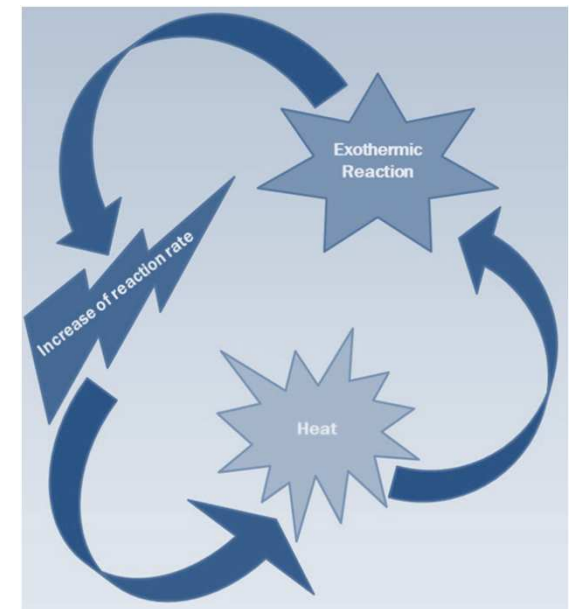
Temperature Control

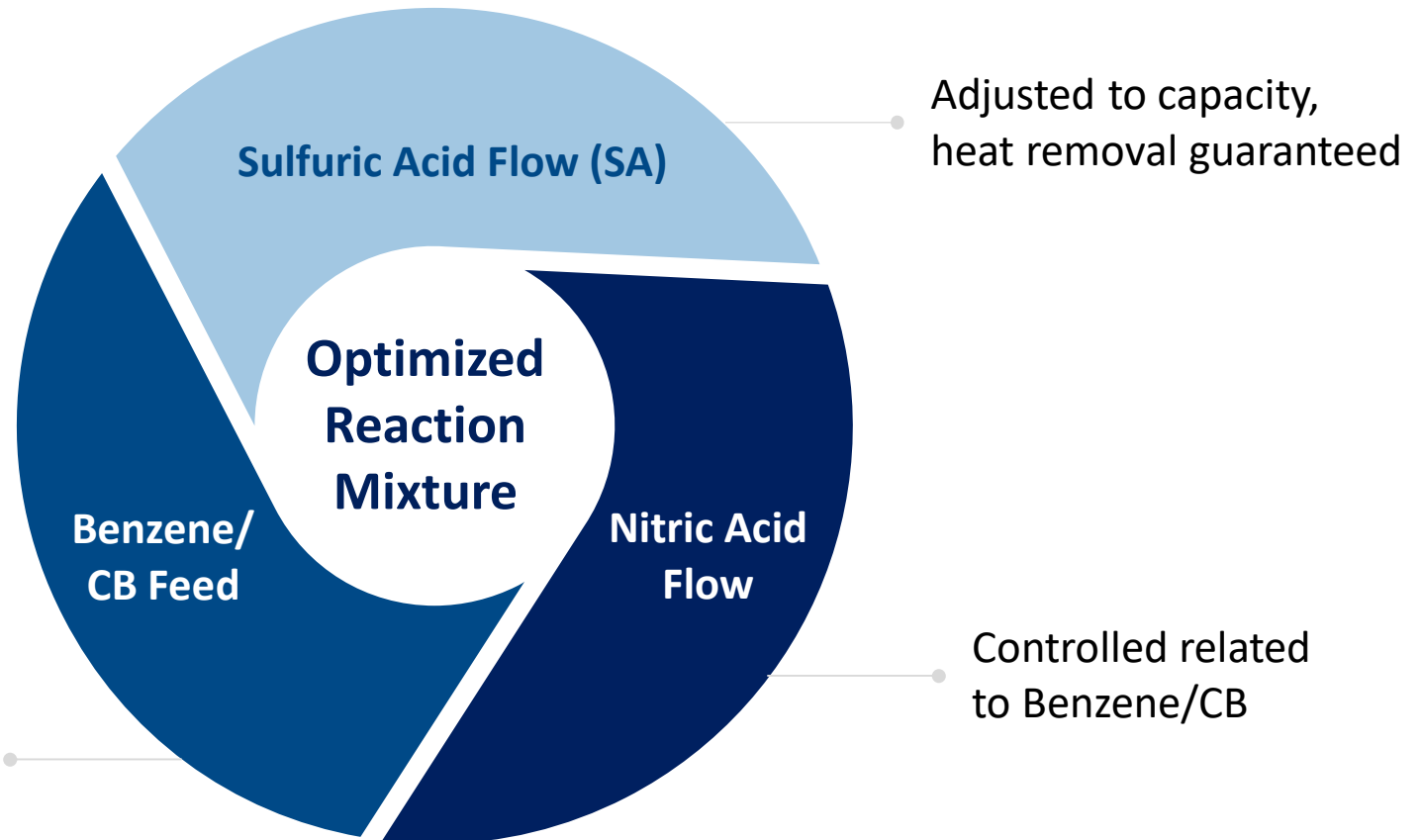
Flow Control

Quality Control

Reaction Mixture Control

Avoidance of Accelerating Effects by absorbing energy in excess Sulphuric acid





Process Integrated Temperature Control

- Circulating Sulfuric Acid absorbs the energy
- **Continuous temperature profile investigation**

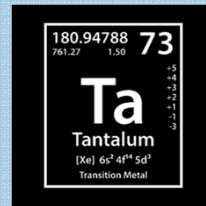
In Case of Deviations

- Nitric Acid feed is stopped automatically
- Benzene/CB feed is stopped automatically
- Circulating Sulfuric Acid still absorbs the energy
- Heat is removed by flash evaporation
- Effect can be intensified by increased acid flow

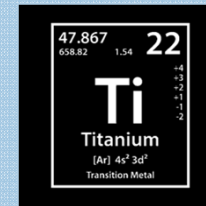


KEY MATERIAL OF CONSTRUCTION OF EQUIPMENT

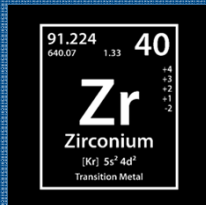
Materials of Construction



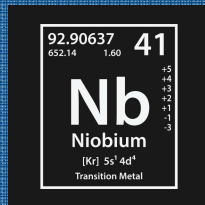
TANTALUM



TITANIUM



ZIRCONIUM



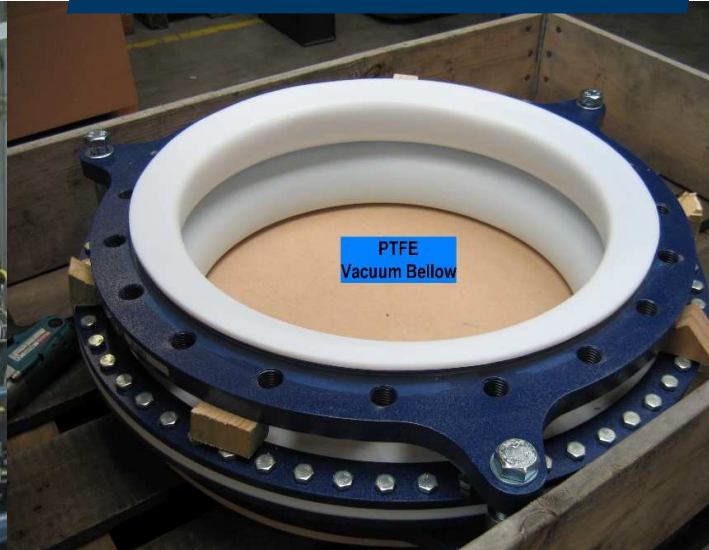
NIوبيUM



Glass



PTFE/PFA lined steel



Glass lined steel



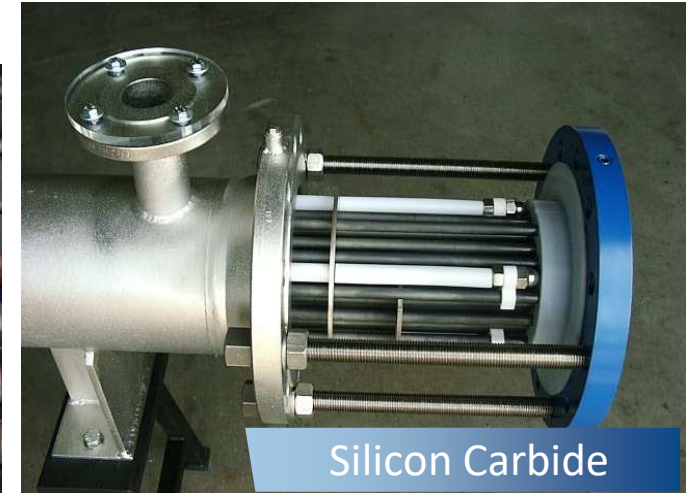
Materials of Construction



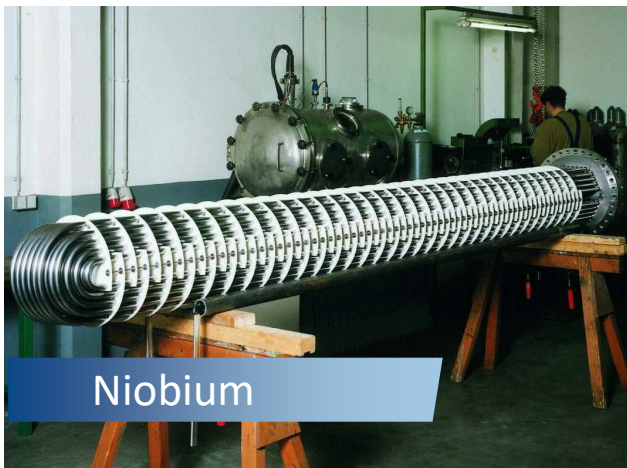
Stainless Steel



- Special Heat Exchanger for H_2SO_4 from 94 up to 98 wt. % for temperatures up to $250^\circ C$
- Special alloy



Silicon Carbide



Niobium



Graphite



KBR EXPERIENCE

KBR Experience – Adiabatic Nitration



Year	Name of Customer	Country	Product	Capacity	Current Status
1996	MCHZ	Czech Republic	NB	98 ktpy	Under operation
2003	MCHZ	Czech Republic	NB	98 ktpy	Under operation
2005	KAROON Petrochemical	Iran	NB	98 ktpy	Under operation
2019	Confidential	India	NCB	72 ktpy	Project canceled
2020	Confidential	India	NB & NCB	70 ktpy	Under Execution
2021	Confidential	India	NCB	36 ktpy	Under Execution



SUMMARY – KEY BENEFITS OF ADIABATIC NB/NCB PROCESS

Summary – Key benefits of Adiabatic NB/NCB process



Adiabatic NB/NCB has 10 to 15% lower cost of production compared to Isothermal process

Lower net CAPEX if independent SAC is installed for Isothermal process

WNA (54-67 wt.%) is used in Adiabatic process, no need of CNA (98-99 wt.%), which will further reduce operating cost and possibly set free production capacities of CNA for other products

No Dependency on fresh Sulfuric Acid & disposal of spent sulfuric Acid

Excellent quality & yield of product Nitrobenzene/NCB

Safe & fully automatic plant – KBR's Adiabatic NB plants are operating since year 2003

Depending on plant capacity/location payback period of Adiabatic NB/NCB plant would be <3 years

On case-to-case basis, plant can be engineered & designed to produce both NB & NCB on campaign basis

KBR's Proprietary NO_x absorption system (depending on Plant capacity of Nitration)



Sustainability

- Reduction of NO_x Emissions
- Reduction of Waste Water & Spent Acid Discharge
- Reduction 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

- Valuable By-products
- Ensuring Product Quality
- Extending Customer's Products Portfolio
- Optimizing Plant's Operating Cost
- Minimizing Investment Costs

Enhance your plant's **Sustainability | Safety | Profitability** with KBR's Technologies



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Thank you



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