



# KBR Weatherly Nitric Acid Technology

Revolutionary Plant Design Delivering Superior Performance

# A SIMPLIFIED NITRIC ACID PLANT

*KBR maintains a commitment to constantly improve chemical production processes. As a result, the company has developed a superior design for nitric acid production. KBR Weatherly high monopressure plant provides low capital cost, high ammonia conversion, reduced catalyst cost, low maintenance cost, and minimal site area requirements. Additionally, the design is extremely energy efficient.*

## KBR WEATHERLY NITRIC ACID PROCESS OVERVIEW

Manufacturing nitric acid starts with two raw materials – atmospheric air and ammonia ( $\text{NH}_3$ ). These are shown in the flow diagram below. Before atmospheric air can be used, it must be filtered, compressed, heated, and filtered again. KBR Weatherly plants can extract approximately 90% of the horsepower needed for compression from heated tail gas, a highly efficient design feature. Liquid ammonia is prepared separately; it is filtered, vaporized and superheated, and filtered again.

Once prepared, the raw materials move on to conversion and heat recovery stages. The clean streams of air and ammonia are intimately mixed and evenly distributed over a platinum catalyst. At this point, an exothermic reaction between ammonia and oxygen occurs, producing nitric oxide and water vapor. The resulting process gas is passed through the heat exchanger train, where the major portion of this reaction energy is recovered as heat. The process gas is cooled, forming weak nitric acid. Nitric acid and the remaining process gas are separated and fed into the absorption system.

In the final stage, nitric oxide, nitrogen dioxide, oxygen and water are combined in an absorber column, forming nitric acid of the desired strength. A portion of the

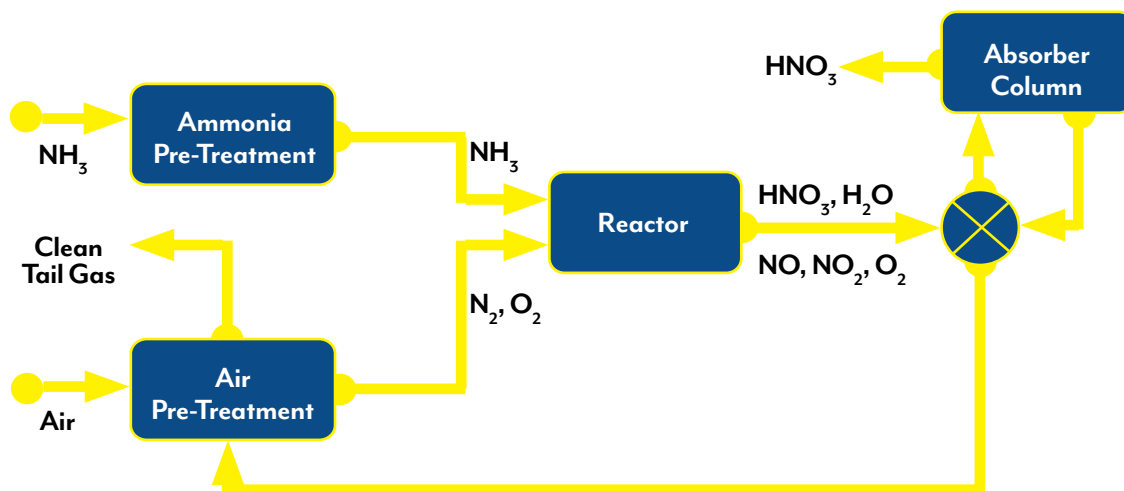
reaction energy recovered in the heat exchanger train is used to reheat the tail gas to provide power for the air compressor by driving a hot gas expander.

## A UNIQUE MONOPRESSURE DESIGN

Unlike other designs that change pressures at different production stages, KBR Weatherly's nitric acid plants utilize a single, high-pressure level. This high-pressure approach allows for smaller, lower-cost plant equipment, which significantly reduces capital cost. Also, KBR Weatherly's high monopressure design is more energy-efficient. Lastly, the plant can be designed to allow manufacturers to produce different product acid concentrations.

KBR Weatherly nitric acid plants are vertically-oriented, minimizing site area requirements. The vertical design and equipment arrangement also minimizes piping runs and expansion problems in high-temperature gas piping. This compact layout provides easy access for operation and maintenance.

Engineers are trained to consider clients' needs and combine energy recovery options to minimize plant operating and capital costs. KBR analyzes specific site utility unit costs and tailors plants to fit site requirements.



## PLANT BENEFITS

- Low capital cost – KBR's Weatherly technology operates at a higher pressure than competing processes, so equipment is smaller and less expensive, reducing the overall plant investment
- High ammonia conversion – emphasizing clean raw materials, thorough mixing, even distribution and stable temperature, the design delivers extremely high ammonia conversion. Also, the catalyst basket design significantly enhances conversion. On average, the system maintains efficiencies of 95% or higher
- Low catalyst cost – the process combines the latest development in platinum recovery systems with KBR Weatherly's high ammonia conversion resulting highly efficient platinum use
- Low NO<sub>x</sub> emissions – KBR Weatherly's proven extended absorption design delivers superior NO<sub>x</sub> emissions performance; even lower emissions are possible by coupling with catalytic NO<sub>x</sub> reduction systems
- Reduced maintenance cost – the vertical equipment arrangement minimizes piping runs and expansion problems, reducing maintenance expense
- Minimal site area requirements – KBR Weatherly's plants are vertically oriented and utilize smaller equipment-site area demands are minimal
- Energy recovery – KBR's plant design obtains energy recoveries as high as 5.23 GJ per metric ton (4,500,000 BTU per short ton). Each plant is customized to minimize costs

## FLEXIBLE POWER RECOVERY OPTIONS

KBR's Weatherly nitric acid plants are designed with flexible power recovery options. Manufacturers can easily add energy recovery equipment according to their own schedules.

Power recovery options include:

- Exploiting steam generation capabilities to supply export of saturated or superheated steam
- Reheating tail gas to enhance power recovery in an expander turbine as part of the air compressor train
- Utilizing excess power available from generated steam and tail gas by converting it into electricity
- Providing ammonia vaporization energy requirements from low-level heat sources

**KBR has been building nitric acid plants worldwide since 1950s, combining years of experience with cutting-edge technology.**



## THE BOTTOM LINE

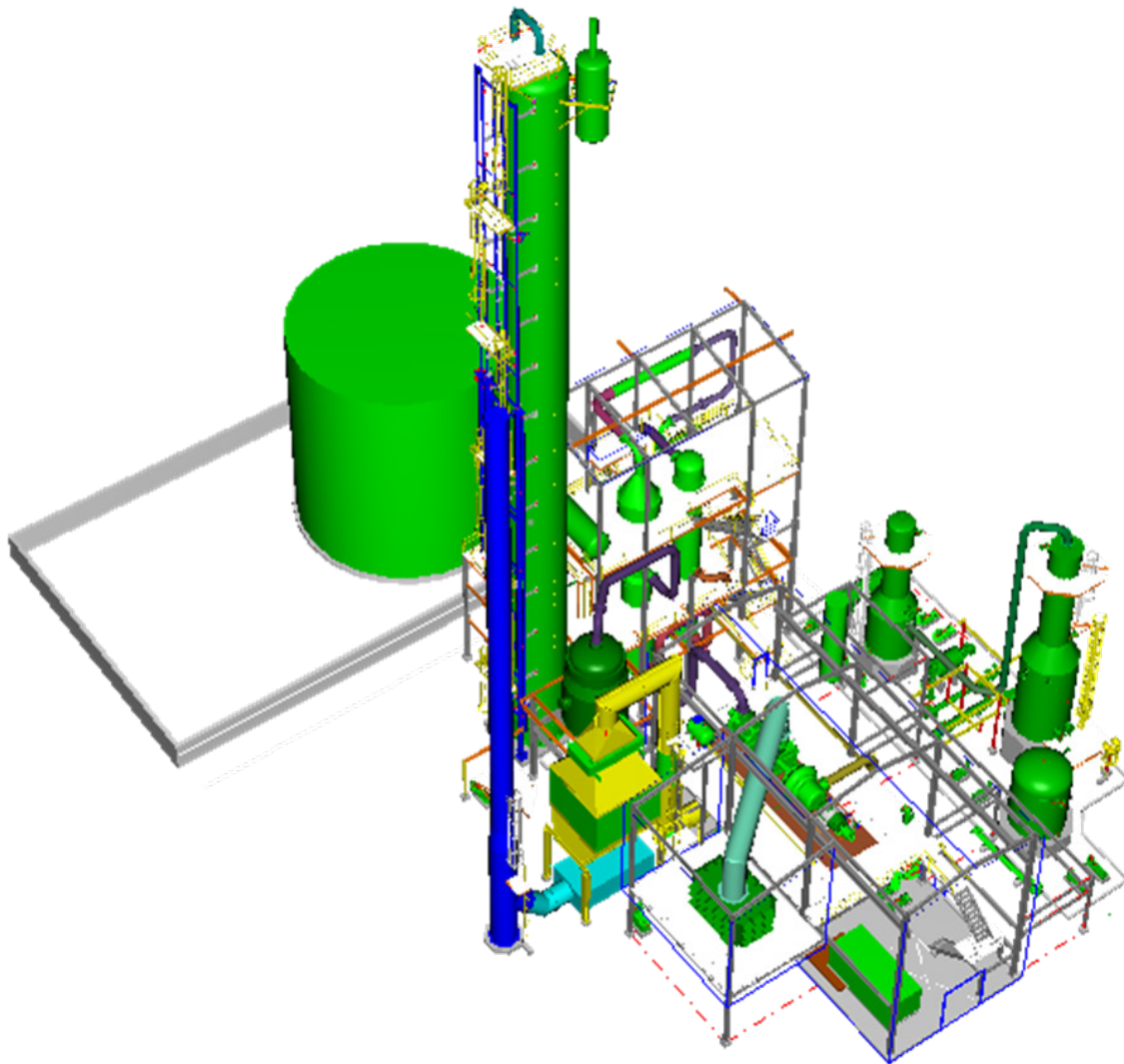
In four decades, KBR has built over 65 Weatherly nitric acid plants. During this time, the company has never stopped seeking ways to improve production processes. No part of the process is insignificant.

KBR Weatherly nitric acid process delivers increased effectiveness and production efficiency. The single-high-pressure design provides for smaller, lower-cost equipment, a reduction in site area needed, and minimized maintenance. Additionally, KBR Weatherly-designed raw material handling, mixing and catalyst basket enhances

ammonia conversion. Power recovery options are available, reducing production costs. Several process innovations contribute to the efficient use of ammonia and platinum. The list goes on.

## THE RESULT

In addition to being a high-quality, dependable source of nitric acid, KBR Weatherly plants are extremely cost-effective to start-up and maintain. If you're looking to bring nitric acid production in-house, KBR Weatherly is your best choice.



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