* **Available process technology of Weak Nitric Acid and Ammonium Nitrate:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S. No.** | **Plant** | **Technology provider** | **Process/technology** | **Client** |
| 1 | Ammonium nitrate melt (AN melt) | Thyssenkrupp | uhde® Vacuum Neutralisation | Gujarat Narmada Valley Fertilizers & Chemicals Limited |
| 2 | Technical Ammonium Nitrate (TAN) | Casale SA | AN2000/Dual Pipe reactor | Smartchem Technologies Ltd. (a subsidiary of Deepak Fertilizer), (**Planned)** |
| 3 | Ammonium nitrate (AN) | Thyssenkrupp | uhde® Vacuum Neutralisation | Deepak fertilizers, Taloja plant |
| 4 | Ammonium nitrate melt (AN melt) | INCRO | Multitubular Reactor (MTR) | Rashtriya Chemicals and Fertilizers Limited |
| 5 | Ammonium nitrate melt (AN melt) | **WIP** | **WIP** | National Fertilizers Limited |
| 6 | NA | NA | NA | Chambal fertilisers and chemicals Ltd. |
| 7 | Weak Nitric Acid (WNA) | Plinke GmbH (KBR's Subsidiary) | NAPC® | Gujarat Narmada Valley Fertilizers & Chemicals Limited |
| 8 | Weak Nitric Acid (WNA) | Thyssenkrupp | uhde® dual pressure nitric acid process | Gujarat Narmada Valley Fertilizers & Chemicals Limited |
| 9 | Weak Nitric Acid (WNA) | Weatherly Inc. (U.S.A.) (KBR’s Sunsidiary) | Weatherly Dual Pressure Nitric Acid Technology | Deepak Fertilizers |
| 10 | Weak Nitric Acid (WNA) | Thyssenkrupp | uhde® dual pressure nitric acid process | Rashtriya Chemicals and Fertilizers Limited |
| 11 | Weak Nitric Acid (WNA) | **WIP** | **WIP** | National Fertilizers Limited |
| 12 | NA | NA | NA | Kutch Chemical |

* **Manufacturing process with flow diagram for Weak Nitric Acid (WNA):**
* Thyssenkrupp: The Uhde dual-pressure process

ThyssenKrupp Industrial Solutions’ state-of-the-art technology to produce nitric acid involves ammonia combustion to form nitric oxide, followed by oxidation of the nitric oxide to nitrogen dioxide, and finally absorption of the nitrogen dioxide in water to form nitric acid. Based on customer-specific requirements an optimized process concept is offered, considering capital expenditure and operating cost. Both mono-pressure and dual-pressure processes can be offered.

Azeotropic nitric acid with an elevated concentration of 68% by weight can replace concentrated nitric acid in some applications such as nitration. We have developed an enhanced process for the reliable production of azeotropic nitric acid without any further weak nitric acid co-production.

The Uhde nitric acid process is known for its:

* high reliability and high on-stream time
* easy maintenance
* cost-effectiveness
* energy efficiency
* low emissions (BAT technology)
* Plinke GmbH (A subsidiary of KBR): Nitric Acid Pre-concentration NAPC®

Weak nitric acid pre-concentration NAPC® is used to concentrate acid up to about 68 wt% HNO3. The NAPC® process removes water from diluted nitric acid by rectification without the use of extractive agents. The maximum concentration by rectification is about 68 wt% nitric acid because the two components mixture of nitric acid and water forms an azeotropic mixture at that concentration level.

* Weatherly Inc. (U.S) (KBR’s Subsidiary): Dual Pressure Nitric Acid Technology

Manufacturing nitric acid starts with two raw materials – atmospheric air and ammonia (NH). 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.

Diagram

Description automatically generated

* **Manufacturing process of Ammonium Nitrate (AN) and flow diagram:**
* Casale SA: Dual pipe reactor process

Dual pipe reactor processes are designed to help optimize the granulation process by installing a second pipe reactor, the DPR, into the dryer. The DPR works in almost the opposite way to the GPR, as it is designed to produce a solid rather than a slurry. In order to avoid clogging, the MR needs to be chosen and kept to around one, so that only solid MAP is produced. No sulfuric acid is used during this stage of the process. Otherwise, all the other components of the NPK plant remain the same. In order to increase the capacity of the plant using a single pipe reactor process, more raw materials are required, contributing to a larger quantity of liquid in the granulator. Therefore, to keep control of the granulation, more solids must be recycled to the granulator, meaning the full loop capacity must be increased across all equipment involved in the process, including the granulator, dryer, elevators, screens, crushers, etc. Meanwhile, within plants using a dual pipe reactor process, a large percentage of the phosphoric acid and ammonia is fed directly to the DPR, where they react to form MAP, which is then recycled to the granulator. Essentially, the DPR supplies the granulation loop with extra MAP and by allowing additional N and P feed to be introduced directly as a solid, the overall output can be increased without having to add extra loop capacity. In addition, because the neutralization of phosphoric by ammonia is exothermic and takes place in the dryer, the heat produced helps contribute to the drying of material. In some plants, the heat of the reaction is the only heat used within the dryer, generating energy savings for the plant.

* INCRO: Pipe reactor and Multitubular reactor

INCRO has developed and patented two different processes to manufacture ammonium nitrate solution 80-97%, using 52-60% nitric acid and ammonia, one of them using Pipe Reactor (PR) and the other using a Multitubular Reactor (MTR). Both processes are highly efficient, very ecological and steam self-sufficient for required concentration, being suitable, not only for fertilizers production, but also for explosives. Process characteristics are furtherly detailed in the explosive section.

Obtained solution can be directly dispatched as final product or employed as one of the required raw materials for manufacture of calcium ammonium nitrate (CAN)/ammonium sulphonitrate (ASN) granulation, or to be concentrated till 99.5-99.8% for pure ammonium nitrate/calcium ammonium nitrate prills production.

* Thyssenkrupp: Vacuum Neutralization and evaporation

The reaction takes place in a slightly pressurized neutralizer to prevent the ammonium nitrate solution from boiling in the mixing and reaction sections thus minimizing ammonia loss. Subsequently the solution is flashed into a vacuum through a restriction orifice adjacent to the vapor separator, thereby utilizing the reaction heat for water evaporation. A solution concentration of 95 wt.% can be achieved with a preheated feed of 60 wt.% nitric acid. For control and safety reasons, however, the AN solution concentration is mostly limited to 92 wt.%.

The higher concentration is necessary for further process steps, such as granulation or prilling is achieved by steam heating the solution under vacuum pressure. For optimum process control and stability, Thyssenkrupp industrial solutions preferably applies a thermosyphon evaporation system. The scrubbed process vapors are used for feedstock preheating, surplus vapors are condensed.

Diagram

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