Ammonia
Ammonia

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Introduction

- The most familiar compound composed of the elements nitrogen and hydrogen, NH₃.
- Colourless, pungent gas composed of nitrogen and hydrogen, chemical formula NH₃.
Ammonia forms a minute proportion of the atmosphere;
- it is found in volcanic gases and as a product of decomposition of animal and vegetable matter.

Ammonia has also been called alkaline air and volatile alkali.
Introduction

- Easily liquefied by compression or cooling for use in refrigerating and air-conditioning equipment, it is manufactured in huge quantities.

- Ammonia is made by the Haber-Bosch process.
Introduction

- Its major use is as a fertilizer, applied directly to soil from tanks of the liquefied gas.

- Also employed as fertilizers are salts of ammonia, including

  - ammonium phosphate and

  - ammonium nitrate (the latter used in high explosives as well).
Introduction

- Ammonia has many other industrial uses as
  - a raw material,
  - catalyst, and
  - alkali.

- It dissolves readily in water to form ammonium hydroxide, an alkaline solution familiar as a household cleaner.
Introduction

- Ammonia has a wide range of industrial and agricultural applications.

- Examples of its use are
  - the production of nitric acid and ammonium salts, particularly the sulfate, nitrate, carbonate, and chloride, and
  - the synthesis of hundreds of organic compounds including many drugs, plastics, and dyes.
Introduction

- Its dilute aqueous solution finds use as a household cleansing agent.
- Anhydrous ammonia and ammonium salts are used as fertilizers, and
  - anhydrous ammonia also serves as a refrigerant, because of its high heat of vaporization and relative ease of liquefaction.
Introduction

- The physical properties of ammonia are analogous to those of water and hydrogen fluoride
- in that the physical constants are abnormal with respect to those of the binary hydrogen compounds of the other members of the respective periodic families.
Introduction

- These abnormalities may be related to the association of molecules through intermolecular hydrogen bonding.

- Ammonia is highly mobile in the liquid state and has a high thermal coefficient of expansion.
Introduction

Most of the chemical reactions of ammonia may be classified under three chief groups:

1. addition reactions, commonly called ammonation;
2. substitution reactions, commonly called ammonolysis; and
3. oxidation-reduction reactions.
**Introduction**

- Ammonation reactions include those in which ammonia molecules add to other molecules or ions.
- Most familiar of the ammonation reactions is the reaction with water to form ammonium hydroxide.
- The strong tendency of water and ammonia to combine is evidenced by the very high solubility of ammonia in water.
Introduction

- Ammonia reacts readily with strong acids to form ammonium salts.
- Ammonium salts of weak acids in the solid state dissociate readily into ammonia and the free acid.
Introduction

- Ammonation occurs with a variety of molecules capable of acting as electron acceptors (Lewis acids), such as sulfur trioxide, sulfur dioxide, silicon tetrafluoride, and boron trifluoride.

- Included among ammonation reactions is the formation of complexes (called ammines) with many metal ions, particularly transition metal ions.
Introduction

Ammonolytic reactions include reactions of ammonia in which an amide group (NH$_2$), an imide group (\(=\text{NH}\)), or a nitride group (\(=\text{N}\)) replaces one or more atoms or groups in the reacting molecule.
Introduction

- Oxidation-reduction reactions may be subdivided into those which involve a change in the oxidation state of the nitrogen atom and those in which elemental hydrogen is liberated.
- An example of the first group is the catalytic oxidation of ammonia in air to form nitric oxide.
- In the absence of a catalyst, ammonia burns in oxygen to yield nitrogen.
- Another example is the reduction with ammonia of hot metal oxides such as cupric oxide.
Introduction

- The physical and chemical properties of liquid ammonia make it appropriate for use as a solvent in certain types of chemical reactions.

- The solvent properties of liquid ammonia are, in many ways, qualitatively intermediate between those of water and of ethyl alcohol.
Introduction

- This is particularly true with respect to dielectric constant; therefore, ammonia is generally superior to ethyl alcohol as a solvent for ionic substances but is inferior to water in this respect.

- On the other hand, ammonia is generally a better solvent for covalent substances than is water.
The Haber-Bosch synthesis is the major source of industrial ammonia.

In a typical process, water gas (CO, H₂, CO₂) mixed with nitrogen is passed through a scrubber cooler to remove dust and undecomposed material.

The CO₂ and CO are removed by a CO₂ purifier and ammoniacal cuprous solution, respectively.

The remaining H₂ and N₂ gases are passed over a catalyst at high pressures (up to 1000 atm or 100 megapascals) and high temperatures (approx. 1300°F or 700°C).
Introduction

- Other industrial sources of ammonia include its formation as a by-product of the destructive distillation of coal, and its synthesis through the cyanamide process.

- In the laboratory, ammonia is usually formed by its displacement from ammonium salts (either dry or in solution) by strong bases. Another source is the hydrolysis of metal nitrides.
Introduction

- Ammonia solutions are used
  - to clean,
  - bleach, and deodorize;
  - to etch aluminum;
  - to saponify (hydolyze) oils and fats; and
  - in chemical manufacture.
Introduction

- The ammonia sold for household use is a dilute water solution of ammonia in which ammonium hydroxide is the active cleansing agent.

- It should be used with caution since it can attack the skin and eyes.

- The vapors are especially irritating—prolonged exposure and inhalation cause serious injury and may be fatal.
Introduction

- Water solutions of ammonia are also called ammonium hydrate, aqua ammonia, or ammonia water;
- the solution may contain up to 30% ammonium hydroxide by weight at room temperature and pressure.
Introduction

- The major use of ammonia and its compounds is as fertilizers.
- Ammonia is also used in large amounts
  - in the Ostwald process for the synthesis of nitric acid;
  - in the Solvay process for the synthesis of sodium carbonate;
  - in the synthesis of numerous organic compounds used as dyes, drugs, and in plastics; and
  - in various metallurgical processes.
Introduction

- Ammonia (NH3) mempunyai banyak manfaat,
  - sebagian besar ammonia digunakan sebagai bahan baku pupuk
  - sedangkan sisanya digunakan untuk produksi asam nitrit,
  - sebagai indikator universal,
  - refrigerant,
  - bahan bakar roket,
  - desinfektan, serta sebagai zat tambahan pada rokok.
Introduction

- Ammonia ditemukan dalam jumlah kecil di atmosfer, dihasilkan dari penguraian nitrogen dari sisa-sisa tumbuhan dan hewan,
  - ammonia dan garam ammonium juga sedikit ditemukan pada air hujan,
  - ammonium klorida dan ammonium sulfat banyak ditemukan pada daerah sekitar gunung berapi,
  - kristal ammonium bikarbonat ditemukan pada kotoran burung didaerah pentagonia.

- Zat yang mengandung ammonia atau senyawanya biasa disebut ammoniacal
Introduction

- Sejarah ammonia dimulai pada abad ke-13 ketika seorang ahli kimia bernama Albertus Magnus mengemukakan ammonia dalam bentuk sal-ammoniac.
- Pada abad ke-15 Basilius Valentinus mengemukakan bahwa ammonia dapat diperoleh dari proses alkali pada sal-ammoniac,
  - pada periode selanjutnya sal-ammoniac dapat diperoleh dari distillasi kuku dan tanduk sapi.
Introduction

- Ammonia dalam bentuk gas pertama kali diisolasi oleh Joseph Priestley pada tahun 1774.

- Proses Haber yang merupakan proses untuk memproduksi ammonia dari nitrogen yang terkandung di dalam udara dikembangkan oleh Fritz Haber dan Carl Bosch pada tahun 1909 dan dipatenkan pada tahun 1910.

- Proses ini pertama kali digunakan pada skala industri pada saat perang dunia I ketika jerman tidak dapat memperoleh nitrat dari chile karena embargo.
Introduction

- Pada tahun 2004 produksi ammonia 109 juta meter kubik ton,
  - RRC merupakan penghasil terbesar dengan presentase 28,4% dari total produksi dunia,
  - diikuti oleh india sebesar 8,6%,
  - sisanya Rusia (8,4%) dan Amerika (8,2%).
Introduction

- Sekitar 80% ammonia digunakan sebagai bahan untuk pembuatan pupuk.
- Sebelum perang dunia I ammonia kebanyakan diperoleh dari distilasi kering sayuran dan kotoran hewan yang banyak mengandung nitrogen misalnya kotoran unta,
  - ammonia juga dihasilkan dari distilasi batubara dan juga dekomposisi garam ammonium oleh alkaline hydroxides.
Introduction

- Produksi ammonia secara modern berbahan baku
  - gas alam (metana),
  - Liquified Petroleum Gas (propana and butana).
Beberapa perusahaan yang bergerak dalam desain pabrik untuk sintesis ammonia antara lain,

- **Haldor Topsoe (Denmark)**,
- **Lurgi AG (Germany)**,
- **Uhde (Germany)**, dan
- **Kellogg, Brown and Root (the United States)**
Pada tahun 1968,
- 89% amonia yang diproduksi di Amerika serikat digunakan untuk industri pupuk,
- sedang sisanya digunakan untuk produksi bahan kimia organik maupun anorganik, seperti bahan peledak dan acrylonitril.
Proses Pembuatan

- Metode katalitik steam reforming ini digunakan untuk membentuk amoniak anhidrat yang diproduksi dengan mereaksikan gas Hydrogen (H₂) dan Nitrogen (N₂) dengan rasio H₂/N₂ sejumlah 3 : 1.
Proses Pembuatan

Disamping dua komponen tersebut campuran juga berisi inlet dan gas-gas yang dibatasi kandungannya, seperti

- Argon (Ar) dan
- Methan (CH₄)

dimana gas yang terbentuk dikompres dan didinginkan sampai pada temperatur -27 °F.
Proses Pembuatan

- Gas Nitrogen ini diperoleh dari udara dan gas Hidrogen diperoleh dari proses katalitik steam reforming gas alam (Metana) ataupun dari Nafta.
Proses Pembuatan

Figure 8.3.1. General flow diagram of a typical ammonia plant. (Source: Classification Codes in parentheses.)

101.7 pm

107.8°
Dengan metode katalitik steam reforming ada enam langkah dalam tahapannya yaitu

1. natural gas desulfurization,
2. catalytic steam reforming,
3. carbon monoxide (CO) shift,
4. carbon dioxide (CO2) removal,
5. methanation, dan
6. ammonia synthesis.
Proses Pembuatan

- Pada tahap 1, 3, 4, 5 berguna untuk menghilangkan pengotor seperti Sulfur, Air, CO dari hydrogen.

- Sedangkan tahap dua adalah pembentukan hidrogen dan nitrogen dari udara hadir dan akhirnya pada langkah terakhir merupakan pembentukan amonia anhydrat dari gas sintetik
Proses ini bertujuan untuk menghilangkan kadar Sulfur sebagai pengotor

- yaitu gas Hidrogen Sulfida
- yang harus diturunkan sampai dibawah 280 micrograms per cubic meter (µg/m3) (122 grams per cubic feet)
- untuk mencegah meracuni katalis yang digunakan dalam (Nikel),
- proses desulfurisasi ini bisa dijalankan dengan menggunakan karbon aktif atau Zinc Oksida.
Hidrokarbon berat dapat mengurangi keefektifan activated carbon bed, sehingga karbon bed ini juga memiliki kerugian tdk dapat memindahkan Karbonil Sulfida,

untuk proses regenerasi karbon dilakukan dengan mengalirkan uap superheated dalam karbon bed,
Catalytic Steam Reforming

- Gas alam tadi yang telah meninggalkan desulfurization tank
  - dicampur dengan proses steam
  - dan dipanaskan sampai pada 540°C (1004°F),
  - lalu campuran steam dan gas masuk dalam primary reformer.
Disini 70 % Metana dikonversi menjadi Hidrogen dan CO$_2$ serta ada sebagian yang terkonversi menjadi CO,

gas dari sini akan menuju secondary reformer yang tercampur udara terkompresi dengan suhu 540°C (1004°F),

akhirnya gas yang meninggalkan secondary reformer ini didinginkan sampai 360°C (680°F).
Carbon Monoxide Shift

Sesudah proses pendinginan tadi gas keluaran secondary reformer masuk dalam CO shift converter yang bersuhu tinggi yang terisi kromium oksida sebagai inisiator dan katalis Besi Oksida yang reaksinya:

\[ \text{CO} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{H}_2 \]
Gas keluaran lalu didinginkan dalam heat exchanger,

- gas keluaran akhir dari shift converter yang bersuhu rendah yang terisi dengan Copper Oksida sebagai katalis didinginkan dari 210 - 110°C (410 - 230°F)

- lalu masuk ke dalam sistem absorbsi Karbondioksida.
Carbon Monoxide Shift

- Disini steam yang tak bereaksi akan terkondensasi dan terpisah dari gas di knockout drum yang mengandung ammonium carbonate ([\((\text{NH}_4)_2\text{CO}_3 \cdot \text{H}_2\text{O}\)](\text{shift converter})) pada suhu tinggi.

- Akhirnya proses kondensat dikirim ke stripper untuk memindahkan gas volatil seperti amonia, metanol, dan karbondioksida.
Pada langkah ini Karbondioksida dari final shift gas dipindahkan

proses pemindahannya digunakan dua metode

yaitu monoethanolamine \((C_2H_4NH_2OH)\) scrubbing dan

hot potassium scrubbing

umumnya sekitar 80 % pabrik amonia menggunakan MEA (monoethanolamine) untuk membantu membuang \(CO_2\).
Gas CO2 dengan kadar 98,5 % dapat dibuang ke udara atau digunakan sebagai bahan baku kimia dalam industri lainnya.

MEA tadi yang telah diregenerasi dipompa kembali ke menara absorber setelah didinginkan dalam heat exchanger dan larutan pendingin.
Sisa atau residu dari karbondioksida pada proses sintesis gas dihilangkan dengan katalitik metanasi yang dilakukan dengan katalis Nikel pada suhu 400 - 600°C (752 - 1112°F) dan tekanan dinaikkan sampai 3000 kPal (435 psia) berdasarkan reaksi:

- \( \text{CO} + 3\text{H}_2 \rightarrow \text{CH}_4 + \text{H}_2\text{O} \)
- \( \text{CO}_2 + \text{H}_2 \rightarrow \text{CO} + \text{H}_2\text{O} \)
- \( \text{CO}_2 + 4\text{H}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O} \)

Gas keluaran dari methanator yang memiliki rasio 3 : 1 antara Hidrogen dan Nitrogen lalu didinginkan sampai pada 38°C (100°F).
Pada tahap akhir yaitu tahap sintesis,
- proses sintesis gas dari methanator dikompres pada tekanan 13,800 - 34,500 kPa (2000 - 5000 psia)
- dan dicampur dengan recycled synthesis gas untuk kemudian didinginkan sampai 0°C (32°F).
Ammonia Synthesis

- Amonia yang terkondensasi
  - akan dipisahkan dari unconverted synthesis gas pada separator berfasa cair-uap dan dikirim ke separator let down,
  - unconverted synthesis dikompres dan dipanaskan sampai 180°C (356°F) sebelum masuk sintesis konvertor yang mengandung katalis Besi Oksida.
Ammonia Synthesis

- Amonia dari gas keluaran dikondensasi dan dipisahkan lalu dikirim ke separator let down, produk gas atas dibersihkan untuk mencegah pembentukan gas inert seperti argon dalam sistem sirkulasi gas.
Ammonia Synthesis

- Amonia pada separator let down diflash pada kondisi 100 kPa (14.5 psia) dengan suhu -33°C (-27°F) untuk menghilangkan pengotor pada cairan.

- Uap flash yang terbentuk lalu dikondensasi pada let-down chiller dimana amonia anhidrat sebagai produk akhir yang terbentuk akan disimpan pada suhu yang rendah.
Bahan Baku Produksi Amonia

- Material bahan baku yang berperan penting dalam produksi ammonia pada tahun 1970an adalah gas alam dan nafta.

- Dalam beberapa industri masih digunakan minyak mentah ataupun batubara sebagai material bahan baku penyedia karbon yang akan mengikat hidrogen.
Bahan Baku Produksi Amonia

- Kandungan impuritis yang tinggi dan rasio hidrogen – karbon yang rendah, menyebabkan minyak mentah dan batubara kurang ekonomis dibandingkan dengan industri yang menggunakan gas alam ataupun nafta.
Bahan Baku Produksi Amonia

- Pada industri awal ammonia, hidrogen didapatkan sebagai byproduct coke-oven gas, dari elektrolisis air, dan gasifikasi arang.

- Penggunaan bahan baku ini menimbulkan biaya produksi tinggi, permasalahan lingkungan dan kandungan impuritis yang tinggi.

- Gas alam dan nafta jarang dipakai karena ketersediannya yang masih terbatas.
Bahan Baku Lain

- Gasifikasi arang
- Gasifikasi batubara
- Elektrolisis air
- Byproduct hidrogen dari produksi klorin.
- Kayu dan biomassa lainnya
Bahan Baku Produksi Amonia

- Impuritis pada bahan baku, merupakan salah satu tolak ukur pemilihan bahan baku tersebut.

- Oleh karena itu bahan baku yang paling disukai adalah gas alam, karena gas alam mengandung sedikit pengotor.
Bahan Baku Produksi Amonia

- Batubara yang berbentuk padatan banyak terkotori oleh zat lain, begitu juga minyak bumi termasuk nafta yang berwujud larutan yang sangat mungkin melarutkan pengotor yang tidak diinginkan.

- Gas alam yang dikirim umumnya sudah melalui proses pemurnian atau pelucutan impuritis sesuai dengan spesifikasi yang ditetapkan oleh industri ammonia.
Manfaat Ammonia

Produksi asam nitrit

Campuran antara ammonia dan udara dengan perbandingan 1:9 dilewatkan pada katalis platinum yang berbentuk seperti kain kasa pada 850° C, kemudian ammonia di oksidasi menjadi nitrit oksida.

\[ 4 \text{NH}_3 + 5 \text{O}_2 \rightarrow 4 \text{NO} + 6 \text{H}_2\text{O} \]
Manfaat Ammonia

Produksi asam nitrit

- Campuran gas tersebut didinginkan sampai suhu 200-250\(^\circ\)C,
- NO kemudian akan teroksidasi apabila oksigen yang digunakan berlebihan sehingga menghasilkan NO2.
- Selanjutnya NO2 bereaksi dengan air menghasilkan asam nitrat yang digunakan untuk produksi Pupuk dan bahan peledak
Indikator Universal

- Campuran ammonia juga dapat digunakan sebagai indikator universal untuk menguji gas yang berbeda-beda yang memerlukan indikator universal untuk mengetahui keberadaan gas tersebut.
Pupuk

Ammonia merupakan salah satu bahan utama dari pupuk, ammonia dapat langsung digunakan sebagai pupuk dengan mencampurkan ammonia tersebut dengan air tanpa adanya proses kimiawi tambahan.
Refrigeran

- Karakteristik termodinamika ammonia membuat ammonia banyak digunakan sebagai refrigerant sebelum ditemukannya dichlorodifluoromethane (Freon) pada tahun 1928.
Refrigeran

- Pada siklus absorpsi ammonia sebagai refrigerant rumah tangga tidak digunakan compressor dan expander, tetapi dikendalikan oleh perbedaan temperatur.

- Efisiensi energi pada pendingin yang menggunakan refrigerant relatif rendah.
Desinfektan

- Ammonia kadang-kadang ditambahkan pada air minum bersama dengan klorin menjadi *chloroamine* sebagai desinfektan.

- *Chloroamin* tidak bersenyawa dengan material organik yang berasal dari *carcinogenic halomethanes* misalnya *chloroform*
Bahan bakar

- Ammonia cair digunakan sebagai bahan bakar pada roket.
- Walaupun tidak sebaik bahan bakar yang lain, ammonia tidak meniggalkan sisa pada mesin roket dan juga mempunyai massa jenis yang sama dengan zat pengoksidasi, oksigen cair.
Pada tahun 1960, perusahaan rokok misalnya Brown & Williamson dan Philip Morris mulai menggunakan ammonia pada rokok.

Bahan aditif ammonia digunakan untuk menambah mempertinggi aliran nikotin menuju aliran darah, sehingga efek dari nikotin bertambah tanpa menambah kandungan nikotin dalam rokok.
Nitrogen is an essential ingredient in the growth process of plants and the only readily available source of nitrogen is from the air.

However nitrogen in air is virtually non-reactive.

Despite all attempts to develop other ways of fixing nitrogen from air the route via ammonia remains the only commercially proven technology.
The Market

- Ammonia, then, is the raw material from which various nitrogenous fertilizers are made.

- Ammonia itself can be applied directly to the soil as a fertilizer but its use in this way is rapidly declining in favor of solid and liquid applications.
The Market

- The production of fertilizers including
  - urea,
  - ammonium nitrate,
  - phosphate and
  - sulfate,

- amongst others, detailed in the diagram, consumes about 82% of all ammonia produced worldwide.
The Market

- Ammonia has a wide range of non-fertilizer uses in industry for
  - fibers,
  - pulp & paper,
  - pharmaceuticals,
  - mining,
  - explosives and
  - specialty chemicals.
The Market

- It is also suitable for refrigeration and cleaning purposes.
- The use of fertilizer, over the last 50 years, to replace soil nutrients depleted by the growing of agricultural products has enabled farmers the world over to roughly double the production of food with virtually no increase in the amount of arable land.
- Thus with the world population continuing to increase mankind has in fact become dependent on the use of fertilizer for their survival.
The Market

- World ammonia demand amounts to about 140 million tons per year.
  - Asia, inclusive of South Asia, South East Asia and China,
    - is the largest producer at about 40 to 50%
    - followed by North America and the Former Soviet Union.
  - Asia is essentially self-sufficient, whereas North America relies on imports.
The Market

- World ammonia demand amounts to about 140 million tons per year.
  - The USA has become the world’s largest importer of ammonia owing to
    - high gas prices in the USA and due
    - to the ready availability of competitively priced ammonia imported from countries with a low gas cost.
The Market

- World ammonia demand amounts to about 140 million tons per year.
  - Worldwide, ammonia consumption and capacity are forecast to steadily increase into the next decade.
  - Global demand is predicted to rise by about 2% per year for at least the next fifteen years.
  - A consumption growth rate of 2% per year is forecast for the USA and Asia compared with 1% per year for Eastern Europe.
The Market

- World ammonia demand amounts to about 140 million tons per year.
- The Middle East and North Africa are now the fastest growing regions in the world in terms of fertilizer production.
- Production capacity in this region is expected to double over the next 10 years.
Investment and Production Cost

- Restructuring of the market is needed and will occur,
- which means closing of inefficient plants and
- withdrawal of companies declaring fertilizer production a non-core business.
This is directly affected by the price of natural gas,
as even in low-cost natural gas regions, the gas cost may account for 80% or more of the ammonia production cost.
As a proportion of ammonia produced, the amount traded internationally is less than 12%.

Ammonia is costly to ship, and therefore most ammonia is converted to fertilizers and other industrial products where it is produced.
Investment and Production Cost

- Today’s ammonia plant owners focus on improvement of profit margins.
- Due to the extreme capital budget limitations in this business, cost effective solutions must be found for revamps and new plants.
Investment and Production Cost

- The fields considered are always similar:
  - Increase of capacity gaining the economy of scale benefit,
  - Reduction of energy consumption,
  - Maximizing on-stream factors.
Investment and Production Cost

- The differences of investment cost between MEGAMMO-NIA® and conventional technologies are illustrated by the following comparison.
The figures for plants in Trinidad were taken from a report recently compiled by British Sulphur.

The two plants are of the most recent ammonia technology with precious metal-based, high activity ammonia synthesis catalyst.

As such these plants are regarded as the "best available technology" (BAT).
The new energy-efficient and cost-effective design of MEGAMMONIA® is mainly based on:

- Single train design for ultra-large capacities, i.e. economy of scale effects,
- Most suitable synthesis gas generation and gas purification,
- Ideal combination of synthesis reactors and catalysts,
- Reliable and safe operation.
Therefore, investment cost savings of about 20% can be achieved compared with conventional modern plants.

The comparison of relative cash costs between MEGAMMONIA® and a representative range of Trinidad producers also demonstrates the superiority of MEGAMMONIA®.
Relative cash cost (pro t NH$_3$)

- Trinidad highest cash cost: 100
- Trinidad lowest cash cost: 68
- MEGAMMONIA°: 60

Bond distances and angles:
- Nitrogen-Nitrogen distance: 101.7 pm
- Nitrogen-Hydrogen angle: 107.8°
The cash cost for MEGAMMONIA® is about 12% lower than the lowest cash cost.

Feedstock consumption depends on specific project conditions.
Investment and Production Cost

- An estimate of natural gas consumption results in about 28 million BTU per metric ton of ammonia given on a Low Heating Value (LHV) basis.
- This includes natural gas compression and energy demand for off-sites, utility and storage facilities.
Technology

- MEGAMMONIA is not a spelling mistake.
- It is the name Lurgi has registered for its new ammonia process.
- The name is intended for a single line ammonia process, which is capable of producing 1 million t/a ammonia or more.
In contrast the largest plants employing conventional technology are today in the range of 2,000 – 2,300 t/d, i.e. 2/3 to 3/4 of the above-mentioned capacity.

To understand the advantages of MEGAMMONIA® versus conventional technologies, the differences are illustrated by the process block flow diagrams.
Conventional Ammonia Process
Conventional Ammonia Process

The feedstock, natural gas for example, is desulfurized, mixed with steam and catalytically converted into reformed gas in the primary reformer.
In the secondary reformer, process air is fed to the gas mixture for further reforming and to introduce nitrogen into the process.
After the reforming section, the gas is processed by high and low temperature (HT & LT) CO shift conversion, carbon dioxide removal and subsequent methanation to yield the proper ammonia syngas composition.
Liquid ammonia is separated by condensation from the synthesis loop. The loop must be purged to control the accumulation of methane.
Hydrogen and nitrogen are recovered from the purge gases and recycled to the loop, whereas the remaining gases are used as fuel in the primary reformer.
The essential features of conventional ammonia technologies are:

- A steam reformer limits the pressure for synthesis gas generation to a maximum of about 40 bar,
- Nitrogen is introduced into the process gas stream well before it is actually needed, leading to larger equipment, such as the CO2 absorption column,
The essential features of conventional ammonia technologies are:

- Imperfect purification of ammonia synthesis gas, results in impurities which then accumulate in the ammonia synthesis loop and must be purged.
- The temperature rise in the methanator must be control-led and for this the lowest possible CO slip is necessary, achieved by using an LT shift.
Megammonia Process