Manufacturing Process of Urea by Snamprogetti

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Abstract— Urea is in many ways the most convenient form for fixed nitrogen. It has the highest nitrogen content available in solid fertilizer (46%). It is easy to produce as prills or granules and easily transported in bulk or bags with no explosive hazard. It leaves no salt residue after use on crops. It specific gravity 1.335,decomposes on boiling and in fairly soluble in water. The principle raw materials required for this purpose are NH3 and CO2.two reactions are involves in manufacture in urea. First, ammonium carbamate is formed under pressure by reaction between CO2 and NH3.

$CO2 + 2NH3 \rightarrow NH2COONH4$ $\Delta H=-37.4Kcal$

This highly exothermic reaction is followed by an endothermic decomposition of ammonium carbamate.

$NH2COONH4 \leftrightarrow NH2CONH2 + H2O$

Various processes are;

-Snampogetti ammonia stripping process.
-Steami carbon CO2 Stripping process
-Once through urea process
-Mitsui toatsu total recycle urea process.

Key words: Urea, Snamprogetti

I. INTRODUCTION

Urea is a organic chemical fertilizer which is use dto increase the fertility of soil. later it increase the yield of crop. Now a days this is used as a primary fertilizer , in india many fertilizer industries produces urea in bulk amount .by using fertilizer we can easily provide food supliment for population even using small lands. urea is manufactured by using ammonia and carbon dioxide as a raw material. Natural gas is used as feed stock.

II. PROPERTIES OF UREA

Urea is a white odorless hygroscopic solid. It is non-corrosive .

Chemical properties of urea

Mol. Wt	60.05
Re. Humidity	60%
Max. N_2	46.6%
Sp. Gr.	1.335
Heat of fusion	60cal/gr(endothermic)

III. USES OF UREA

- About 56% urea manufactured is used in solid fertilizer.
- About 30% of urea manufactured is used in liquid fertilizer
- Urea formaldehyde resins have large use as a plywood additives.
- Melamine – formaldehyde resins are used as dinnerware and for making extra hard surfaces.

IV. PROCESS TECHNOLOGY

There are several process used for the manufacture of urea, the underline principle for all process is same .The two main reaction involved are.

$CO_2+2NH_3 \leftrightarrow NH_2COONH_4$

$NH_2COONH_4 \leftrightarrow NH_2CONH_2+H_2O$

Undesirable side reaction taking place is:

$2NH_2CONH_2 \leftrightarrow NH_2CONHCONH_2+NH_3$

(Biuret)

Both 1st &2nd reactions are equilibrium reactions. The first reaction almost goes to completion at 185 to 190^0c and 180 to200atms. The second reaction (decomposition reaction) is slow and determines the rate of reaction.

$NH_2CONHCONH_2$, which must be kept low because it adversely affects the growths of some plants.

V. PROCESS IN GENERAL

ammonia and CO_2 are compressed separately and fed to the high pressure autoclave as which must be water cooled due to the highly exothermic nature of the reaction. A mixture of urea, ammonium carbamate, H_2O and unreacted (NH_3+CO_2) is produced.

This liquid effluent is let down to 27 atms and fed to a special flash evaporator containing a gas-liquid separator and condenser. Unreacted NH_3 , CO_2 AND H_2O ARE thus removed and recycled. An aqueous solution of carbamate urea is passed to the atmospheric flash drum where further decomposition of carbamate takes place. The off gases from this step can either be recycled or sent NH_3 processes for making chemical fertilizer.

VI. THE VARIABLES THAT AFFECT THE AUTOCLAVE REACTION

1) Temperature

Process temperature(185^oC) favours equilibirium yield at a given pressure (180 atm). The conversion of ammonium carbamate to urea gradually increase as temperature increases.

However, after a particular temperature, depending upon the pressure, the conversion suddenly drops with further increase in temperature. the pressure corresponding to this temperature which is usually in the range of 175-185^0C, is known as the decomposition pressure which is about 180 atm.

2) Pressure

The main reaction is sufficiently slow at atmospheric pressure.

However, it starts almost instantaneously at pressure of the order of 100 atm and temperature of 150^0C.there is reduction in volume in the overall reaction and so high pressure favours the forword reaction.

This pressure is selected according the temperature to be maintained and NH_3 :CO_2 ratio.

3) Biuret formation

A problem faced during manufacture of urea is the formation of biuret during the production of urea. It is not desirable substance because it adversely Affect the growth of some plants. Its content in urea should not be more than 1.5% by weight.

$2NH_2CONH_2 \leftrightarrow NH_2CONHCONH_2 + NH_3$

VII. MAJOR ENGINEERING PROBLEMS

1) Carbamate decomposition and recycle :

There many processes that can be used for the manufacture of urea. Main difference in competing processes is in the recycle design. Since, conversion is only 40-50% per pass. The unreacted off gases must be recirculated or used economically elsewhere. Recompression of off gases is virtually impossible because of corrosion and formation of solid carbamate in compressors.

2) Production of granular urea :

Biuret formation is another problem. Vacuum evaporator of urea from 80% to about 99%, spraying to air cool and solidification must be done just above the melting point of urea and with a minimum residence time in the range of several seconds.

3) Corrosion:

This has been the major reason why the ammonia and CO_2 process was slow to develop. High cost silver or tantalum liners are used in the autoclave with hastealloy C, titanium, stainless steel, aluminium alloys used in other parts of the plant. Minimum pressure and temperature conditions with excess NH_3 are desirable to reduce the severe corrosion rates. Under these condition , stainless steel can be used in the autoclave.

VIII. VARIOUS PROCESSES FOR THE MANUFACTURING OF UREA

the urea synthesis reactor always contains unreacted carbamate and more or less excess ammonia, depending upon the composition of the feeds. This poses the problem of separating the unreacted material from the urea solution and of reutilizing this unreacted material. Depending upon the method of reutilization of the unreacted material, the commercial urea synthesis processes are devided into the following main catagories:

IX. INTERNAL CARBAMATE RECYCLE UREA PROCESS:

the unreacted carbamate and the excess ammonia are stripped from the urea synthesis reactor effluent by means of gaseous hot CO_2 or NH_3 at the reactor pressure, instead of letting the reactor effluent down to a much lower pressure.

The NH_3 and carbondioxide gas, thus recovered at reactor pressure, is condensed and returned to the reactor by gravity flow for recovery.

A. Snamprogatti (italy)

This process is based on the principle of the internal carbamate recycle technique and is commonly called the snam ammonia stripping process. The basic difference between the snam process and the conventional carbamate solution recycle urea processes is the fact that in this case the unconverted carbamate is stripped and recovered from the urea synthesis reactor effluent solution at reactor stripped and recovered from the urea synthesis reactor effluent. Solution at reactor pressure, condensed to an aqeuous solution in a steam producing high pressure condenser,& recycle back to the reactor by gravity. Part of the liquid NH_3 reactor feed, vaporized in a steam heated exchanger, is used as inert gas to decompose & strip ammonium carbamate in the steam heated high pressure stripper.

The reactor operates at about 130 atm & 189-190^{0}C. the stripper operates at about 130 atm & 190^{o}C. the stripper off-gas is condensed in a vertical shell and tube condenser, operating at about 130 atm & 148-160^{0}C. low pressure steam is produced in the high pressure carbamate condenser. The urea product solution, produced leaving the stripped & still containing 2-3% of residual unreacted carbamate , is further degassed in a low pressure decomposition-absorption system. The recovered ammoniacal solution of ammonium carbamate is pumped back to the reactor.

The novelty of the stripping process consist of the fact that the reactor effluent is not let down to a lower pressure as in the conventional liquid recycle urea process.

X. RESULT AND DISCUSSION

The selected capacity of the plant is 450000 tons/year based on 300 working days. The product from the prilling tower contains 98% of urea .critical review of all the manufacturing process has been presented .

Snamprogetti process has been for the project the snamprogetti ammonia- stripping urea process involves a high NH_3 to CO_2 ratio in reactor, ensuring the high conversion of carbamate to urea. The highly efficient ammonia stripping operation restrictly reduces the recycling of carbamate and the size of equipment the carbamate decomposition. snamprogetti technology differs from comptitiors in being based on the use of excess ammonia to avoid corrosion as well as the promote the decomposition of unconverted carbamate urea.

Material and energy balance for each for the equipment has been done. The reactor is designed and its volume is found to be 195 m^3. The length and diameter of the reactor has been found to be 40 m and 2.5 m respectively. The L/D ratio of the reactor is found to be 16, which is consistent with the actual plant data. The L/D ratio of the urea reactor according to the actual plant data lies between 14-20.

Climbing-film , long tube vertical evaporator is used for the concentration of urea. The length of the heat exchanger is found to be 6 m. the diameter and height of the separator is 1 m and 4 m respectively.

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