Effluent Treatment and Biohydrolyser for Ammonia and Urea Plant waste streams

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Introduction

National Fertilizers Limited, a Government of India Undertaking, formed in the year 1974, has recently completed more than 40 years of service of farming community by supplying quality fertilizer. NFL has four Units located at Nangal and Bathinda (Punjab), Panipat (Haryana) and Vijaipur (Madhya Pradesh) with its Corporate Office at Noida.

Environment policy of NFL has been formulated for conservation and up gradation of environment. NFL is committed to achieve pollution free environment and balanced ecology by adopting Environment Management System (EMS).

VIJAIPUR UNIT

The Vijaipur Unit of NFL is the first gas based plant on HBJ (Hazira-Bijapur-Jagadishpur) gas pipeline. Commercial production of Line-I group of plants was declared in July 1988 and that of Line-II in March 1997. Line-I Ammonia capacity 1750 MTPD and line-II Ammonia is 1864 MTPD. Two streams of Urea of 3030 & 3231 MTPD capacity. Thus the overall urea capacity is 6261 MTPD. Both the Ammonia Plants are based on the steam reforming of natural gas and naphtha with technology supplied by Haldor Topsoe A/S Denmark. Whereas feedstock for Line-I Plant is natural gas, the Line-II plants have been designed to process natural gas and naphtha to a maximum limit of 50% as feedstock. Urea plants are based on the well-known total recycle ammonia stripping process of M/s. Saipem, Italy.

In the design itself necessary systems were provided to have negligible impact on environment. An effluent treatment Plant has been designed to cater the treatment needs of effluent generated from various sections of the Unit. In addition, adequate provisions have been made in each Plant to ensure maximum recycle of process condensate with minimum generation of effluent. A separate effluent monitoring cell has been set up to keep round the clock vigilance on effluent quality to ensure that the discharges are much lower than that specified by State Pollution Control Board.

This paper illustrate a successful attempt in implementation of 300 m3 per day capacity urea waste stream (containing 200-900 ppm Urea.) treatment plant at NFL Vijaipur with special emphasis on selection of Bacteria developed in Indian Agriculture Research Institute Pusa, New Delhi (India), keeping in view low investment and operating cost and effective treatment system.

BIOLOGICAL PROCESS FOR POLLUTION CONTROL SUCCESSFULLY COMMISSIONED

National fertilizers limited, Vijaipur has developed and commercialized a unique and efficient process in 2003 for control of pollution in the urea plant discharge from the fertilizers plant. The process known as Biohydrolizer process. Urea is waste product generated in urea plant. Some bacteria (like Hafnia Alvie 1426) split the urea molecule into carbon dioxide and ammonia.

The recently in the NFL Vijaipur Biohydrolizer commissioned. It is the 1st of its kind installed in the country and is very simple. The mixed cutler of urea hydrolyser micro-organism HAFNIA ALVIE-1426 BACTERIA has been developed in laboratory under established parameters maintained in liquid medium. The bioculter is highly resistant even to as high concentration of urea as 20000 ppm present in effluent. It can be hydrolyzed 99% urea in to Nitrogen in 4 to 5 hours.

NH_2CONH_2 + Bacteria Hafnia Alvie 1426 + H_2O = CO_2 + 2 NH_3

Urea effluent from urea plant line-I & II	: 200-900 ppm urea.
Name of Bacteria	:"HAFNIA ALVIE 1426"*
Residence time	: 4 - 5 hrs.
PH range	: 6.5 to 9.5
Temperature range	: 10 – 50 °C, suitable 36 °C

Note *: Bacteria developed in Indian Agriculture Research Institute Pusa, New Delhi (India)

The urea waste stream from line-I & line-II plant is collected in concrete Buffer tank; the system comprises three concrete tanks in series having weir for increasing residence time. The ammonia is removed in air stripping tower and bottom waste stream is sent to urea hydrolyser through buffer tank. The waste feed in Biohydrolizer is subjected to 4-5 hrs residence time. The treated waste goes to cleaned pond B, if ammonia content is more than recycle to stripper.

Advantages of Biohydrolizer

1. No chemical required for urea waste stream
2. Low installation cost & no running cost
3. Low space required compared to conventional clarifier

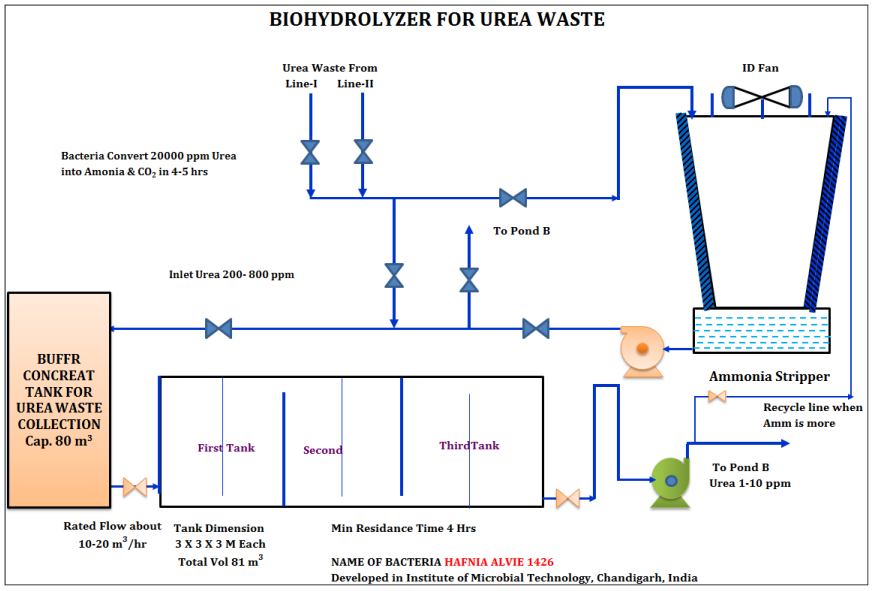

Fig. 1 Process Flow diagram of Urea Biohydrolizer

CHEMISTRY OF HEAVY METALS TREATMENT PROCESS

Introduction

The treatment of waste water stream generated from the synthesis of Ammonia and Urea consists of the following.

1. Cooling water blow down at the rate of 500 m^3/hr (four No Cooling Tower)
2. Neutralized waste stream from ammonia plant discharged intermittently for a period of 30 minutes. Total about in 24 hrs 100 m^3/day
3. Acid regeneration waste from DM plant is discharge intermittently at the rate of 50 m^3/hr.
4. Alkaline regeneration waste from DM plant is an intermittent discharge at the rate of 40 m^3/hr
5. Floor washing from Urea plant line-I and line-II plant is an intermittently discharge at the rate of 20 m^3/hr

The Chromate treatment and heavy metal precipitation plant consist essentially of chemical treatment for the removal of the following pollutant (however the Chromate treatment has been stopped due to cooling water treatment dosing changed):

1. Removal of hexavalent chromium after its reduction to the trivalent state with sodium metabisulphite at a PH range of 2.0 to 3.0 followed by chemical precipitation as chromium hydroxide $Cr(OH)_3$ with lime at an optimum PH
2. Removal of Silica from the Cooling Tower blow down by activated magnesia
3. Chemical precipitation of heavy metals like Arsenic, Copper, Chromium, Nickel, Zinc & Vanadium by Sodium sulphide under alkaline condition

Chemistry of the Treatment Processes

(A) Chromium Removal

Chemical Reaction
The chemical reaction for reduction of hexavalent chromium to trivalent state with sodium Meta bisulphite at a PH range of 2.0 to 3.0 takes place stoichiometric ally and is an instantaneous reaction according to the following equations.

$$4\ H_2CrO_4 + 3\ Ca(OH)_2 + 3\ H_2SO_4 = 2\ Cr_2(SO_4)_3 + 3\ Na_2SO_4 + 7\ H_2O$$

The Trivalent Chromium is removed as chromium hydroxide by precipitation it with lime at PH 8.5 to 9.0 as follows.

$$Cr_2(SO_4)_3 + 3\ Ca(OH)_2 = 2\ Cr(OH)_3 + 3\ CaSO_4$$

The solubility of chromium hydroxide is negligible and is of the order of $8.4X10^{-4}$ mg/lit at PH 9.0

(B) Removal of Heavy Metal from neutralized waste derived from Ammonia Plant

The heavy metals present in the neutralized waste water from ammonia plant will be removed by chemical precipitation with Sodium Sulphide

1. Vanadium: as Vanadium sulphide

$V^{2+} + Na_2S = VS + 2\ Na^+$

2. Arsenic: as Arsenic Sulphide

$2\ As^{3+} + 3\ Na_2S = As_2S_3 + 6\ Na^+$

3. Nickel: as Nickel Sulphide

$Ni^{2+} + Na_2S = NiS + 2\ Na^+$

Conclusions

A coordinated approach comprising of an effective utilization of available asset, development of Biohydrolizer regular laboratory analysis assisted by advanced continuous treatment. This exercise has proven reliability and sustainability of the system. The NFL exercise is valuable for new development at lower cost and no running cost and no chemical required for treatment. The main objective was to reduce urea content in treated water to less than 1 ppm so that it can be used as any service requirements.

In case you are interested in more information about the Biohydrolyzer, please contact UreaKnowHow.com, Mark Brouwer via mark.brouwer@UreaKnowHow.com