Production of Nitric Acid by Ammonia oxidation process

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A. Background

HNO_3 is mostly used for manufacturing Ammonium Nitrate, which is widely used in fertilizer industry. Some manufacturers in India are Dipak Fertilizer and Petrochemicals, Vijay Gas Industry, Chemtex Speciality Ltd. etc. In India, HNO_3 price is around 270 Rs/liter.

B. Description of Flowsheet

The air is compressed in compressor. About 3 atm pressure is achieved in compressor. Ammonia and compressed air are sent mixer. After mixer, composition is found, 90 % air and 10 % ammonia (For recycle, contents may largely very). Then this stream is superheated to 600 ^{0}C. Superheated stream goes into reactor. Reaction is exothermic. So, temperature reaches around 800 ^{0}C. Here, Air and Ammonia reacts and produces Nitric Oxide and water. The product stream then exchanges its heat in heat exchanger. Then, nitric oxide converted into nitrogen dioxide. Here, some Nitric Acid also formed. Again, product stream exchanges its heat with heat exchanger. Product stream goes into 3rd reactor and here we get most of the Nitric Oxide. Nitric Oxide absorbed in water using absorber. Here, unreacted products get separated. We get diluted HNO_3 from absorber. Lean HNO_3 stream recycled to fresh air stream. This stream contains higher content of air. From oxidation reaction, unreacted air is also recycled to main air stream.

C. Result

The capacity of production of HNO_3 is 37.51 ton/day. The reaction temperature is around 600-800 ^{0}C and pressure is 3 atm. 95 % conversion of Ammonia was taken from literature. Reactor outlet was sent to heat exchanger and then to reactors. After reaction, rich HNO_3 stream sent to absorber. Here, almost 60 % HNO_3 with 39 % water found. This matches with book data.

D.Conclusion and Recommendation

There is gape between product concentration and feed composition. Book recommends 90 % air and 10 % ammonia but if one want to achieve near around 55 to 60 % HNO_3 concentration, then 1.5 to 1.8 % ammonia and remaining air + recycle stream should be taken. If one somehow achieves 10 % ammonia, then in absorption tower, water flowrate should be very less. After some limit, water flowrate cannot be decrease.

One has to also to learn how can only be single reaction achieve in single reactor and also study that multiple reactions in single reactor is giving higher conversion or multiple reaction using single reaction – single reactor gives higher conversion. In DWSIM, it is problem comes with recycle because one cannot predict which component gets converted. Ex. If NO to NO_2 conversion takes place, then all mole percent will change, so HNO_3 mole percent will also change. Here, if recycle not taken into account, then one can predict.

E. Unit system and version

All units taken in SI system.

Molar flowrate: mol/s

Mass flowrate: kg/s

Volumetric flowrate: m^3/s

Temperature: K

Pressure: Pa