Ammonia production continued….

* **Steam reforming**
* **CH4+H2O->CO+3H2 Endothermic reaction**
* **CO+H2O<->CO2+H2 Exothermic reaction**
* **If carbon and sulphur are together eg CS2 we go for hydrotreating**
* **If we use naptha instead of natural gas, CO to H2 ratio will be different with more CO forming**
* **This sulphur removal is referred to as gas cleaning.**
* **Next is steam reforming**
* **At the end of primary reforming we have CO2, CO, H20, H2**
* **To prevent the formation of CO2 we keep the temperature as high as possible.**
* **In the secondary reformer, we have a combustion zone and reforming zone**
* **In combustion zone H2 is combusted to H2O**
* **The air that we supply depends on end products(required N2 to H2 ratio) and the temperature we want to achieve.**
* **At the end we are left with CO and H2 but CO can poison the N2 H2 reaction catalyst**
* **We use shift reaction to convert CO to CO2 since direct removal of CO is not feasible**
* **CO2 is removed and we are left with N2 and H2.**
* **Since few traces of CO and CO2 we use METHANATION**
* **CO+3H2<-> CH4+H2O**
* **Since Ammonia synthesis is exothermic and equilibrium limited reaction**
* **It requires multiple bed reactor**
* **But it is different from that of sulphur.**
* **In this reactor cold H2 and N2 are passed to the reactor at each bed so that temperature would come down**
* **Such reactors are called Quench Reactors**
* **One disadvantage of this reactor is that requirement of catalyst will go up**
* **But since we are introducing N2 and H2 at various stages that N2 and H2 will have only one bed worth of catalyst**
* **Improvements**
* **Natural gas as feedstock**
* **Initially syn-gas was produced at a lower pressure but from 1950’s syn-gas is produced at high pressure :- compression cost reduces**
* **Low temperature shift and methanation catalyst**
* **Improvement in compression equipment-> centrifugal compressor**

METHANOL

* Almost similar process for methanol i.e. requires high pressure
* CO+2H2 (syngas) <-> CH3OH exothermic
* CO2+3H2<->CH3OH+H2O exothermic
* On subtracting these two we get shift reaction
* We want our catalyst to be highly selectivity for methanol to get rid of other side reaction
* Since we get 1:3 ratio CO H2 we can introduce CO2 for excess H2 produced
* First step is syn gas production (from steam reforming)
* Here also reactor is quench reactor
* After we separate three kinds of product
* Light components, methanol, heavier components
* Sulphur is a problem here too
* Since classical processes uses catalyst that do not work properly at low temperatures modern process uses alternative catalyst like Copper
* But copper is affected by impurities like sulphur
* But now a day’s sulphur free syn gases are used which allow us to use cu based catalyst
* It shifted classical process to modern process
* Now we have a three phase reactor
* Here the catalyst is suspended in an inert liquid
* Heat removal is efficient
* It prevents runaway reactions (when heat removal is not efficient)