SUMMER – 2022 EXAMINATION

Subject Name: Fertiliser Technology **Model Answer** **Subject Code:** 22615

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1	a	**Nutrients available form Fertilizer** • Nitrogen • Phosphorous • Potassium (Above are three mail nutrients. Apart from these following micronutrients are available from mixed fertilizers) • Calcium • Sulfur • Boron • Iron	1 mark each for any 2
	b	**Public Sector Fertilizer Companies** • FCI Aravali Gypsum & Minerals India Limited (FAGMIL) • Brahmaputra Valley Fertilizer Corporation Limited (BVFCL) • The Fertilizer Corporation of India Limited (FCIL)	½ mark each for any 4

		• Project & Development India Limited (PDIL) • Hindustan Fertilizer Corporation Limited (HFCL) • Rashtriya Chemicals and Fertilizers Limited (RCF) • National Fertilizers Limited (NFL) • The Fertilizers and Chemicals Travancore Limited (FACT) • Madras Fertilizers Limited	
	c	**Industrial applications of Ammonia** For the production of • Urea • Nitric Acid • Ammonium nitrate • Ammonium phosphate • Hydrazine • As a refrigerant	½ mark each for any 4
	d	Availability of P2O5 in triple superphosphate is approximately **43 to 46%**	2 marks
	e	**Raw material used for the manufacturing of triple superphosphate** • Phosphoric Aid • Phosphate Rock	2 marks
	f	**Terms used in NPK** N- Nitrogen P- Phosphorus K- Potassium	2 marks
	g	**Feedstock for biofertilizer** • Agri Waste • Food waste • Garden Waste • Livestock manure (Cattle, Pig, Poultry) • Sewage Sludge	1 mark each for any 2

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2	a	**Importance of micronutrients** Micronutrients are essential elements that are used by plants in small quantities. Yield and quality of agricultural products increased with micronutrients application, therefore human and animal health is protected with feed of enrichment plant materials. Each essential element only when can perform its role in plant nutrition properly that other necessary elements are available in balanced ratios for plant. Micronutrients play a supporting role in overall plant health and development. Micronutrients promote essential plant processes and growth, which translates into nutrient-rich food for animals and humans. Micronutrients include boron, chlorine, copper, iron, manganese, molybdenum, and zinc, which are often in short supply for growing crops. Importance of these micronutrients are s follows **Boron:** This important nutrient ensures healthy cell growth and assists in the formation of pollen. A lack of boron may also stunt plant growth. **Chlorine:** Used primarily in small grains like wheat, chlorine helps plants manage water stress and resist fungal diseases. **Copper:** Copper plays an essential role as a catalyst, promoting chemical reactions without becoming a product of those reactions. It also assists in the formation of protein pigments in red blood cells, making it a key micronutrient for animals and humans. **Iron:** This nutrient works as a catalyst in the formation of chlorophyll and promotes root function in legumes such as peanuts and beans. **Manganese:** Another chlorophyll catalyst, manganese also helps regulate several plant enzymes. Ensuring plants have enough manganese translates into manganese-rich food for humans. **Molybdenum:** This nutrient helps plants use nitrogen and phosphorus (two of the "Big 3" nutrients) more efficiently and gives farmers greater yields and more return on their investment in fertilizer. **Zinc:** This vital nutrient plays key roles in human health as well as plant health. It helps plants form proteins, starches and growth hormones, which helps people grow healthy skin and bones. If we use introduce these micronutrients into soil, it will increase its fertility.	4 marks

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	b	**Importance of Fertiliser industry in green revolution** Food security has been and will continue to be one of the major challenges confronting the world, including India, as the country faces the challenge and pressure to feed more than 1 billion people today. Chemical Fertilisers have played a major role in improving crop yields and increasing agricultural production. After independence India was importer of grains. Traditional framing methods could not yield sufficient crop production. The Green Revolution, or the Third Agricultural Revolution is the set of research technology transfer initiatives occurring between 1950 and the late 1960s, that increased agricultural production in parts of the world, beginning most markedly in the late 1960s.The initiatives resulted in the adoption of new technologies, including high-yielding varieties (HYVs) of cereals, especially dwarf wheat and rice. It was associated with chemical fertilizers, agrochemicals, and controlled water-supply (usually involving irrigation) and newer methods of cultivation, including mechanization. Fertilizers enhance the growth of plants. This goal is met in two ways, the traditional one being additives that provide nutrients. The second mode by which some fertilizers act is to enhance the effectiveness of the soil by modifying its water retention and aeration. Fertilizers typically provide, in varying proportions. As a result, yield of crop production increased. Fertilizer industry played key role in providing massive amount of various fertilizers during green revolution	4 marks
	c	**Feedstock for Nitrogenous Fertilizer** Basic raw material is Ammonia Gases feedstock: Natural gas, Refinery gas, Coke Oven gas Solid Feedstock: Coal, Coke, Lignite **Application of nitrogenous fertilizer** Urea: As a fertilizer, Source of Protein, to produce urea formaldehyde Ammonium Nitrate: As a fertilizer, As explosive Ammonium Phosphate: As a fertilizer, Used as components of intumescent paints	2 marks 2 marks
	d	**Applications of plant nutrients** **Nitrogen**	1 mark each for any 4

Nitrogen is a key element in plant growth. It is found in all plant cells, in plant proteins and hormones, and in chlorophyll.

Phosphorus

Phosphorus helps transfer energy from sunlight to plants, stimulates early root and plant growth, and hastens maturity.

Potassium

Potassium increases vigour and disease resistance of plants, helps form and move starches, sugars and oils in plants, and can improve fruit quality.

Calcium

Calcium is essential for root health, growth of new roots and root hairs, and the development of leaves.

Magnesium

Magnesium is a key component of chlorophyll, the green colouring material of plants, and is vital for photosynthesis (the conversion of the sun's energy to food for the plant). Deficiencies occur mainly on sandy acid soils in high rainfall areas, especially if used for intensive horticulture or dairying.

Sulfur

Sulfur is a constituent of amino acids in plant proteins and is involved in energy-producing processes in plants. It is responsible for many flavour and odour compounds in plants such as the aroma of onions and cabbage.

Boron

This important nutrient ensures healthy cell growth and assists in the formation of pollen. A lack of boron may also stunt plant growth.

Chlorine

Used primarily in small grains like wheat, chlorine helps plants manage water stress and resist fungal diseases.

Copper

Copper plays an essential role as a catalyst, promoting chemical reactions without becoming a product of those reactions. It also assists in the formation of protein pigments in red blood cells, making it a key micronutrient for animals and humans.

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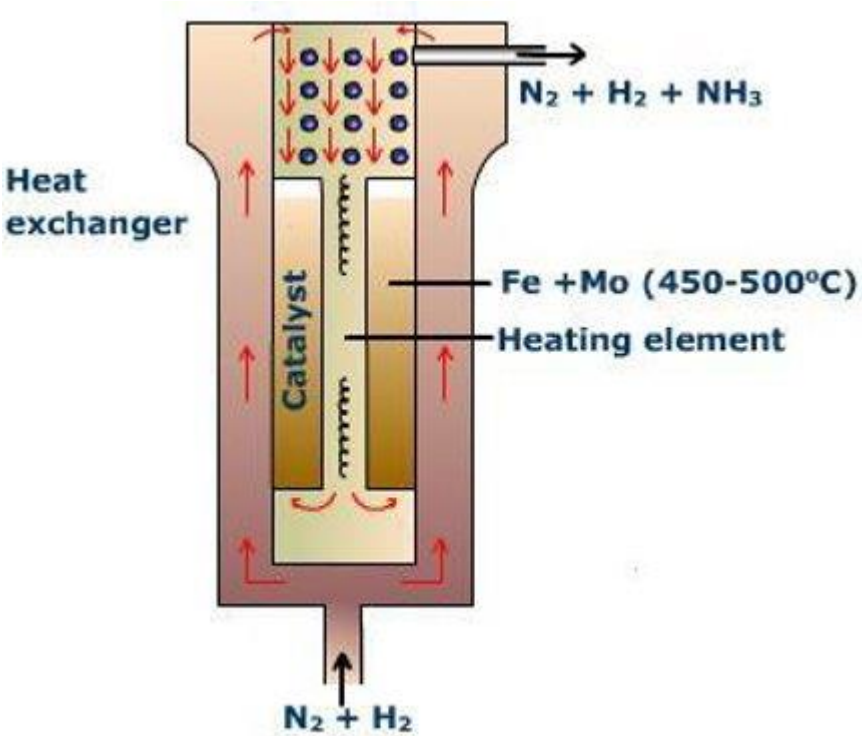
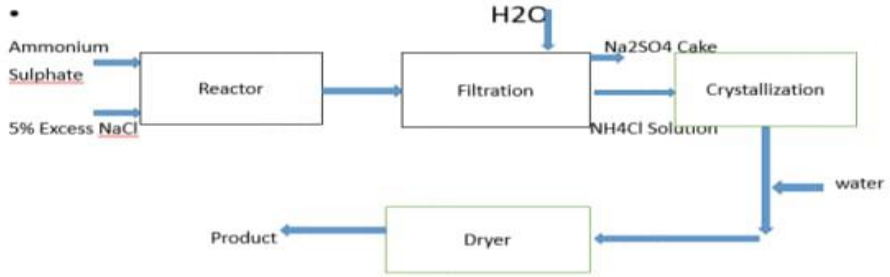
		Iron This nutrient works as a catalyst in the formation of chlorophyll and promotes root function in legumes such as peanuts and beans. Manganese: Another chlorophyll catalyst, manganese also helps regulate several plant enzymes. Ensuring plants have enough manganese translates into manganese-rich food for humans. **Molybdenum** This nutrient helps plants use nitrogen and phosphorus (two of the "Big 3" nutrients) more efficiently and gives farmers greater yields and more return on their investment in fertilizer. **Zinc** This vital nutrient plays key roles in human health as well as plant health. It helps plants form proteins, starches and growth hormones, which helps people grow healthy skin and bones.	
3	a	**Ammonia Converter**  	4 marks
	b	**Manufacturing of Ammonia Chloride** • Raw Material: Ammonium sulphate & NaCl • Reaction:	1 mark for reaction and 3 marks for descriptio

(NH4)2SO4 + 2NaCl → 2NH4Cl + Na2SO4

n



Process description

Ammonium sulphate & 5% excess sodium chloride solution are charged into reactor and agitated vigorously while heating. The product obtained is filtered & wash repeatedly to remove traces of ammonium chloride. The ammonium chloride solution is run into crystallization pan where it is cooled, it is crystallized out in lead line crystallizer. The crystalline ammonium chloride is washed with water to remove sulphate & dried to yield product of high purity. Properties: Molecular weight: 53.431 g/mol Density: 1.53 gm/cm3 Boiling point: 520 c Melting point: 338 c Uses: It is used as a fertilizer. It is used in medicine as a expectorant. It is used food additives. It is used as an acidifier. It is given to cattle as feed supplement

OR

The modified Solvey process is used for production of ammonium chloride. In this process, sea salt is first washed with saturated magnesium salts. The purified salt is then pulverized and mixed with ammonia. Ammoniated brine is reacted with carbon dioxide in a series of carbonation towers to form sodium bicarbonate and ammonium chloride.

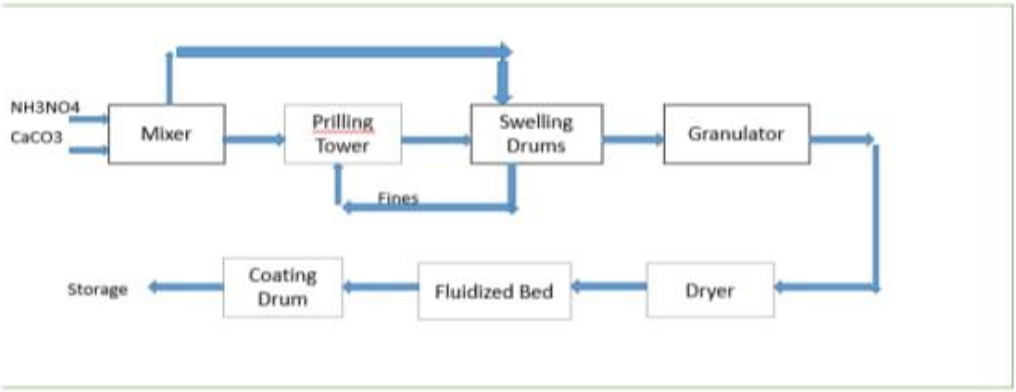
NaCl+NH2+CO2+H2O→NaHCO3+NH4Cl

Sodium bicarbonate crystals out and is separated by filtration while ammonium chloride remains in the filtrate. Ammonium chloride solution thus obtained is cooled to subzero temperature and pure sodium chloride salt is added for crystallization of ammonium chloride. Ammonium chloride crystals are separated by centrifugation and the brine is recirculated to the carbonation tower. The ammonium chloride crystals are dried in rotary driers to obtain the product.

	c	**Precautions (handling & Storage of ammonia)** Ammonia is almost invariably transported in a liquid state, therefore it must be compressed or refrigerated, semi refrigerated and a similar classification can be applied to transport equipment. Any ammonia containing container should be place in a cool, dry, temperature stable environment. They should kept out of direct sunlight. The storage area should be well ventilated & free of flammable materials Buildings used to hold ammonia containers and equipment should comply with all local building and fire codes. If the storage facility is to have any flammable materials inside then a fire wall must be built to segregate the two areas. Non-combustible building material is recommended and ammonia gas monitors should be installed in the facility. Ammonia gas is lighter than air so gas monitors should be mounted approximately two feet below the ceiling for quick and accurate detection. All facilities should be designed with at least two outward opening exits. Ventilation should be installed in accordance with local building codes. The facility should not have any heavy objects placed above the containers, nor should the containers be placed near elevators or other quick leak paths. Ammonia storage facilities should be maintained at 60-70 ˚F (15-20 ˚C) to facilitate safe and consistent discharge rates of ammonia. Never apply heat directly to a ammonia container as a malfunction could result in a large pressure build up leading to an explosion/leak. Take special care to avoid restrictive spaces in working areas	4 marks
	d	**Manufacturing of calcium ammonia nitrate** Calcium Ammonium Nitrate Molecular formula:- 5Ca(NO3)2.NH4NO3.10H2O It is preferred to use on acid soil. It is made by adding powdered lime stone to ammonium nitrate. In countries where ammonium nitrate is not allowed for application, CAN is substitute.	2 marks for diagram and 2 marks for description

Reaction:-

$2NH_4NO_3 + CaCO_3 \rightarrow Ca(NO_3)2.2NH_4NO_3$



Manufacturing Process:

CAN is produced by mixing concentrated ammonium nitrate solution with ground calcite or dolomite limestone, chalk or precipitated calcium carbonate from nitro phosphate production. The mixing should be done quickly to avoid decomposition of ammonium nitrate. Then the product is fed to prilling tower. The prilled CAN conditioned with china clay or calcined fullers earth in amount ranging from 1 to 3%. In the prill tower mean particle size is 2mm to 2.5mm. In prilling tower produces only seed prills from about 35% ammonium nitrate solution. The prills are directed to a swelling drum where rest ammonium nitrate & CaCO3 added to the ammonium nitrate solution. The fines are recycled. After that product is fed to granulation where granules form & then they are fed to dryer. The oversize product cooled in fluidized bed cooler with conditioned air. Before storage or bagging the product is coated.

4 a **Difference between single and triple super phosphate** — 2 marks each for 2 points

		Single Super Phosphate	**Triple super phosphate**
1	Definition	Single Super Phosphate is a mineral fertilizer containing relatively a low percentage of phosphorus	Triple super phosphate is a mineral fertilizer containing relatively a high amount of phosphorus
2	Denotation	SSP	TSP
3	Phosphorus content	LOW	HIGH

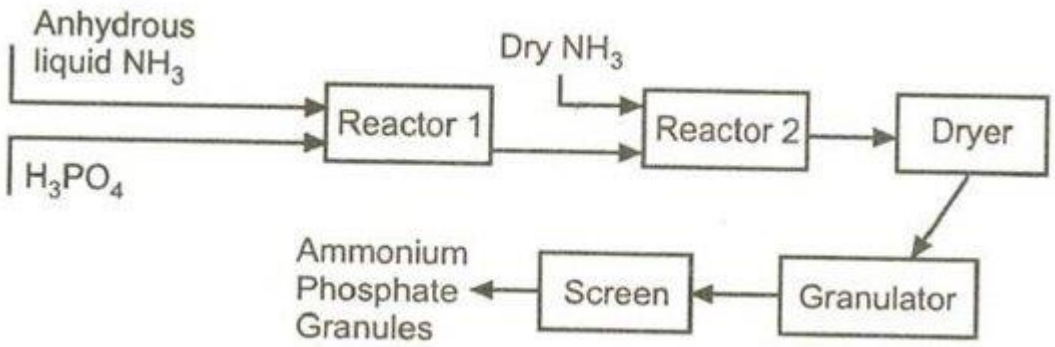
		4	Phosphorus Percentage	About 7-90 %	About 44 – 46 %
		5	Other Nutrients	Sulfur	No other plant nutrients present in this fertilizers
		6	Production	Via the addition of Sulfuric acid to Phosphate rock	Via the addition of Phosphoric acid to Phosphate rock

b **Diammonium Phosphate** — 2 marks for process and 2 marks for diagram

Reactions

$NH_3 + H_3PO_4 \rightarrow NH_4H_2PO_4$

$NH_3 + NH_4H_2PO_4 \rightarrow (NH_4)_2HPO_4$



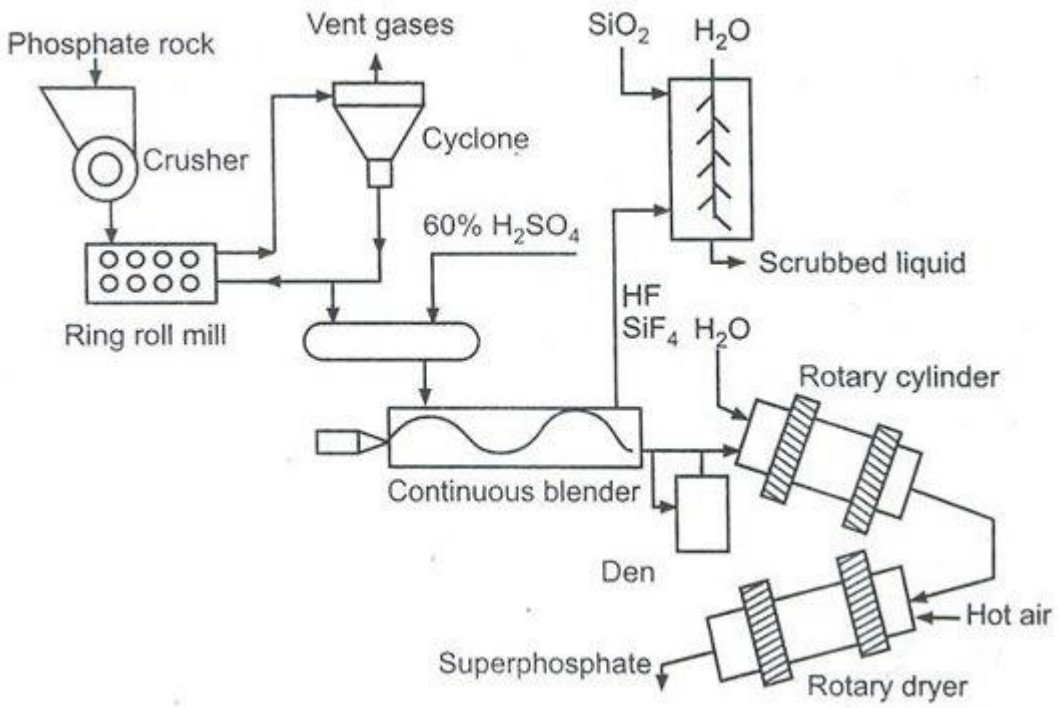
Process Description :

• Anhydrous & dry ammonia & phosphoric acid are changed into the first reactor. About 80% neutralization is done in the first reactor. Further ammonia is added to the second reactor. So conversion to the diammonium salt is obtained.

• The reaction is exothermic and hence due to heat of reaction, the excess ammonia vapours are given out. These are collected at the top of the tank and recharged. This cut ammonia losses.

• The slurry obtained in the second reactor is allowed to pass to a rotary adiabatic dryer, in which moisture is reduced to less than 1%.

• The bed of dry particles is recycled by moving them through a rotating drum granulator. The particles are screened & dried further.

		• It is not so much hygroscopic as ammonium nitrate. Therefore coating with clay may not be needed. White crystalline solid material is obtained	
	c	**Single superphosphate**  Process Description • The phosphatic rocks are ground in a jaw crusher and sized in a ring roll mill to a size of 100 mesh. • The ground rock and dilute H2SO4 (60%) is charged into a mixer. • The evolved HF is treated with silica to form volatile silicon tetra-fluoride and hydro-silico fluoride. The florous gases containing H2SiF6 vapours are withdrawn to absorber and are utilized for making sodium-fluo-silicate. • The product is fed through a rotary cylinder where water is sprayed to form flowing granules. The granules are dried in rotary and then packed in the jute bags.	2 marks for process and 2 marks for diagram

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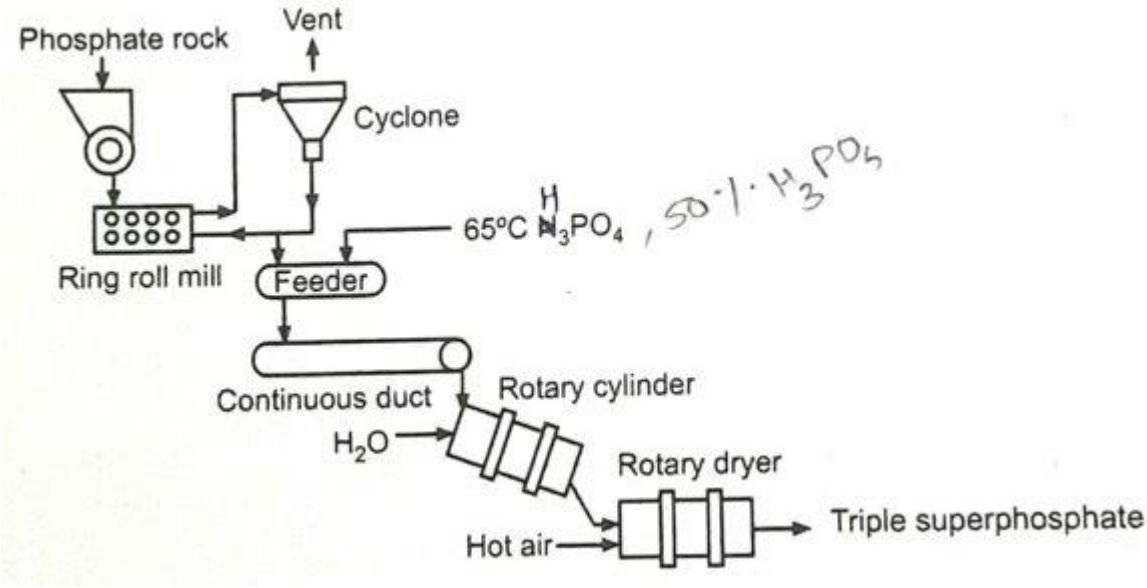
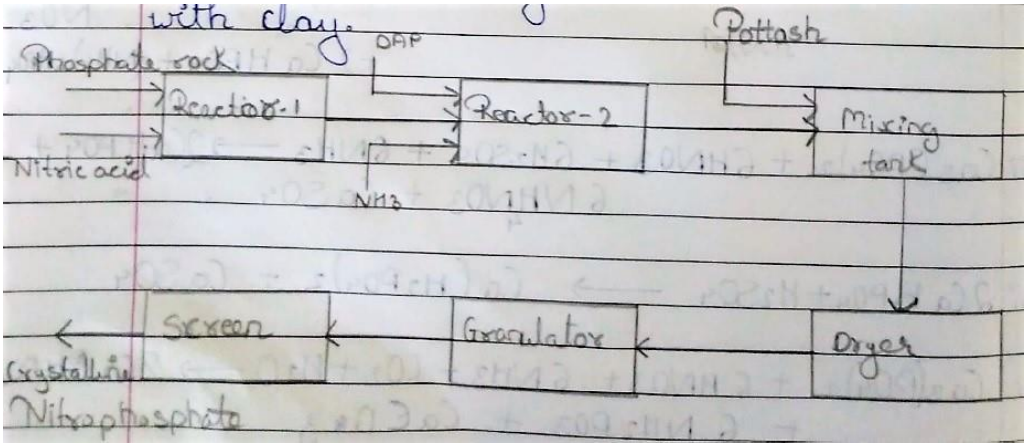
	d	**PFD of triple super phosphate** 	4 marks
	e	**Molecular Formula** Single super phosphate $[Ca_3(PO4)_2]_3CaF_2 + 7H_2SO_4 = 3CaH_4(PO4)_27CaSO_4 + 2HF$ Triple super phosphate $[Ca_3(PO4)_2]_3CaF_2 + 14H_3PO_4 = 10CaH_4(PO_4)_2 + 2HF$	2 marks each
5	a	**Importance of mixed fertilizer over Regular Fertilizer** The mixed fertilizers typically consist of two or more elements of nitrogen, phosphorous and potassium (NPK) for promoting the nutritional growth of plants and yield high growth. These are obtained by mixing manually or mechanically. These are recommended by agricultural scientist to enhance the output of plants by giving specific and exclusive blend of plant nutrients. They are tailor made as per the soil and are crop specific. Mixed fertilizers are important because: 1) They provide all nutrient at once and readily available in low cost as compared to single nutrient 2) Available in granular form and easy to apply to soil 3) Mixed fertilizers acidity can be controlled by using specific neutralizers 4) Mixed fertilizers provide the micro nutrients helps to facilitates uniform soil application of	2 marks 4 marks

		plant nutrients . Use of mixed fertilizers results in reduction of labor cost as it can easily apply	
	b	**Manufacturing of Nitro phosphate with PFD** Nitro phosphates are mixtures of ammonium nitrate and various phosphates made by acidulation of phosphate rock with nitric acid alone or in combination with sulfuric acid **Raw material** • Phosphate rock • Nitric acid • Sulfuric acid • Ammonia **Reaction** Nitric acid Digestion $Ca_3(PO_4)_2 + 6HNO_3 + 4NH_3 \rightarrow Ca(NO_3)_2 + 2CaHPO_4 + 4NH_4NO_3$ Nitric acid –Sulfuric acid Digestion $Ca_3(PO_4)_2 + 6HNO_3 + 4NH_3 + H_2SO_4 \rightarrow 2CaHPO_4 + 4NH_4NO_3 + CaSO_4$ **PFD**  	2 marks 2 marks

		Process: Rock phosphate is pulverized and digested with nitric or mixed acid in equipment similar to the wet process for producing phosphoric acid .Acid strength is 25-40 % HNO_3.The digested slurry is pumped to an ammoniating tank where chemical reactions are completed. The slurry is granulated and dried in rotary equipment and screened in a conventional classifying circuit.	2 marks
	c	**Methods of Mixed Fertilizer with PFD** Mixed fertilizer typically refers to a fertilizer containing two or more of the elements of nitrogen, phosphorus and potassium (NPK) which are essential for promoting plant growth and high crop yields. They are obtained by thoroughly mixing the ingredients either manually or mechanically. Mixed fertilizer reactions $NH_3 + H_3PO_4 = NH_4H_2PO_4$ $NH_4H_2PO_4 + NH_3 = (NH_4)2HPO_4$ DAP+UREA+POTASH+FILLER = MIXED FERTILISER 30-30-40 means 30% N2, 30% P and 40% K All the plants are using the so called “slurry process” for the production of NPK’s. Gaseous ammonia reacts with phosphoric and sulphuric acid in a special vessel (preneutralizer). The operating conditions are regulated in such a way that the phosphoric acid is partially neutralized by ammonia. The produced slurry is introduced in a rotating drum (granulator) where it is mixed with solid recycle. Further ammoniation is taking place in the granulator by liquid ammonia. The produced granules are dried in a dryer and screened. The coarse material is crushed, mixed with fines and returns to the granulator. The commercial product is cooled, treated with anticaking agent and sent to storage	3 marks for description and 3 marks for PFD

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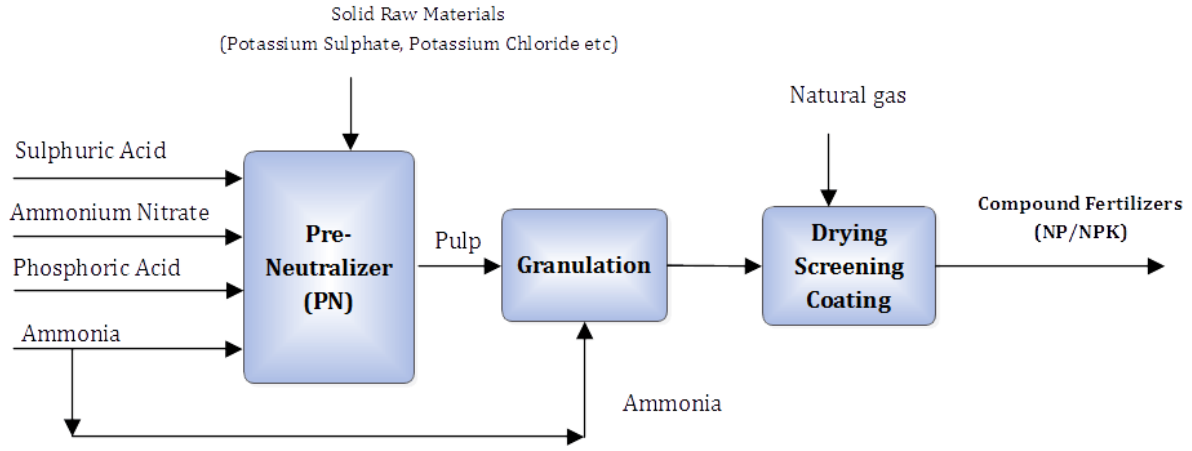
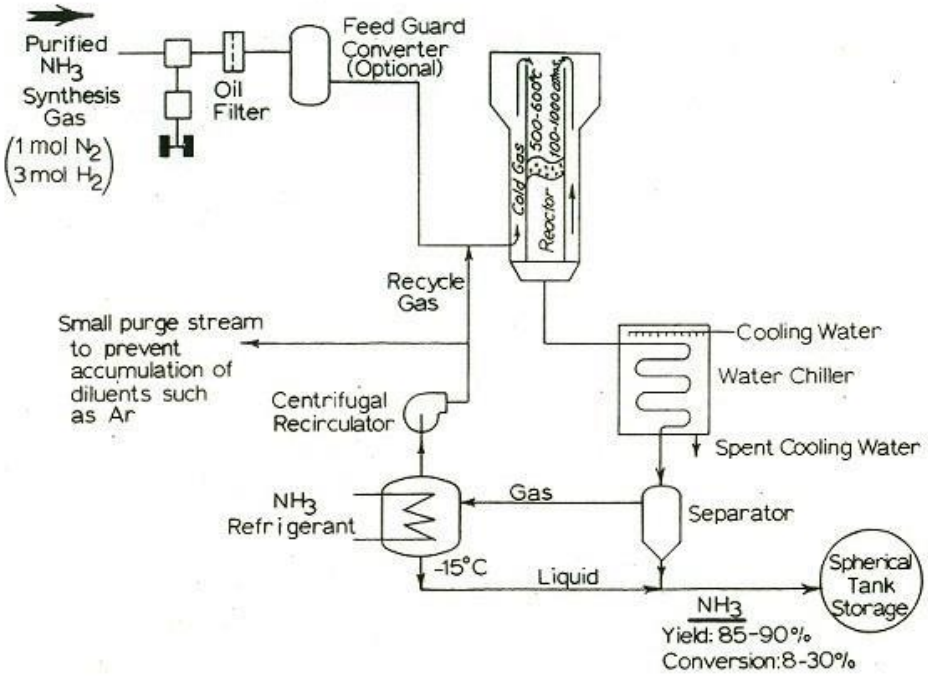
			
6	a	**Manufacturing of bio fertilizer from Kitchens waste** Nearly all food waste go directly to the trash can or garbage disposal; a practice that is essentially wasteful especially considering that these products can be turned into something really useful: fertilizer. Food waste is composed of organic matter which can be used for composting to make fertilizer. It is an effective and eco-friendly way of disposing food waste in your kitchen. By using leftovers and other food waste, you can convert these smelly items from the kitchen waste into a highly organic product rich in nutrients that you can use to grow vegetables or flowers with it. To make bio fertilizer from your kitchen waste, follow the steps below: **1.Go through your kitchen waste.** Vegetables and fruit peelings are the number one food remnants you should keep aside. Keep over-ripened fruits and vegetables, nuts, and egg shells. However, do not include grease, oils, fatty meats, and milk products in your composting materials since they will make your compost pile a wet mess and produce an annoying odor. Put these items on a well-drained, level, and open area and sprinkle some wood ash to boost the composting process. **2. Add other organic materials to the compost.** Aside from wood ash, you can also add sawdust to the compost to help speed up the composting process. If you have some livestock, you can add the excess manure to the compost. If you don't have sawdust or manure readily at home, you can buy them from a gardening supplies store.	6 marks

		3. Collect some garden waste. To come up with a nutrient-rich fertilizer, you will also need to add some natural waste to your compost. You can do this by collecting grass clippings and leaves from your lawn. When you mow your lawn, all the organic waste will be sucked and mixed inside the lawnmower bag. Remove all the contents from the lawnmower and place them into your compost bin. **4. Create the compost.** Add the prepared kitchen waste to the garden waste already in the compost bin. The compost bin should have a handle you can use to turn as you rotate the compost for thorough mixing and to incorporate oxygen into the mixture. Also, make sure the bin has some holes on the side to enable excess moisture to escape as you spin the compost. Lawn care experts recommend spinning the compost bin 2 to 3 times a day for best results. **5. Apply the fertilizer.** Wait for your compost to achieve a soil-like mixture that is dark in color. Once the compost reaches this appearance, it is ready to be spread. Use a garden fork to spread the compost on the garden fields you want to fertilize. Apply the right amount of compost and wait for the fertilizer to seep in and see some effect on the areas applied before you adding more. Composting your kitchen waste offers several benefits which include getting rid of unwanted rubbish and having some fertilizer you can use on your lawn. Before throwing your leftovers and other food remnants, determine if they will work great as compost materials first.	
	b	**Reasons for popularity of biofertilizres.** 1. The use of biofertilizers improves soil fertility status by increasing the organic matter, microbial biomass, and available nutrient status, particularly that of nitrogen and phosphorous. 2. They are eco-friendly and cost-effective. Biofertilizers protect the environment from pollutants since they are natural fertilizers. 3. They destroy many harmful substances present in the soil that can cause plant diseases.. 4. Biofertilizers are proved to be effective even under semi-arid conditions.	3 marks

		Initiative taken by government for the production of biofertilizers • Government of India has been encouraging use of bio fertilizers instead of chemical fertilizers through State Governments. • National Mission on Oilseeds and Oil Palm (NMOOP), National Food Security Mission (NFSM). ICAR under "Network project on soil biodiversity- bio fertilizers" has developed improved and efficient strains of biofertilizers specific to different crops and soil types. • ICAR study indicates that biofertilizers can improve crop yields by 10-25% and supplement costly chemical fertilizer (N, P) by nearly 20-25% in most of the cases when used along with the chemical fertilizers. • All India Network Programme on Organic Farming (AI-NPOF): Under this programme, management package involving reduced application of nutrients through manures with innovative practices are being evaluated at different locations which also includes use of bio fertilizers.	3 marks
	c	**Manufacturing of Ammonia with PFD** **Raw material** 1) H_2 from synthesis gas 2) N_2 from air **Reaction** $N_2 + 3H_2 \text{----} \rightarrow 2NH_3$ **Process:-** Ammonia synthesis gas (3 moles pure H2 : 1 moles pure N2) is compressed to the operating pressure (100-1000 atms. depending on conversion required) .It is sent through a filter to remove compression oil and additionally through a high temperature guard converter .This is done by catalyst and suitable getter materials. The relatively cool gas is added along the outside of converter tube walls to provide cooling so that carbon steel can be used for the thick wall pressure vessel and internal tubes. The preheated gas flows next through the inside of the tube which contains promoted pours	1 marks 3 marks

		iron catalyst at 500-550°C.The NH3 product, with an 8-30% conversion depending on process condition, is removed by condensation, first with water cooling and then NH3 refrigeration. The unconverted N2-H2 mixture is recalculated to allow an 85-90% yield.  	2 marks