Live MCQ™

৪৯তম স্পেশাল বিসিএস (শিক্ষা) বিষয়ভিত্তিক প্রস্তুতি

বিষয়: ফলিত রসায়ন (৫৪১)

Compendium PDF

(সিলেবাস অনুসারে সর্বাধিক গুরুত্বপূর্ণ টপিক ও এমসিকিউ-এর সমন্বয়ে রচিত)

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প্রিয় চাকুরিপ্রার্থী ভাই ও বোনেরা, আসসালামু আলাইকুম।

পরম করুণাময়ের অশেষ মেহেরবানীতে ৪৯তম (বিশেষ) বিসিএস পরীক্ষা-২০২৫ এর বিষয়ভিত্তিক প্রস্তুতির **ফলিত রসায়ন** বিষয়ে PSC কর্তৃক নির্ধারিত সিলেবাসের ওপর সকল ক্লাস ইতোমধ্যেই সম্পন্ন হয়েছে। আসন্ন চূড়ান্ত পরীক্ষাকে সামনে রেখে বিষয়ভিত্তিক প্রস্তুতিকে হাতের মুঠোয় এনে দিতে Live MCQ একাডেমিক টিম এই বিশেষ কমপেনডিয়াম পিডিএফ প্রদান করছে। আশা করছি, এর মাধ্যমে আপনাদের প্রস্তুতি আরও শাণিত হবে ইনশাআল্লাহ।

সূচিপত্র

PSC কর্তৃক নির্ধারিত সিলেবাস

Applied Chemistry

Part-I

(Mark-50)

1. Importance of Chemical technological processes. Development of Chemical technology, Classification of Chemical technological processes.

2. Techno-economic feasibility study of a project. Site selection for chemical industry. Unit process and unit operation. Design and implementation of a chemical project.

3. Chemical Process Industries: Fundamentals of Chemicals Industries, Importance of Chemical Technology for Industry. Pre-conditions for setting up of a new Chemical Industry. Problems of Chemical Process Industries in Bangladesh and their solutions.

4. Fluid Mechanics: Types of fluid, general properties of fluid, Fluid statics, Fluid dynamics, Euler's equation, Bernoulli's equation, Fluid flow measurement.

5. Corrosion: Corrosion damage. Types of Corrosion. Corrosion prevention. Electrochemical aspects of Corrosion, Corrosion Testing.

6. Metallurgy of Iron: Detailed Study on Pig iron, Wrought iron and steel.

7. Principles of industrial separation processes. Distillation: Design & operating characteristics of plate column, operation efficiency. Analysis of fractionating column by McCabe-Thiele method and enthalpy-concentration method. Construction details of plate column, sieve column.

8. **Refrigeration and Air conditioning:** Basic theory. Compression and Absorption Refrigeration Cycles. Ammonia Absorption machines. Refrigerants.
9. **Air and water pollution.** Greenhouse effect. Ozone hole. Kyoto protocol. Industrial waste management.
10. **Water conditioning & water treatment**. Physical & chemical methods of treatment. Municipal water supply. Boiler feed water. Water treatment plants in Bangladesh. Electrodialysis, ultrafiltration, activated carbon absorption, BOD, COD.

Applied Chemistry

Part-II

(Mark-50)

1. **Sulphur and sulphuric Acid:** Sources of sulphur, Recovery of sulfur from nature, Manufacture of sulphuric acid, Technological aspects of Fertilizer industries of Bangladesh. Ammonia, Urea and triple superphosphate manufacturing processes. Environmental aspects.
2. **Sugar industry:** Manufacture of sugar from sugarcane and sugar beat. Utilization of byproducts. Sugar Industry in Bangladesh.
3. **Coal:** Coal deposits in Bangladesh. Composition, classification, carbonization, gasification. Utilization and environmental aspects.
4. **Petroleum:** Atmospheric and Vacuum distillation. Thermal cracking, catalytic cracking, Reforming, Hydrocracking. Products of petroleum processing and their uses. Petroleum refining industry in Bangladesh.
5. **Glass and Ceramics:** Composition, classification, manufacturing processes, special glasses and ceramic products.
6. **Cement:** Classification, strength of cement. Cement kilns. Manufacturing processes. Cement industry in Bangladesh.
7. **Caustic-Chlorine Industries:** Methods of production of caustic soda and soda ash. Electrolytic process for caustic soda and chlorine. Diaphragm, Mercury and Membrane processes. Caustic soda-chlorine industry in Bangladesh. Environmental aspects.
8. **Plastic Industry:** Polyethylene, polypropylene, polyvinyl chloride, polymethylacrylate, polystyrene.
9. **Pulp, Paper and Rayon Industries:** Manufacturing processes and their comparisons. Environmental aspects.
10. **Soaps and Detergents:** Manufacture of Soap, Detergent and Glycerine.
11. **Leather Industry:** Leather processing including Chrome and Vegetable Training.
12. **Edible oils:** Extraction, Purification and Hydrogenation, Different Tests for Oils.
13. **Surface Coatings:** Paints; Pigments; Varnishes; Lacquers-constituents, manufacture, classification and application.

গুরুত্বপূর্ণ টপিকসমূহ

Applied Chemistry

[Part-I] (Mark-50)			
SL	Subject	Topic	Importance
1.	Chemical Process Industries	1. Development of Chemical technology 2. Problems of Chemical Process Industries in Bangladesh and their solutions.	**** **
2.	Fluid Mechanics	1. Types of fluid, 2. general properties of fluid, 3. Fluid statics, 4. Fluid dynamics.	**** * ** **
3.	Corrosion	1. Corrosion damage. 2. Types of Corrosion. 3. Corrosion prevention. 4. Electrochemical aspects of Corrosion, 5. Corrosion Testing.	*** *** **** ** **
4.	Metallurgy of Iron	1. Blast furnace 2. Study on Pig iron, 3. Wrought iron and steel.	**** *** ***
5.	Principles of industrial separation processes:	1. Distillation, 2. Construction details of plate column, sieve column.	*** *
6.	Refrigeration & Air conditioning	1. Basic theory, 2. Refrigerants.	*** ****
7.	Air and water pollution	1. Greenhouse effect. 2. Ozone hole. 3. Kyoto protocol. 4. Industrial waste management.	**** **** **** ***
8.	Water conditioning & water treatment.	1. Physical & chemical method of treatment. 2. Municipal water supply, 3. Water treatment plants in Bangladesh, 4. BOD, 5. COD.	**** ** **** ********

Applied Chemistry [Part-II] (Mark-50)			
SL	Subject	Topic	Importance
1.	Sulphur and sulphuric Acid	1. Sources of sulphur, 2. Manufacture of sulphuric acid, 3. Fertilizer industries of Bangladesh. 4. Ammonia, Urea and TSP manufacturing processes	******** *** ****
2.	Sugar industry	1. Manufacture of sugar from sugarcane and sugar beat. 2. Utilization of byproducts. 3. Sugar Industry in Bangladesh.	*** **** ****
3.	Coal	1. Coal deposits in Bangladesh. 2. Coal Composition & classification.	**** ****
4.	Petroleum	1. Thermal cracking, 2. Catalytic cracking, 3. Reforming, 4. Hydrocracking. 5. Products of petroleum processing and their uses. 6. Petroleum refining industry in Bangladesh.	** ** ** ** **** ****
5.	Glass and Ceramics	1. Composition, 2. classification, 3. special glasses and ceramic products.	**** **** ****
6.	Cement	1. Classification, 2. strength of cement, 3. Cement industry in Bangladesh.	**** *** ****
7.	Caustic-Chlorine Industries	1. Methods of production of caustic soda and soda ash. 2. Electrolytic process for caustic soda and chlorine. 3. Diaphragm, Mercury and Membrane processes. 4. Caustic soda-chlorine industry in Bangladesh. 5. Environmental aspects.	**** **** **** **** **
8.	Plastic Industry	1. Polyethylene, 2. polypropylene, 3. polyvinyl chloride, 4. polymethylacrylate,	**** **** **** ****

		5. polystyrene.	****
9.	**Pulp, Paper & Rayon Industries**	1. Manufacturing processes. 2. Environmental aspects.	**** ***
10	**Soaps and Detergents**	1. Manufacture of Soap, Detergent and Glycerine. 2. Characterstics of Soap & Detergent.	*** ****
11	**Leather Industry**	1. Leather processing methods 2. Chrome Taning. 3. Vegetable Taning	**** **** **
12	**Edible oils**	1. Extraction, 2. Purification 3. Hydrogenation, 4. Different Tests for Oils.	*** ** *** ****
13	**Surface Coatings**	1. Paints 2. Pigments 3. Varnishes 4. Lacquers	**** **** ** **

রেফারেন্স বইসমূহ

1. IEGELS HANDBOOK OF INDUSTRIAL CHEMISTRY 9ED (PB 1997) · by KENT J.A.
2. Essentials of Physical Chemistry by Arun Bahl, B.S Bahl & G.D-Tuli
3. Handbook of Industrial Chemistry: Organic Chemicals by M. Farhat Ali, Bassam Ali
4. Environmental Chemistry: Eleventh Edition by Stanley Manahan
5. Process Technology. An Introduction by De Haan, 2015
6. Product-Driven Process Design. From Molecule to Enterprise by Zondervan, Almeida-Rivera, Carmada, 2020
7. Refrigerant types, issues, trends & future options by Selvaraji Muthu (Mahle Engine Components India Pvt. Ltd.) and Aseem Kumar
8. EPA's Guide for Industrial Waste Management

বিসিএস ফলিত রসায়ন প্রস্তুতির শেষ মুহূর্তের নির্দেশনা

১। সিলেবাসে উল্লিখিত বিভিন্ন শিল্প (লৌহ, সালফার, চিনি, কয়লা, কাঁচ, সিরামিক, সিমেন্ট, কস্টিক-ক্লোরিন, পাল্প, পেপার, রেয়ন, সাবান, ভোজ্যতেল, পেইন্ট, পিগমেন্ট ইত্যাদি) সম্পর্কে বাংলাদেশ প্রেক্ষাপটে আপডেটেড তথ্য জানার চেষ্টা করুন। এ সম্পর্কিত নিউজগুলো ইন্টারনেটে সার্চ করে পড়ুন।
২। সিলেবাসে উল্লিখিত বিভিন্ন শিল্প প্রক্রিয়ার নিয়ামক ও শর্তগুলো (যেমন- তাপমাত্রা, চাপ, ঘনমাত্রা ইত্যাদি) ভালো করে পড়ুন।
৩। সিলেবাসে উল্লিখিত বিভিন্ন শিল্প প্রক্রিয়ার ব্যতিক্রমী বৈশিষ্ট্যগুলি গুরুত্বের সাথে অধ্যয়ন করুন।
৪। বিভিন্ন শিল্প প্রক্রিয়াগুলো চিত্র বা ডায়াগ্রাম সহ বুঝে অধ্যয়ন করুন।

৫। গুরুত্বপূর্ণ keywords আলাদা করে লিখে সংক্ষিপ্ত নোটস তৈরি করুন।
৬। কনফিউজিং তথ্যগুলো টেবিল আকারে পড়ুন।
৭। গুরুত্বপূর্ণ শিল্প প্রক্রিয়াগুলোর বিক্রিয়া এবং বৈশিষ্ট্য ছক আকারে মুখস্থ করুন।
৮। সাম্প্রতিক জুওলজি রিলেটেড তথ্যগুলো অর্থনৈতিক সমীক্ষা থেকে দেখে নিতে হবে।

শেষ মুহূর্তের প্রস্তুতির কৌশল

১। প্রতিদিন ১ ঘন্টা করে পূর্ববর্তী বছরের বিসিএস প্রশ্ন সমাধান করুন।
২। প্রতিদিন নূন্যতম একটি মডেল টেস্ট পরীক্ষা দিন এবং সঠিক উত্তরগুলো ব্যাখ্যাসহ সমাধান করুন।
৩। পড়ার সাথে গুরত্বপূর্ণ পয়েন্টগুলো নিজে হাতে লিখে শর্ট নোট তৈরি করুন।
৪। সরাসরি তথ্য পড়ার চেয়ে MCQ প্রশ্নোত্তর ভিত্তিক পড়া বেশি কার্যকর হয়। তাই MCQ ফোকাস করুন।
৫। শেষ মুহূর্তে দ্রুত রিভিশনের জন্য প্রদত্ত গুরুত্বপূর্ন MCQ প্রশ্নগুলো সলভ করুন।
৬। অপশন অনুযায়ী key words মনে রাখুন।

❖ **সময় ব্যবস্থাপনাঃ-**
✓ প্রতি টপিকের জন্য ২০-৩০ মিনিট সংক্ষিপ্ত রিভিশন।
✓ Exam Hall-এ প্রথমে সহজ MCQ চিহ্নিত করে উত্তর দিন।

❖ **স্মার্ট স্টাডি আইডিয়াঃ-**
✓ প্রতিটি টপিককে ৫-৭টি মূল শব্দে সংক্ষেপে লিখুন।
✓ প্রতিটি লেকচারকে একটি পৃষ্ঠায় সংক্ষেপে লিখুন।
✓ Process Diagram সবসময় আঁকুন এবং মনোযোগ দিয়ে স্টাডি করুন।
✓ Comparative tables (যেমনঃ- Tharmal vs Catalytic vs Hydrocracking) বানান।
✓ গুরত্বপূর্ণ পয়েন্টগুলো mnemonic / short phrases এ রূপান্তর করুন → পরীক্ষায় দ্রুত মনে আসে।

❖ **চাপ কমাতেঃ-**
✓ পুরো বিষয় একসাথে পড়ার চেষ্টা করবেন না; মূল keywords, বৈশিষ্ট্য ও পার্থক্য মনে রাখুন।
✓ শেষ মুহূর্তে প্রশ্ন পর্যালোচনা ভিত্তিক স্মার্ট স্টাডি সবচেয়ে কার্যকর।
✓ "সংক্ষিপ্ত রিভিশন + মূল keywords" দিয়ে অনেক MCQ অল্প সময়ে কভার করা যায়।
✓ আত্মবিশ্বাস রাখুন, ইতিমধ্যেই যা পড়েছেন পরীক্ষায় ভালো করার জন্য তাই যথেষ্ট।

পরীক্ষার হলে করনীয়

✓ প্রশ্ন যেমনই হোক, ঠাণ্ডা রাখুন। উত্তেজিত হয়ে জানা উত্তর ভুল করা যাবে না।
✓ প্রতি টপিকের উত্তর করার জন্য সময় ভাগ করে নিন।
✓ প্রশ্ন কঠিন হোক বা সহজ- সবগুলোতেই একই নম্বর। তাই নিজের নিশ্চিতভাবে জানা প্রশ্নগুলোর উত্তর আগে দিন।
✓ কিছু অতিরিক্ত সময় হাতে রাখুন। সম্পূর্ণ প্রশ্ন একবার উত্তর করার পরেও যেন পুনরায় আরেকবার রিভিশন দেয়ার সময় থাকে।
✓ প্রথমেই অতিরিক্ত জটিল প্রশ্নের উত্তর করতে গিয়ে সময় নষ্ট করবেন না।
✓ কোন প্রশ্নের পেছনে নির্ধারিত সময়ের অতিরিক্ত সময় ব্যয় করবেন না।
✓ অনেকেই প্রশ্ন হাতে পেয়ে প্রথমে সম্পূর্ণ প্রশ্নটি পড়তে যায়। MCQ পরীক্ষার ক্ষেত্রে এটি মারাত্মক ভুল স্ট্রাটেজি।
✓ কোন নির্দিষ্ট টপিক ভিত্তিক অ্যানসার করতে যাবেন না। শুরু থেকে সিরিয়াল ধরে শেষ পর্যন্ত উত্তর করে যান।

টপিকভিত্তিক সংক্ষিপ্ত আলোচনা

প্রথম পত্র

Chemical technological processes

❖ **Ancient Period:**

✓ Metallurgical techniques for smelting metals like copper and iron.
✓ Production of glass and ceramics.
✓ Fermentation processes for alcohol and vinegar.

❖ **Alchemical Period (Middle Ages)**

✓ Focus on mystical and experimental chemistry.
✓ Development of apparatus & processes like distillation & sublimation.
✓ Emergence of basic chemical compounds, such as acids and salts.

❖ **Early Modern Chemistry (16th–18th Century)**

✓ Shift from alchemy to systematic experimentation and theory.
✓ Significant Advancements: Lavoisier's discovery of role of oxygen in combustion (1770s).
✓ Early development of industrial chemical processes, such as sulfuric acid production using lead chambers

❖ **Industrial Revolution (18th–19th)**

✓ Chemical technology began to scale up for industrial purposes.
✓ Leblanc process for producing soda ash from salt.
✓ Solvay process as a more efficient alternative to the Leblanc process.
✓ Development of synthetic dyes and fertilizers.

❖ **20th Century**

✓ Advancements in thermodynamics, reaction kinetics, and material science.
✓ Haber-Bosch process for ammonia synthesis, revolutionizing agriculture with synthetic fertilizers.
✓ Development of fluid catalytic cracking (FCC) helped with Petrochemical industry.
✓ Emergence for producing plastics, fuels & synthetic fibers.
✓ Polymer technology leading to materials like nylon, Teflon, and polyethylene.

❖ **Late 20^{th} and Early 21^{st} Century**

✓ Emphasis on sustainability, efficiency, and advanced technologies.
✓ Green chemistry principles to reduce waste and environmental impact.
✓ Biochemical processes, including enzyme catalysis & fermentation for biofuels & pharmaceuticals.
✓ Development of nanotechnology for precision material design.
✓ Advancements in renewable energy tech like H production & solar cells.

Unit Processes:- Unit processes are the chemical transformations or conversions that are performed in a process.

For example; smelting, reduction, calcination, dehydrogenation, electrolysis etc.

Unit Operations:- Unit operations are physical treatment steps in chemical processes, which are required to: put raw materials in a form in which they can be reacted chemically and to put the product in a form which is suitable for the market.

Examples of unit operations are Agitation, Dispersion, Heat transfer, Atomization, Separation, Centrifuging ,Evaporation, Mixing, Pumping etc.

Classification of Unit Operation:-

1. Material handling, transportation/Fluid flow process:-Pumping, Compression, Fluidization
2. Mechanical unit operations:- Size reduction, Size enlargement, Mixing, agitation, blending, etc
3. Mass transfer operations:- Evaporation, Distillation, Absorption, Extraction, Leaching.
4. Heat transfer operations:- Conduction, Convection, Radiation.

Example of Unit process

Example-1:- Electrolysis of sodium chloride solution

Explanation – Here, electrolysis of NaCl is done and sodium hydroxide is produced. In this reaction, a decomposition reaction takes place. Hence, this is a unit operation.

Example-2:- Production of Hydrogen

Explanation– Hydrogen is produced using a very popular method i.e. Steam-methane reforming reaction. In this method, methane reacts with steam under 3–25 bar pressure in the presence of a Nickel catalyst to produce hydrogen. In this process, a chemical reaction under pressure and temperature is conducted to react Methane with steam and generate Hydrogen. As the reaction is conducted, this process comes under the unit process.

Design and implementation of a chemical project:-

1. **Project Definition and Conceptualization:-**Define the Objective, Identify Reactions, Gather Information, Define Scope.
2. **Process Design:-** Develop a Process Flow Diagram (PFD), Equipment Selection and Sizing, Material and Energy Balances, Process Optimization.
3. **Control System Design:-** Develop Control Strategies, Select Control Devices, Implement a control system.
4. **Safety Analysis and Risk Assessment:-** Identify Hazards, Assess Risks, Implement Safety Measures.
5. **Detailed Engineering and Implementation:-** Equipment Design, Piping and Instrumentation Diagram (P&ID), Procurement and Construction, Commissioning and Start-up.
6. **Project Management:-** Develop a Project Plan, Manage Communication, Ensure Quality Control.
7. **Sustainability Considerations:-** Minimize Waste, Reduce Energy Consumption, Use Sustainable Materials.

❖ We can categorize the Chemical Industry into five sub categories based on the products they manufacture:- 1. Basic Chemicals, 2. Agrochemicals, 3. Specialty Chemicals, 4. Industrial Gases, and 5. Downstream Industries

Pre-conditions for setting up of a new Chemical Industry:-

I. Market and Feasibility Study:- Market Analysis, Raw Material Availability, End-Use Applications, Technological Suitability.

II. Legal and Regulatory Framework:- Permits and Licenses, Compliance with Regulations.

III. Infrastructure and Resources:- Raw Material Supply, Site Selection, Skilled Labor, Utilities and Services.

IV. Environmental Sustainability:- Environmental Impact Assessment, Waste Management.

Fluid Mechanics

Fluids can be classified into the following types:

1. Ideal Fluid:- There is no ideal fluid in reality.
2. Real Fluid:- Water, air, oil, kerosene, petrol etc.
3. Newtonian Fluid:- water, air, alcohol, glycerol, thin motor oil etc.
4. Non-Newtonian Fluid:- Blood, saliva, Soap solutions, cosmetics, and toothpaste etc.
5. **Ideal Plastic Fluid:-** clay, toothpaste, and certain types of paint, which exhibit solid-like behavior until a critical stress is applied.

Key Concepts in Fluid Statics are:-

1. **Pressure:-** pressure varies within a fluid at rest. Pressure increases with depth due to the weight of the fluid above.
2. **Buoyancy:-** upward buoyant force that a fluid exerts on a submerged object, equal to the weight of the fluid displaced by the object.
3. **Pascal's Principle:-** states that pressure applied to a confined fluid is transmitted equally to every point within the fluid.
4. **Hydrostatic Pressure:-** the pressure exerted by a fluid at rest due to gravity. It is directly proportional to the density of the fluid, acceleration due to gravity, and depth.
5. **Manometers:-** measure pressure differences by balancing weight of a fluid column.

- **Euler's equation:-** The total mechanical energy per unit mass remains constant along a streamline in an ideal fluid flow. It describes the motion of inviscid (non-viscous) fluid.
- **Bernoulli's equation:-** If the velocity of a fluid increases, its pressure must decrease. And vice versa, assuming the height remains constant.
- Fluid flow measurement process:- **1.** Volume Flow Rate **2.** Mass Flow Rate.

※ Various devices are used to measure fluid flow:-**1.** Differential Pressure, **2.** Flowmeters, 3. Coriolis Flowmeters, **4.** Ultrasonic Flowmeters, **5.** Turbine Flowmeters, **6.** Positive Displacement Flowmeters.

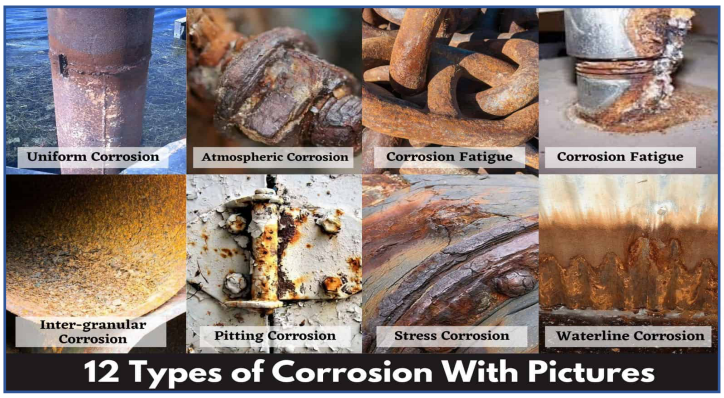
Corrosion

- **Types of Corrosion:-**

1. Uniform (General) Corrosion,
2. Localized Corrosion:- (i)Pitting Corrosion, (ii) Crevice Corrosion, (iii) Galvanic Corrosion,

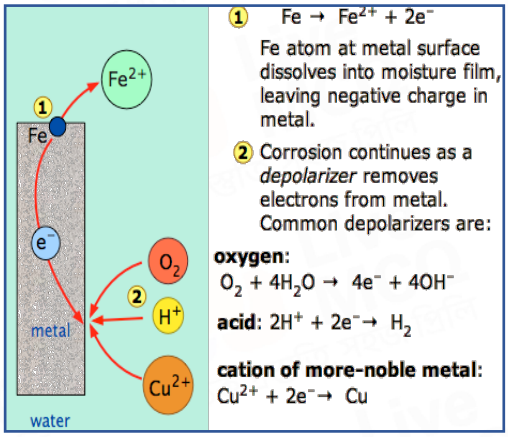
(iv) Stress Corrosion Cracking (SCC) (v) Erosion Corrosion.

3. Intergranular Corrosion.
4. High-Temperature Corrosion
5. Microbial Corrosion.
6. Fretting Corrosion.
7. Cavitation corrosion
8. De-Alloying (Selective Leaching).



- **Methods of Corrosion Prevention:-**

1. Protective Coatings:- Painting, Powder Coating, Metal Plating, Oiling and Greasing, Plastic Coating.
2. Material Modification:- Using Corrosion-Resistant Materials, Alloying.
3. Environmental Modification:- Adding Inhibitors (Such as:- Chromates, Molybdates, Silicates, Amines, Pyridines, Thiols, Alcohols), Controlling Temperature and Flow Velocity.
4. Cathodic Protection:- Sacrificial Anodes, Impressed Current Cathodic Protection.
5. Other Methods:- Galvanization, Passivation, Controlling Moisture.



- **Electrochemical aspects of Corrosion:-**

1. Anode (oxidation),

2. Cathode (reduction),

3. Electrolyte (water),

4. Salt Bridge,

5. Electrochemical Reactions: Oxidation (Anodic Reaction) & Reduction (Cathodic Reaction)

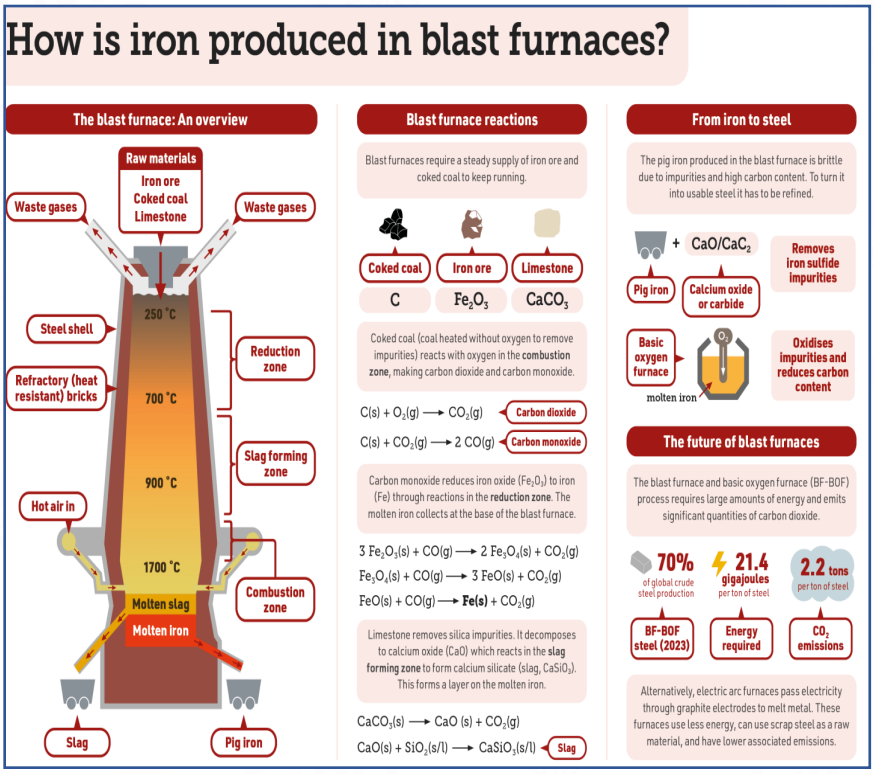
- **Factors Affecting Electrochemical Corrosion:-** Metal Type, Electrolyte Composition, Temperature, Surface Condition, Electrical Contact.
- **Mitigation Techniques:-**Material Selection, Coatings, Corrosion Inhibitors, Cathodic Protection.
- **Types of Corrosion Tests:-** Salt Spray (Fog) Test, Electrochemical Tests, Exposure Tests, Intergranular Corrosion (IGC) Testing, Stress Corrosion Testing.

Metallurgy of Iron

❖ About 98% of all iron ore is converted into pig iron for Steel making.

❖ Over 95% of mined iron ore is used to produce steel.

Mineral	Formula	% of Iron
Hematite	Fe_2O_3	70.0
Magnetite	Fe_3O_4	72.4
Limonite	$2Fe_2O_3.3H_2O$	59.8
Siderite	$FeCO_3$	48.2



❖ **Steelmaking Processes:-**

1. Basic Oxygen Furnace (BOF) Route:- Oxygen is blown into the molten iron (from blast furnace) to oxidize and remove impurities like carbon, silicon, and phosphorus, transforming it into molten steel.

2. Electric Arc Furnace (EAF) Route:- Recycled steel scrap and direct-reduced iron (DRI) from blast furnace are melt in High-power electric arcs with graphite electrodes at very high temperatures reaching up to 1,800 °C (3,300 °F).

Typical wrought iron composition (percent weight)

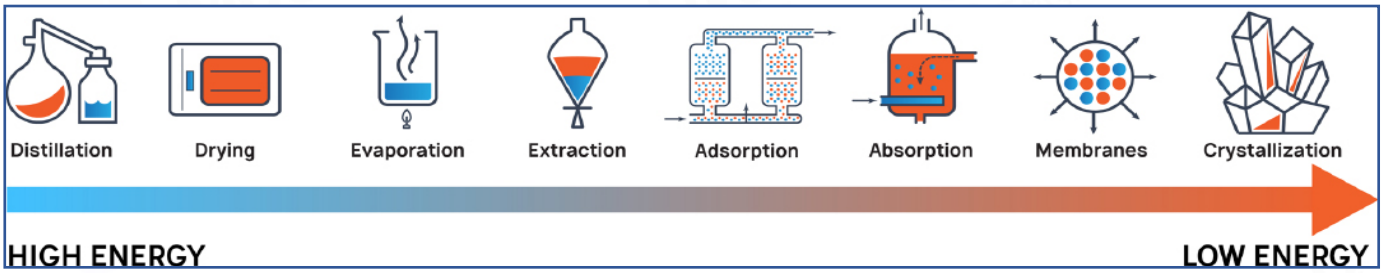
Material	Iron	Carbon	Manganese	Sulfur	Phosphorus	Silicon
Pig iron	91–94	3.5–4.5	0.5–2.5	0.018–0.1	0.03–0.1	0.25–3.5
Carbon steel	98.1–99.5	0.07–1.3	0.3–1.0	0.02–0.06	0.002–0.1	0.005–0.5
Wrought iron	99–99.8	0.05–0.25	0.01–0.1	0.02–0.1	0.05–0.2	0.02–0.2

Material	Iron	Carbon	Manganese	Phosphorus	Sulfur
Low Carbon Steel	98%	0.25%	1.03%	0.04%	0.05%
Medium Carbon Steel	98.6%	0.4%	0.9%	<0.04%	<0.05%
High Carbon Steel	98.4%	0.95%	0.5%	<0.04%	<0.05%
Ultra High Carbon Steel (Damascus)	97.7%	1.6%	0.6%	0.1%	<0.05%

Principles of industrial separation processes

❖ **Core Principles of Industrial separation processes are:-** Phase Equilibrium, Mass Transfer, Size Differences, Density Differences, Chemical Affinity.

❖ **Common Separation Techniques are:-** 1. Distillation, 2. Extraction, 3. Adsorption, 4. Membrane Separation, 5. Crystallization, 6. Centrifugation, 7. Filtration, 8. Equilibrium, 9. Evaporation and Drying, 10. Rate-Controlled Processes.



❖ **Azeotrope** is *a mixture that exhibits the same concentration in the vapor phase and the liquid phase*. Whose proportions cannot be changed by simple distillation.

❖ Fractional distillation is suited for separating liquids whose boiling points differ by less than 25 K

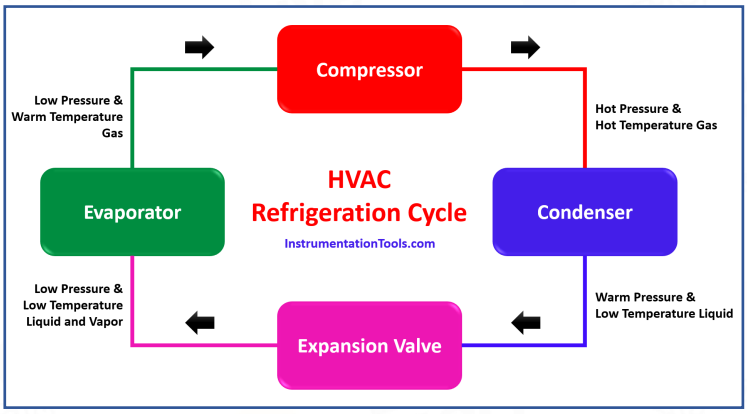
❖ Typical hole diameters in sieve trays for distillation columns fall within the range of 3-12.5 mm; with 5 mm being particularly common.

❖ Sieve Trays typically have around 50% efficiency.

● **McCabe-Thiele method relies on several key Assumptions:- 1.** Constant Molar Overflow, **2.** Constant Relative Volatility, **3.** Negligible Heat Effects, **4.** Equilibrium Stages.

● **Enthalpy-Concentration method:- 1.** Construct Enthalpy-Concentration Diagram, **3.** Locate Feed and Product Points, **3.** Draw Operating Lines, **4.** Determine Theoretical Trays, **5.** Optimize Reflux Ratio.

Refrigeration and Air conditioning



- Refrigeration cycle consists of just 4 basic components:-
  (i) Evaporator (ii) Compressor
  (iii) Condenser (iv) Expansion Valve
- **Absorption Refrigeration Cycle:-**
  1. Evaporation, **2.** Absorption,
  3. Generation, **4.** Condensation,
  5. Expansion

❖ *Ammonia absorption refrigeration system* uses ammonia as a refrigerant and water as an absorbent. Ammonia has a very low boiling point of -28° Fahrenheit.

- **Various Refrigerants:-**

1. *Inorganic Refrigerants:-* Ammonia (R-717), Carbon Dioxide (R-744).
2. *Organic Refrigerants:-* CFCs (Chlorofluorocarbons), HCFCs (Hydrochlorofluorocarbons), HFCs (Hydrofluorocarbons), Hydrocarbons, (propane, butane & isobutane)
3. *Natural Refrigerants:-* Ammonia (R-717), Carbon Dioxide (R-744), Water (R718), Air (R729), Isobutane (R600a).

Type	Name	Chemical Name	Formula	A. Life	GWP	ODP
CFC	R-12	Dichlorodifluoromethane	CCl_2F_2	100	10200	1
HCFC	R-22	Chlorodifluoromethane	$CHClF_2$	12	1760	.05
HFC	R-32	Difluoromethane	CH_2F_2	4.9	677	0
HFC	R-134a	1,1,2,2-Tetrafluoroethane	$C_2H_2F_4$	9.6	1120	0
HFC	R-407a	R-32/125/134a (20±2/40±2/40±2)		18	2107	0
HFC	R-407C	R-32/125/134a (23±2/25±2/52±2)		15	1704	0
HFC	R-410a	R-32/125 (50+.5,−1.5/50+1.5,−.5)		17	2088	0
HC	R-290	Propane	C_3H_8	12	3	0
HC	R-600a	Isobutane	C_4H_{10}	12	3	0
	R-717	Ammonia	NH_3	0	0	0
	R-718	Water / Steam	H_2O	0	0	0

Refrigerant	GWP	Common System Application	Notes
R410A	2088	Conventional VRF systems and Heat Pumps / Chillers	Commonly used refrigerant with high GWP, also regularly used in distributed refrigerant systems with high system volumes increasing risk of leakage and potential climate damage
R134a	1430	Heat Pumps/ Chillers	
R32	633	Hybrid VRF systems and Heat Pumps / Chillers	R32 is mildly flammable* and is a HFC with a reasonably high GWP, however this is <1/3 of the GWP of other common HFCs such as R410A
R290 (propane) & R600 (butane)	3 & 4 respectively	Heat Pumps/ Chillers	R290 and R600 are Hydrocarbons which are highly flammable and heavier than air*
R1234ze	<1	Heat Pumps/ Chillers	An HFO refrigerant, typically available for large plant, R1234ze is mildly flammable*
R744 (CO2)	1	Heat Pumps	CO2 can be used in high temperature heat pumps, such as those dedicated to the production of domestic hot water. Systems are high pressure and require a low water temperature onto the heat pump to maximise coefficients of performance (COP) in heating
R717 (NH4, ammonia)	0	Heat Pumps	Typically available for large plant, Ammonia is mildly flammable and has medium toxicity concerns*

Air Pollution

- **Primary Air Pollutants:-** Pollutants that released directly into atmosphere from source.
  Examples: 1. Sulfur dioxide (SO2), 2. Nitrogen oxides (NOx), 3. Carbon monoxide (CO), Volatile organic compounds (VOCs), Particulate matter (PM).
- **Sources:-** Vehicle emissions, Industrial processes, Power plants, Volcanic eruptions.
- **Secondary Air Pollutants:-** Pollutants that are not emitted directly but are formed when primary pollutants undergo chemical reactions in the atmosphere.

Examples:- Ozone (O3), Sulfuric acid (H2SO4), Nitric acid (HNO3), Secondary particulate matter, Peroxy Acetyl Nitrate (PAN), H2O2, SO3

Formation:-

- Photochemical reactions (involving sunlight)
- Chemical reactions with other atmospheric components like water vapor

- **Key pollutants present in the air are:-** 1. particulate matter (PM2.5 and PM10), Sulfur dioxide (SO2), 3. Oxides of nitrogen (NOX), 4. Ozone (O3), 5. carbon monoxide (CO), 6. Carbon dioxide (CO2).
- **Drivers of air pollution in Bangladesh:-** 1. Vehicular emission, 2. Brick kilns, **2.** Construction activities, 4. biomass burning, 5. waste burning, 6. burning of agricultural residue.

- Bangladesh was the world's **second** most polluted country in 2024, with average smog levels exceeding World Health Organization (WHO) guidelines by more than 15 times
- Dhaka was the world's third most polluted capital in 2024, with an average PM2.5 level of 78 $\mu g/m^3$.

➢ **Greenhouse Effect:-**

✓ Joseph Fourier first proposed the concept of greenhouse effect.
✓ Greenhouse effect causes a mild increase in temperature of earth (about 14 °C).
✓ Without the greenhouse effect, the Earth's average surface temperature would be about -18 °C.
✓ Global warming of about 1.2 °C (2.2 °F) has occurred since the Industrial Revolution.

- **Greenhouse gases include:-** Carbon Dioxide, Methane, CFCs, HCFCs, Nitrous Oxide, Water vapor.

✓ Water vapor is the most abundant (95%) greenhouse gas in the atmosphere.
✓ Carbon Dioxide is the most abundant (84%) *man-made* greenhouse gas in the atmosphere.

- **Causes of Greenhouse Effect:-** Burning of Fossil fuels, Industry & Manufacturing, Deforestation, Agriculture & farming, Waste Management, Natural Factors.
- **Consequences of Greenhouse Effect:-** Global Warming, Rising Sea Levels, Extreme Weather Events, Ecosystem Disruptions, Ocean Acidification, Health Impacts, Economic Impacts, Changes in Precipitation Patterns, Loss of Sea Ice and Glaciers, Impacts on Agriculture, Water Availability, Human Displacement.
- **Measures to reduce Greenhouse Effect:-** Transition to Renewable Energy, Improve Energy Efficiency, Transition to Renewable Energy, Improve Energy Efficiency, Sustainable Transportation, Industrial Emissions Reduction, Reduce-Reuse-Recycle, Protecting Forests, Carbon Capture and Storage (CCS), Dietary Changes,

➢ **Ozone:-**

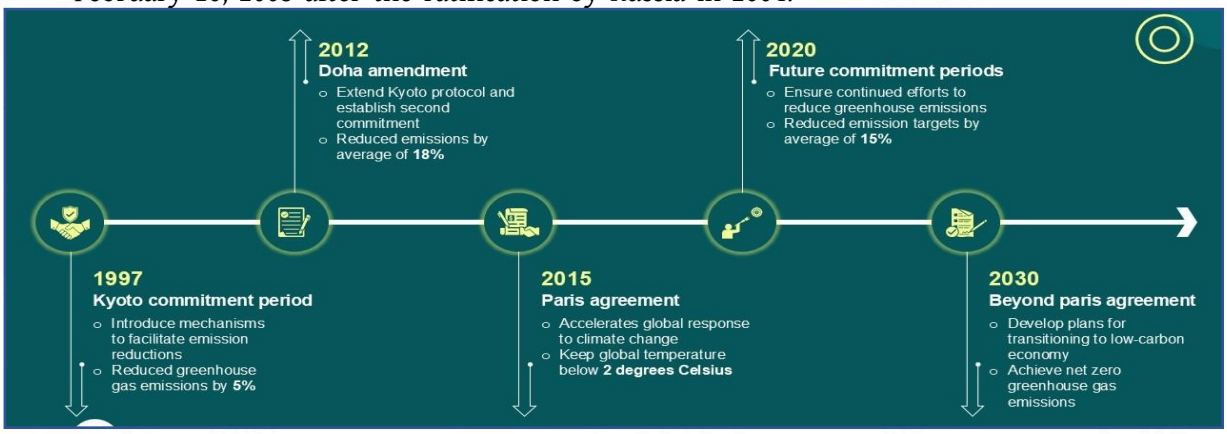
✓ Ozone exists in both the Earth's upper atmosphere (stratosphere) and lower atmosphere (troposphere).
✓ While stratospheric ozone is beneficial, protecting us from harmful UV radiation, tropospheric ozone is a harmful air pollutant.
✓ Most ozone resides in the stratosphere at altitudes ranging from about 10-50 kilometres above the Earth's surface.
✓ Ozone production occurs most efficiently in the upper stratosphere, where UV-C radiation is most intense.
✓ The **ozone hole** is actually a region of exceptionally depleted ozone in the stratosphere over the Antarctic that happens at the beginning of Southern Hemisphere spring (August–October).
✓ One chlorine molecule can dissociate about 1,00,000 molecules of ozone before it leaves the stratosphere.
✓ Ozone concentration in the atmosphere is measured in Dobson Units (DU)

■ **Protocols:-**

✓ **Montreal Protocol** was signed in 1987 and came into force in 1989. It has since been ratified by 195 countries. It was established to phase out ozone-depleting substances.

✓ **Vienna Convention** for the Protection of the Ozone Layer **(1985),** established the legal framework for ozone protection.

✓ **Kyoto Protocol** is adopted in Kyoto, Japan, in December 1997. It entered into force in February 16, 2005 after the ratification by Russia in 2004.



✧ *First commitment period:* from 2008 to 2012, aimed for a collective reduction of 5.2% below 1990 levels.

✧ *Second commitment period:* It was agreed upon during the Doha Amendment in December 2012 and runs from 2013 to 2020, setting a target of at least 18% reduction below 1990 levels.

✧ During the Doha Amendment, Nitrogen Trifluoride (NF3) was added to the list of greenhouse gases.

✧ The United States, a major emitter, did not ratify the protocol, and Canada withdrew in 2012.

● ***Search internet for more updated data***

Water Pollution

✓ **Contaminated Water Use:-** 70 million people (40.9%) used contaminated water in 2022.

✓ **Safe Water Access:-** Only 42.6% of the population has access to safe water.

✓ **Arsenic Exposure:-** 17.5 million people (11.8%) are exposed to arsenic.

✓ **E. coli Contamination:** Over 50% of households consume contaminated drinking water.

✓ **Wastewater Discharge:** Around 1.5 million cubic meters of wastewater from industrial units near Dhaka enter rivers daily containing heavy metals (such as lead, chromium, and cadmium).

✓ Unsafe water cause over 272,000 premature deaths and 5.2 billion days of illness annually, costing the equivalent of 17.6% of Bangladesh's GDP in 2019.

● **Industrial waste management:-**

❖ **Physical Treatment:-** These methods focus on separating or modifying waste components. Examples include:- Clarification, Filtration, Dissolved Air Flotation, Evaporation, Adsorption.

❖ **Chemical Treatment:-** These methods involve using chemical reactions to alter or remove pollutants. Examples include:- Neutralization, Oxidation, Ion Exchange, Advanced Oxidation Processes (AOPs),

❖ **Biological Treatment:-** These methods utilize microorganisms to break down organic pollutants. Examples include:- Activated Sludge, Trickling Filters, Anaerobic Digestion.

Water conditioning & water treatment

- **Water conditioning methods:-** 1. Template-Assisted Crystallization (TAC), 2. Electrically Induced Precipitation, 3. Reverse Osmosis, 4. Ion Exchange

Chemical Category	Typical Chemicals	Main Functions
Coagulants & Flocculants	Poly Aluminium Chloride (PAC), Aluminum Sulfate, Polyacrylamide (PAM)	Aggregate fine particles for sedimentation, remove turbidity and suspended solids
Disinfectants	Chlorine, Sodium Hypochlorite, Chlorine Dioxide, Ozone	Kill pathogens and ensure the safety of drinking water and reclaimed water
pH Adjusters	Lime, Sodium Hydroxide, Sulfuric Acid	Regulate water acidity/alkalinity to protect equipment and optimize treatment processes
Scale & Corrosion Inhibitors	Organic Phosphonates, Polycarboxylates	Prevent scaling and corrosion in pipelines and heat exchangers
Phosphorus Removers & Decolorants	Ferric Salts, Aluminum Salts	Reduce total phosphorus and color in wastewater to meet discharge standards
Oxidizing & Reducing Agents	Sodium Bisulfite, Ferrous Sulfate	Remove residual chlorine or reduce heavy metal ion concentrations

- **Water treatment process:-** 1. coagulation 2. flocculation 3. sedimentation 4. filtration 5. disinfection

❖ **Water Treatment: Physical Methods:-** Screening > Grit Chambers > Sedimentation (Clarification) > Flotation > Filtration > Reverse Osmosis (RO) > Distillation > Flocculation > Coagulation > Dissolved Air Flotation (DAF).

❖ **Water Treatment: Chemical Methods:-** 1. Coagulation and Flocculation 2. Disinfection 3. Ion Exchange 4. Chemical Oxidation, 5. pH Adjustment, 6. Adsorption,

- **Municipal water treatment:-** process for treating municipal water includes FIVE crucial steps:- 1. Chemical Addition, (aluminum sulfate, ferrous sulfate, sodium aluminate, ferric chloride), 2. Coagulation and Flocculation, 3. Sedimentation and Clarification, 4. Filtration, 5. Disinfection (Chlorine gas, chlorine dioxide, hypochlorite, ozone and ultraviolet (UV) light)
- **Boiler feed water Treatment:-** This process has two parts: internal treatment and external treatment.

1. **External Treatment (Pre-treatment):-** Dealkalization, Filtration, Ion Exchange (Water Softening), Reverse Osmosis (RO), Deaeration.

2. **Internal Treatment (Chemical Conditioning):-** Oxygen Scavengers (sodium sulfite or DEHA), Scale Inhibitors, Alkalinity and pH Control, Corrosion Inhibitors (nitrites, molybdates, and filming amines).

● **Water treatment plants in Bangladesh:-**

বাংলাদেশের বৃহত্তম পানি শোধনাগার অবস্থিত - সায়েদাবাদ, ঢাকা (নির্মাণকাল - ২০০২)। ঢাকা শহরে পানি সরবরাহের জন্য প্রথম পানি সরবরাহ কার্যক্রম (পানি শোধনাগার) স্থাপিত হয় ১৮৭৪ সালে ঢাকার চাঁদনীঘাটে।

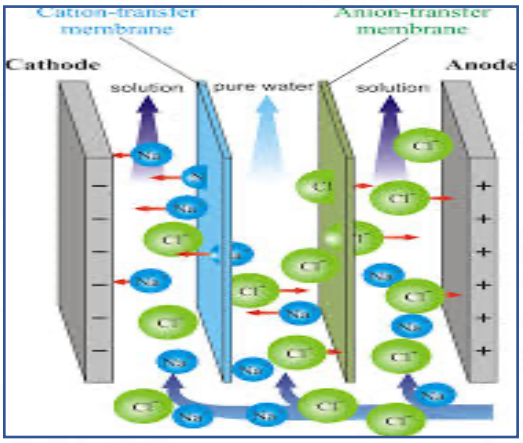
ক্রম.	পানি শোধনাগারের নাম	অবস্থান	সক্ষমতা (দৈনিক)	নির্মাণ
০১.	সায়েদাবাদ পানি শোধনাগার	সায়েদাবাদ, ঢাকা	৯৫ কোটি লিটার	২০০২
২.	পদ্মা-জশলদিয়া পানি শোধনাগার	মাওয়া , মুন্সিগঞ্জ	৪৫ কোটি লিটার	২০১৯
৩.	মদুনাঘাট পানি শোধনাগার	মদুনাঘাট , চট্টগ্রাম	৯ কোটি লিটার	২০২০
৪.	কর্ণফুলী পানি শোধনাগার	রাংগুনিয়া, চট্টগ্রাম	১৪ কোটি লিটার	২০২১
৫.	ভান্ডালজুড়ি পানি শোধনাগার	বোয়ালখালী, চট্টগ্রাম	৬ কোটি লিটার	২০২৫
৬.	গন্ধর্বপুর পানি শোধনাগার	রূপগঞ্জ, নারায়ণগঞ্জ	৫০ কোটি লিটার	২০২৫

■ **Electrodialysis:-** Key components are:-

1. Anode and cathode,
2. Ion-exchange membranes:-

(i)Anion-exchange membranes (AEM),
(ii) Cation-exchange membranes (CEM)},

3. Feed water,
4. Diluate and concentrate streams



■ **Ultrafiltration:-** Water is forced through a semipermeable membrane. Pores in the membrane ranges from 0.01 to 0.1 microns. The typical pressure range is 1-10 bar. *Process steps are:-* Pre-filtration > Pressurization > Membrane separation > Permeate collection > Concentrate removal > Backwashing.

■ **Activated Carbon Absorption:-**

✓ surface area of activated carbon can be exceeding several hundred square meters per gram.
✓ carbon is "activated" by subjecting it to high temperatures (600–1100 °C) in an inert atmosphere, followed by exposure to steam or oxygen.
✓ purification power comes from Van der Waals Forces.

■ **Biochemical Oxygen Demand (BOD):-**

✓ The standard test is known as BOD_5
✓ water sample's DO after being incubated for five days in the dark at 20°C.

BOD Calculation Example

A 15-ml water sample is diluted to 300 ml with nutrient solution and incubated in the dark for five days at 20° C. The initial dissolved oxygen concentration is 9.05 mg/l and the final concentration is 4.25 mg/l. The blank for the dilution water decreased in dissolved oxygen concentration from 9.05 mg/l to 8.80 mg/l. BOD_5 is estimated as:

Oxygen decrease in blank = (9.05 - 8.80) mg/l = 0.25 mg/l

Oxygen decrease in sample = (9.05 - 4.25) mg/l = 4.80 mg/l

$$\text{Dilution factor} = \frac{300 \text{ ml}}{15 \text{ ml}} = 20$$

BOD_5 = (4.80 mg/l - 0.25 mg/l) 20 = 91 mg/l

✓ In general, a higher BOD value indicates a greater level of organic pollution and lower water quality.

✓ BOD is measured in milligrams of oxygen per liter (mg/L).

Chemical Oxygen Demand (COD):-

A water sample is mixed with a strong oxidizing agent, most commonly potassium dichromate ($K2Cr2O7$).

catalyst is commonly used in COD tests? Silver sulfate (Ag_2SO_4)

দ্বিতীয় পত্র

Sulphur and Sulphuric Acid

❖ Yellow color and rotten egg like odor are sulfur's most distinctive features. Melting point is 115°C.

❖ **Native sulphur deposits:-** Active volcanic zones, hot springs and fumaroles, salt domes and sedimentary rock layers, large native Sulphur(S0) deposits like deposits in the Gulf of Mexico and regions of Eastern Europe. Dimethyl sulfide (DMS) produced by decomposing marine phytoplankton is also a major natural sulfur gas source.

❖ **Sulphide minerals:-**

1. Pyrite (FeS2):- Known as "fool's gold". Bioleaching of pyrite yields soluble ferrous sulfate and sulfuric acid. Bioleaching uses bacteria like Acidithiobacillus ferrooxidans or A. thiooxidans to oxidize sulfur and metal sulfides.

2. Chalcopyrite (CuFeS2):- The primary ore for copper.

3. Galena (PbS):- The main ore for lead.

4. Sphalerite (ZnS): The principal ore for zinc.

5. Seafloor massive sulphide (SMS) deposits.

❖ **Sulfate minerals:-** Sulfate minerals contain the sulfate ion $(SO4)^{2-}$

1. Gypsum ($CaSO_4.2H_2O$), 2. Anhydrite ($CaSO_4$), 3. Barite ($BaSO_4$) 4. Celestite ($SrSO_4$)

❖ **Hydrocarbon sources:-** The refining of fossil fuels- 1. Natural gas 2. Petroleum, 3. Tar sands 4. Oil shale.

● **Recovery of Sulfur from Nature:-**

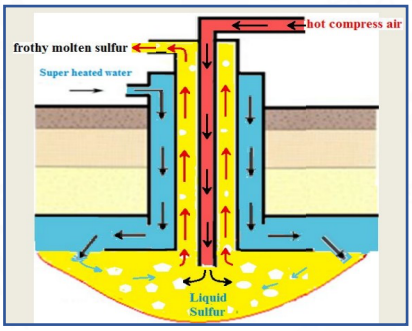
❖ *Recovery from petroleum & natural gas (Claus process):-* Over 90% of the world's sulfur is recovered as a byproduct from hydrocarbon refining. Claus process is a two-step method:-

1. Thermal stage:- $2H_2S + 3O_2 \rightarrow 2SO_2 + 2H_2O$

2. Catalytic stage:- $2H_2S + SO_2 \rightarrow 3S + 2H_2O$

✓ Conventional Claus units achieve 95–97% sulfur recovery. Tail gas treatment unit (TGTU) increases recovery to over 99.9%.

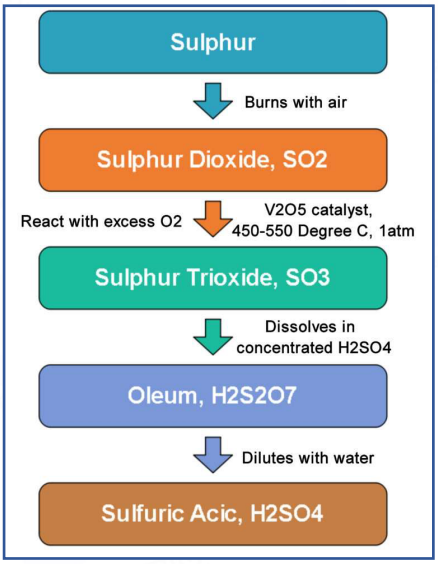
❖ *Recovery from elemental deposits (The Frasch process):-* A major source of sulfur in the 20th century. Three pipes are used in the process.



➢ Outermost pipe (Superheated water (about 165°C)
➢ Innermost pipe (Compressed hot air)
➢ Middle pipe (molten sulfur froth rise to surface)
✓ Typically 99.5% pure Sulfur.

● **Manufacture of Sulphuric acid:-** Two manufacture process of sulphuric acid:- Contact process and Chamber process

1. **The contact process:-** Combusting sulfur to create sulfur dioxide (SO_2)→ catalytically oxidizing this gas to sulfur trioxide (SO_3) → then absorb the SO_3 in concentrated sulfuric acid to form oleum, which is diluted to the desired concentration.



✓ Optimam temperature is approximately 450°C
✓ pressure of 1–2 atmosphere.
✓ Vanadium penta oxide (V2O5) catalyst is used.
✓ Oleum is fuming sulfuric acid. $H_2S_2O_7$ (l)+ SO_3 (g) → H_2SO_4 (l)

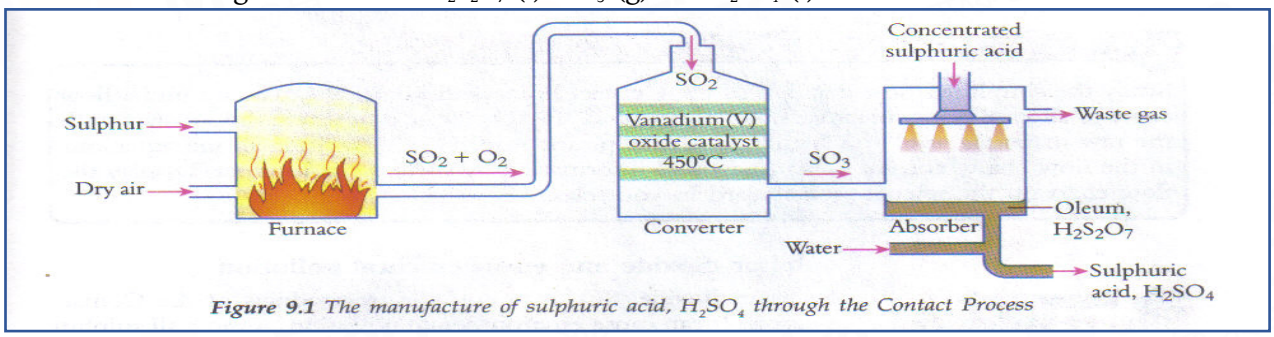


Figure 9.1 The manufacture of sulphuric acid, H_2SO_4 through the Contact Process

➢ *Single Contact, Single Absorption (SCSA):-* Conversion efficiency (96–98%).
➢ *Double Contact, Double Absorption (DCDA):-* Higher conversion rate of over 99.5%

2. **The Chamber process:-** Nitrogen oxides used as a catalyst for the oxidation of sulfur dioxide (SO_2) in large, lead-lined chambers. Yields a less pure acid (max 78%). Usual concentration is 60–70% and often called "chamber acid".

➢ *Process involves three main parts:* 1. Glover tower, 2. lead chambers, 3. Gay-Lussac tower.

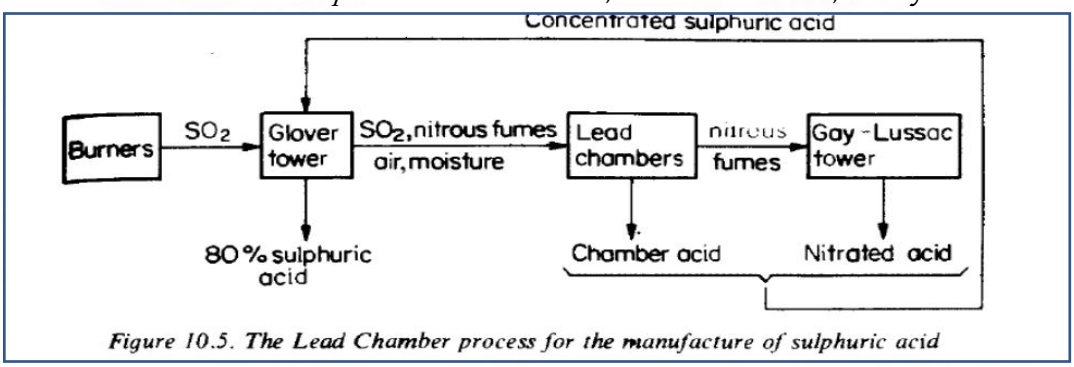


Figure 10.5. The Lead Chamber process for the manufacture of sulphuric acid

Glover tower:- concentrates the dilute acid and recycles the nitrogen oxides.

❖ Pyrosulphuric acid, also known as disulphuric acid or oleum, is a fuming liquid acid with the chemical formula H_2S_2O, formed by adding sulfur trioxide (SO_3) to concentrated sulfuric acid (H_2SO_4).

❖ **Sulfur Trioxide - SO_3 is** Also known as an alternative name for Sulfur Trioxide (SO_3).

Fertilizer industries of Bangladesh

✓ BFA (Bangladesh Fertilizer Association) was established in 1994 which represents both importers and manufacturers.

✓ The import price of Urea is Tk 96/kg; the subsidized rate is around 16/kg.

✓ ২০২৫ সালে ইউরিয়ার চাহিদা ২৭ লক্ষ মেট্রিক টন। সরবরাহ ৫.৭ লক্ষ মেট্রিক টন।

✓ অন্যান্য সারের (TSP, DAP, MOP) চাহিদা ৩২ লক্ষ মেট্রিক টন। সরবরাহ ১১.২৩ লক্ষ মেট্রিক টন।

✓ বর্তমানে দেশে সরকারি ব্যবস্থাপনায় ৮টি সার কারখানা চালু আছে। এদের মোট উৎপাদন ক্ষমতা ২৪ লক্ষ মেট্রিক টন।

✓ বর্তমানে শুধু ইউরিয়া সার উৎপাদনের জন্যই রাষ্ট্রায়াত্ত পাঁচটি কারখানা রয়েছে। এগুলো হলো-চট্টগ্রামের চিটাগং ইউরিয়া ফার্টিলাইজার ফ্যাক্টরি, জামালপুরের যমুনা ফার্টিলাইজার, ব্রাহ্মণবাড়িয়ার আশুগঞ্জ ফার্টিলাইজার অ্যান্ড কেমিক্যাল, নরসিংদীর ঘোড়াশাল-পলাশ ফার্টিলাইজার এবং সিলেটের শাহজালাল ফার্টিলাইজার কোম্পানি লিমিটেড। এগুলোর উৎপাদন সক্ষমতা ৩১ লাখ মেট্রিক টন।

✓ গত ২০২৪ সালে দেশে ইউরিয়া, ট্রিপল সুপার ফসফেট (টিএসপি), ডাই-অ্যামোনিয়াম ফসফেট (ডিএপি) ও মিউরেট অব পটাশ (এমওপি) মিলিয়ে মোট ৪৭ লাখ টন সার আমদানি হয়েছে। আমদানি বেড়েছে ১৯ শতাংশ। যার আর্থিক মূল্য ২৪ হাজার ৭০০ কোটি টাকা।

✓ ২০২৩ সালে ১১ লাখ ৯৭ হাজার টন ইউরিয়া আমদানিতে ব্যয় হয়েছে ৬ হাজার ৫৩২ কোটি টাকা। আর ২০২৩ সালে সর্বমোট সার আমদানির পরিমাণ ছিল ৩৮ লাখ টন।

● ***বাংলাদেশের সরকারি ব্যবস্থাপনায় চলমান সার কারখানাগুলো নিম্নরূপঃ-***

১। ঘোড়াশাল সার কারখানাঃ- ১৯৭৩ সালে প্রতিষ্ঠিত হয়। উৎপাদন ক্ষমতা বছরে ৩ লক্ষ ৪০ হাজার মেট্রিক টন ইউরিয়া সার। প্রতি বছর ১ লাখ ২২ হাজার টন উৎপাদিত হয়, যা জাতীয় ইউরিয়া চাহিদার ৩৫%

২। ফেঞ্চুগঞ্জ সার কারখানাঃ- ১৯৩১ সালে স্থাপিত হয়। এর বর্তমান বার্ষিক ক্ষমতা হলো ১ লক্ষ ৬০ হাজার মেট্রিক টন ইউরিয়া সার এবং ১২,৫০০ মেট্রিক টন এ্যামোনিয়া সালফেট সার।

৩। আশুগঞ্জ সার কারখানাঃ- ১৯৮১ সালের আগষ্ট মাসে উৎপাদন শুরু। বার্ষিক ৫ লক্ষ ৩০ হাজার মেট্রিক টন ইউরিয়া সার উৎপাদন ক্ষমতা সম্পন্ন। এটি দেশে স্থাপিত সর্ববৃহৎ সার কারখানা।

৪। যমুনা সার কারখানাঃ- ১৯৯১ সালের ডিসেম্বর মাসে উৎপাদন শুরু হয়। দৈনিক উৎপাদন ক্ষমতা এক হাজার মেট্রিক টন এমোনিয়া এবং ১৭০০ মেট্রিক টন ইউরিয়া। বার্ষিক ইউরিয়া উৎপাদন গড়ে প্রায় ৫ লক্ষ ৬১ হাজার মেট্রিক টন।

৫। পলাশ ইউরিয়া সার কারখানাঃ- ১৯৮৫ সালে এখানে উৎপাদন শুরু হয়। বার্ষিক উৎপাদন ক্ষমতা প্রায় এক লক্ষ মেট্রিক টন।

৬। চট্টগ্রাম ইউরিয়া সার কারখানাঃ- বার্ষিক উৎপাদন ক্ষমতা ৫ লক্ষ ৬১ হাজার টন ইউরিয়া এবং ৩ লক্ষ ৬০ হাজার টন অ্যামোনিয়া। প্রধানত সার রপ্তানির উদ্দেশ্য এটি প্রতিষ্ঠিত হয়েছে ।

৭। চট্টগ্রাম ট্রিপল সুপার ফসফেট সার কারখানাঃ- এটি দুইটি প্রকল্প বিশিষ্ট কারখানা। প্রথমটি ১৯৬৮ সালে চালু হয় এবং দ্বিতীয়টি ১৯৭৪ সালে উৎপাদন শুরু করে। প্রথম প্রকল্পটির উৎপাদন ক্ষমতা বার্ষিক ৩২ হাজার মেট্রিক টন এবং দ্বিতীয়টির উৎপাদন ক্ষমতা ১ লক্ষ ২০ হাজার মেট্রিন টন।

৮। কর্ণফুলী ইউরিয়া সার কারখানাঃ- বাংলাদেশ ও জাপানের যৌথ সহযোগিতায় ১৯৯৪ সালে এ কারখানাটি স্থাপিত হয়। বার্ষিক উৎপাদন ক্ষমতা প্রায় ৫.৬১ লক্ষ মেট্রিক টন ইউরিয়া সার।

✓ এছাড়াও খুলনায় বার্ষিক ৪.৫৮ লক্ষ মেট্রিক টন উৎপাদন ক্ষমতাসম্পন্ন একটি টি.এস.পি. সার কারখানা স্থাপনের সরকারি পরিকল্পনা রয়েছে। অন্যদিকে ফেঞ্চুগঞ্জে জালালাবাদ ইউরিয়া সার কারখানা এখন নির্মাণাধীন রয়েছে।

- ***যৌথ উদ্যোগে স্থাপিত সার কারখানাঃ-***

১। কর্ণফুলী ফার্টিলাইজার কোম্পানি লিমিটেড (KAFCO): বাংলাদেশ সরকার, BCIC এবং জাপান, ডেনমার্ক এবং নেদারল্যান্ডসের বেসরকারি বিনিয়োগকারীদের যৌথ মালিকানাধীন। এটি ইউরিয়ার একটি প্রধান উৎপাদক এবং অ্যামোনিয়া রপ্তানিও করে।

- ***বেসরকারি উদ্যোগে স্থাপিত সার কারখানাঃ-***

১। এসিআই সার: ২০০৪ সালে প্রতিষ্ঠিত এসিআই গোদরেজ অ্যাগ্রোভেট ঢাকার একটি বেসরকারি উৎপাদনকারী প্রতিষ্ঠান যারা জৈব সারের উৎপাদক।

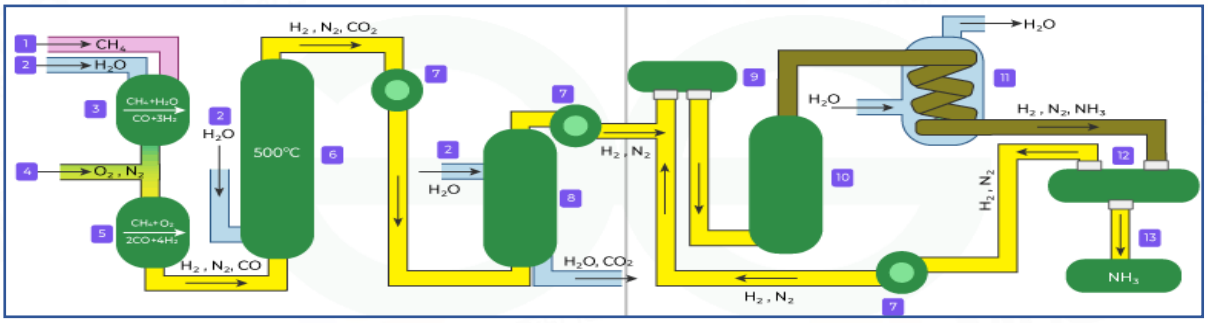
২। ইউনিয়ন ফার্টিলাইজার: মির্জা গ্রুপের একটি সহযোগী প্রতিষ্ঠান, এই কোম্পানিটি মূলত আন্তর্জাতিক বাজার থেকে সার আমদানি করে এবং সারা বাংলাদেশে বিতরণ করে।

৩। অর্গানিক নিউট্রিশন লিমিটেড: ২০১৬ সালে প্রতিষ্ঠিত ঢাকা ভিত্তিক এই প্রতিষ্ঠানটি জৈব সার উৎপাদন ও বিপণনে কাজ করছে।

৪। ইস্পাহানি অ্যাগ্রো লিমিটেড (আইএএল): জৈব-কীটনাশক এবং জৈব-ভিত্তিক ফাঁদ সহ পরিবেশ-বান্ধব কৃষি-উৎপাদন সরবরাহ করে।

- **Ammonia:-** Common form includes anhydrous ammonia (82% N) which can be converted to aqua ammonia (NH_4OH), or liquid ammonia dissolved in water; Urea (NH_2CONH_2), Ammonium Sulfate $(NH_4)_2SO_4$) & ammonium nitrate (NH_4NO_3), which provides nitrogen in ammonium and nitrate forms.
- ***Haber-Bosch process for Ammonia production:-*** The Haber-Bosch process is the primary industrial method for producing ammonia (NH_3) by reacting nitrogen (N_2) with hydrogen (H_2) under high temperatures and pressures, using an iron-based catalyst. The chemical reaction is as follows:-

$$N_2\ (g) + 3H_2\ (g) \rightleftharpoons 2NH_3\ (g) \qquad \Delta H = -92.4\ kj/mol$$



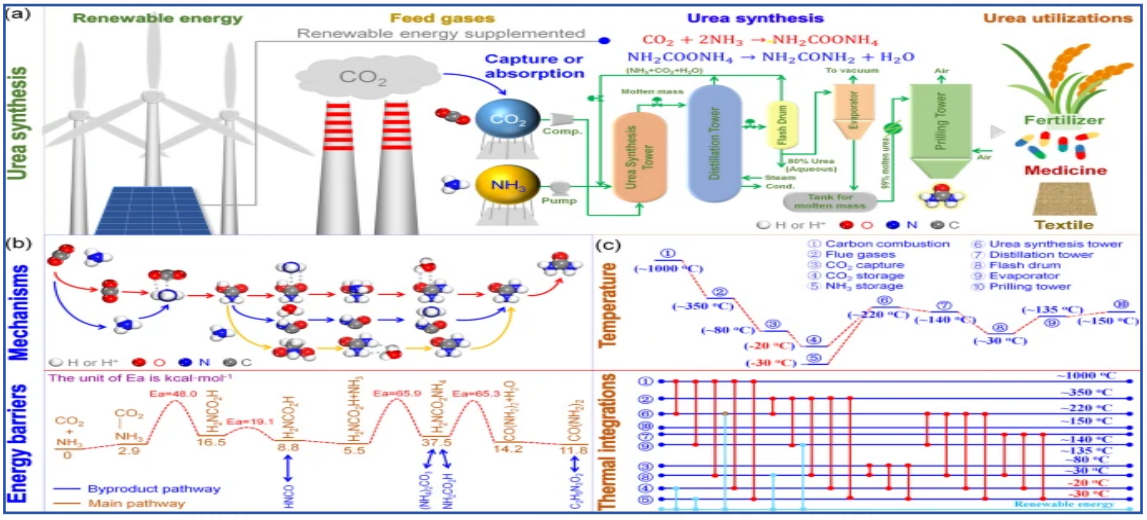
✓ H_2 is most commonly produced through Steam Methane Reforming (SMR).
✓ SMR produces carbon monoxide (CO) and H_2 as byproducts.
✓ Purified N_2 and H_2 are mixed in 1:3 ratio & compressed to high pressure (150-300 atm). This mixture is passed through a reactor containing a finely divided iron-based catalyst at high temperatures (400°C-500°C).
✓ In Haber-Bosch process Ammonia Conversion rate is only 15%

■ **Urea:-**

✓ chemical formula $CO(NH_2)_2$.
✓ Friedrich Wöhler in 1828 converted the inorganic compound ammonium cyanate ($[NH_4][OCN]$) or CH_4N_2O into urea.
✓ Approximate nitrogen content of Urea is 46% (commonly cited as ~47%)
✓ Urea has the highest nitrogen content of all common solid nitrogenous fertilizers.

❖ *Urea production is based on two main reactions:-*

1. Formation of ammonium carbamate (NH_2COONH_4 or $[NH_4][H_2NCO_2]$)



❖ **Biuret Formation:** Two moles of urea are converted into one mole of biuret and one mole of NH_3 by heating.

$2NH_2CONH_2$ -----> NH_2-CO-NH-CO-NH_2 + NH3

➢ The following conditions are favourable for biuret formation:-
  ✓ High residence times.
  ✓ High temperature.
  ✓ Low amount of water.

➢ Biuret in urea can be used as a slow-release nitrogen (N) fertilizer and a non-protein nitrogen source for ruminants.

■ **Triple Super Phosphate (TSP):-**

✓ Triple superphosphate is a fertilizer containing about 20% total P (44-48% P_2O_5)
✓ It is over 90% water-soluble.
✓ TSP also contains 13-15% calcium (Ca) and upto 4% residual phosphoric acid (H_3PO_4).

■ **Modern and sustainable technologies:-**

✓ Use of nano urea in Bangladeshi agriculture could reduce fertilizer costs by up to 50%,
✓ Developed by Professor Dr. Javed Hossain Khan, where Traditional urea fertilizer costs 4,200 BDT per bag, nano urea can be applied for 230 BDT per bigha!
✓ Urea Deep Placement (UDP) allows placing briquetted urea directly into plant root zones, reducing nitrogen loss significantly upto 30%
✓ Bio-organic fertilizer technology in Bangladesh can reduce urea usage by 30% urea, and 100% TSP replacement.
✓ About 65-70% of nitrogen applied as fertilizer in Bangladesh is typically lost to the environment.

Sugar Industry

✓ Globally, about 80% of sugar is extracted from sugar cane, grown in the tropics
✓ 20% from sugar beet, grown mostly temperate climate in North America or Europe.
✓ As of 2019, 3/4 of world sugar production is never traded on the open market.
✓ Brazil controls half the global market, paying the most ($2.5 billion per year) in subsidies to its sugar industry.
✓ আখ থেকে চিনি উৎপাদনের বৈশ্বিক গড় হার ১০-১২%
✓ ভারতে এই হার গড়ে ১০% এবং পাকিস্তানে ৯.৮%
✓ বাংলাদেশের মিলগুলোতে এই হার মাত্র ৫.৫-৬%
✓ বাংলাদেশ তার বার্ষিক চিনির চাহিদার প্রায় ৫% দেশীয় উৎপাদনের মাধ্যমে পূরণ করতে পারে।
✓ দেশের চিনিকলে বছরে ২.১ লক্ষ টন চিনি উৎপাদনের ক্ষমতা রয়েছে।
✓ প্রায় ৫ কোটি মানুষ চিনি শিল্পের উপর নির্ভরশীল।
✓ বাংলাদেশ চিনি উৎপাদন খরচ দাঁড়ায় প্রতি কেজি ২৬০ টাকা।
✓ এই চিনি বিক্রি হয় ১২৫ টাকা কেজি দরে।
✓ ফলে, প্রতি কেজিতে লোকসান হয় ১৩৫ টাকা।

Country	Production (Tons)
Brazil	672,157,000
India	285,029,000
People's Republic of China	116,251,272
Thailand	66,816,400
Pakistan	50,045,400
Mexico	49,492,700
Colombia	38,500,000
Philippines	32,500,000
Australia	30,284,000
Argentina	29,000,000
World	**1,743,068,525**

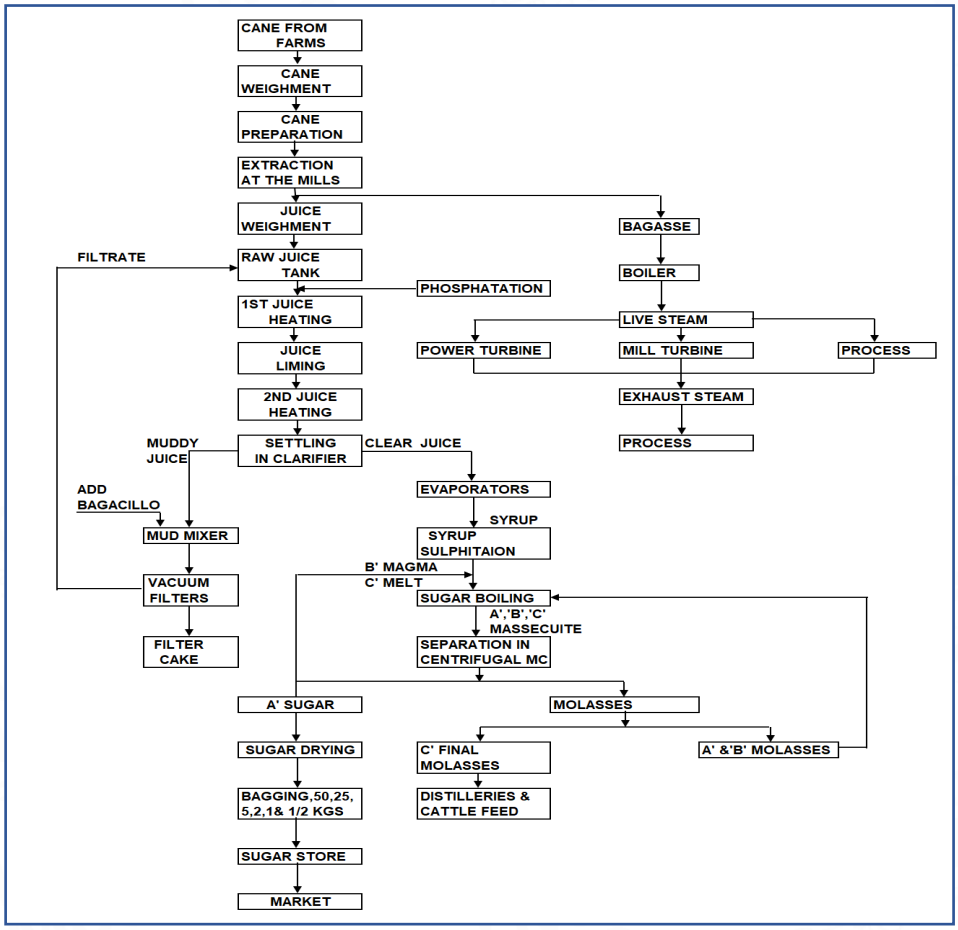
By-products:-

1. **Molasses:-** used as a sweetener in baking, fermentation agent for producing rum & ethanol & supplement in animal feed.

2. **Bagasse:-** burned as a fuel to generate electricity, produce paper and hardboard.

3. **Filter Cake (Press Mud):-** used as fertilizer and soil conditioner.

4. **Jaggery (gur):** popular in parts of Asia as a traditional sweetener.



- **Function of lime on cane juice:-**

✓ Adjust the pH levels of sugar juice.
✓ Aids in the juice clarification process, resulting in a cleaner sugar juice.
✓ Assists in the removal of unwanted colorants to produce white, refined sugar.
✓ Promotes precipitation of impurities like calcium carbonate & magnesium hydroxide.
✓ Prevent microbial growth in the juice, enhancing overall quality & shelf life of sugar.

- **বাংলাদেশের চিনি শিল্প;-**

✓ বাংলাদেশে ১৫টি চিনিকল, ১টি ইঞ্জিনিয়ারিং কারখানা ও ২টি বাণিজ্যিক প্রতিষ্ঠান আছে।
✓ কেরু অ্যান্ড কোম্পানি (বাংলাদেশ) লিমিটেড এর সাথে একটি ডিস্টিলারি প্লান্ট ও একটি জৈবসার কারখানা রয়েছে।
✓ বাংলাদেশে ৭ টি চিনি পরিশোধনকারী প্রতিষ্ঠান রয়েছে, যারা বিদেশ থেকে অপরিশোধিত চিনি (র' সুগার) আমদানী করে তা পরিশোধনের মাধ্যমে বাজারজাত করে থাকে।
✓ দেশবন্ধু চিনি কল লিমিটেড চিনি পরিশোধনের মাধ্যমে বাজারজাত করার পাশাপাশি চিনি উৎপাদনও করে।
✓ দেশে বার্ষিক চিনির চাহিদা প্রায় ২২ লাখ টন।
✓ ২০২৫ সালের আগস্ট পর্যন্ত গুদামগুলোতে প্রায় ৩৫ হাজার টন চিনি অবিক্রিত রয়ে গেছে।
✓ ২০২৩-২৪ অর্থবছরে নিট লোকসান দাঁড়িয়েছে ৫০৮ কোটি ২৪ লাখ টাকা।
✓ একমাত্র কেরু অ্যান্ড কোম্পানি ২০২৩-২৪ অর্থবছরে ৮৫ কোটি টাকার বেশি মুনাফা করেছে-যা আগের বছরের তুলনায় ৩২ শতাংশ বেশি। তবে এই মুনাফা হয়েছে কেবল তাদের ডিস্টিলারি ব্যবসা থেকে। চিনি ইউনিটের লোকসান ৬০ কোটির বেশি।

বাংলাদেশের কয়লাখনি

✓ বাংলাদেশে ১৯৫৯ সালে সর্বপ্রথম কয়লা আবিষ্কৃত হয়।
✓ দেশে কয়লাখনির মোট সংখ্যা ৫টি।
✓ আবিষ্কৃত সকল কয়লাখনিই দেশের উত্তর-পশ্চিমাঞ্চলে অবস্থিত।
✓ বিশ্বে কয়লার সবচেয়ে বড় খনি যুক্তরাষ্ট্রের ওয়াইয়োমিংয়ের নর্থ অ্যান্টিলোপ রোশেল কোল মাইন। যাতে কয়লার উত্তোলনযোগ্য মজুদ ১৭০ কোটি টন।

✓ বাংলাদেশে ভূগর্ভস্থ কয়লার সবচেয়ে বড় মজুদটি জয়পুরহাটের জামালগঞ্জে। যার সম্ভাব্য মোট পরিমাণ ৫৫০ কোটি টন।

✓ বিশেষজ্ঞরা বলছেন, এর একদশমাংশও (৫৫ কোটি টন) যদি উত্তোলন করা যায়, তাহলেও খনিটি উত্তোলনযোগ্য কয়লার মজুদের দিক থেকে বিশ্বের শীর্ষ ১০ খনির তালিকায় উঠে আসবে।

বিশ্বের বৃহত্তম কয়লা খনিগুলোর উত্তোলনযোগ্য মজুদ

খনি	দেশ	মজুদ (টন)
নর্থ অ্যান্টিলোপ রোশেল	যুক্তরাষ্ট্র	১৭০ কোটি
হায়েরউসু	চীন	১৬০ কোটি
হেই দাই গোউ	চীন	১৫০ কোটি
রাসপাদস্কায়া	রাশিয়া	১৩৪ কোটি
মোয়াটিজ	মোজাম্বিক	৯৮ কোটি ৫৭ লাখ
ব্ল্যাক থান্ডার	যুক্তরাষ্ট্র	৮১ কোটি ৬৫ লাখ
পিক ডাউনস	অস্ট্রেলিয়া	৭১ কোটি ৮০ লাখ
মাউন্ট আর্থার	অস্ট্রেলিয়া	৫৯ কোটি ১০ লাখ
গুনিয়েলা রিভারসাইড	অস্ট্রেলিয়া	৫৪ কোটি ৯০ লাখ
সারাজি	অস্ট্রেলিয়া	৫০ কোটি ২ লাখ

সূত্র : মাইনিং টেকনোলজি

✓ ১৯৬২ সালের প্রথম অনুসন্ধানে খনির আয়তন নির্ধারণ করা হয়েছিল ১১ দশমিক ৬৬ বর্গকিলোমিটার।
✓ পরের জরিপে এর সম্ভাব্য আয়তন নির্ধারণ হয় ৬৪ বর্গকিলোমিটার।
✓ বাংলাদেশের অন্যান্য কয়লা খনির গভীরতা যেখানে ১২০ থেকে ৫০০ মিটার সেখানে জামালগঞ্জের কয়লা ৯০০ থেকে ১ হাজার মিটার গভীরে অবস্থিত।
✓ এত গভীর থেকে কয়লা উত্তোলন কঠিন এবং অত্যন্ত ব্যয়বহুল।

কয়লা খনি ৫ (পাঁচ) টি

খনির নাম ও অবস্থান	আবিষ্কারক ও আবিষ্কারের সন	গভীরতা (মিটার)	মজুদ (মি.টন)
বড়পুকুরিয়া, দিনাজপুর	জিএসবি, ১৯৮৫	১১৭-৫০৬	৩৮৯
দীঘিপাড়া, দিনাজপুর	জিএসবি, ১৯৯৫	৩২৮-৪৫৫	১৫০
খালাসপীর, রংপুর	জিএসবি, ১৯৮৯	২৯৭-৪৮২	৬৮৫
ফুলবাড়ী, দিনাজপুর	বি.এইচ.পি মিনারেলস, ১৯৯৭	১৫০-২৪০	৩৮৭
জামালগঞ্জ, জয়পুরহাট	জিএসবি, ১৯৫৯	৬৪০-১১৫৮	১০৫৪

✓ **বড়পুকুরিয়া কয়লাখনি** বাংলাদেশের একমাত্র বাস্তবায়িত কয়লা খনি। এটি দিনাজপুরের পার্বতীপুরে অবস্থিত।
✓ এটি আবিষ্কৃত হয় ১৯৮৫ সালে। এর আয়তন ৬.৬৮ বর্গ কিলোমিটার।
✓ এখানে কয়লা মজুদের পরিমাণ ৩৯০ মিলিয়ন মেট্রিক টন। এখানে বিটুমিনাস কয়লা পাওয়া যায়।
✓ ২০০৫ সালের সেপ্টেম্বর মাস থেকে বড়পুকুরিয়া কয়লাখনি থেকে বাণিজ্যিকভাবে কয়লা উৎপাদন শুরু হয়।

Coal

✓ Barapukuria coal has a higher volatile matter content and carbon content of 56.47%.
✓ The composition of coal ash from Barapukuria includes significant amounts of silica (SiO_2), alumina (Al_2O_3), and iron oxide (Fe_2O_3).

Coal field (district)	Depths of coal seam (in meter)	Estimated Reserve (million ton)	Coal Compositions (%)				Calorific value	Status
			FC	VM	Ash	S		
Jamalganj (Joypurhat)	640-1158	1053	47	38	22	0.62	11000	Mining not feasible economically
Barapukuria (Dinajpur)	118-506	303	45.5 -54.7	2.28 -3.60	11.79- 23.71	0.43 -1.33	10547-12529	Underground mine started production
Khalashpir (Rangpur)	257-451	147	32.0 -80.8	32.0-80.8	2.93-30.47	7.6-50.51	0.24-3.15	Undeveloped
Dighipara (Dinajpur)	250	200	51.3 -65.6	25.3-38.23	2.64-20.05	0.51-1.02	10200-1477	Undeveloped
Phulbari (Dinajpur)	152-246	572	-----	-----	-----	-----	------	Open pit mine feasibility study undertaken in 2004

Source: Bangladesh Oil, Gas and Mineral Corporation (PteroBangla); 2017.

■ **Coal : Carbonization:-** Carbonization of coal can be carried out at the following three temperature ranges.

1. Low temperature carbonization:- 500^{0}C to 700^{0}C.
2. Medium temperature carbonization:- about 800^{0}C. Rarely practiced these days.
3. High temperature carbonization:- above 900^{0}C. produces hard coke.

■ **Coal : Gasification:-**

✓ The produced "syngas" consists carbon monoxide, carbon dioxide, hydrogen, hydrogen sulfide etc.

✓ "Syngas" can be used for a range of applications including:

1. Hydrogen Production
2. Synthetic Natural Gas
3. Methanol Production
4. Ammonia Production

✓ It can also be burned directly within an integrated gasification combined cycle power plant to generate electricity.

■ **Atmospheric Distillation:-**

✓ It can only separate the lighter fractions that can be vaporized below 400°C.

✓ Crude oil must first be desalted by heating to 100-150 °C temperature and mixing with 4-10% fresh water to dilute.

✓ The pressure at the top is maintained at 1.2–1.5 atm.

■ **Thermal Cracking:-**

✓ High temperature:- between 450°C to 900°C, depending on the desired products.

✓ High pressure: Ranging up to 70 atmospheres.

✓ Absence of a catalyst: High-energy conditions cause the molecular bonds to break.

■ **Catalytic Cracking:-**

✓ Temperature ranges between 475°C to 530°C

✓ Pressure ranging up to 20 atmospheres.

✓ Used to obtain fuel with octane number 65-70.

■ **Catalytic Reforming:-**

✓ Temperature ranges between 490°C to 540°C.

✓ Pressure range is Moderate.

✓ bifunctional catalysts consisting of platinum (Pt) on a chlorinated alumina support.

✓ Rhenium (Re) and tin (Sn) are often added as co-catalysts

■ **Hydrocracking:-** It combines two primary chemical reactions in a single process: Catalytic cracking and hydrogenation.

✓ High temperatures between 280°C and 475°C (540°F to 890°F)

✓ Pressures ranging from 35 to 215 bar.

✓ Utilizes bifunctional catalysts. nickel, molybdenum, platinum, or palladium supported on materials such as zeolites.

✓ The hydrogen also helps to remove impurities such as sulfur and nitrogen, which are converted into hydrogen sulfide & ammonia.

■ **Common Petroleum Products:-**

✓ **Fuels:-** Gasoline **(Petrol),** Diesel, Jet Fuel **(Kerosene),** Liquefied Petroleum Gas **(LPG),** Fuel Oil etc.

✓ **Materials:-** Asphalt**/Bitumen, Lubricating Oil,** Paraffin Wax.

✓ **Petrochemicals (Chemical Feedstocks):-** Plastics, Synthetic Rubber, Solvents, Fertilizers, Pharmaceuticals **and** Cosmetics**:** Mineral oil, tar, and other petroleum derivatives are used in many creams, perfumes, and medicines.

✓ **Other Materials:** Feedstocks for making paints, synthetic fibers, detergents, dyes, and many other industrial and consumer goods.

বাংলাদেশের পেট্রোলিয়াম পরিশোধন শিল্প

✓ রাষ্ট্রায়ত্ত খাতে দেশের একমাত্র জ্বালানি তেল শোধনাগার ইস্টার্ণ রিফাইনারী লিমিটেড (ইআরএল)।

✓ চট্টগ্রামের কর্ণফুলী নদীর তীরবর্তী উত্তর পতেঙ্গা এলাকায় প্রায় দুইশত দুই একর জায়গা জুড়ে বিস্তৃত।

✓ সৌদি আরব এবং সংযুক্ত আরব আমিরাত থেকে আমদানিকৃত যথাক্রমে এরাবিয়ান লাইট ক্রুড অয়েল ও মারবান ক্রুড অয়েল পাতন প্রক্রিয়ায় পরিশোধনের মাধ্যমে বিভিন্ন ধরনের পেট্রোলিয়ামজাত পণ্য উৎপাদন ও দেশব্যাপী সরবরাহ করা হয়।

✓ বাংলাদেশে ইআরএল ছাড়াও বসুন্ধরা অয়েল অ্যান্ড গ্যাস কোম্পানি লিমিটেড-এর একটি বেসরকারি তেল শোধনাগারও রয়েছে.

✓ ইআরএল'এ উৎপাদিত পেট্রোলিয়ামজাত পণ্যসমূহের মধ্যে লিকুইফাইড পেট্রোলিয়াম গ্যাস (এলপিজি), স্পেশাল বয়েলিং পয়েন্ট সলভেন্ট (এসবিপিএস), মোটর গ্যাসোলিন রেগুলার (পেট্রোল), মোটর গ্যাসোলিন প্রিমিয়াম (অকটেন), ন্যাফথা, মিনারেল টার্পেনটাইন (এমটিটি), সুপিরিয়র কেরোসিন অয়েল (এসকেও), এভিয়েশন টারবাইন ফুয়েল (জেট এ-১), হাই স্পীড ডিজেল (এইচএসডি), জুট ব্যাচিং অয়েল (জেবিও), লাইট ডিজেল অয়েল (এলডিও), ফার্নেস অয়েল (এফও) ও বিটুমিন অন্যতম।

✓ ইআরএল উৎপাদিত ন্যাফথা বিদেশে রপ্তানি করা হয়।

Glass

✓ Glasses primarily contain soda (Na_2O), lime (CaO), and silica (SiO_2) as their primary constituents.

✓ Glass = 16 wt% Na_2O + 10 wt% CaO + 74 wt% SiO_2

✓ Temperatures in excess of 2000°C must be attained to work pure silica glasses.

- ✓ Soda (Na_2O) is a flux that reduces the melting temperature of the silica.
- ✓ Lime (CaO) acts as a stabilizer.
- ✓ With 24-28% PbO, the glass is considered "crystal," & in higher amounts creates an x-ray absorptive glass.
- ✓ Soda (Na_2O) & Lithia (Li_2O) make for good x-ray transmittive glasses.
- ✓ chromia (Cr_2O_3) gives a green, neodymium (III) oxide (Nd_2O_3) colors glass purple, iron (III) oxide (Fe_2O_3) lends a green tint.

Element	Type of glass				
	Fused silica	Soda-lime silica	Boro-silicate glass	Alumo silicate glass	lead borate glass
SiO2	100%	60- 75%	70-81%	62%	54-65%
Al2O3		1%	2-7%	17%	2%
CaO		5-12%		8%	
MgO		4%		7%	
Na2O		12-18%	4-8%	1%	13-15%
K2O					
B2O3			7-13%	5%	
PbO					18-38%

- ✓ Iron (II) oxide (FeO) also couples with infrared, resulting in an IR-absorptive glass.
- ✓ Reducing FeO to Fe_2O_3 in glasses can transform a heat-absorptive glass into an IR-transmissive glass.

Ceramics

Ceramics are inorganic, non-metallic solid materials made from inorganic compounds such as:- Clay (Al_2O_3. $2SiO_2$. $2H_2O$), Silica (SiO_2), Feldspar, potassium oxide (K_2O), sodium oxide (Na_2O), magnesium oxide (MgO), iron oxide (Fe_2O_3), Bone Ash, Alumina (Al_2O_3), Silicon carbide (SiC), Silicon nitride (Si_3N_4),

Constituents	% by Mass
Silicon dioxide (SiO_2)	66.57
Aluminium Oxide (Al_2O_3)	21.60
Iron Oxide(Fe_2O_3)	1.41
Calcium Oxide(CaO)	2.41
Sodium Oxide (Na_2O)	1.41
Potassium Oxide(K_2O)	2.79
Zirconium Oxide (ZrO_2)	1.49

- ✓ **Nano ceramics:-** grain size, grain boundary width, second phase distribution, and defect size are all below 100 nm and have inherent characteristics of nanomaterials.
- ✓ **Ceramic separation membrane:-** composed of Al_2O_3, ZrO_2, TiO_2 & SiO_2. Generally, the pore size of separation membrane is: 2~50nm.
- ✓ **Biomimetic composite ceramics:-** SiC ceramics form a Si_3N_4 surface layer through N_2
- ✓ **Substrate material:-** diamond (C), cubic boron nitride (BN), beryllium oxide (BeO), silicon carbide (SiC), aluminum nitride (AlN), Boron carbide (B_4C).
- ✓ **dielectric material:-** based on $SrTiO_3$

Major Components	Chemical Composition (% by mass)		
	Ceramic powder	Porcelain powder	Ordinary Portland Cement Standard
SiO_2	66.39	73.04	21.03
CaO	3.64	1.43	64.67
Al_2O_3	18.14	19.39	6.16
Fe_2O_3	3.79	1.42	2.58
MgO	3.60	1.58	2.62
K_2O	3.39	2.56	0.61

Cement

GENERAL FEATURES OF THE MAIN TYPES OF PORTLAND CEMENT

ASTM Type	Classification	Characteristics	Applications
Type I	General purpose	Fairly high C_3S content for good early strength development	General construction (most buildings, bridges, pavements, precast units, etc)
Type II	Moderate sulfate resistance (Modified cement)	Low C_3A content (<8%)	Structures exposed to soil or water containing sulfate ions
Type III	High early strength (Rapid-hardening)	Ground more finely, may have slightly more C_3S	Rapid construction, cold weather concreting
Type IV	Low heat of hydration (slow reacting)	Low content of C_3S (<50%) and C_3A	Massive structures such as dams. Now rare.
Type V	High sulfate resistance	Very low C_3A content (<5%)	Structures exposed to high levels of sulfate ions
White	White color	No C_4AF, low MgO	Decorative (otherwise has properties similar to Type I)

- **Strength of Cement:-**

✧ **MC 22.5X** – Masonry cement (denoted by the 'MC'). 'X' means that the cement does not contain an air-entraining or trapping agent.

✧ **32.5N** – Standard cement for general applications. 'N' denotes normal strength. This is the most widely used type of cement.

✧ **32.5R** – 'R' denotes rapid strength. This cement cures quickly at average ambient temperatures (10 – 15°C) and with constructions of standard thicknesses (< 50 cm).

✧ **42.5N** – Stronger class of cement, able to withstand higher pressures and loads. Often used in builds that require the strength of concrete at 28 days exceed 30 N/mm^2.

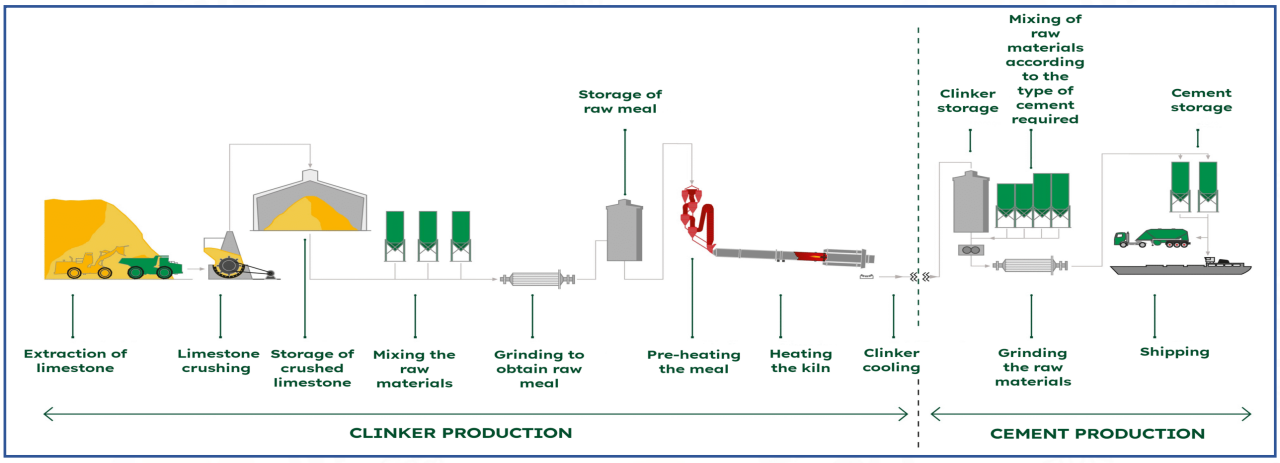
✧ **52.5-** used where a higher initial compressive strength is required.

- **Cement Manufacturing processes:-** can be divided into two basic steps:

1. Clinker production:- Clinker (the main constituent of cement) is first made in a kiln with gas up to 2000°C, which heats raw materials such as limestone/calcium carbonate ($CaCO_3$), iron oxide (Fe_2O_3), alumina (Al_2O_3) and silica (SiO_2) to 1,450°C.

This near-molten material is rapidly cooled to a temperature of 100 - 200°C.

3. Cement Production:- Clinker is then ground with gypsum (about 4-5%) and other materials to produce the grey powder known as cement.



Caustic-Chlorine Industries

➢ The chlor-alkali process uses electrolysis of a sodium chloride (brine) solution to produce caustic soda (NaOH), chlorine gas (Cl_2), and hydrogen gas (H_2).

Reaction:- $2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$

➢ Three types of electrolytic cells are used:-

- **Mercury Cell:-** This cell has two products:- (i) Hot, wet chlorine (ii) Sodium amalgam

This method produces 71% of NaOH.

- **Diaphragm Cell:-** This process utilizes asbestos or alternate substitutes to asbestos, to separate the co-products Sodium Hydroxide (Caustic Soda) and Chlorine. The diaphragm cell produces a very weak 'cell liquor,' that contains 12-14% NaOH. cell liquor is subsequently evaporated in a three or four 'effect' evaporation to a final concentration of

50% NaOH. This method produces the lowest quality electrochemical NaOH solutions.

- **Membrane Cell:-** This method produces approximately 13% of NaOH.
  This method utilizes a selective membrane that separates the Chloride and Sodium ions.

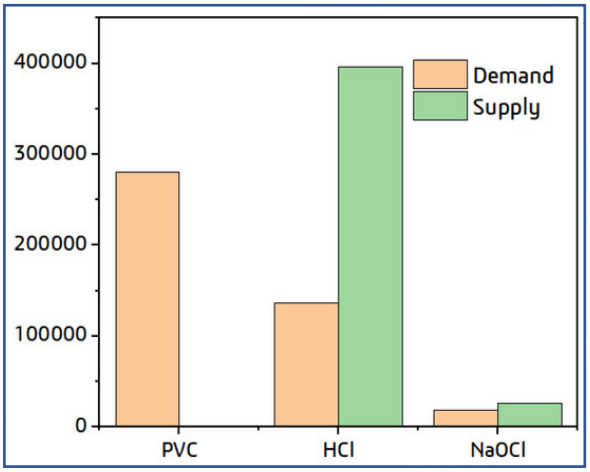
- **Production of soda ash:-** The Solvay process results in soda ash (sodium carbonate (Na2CO3) from brine (sodium chloride (NaCl)) and from limestone (calcium carbonate (CaCO3)). The overall process is:

  $2NaCl + CaCO_3 \rightarrow Na_2CO_3 + CaCl_2$

✓ Ammonia (NH_3) Acts as a catalyst and is recycled within the process.
✓ This process produces approximately three-fourths of the world's soda ash supply.
✓ The experiment used a temperature of 20°C, a CO_2 flow rate of 1.54 L/min, and an NH_3 to NaCl molar ratio of 3.3.
✓ **CO_2 Capture:** A specific modified process attained 86% CO_2 sequestration efficiency.

- **Caustic - chlorine industry in Bangladesh:-**

✓ Anticipated growth rate of Bangladesh's Caustic Soda market is 12.39% by 2027.
✓ The growth rate starts at 11.42% in 2025 and reaches 14.75% by 2029.
✓ The current domestic demand for chlor-alkali-generated caustic soda is 400,000 MT.
✓ In Bangladesh, only five companies produce chlor-alkali by membrane cell technology:- ***1.*** *Tasmin Chemical Complex Ltd.* ***2.*** *Samuda Chemical Ltd.* ***3.*** *Global Heavy Chemicals Ltd. (GHCL)* ***4.*** *ASM Chemical Industries Ltd. (ASM)* ***5.*** *SR Chemical Industries Ltd.*
✓ Globally, 40% of Cl_2 from chlor-alkali process is utilized in PVC production.
✓ In India, it is 6.64% and in Bangladesh, it is 0%.
✓ Recently, Meghna Group of Industries (MGI) is ongoing with a PVC resin production plant named 'Meghna PVC' in production from September 2022.
✓ The production capacity of the plant is only 150,000 MT of PVC resin.

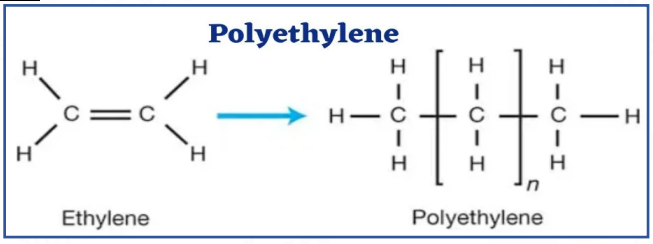


The figure above presents the demand and supply bar chart of PVC, HCL, and NaOCl in BD.

Plastic Industry

■ **Polyethylene (PE):-**

✓ It is the most widely used plastic.
✓ Melting point:- LDPE melts around 105–115°C while HDPE melts between 120–140°C.



❖ *Common types of polyethylene are:-*

1. High-Density Polyethylene (HDPE)- It is rigid and offers high impact strength. .

2. Low-Density Polyethylene (LDPE)- LDPE is very flexible.

3. Linear Low-Density Polyethylene (LLDPE)- higher tensile strength and better puncture resistance .

4. Ultra-High-Molecular-Weight Polyethylene (UHMWPE)- It is known for its exceptional impact and abrasion resistance.

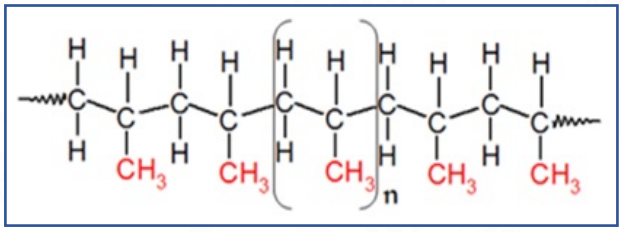
5. Cross-Linked Polyethylene (PEX or XLPE)- A thermoset version of PE with strong cross-linked bonds. It is used in critical applicat.

✓ Catalysts are used such as Ziegler-Natta or chromium oxide.

➢ Ziegler-Natta Catalyst is comprised of a transition metal halide, such as titanium tetrachloride ($TiCl_4$) and an alkyl aluminum compound like triethylaluminum (Et_3Al).

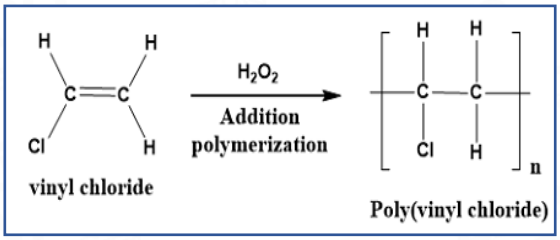
✓ PE is non-hygroscopic, meaning it does not absorb moisture.

■ **Polypropylene (PP):-**



✓ It is the second most widely used plastic after PE.
✓ Melting point between 130°C and 171°C.
✓ PP has a very low density (0.895 to 0.92 g/cm^3)
✓ It is one of the lightest commercial plastics.
✓ PP is non-hygroscopic, meaning it does not absorb moisture.
✓ PP, identified by the #5 resin code, is a recyclable thermoplastic.
✓ The global polypropylene market size was valued at about £103.5 billion in 2022.
✓ The global production volume of PP was 79.01 million MT (approx) in 2022.
✓ The demand for PP in 2022 was 86.74 million tons.
✓ The post-consumer recycling rate of PP worldwide is about 1%.

■ **Polyvinyl chloride (PVC):-**



✓ Polyvinyl Chloride (PVC) is a thermoplastic polymer.
✓ It is the world's third-largest thermoplastic by volume after PE & PP.
✓ It is a white, brittle solid material available in powder form or granules.
✓ PVC is available in two categories: Flexible and Rigid. But there are more types like CPVC, PVC-O and PVC-M.

➢ Plasticized or Flexible PVC (Density: 1.1-1.35 g/cm3): Flexible PVC is formed by the addition of compatible plasticizers to PVC which lower the crystallinity. This type of PVC is sometimes called as PVC-P.

➢ Unplasticized or Rigid PVC (Density: 1.3-1.45 g/cm3): Rigid PVC is a stiff & cost-effective plastic. It shows high resistance to impact, water, weather, chemicals & corrosive environments. This type of PVC is known as UPVC, PVC-U or uPVC.

✓ Chlorinated Polyvinyl Chloride or perchlorovinyl (CPVC):- is prepared by chlorination of PVC resin. High chlorine content imparts high durability, chemical stability and flame retardancy.

✓ CPVC can withstand a wider range of temperatur. CPVC has higher chlorine content from 56% to around 66%.

■ **Polymethyl Acrylate (PMA):-**

✓ (PMA) is a family of organic polymers with the formula $(CH_2CHCO_2CH_3)_n$.

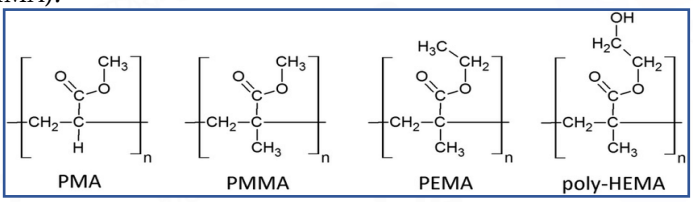
✓ There are more important copolymers derived from methyl acrylate and other monomers such as poly methyl methacrylate (PMMA), styrene, acrylonitrile, vinyl acetate, vinyl chloride, vinylidene chloride, and butadiene.

✓ PMA is softer than polymethyl methacrylate (PMMA).

✓ It is tough, leathery, and flexible.

✓ It has a low glass-transition temperature about 10°C.

✓ It is soluble in dimethyl sulfoxide.

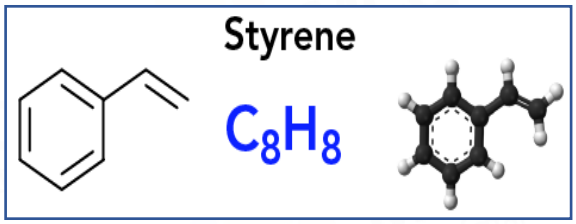


✓ PMA is water-sensitive and not stable against alkalies.

✓ High-energy radiation leads to cross linking in PMA

❖ **Polymethyl methacrylate or PMMA-** more popularly known as acrylic- is transparent and rigid thermoplastic. PMMA is used in car windows, smartphone screens.

■ **Polystyrene (PS):-**



✓ It is a synthetic polymer made from the monomer styrene, a liquid petrochemical.

✓ The chemical formula for its repeating unit is (C8H8)n

✓ Its glass transition temperature (around 100°C)

✓ Polystyrene comes in several forms:- General Purpose Polystyrene (GPPS), High-Impact Polystyrene (HIPS), Expanded Polystyrene (EPS), Extruded Polystyrene (XPS),

Pulp, Paper and Rayon Industries

➢ The paper manufacturing is a two step process: **1. Pulping:-** converting raw fibrous material into pulp & **2. Paper making:-** Converting the pulp into paper.

➢ Pulping: The wood chips are converted into pulp using either mechanical or chemical methods.

✧ *Mechanical pulping:* The physical grinding or refining of wood chips separates the cellulose fibers. This process is highly efficient but leaves lignin in the pulp, which can weaken the fibers and cause yellowing over time.

✧ *Chemical pulping:* The most common method, *the Kraft process,* cooks wood chips in a solution of sodium hydroxide (NaOH) and sodium sulfide (Na_2S) to dissolve the lignin and separate the fibers. This produces a stronger, higher-quality pulp.

● **The rayon industry:-** produces a semi-synthetic fiber from processed cellulose, typically sourced from wood pulp. Historically known as "artificial silk," rayon is valued for its softness, absorbency, and ability to mimic the texture of natural fibers like cotton and silk.

❖ **Xanthation:-** The crumbs are churned with Carbon disulfide (CS_2), turning the mixture into a thick, orange liquid called "*cellulose xanthate*".

❖ **Lyocell:-** A more environmentally friendly type of rayon made in a closed-loop process where the solvent is recycled.

✓ In 2025, Rayon fiber market is 21 Billion Doller.

✓ It is estimated to be about 32.64 Billion USD in 2032.

Soaps & Detergents

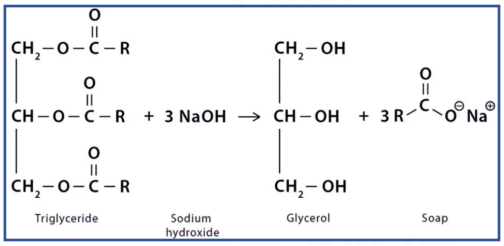
➢ Soaps are made from natural fats and oils, whereas detergents are made from petrochemicals.

➢ In detergent or Soaps, each individual molecule possesses a hydrophilic (polar) ***head*** and an elongated hydrophobic (non-polar) ***tail.***

✧ A "head" that loves water: The carboxylate end of the molecule is hydrophilic, meaning it is attracted to water.

✧ A "tail" that loves oil: The long hydrocarbon chain is hydrophobic, or repelled by water, which causes it to be attracted to grease and oil.

● **Saponification reaction:-** The fat or oil, (triglyceride) is mixed with the alkali (lye). This causes a chemical reaction that breaks the triglyceride into soap Molecules and glycerin.



● **Saponification methods:-**

✧ *Cold process:-* Traditional, hands-on method- ingredients mixed at low temperature. Process takes 4 to 6 weeks as the saponification completes and water evaporates.

✧ *Hot process:* This method uses heat to accelerate saponification.

✧ *Continuous process:* Industrial, large-scale production. It is a highly efficient process that continuously combines fats and alkalis in a reactor at high temperatures.

● **Types of detergents:-**

✧ ***Anionic detergents:-*** Most common type of household detergents, found in products like laundry and dish soaps. They carry a negative electrical charge on their hydrophilic "head". **Examples:-** sodium lauryl sulfate and sodium dodecyl benzene sulfonate.

✧ ***Cationic detergents:-*** Often used as fabric softeners, hair conditioners and germicides. Having poor cleaning properties, they reduce static electricity. These detergents carry a positive electrical charge on their head. **Example:-** cetyltrimethylammonium bromide (CTAB).

✧ ***Non-ionic detergents:-*** These surfactants have no electrical charge on their head. They produce very little foam and are excellent at emulsifying grease. Ideal for automatic dishwashing liquids and commercial cleaners. **Examples:-** alkyl polyglucosides (APG) & polyethylene glycol (PEG).

✧ ***Zwitterionic (or amphoteric) detergents:-*** These contain both a positive and negative charge, but with a net charge of zero. They are milder and less irritating, and are used in products like shampoos and cosmetic creams.

Leather Industry

❖ **Chrome tanning:-** The most widely used method (about 90% of global leather production). It uses trivalent Chromium salts, specifically chromium(III) sulfate and is a fast, efficient process. The tanned leather is light blue and known as "wet blue".

❖ **Vegetable tanning:-** The oldest method, using natural tannins found in bark, wood, and leaves of plants. It is a much slower process, taking weeks or months.

❖ **Chrome-free tanning:-** A variety of methods that do not use chromium, often grouped under this label. They use alternative agents like aldehydes (glutaraldehyde), syntans, or aluminum salts to produce leather for specialized applications, such as automotive or washable fashion leather.

❖ **Combination tanning:-** A modern process that combines different tanning methods to achieve desired properties. For example, a "wet white" leather produced with a chrome-free process can be retanned with vegetable tannins.

Edible oils

● **Oil Etraction:-**

➢ **Hot pressing:-** This method uses heat during or before pressing to decrease the oil's viscosity and increase the extraction efficiency. The higher temperatures can affect the oil's flavor, color, and nutritional value.

➢ **Cold pressing:-** To produce higher-quality, "virgin" oils, cold pressing is done at lower temperatures, typically below 49°C (120°F).

➢ **Solvent extraction:-** solvent used is typically a food-grade hexane.

➢ **Alternative and advanced methods:-** For specialty, high-value oils, more advanced or alternative methods are sometimes used:-

✧ *Supercritical fluid extraction (SFE):-* This method uses carbon dioxide in a supercritical state as a solvent. This process avoids high temperatures and chemical solvents, resulting in a high-quality oil. SFE is typically used for lower-capacity, higher-value products due to the expense of specialized equipment.

✧ *Aqueous enzymatic extraction (AEE):-* Enzymes are used to break down the plant cell walls and release the oil in a water-based process. This environmentally friendly method avoids organic solvents and produces high-quality oil and a protein-rich meal.

● **Edible oil hydrogenation:-** It is a fat modification process that chemically alters the properties of an oil, enabling a wider range of applications in the food industry. Purpose is to- Solidify liquid oils, Improve oxidative stability, Enhance texture and functionality.

● **Different Tests for edible Oil:-**A range of physical, chemical & advanced tests are used to determine the quality, authenticity & safety of edible oils. Those are as follows:-

- ✓ ***Specific gravity and refractive index:-*** measured to verify the oil's identity and detect adulteration.
- ✓ ***Smoke point:-*** measures the temperature at which an oil begins to smoke continuously. Fresh oil has a high smoke point. A low smoke point is a sign of degradation from repeated heating or frying.
- ✓ ***Acid Value (AV) and Free Fatty Acids (FFA):-*** measures the amount of free fatty acids in the oil. A high AV or FFA indicates hydrolysis has occurred, which can signal poor-quality oil, improper storage, or excessive heating.
- ✓ ***Peroxide Value (PV):-*** measures the concentration of peroxides and hydroperoxides. A high peroxide value indicates rancidity and that the oil is close to its expiry.
- ✓ ***p-Anisidine Value (AV):-*** Measures the level of secondary oxidation products, such as aldehydes. It is often used with peroxide value to get a comprehensive picture of the oil's oxidative state.
- ✓ ***Iodine Value (IV):-*** This is a measure of the oil's degree of unsaturation (double bonds). A higher iodine value means more unsaturated fatty acids. This affects the oil's shelf life and susceptibility to oxidation.
- ✓ ***Saponification Value (SV):-*** This test determines the average molecular weight of the fatty acids in the oil. The value can help identify the type of oil and reveal the presence of foreign fats.
- ✓ ***Moisture and Volatile Content:-*** Excess moisture in oil can promote microbial growth and hydrolysis, leading to spoilage. Tests like Karl Fischer titration are used to precisely measure moisture content.
- ✓ ***Baudouin Test (adulteration):-*** A specific test to detect sesame oil in ghee or other oils. Presence of sesame oil is indicated by a characteristic rose-red color reaction.

Paints : Pigments : Varnishes : Lacquers

- ● **Paints** are composed of 4 components:- 1. Pigments, 2. Binder, 3. solvent, 4. additive,
- ✓ *Common **binders** are:-* Acrylic resins (water-based), alkyd resins (oil-based), epoxy resins (industrial coatings) & polyurethane resins (tough, abrasion-resistant finishes).
- ✓ *Common **solvents** are:-* Water (for latex/water-based paints), mineral spirits & turpentine (for oil-based paints).
- ● **Pigments:-** These pigments are mineral-based and contain metal compounds.
- ✓ *White pigments:-* titanium dioxide (TiO_2) and zinc oxide (ZnO).
- ✓ *Black pigments:* Primarily made from carbon particles, such as carbon black.
- ✓ *Earth pigments:* Naturally occurring iron oxides and clays. Examples:- yellow ochre, red ochre, raw sienna, burnt sienna, and umber.
- ✓ *Cadmium pigments:* Cadmium sulfide & selenide create vibrant yellows, oranges, reds.
- ✓ *Chromium pigments:* Chromates provide yellows, oranges, and greens.
- ✓ *Cobalt pigments:* Offer various shades of blue and violet.
- ✓ *Ultramarine pigments:* Complex sodium aluminum sulfosilicates provide blue and violet hues.

- ✓ *Azo pigments:* Contain a nitrogen-based azo group & are major class for producing yellow, orange & red pigments.
- ✓ *Polycyclic pigments:* Complex, fused-ring structures with good light and heat stability. Examples include phthalocyanine, quinacridone, and perylene pigments.
- ✓ *Perylene pigments:* Create strong red and maroon colors.
- ✓ *Phthalocyanine pigments:* Complex organic molecules containing metal salts, such as copper. They are known for providing exceptionally colorfast blues and greens.
- ✓ *Quinacridone pigments:* Synthesized organic compounds that produce a range of pink, magenta, and red colors.
- ✓ *Luminescent pigments:* Absorb radiation and emit it as light. This includes fluorescent pigments (emit light without delay) and phosphorescent pigments (emit light with a delay).
- ✓ *Metallic effect pigments:* Create a pearlescent or metallic shimmer, often made by coating mica with metal oxides like titanium dioxide.

- ➢ **Polyurethane varnishes:** Extremely hard and abrasion-resistant, making them ideal for floors and high-traffic areas. Available in both oil-based & water-based formulations.
- ➢ **Resins (Binders):** This is the film-forming component that provides the lacquer's hardness and protective qualities. Common resins include:-
- ✓ *Nitrocellulose:* A traditional and still widely used resin derived from nitrated cotton fibers. It dries quickly and offers a flexible, repairable finish but can yellow with age.
- ✓ *Acrylic Polymers:* Synthetic resins developed to produce non-yellowing, "water-white" clear finish woods.
- ✓ *Urea-formaldehyde/Melamine:* Used in catalyzed lacquers to create a significantly harder and more durable film through chemical cross-linking.
- ✓ *Polyurethane:* Provides excellent durability, chemical, and water resistance, often used in two-component systems for automotive and high-traffic wood finishes.
- ✓ *Solvents:* These are volatile organic compounds (VOCs) or water that dissolve the resins and allow the lacquer to be applied as a liquid. Common organic solvents include toluene, acetone, and lacquer thinner. Water is used as the solvent in more environmentally friendly water-based lacquers.

- ➢ **Urushiol-Based Lacquers:** Traditional Asian lacquers made from tree sap. They cure through oxidation and polymerization in a humid environment, producing an extremely hard and durable film.
- ➢ **Nitrocellulose Lacquers:** The traditional solvent-based lacquer, valued for its fast-drying time and ease of repair.
- ➢ **Acrylic Lacquers:** Formulated with synthetic acrylic polymers to provide a crystal-clear, non-yellowing, and durable finish. A popular variant is CAB-acrylic, which includes cellulose acetate butyrate for added flexibility.
- ➢ **Water-Based Lacquers:** These environmentally friendly formulations use water as the solvent, resulting in lower VOCs. They are less toxic but may be less durable than solvent-based versions.

➢ **Polyurethane Lacquers:** Known for high durability, chemical resistance, and an attractive glossy finish, often used in two-part systems for heavy-duty applications.

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ফলিত রসায়নের গুরুত্বপূর্ণ ২০০টি MCQ প্রশ্নোত্তর

1. Which innovation marked the upshift in chemical industry in the 18th century?

A) Inventing the first synthetic dye B) The Leblanc process for soda ash production
C) The Haber–Bosch ammonia synthesis D) Development of celluloid plastics

Answer: B – The Leblanc process (1791) enabled large-scale production of soda ash (sodium carbonate), essential for glass, textiles, soap, and paper industries.

2. Distillation process developed in which Period?

A) Ancient period. B) Alchemical Period C) Early modern Period. D) Industrial Period.

Answer: B – Development of apparatus & processes like distillation & sublimation happened in Alchemical Period.

3. During the mid-20th century, which process revolutionized petroleum refining?

A) Leblanc process B) Synthetic dye manufacturing
C) Fluid catalytic cracking (FCC) D) Solvay soda process

Answer: C – The development of fluid catalytic cracking (FCC) in 1942 dramatically increased high-octane fuel production.

4. Which of these is an example of a Unit Operation?

A) Hydrogenation B) Nitration C) Distillation D) Sulfonation

Answer: C- Distillation is a classic unit operation involving physical separation without chemical reaction.

5. An example of a Unit Process is:

A) Drying B) Extraction C) Esterification D) Filtration

Answer: C- Esterification is a chemical reaction—making and breaking bonds—thus a unit process.

6. Which of the following is not one of the five subsegments of the chemical industry?

A) Basic Chemicals B) Specialty Chemicals C) Industrial Gases D) Pharmaceuticals

Answer: D – The recognized subsegments include Basic Chemicals, Agrochemicals, Specialty Chemicals, Industrial Gases, and Downstream Industries.

7. What percentage of all manufactured goods relies on the chemical industry?

A) 50% B) 75% C) 96% D) 86%

Answer: C – The chemical industry supports approximately 96% of worldwide manufactured goods.

8. Which type of fluid behaves like a solid until a certain yield stress is reached?

A) Newtonian fluid B) Ideal fluid
C) Ideal plastic (Bingham plastic) fluid D) Non-Newtonian thixotropic fluid

Answer: C – Ideal plastic (e.g., Bingham plastic) fluids require a yield stress to start flowing.

9. What is the defining characteristic of a Newtonian fluid?

A) Viscosity decreases under shear stress
B) Viscosity increases under shear stress
C) Shear stress is directly proportional to the rate of shear strain
D) Flow requires exceeding a yield stress before starting

Answer: C – Newtonian fluids follow Newton's law of viscosity: constant viscosity, and shear stress ∝ shear rate

10. Which principle explains the buoyant force experienced by a body submerged in fluid?

A) Archimedes' principle B) Pascal's principle
C) Bernoulli's principle D) Newton's second law

Answer: A – Archimedes' principle explains the buoyant force experienced by a body submerged in a fluid.

11. A fluid that is at rest falls under which category?

A) Fluid Dynamics B) Fluid Mechanics
C) Fluid Statics D) Fluid Kinematics

Answer: C – Fluid Statics describes a fluid that is at rest.

12 Under which condition is Bernoulli's equation valid?

A) Compressible, turbulent flow
B) Steady, inviscid, incompressible & irrotational flow
C) Rotational, viscous flow
D) Transient turbulent flow

Answer: B — It holds under assumptions of steady, inviscid, incompressible, and irrotational continuous flow.

13. Which type of corrosion occurs when two different metals are in contact with each other in the presence of an electrolyte?

A) Uniform corrosion B) Intergranular corrosion
C) Pitting corrosion D) Galvanic corrosion

Answer: D — Galvanic corrosion (a type of electrochemical corrosion) occurs under these conditions.

14. Which of the following factors affect the corrosion rate of metals?

A) Relative surface area of anode & cathode B) Nature of the oxide layer
C) Purity of the metal D) All of the above

Answer: D — All these factors collectively influence corrosion rate.

15. Which of the following is the purest iron?

A) Steel B) Pig iron C) Cast iron D) Wrought iron

Answer: D- Wrought iron is the purest form of iron of all.

16. What is the carbon percentage present in Pig iron produced in blast furnace?

A) 0.05–0.25% B) 0.25–0.59% C) 4–5% D) 1–2%

Answer: C- Pig iron produced in blast furnace contains 4–5% carbon.

17. Which is the smelting zone of the furnace called?

A) Tuyere B) Inwall C) Bosh D) Hearth

Answer: C- the smelting zone of the furnace called Bosh

18. Corrosion resistance of alloy steel improved by adding-

A) Tungsten B) Vanadium C) Chromium D) Titanium

Answer: C- Chromium is added with steel to improve corrosion resistance.

19. Tensile strength of alloy steel improved by adding-

A) Nickel B) Vanadium C) Manganese D) Titanium

Answer: A- Nickel is added with steel to improve tensile strength.

20. How much carbon is present in cast irons?

A) Less than 0.05% B) Up to 1.5% C) 1.5% to 2% D) More than 2%

Answer: D- More than 2% carbon is present in cast irons.

21. Which separation technique is based on exploiting differences in volatility?

A) Distillation B) Crystallization C) Magnetic separation D) Fractional crystallization

Answer: A- Distillation Exploits differences in boiling points to separate liquid mixtures. More volatile components vaporize more readily and are then condensed back into liquid form.

22. What principle does centrifugation primarily exploit in separating components?

A) Differences in boiling point B) Differences in density (and size)

C) Differences in solubility D) Electric charge differences

Answer: B- Differences in density (and size). Centrifugation process separates based on density differences by using centrifugal force.

23. Which of the following is not a stage in the distillation process?

A) Heating (vaporization) B) Condensation

C) Precipitation D) Collection of distillate

Answer: C– Precipitation is not part of distillation.

24. What is an azeotrope?

A) A liquid mixture that forms a homogeneous solution

B) A mixture where vapor & liquid compsitions are identical

C) A mixture easily separated by simple distillation

D) A mixture boiling at multiple temperatures

Answer: B – An azeotrope has identical compositions in vapor and liquid, making separation by distillation ineffective.

25. Which of the following is not separated by distillation?

A) Acetone and water B) Aniline and chloroform

C) Impurities in seawater D) Milk and water

Answer: D – Milk & water cannot be separated by distillation

26. Which of the following is a key assumption in the McCabe–Thiele method?

A) Heat of mixing is significant B) Sensible heat effects are included

C) Constant molar overflow D) Variable flow rates in the column

Answer: C- The method assumes constant molar overflow, meaning liquid and vapor molar flow rates remain constant throughout the column, with negligible heat effects.

27. Under what condition do the rectifying and stripping lines coincide with the diagonal (x = y) on the McCabe–Thiele diagram?

A) Minimum reflux B) Total reflux C) Operating reflux D) Maximum permissible reflux

Answer: B- At total reflux (when no distillate is withdrawn), both operating lines coincide with the diagonal (x = y).

28. In an enthalpy–concentration diagram, the straight line with a negative slope running down the plot is known as the:

A) Boiling line B) Azeotropic line C) Dew line D) Auxiliary line

Answer: C- Dew line — The dew line is represented by the straight line with a negative slope in the diagram.

29. Which line in the enthalpy–concentration diagram joins the dew line to boiling line?

A) Azeotropic line B) Isothermal line

C) Auxiliary line D) Freezing line

Answer: B- Isothermal line — This line connects the dew line and boiling line, representing constant-temperature profiles.

30. In the vapor-compression refrigeration cycle, which component increases the refrigerant's pressure & temp?

A. Evaporator B. Expansion valve

C. Compressor D. Condenser

Answer: C — The compressor raises both pressure and temperature of the refrigerant.

31. Which refrigerant is commonly used in a vapor-absorption refrigerator?

A. Freon-12 B. Ammonia C. Aqua-ammonia D. CO_2

Answer: C — Aqua-ammonia is a typical refrigerant in vapor absorption systems.

32. Which refrigerant category includes ammonia & CO_2?

A. Synthetic refrigerants B. Natural refrigerants

C. CFCs D. HCFCs

Answer: B— Ammonia and CO_2 are considered natural refrigerants

33. Which component replaces the compressor in a vapor-compression system when using an absorption refrigeration cycle?

A. Compressor B. Pump alone

C. Absorber–Generator assembly D. Expansion valve

Answer: C— The compressor is replaced by the absorber-generator assembly

34. What is the chemical name of R-717?

A) Carbon dioxide B) Isobutane C) Ammonia D) Freon-12

Answer: C- Ammonia

35. Which of the following refrigerants is natural?

A) R-12 B) R-600a C) R-134a D) R-410A

Answer: B- (R-600a) Isobutane is a natural refrigerant.

36. Which refrigerant has the highest Ozone Depletion Potential (ODP)?

A) R-12 B) R-134a C) R-717 D) R-290

Answer: A- (R-12) It also known as Freon-12 is a chlorofluorocarbon (CFC) that was widely used as a refrigerant and aerosol propellant.

36. R-744 is the refrigerant name for:

A) Ammonia B) Carbon dioxide C) Propane D) Freon

Answer: B- Carbon dioxide.

37. Which of the following are considered secondary air pollutants?

A) Carbon dioxide (CO_2) and Sulfur dioxide (SO_2)

B) Ozone (O_3) and Peroxyacetyl Nitrate (PAN)

C) Nitrogen monoxide (NO) and Carbon monoxide (CO)

D) Particulate matter and Dust

Answer: B- Secondary pollutants like O_3 and PAN form in the atmosphere through reactions involving primary pollutants.

38. Which of the following pollutants are most responsible for the formation of acid rain?

A) CO B) NO_2 C) O_3 D) SO_2

Answer: B- Nitrogen dioxide (NO_2) and **D)** Sulfur dioxide (SO_2)

Explanation: NO_2 forms nitric acid and SO_2 forms sulfuric acid upon reacting with water vapor, both key contributors to acid rain

39. What serious water pollution issue has affected vast parts of Bangladesh, impacting millions?

A) Excess nitrates causing blue baby syndrome B) Arsenic contamination of groundwater

C) Oil spills in turbans D) Plastic microbeads in rivers

Answer: B- Bangladesh faces a severe crisis of arsenic in groundwater—up to 49% of water sources exceed WHO safety limits, endangering 35 to 77 million people, leading to skin lesions and potentially cancer.

40. Without the greenhouse effect, Earth's average surface temperature would be approximately:

A) 15 °C B) 0 °C C) −18 °C D) 30 °C

Answer: C- Without the greenhouse effect, Earth's average surface temperature would be approximately −18 °C

41. Which greenhouse gas is the most abundant in terms of overall effect?

A) Carbon dioxide B) Methane C) Ozone D) Water vapor

Answer: D- Water vapor is the most abundant (95%) greenhouse gas in the atmosphere.

42. Which gas is NOT considered a greenhouse gas?

A) Carbon dioxide B) Methane C) Ethane D) Water vapor

Answer: C- Ethane is NOT considered a greenhouse gas.

43. Greenhouse gases trap which kind of radiation?

A) Short-wave (UV) B) Visible light C) Long-wave (infrared) D) Gamma rays

Answer: C- Greenhouse gases trap Long-wave (infrared) radiation.

44. What percentage of the Earth's emitted longwave radiation is absorbed by atmosphere?

A) 60% B) 70% C) 80% D) 90%

Answer: D- About 90% of the Earth's emitted longwave radiation is absorbed by the atmosphere.

45. Who first proposed the concept of the greenhouse effect?

A) Claude Pouillet B) Joseph Fourier

C) Eunice Newton Foote D) Nils Gustaf Ekholm

Answer: B- Joseph Fourier first proposed the concept of the greenhouse effect.

46. When was the ozone hole first reported?

A) 1965 B) 1975 C) 1985 D) 1995

Answer: C- The ozone hole was first reported in 1985- same year "Vienna Convention" was established.

47. The ozone hole forms during which season in Antarctica?

A) Summer B) Autumn

C) Winter D) Spring

Answer: D- Ozone hole forms during Spring, from September to early December

48. Which international treaty was established to phase out ozone-depleting substances?

A) Paris Agreement B) Kyoto Protocol

C) Montreal Protocol D) Geneva Convention

Answer: C- Montreal Protocol was established to phase out ozone-depleting substances.

49. What measurement unit is used to express ozone concentration in the atmosphere?

A) Parts per million (ppm) B) Percent

C) Dobson Units (DU) D) Milligrams per cubic meter

Answer: C- Dobson Units (DU) is used to express ozone concentration in the atmosphere.

50. Which greenhouse gas was added during the second commitment period (Doha Amendment)?

A) SF_6 B) HFCs C) NF_3 D) PFCs

Answer: C- Nitrogen Trifluoride (NF_3)

51. Which of the following is the most effective approach for industrial waste management according to the waste management hierarchy?

A. Energy recovery B. Waste minimization at the source

B. Landfilling D. Incineration

Answer: C- The most effective method addresses the problem before it even begins.

52. What method is typically employed for destroying large quantities of industrial toxic waste?

A. Open burning with garbage B. Landfilling

C. Controlled incineration D. Composting **Answer: C-** Controlled incineration is typically used for destroying large quantities of industrial toxic waste?

53. Which method is used to stabilize hazardous waste before disposal?

A. Incineration B. Landfilling C. Solidification D. Composting

Answer: C- Solidification method is used to stabilize hazardous waste before disposal.

54. Which of the following is NOT a physical treatment technique?

a) Filtration b) Sedimentation c) Ion exchange d) Degasification

Answer: c) Ion exchange (chemical method)

55. Which method provides continuous ion removal without the use of chemical regenerants?

a) Ion exchange resin b) EDI c) Chemical softening d) AOP

Answer: b) Electrodeionization (EDI) process provides continuous ion removal without the use of chemical regenerants.

56. All of the following are physical water treatment processes except:

A) Sedimentation B) Filtration C) Flocculation D) Dissolved air flotation

Answer: C – Flocculation is a physico-chemical process, not purely physical

57. Which disinfectant is known to potentially create harmful disinfection by-products (DBPs)?

A) Ozone B) UV light C) Chlorine D) Filtration

Answer: C– Chlorine can react with organics to form DBPs like trihalomethanes (THMs) and haloacetic acids (HAAs)

58. Which of these is not typically used as a coagulant?

A) Alum (aluminum sulfate) B) Ferric chloride

C) Sodium carbonate D) Ferric sulfate

Answer: C– Sodium carbonate is not a coagulant; the others are commonly used.

59. The process of dechlorination is commonly done using:

A) Sodium sulfate B) Sodium thiosulfate

C) Sodium biosulfate D) None of these

Answer: B– Sodium thiosulfate is used to neutralize excess chlorine in treated water

60. A typical desirable pH range for boiler water is:

a) 6.0–7.0 b) 7.0–8.5 c) 9.5–11.0 d) 12.0–14.0

Answer: c) typical desirable pH range for boiler water is 9.5–11.0

61. Internal boiler treatment chemicals include all except:

A) Sodium hydroxide b) Sodium carbonate

c) Sodium aluminate d) Zeolite resin

Answer: d) Zeolite resin

62. Which of the following is not removed by electrodialysis?

A. Sodium ions B. Chloride ions

C. Organic molecules D. Calcium ions

Answer: C- Organic molecules are not removed by electrodialysis.

63. Ultrafiltration is classified as:

A. A biological process B. A chemical reaction
C. A physical separation D. An adsorption process

Answer: C. A physical separation

64. Which type of activated carbon is commonly used in water treatment?

A. Powdered Activated Carbon (PAC) B. Crystalline Carbon
C. Carbon Nanotubes D. Carbon Monoxide

Answer: A. Powdered Activated Carbon (PAC)

65. Which gas is commonly used during the activation of carbon?

A. Oxygen B. Carbon dioxide or steam C. Nitrogen D. Hydrogen

Answer: B. Carbon dioxide or steam

66. BOD is generally measured over a period of:

A. 1 hour B. 5 hours C. 5 days D. 15 days

Answer: C. 5 days

67. The standard temperature for BOD measurement is:

A. 0°C B. 20°C C. 37°C D. 50°C

Answer: B. 20°C

68. The unit of COD is:

A. Ppm B. mg/kg C. mg/L D. µg/mL

Answer: C. mg/L

69. A common oxidizing agent used in COD test is:

A. Potassium dichromate ($K_2Cr_2O_7$) B. Sodium chloride (NaCl)
C. Calcium carbonate ($CaCO_3$) D. Ferric sulfate ($Fe_2(SO_4)_3$)

Answer: A. Potassium dichromate (K_2Cr_2O)

70. The COD test usually takes:

A. 1 hour B. 2 hours C. 4 hours D. 24 hours

Answer: C. 4 hours

71. Which catalyst is commonly used in COD tests?

A. Silver sulfate (Ag_2SO_4) B. Magnesium chloride ($MgCl_2$)
C. Copper sulfate ($CuSO_4$) D. Zinc oxide (ZnO)

Answer: A. Silver sulfate (Ag_2SO_4)

72. Which of the following minerals does NOT commonly contain sulfur?

A) Cinnabar B) Galena C) Quartz D) Sphalerite

Answer: C — Quartz is silicon dioxide and does not contain sulfur; the others are sulfide minerals.

73. Which of these is a natural biological source of atmospheric sulfur gas?

A) Volcanoes B) Decaying plant matter
C) Dimethyl sulfide (from plankton) D) Combustion gases

Answer: C— Dimethyl sulfide (DMS) produced by decomposing marine phytoplankton is a major natural sulfur gas source

74. Which is commonly used to recover sulfur from hydrogen sulfide in refineries?

A) Electrolysis B) Claus process C) Distillation D) Hydration

Answer: B — The Claus process is the standard method to recover sulfur from H_2S in refineries.

75. Which biological compounds in living organisms contain sulfur?

A) Cellulose and glucose B) Methionine and cysteine
C) Cholesterol and starch D) Cellulose and keratin

Answer: B — The amino acids methionine and cysteine contain sulfur, as part of organic life

76. What is the most important industrial method of recovering elemental sulfur from gas streams containing H_2S?

A) Frasch process B) Claus process C) Ostwald process D) Contact process

Answer: B — The Claus process converts hydrogen sulfide (H_2S) into elemental sulfur and is widely used in refineries and gas plants.

77. Which method applies a solvent to dissolve S compounds?

A) Frasch process B) Heap leaching
C) Solvent extraction D) Sicilian method

Answer: C — Solvent extraction dissolves sulfur and precipitates it via heating, achieving high recovery (~90%).

78. What are the main products of bacterial oxidation of pyrite (FeS_2) in bioleaching?

A) Elemental sulfur and water B) Ferrous sulfate & sulfuric acid
C) Hydrogen sulfide & iron oxide D) Sulfur dioxide & iron sulfide

Answer: B — Bioleaching of pyrite yields soluble ferrous sulfate and sulfuric acid. Bioleaching uses bacteria like Acidithiobacillus ferrooxidans or A. thiooxidans to oxidize sulfur and metal sulfides.

79. What safer solvent is often used to recrystallize sulfur instead of carbon disulfide?

A) Toluene or xylene B) Water C) Acetone D) Ethanol

Answer: A — Users recommend that xylene or toluene (safer than CS_2) can be used for sulfur recrystallization.

80. What catalyst is commonly used in the Contact process to oxidize SO_2 to SO_3?

A) Platinum B) Iron oxide
C) Vanadium(V) oxide D) Zinc oxide

Answer: C — Vanadium(V) oxide (V_2O_5) is the preferred catalyst owing to its resistance to arsenic poisoning.

81. What product is formed when SO_3 is absorbed into concentrated sulfuric acid?

A) Water B) Oleum C) Nitric acid D) Pyrosulfuric acid

Answer: B — Oleum (also known as fuming sulfuric acid) forms when SO_3 absorbs into H_2SO_4 .

82. Which catalyst was used in earlier versions of the Contact process before V_2O_5?

A) Iron B) Platinum C) Copper D) Nickel

Answer: B — Platinum was initially used but later replaced due to its susceptibility to poisoning.

83. What modern advancement improves efficiency beyond the basic Contact process?

A) Wet H_2SO_4 system B) Double contact double absorption (DCDA)

C) Single absorption system D) Lead-lined chambers

Answer: B — DCDA improves conversion efficiency and allows higher acid concentration.

84. What is oleum commonly referred to as?

A) Dilute sulfuric acid B) Fuming sulfuric acid

C) Pyrosulphuric acid D) Both B and C

Answer: D — Oleum is also known as fuming or pyrosulphuric acid.

85. During the early stages of reaction in the Lead Chamber process, what acts as a catalyst?

A) Vanadium pentoxide B) Nitrogen oxides C) Platinum D) Air

Answer: B — Nitrogen oxides acted as catalysts in the Lead Chamber process.

86. In which year was Karnaphuli Fertilizer Company Limited (KAFCO) incorporated?

A) 1974 B) 1981 C) 1991 D) 2011

Answer: B) 1981

87. How much gas (in million cubic feet) do state-owned fertilizer plants in Bangladesh reportedly use to produce 1 tonne of urea?

A) 25 MCF B) 35 MCF C) 43.72 MCF D) 50 MCF

Answer: C) 43.72 MCF

88. What is the name of the largest and first "green" urea fertilizer plant in South Asia?

A) Shahjalal Fertilizer Factory B) Jamuna Fertilizer Company

C) Ghorasal Polash Urea Fertilizer Project D) KAFCO

Answer: C) Ghorasal Polash Urea Fertilizer Project

89. Which salt of nitrogenous fertilizer has the minimum nitrogen content?

A) Urea B) Ammonium nitrate

C) Ammonium sulphate D) Ammonium chloride

Answer: C) Ammonium sulphate (option with lowest N content)

90. What is the approximate nitrogen content of Urea?

A) 34% B) 46% C) 60% D) 75%

Answer: B) 46% (commonly cited as ~47%) Urea has the highest nitrogen content of all common solid nitrogenous fertilizers.

91. How is biuret formation minimized during prilling of urea?

A) Using very high temperature

B) Cooling below melting point

C) keepin temperature just above melting point with minimal time

D) Adding biuret inhibitors

Answer: C) Keep the temperature just above urea's melting point with very short retention time

92. What is the approximate temperature and pressure used in industrial urea production (autoclave phase)?

A) 120 °C and 300 atm B) 190 °C and 200 atm

C) 400 °C and 550 atm D) 200 °C and 10 atm

Answer: B) 190 °C and 200 atm

93. What is the chemical formula of TSP (Triple Super Phosphate)?

A) $Ca(H_2PO_4)_2$ B) $Ca(H_2PO_4)_2 \cdot H_2O$

C) $Ca_3(PO_4)_2$ D) $Ca_3(PO_4)_2 \cdot H_2O$

Answer: B) $Ca(H_2PO_4)_2 \cdot H_2O$

94. What percentage range of P_2O_5 does TSP typically contain?

A) 20–30% B) 40–48% C) 10–15% D) 60–70%

Answer: B) 40–48%

95. Which potent greenhouse gas is emitted during agricultural use of nitrogen fertilizers, and is a major contributor to climate change?

A) Carbon dioxide (CO_2) B) Methane (CH_4)

C) Nitrous oxide (N_2O) D) Flourine gas

Answer: C) Nitrous oxide (N_2O)

96. Approximately what °Brix (sugar content) does the syrup reach after evaporation?

A) 40–50 °Brix B) 60–65 °Brix C) 80–85 °Brix D) 90–95 °Brix

Answer: B – The syrup reaches around 60–65 °Brix.

97. What is the thick mixture of crystals and mother liquor called?

A) Molasses B) Juice C) Massecuite D) Syrup

Answer: C – This mixture is known as massecuite.

98. What is "press mud" (filter cake), and how is it used?

A) A fibrous material used for making paper

B) A nutrient-rich residue used in compost and as fertilizer

C) A type of molasses used in alcohol production

D) A binding agent in construction

Answer: B — Press mud is used as a soil conditioner and organic fertilizer, enhancing crop yield and soil health.

99. Which by-product is used as a starter feed for mushroom cultivation?

A) Bagasse B) Molasses C) Leaves D) Vinasse

Answer: A — Bagasse serves as a nutrient-rich substrate ideal for mushroom cultivation.

100. Vinasse is a by-product of which process?

A) Sugar crystallization B) Ethanol distillation

C) Paper-making D) Filter cake drying

Answer: B — Vinasse remains after ethanol (or alcohol) distillation and is used in biogas production and soil amendment.

101. Which is the only currently operational coal mine in Bangladesh?

A) Phulbari B) Jamalganj C) Khalashpir D) Barapukuria

Answer: D — Barapukuria is the sole active coal mine in Bangladesh, operated by Petrobangla's subsidiary, BCMCL.

102. Which coalfield was discovered first?

A) Phulbari B) Jamalganj C) Dighipara D) Khalashpir

Answer: B — Jamalganj was discovered in 1962.

103. Which coalfield has the largest estimated reserves?

A) Barapukuria B) Jamalganj C) Phulbari D) Khalashpir

Answer: B — Jamalganj holds about 1,053 million tons.

104. Which coalfield lies deepest underground?

A) Barapukuria B) Phulbari C) Jamalganj D) Dighipara

Answer: C- Jamalganj has seams at about 640–1,158 meters depth.

105. Which constituent is most abundant in bituminous coal (dry, ash-free basis)?

A) Hydrogen B) Oxygen C) Carbon D) Nitrogen

Answer: C — Bituminous coal comprises about 84.4% carbon.

106. Which pollutants does carbonization typically release?

A) Only CO_2 B) VOCs, PAHs, and greenhouse gases

C) Only water vapor D) Pure carbon

Answer: B — Carbonization emits VOCs, polycyclic aromatic hydrocarbons, and CO_2.

107. Heavy oil fractions are distilled under vacuum primarily to avoid what?

A) Water contamination B) Thermal cracking or coking

C) Color change D) Low output

Answer: B — High temperatures can cause coking or thermal breakdown.

108. Which catalysts are commonly used in fluid catalytic cracking (FCC)?

A) Platinum; B) Nickel-cobalt;

C) Silica, alumina & zeolites D) Iron oxides

Answer: C — FCC typically uses silica–alumina & zeolite catalysts.

109. Which process produces aromatic hydrocarbons and reformate?

A) Thermal cracking B) Catalytic cracking

C) Catalytic reforming D) Hydrocracking

Answer: C — Reforming generates aromatics and high-octane reformate.

110. Which petroleum product is used as a fuel in ships?

A) LPG B) Diesel C) Kerosene D) Petrol

Answer: B) Diesel. Marine diesel is commonly used in ships due to its energy density and efficiency.

111. Which petroleum product is used in the production of fertilizers?

A) Naphtha B) LPG C) Kerosene D) Bitumen

Answer: A) Naphtha is used in the production of ammonia, a key component in fertilizers.

112. Which of the following is used as a solvent in dry cleaning?

A) Petrol B) Kerosene C) LPG D) Naphtha

Answer: D) Naphtha is a solvent used in dry cleaning due to its ability to dissolve oils and greases.

113. The ingredient that acts as a flux in glass manufacturing is:

A. Silica B. Alumina C. Soda ash (Na_2CO_3) D. Lime

Answer: C- Soda ash (Na_2CO_3) lowers the melting point of silica, acting as a flux.

114. Which oxide makes glass more brilliant and increases refractive index?

A. Boric oxide B. Lead oxide (PbO)

C. Zinc oxide D. Magnesium oxide

Answer: B- Lead oxide is used in lead glass to enhance brilliance and clarity.

115. Cullet is added to the glass batch to:

A. Increase brightness B. Reduce cost

C. Lower melting point D. Remove impurities

Answer: C- Cullet (recycled glass) lowers energy usage by reducing the melting temperature.

116. Annealing in glass manufacturing refers to:

A. Cooling glass rapidly B. Coloring glass

C. Removing internal stress D. Heating glass until molten

Answer: C- Annealing slowly cools the glass to relieve internal stresses that could cause cracking.

117. Which type of glass is commonly used in laboratory apparatus?

A. Lead glass B. Borosilicate glass

C. Soda-lime glass D. Fused silica glass

Answer: B- Borosilicate glass can withstand thermal shock and chemical exposure, ideal for lab use.

118. Sintering in ceramic processing involves:

A. Melting the ceramic B. Adding water

C. Heating without melting D. Applying glaze

Answer: C. Heating without melting. Sintering bonds ceramic particles at high temperature below melting point.

119. Which material lowers firing temperature in ceramics?

A. Kaolin B. Feldspar C. Quartz D. Alumina

Answer: B. Feldspar acts as a flux, reducing firing temperature and promoting vitrification.

120. Which of these is a bio-ceramic?

A. Silicon nitride B. Zirconia

C. Hydroxyapatite D. Lead zirconate

Answer: C. Hydroxyapatite mimics bone mineral and is used in implants.

121. Cutting tools use which ceramic?

A. Quartz B. Porcelain C. Ferrite D. Silicon nitride

Answer: D. Silicon nitride is hard, wear-resistant, and can handle high-speed machining.

122. What is the main chemical compound in Portland cement responsible for strength?

A. C_2S B. C_3A C. Ca_3S D. C_4AF

Answer: C. Tricalcium silicate (Ca_3S) is mainly responsible for early strength development in cement.

123. Alumina in cement helps to:

A. Add color B. Accelerate strength

C. Add plasticity D. Lower clinkering temperature

Answer: D. Lower clinkering temperature. Alumina facilitates early melting during kiln operations.

124. Which material controls the setting time of cement?

A. Fly ash B. Lime C. Clay D. Gypsum

Answer: D. Gypsum delays hydration of C_3A, controlling setting time.

125. Which of the following is not a method used in the industrial production of NaOH?

A) Membrane cell B) Diaphragm cell

C) Mercury cell D) Solvay process

Answer: D) Solvay process is used for the production of sodium carbonate (Na_2CO_3), not sodium hydroxide.

126. Which of the following processes is considered the most updated and environmentally friendly for producing NaOH?

A) Diaphragm cell B) Mercury cell

C) Membrane cell D) Solvay process

Answer: C) The membrane cell avoids mercury contamination & produces higher purity NaOH, making it environmentally safer.

Which method of caustic soda production is being phased out due to environmental concerns?

A) Membrane cell B) Diaphragm cell

C) Mercury cell D) Electrolytic cell

Answer: C) Mercury cells are being replaced due to toxicity and environmental hazards associated with mercury.

127. In the Solvay process, ammonia is used to:

A) Neutralize acid B) Absorb carbon dioxide

C) Act as a catalyst D) Oxidize calcium

Answer: B) Absorb carbon dioxide. Ammonia reacts with CO_2 and brine to form ammonium bicarbonate, which helps precipitate $NaHCO_3$.

128. What is the role of brine in the Solvay process?

A) Acts as a solvent B) Source of sodium ions

C) Reactant with ammonia D) All of the above

Answer: D) All of the above. Brine provides Na^+, acts as a medium, and participates in key reactions.

129. What is the main by-product of the Solvay process?

A) Calcium carbonate B) Calcium chloride

C) Sodium hydroxide D) Ammonium nitrate

Answer: B) Calcium chloride ($CaCl_2$) is formed during ammonia recovery and is usually disposed of or used as a de-icing agent.

130. Which of the following industries is the largest consumer of soda ash?

A) Soap B) Glass C) Cement D) Fertilizer

Answer: B) Glass Industry. Soda ash is a major ingredient in glass manufacturing.

131. The environmental concern related to chlorine production in Bangladesh is mainly due to:

A) Mercury emissions B) Chlorine gas leakage

C) CO_2 emissions D) Sulfur dioxide release

Answer: B) Chlorine is toxic and can cause environmental and health hazards if leaked.

132. Which sector is the biggest consumer of caustic soda produced in Bangladesh?

A) Textile industry B) Pharmaceutical industry

C) Fertilizer production D) Food processing

Answer: A) Textile industry. Caustic soda is extensively used in textile processing for bleaching and dyeing.

What is the approximate purity percentage of caustic soda produced by membrane cell technology in Bangladesh?

A) 50-60% B) 70-80% C) 98-99% D) 40-50%

Answer: C) 98-99%. Membrane cell technology produces high purity caustic soda solution.

133. Which type of polyethylene is produced using Ziegler-Natta or Phillips catalyst?

A) LDPE B) HDPE C) UHMWPE D) Crosslinked PE (PEX)

Answer: B) HDPE is made under lower pressures using catalysts such as Ziegler-Natta or Phillips catalysts.

134. Which type of polyethylene has the highest branching?

A) HDPE B) MDPE C) LDPE D) LLDPE

Answer: C) LDPE has both long-chain & short-chain branching, more than HDPE or MDPE. Branching reduces crystallinity, lowers density.

135. Which of the following is not a common catalyst type used in industrial PP synthesis to control tacticity?

A) Ziegler-Natta catalyst B) Metallocene catalyst

C) Radical initiator D) Phillips catalyst

Answer: C) Radical initiator. PP is not made via radical polymerization. It is made using Ziegler-Natta or metallocene catalysts etc. Radical polymerization does not give the required tacticity control.

136. Which of the following forms of PVC used without plasticizers?

A) Flexible PVC B) Plasticized PVC

C) Unplasticized PVC (uPVC) D) Gel PVC

Answer: C) Unplasticized PVC (uPVC, also called rigid PVC or RPVC) is PVC without plasticizers; it is stiff and used for rigid products.

137. The glass transition temperature (Tg) of PVC approximately:

A) -20 °C B) 25 °C C) 80–90 °C D) 120–140 °C

Answer: C) PVC has a glass transition (for rigid/unplasticized type) of about ~ 80-90 °C.

138. Which stabilizer would be added to PVC to improve heat stability?

A) Benzoyl peroxide B) Heavy metal stabilizers

C) Plasticizers D) Fillers

Answer: B) Heavy metal stabilizers like lead, tin, or calcium-zinc. Heat stabilizers, such as lead compounds, tin stabilizers, or calcium-zinc combinations, are used to prevent degradation during processing.

139. PMA has a glass transition temperature (Tg) approximately:

A) -50 °C B) -10 °C C) +10 °C D) +80 °C

Answer: C) PMA Tg is low, around +10 °C (≈10-12.5 °C).

140. Which solvent is PMA soluble in?

A) Water B) Alkaline solutions

C) DMSO (dimethyl sulfoxide) D) Strong acids only

Answer: C) DMSO (dimethyl sulfoxide). PMA is soluble in DMSO. It is not stable against strong alkalis; not water soluble.

141. What is the typical continuous service temperature (use temperature limit) for polystyrene for long periods?

A) -20 °C B) 25-40 °C C) 60-70 °C D) 150-200 °C

Answer: C) Long-term use temperature is usually around 60-70 °C; above that PS softens/loses strength.

142. Which of the following polymers is formed by addition polymerization of ethene?

A) Polypropylene B) Polyethylene
C) PVC D) PMMA

Answer: B- Polyethylene is formed by addition polymerization of ethene (CH_2=CH_2)

143. Which of the following polymers is most likely to show isotactic, syndiotactic, and atactic forms depending on the catalyst used?

A) Polyethylene B) Polyvinyl chloride
C) Polypropylene D) PMMA

Answer: C- The presence of a chiral center in the polypropylene monomer allows tacticity. Ziegler–Natta catalysts help control this.

144. Which property best distinguishes LDPE from HDPE?

A) Thermal conductivity B) Presence of side chains
C) Chain length D) Color

Answer: B- LDPE has highly branched chains, preventing close packing and crystallinity unlike HDPE.

145. Which polymer has the highest glass transition temperature (Tg)?

A) Polyethylene B) PMMA
C) Polypropylene D) PVC

Answer: B- PMMA has a Tg around 105°C–110°C, higher than most of the others due to stiff ester side groups.

146. In terms of polymer structure, the bulky phenyl group in polystyrene contributes to—

A) Flexibility B) Crosslinking
C) Brittleness D) Thermal conductivity

Answer: C- The phenyl group restricts rotational freedom, increasing rigidity and brittleness.

147. Which polymer is most suitable for producing microwave-safe plastic containers due to high melting point?

A) PVC B) Polystyrene
C) Polypropylene D) PMMA

Answer: C- Polypropylene has a high melting point (~160°C), making it safe for microwaving.

148. Which of the following polymers is not made from a vinyl monomer?

A) PVC B) PMMA
C) Polystyrene D) Polyethylene

Answer: B- PMMA is derived from an acrylic ester (methyl methacrylate), not a vinyl compound.

149. Which polymer's thermal degradation is autocatalytic due to released HCl?

A) PMMA B) Polystyrene
C) PVC D) Polyethylene

Answer: C- HCl released from PVC accelerates further degradation, making the process autocatalytic.

150. The monomer of PMMA contains which of the following functional groups?

A) Ether B) Ketone
C) Ester D) Amide

Answer: C- Methyl methacrylate contains an ester group: $-COOCH_3$.

151. Which polymer exhibits a glass-like fracture behavior due to amorphous, brittle nature?

A) HDPE B) Polystyrene
C) PMMA D) Polypropylene

Answer: B- Polystyrene is amorphous and fractures without deformation under stress.

152. Which of the following is most susceptible to photo-oxidative degradation?

A) PMMA B) Polypropylene
C) PVC D) Polystyrene

Answer: B- Polypropylene degrades under UV light due to tertiary carbon atoms that form free radicals.

153. Which polymer shows high transparency and impact resistance and is used in optical lenses?

A) PVC B) PMMA
C) Polystyrene D) Polyethylene

Answer: B- PMMA is known for its transparency and resistance to impact, suitable for optical applications.

154. Syndiotactic polystyrene exhibits improved properties because—

A) It is more amorphous B) It is isotropic
C) It has higher crystallinity D) It is more branched

Answer: C- Syndiotactic polystyrene is more crystalline, giving it better mechanical and thermal properties.

155. In the Kraft process of pulping, the main cooking chemicals are:

A) NaOH and Na_2S B) CaO and Na_2CO_3
C) H_2SO_4 and Cl_2 D) NaCl and NaOH

Answer: A) NaOH and Na_2S. Kraft (sulfate) pulping uses sodium hydroxide and sodium sulfide to dissolve lignin and release cellulose fibers.

156. Which country is the largest producer of paper and paperboard **in the world?**

A) USA B) Japan

C) China D) Canada

Answer: C) China has overtaken the USA and dominates global paper production due to its massive industrial base.

157. Which chemical is commonly used for bleaching pulp **in an environmentally friendly process?**

A) Chlorine B) Chlorine dioxide

C) Hydrogen peroxide D) Sodium hypochlorite

Answer: C) Hydrogen peroxide. Elemental chlorine is being phased out (due to dioxin pollution). Hydrogen peroxide and chlorine dioxide are preferred in ECF/TCF bleaching.

158. Which of the following is a by-product **of the Kraft process, often used to generate energy?**

A) Black liquor B) White liquor

C) Green liquor D) Sulfite sludge

Answer: A) Black liquor (containing lignin, hemicellulose, and spent chemicals) is burned to generate steam and recover chemicals.

159. Which process is used for the manufacture of Viscose Rayon?

A) Acetylation B) Xanthation

C) Sulfonation D) Nitration

Answer: B) Xanthation. Cellulose is treated with NaOH and carbon disulfide → cellulose xanthate → dissolved → regenerated as viscose rayon.

160. In **sulfite pulping**, the cooking liquor mainly contains:

A) Sodium sulfite + sulfur dioxide B) Sodium hydroxide + sodium sulfide

C) Sodium carbonate + caustic soda D) Calcium carbonate + chlorine dioxide

Answer: A) Sodium sulfite + sulfur dioxide

Explanation: Sulfite process uses SO_2 and a base (Na, Ca, Mg, NH_4) to form sulfite/bisulfite cooking liquors.

161. Which type of pulp is most suitable for **newsprint**?

A) Mechanical pulp B) Kraft pulp

C) Sulfite pulp D) Rag pulp

Answer: A) Mechanical pulp

Explanation: Newsprint requires cheap, bulky, opaque paper. Mechanical pulp (groundwood) provides that, though it is weaker and yellows.

162. Which of the following has the **highest cellulose content**?

A) Hardwood B) Bamboo

C) Cotton linters D) Bagasse

Answer: C) Cotton linters

Explanation: Cotton linters ~98% cellulose; excellent for rayon production.

163. Which chemical is NOT used in the viscose rayon process?

A) NaOH B) CS_2

C) H_2SO_4 D) HCl

Answer: D) HCl

Explanation: Viscose rayon process involves NaOH (alkali cellulose), CS_2 (xanthation), H_2SO_4 (regeneration bath). HCl is not used.

164. Which rayon type has the finest filament diameter?

A) Acetate rayon B) Cuprammonium rayon

C) Viscose rayon D) Polynosic rayon

Answer: B) Cuprammonium rayon

Explanation: Cuprammonium rayon gives very fine, silk-like filaments.

165. Which one is the main filler used in paper manufacturing to improve opacity and printability?

A) Talc B) Kaolin clay

C) Bauxite D) Gypsum

Answer: B) Kaolin clay

Explanation: Kaolin is widely used as a paper filler for opacity, brightness, smoothness.

166. Which fatty acid is most commonly used in soap manufacture?

A) Stearic acid B) Palmitic acid

C) Oleic acid D) Lauric acid

Answer: A) Stearic acid

Explanation: Stearic acid (C18) gives hardness to soap and is widely used in commercial soap formulations.

167. Which compound is added to soaps to prevent rancidity?

A) Borax B) Sodium chloride

C) Sodium silicate D) Antioxidants

Answer: D) Antioxidants

Explanation: Oxidation of unsaturated fatty acids causes rancidity; antioxidants (BHT, BHA) are added.

168. Which chemical is traditionally used in vegetable tanning?

A) Chromium salts B) Tannins

C) Formaldehyde D) Aluminum salts

Answer: B) Tannins

Explanation: Vegetable tanning uses tannins from bark/leaves, giving brown-colored, flexible leather.

169. Which tanning process produces the strongest and most water-resistant leather?

A) Chrome tanning B) Vegetable tanning

C) Oil tanning D) Aldehyde tanning

Answer: A) Chrome tanning

Explanation: Chromium(III) salts cross-link collagen, making leather durable and resistant to water/heat.

170. Which toxic compound is a major environmental concern in chrome tanning?

A) Cr(III) B) Cr(VI)
C) SO_2 D) H_2S

Answer: B) Cr(VI)

Explanation: Improper oxidation of Cr(III) can form carcinogenic Cr(VI), polluting effluents.

171. Which method gives the highest yield **of edible oil?**

A) Mechanical pressing B) Solvent extraction
C) Cold pressing D) Fermentation

Answer: B) Solvent extraction

Explanation: Hexane extraction yields >99% oil recovery, higher than mechanical methods.

172. Which oil has the highest amount of polyunsaturated fatty acids (PUFA)?

A) Coconut oil B) Palm oil
C) Soybean oil D) Mustard oil

Answer: C) Soybean oil

Explanation: Soybean oil is rich in PUFA (linoleic acid ~50%).

173. The degumming **process mainly removes:**

A) Carotenoids B) Phospholipids
C) Free fatty acids D) Peroxides

Answer: B) Phospholipids

Explanation: Water/acid is added to crude oil; phospholipids hydrate and are separated.

174. Which antioxidant is commonly added to edible oils to improve shelf life?

A) Sodium benzoate B) Butylated hydroxytoluene (BHT)
C) Citric acid D) Ascorbic acid

Answer: B) Butylated hydroxytoluene (BHT)

Explanation: BHT and BHA are synthetic antioxidants preventing rancidity.

175. Hydrogenation of vegetable oils produces:

A) Shorter chain fatty acids B) Trans fats
C) Sterols D) Glycerol

Answer: B) Trans fats

Explanation: Partial hydrogenation saturates some double bonds, but also forms harmful trans isomers.

176. Which edible oil is richest in erucic acid**?**

A) Mustard oil B) Coconut oil
C) Olive oil D) Sunflower oil

Answer: A) Mustard oil

Explanation: Mustard oil has up to 40–50% erucic acid, linked with heart health concerns.

177. Winterization of oils is carried out to:

A) Increase viscosity
B) Remove high melting point triglycerides
C) Reduce rancidity
D) Remove free fatty acids

Answer: B) Remove high melting point triglycerides

Explanation: Winterization prevents cloudiness in oils at low temperature (e.g., salad oils).

178. The main function of pigments **in paints is to:**

A) Act as a binder
B) Provide color and opacity
C) Control viscosity
D) Prevent foaming

Answer: B) Provide color and opacity

Explanation: Pigments impart color, opacity, and UV resistance.

179. Which compound is used as a white pigment**?**

A) TiO_2
B) Pb_3O_4
C) ZnO
D) $BaSO_4$

Answer: A) TiO_2

Explanation: Titanium dioxide gives high opacity and brightness; safer alternative to toxic lead white.

180. Which resin is the main binder in alkyd paints**?**

A) Epoxy resin
B) Polyurethane
C) Polyester + drying oil
D) Polyacrylate

Answer: C) Polyester + drying oil

Explanation: Alkyd resins are modified polyesters with drying oils (linseed, soybean).

181. Which of the following is a primer pigment **preventing rust on steel?**

A) Titanium dioxide
B) Zinc chromate
C) Lead carbonate
D) Carbon black

Answer: B) Zinc chromate

Explanation: Anti-corrosive pigment that passivates steel surfaces.

182. In paints, the volatile component **that evaporates during drying is:**

A) Pigment
B) Binder
C) Solvent
D) Additive

Answer: C) Solvent

Explanation: Solvent dissolves resin; evaporates after application, leaving film.

183. The drying of oil-based paints **is mainly due to:**

A) Evaporation of oil
B) Polymerization and oxidation
C) Precipitation of pigments
D) Neutralization reaction

Answer: B) Polymerization and oxidation

Explanation: Unsaturated drying oils (linseed) auto-oxidize to form cross-linked film.

184. Which is NOT a drying oil**?**

A) Linseed oil
B) Tung oil
C) Castor oil
D) Poppyseed oil

Answer: C) Castor oil

Explanation: Castor oil has hydroxyl groups, not suitable as drying oil.

185. Varnish differs from paint mainly because it:

A) Contains no pigment B) Dries faster

C) Is water-based D) Contains wax

Answer: A) Contains no pigment

Explanation: Varnish = resin + solvent + oil; transparent protective coating.

186. Which toxic pigment was once used in paints but is now banned?

A) Titanium dioxide B) Lead chromate

C) Zinc oxide D) Iron oxide

Answer: B) Lead chromate

Explanation: Lead-based pigments (bright yellow, red) are highly toxic and phased out.

187. Epoxy resins are widely used in coatings because they provide:

A) Flexibility B) Gloss only

C) High chemical and corrosion resistance D) Cheap production

Answer: C) High chemical and corrosion resistance

Explanation: Epoxy coatings protect metals, concrete, pipelines, and tanks.

188. Which solvent is commonly used in oil paints**?**

A) Water B) Turpentine

C) Ethanol D) Acetone

Answer: B) Turpentine

Explanation: Turpentine (or mineral spirits) thins oil paints and helps drying.

189. In water-based paints, the binder is usually:

A) Acrylic latex B) Epoxy resin

C) Polyester D) Urea-formaldehyde

Answer: A) Acrylic latex

Explanation: Latex paints use acrylic polymer emulsions as binders, water as solvent.

190. Which test is commonly used to determine the cleansing power of detergents**?**

A) Drop weight method B) Ross–Miles foam test

C) Saponification value test D) Karl Fischer titration

Answer: B) Ross–Miles foam test

Explanation: Foam height and stability are measured by Ross–Miles test, indirectly indicating detergent performance.

191. The critical micelle concentration (CMC) **of a detergent refers to:**

A) The pH of the solution. B) The concentration at which micelles begin to form

C) The maximum solubility in water D) The point of rancidity

Answer: B) The concentration at which micelles begin to form

Explanation: CMC is the detergent concentration above which micelles form and cleaning efficiency increases.

192. Which chemical is used in pickling before chrome tanning?

A) $NaCl + H_2SO_4$ B) $Na_2CO_3 + NH_4Cl$

C) $NaOH + HCl$ D) $H_2O_2 + Ca(OH)_2$

Answer: A) $NaCl + H_2SO_4$

Explanation: Pickling lowers pH with acid and salt to prepare hides for chrome penetration.

193. Which enzyme is commonly used in the bating process?

A) Amylase B) Lipase

C) Protease D) Cellulase

Answer: C) Protease

Explanation: Proteases degrade non-collagen proteins, making leather softer and more flexible.

194. Which edible oil has the highest monounsaturated fatty acid (MUFA) content?

A) Olive oil B) Palm oil

C) Coconut oil D) Soybean oil

Answer: A) Olive oil

Explanation: Olive oil is rich in oleic acid (MUFA ~70%), beneficial for cardiovascular health.

195. The iodine value of an oil is a measure of:

A) Degree of oxidation B) Unsaturation of fatty acids

C) Free fatty acid content D) Viscosity

Answer: B) Unsaturation of fatty acids

Explanation: Higher iodine value = higher unsaturation (more double bonds).

196. Which process removes unpleasant odors from edible oils?

A) Degumming B) Neutralization

C) Deodorization D) Bleaching

Answer: C) Deodorization

Explanation: Deodorization (steam distillation under vacuum) removes volatile odor compounds.

The END