CHEMISTRY - DSE :

Industrial chemicals and Environment

Assignment Work on topic

"Nitrogen"

Submitted To :-

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Introduction

Nitrogen is one of the most basic and abundant elements we know to exist. In its naturally gaseous form or as a liquid (boiling point $-195.8°C$), it is highly stable as well as colourless and odourless. It is estimated to be the 7th most abundant element in our galaxy and occurs naturally in our planet's atmosphere, accounting for 78% of the air we breathe.
Since its initial discovery, nitrogen gas has been found to have a no. of important uses. Its clean, dry and inert properties mean it can serve various functions across numerous industries. In analytical chemistry/science, nitrogen can assist with the techniques of mass spectrometry and spectroscopy.
In manufacturing and processing, nitrogen can help prevent the dangerous and undesirable results of reactions with oxygen. In humans, nitrogen is essential to our body's ability to synthesize proteins, amino acids, and nucleic acids for DNA.

Large Scale Production of Nitrogen

Nitrogen gas is a compound that forms from elemental nitrogen. One of the nitrogen's unique properties is its ability to form multiple bonds with various other elements and compounds. Nitrogen compounds can be found in just about every industry and are used in many forms to carry out tasks ranging from oxidation prevention to surgical anesthesia.

The industrial preparation of nitrogen can be undertaken using two methods :-

(i) Fractional Distillation

Fractional distillation is an energy-intensive process that cools the air to a liquid form and then seperates the nitrogen from other compounds using differential boiling points. This method of nitrogen yields an extremely high purity (99.9995%)

(ii) Mechanical Generation

→ Through semipermeable hollow fibre membrane filteration or pressure swing absorption (PSA)

Membrane filtration uses tiny semipermeable hollow fibre tube filters to seperate compounds

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in the air based on speed and weight.
The process of using a nitrogen seperation membrane is fast and consumes less energy than fractional distillation, but provides a lower grade of purity (about 90 to 99.9 %).

Pressure swing Absorption (PSA) is more complicated process. It uses specialized materials carbon molecular sieve (CMS) that can attract the wanted compound based on various molecular properties and seperate it from unwanted compounds. Using a PSA nitrogen generator will provide a high purity (95 to 99.995 %).
Once the nitrogen is seperated using one of these techniques, it can be stored for use on future nitrogen gas applications. With gaseous nitrogen storage, there are no hazmat, special handling, safety or insurance issues.

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Industrial Uses :

Food Packaging - Nitrogen is used to displace oxygen in food packaging. By eliminating the oxygen, the food can last longer. It can also add a cushion around the food.

Light Bulb Production - In incandescent light bulbs, nitrogen gas is often used as a cheaper alternative to argon.

chemical plants - Nitrogen is used to displace oxygen and prevent explosions in highly dangerous atmospheres such as chemical plants and manufacturing facilities.

Tire Inflation - Nitrogen offers many benifits when used to fill tires, such as giving them a longer life by reducing oxidation. It also improves tire pressure retention to give drivers better gas mileage.

Electronics - when electronics are being assembled nitrogen gas is used for soldering. Using nitrogen reduces the surface tension to provide a cleaner breakaway from the solder site.

Pollution control - Nitrogen gas can be used to remove the VOCs in liquids before they are discarded.

Pharmaceuticals - Almost every major drug class contains some nitrogen, even antibiotics. Nitrogen, in the form of nitrous oxide, is also used as an anesthetic.

Mining - In the mining industry, nitrogen gas is used to quickly extinguish fires by eliminating the oxygen from the air. And when an area is going to be abandoned they use nitrogen to ensure the area will not explode.

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Handling and Storage:

- Cylinders should be stored upright in a well ventilated, dry, cool, secure area that is protected from weather and preferably fire-resistant.
  No part of the cylinder should ever be allowed to exceed 125°F (52°C) and areas should be free of combustible materials

- Liquid nitrogen should be handled slowly to minimize boiling and splashing. Use tongs to withdraw objects immersed in a cryogenic liquid.

- Do not transport liquid nitrogen in wide mouthed glass Dewars or dewars not protected with safety tape.

- Use only approved containers. Materials such as carbon steel, plastic and rubber become brittle at these temperatures.

- Only store liquid nitrogen in containers with loose fitting lids (Never seal liquid nitrogen in a container).
  (A tightly built up (sealed up) container will build up pressure as the liquid boils and may explode after a short time.

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- Never touch non-insulated vessels containing cryogenic liquids. Flesh will stick to extremely cold materials.

- Never tamper or modify safety devices such as cylinder valve or regulator of the tank.

- Do not store liquid nitrogen for longer periods in an uncovered container.

- Cylinders and Dewars should not be filled to more than 80 % of capacity, since expansion of gases during warming may cause excessive pressure buildup.

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Hazards :

(i) Extreme cold-
The vapour of liquid nitrogen can freeze skin tissue and eye fluid, resulting in cold burns, frostbite, and permanent eye damage even by brief exposure.

(ii) Asphyxiation-
Liquid nitrogen expands 695 times in volume when it vaporizes and has no warning properties such as odour or colour.
Hence, if sufficient liquid nitrogen is vaporized so as to reduce the oxygen percentage to below 19.5%, there is a risk of oxygen deficiency which may cause unconsciousness.

(iii) Oxygen Enrichment -
When transferring liquid nitrogen, oxygen in the air surrounding a cryogen system can dissolve and create an oxygen-enriched environment. Since the boiling point of nitrogen is lower than oxygen's, liquid oxygen evaporates slower than nitrogen and may build up to levels which can increase the flammability of materials such as clothing near the system.

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(iv) Pressure buildup and Explosions –
without adequate venting or pressure relief devices on the ~~computer~~ containers, enormous pressures can build upon cryogen evaporation.
Users must make sure that cryogenic liquids are never contained in closed system.

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First Aid :

- Skin/Eye contact - immediately flush area thoroughly with copious quantities of tepid water (water must not be hotter than 44°C).

- Do not apply any form of direct heat.
- Do not rub affected parts with bulky, dry, sterile dressings.

- Anoxia -

→ If a person becomes dizzy or loses consciousness while working with liquid nitrogen, move to a well-ventilated area immediately.
→ If breathing has stopped, apply artificial respiration
→ Seek immediate medical attension.

- Cuts/ Punctures from exploding vials - wash area and apply sterile dressings. Seek immediate medical attention.


Thank
you

Industrial effluents from electroplating industry and their treatment :

* General introduction to electroplating :

Electroplating is the process of plating one metal onto another to resist corrosion, to get shiny appearance etc.
The plating of metals such as copper, silver, chromium etc. are done generally.

* Industrial effluents :

Industrial effluents (liquid discharge) arise from the constituents of the plating bath used for electroplating.
Electroplating baths may contain nickel, lead, tin etc.

- The anionic components likely to be present include borate, cyanide, fluoride, tartarate, phosphate, chloride, sulfide etc. which pollute water.
- Also, many other additives used to surface leveling are Mo, As, Co etc. which contribute to waste streams.
- Contaminants like oil, grease, suspended solids etc. also contribute to wastestreams.
- Salts of heavy metals like Cd, Pb etc., chromic acid, chromates also act as industrial effluents

Colour, pH, Dissolved Oxygen (D.O.), Biological Oxygen Demand (B.O.D), Chemical Oxygen Demand (C.O.D.), Total Dissolved Solids (TDS) etc. are some of the parameters that are used to assess the quality of water

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released from industry and these parameters help us to assess how much toxic the wastewater is (due to the industrial effluents present).

* ## Effects of the industrial effluents :

(i) Heavy metal salts : Toxic to aquatic life. ~~Their toxicity~~

(ii) Phosphates and nitrates : Result in excessive algae growth (Algal Bloom) which is undesirable as it blocks sunlight from reaching other microorganisms and cause depletion of O_2 levels in water.

(iii) Fe, Sn : Impart unpleasant colour to stream.

(iv) Suspended impurities : Clog the ~~m~~ sewer systems.

(v) Arsenic : Causes skin cancer and bladder cancer.

(vi) Cyanide : CN^- combined with H^+ forms deadly HCN which causes seizures, fainting etc.

(vii) Lead : Causes Plumbism (Lead Poisoning)

(viii) Chromium : Cr^{+6} in low dose causes necrosis (death of body cells due to failure of blood supply) and Cr^{+6} in high dose causes lung cancer.

* ## Treatment :

(i) Coagulation and precipitation :

This involves precipitation in the form of insoluble compounds but this generates HCN gas that creates air pollution problem.

~~ii~~ The coagulation & precipitation are done by :

~~(ii)~~ • Treatment with Barium Chromate

• Treatment with Sulphur Dioxide

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- Treatment with sulphuric acid.
- Treatment with ferrous sulphate

(ii) Alkaline Chlorination Method: [~~Successful~~ Satisfactory Method]

When the CN^- concentration in waste stream is less than 1000 mg/L, this process can be applied. This process involves chlorination of water at high pH. When cyanide is treated with chlorine, it first forms cyanogen chloride which is alkaline solution is converted to relative non-toxic cyanate.

(iii) Electrolytic Decomposition Method:

In this, the cyanide waste is subjected to electrolysis at high temperature. CN^- is completely broken down to CO_2 and NH_3 with cyanate as intermediate.

(iv) Evaporation:

Single and multistage evaporation ~~are~~ carried out to recover the process water and plating chemicals

(v) Ion-exchange method:

The treatment of chromate containing water can be achieved by passing through a column of acid absorbing artificial resin Deminrolit B. Chromate is completely absorbed until the resin gets exhausted. ~~but~~

Questions

Week III

Nitrogen

1. Except for fractional distillation what other method may be used to manufacture nitrogen?
2. Liquid nitrogen needs careful handling and storage, why?

Effluents from Electroplating Industry

1. Name the chemicals present in an Electroplating industry effluent. How can they be removed?

NEON

1. Explain the charcoal method of separation of Neon gas from the mixture of inert gases.
2. List three applications of Neon gas.

ARGON

1. Give the hazards associated with Argon gas.
2. List some uses of Argon.

SO_2

1. Name the different sources of SO_2 in environment. How can SO_2 emissions be controlled?
2. SO_2 is hazardous to vegetation as well as animals. Comment.

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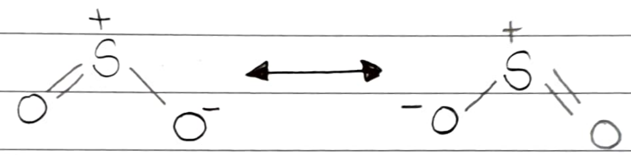
Sulfur Dioxide

Sulphur Dioxide (also sulfur dioxide) with formula SO_2, is a toxic gas responsible for the smell of burnt matches.
It is a colourless gas, soluble in H_2O, nonexplosive and non explosive and non-flammable.

→ **Structure:-**



SO_2 is a bent molecule with C_2 symmetry
The S–O bond has a bond order of 1.5.

→ **Occurrence:-**

- Natural sources, such as volcanoes, contribute to environmental levels of sulfur dioxide.
- Use of sulfur containing fossil fuels for domestic heating and for power generation
- Other sources can be smelting, manufacture of sulphuric acid, conversion of wood pulp to paper, forest fires
- Coal burning is the single largest man-made source of SO_2 accounting for about 50% of annual global emissions.

→ Production :-

- By Combustion –
Sulphur dioxide is the product of the burning of sulphur or of burning materials that contain S.

$$S + O_2 \longrightarrow SO_2 \qquad \Delta H = -297\ KJ mol^{-1}$$

- Roasting of sulphide ores –
$4FeS_2 + 11O_2 \longrightarrow 2Fe_2O_3 + 8SO_2$
(Iron pyrite)

$2ZnS + 3O_2 \longrightarrow 2ZnO + 2SO_2$
(Sphalerite)

- Oxidation of H_2S
- Contact Process –
SO_2 is an intermediate in production of sulfuric acid.

→ Uses :-

- Precursor to Sulphuric Acid :-
Contact Process –
$S(s) + O_2(g) \longrightarrow SO_2(g)$
$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

$H_2SO_4(l) + SO_3(g) \longrightarrow H_2S_2O_7(g)$
oleum / fuming sulphuric acid

$H_2S_2O_7(l) + H_2O(l) \longrightarrow 2H_2SO_4(l)$

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- As a preservative –

SO_2 can be used as a preservative for dried apricots, dried fruits, owing to its antimicrobial properties.

It prevent rotting and maintains the colourful appearance of the fruit

- In winemaking –

It serves as an antibiotic and antioxidant, protecting wine from spoilage by bacteria and oxidation, which causes browning of the wine and loss of specific flavour.

- As a reducing agent –

It is a useful bleach for papers and delicate materials such as clothes.

This reducing bleach action of SO_2 does not last very long.

Action :- SO_2 removes oxygen from the coloured substances and make it colourless.

- It is used in production of steel, fertilizers, medicines fuels, batteries, paper, plastic and in many other application.

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→ Impact On Plants :-

- It causes the stomata of the plant to open and the leaves to lose water.
- It can result in decreased quality or quantity of crop yield.
- High concentration of sulfur dioxide can produce acute injury in the form of foliar necrosis, which is darkening of leaves, stems and other parts of plants. Necrosis weakens the plants and make them more susceptible to other diseases and pests.
- SO_2 combines with oxygen and water molecu-les in the atmosphere, producing sulphuric acid. This causes acid rain and acid smog which causes huge damage to biotic and abiotic components.
- SO_2 influence global warming

→ Impact on Animals and Human :-

- Sulphur dioxide forming H_2SO_4 in acid rain decreases the pH of water bodies causing harm to aquatic life.
- Drinking acidified H_2O causes harm to animals
- SO_2 leads to deforestation indirectly, thus decreasing the vegetation available to life forms.
- SO_2 particulate matter may penetrate deeply into lungs and in sufficient quantity can contribute to health problems like bronchitis in humans.

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- Inhaling SO_2 is associated with difficulty in breathing and premature death.
- It causes irritation in nose, throat and airways, coughing, wheezing or feeling of chest contraction.
- Exposure to SO_2 may be fatal to asthmatic patients.

→ Ways To Control SO_2 emission :-

- Use coal that contain less sulphur content.
- The power plant can also install equipment called scrubbers, which remove SO_2 from gases leaving the smoke-stack.
- Fossil fuels can be replaced by renewable sources of energy like solar and wind power.
- Using Wet Systems –
In this system, crushed limestone/lime is mixed with water, or caustic soda diluted in H_2O to form slurry or liquid, which is then sprayed onto the exhaust gases in plants. The adsorbant reacts with SO_2 to form an aqueous slurry of manageable sulphur species that could have the potential to be monetized or at least safely disposed.
- Dry/Semi-Dry systems –
Within the spray dry system, a slurry of alkali sorbent, usually slaked lime is injected into the flue gases in a fine spray. The heat from the flue gases causes the water to evaporate, cooling the gases as it does so. The present SO_2 reacts with drying sorbent to form a solid reaction product with no waste water.

GOOD WRITE A Mark of Quality.....

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ARGON

• **Extraction :**

Argon can be produced from liquid air by fractional distillation. It can also be produced by heating Nitrogen gas from atmosphere with hot magnesium or calcium. The Mg/Ca combine with N_2 to form a Nitride and Ar is left.

Argon also occurs in wells with natural gas. When the natural gas is purified, some argon can be recovered as a by-product.

• **Isotopes :**

Three isotopes of Argon exist naturally, viz a viz, argon-36, argon-38, and argon-40.

Six radioactive isotopes of argon are also known. A radioactive isotope is one that breaks apart and gives off some form of radiation.

No radioactive isotope of argon has any practical application. One non-radioactive isotope, however, is used to find the age of very old rocks.

This dating of rocks involves the decaying of Radioactive K-40. Younger rocks contain more potassium-40 and less argon-40 ~~and~~ vice-versa.

USES OF ARGON:

- Argon is used in situations where materials need to be protected from oxygen or other gases. A good example is incandescent lightbulb, which consists of a metal wire inside a clear glass bulb. An electric current passes through the wire, causing it to get very hot and give off light.

  Oxygen will combine with the hot metal very easily, forming a compound of the metal and oxygen. This compound will not conduct an electric current very well, thereby causing the lightbulb to stop giving off light.

  Argon, however, is used to prevent this from happening. Because Argon is inert, it will not react with hot wire, leaving the metal hot for very long periods of time. The lightbulb will stop giving off light only when the metal breaks. Then it can no longer carry an electric current.

- Argon is also used in welding.
- Argon is also used in Argon lasers and Argon-dye lasers.
- An Argon-dye laser is used in eye-surgery.

HEALTH EFFECTS OF ARGON:

Routes of Exposure: The Substance can be absorbed into the body by inhilation.

Inhilation Risk: On loss of containment this liquid evaporates very quickly causing supersaturation of the air with serious risk of suffocation when in confined areas.

Effects of Exposure: • Inhalation: • Dizziness.
• Dullness.
• Headache.
• Suffocation.

• Skin: • On Contact with liquid: Frostbite.

• Eyes: On Contact with liquid: Frostbite.

About Inhalation:

• The gas is inert and is classified as a simple asphyxiant. Inhilation in excessive concentrations can result in dizziness, nausea, vomiting, loss of consciousness, and death.

• At low oxygen concentrations, unconciousness and death may occur in seconds without warning.

ENVIRONMENTAL EFFECTS OF ARGON:

- No known ecological damage caused by argon.
- No adverse environmental consequences are expected. Argon gas occurs naturally in the environment.
- The gas will dissipate rapidly in well ventilated areas.
- The effects of argon on plants or animals is not currently known. It is not expected to harm aquatic life.
- Argon does not contain any ozone depleting chemicals and is not listed as a marine pollutant by DOT (Department of Transportation, USA).
- Argon does not have any biological use.
- Diazotrophs, bacteria that absorb nitrogen and convert it to ammonia, may absorb argon, but they cannot apply it
- Argon is non-water hazardous and no known environmental environmental effects have occured.

- The effect of simple asphyxiant gases is propartional to the extent to which they diminish the amount (partial pressure) of oxygen in the air that is breathed. The oxygen may be diminished to 75% of it's normal percentage in air before appreciable symptoms develop.

This in turn requires the presence of a simple asphyxiant in the concentration of 33% in the mixture of air and gas. When a simple asphyxiant reaches a concentration of 50%, marked symptoms can be produced.

A concentration of 75% is fatal in a matter of minutes.

Symptoms :

- The first symptoms produced by a simple asphyxiant are rapid respirations and air hunger.

- Mental ~~att~~ alertness is diminished.

- Muscular co-ordination is impaired.

- Emotional instability often results and fatigue occurs rapidly.

- Finally convulsions, deep coma and death.

NEON

stars of more than 8 solar masses.

* **Industrial Production :**

Air is the only source of Neon. Neon is separated from air in a number of ways as:

1) This method was originally used by Ramsay and Travers. In this process of separation by low temperature rectification most volatile components move into the first isolated part. The primary gas consists of 3-10% of ~~ne~~ Neon - helium mixture and rest is Nitrogen. It is natural because the volume concentration of Neon in 1000 L of air is 18.2 sm^3 and that of He is 5 sm^3. The mixture is then sent to the dephlegmator, that is a distillation tube, in which the most part of Nitrogen is condensed. As a result, the conc. of neon-helium binary mixture grows upto 35-40%. Another apparatus called dephlegmator - adsorber almost completes the nitrogen separation process. Depending on the degree of purification the final mixture contains 30-75% of

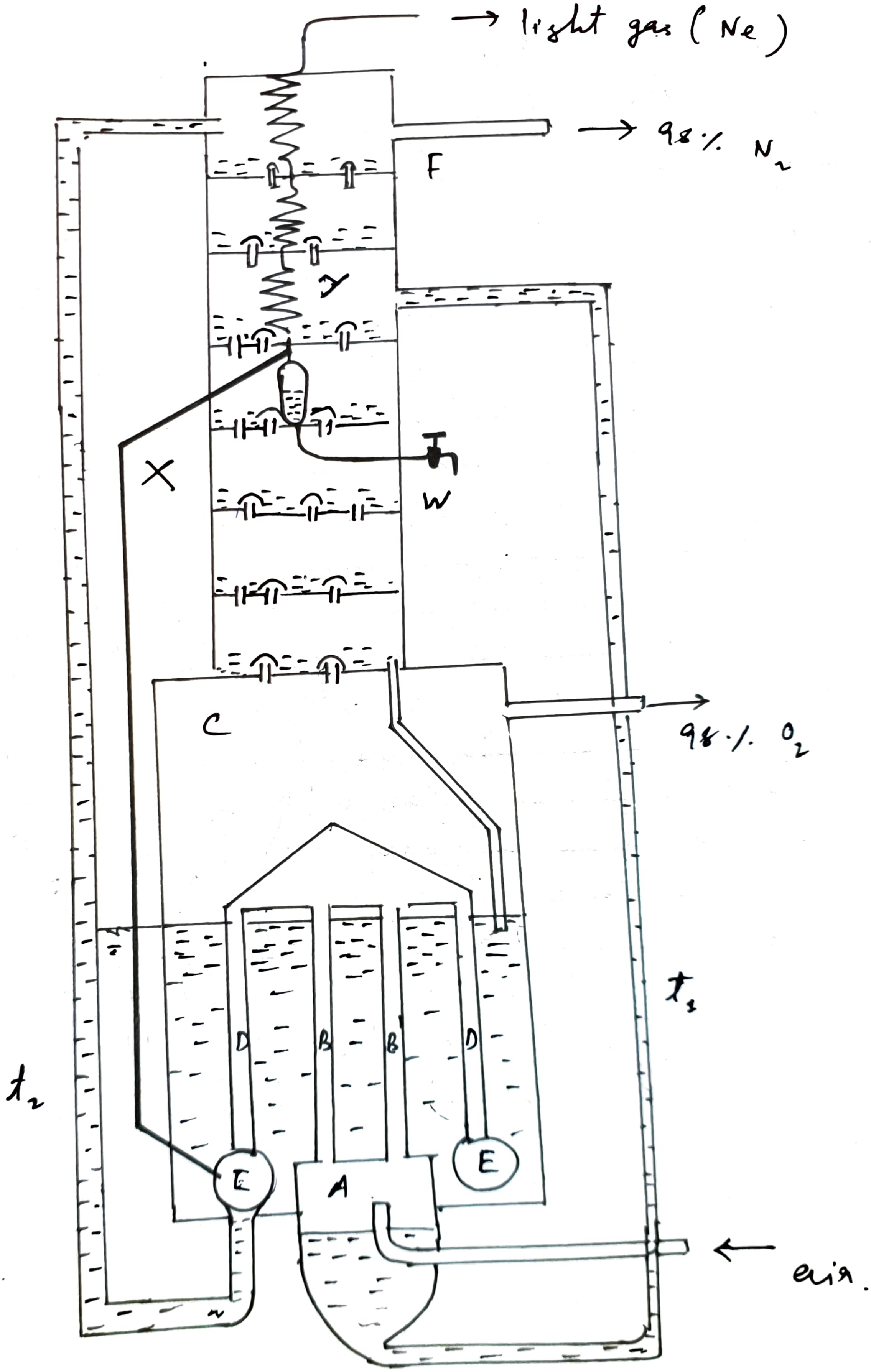

Fig: Claude's Apparatus for liquid air distillation

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neon and 10-25% of helium.

2) <u>Claude's</u> <u>method</u>: The most convienient method of obtaining Neon from air is by means of a modification of Claude's apparatus for the fractional condensation and distillation of liquid air. Cooled air under pressure is introduced into the vessel A and ascends the tube BB', which are cooled in a bath of liquid oxygen. Here the greater part of the O_2 and some N_2 are condensed and the liquid falls back into the reservoir A. The gas next passes down other tubes DD', which are also surrounded by the liquid oxygen, and here the Nitrogen is condensed almost completely and collects in reservoir E.

The upper part consists of a rectifying column. By the pressure of gas in the tubes, the liquid in the reservoir A is forced upto the tube t, and is delivered into the column at a point a little below the top, while the liquid in E is similarly forced

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X into through a spirals Y at the top of the column and released to the atmosphere. Here, a great part of the residual N_2 is condensed and falls back into the small reservoir Z, from which it is blown off from time to time through cloct W.

3) Another method of separating Ne from the mixture of inert gases (Xe, Kr, Rd) obtained from air is to ~~cool~~ adsorb the mixture in cooled charcoal at about -100°C. Ar, Kr, Xe are completely adsorbed while He and Ne are not. The un-adsorbed gases are pumped away and brought in to contact with charcoal cooled to the temp^n of liquid air (-180°c to -190°c). While the Neon is largely absorbed while all the helium with a little of the neon can be pumped off. When the charcoal is allowed to warm up to the ordinary temperature. The neon is evolved in a fairly pure state.

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to the top of the column through tube d_2.

The O_2 in C is at its boiling point under atmospheric pressure, and the highest temperature is found in this liquid and at the bottom of the rectifying column. On the other hand the liq in E when suddenly placed under atmospheric pressure at the top of the column, boils rapidly losing the greater part of its Nitrogen and producing the lowest temperature found in any part of the apparatus. As the liq passes down the column it becomes steadily warmer, and meets a current of gas which becomes steadily cooler as it ascends. The net result of these heat interchanges ~~exchanges~~ is that practically all the O_2 in the ascending gas is liquefied and drops back into C, while all the Nitrogen in the descending liquid is distilled off and passes out into the atmosphere at F.

The Neon, He presents above the liquid in E is led by a narrow tube

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Applications: Neon is often used in signs and produce an unmistakable bright reddish-orange light. Althouge tube lights with other colors are often called "neon" they use different noble gases or varied colours of fluorescent lighting.
Neon is used in vaccum tubes, high-voltage indicators, lighting arresters, wave meter tubes, television tubes, and helium-Neon lasers. Liquified neon is ~~commonly~~ commercially used as a cryogenic refrigerant in applications not requiring the lower temp. range attainable with more -extreme liquid helium refrigeration.
Neon, as liquid or gas, is relatively expensive - for small quantities, the price of liquid neon can be more than 55 times that of liquid helium. Driving neon's expense is the rarity of neon, which, unlike helium, can only be obtained from air.

Neon lights are ~~t~~ composed of a sealed glass tube containing a small quantity of neon gas. At each end of the tube there is an electrode, which allows the tube to be connected to an electric power source and to create an electric circuit. Once electric voltage is applied to the neon atoms, the energy removes one electron from the atom's outer shell - having lost one electrode at this point the neon atoms are positively charged and are attracted to the negative terminal, while the single electrons are attracted to the positive terminal.
The movement of atoms and electrodes is what causes the light to be produced: as atoms hit each other and electrodes release

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energy in the form of a photon, light and heat are produced. The electrodes of each noble gas release a specific and characteristic wavelength of photons, which determines the colour of gas will shine in - neon for example glows red - orange.

The colour of neon is strictly orange-red, in its pure form and in a transparent glass tube it makes the colour classic red. All neon signs that are not in classic red, do not actually contain the gas neon. Each of the noble gases glows in its own colour when exposed to high voltage; for example He : pink

Kr : yellow/green

Xe : lavender blue

Ar : light blue

Radon is the only noble gas that does not react to electricity by lighting up in the colour, and is thus the only noble gas that is never used in neon signs. Today however, all colours except classic red actually contain argon. This is because argon is the gas that requires the least amount of electrical input to react and thus uses the least energy of all.

The broader spectrum of neon lights colours is achieved by using different kinds of coating for the glass employed for the tubes: that is why neon tubes are mostly white when turned off, or sometimes tinted. So while classic red & classic blue are made of transparent glass and respectively neon and argon glass, all other colours are achieved by manipulating the glass either with fluorescent powders (such as

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for pink, purple or green neons) or by actually colouring the glass (for orange, cobalt blue and ruby red), rather than the gas.

The required electrical input for neon signs, your typical 'Open' sign, is about 90 watts, which actually makes it more efficient in terms of energy consumption than a fluorescent light bulb. In addition neon lights generally last for about 10 years, after which they simply need to be refilled with gas.

Conclusion:

With the varied uses of Neon and with the development of the right technology in the future, ~~it~~ ~~is~~ Neon possible has the potential to impact many areas of human life.