QUINOLINE

Replacing one carbon atom of naphthalene with a nitrogen atom creates the isomeric quinoline (melting point: –15.6°C, boiling point: 238°C, density: 1.0929) and *iso*-quinoline (melting point: 26.5°C, boiling point: 243°C, density: 1.0986).

Quinoline is isolated from coal-tar distillates in a process in which the tar acids are removed by caustic extraction, and the oil is distilled to produce the methylnaphthalene fraction (230 to 280°C). Washing with dilute sulfuric acid produces sulfate salts, from which the tar bases are liberated by treatment with caustic followed by distillation. The composition of this product is typically 92% quinoline and 5% *iso*-quinoline by weight with smaller amounts of all monomethylquinolines, 2,8-dimethylquinoline, and some homologues of *iso*-quinoline.

Iso-quinoline (>95% pure) can be isolated by treating a crude fraction with hydrochloric acid followed by addition of an alcoholic solution of cupric chloride in a mole ratio of 1:2 $CuCl_2$/*iso*-quinoline.

See ***Naphthalene.***

ISO-QUINOLINE

See ***Quinoline.***

RARE GASES

Oxygen (approximately 20% by volume) and nitrogen (approximately 80% by volume) are the primary components of the atmosphere, but air also contains argon, neon, krypton, and xenon (approximately 1% by volume).

Argon, neon, krypton, and xenon are all produced commercially as byproducts from large cryogenic air separation plants. The distillation of liquid air is normally performed in the double-column arrangement (Fig. 1). The rare gases are produced in side columns operated in conjunction with the standard double-column plant.

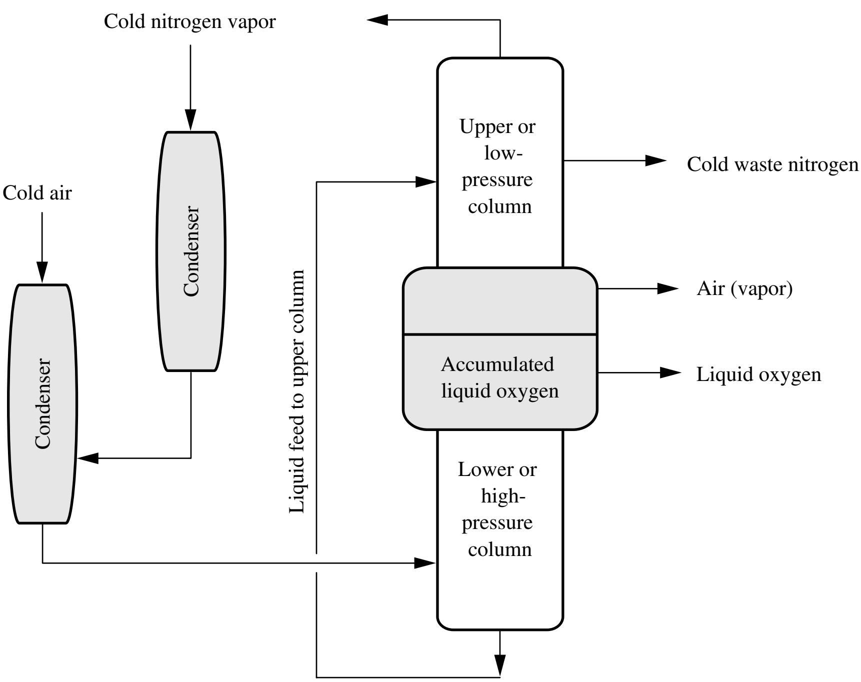

FIGURE 1 A double-column distillation unit for production of rare gases.

Since *argon* boils at a temperature just below oxygen, its concentration level builds up in the upper column at a point above the oxygen product level. The argon-rich vapor is withdrawn from the upper column and is fed to a side argon column. The liquid reflux from the argon column is returned to the upper column at the same point as the vapor withdrawal. The crude argon product is withdrawn from the top of the argon column. The crude argon, which contains oxygen and nitrogen, is processed further to remove oxygen (by the addition of hydrogen and subsequent catalytic combustion and gas drying to recover the water) and nitrogen (by another distillation step) that produces argon having a purity of 99.999%.

Neon boils at a considerably lower temperature than nitrogen and usually collects in the dome of the main condenser as a noncondensable gas. It can be recovered by the addition of a side column.

Krypton and *xenon* have high boiling points relative to oxygen and tend to accumulate in the liquid oxygen sump of the upper column of the main plant.

Helium can be produced from natural gas. A typical plant removes the 2% helium from natural gas of up to 95 percent. The pipeline gas (at 3 to 4.5 MPa) is scrubbed, to remove water and condensable hydrocarbons and is then passed through a gas cleaner, which removes pipeline dust. From the cleaner, the gas goes to absorption towers to remove carbon dioxide (using monoethanolamine) and finally passes through a bauxite dryer. To obtain the helium, the purified gas enters coolers where the gas is chilled to –156°C and then expanded into a separator-rectifier column. The natural gas is liquefied and separated and the crude-helium (75% helium, 25% nitrogen), passes through a heat exchanger counter to the incoming gas.

The crude helium is purified by removing any trace amounts of hydrogen (using a reactor with a small amount of air, where the hydrogen is oxidized to water over a platinum catalyst) and the hydrogen-free gas is further purified utilizing a pressure-swing adsorption (PSA) process that removes all contaminants to a very low level, usually less than 10 ppm. The pressure-swing adsorption process does not remove neon but for most helium uses it is not considered a contaminant.

RDX

See ***Explosives.***

RED LEAD

Red lead (Pb_3O_4) has a brilliant red-orange color, is quite resistant to light, and finds extensive use as a priming coat for structural steel because it possesses corrosion-inhibiting properties.

Red lead, or *minium*, is manufactured by oxidizing lead to litharge (PbO) in air and further oxidizing the litharge to red lead. In the fumed process, which produces smaller particles, molten lead is atomized by compressed air and then forced through the center of a gas flame, which in turn converts it into litharge as a fume collected in filter bags. The litharge is then oxidized to red lead by roasting in air.

RESERPINE

Reserpine, an indole alkaloid that is obtained from the *Rauwolfia* plant, was the first successful drug to treat high blood pressure.

Reserpine is isolated from its plant producers by using a nonaqueous solvent process, using, for example, boiling methanol extraction of the African root *Rauwolfia vomitoria*. Naturally, these extractions are carried out under countercurrent methods. The methanol extract is concentrated and acidified with 15% acetic acid and then treated with petroleum naphtha to remove impurities. Extraction is made using ethylene dichloride. The solvent is neutralized with dilute sodium carbonate, evaporated to drive off the ethylene dichloride, and further evaporated to crystallize the crude reserpine crystals that are then crystallized.

In common with other indole derivatives, reserpine is susceptible to decomposition by light and oxidation, so it must be stabilized. Modifying the trimethoxyphenyl portion of the molecule gives other antihypertensive drugs with various potency and rapidity of action.

Reserpine is used for its tranquilizing effect on the cardiovascular and central nervous systems and as an adjunct in psychotherapy.

ROTENONE

Rotenone is the toxic principle of several tropical and subtropical plants, the chief of which is derris. It is a complex organic heterocyclic compound and rotenone derivatives are stomach and contact poisons.

Ground derris roots are extracted with chloroform or carbon tetrachloride and the solvent evaporated, leaving a mixture of rotenone and some other less toxic substances, which are not separated.

RUBBER (NATURAL)

Rubber is a natural polymer that is obtained from the rubber tree and has the all *cis*-1 ,4-polyisoprene structure. This structure has been duplicated in the laboratory and is called *synthetic rubber*, made with the use of Ziegler-Natta catalysis.

Natural rubber may contain less than 10% of nonrubber chemicals and has an outstanding heat-buildup resistance.

RUBBER (SYNTHETIC)

Synthetic rubbers are manufactured from a variety of starting materials that have been classified into vulcanizable and nonvulcanizable and also by the chemical composition of the polymer chain.

The most widely used synthetic rubber is styrene-butadiene rubber (SBR) (Fig. 1). Other commonly used elastomers are polybutadiene, polyethylene-propylene, butyl rubber, neoprene, nitrile rubbers, and polyisoprene.

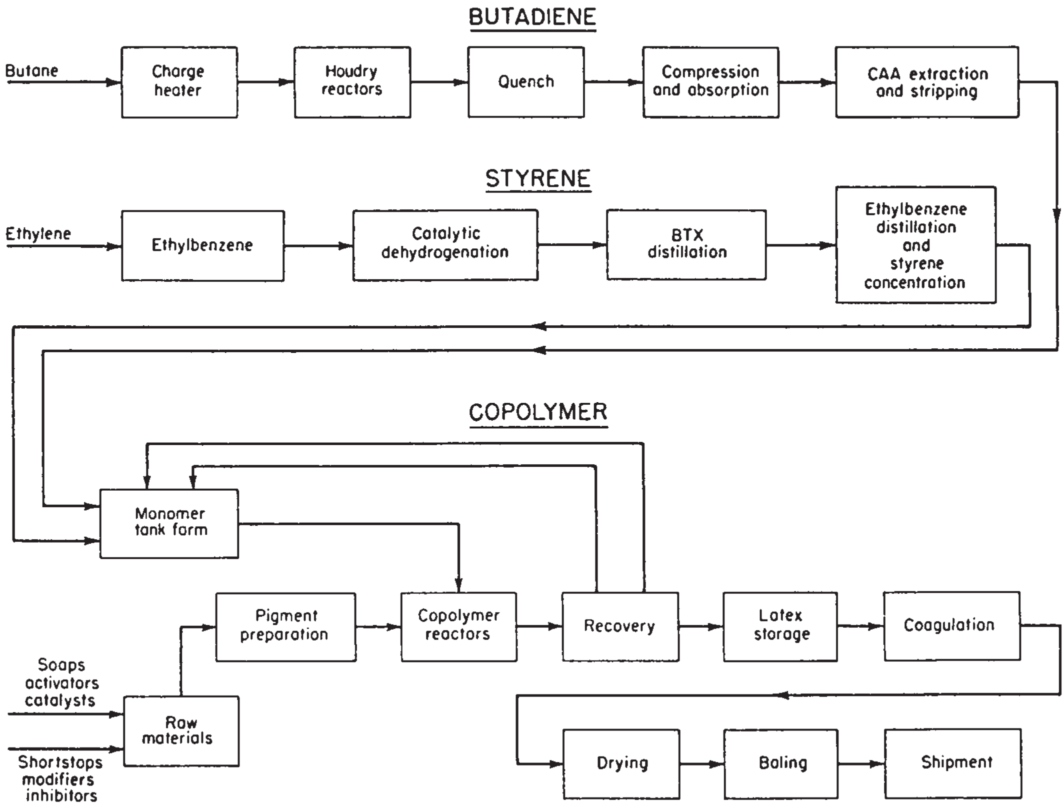

FIGURE 1 Manufacture of styrene-butadiene rubber.