...and here's how it's done:

1 Air intake

Air is a mixture of nitrogen and oxygen. This accounts for 99 %. The remainder consists of argon, carbon dioxide and other rare gases. Oxygen, nitrogen, argon, as well as the rare gases neon, xenon and krypton are obtained from the air by the method of low-temperature rectification.

This is air*

78.108000	%	nitrogen
20.932000	%	oxygen
0.917000	%	argon
0.040000	%	carbon dioxide
0.001820	%	neon
0.000525	%	helium
0.000114	%	krypton
0.000050	%	hydrogen
0.000009	%	xenon

*Main ingredients: figures indicate volume percentage

2 Preliminary purification

Before the air is separated into its gaseous components, unwanted ingredients must be removed. These are filtered out, chemically absorbed of surfaces or frozen out.

3 Compression

The air that has been sucked in is compressed at a pressure of around 6 bar. Heat is created as a result (this effect is familiar from the bicycle pump).

4 Preliminary cooling

The compressed air is first cooled down to a temperature of minus 180°C. As it expands in the separation columns, it cools down still further (reversed bicycle pump effect). As a result it liquefies to some extent (the temperature being lower than the boiling point).

5 Cooling and separating

By means of the separation column, the air is separated into its components. This is a purely physical process, not involving any chemical reactions. The liquid mixture of products trickles down to meet the rising stream of gas. The liquid collects on the trays of the column, and is penetrated by the vapor bubbles from beneath. Here it is oxygen preeminently, with its higher boiling point (-183 degrees C), which condenses out of the stream of gas. The drops of liquid, on the other hand, give rise for preference to evaporating nitrogen, with its lower boiling point of -196°C.

Gaseous nitrogen collects, in consequence, at the top of the separation column, while liquid oxygen collects at the bottom of the column. The oxygen at the bottom is vaporized, while nitrogen in liquid form is introduced at the top of the column. This process is continued as long as is required to reach the desired level of purity.

6 Rare gas recovery

With a view to obtaining the rare gases, the separation column of the air separation unit is equipped with additional aggregates for raw argon, a neon/helium mixture and a krypton/xenon mixture. These mixtures must be purified still further. In a modern air separation unit with a production capacity of 45,000 cubic meters of oxygen per hour, 1700 cubic meters of argon per hour and 91 cubic meters of rare gases (neon, krypton and xenon) per hour can be recovered.
Of these, 60 to 85 % can be obtained in the form of high purity gases.

7 Compression

The gas products oxygen and nitrogen are fed into a pipeline network at a pressure of 40 bar.

Filling

Liquid oxygen, nitrogen and argon are filled into

8 cryogenic tanks or

9 road tankers or

10 compressed to 300 bar, vaporized and filled into steel cylinders.

(To create liquid products a further refrigeration stage filled is required – this has not been shown in the diagram).

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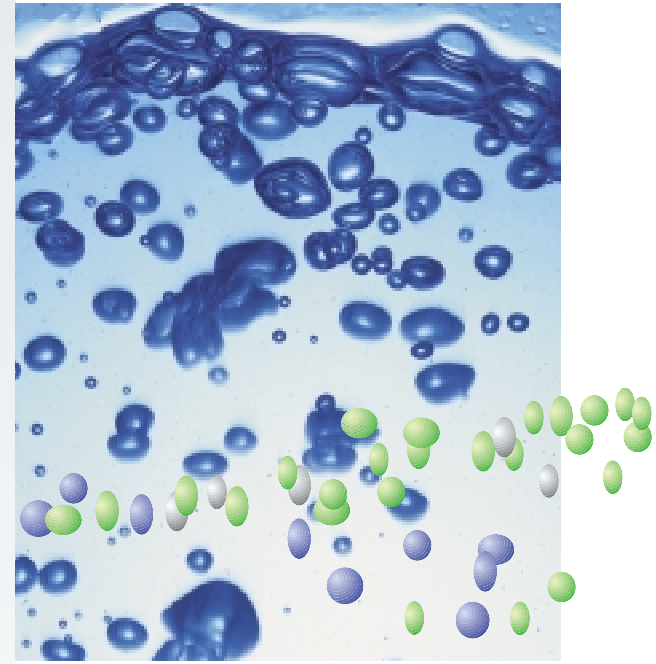

This is how air separation works

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