

# PENGOLAHAN URANIUM



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# Pengolahan uranium alam

- Proses konsentrasi, konsentrat uranium disebut yellow cake.
- Proses pemurnian, hingga mencapai kemurnian 99,9%.
- Proses pabrikasi, membentuk serbuk menjadi elemen bahan bakar berbentuk pellet yang dimasukkan kelongsong bahan bakar.



# Mining

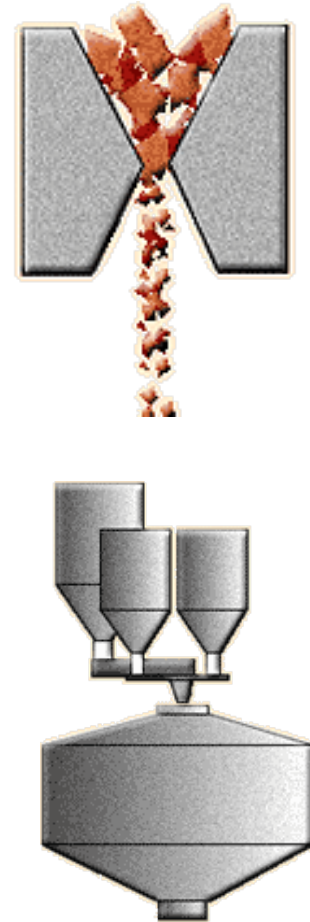


Uranium ore is usually located aurally; samples are then and analyzed by geologists. The

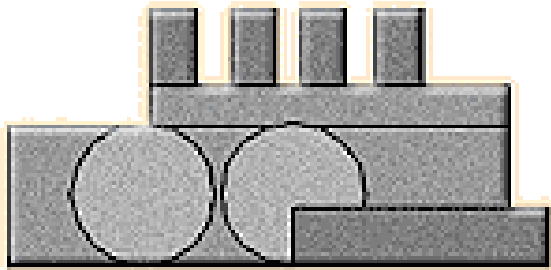
uranium ore is extracted by means of drilling and blasting. Mines can be in either open pits or underground. Uranium concentrations are a small percentage of the rock that is mined, so tons of tailings waste are generated by the mining process.

# Milling & Leaching

- The ore is first crushed into smaller bits, then it is sent through a ball mill where it is crushed into a fine powder. The fine ore is mixed with water, thickened, and then put into leaching tanks where 90% of the uranium ore is leached out with sulfuric acid. Next the uranium ore is separated from the depleted ore in a multistage washing system. The depleted ore is then neutralized with lime and put into a tailings repository.



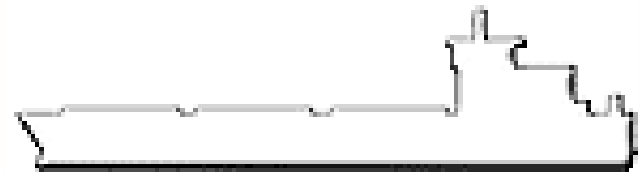
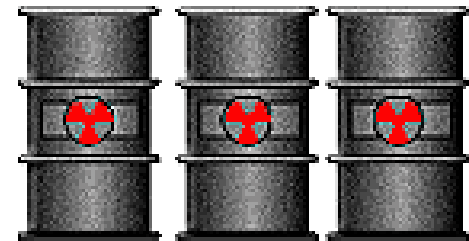
# Yellowcake

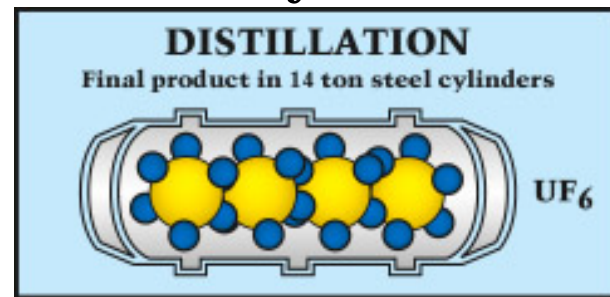
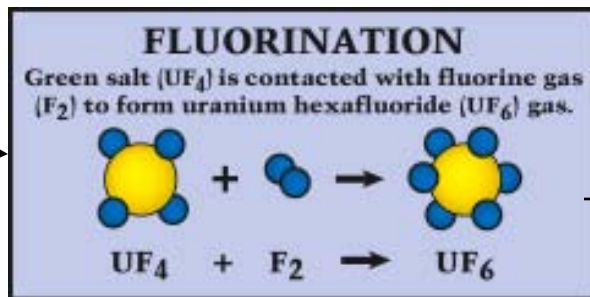
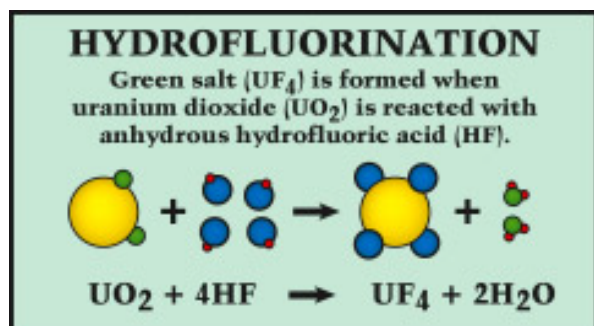
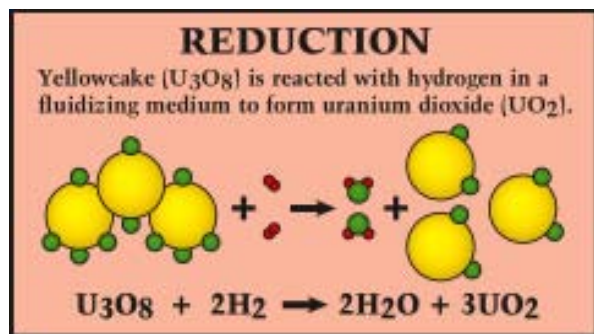


- Meanwhile, the uranium solution is filtered, and then goes through a solvent extraction process that includes kerosene and ammonia to purify the uranium solution. After purification the uranium is put into precipitation tanks—the result is a product commonly called yellowcake.

# Transportation

- In the final processes the yellow cake is heated to  $800^{\circ}$  Celcius which makes a dark green powder which is 98%  $U_3O_8$ . The dark green powder is put into 200 liter drums and loaded into shipping containers and are shipped overseas to fuel nuclear power plants.





To enrich uranium it must be in the gas form of  $UF_6$ . This is called conversion. The conversion diagram shown here is from Honeywell. First the yellow cake is converted to uranium dioxide through a heating process (this step was also mentioned in the mining process). Then anhydrous hydrofluoric acid is used to make  $UF_4$ . Next the  $UF_4$  is mixed with fluorine gas to make uranium hexafluoride. This liquid is stored in steel drums and crystallizes.

# Enrichment

- **Uranium enrichment increases the amount of U235 in comparison to U238. Domestic power plants use a mixture that is 3-5% U235, while “highly enriched uranium” is generally used for weapons, some research facilities, and naval reactors. Domestic reactors usually require fuel in the form of uranium dioxide and weapons use the enriched mix in the form of a metal. The conversion and enrichment process is very dangerous because not only is the uranium hexafluoride radioactive, it is also chemically toxic. In addition, if the uranium hexafluoride comes in contact with moisture it will release another very toxic chemical called hydrofluoric acid. There have been numerous accidents during the conversion and enrichment process. Depleted uranium is the waste that is generated from the enrichment process.**



# Fuel Fabrication

- After being enriched, the UF<sub>6</sub> is taken to a fuel fabrication facility that presses the powder into small pellets. The pellets are put into long tubes. These tubes are called fuel rods. A fuel assembly is a cluster of these sealed rods. Fuel assemblies go in the core of the nuclear reactor. It takes approximately 25 tonnes of fuel to power one 1000 MWe reactor per year. The picture on the right is a fuel assembly.



Source: <http://www.world-nuclear.org/education/nfc.htm>