Liquid Thermal Diffusion

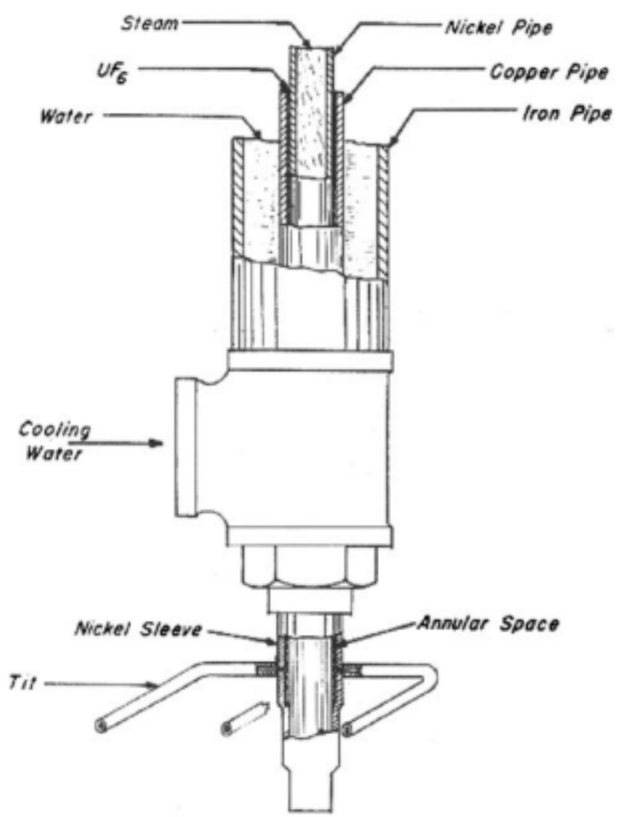


Fig. 2. Sectional view of a process column. Uranium hexafluoride consisting of a mixture of light (U-235) and heavy (U-238) isotopes is driven by vapor pressure into the narrow annular space (0.25 millimeter = 0.1 inch wide) between the nickel and copper pipes; the nickel pipes were 1.25 inches in outside diameter. Gas (or fluid) containing the lighter isotope will move toward the hotter region while the heavier-isotope material moves toward the cooler. The hotter material will rise by convection while the cooler will descend; the desired lighter-isotope material can then be harvested from the top of the 48-foot column. Steam at 545°F and 1,000 psi (pounds per square inch) is introduced into the inner pipe from the top and collected as condensate at 535°F and 950 psi at the bottom. Cooling water enters the 4-inch diameter outer pipe at a temperature of 150°F. At the top and bottom of each tube, three small projecting "tits" provided access to the annular space for supply and withdrawal of material. *Source*: MDH (ref. 5), between pp. 3.7 and 3.8.

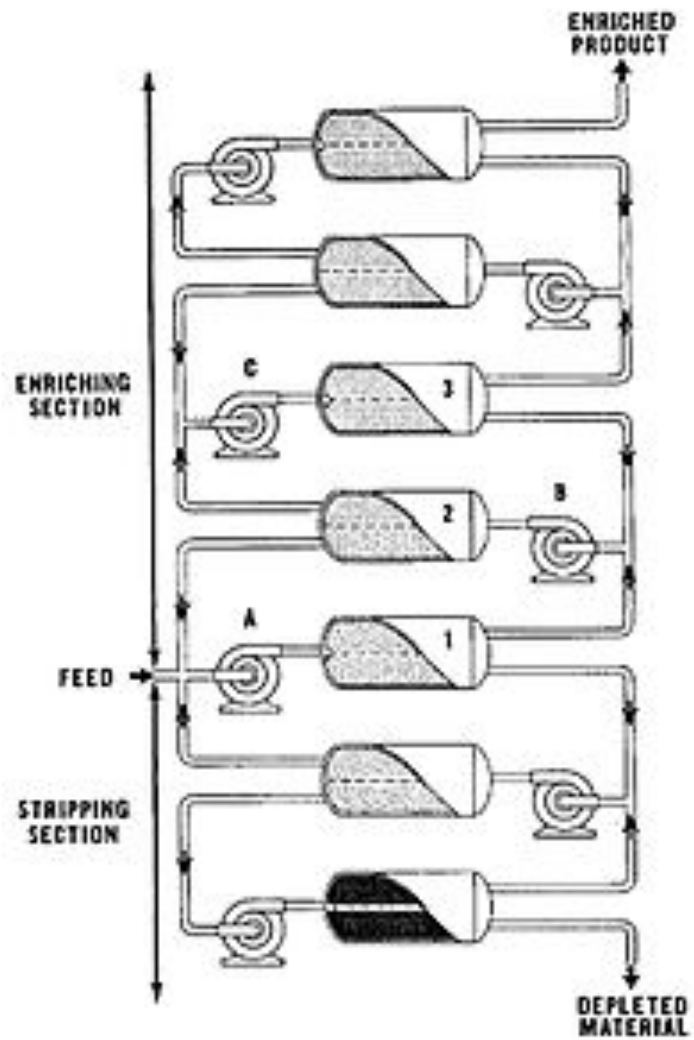
- 48-foot (!!) vertical columns @ S-50
- .712%->.864%
- Equilibrium time ~months-years
- "The S-50 plant surpassed the wildest dreams of the cartoonist Rube Goldberg"

Throughput ★★★☆☆

Separation factor ★☆☆☆☆

Energy hungry; requires 1000C steam in massive quantities (Japan attempted electrical heating)

Gaseous Thermal Diffusion



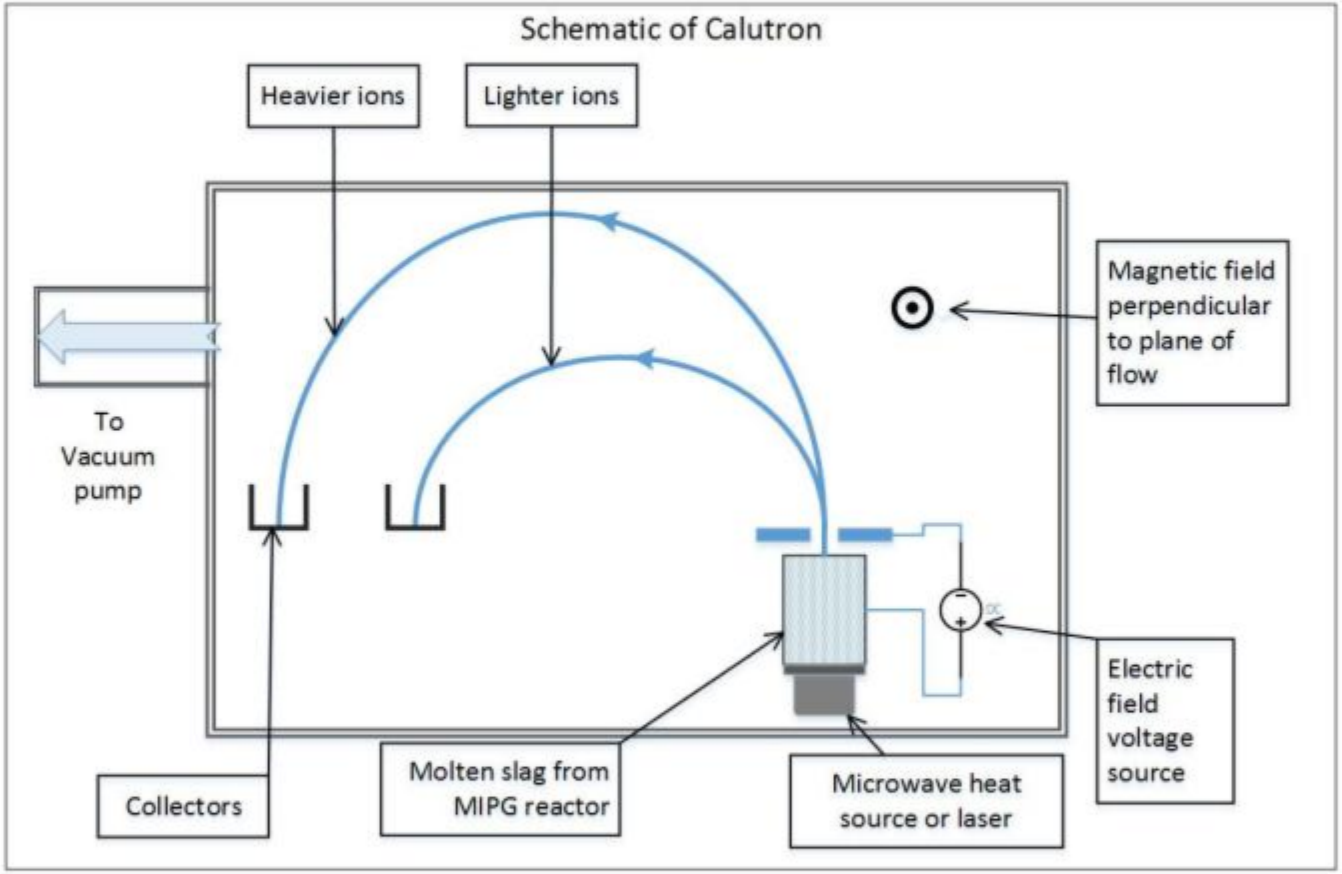
- Simple, efficient…but troubled
- Norris-Adler barrier (created by an interior designer and chemist) based on crushed mesh failed
- Replaced by "Johnson Barrier" (details sketchy, probably an etched nickel alloy)
- Not fully operational until late 43-early 44 due to barrier problems and nickel shortage

Throughput ★★★☆☆

Separation factor ★★★★☆

EXTREMELY energy hungry

Electromagnetic (Calutron)



- Simple, inefficient, ready-to-go in ~1941
- Requires huge quantities of Cu/Ag for field coils

Throughput ★☆☆☆☆

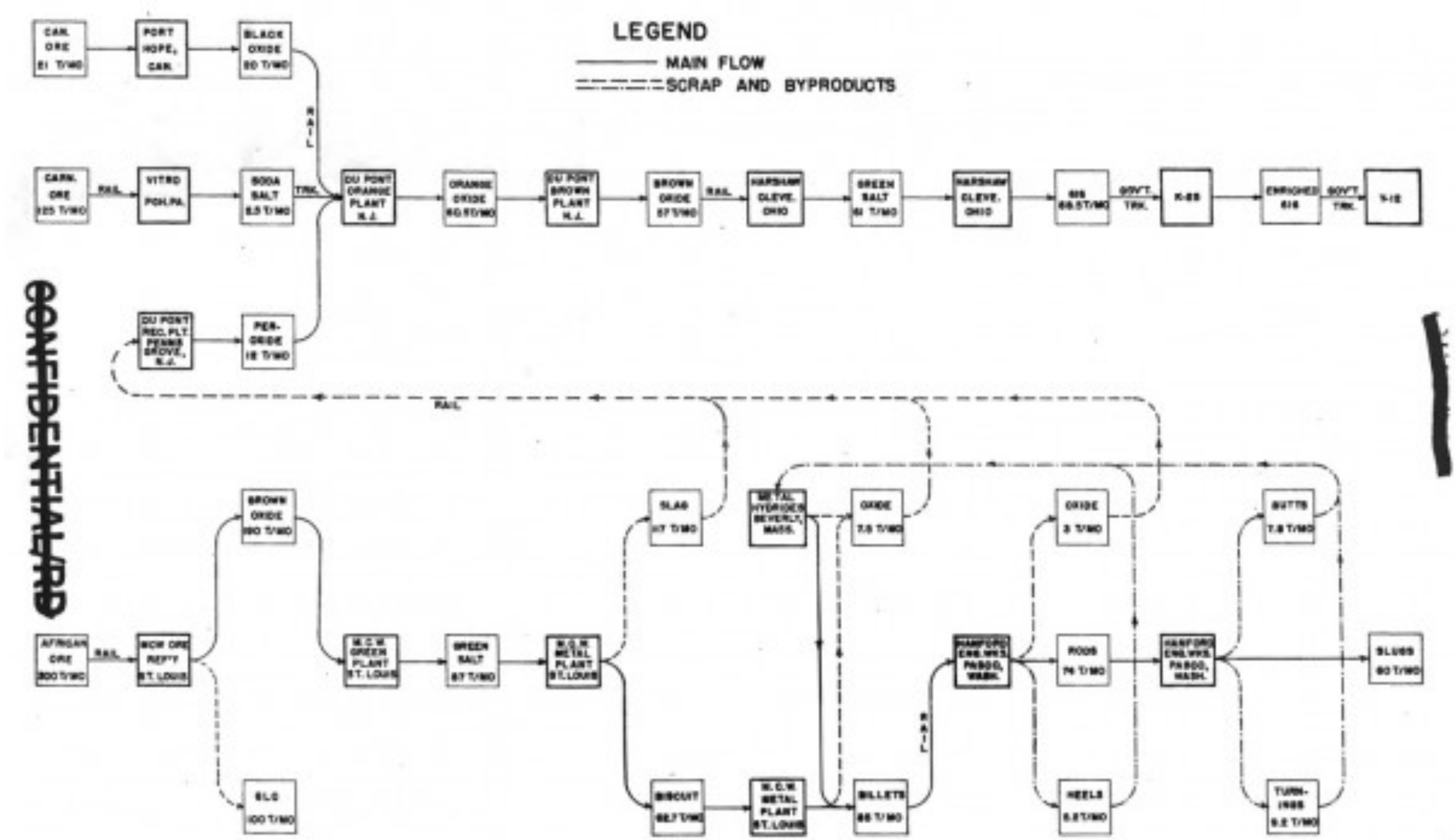
Separation factor ★★★★★

Requires large B-field, large vac pump

Optimizing an array of suboptimal technologies

- Main problem: How to daisy-chain technologies together to maximize output within the time and resource constraints given

URANIUM PRODUCTION FLOW DIAGRAM



https://www.osti.gov/opennet/manhattan_district