

Health Physics Aspects of Cryogenic Liquid Activation Targets

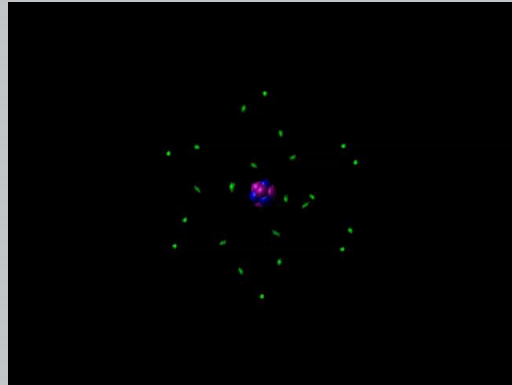
Tracy N. Tipping

Nuclear Engineering Teaching Laboratory



What are Activation Targets?

- Raw material bombarded with neutrons
 - Neutron capture results in radioactive product



Important Activation Parameters

$$A = N\sigma\Phi$$

A - activity of product at saturation

N - number of target atoms

σ - neutron capture cross section of the target

Φ - neutron fluence



How Do We Get More A?

$$A = N\sigma\Phi$$

σ and Φ are fixed

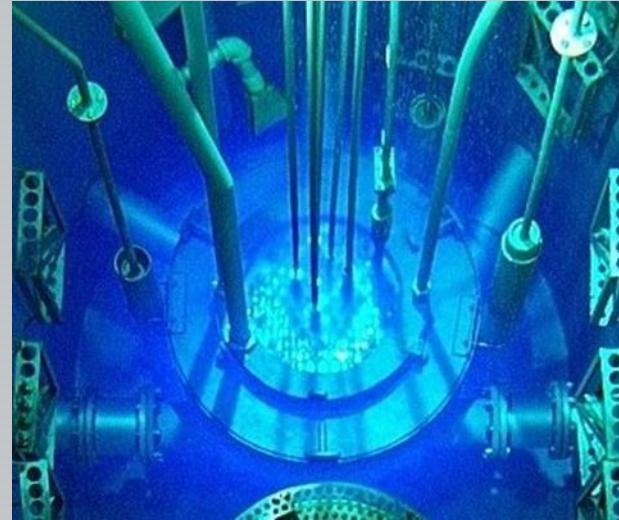
Therefore, increasing N will increase A.



How Do We Increase N?

Physical size (volume) is fixed.

Must increase density to increase N.

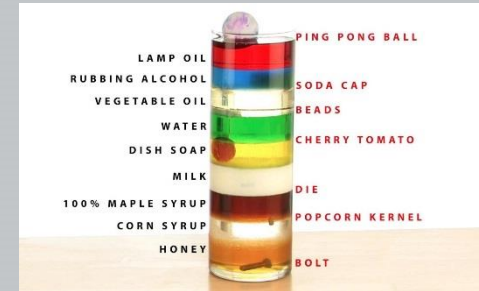


Density Comparisons

At Room Temperature – Density = X

At Cryogenic Temperature – Density = ~ 700 X

What about increasing pressure?



Density Comparisons

At Room Temperature – Density = X

At Cryogenic Temperature – Density = $\sim 700 X$

What about increasing pressure?

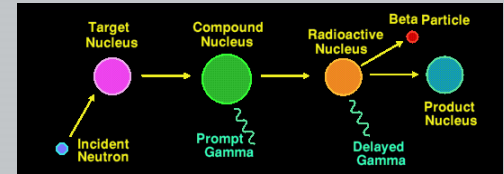
Would require $> 10^4$ psi



On a Good Day



- Cooling system condenses target gas in irradiation volume.
- Target is activated ($\sim 1 \text{ Ci } ^{41}\text{Ar}$)
- After irradiation, activated target is expanded into shielded shipping container.



On a Bad Day



- Cooling system fails and liquid boils off.

- Gas expands out of the irradiation volume.



- Activated gas is captured in shielded emergency reservoir.

- 1 Ci ^{41}Ar = 700 mrem/hr @ 1 meter



On a Really Bad Day



- Cooling system fails and liquid boils off.
- Gas expands out of the irradiation volume.
- System leaks releasing activated gas into building.



On a Really Bad Day



- Release of 1 Ci ^{41}Ar into reactor room results in 81 times the DAC.



On a Really Bad Day



- Release of 1 Ci ^{41}Ar into reactor room results in 81 times the DAC.
- Ventilation system purges room in about 30 minutes...worker exposure mitigated.



On a Really Bad Day



- Release of 1 Ci ^{41}Ar into environment results in dose to maximally exposed individual of about 1 μrem .



On a Really Bad Day



- Release of 1 Ci ^{41}Ar into environment results in dose to maximally exposed individual of about 1 μrem .
- Catastrophe avoided (assuming the news media doesn't find out).



