Radiation Processing

Manufacture of Chemicals

Production of Organic Chemicals by Irradiation

- Irradiation produces several products from organic substrates
- Depending on the yield, some of the products may be economical to produce, via irradiation
- According to Woods and Pikaev (1994), chemicals produced commercially by irradiation included bromoethane (Dow Chemical, 1962 ~ 1970)

- Several processes have been taken up to the pilot scale level, e.g.
  - sulfonic acids
  - hexachlorocyclopentene

Economics of the Irradiation Process for Chemicals

- Assume cost of irradiation $0.01/kGy/kg
- Dose absorbed, 100 kGy; $1/kg
- 100 kGy/kg = 6.24×10^{23} eV/kg
- Assume G value of product (mol.wt = 100) = 5
- Molecules of the product produced = 31.2×10^{21}
  - 5.2×10^{-2} moles = 5.2 g
- Cost of irradiation for the product, $1 for 5.2 g
  - $192.3 (~200) for 1 kg
- Projected costs for the higher G values
  - G= 50, cost $40/kg
  - G=500, cost $4/kg
- Cost of the substrate used, separation of the product from the reaction mixture, purification, etc., to be added to the cost of irradiation

Potential of Manufacture of Some Chemicals by Irradiation

Chemical[1]	Substrate[1]	G-Value	Cost of Irrad($)	Potential for Manufacture[2]
2-Bromo-methyl-propane(175)	1-Bromo-methyl-propane(70)	1.8×10^4	0.08	Yes
Chloroethane (860)	Ethylene (405) HCl (13)	1.6×10^4	0.016	Marginal
t-Amyl alcohol (276)	Ethylene (294), 2-Propanol (7)	120	19	No

[1] Retail price/kg (Aldrich, US$) given in parentheses; for two substrates, price is for the amounts equivalent to the chemical produced

[2] Cost of separations, etc., to be added