

Radiation Processing

Manufacture of Chemicals

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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