



# IRRADIATION TECHNOLOGIES AND COMPOUNDS FOR CABLES CROSS-LINKING – DEVELOPMENTS FOR FLAT AND HEAT-TRACE CABLES



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## ABSTRACT

Irradiation technology is used since the seventies to cross-link sheath and insulation of cables. Generally, the main expected improvement is temperature and creep resistance (hot set test), but secondary improvements like increased chemical resistance to fluids like oils, greases, and higher resistance to abrasion are also researched. Irradiation technologies and facilities are presented hereinafter, followed by the suitable materials for that technology and some scopes of applications of cross-linked cables.

## KEYWORDS

Irradiation, cross-linking, temperature resistance, creep resistance, hot set test.

## INTRODUCTION

2 types of radiations can be use for cross-linking:

- Accelerated Electrons:
  - o They are generated by an accelerator, creating an electron beam (EB technology).
  - o The electron beam scans the cables filing off under it (fig. 1).
  - o Penetration and treated depth are correlated to the energy of the accelerated electrons and of the type of accelerator.
- Gamma Rays:
  - o It consists of photons emitted by a radioactive source (Cobalt 60). It is an electromagnetic radiation.
  - o Complete bobbins are disposed in totes (containers) and file off around the Cobalt source

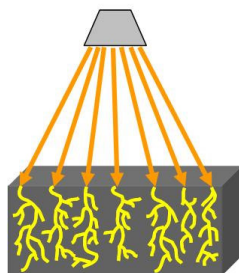


Figure 1: Principle of EB process

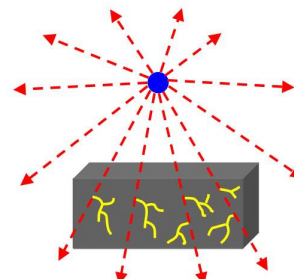


Figure 2: Principle of Gamma process

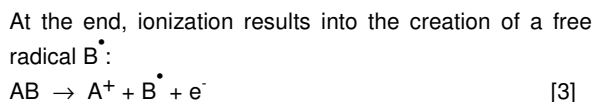
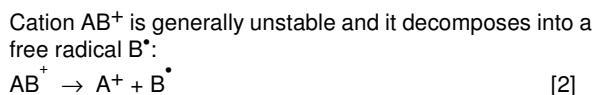
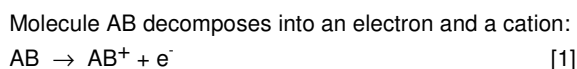
## IRRADIATION TECHNOLOGY

Electron beam (EB) is the most well-known and widespread technology for cross-linking cables, but gamma rays can be more practice for specific products whose potentialities are increasing: flat cables and of heat-trace cables.

Irradiation is used since the seventies to cross-link sheath and insulation of cables.

### Principle of radiation cross-linking reaction and process

The first effect of irradiation is to create the **ionization** of the material: a great amount of free radicals are created along the polymer chain, according to the following reactions [1]:



B<sup>•</sup> is able to induce different chemical reactions based a free radical process: cutting of polymer chains, polyaddition, polymerization ...

Generally, on a hydrocarbon polymer chain, A = H (hydrogen), B = C (carbon).

On a second step, irradiation cross-linking is based on the reactions between free radicals. They react between each other to give new covalent bondings between the polymer chains, and create a three dimensionnal network in the polymer.