

## On the Use of a 5 MeV Electron Linac for Electron Beam Tests Processing

G.Messina, L.Picardi, C.Ronsivalle, A.Vignati,  
ENEA, INN-SVIL 00044 Frascati(Italy)  
G.Tropiano, G.Stoppini,  
Dip.Fisica Univ. di Pisa 56100 Pisa (Italy)  
G.Finazzi Agrò,  
NUCLECO Spa, Via Anguillarese 301 00060 Roma  
R.Gabellieri,  
GGF 56100 Pisa (Italy).

### ABSTRACT

Some years ago a 5 MeV S-band on axis coupled linac with an energy selector 270° magnet has been constructed at the ENEA Frascati Centre, for electron beam tests processing.

Among these, the destruction of PCB in transformer oil is presented, which is particularly interesting due to its environmental impact.

The samples under test with a concentration of PCB up to 50% have been mixed to various substances such as NaOH, AgNO<sub>3</sub>, H<sub>2</sub>O or gurgled with O<sub>2</sub> or H<sub>2</sub>.

The best results have been obtained gurgling H<sub>2</sub>, exploiting a degradation of the order of 99.9% with an absorbed dose of 10 Mrad.

### 1. INTRODUCTION

Electron accelerators have already entered the industry in fields of high technology, and recently also a wide range of application has been reached, particularly in the low energy high power e-beam processing of the cheapest waste products, such as sewage sludge or in the cleaning up of stack combustion gases SO<sub>2</sub>, NO<sub>x</sub>.

In particular, at the ENEA Frascati Research Centre pulsed standing wave RF linac in S-band have been designed [1,2] for race-track microtron accelerating device and for e-beam processing tests such as:  
-Crosslinking of polymers and Heat-shrinkable materials.

-Production of color-centres in Tl<sup>+</sup> doped KCl crystals for laser application in the 1.5 ÷ 1.6 μm wavelengths range [3].

-Crosslinking of commercial resins.

The use of accelerated electrons (1 - 10 MeV) represents an effective alternative to the use of natural sources of radiation (e.g. <sup>60</sup>Co) or to the many chemical and thermal process in industry, avoiding dangerous environmental secondary effects.

Among the many applications previously described, the destruction of policloro biphenyls (PCB) in dielectric oils is presented, by the use of a 5 MeV S-band standing wave pulsed linear accelerator, in alternative to the high temperature or special plasma discharge method [4].

### 2. E-BEAM IRRADIATION TECHNIQUE AND RESULTS

Studies and experiences are directed to the understanding of the phenomena and to the detection of the parameters involved in the irradiation process, because one of the main problems is the recombination of the reaction products after the irradiation.

The described method consists in irradiating commercial dielectric oils with opportune substances for trapping Cl<sup>-</sup> ions. Here we report the results for oils of the types:

1) ELF 1/1 with 11940 ppm of PCB and a density 0.882 g/cm<sup>3</sup>.

2) ELF 2/1 with 456957 ppm of PCB (ASKAREL), density 1.51 g/cm<sup>3</sup>.

These oils were emulsified with water (90% in volume) with gurgling of 70 cm<sup>3</sup>/s of molecular hydrogen through the sample.

The water emulsified oil was put in a 5 cm diameter glass cell provided with a gas (H<sub>2</sub>) inlet and a water storage device for not trapped Cl<sup>-</sup>.

A thickness of 2 cm of the irradiated sample was sufficient to stop the accelerated electrons.

This arrangement represents the best tested method with respect to other arrangements and traps such as AgNO<sub>3</sub> or NaOH [5].

The linac parameters used in this experiment were the following:

ENERGY 5 MeV  $\pm$  2%  
 PEAK CURRENT  $\bar{1}$  A  
 PULSE LENGTH 3.5  $\mu$ s  
 REP. FREQ. 10 Hz

Under these conditions 50 s needed to insure a dose of 10 KGy (1 MRad) to the sample positioned at 30 cm from the exit accelerator window.

At this distance an irradiation uniformity within 10% over the sample under test was measured by the optical density variation of a cellophane blue film and the absolute dose measurement was performed by a water calorimeter.

In fig 1 a drawing of the experimental set up is showed.

After irradiation the two phases of the sample were separated by gravity and so the residual PCB was measured by gas chromatography, showing a degradation of PCB of the order of 99.9% with an absorbed dose of 100 KGy (10 Mrad), and the water showed a pH  $\leq$  1.

### 3. CONCLUSIONS

A system for PCB demolition by accelerated e-beam has been presented and now we are

planning a set of measurements in order to find the best experimental conditions and optimum dose-rate in order to evaluate also the cost of an industrial plant based on the method presented in this work.

### 4. REFERENCES

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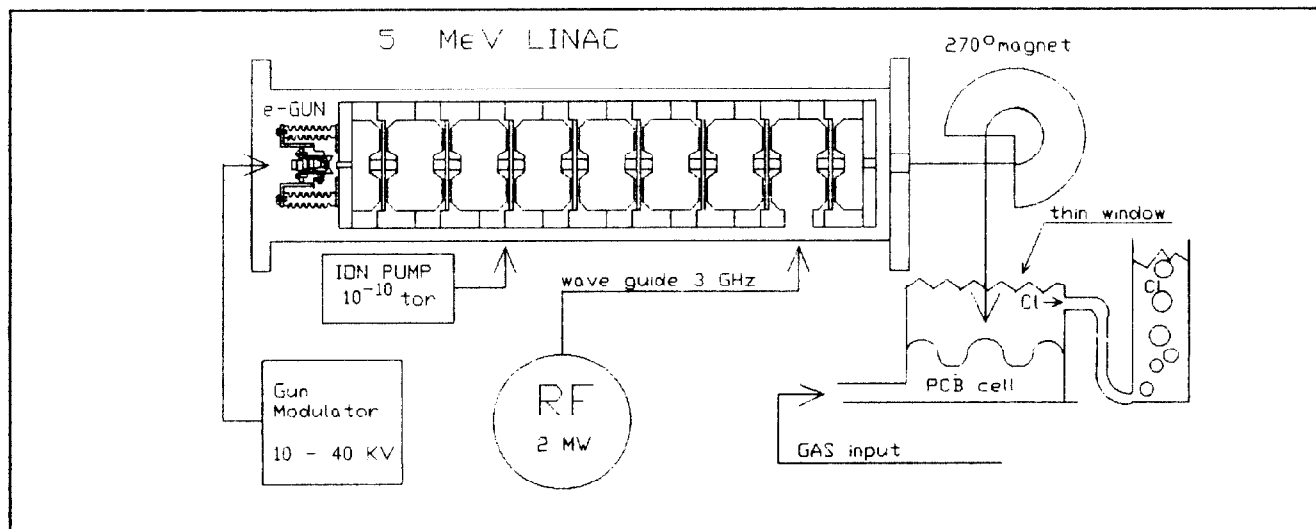


Fig 1 Drawing of the experimental set up for e-beam PCB degradation.