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ELECTRON ACCELERATORS FOR RADIATION PROCESSING: CRITERIONS OF SELECTION AND EXPLOITATION

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The progress in accelerator technology is tightly attached to the continuously advanced development in many branches of technical activity. Although present level of accelerators development can satisfy most of commercial requirements, this field continues to expand and improve quality by offering efficient, cheap, reliable, high average beam power commercial units. Accelerator construction must be compromise between size, efficiency and cost in respect to the field of its application. High power accelerators have been developed to meet specific demands of flue gas treatment and other high throughput to increase the capacity of the process and reduced unit cost of operation. Presented Table illustrates basic parameters of the accelerators which are affordable presently and in near future.

Table 1. Electron accelerators suitable for radiation processing

Electron beam	Continuous		Pulsed		
Accelerator	Direct	HF/UHF	HF	UHF	Induction
Pulse duration	DC	Substructure	1 μs – 1 ms	1 - 10 μs	50 ns - 2 μs
Beam current: pulse Average	- < 1,5 A	- < 100 mA	0,1 - 1 A < 50 mA	0,5 - 5 A < 100 mA	0,5 - 10 kA < 1 A
Energy range	0,3 - 5 MeV	1 – 10 MeV	1 – 7,5 MeV	3 - 10 MeV	1 - 5 MeV
Beam power present Future	500 kW 1 MW	200 kW 500 kW	50 kW 150 kW	50 kW 500 kW	350 kW 1 MW
Efficiency	60 - 80 %	20 – 40 %	30 %	10 - 20 %	60 %
Industrial application	+	+	+	+	-

Automatic control, reliability and reduced maintenance, adequate adoption to process conditions, suitable electron energy and beam power are the basic features of modern accelerator construction. Accelerators have the potential to serve as industrial radiation sources and eventually may replace the isotope sources in future. Electron beam plants can transfer much higher amounts of energy into the irradiated objects than other types of facilities including gamma plants. That provide opportunity to construct technological lines with high capacity and they are more technically and economically suitable with high throughputs, short evidence time and grate versatility.

The most significant advantages of application electron beam sources in radiation facilities are related to very short exposure time, strictly controlled irradiation zone, high fraction energy of electron beam deposited in irradiated object, simple product handling systems for continuous and unit operation irradiation process, safety, electron beam shut off capabilities to stop irradiation, economic advantages of electron beam processing, easy control of irradiation process, facility compactness. Disadvantage of electron beam processing to compare with gamma irradiation: limited penetration of electrons, more complex dosimetry, more complex maintenance, cost of spare parts required for stable service for certain accelerator constructions, higher qualification of service personnel.

Relatively high investment and operating costs for electron beam facilities to compare with more conventional processes may be justified by better results and flexibility of such installations. The development of compact and cost effective accelerator systems may have great impact in application of many different radiation technology. The most suitable type of accelerator for certain application depends at first on required electron energy which is directly related to density and structure of irradiated objects and beam power which defines total capacity of the installation. Founds and time necessary for realization of the investment process depends on condition accelerator purchase: accelerator cost, delivery time, producer specification (prototype or serial device), installation and personnel training, warranty conditions. The other technical and economical parameters which are usually taken into account are related to criterions with auxiliary importance: electrical efficiency of the accelerator, physical size, reliability, maintainability, working position of the accelerator, spare parts, cost of exploitation. Computer based control systems are used commonly now what has simplified the operation of those complex devices.

Investment in general includes cost of accelerator and necessary building with shielding walls, safety interlock system, conveyor and auxiliary equipment, land, documentation and installation. Investment cost is frequently connected to the bank credit and became important part of operation costs which are also related to labor and administration spendings, electrical energy consumption and spare parts.

The investment and operating costs for electron beam accelerators vary widely because of different accelerator specification, type of accelerator and accelerator producers. High facility throughput which is directly related to the beam current level may significantly reduce total unit cost of the process. The accelerators with higher energy of electrons cost more then low energy devices with the same beam power level. Therefore, the lowest energy rating with suitable dose distribution in irradiated object will give better economical parameters of the radiation process. A reduction of the operating time would increase the unit cost significantly because fixed annual cost of investment will be allocated to fewer hours of accelerator exploitation. On the other hand the lower dose will increase the process throughput and reduce the unit costs.