

Innovations, trends and opportunities for e-
beam applications:
environmental protection

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Advantages of e-beam processing

- Cheapest source of both oxidizing ($\bullet\text{OH}$) and reducing (e^-_{aq} and $\text{H}\bullet$)
- Reactive species are produced in approximately equal concentrations
- Process is rapid, typical reaction time is less than a second
- Process is pH independent (pH 3 – 11)
- Process is not affected by solids, up to 3 % by weight
- Proven and accepted for food irradiation
- Proven technology for many applications
- Destruction process not phase transfer
- Easily coupled with biological processes
- Does not require addition of any additional chemicals
- Processes scales linearly
- Minimum down time compared to other unit processes

Why hasn't the process been implemented?

- One problem is that the manufacturers of e-beams are always talking about the beams that are being developed that will supposedly be cheaper, more powerful and requiring less maintenance
- In other words – e-beamers are their own worst enemy!

Issues facing widespread application

- Use to be high capital costs limited market (maybe eliminated it); however, the costs have come down considerably and this may eliminate this concern
- Environmental market is risk adverse and very fragmented
- Time cycle for sales is very long
- Regulatory environment inadvertently discourages innovation
- Expensive to establish a true demonstration facility
- Mineralization is expensive

PCBs and Pharmaceuticals

- We adsorbed a PCB mixture onto clay and were able to destroy the compounds to below detection limit.
 - High doses were required – but even as recalcitrant as they are they were destroyed.
- Pharmaceutical compounds are much more soluble in general and there the major issue is the formation of reaction by-products
 - Most pharmaceuticals are soluble; the lack of regulations hinders the need for a technology

Market Entry

- In the US e-beam is approved for sludge or biosolids applications and dose required is 10 kGy
 - Fertilizer value of treated biosolids is good and will increase with phosphate likely to increase in cost
- It is possible that with the increased concern of pharmaceuticals in water – there will be opportunities there as well

Market Entry

- The economic value for the first adaptor must be clear with 'overwhelming' advantages over conventional technologies
 - In the US I believe that the first market will be for the treatment of sludge or biosolids from municipal wastewater treatment plants
- It may be that the market will be opened in a developing country where infrastructure is not established

Innovations

- I believe that the main innovations have been made since the e-beam that we used in our studies in Miami.
 - Improved electronic/computer control
 - Increased scanning rates