Theodore has authored in this area. The first of these two books, I recall, said very little about nanoparticles. This book has more on nanotechnology but the discussion of nanotechnology is limited to a couple of chapters which are in Part 3 entitled "Applications."

The above noted section begins with a chapter on legal considerations. It is followed by chapters on size reduction, prime materials, and production manufacturing routes. Clearly, particle science is important as is the topic title nanotechnology which still is quite new. Theodore says, "Despite some modest successes in the nanotechnology field, most conceived, however, that real, commercial-scale success in this arena is still years, if not decades, away."

Patents issued are a measure of activity in the field. In terms of patents issued, "... those involving nanotechnology have increased by over 600% in the 1997–2002 time period; from 370 in 1997 to 2650 in 2002." "New filings of nanotechnology-related patent applications are evenly split between process inventions and product inventions, as is typical for all patent applications."

Nanoparticles are available for experimentation. Various oxides of metals including iron oxides, silica dioxide, titanium dioxide, aluminum oxide, zirconium dioxide, and zinc oxide are readily available in commercial quantities and presently are being used in a wide range of existing applications and envisioned in many others.

According to the author, the future looks bright. He notes:

> "For technology's most ardent supporters, the scope of the emerging field seems to be limited only by the imaginations of those who would dream at these unprecedented dimensions. However, considerable technological and financial obstacles will need to be reconciled before nanotechnology's full promise can be realized."

The book further notes:

> "Beyond just their efforts to produce and use nanometer-sized particles of various materials, some nanotechnology-related scientists and engineers are pursuing far more ambitious – and some would say fantastic or futuristic – applications of this powerful new technical paradigm. For instance, the research community is working toward being able to design and manipulate nanoscaled objects, devices, and systems by the manipulation of individual atoms and molecules."

However, the book's contents mainly deal with topics other than nanotechnology. The main focus of the writing is on problem solving in the chemical engineering area. In this regard, the author has done an exceedingly good job at providing problems and their solutions. The back cover of the book notes:

> "The author has developed nearly 300 problems that provide a clear understanding of this growing field in four distinct areas of study: (1) chemistry fundamentals and principles, (2) particle technology, (3) applications and (4) environmental concerns."

Both mathematical and discussion exercises are included. The book begins at the beginning with the simplest process of unit conversion being discussed. The problems become more complex after that and span a wide spectrum of environmental engineering topics with an emphasis on air pollution. Problem statements were followed by solutions, but the material was not limited solely to mathematical exercises. Answers follow all problems and discussion questions.

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19 January 2006

Available online 28 February 2006

doi: 10.1016/j.jhazmat.2006.01.074

Rubber Recycling, S.K. De, A.I. Isayev, K. Khait (Eds.). CRC Press, Taylor & Francis Group, Boca Raton, FL (2005). (528 pp., US$ 149.95, ISBN 0-8493-1527-1).

Only a few of the books I have reviewed dealt with untreated (or rarely treated) topics as this one does. This book, Rubber Recycling, is one that deals with an important but rarely discussed problem—the dilemma of the increasing number of discarded tires which are stockpiled (discarded) too often in fields where fires occur, emitting clouds of toxic gasses and taxing the resources of the local fire department to suppress the smouldering mass. Even if they do not catch fire, tires provide a ready breeding site for mosquitoes.

For developed countries, one of the contributors notes, the rule of thumb is that one scrap tire is generated per inhabitant per year. In the United States, this translates to 300 million tires generated in 2003. The disposal (or reuse) of these discarded tires presents a major challenge to society. Should they be burned and burned safely or can they be recycled? The former process poses the challenge of air emissions; the latter process presents technical questions regarding how they can be economically and technically reused.

The authors note, "The processing or reduction of old tires into useful particle sizes has been a challenge to the recycler since Charles Goodyear first discovered vulcanization." Once vulcanized, the tire produced is nearly indestructible to normal mechanical fracturing mechanisms. Thus the challenge is to break the tire down into its separate major components—fiber, steel, and rubber. What can these scrap tires be used for? The authors note that they can be sold as secondhand usable tires, used as fuel in cement kilns, included as recycled rubber crumb as flexible filler in ceramic tile adhesives, incorporated (the steel

fraction) into pallets, utilized as cover for silage, used as a source of raw material for special shoe-manufacturing, pyrolyzed to produce oils, gas, and char and as an ingredient in asphalt rubber.

The problem with many of the above processes is that for vulcanized rubber it is difficult to break the cross-links that are formed during the vulcanization process in order to obtain material the same as or similar to unvulcanized virgin compound.

Currently, four major technologies are being used for tire disposal. They are: (1) recycling, (2) reclaiming, (3) pyrolysis and (4) tire-derived fuel (TDF). Among the more innovative uses are inclusion of rubber in highways or use in covering athletic fields.

One of the interesting ways to break down tires is cryogenic grinding. Another technique employs ultrasound to devulcanize used tires and waste rubber (as an aside, I might note that ultrasonic technologies have been used in several projects dealing with water and wastewater research that I have sent out for review lately).

The editors have cast their net wide for authors, obtaining contributions from scientists in the United States, Canada, The Netherlands, India, and South Africa. The authors have contributed the following chapters:

1. Manufacturing practices for the development of crumb rubber materials from whole tires;
2. Quality performance factors for tire-derived materials;
3. Untreated and treated rubber powder;
4. Tire rubber recycling by mechanochemical processing;
5. Recycling cross-linked networks via high-pressure high-temperature sintering;
6. Powdered rubber waste in rubber compounds;
7. Rubber recycling by blending with plastics;
8. Strategies for reuse of rubber tires;
9. Ultrasonic devulcanization of used tires and waste rubbers;
10. Devulcanization by chemical and thermomechanical means;
11. Conversion of used tires to carbon black and oil by pyrolysis;
12. Markets for scrap tires and recycled rubber.

In ending this review, I quote from the flyer provided by the publisher:

> "Rubber Recycling is one of those rare books that has the potential to directly impact our ecological well-being. The editors of this important volume have filled a void in technological responsibility by bringing together a group of international experts who, using substantial research evidence, prove that the utilization of recycled rubber is not just desirable, but is all quite feasible and profitable."

I agree with the foregoing comment. The book clearly and thoroughly discusses the topic (potential and problems) of rubber recycling. It will be the standard reference on the topic for many years to come.

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26 January 2006

Available online 28 February 2006

doi: 10.1016/j.jhazmat.2006.01.075

I.G. Droppo, G.G. Leppard, S.N. Liss, T.G. Milligan (Eds.), Flocculation in Natural and Engineered Environmental Systems, CRC Press, Boca Raton, FL, 2005 (457 pages, US$ 149.95, ISBN 1-56670-615-7).

This book resulted from a workshop held in September 2003 at the Canada Centre for Inland Waters. It contains 19 peer-reviewed papers presented at this conference by contributors from both North America and Europe. The papers have been published under three main headings:

1. Freshwater environments
2. Saltwater environments
3. Engineered systems

The importance of the topics is illustrated by the editors who write the following in the initial paragraph of the preface:

> "In the history of environmental science, there has probably been no greater struggle than the attempt to control the impact of the sediment and solids generated by nature and human influence (including industrial processing) on the terrestrial and aquatic environment and on socioeconomics in general. Untold billions of dollars are spent each year on dredging to maintain navigation channels and harbors. Further costs are added by the need to treat these sediments prior to disposal because of high levels of contamination resulting from anthropogenic impacts on the environment. Significant financial burdens arise as a result of the need to remove solids during drinking water and wastewater treatment processes, a necessity for sustainable development, and the protection of human and aquatic health. It is now well established that the majority of particles within natural (freshwater and saltwater) systems are present in a flocculated form (i.e., flocs), and that the formation of flocs is essential for the effective performance of engineering processes such as biological wastewater treatment."

Flocculation is thoroughly discussed in the 19 papers in this book. The final chapter, written by the editors, is entitled "Opportunities, Needs, and Strategic Direction in Research in Flocculation in Natural and Engineered Systems." They review