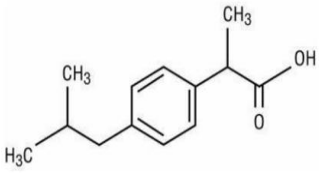
Sujet 9 GREEN SYNTHESIS OF IBUPROFEN

Chemical industry is focusing from many years on some classic synthetic processes of important starting chemicals or crucial chemicals produced in high volume as intermediates in synthetic industrial reactions. The intention is to reduce the synthetic stages, to lower the energy use, to increase efficiency with higher yields and to minimize waste. Also, renewable starting chemicals away from the traditional petrochemical supplies of raw chemicals is another desired innovation.
Every Green Chemistry textbook describe the big successes of the last decades in the field of new synthetic routes for industrial chemicals. The first is the synthesis of Ibuprofen (doc. 1), the second is the synthesis of Adipic acid (important starting chemical substance for Nylon) and the third is the synthesis of Maleic anhydride (starting material for polyesters and dyes).
The pharmaceutical industry is considered now as the most dynamic sector of the chemical industry for the 21st century. Sales of medicines and other pharmaceutical products have increased fourfold from 1985. The analgetic and anti-inflammatory drugs is a category of medicines which are produced in vast amounts every year. Some of the most important are : Aspirin (acetylosalicilic acid), Acetaminophen (Tylenol, paracetamol) and Ibuprofen. Ibuprofen belongs to non-steroidal anti-inflammatory drugs with very high sales.
Ibuprofen was synthesized in 1960 by the pharmaceutical company Boot (England) and sold under the commercial name Aspro, Panadol and Nurofen. The synthesis of Ibuprofen was performed in six steps with the production of secondary by-products and waste. The main problem according to the scientists at the time was that this synthesis had a very "poor atom economy".

Doc. 1

Ibuprofen as a non-steroid anti-inflammatory drug was very successful and its sales were increased substantially in the last decades.



The initial synthesis, observed under the "green" principles, had many disadvantages. The starting chemical could not be incorporated into the product, producing lots of by-products and waste. The six steps of the synthetic route was consuming chemicals and energy while lowering the yield of the final product.

QUESTIONS

1. Present and comment on this document.
2. What are the drawbacks of the old synthesis of ibuprofen ?
3. What are the principles of green chemistry used in the ibuprofen synthesis (doc. 2) ? What does “poor atom economy” mean (**video1**) ?
4. Why is it important to develop green chemistry (**video2**) ?

Doc. 2

A *New* Kind of Chemistry

Green Chemistry is based on a set of principles that when used in the design, development and implementation of chemical products and processes, enables scientists to protect and benefit the economy, people and the planet.

Green Chemistry uses renewable, biodegradable materials which do not persist in the environment.

Green Chemistry is using catalysis and biocatalysis to improve efficiency and conduct reactions at low or ambient temperatures.

Green Chemistry is a proven systems approach.

Green Chemistry reduces the use and generation of hazardous substances.

Green Chemistry offers a strategic path way to build a sustainable future.

To catalyze and enable the implementation of green chemistry and engineering throughout the global chemical enterprise

Green Chemistry
Everyone's Doing It!

The 12 Principles of Green Chemistry

A framework for designing or improving materials, products, processes and systems.

1. Prevent Waste
2. Atom Economy
3. Less Hazardous Synthesis
4. Design Benign Chemicals
5. Benign Solvents & Auxiliaries
6. Design for Energy Efficiency
7. Use of Renewable Feedstocks
8. Reduce Derivatives
9. Catalysis (vs. Stoichiometric)
10. Design for Degradation
11. Real-Time Analysis for Pollution Prevention
12. Inherently Benign Chemistry for Accident Prevention

*Anastas, P. T.; Warner, J. C. Green Chemistry: Theory and Practice, Oxford University Press: New York, 1998, p.30. By permission of Oxford University Press.

www.acs.org/greenchemistry