

Petroleum Chemistry in Organic Chemistry Textbooks and its Possible Connection to Public Knowledge

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Abstract Organic chemistry textbooks are constantly growing due to the need to include modern material. However, the amount of content is limited by their physical size, which brings up concerns that old, very important, topics will be excluded to make room. To point out this ominous trend, we have tracked the coverage of the topics, petroleum and petroleum chemistry, in organic chemistry textbooks from 1856 to the present day. We have uncovered the troubling trend that, starting in 1970, the coverage of these topics has steadily diminished. Also, through polls we have shown that the general public has very little knowledge of how petroleum shows up in their lives. We imply that there is a connection.

Keywords: *organic chemistry, textbooks, public knowledge, petroleum, pedagogy*

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1. Introduction

The analysis of textbook content has provided a wealth of information regarding science pedagogy and the effect on society. [1,2] One of the most important questions asked is what should be included in textbooks and why? It has been pointed out that many lower division chemistry courses should provide knowledge and skills that will be useful to students once they leave school. [3,4] Also, it has been proposed that textbook content should be decided, in part, through formal textbook analyses. [1,5] This study represents one response to calls for critical examination of chemistry textbook as important for addressing particular chemistry-related societal issues.

Petroleum products permeate nearly all aspects of our daily lives; from the fuel we use, to a multitude of commercial products: such as pharmaceuticals and plastics. Yet despite this, few people know the connection between these products and the petroleum starting materials from which they originate. Arguably, the chemical knowledge of the general public is, in part, disseminated through those who have studied chemistry at the collegiate level. Moreover, all but the most liberal of institutions require a standardized text that the lecturer uses to structure their lesson plan. So it is not a far leap to claim that the general public is affected by the knowledge which is incorporated into organic chemistry textbooks. Poll data obtained, suggests that the majority of laymen and undergraduate chemists are ignorant of petroleum's significance as a carbon source in society.

The authors of this paper hypothesize that within organic chemistry textbooks, petroleum chemistry is underrepresented when compared to its significance and this lack of coverage has had an effect on public knowledge.

2. Results

It is important to develop a method to quantitatively analyze how petroleum is treated in these texts and to have a large enough sample from as many years as possible. Fortunately, the Google Books project has made countless volumes of older textbooks available. This source, along with the libraries at University of California Davis and Sonoma State University, and the personal collection of Dr. Steven Farmer afforded 84 textbooks for review. These texts, listed in were published between 1865 and 2014 and surveyed for their petroleum content. References to petroleum were documented to the nearest quarter page and averaged by decade. However, because these textbooks increased dramatically in number of pages over these 150 or so years [6], the relative percent of petroleum coverage is a truer representation of the actual trends. The average percent petroleum content of organic chemistry textbooks decade wise is given in Figure 1.

A marked increase in petroleum content is evident beginning in the 1930s and reaches its peak in the 1950s. The decade ending in 1950, organic chemistry textbooks averaged over 11 pages dedicated to petroleum chemistry. This is due in large part to WWII and the chemical advancements made during and just prior to the war. Not the least of which was an improved method of refining petroleum to generate the toluene needed to manufacture larger quantities of the explosive trinitrotoluene (TNT). With World War II looming, the US alone required a ten-fold increase (250 million gallons/year) in the production of benzene and toluene; [7] a requirement that could not be fulfilled by the current production methods from coal tar. In 1938, Standard Oil Development (SOD) (a precursor to Exxon) opened the first commercial synthetic

toluene plant. Using hydroforming, SOD produced more than half of wartime toluene (5.5 million barrels) [8], and all from petroleum starting products. Ultimately, the advances made just prior to and during world war II in the field of petroleum processing resulted in at least half of all US industrial organic materials being made from petroleum products. [9] The consequence of this is

reflected in the coverage of petroleum in organic chemistry textbooks. In fact, 1944 had the highest number of pages of petroleum pages of any textbook in any other year, with 23 pages dedicated to the subject. The decades ending in 1940 and in 1950 were the fourth and third highest in percent petroleum coverage respectively.

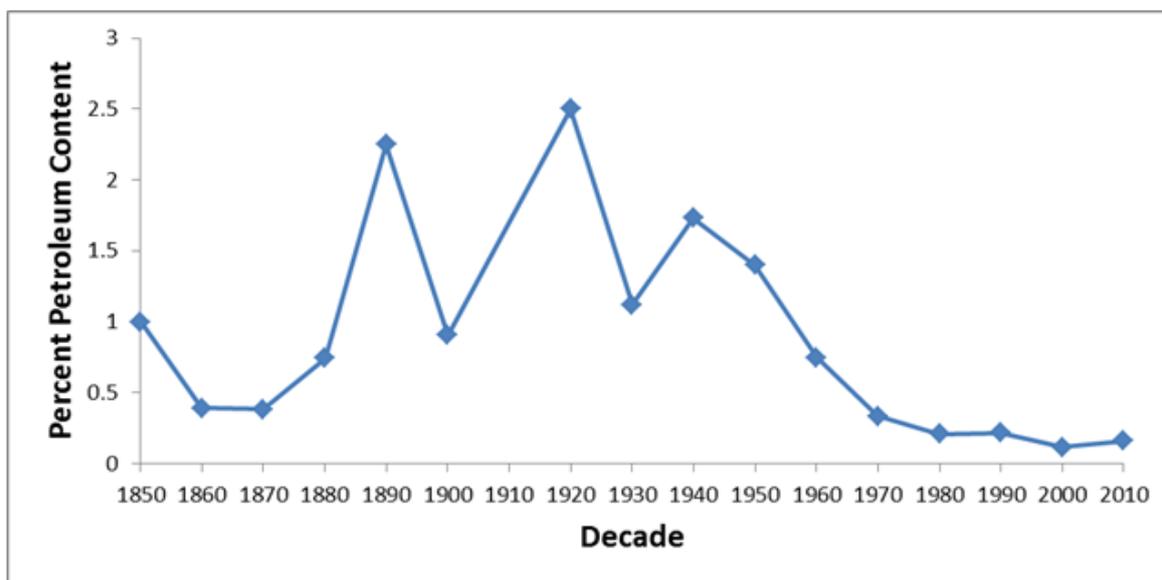


Figure 1. The average percent petroleum content of organic chemistry textbooks by decade wise

The 1950s and 60's could easily be described as the golden age of the pharmaceutical industry and accounts for the two decades with the largest amount of textbook coverage of petroleum starting products. Indeed four out of five of the textbooks with the most pages dedicated to the subject were published during these two decades. The post war prosperity created a public who demanded access to improved health care and preventative drugs and the pharmaceutical industry was primed to respond. A steep increase in the rate of world oil production [10] ensured that the hydrocarbon starting materials required for this pharmaceutical push would indeed be available. The result was an industry that was ranked as the fifth most profitable in the world between 1951 and 1961. While pharmaceuticals are still manufactured from these starting

products, the coverage of this process experienced a decline in discussion by organic chemistry textbook authors. The following decades of the 1970s and 1980s show a marked decrease in the percent of petroleum chemistry coverage. This trend has culminated in the current trend of an average of 1.7 pages of petroleum content for a roughly 1200 page organic chemistry textbook. And in one case not petroleum was mentioned at all (Jones 4th ed.)

To show the lack of knowledge of petroleum products in the general public a series of online polls were given. One was given to the general public through the online polling site, Survey Monkey. The results of which are given in Table 1.

Table 1. Results of polls regarding public knowledge of the common uses of petroleum products

| Question | Correct Answers |
|--|-----------------|
| The starting materials for most pharmaceuticals are obtained from what substance?" | 3% |
| What material is used to make the sticky base of most chewing gum? | 1% |
| Asphalt is obtained from what substance? | 28% |
| The starting materials for most plastics are obtained from what substance?" | 34% |

3. Conclusions

This manuscript has shown that the topic of petroleum products, although once a major topic in organic chemistry textbook, has almost been eradicated. The authors presume that this topic has been deemed unnecessary due to its lack of inclusion in standardized exams, such as the MCAT and the ACS Examination in Organic Chemistry, and has been slowly removed to make room for new material. This manuscript has also shown that the typical

layperson has no idea how important petroleum products are in their everyday life. Clearly a correlation does exist between the two. We submit that there is a knowledge gap created by the absence of discussing carbon sourcing in organic chemistry textbooks, resulting in a poorly informed general public.

Because of the finite nature of petroleum as a natural resource, it is of critical importance that the general public understands the enormous role it plays in society, not only for fuel but for every other significant use. Thus it is imperative that the authors of organic chemistry textbooks do include, in an expanded form, the topic of petroleum

chemistry in their future works. Also, additional topics, both included and excluded, in chemistry textbooks should be examined as to their effect on the society because their content affects not only the chemistry undergraduates and also the general public.

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