Future Energy

As a result of the interest shown in the first edition of *Future Energy*, (project 2007-015-2-100, published in 2008 by Elsevier; ISBN 13: 978-0-08-054808-1) and because the subject has expanded enormously with new developments in traditional fields and new approaches in emerging technologies, a new edition is being produced with 31 chapters as opposed to the 20 chapters in the first edition. The new edition has chapters devoted to hydraulic fracturing, coal-bed methane, liquid natural gas as a transport fuel, lithium ion batteries, hydrogen as an energy carrier, carbon dioxide capture and sequestration, energy storage systems, environmental impacts of energy production, distribution and transport, smart grids, energy resources in developing countries, the transition to future energy, and the energy options and predictions in China. Singled out as it is the most rapidly developing super power, China will soon produce more energy that any other country if its development continues at its present rate.

The book looks at all types of energy that may be used in the future and not just the sustainable types such as solar, wind, tidal, and wave energy. Fossil fuel in all its forms, from coal, oil, methane gas, and even methane hydrates, is very much part of this book as these energy sources will be with us for many decades before we have expanded and developed renewable energy sources, built new nuclear fission plants, or possibly even developed new types of energy such as nuclear fission.

This book, like the first edition, is intended give the reader a reasonable, logical, and correct understanding of our future use of energy. The final decision as to which energy options should be developed in a country or region must take into account sustainability, the general safety and health of the general public, the overall energy requirements of society, the geographical position of each region, and above all, the alarming rise in atmospheric carbon dioxide over the past 50 years, which threatens to change the world's climate through global warming.

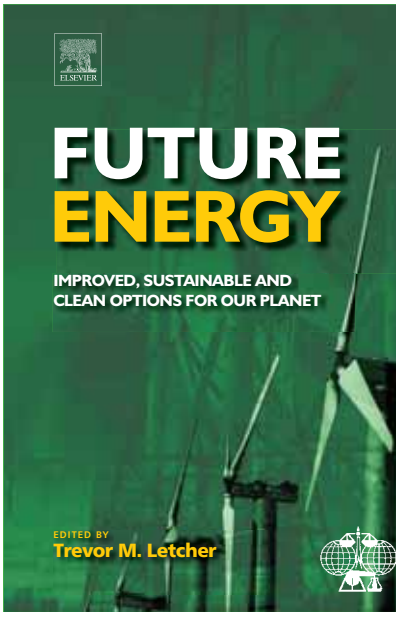
The first edition of this book had its origins in the committee meetings of the International Association of Chemical Thermodynamics, an organization affiliated with IUPAC. The book is supported by IUPAC through its Physical and Biophysical Chemistry Division.

IUPAC's adherence to the International System of Quantities is reflected in the use of SI Units throughout the book, although other units that may be more familiar to specific areas are included, usually in parentheses. The index notation is used to remove any ambiguities (e.g., billion and trillion are written as 10^9 and 10^{12} respectively). To further remove any ambiguities, the concept of the quantity "calculus" is used.

This volume is unique in this genre of books because each chapter is written by an expert, scientist or engineer, working in the field. Authors were chosen for their expertise in their respective fields from 19 countries: Belgium, Brazil, Canada, China, England, Finland, France, Germany, The Netherlands, India, Ireland, Italy, Japan, Luxembourg, Korea, Norway, Scotland, South Africa, and the USA.

The book is divided into eight sections:

- Introduction
- Fossil Fuels (energy sources)
- Nuclear Power (energy sources)
- Transport Energy (energy sources)
- Transport Energy (energy storage)
- Renewable Energy (energy sources)
- New Possible Energy Options
- Environmental and Related Issues



A vital concern is what is to be done when it appears that politicians deliberately misunderstand, and corporations deliberately ignore, the realities of finite fuel sources and our changing climate? The solution lies not in the realm of new technologies but in the area of geopolitics and social-political actions. As educators we believe that only a sustained grassroots movement to educate citizens, politicians and corporate leaders of the world, has any hope of success. There are such movements, but they are slow in making headway. This book is part of that education process. It presents a non-political and unemotional set of energy options for readers to consider and arrive at sensible solutions to the problems facing the world today.

The book will be published and available early in 2014.

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www.iupac.org/project/2012-041-1-100

Recommendations for Isotopic Data in Geosciences

The joint task group of the International Union of Geological Sciences (IUGS) and IUPAC on 'Recommendations for Isotopic Data in Geosciences' issues its final report (IUPAC project 2006-016-1-200). In the process of evaluating data and making recommendations on the decay constants (radioactive half-lives) of isotopes of interest to the geochronology community, the task group first had to deal with the problem of the definition of the year as the unit of time most appropriate for very-long-lived nuclides. This work effort was published[1] in *Pure Applied Chemistry* in 2011. This publication has led to communications with representatives of the SUNAMCO committee of the International Union of Pure and Applied Physics (IUPAP), Stephan Lea, the International Bureau of Weights and Measures (BIPM), Felicitas Arias and the International Astronomical Union (IAU), Nicole Capitaine. These communications are still intermittently ongoing.

After this extended delay, work began on the major effort of the project. The task group has evaluated the published measurement results for the decay constants (half-lives) of ^{87}Rb, ^{235}U and ^{324}U. A significant part of the evaluation was the effort to follow strict metrological criteria VIM[2] in the assessment of the measurement uncertainties according to GUM.[3]

The ^{87}Rb half life has been estimated by three groups using totally independent approaches. Kossert[4] determined the specific activity of ^{87}Rb salts by liquid scintillation counting. This approach assumes that inter-sample variations are due to stoichiometry. Nebel[5] compared Rb-Sr and U-Pb ages of co-genetic minerals. This approach assumes that certain natural samples behave "ideally" (i.e., all the relevant ages are expected a priori to be equal and relies on control on the samples' petrology). Rotenberg[6] measured the radiogenic ^{87}Sr accumulated in a batch of Sr-free Rb salt over 35 years. This approach relies on having performed precise and accurate measurements on the concentration and isotopic composition of the Sr present in the $RbClO_4$ at the time of crystallization. The three sets of experiments yield indistinguishable results, which is a good indication that systematic biases were either coincidentally of the same magnitude and direction in thee radically different experimental designs, or negligible after accurate corrections. The resulting best estimates for the ^{87}Rb decay constant and the radioactive half life values are $\lambda_{87} = (1.395 \pm 0.002) \times 10^{-11}$ a^{-1} (1s uncertainty) and $t_{½} = 49.7 \pm 0.1$ Ga, which is a preliminary estimate and data will be finalized in a follow-on project.

The U half life has been the focus of recent intense research. Following the counting experiments by Jaffey,[7] which yielded the U half life still deemed reliable, albeit with a higher uncertainty, the endeavor in the geo-chronological community (Schoene,[8] and Mattinson[9]) moved to determining the U half life indirectly, based on U-Pb dating of single crystals of zircon (natural $ZrSiO_4$). The approach is based on the assumption that certain natural samples behave "ideally" (i.e., their ^{238}U-^{206}Pb and ^{235}U-^{207}Pb ages [hereafter t_{206} and t_{207}, respectively] are expected *a priori* to be equal). However, in current practice only the concentration N(^{238}U) is measured at present and the concentration N (^{235}U) is calculated assuming a constant number ratio, $\eta = N(^{238}U)/N(^{235}U) = 137.88$. Recent reports on η measurements in the same zircon samples used for geo-chronology (Heiss[10]) indicate an individually variable number ratio, on average lower by (0.031 ± 0.011) % relative to the assumption that $\eta = 137.88$. Moreover, some workers reported a mass-independent fractionation of incompletely understood origin that affects odd- and even- mass isotopes in a different way (Amelin[11]). From these results, the task group calculated a provisional value for the ^{235}U half life of (703.41 ± 0.19) Ma (1s uncertainty), corresponding to $\lambda_{235} = (0.98540 \pm 0.00027)$ Ga^{-1}.

The U half life (Cheng[12]) was obtained following strict material traceability protocols and had the explicit goal of ensuring the radioactive equilibrium of natural samples. The η number ratios of the NBS CRM 112a and U-500 reference materials that they used as spike and detector calibrators were subsequently revised (Condon[13]). In particular, recalculating η in Cheng's spike, using Condon's revised η for U-500 also accounts for a shift in the η for NBS CRM 112a. As a consequence, the preliminary half life estimate for ^{234}U is modified by + 0.07 % to (245.44 ± 0.16) ka (1s uncertainty), corresponding to $\lambda_{234} = (2.8241 \pm 0.0018)$ Ma^{-1}.

Again the data will be finalized in a follow-on project.

Preliminary results on uranium were presented in 2011[14] and on uranium and rubidium in 2012.[15]

This constitutes the final report of this project of the joint IUGS-IUPAC task group. Further support for this work will be requested via a new IUPAC project. The Executive Board of the IUGS, at its February 2013 meeting in Paris, agreed to continue funding the IUGS members of the task group for this international effort.

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www.iupac.org/project/2006-016-1-200

UNESCO/IUPAC Postgraduate Course in Polymer Science

The 17th edition of the UNESCO/IUPAC Postgraduate Course in Polymer Science has been in progress since October 2012 and will be concluded by a final seminar in July 2013 within the scope of the workshop Careers in Polymers V. Twelve students from the following countries have been attending the course: Bulgaria, Poland, Russia, Ukraine, and Vietnam. In March 2013, the midterm seminar was held at which the students reported on the results of their research projects. More than half of the projects are likely to result in publication in international journals or in communications at meetings.

Preparations for the 18th Course are in the final stages. Out of the large number of applicants, 13 have been nominated from Croatia, Mongolia, Poland, Russia, Ukraine, and Vietnam. The course will start in October 2013 and will conclude in July 2014.

As of January 2013, the cumulative results of the 17 editions of the course held so far are as follows: 138 graduates, 20 nationalities, 285 publications in international journals, 329 communications at international meetings, more than 4500 citations. From this experience, the course organizers are able to draw a few generalizing conclusions:

1. The Course has become a global activity. Students from all continents except Australia and North America have graduated.
2. The average publication output is more than two papers in an impacted journal, two conference communications, and about 35 citations per graduate. Of course, the distribution of scientometric hits per individual is very non-uniform.
3. In several cases, a productive long-term cooperation has developed between the Institute and the graduate's mother institution.
4. In the last seven years, 20 graduates became doctoral students at Czech universities.
5. Graduation from the Course often enhances professional promotion in the home countries of the graduates.
6. The Course contributes to a positive image of IUPAC, both inside and outside the professional community.

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www.iupac.org/project/2011-052-1-400