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Book review

Reactive hydrocarbons in the atmosphere: C. Nicholas Hewitt (Ed.), *Reactive hydrocarbons in the atmosphere*, Academic Press, San Diego, 1999 (ISBN 0-12-346240-1). Price $75.00.

What is it that qualifies a book about reactive hydrocarbons to be reviewed in the *Journal of Photochemistry and Photobiology*? The answer must be that these are hydrocarbons that are found in the Earth's atmosphere, and that the atmospheric chemistry in which they participate – and, indeed, that leads to their ultimate oxidation – is driven by solar radiation. Initiation of the oxidation chains is effected mainly by OH during the day, NO_3 during the night, and by O_3 by day and by night. All these reactive species are photochemical in origin; they each show different patterns of reactivity towards different kinds of hydrocarbons. Some of the hydrocarbons found in the atmosphere are 'natural'. Some methane is of directly biogenic origin, but man also makes his mark by extracting and using fossil fuels (some might remark that the fossil deposits are, in any case, of biological origin). Plants are a rich source of a wide variety of hydrocarbons, most notably ethylene, isoprene and a large number of terpenoid compounds, but also aldehydes, alcohols and esters that are generated at least in part in the service of the plant. Forests cover more than 40% of all land surfaces, and the release of volatile organic compounds (VOCs), and especially non-methane hydrocarbons, from them plays an important role in shaping tropospheric chemistry. The list of natural VOCs known to enter the atmosphere now extends to well over 1000 compounds. Most of these compounds are emitted primarily from terrestrial plants. Aromatic hydrocarbons have dominantly, or perhaps even exclusively, anthropogenic sources. These many hydrocarbons enter the atmosphere, are oxidized, and in the course of their oxidation provide the potential for the creation of ozone and other photochemical oxidants; there is thus an autocatalytic aspect to these atmospheric processes. The very oxidizing capacity of the atmosphere is itself affected by the emission of reactive hydrocarbons, and the subject of this book is central to understanding the environment in which we find ourselves.

Reactive hydrocarbons in the atmosphere is a collection of eight chapters that address different aspects of VOCs in the atmosphere. A useful starting point in discussing the book must be to list these chapters and their authors, in order to hint at the flavour of the work. The chapters, in the order that they appear, are

1. Anthropogenic emissions of volatile organic compounds (Friedrich and Obermeier);
2. Biogenic emission of volatile organic compounds from higher plants (Fall);
3. Modeling biogenic volatile organic compound emissions to the atmosphere (Guenther);
4. The sampling and analysis of volatile organic compounds in the atmosphere (Cao and Hewitt);
5. Reactive hydrocarbons in the atmosphere at urban and regional scales (Ciccioli, Brancaleoni and Frattoni);
6. Global distributions of reactive hydrocarbons in the atmosphere (Bonsang and Boissard);
7. Reactive hydrocarbons and photochemical air pollution (Derwent);
8. Global atmospheric chemistry of reactive hydrocarbons (Seinfeld).

This list makes clear enough the eclectic nature of the book: it covers much ground, but is surely not a comprehensive handbook. Let us be clear that one of the strengths of the book lies in the expertise possessed by the authors, most of whom are world authorities on their topics writing in an up-to-date way on matters of contemporary interest. Another lies in the choice of the topics themselves, a matter for which the editor is presumably largely responsible. My own belief is that, if one is to edit a book consisting of roughly 320 text pages, and eight chapters, then Nick Hewitt has provided a selection that represents as stimulating a choice as one could hope for. The anthropogenic and biogenic sources of hydrocarbons are examined (Chapters 1 and 2). Chapter 3 looks at ways in which these emissions can be represented in numerical models. Methods for measuring the concentrations of VOCs in the atmosphere are discussed (Chapter 4) in preparation for presentations of experimental data about the distribution of the hydrocarbons on urban and regional scales (Chapter 5) and globally (Chapter 6). Chapter 8 examines the chemical transformations that underlie the oxidation of all the VOCs released, and Chapter 7 concentrates on the part that the emissions play in photochemical air pollution in general, and ozone production in particular.

Naturally enough, chapters by such a range of authors differ quite widely in scope and approach. Chapter 2, for example, is expository and tutorial in style, while Chapter 8 focuses more severely and baldly on chemical reaction steps

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and numerical values for rate coefficients; Chapter 5 quite reasonably reflects the authors' Italian background, and Chapter 7 concentrates on the reactivity scales and photochemical ozone formation potentials for which the author is renowned. If I had to nominate a favourite, I suppose that it would be Chapter 2. I was fascinated anew to discover how plants use the emissions of VOCs for their own purposes. Why do plants produce VOCs on a large scale and in wide variety? Strongly emitting plants typically convert one or two per cent of the CO_2 that they have fixed by photosynthesis into the VOCs, and the biochemical energy required to convert the CO_2 into VOC is considerable. It would seem likely that there would be some advantage to the plant in expending this energy. Floral scents are, perhaps, fairly obviously designed to attract pollinating insects, and other VOCs play the same role. Attracting predators of herbivores would be another similar use, and some VOCs are repellants of the herbivores themselves. Many of the VOCs that have been identified also possess antibacterial, antiviral, or antifungal activity. Ethylene (ethene) has been shown to play a most important role in controlling plant growth and development, and it behaves as a volatile plant hormone. Seed germination, flowering, fruit ripening, senescence of flowers and leaves, and sex determination are all affected by exposure to ethylene. Furthermore, ethylene production is greatly enhanced in response to stress: infection, physical wounding, and exposure to some chemicals can all increase the production rate by up to 400-fold.

It is evident from my review that I regard this book very highly. I really enjoyed reading some chapters in detail, and dipping into the others. Of course, there are matters with which I would take issue. The index, for a start, consists of only two pages, with just under 100 entries. Yet this is a book that really demands a comprehensive index. Then, of the 13 authors, nine are European, yet we see in the title of Chapter 3 the word 'modeling', which I cannot pronounce except to rhyme with 'yodelling'. The book is also, undoubtedly, rather expensive, but I have to add that it is also well presented and well constructed. The real question is who will read it. Most photochemists who use this journal are unlikely to need much of the detail presented in *Reactive hydrocarbons in the atmosphere*, although atmospheric photochemists will find it a valuable resource. However, I believe that many more will find the book interesting and worthwhile, and I exhort those who can get hold of a copy to look at it themselves to see if it can help to fill some gap in their wider appreciation of how nature and man interact with our environment in this rather specific way.

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