

one hundred miles, the sound arrives later than would be expected.

The inner ring of silence occurs because the drop in temperature with increasing altitude curves all sound waves upward. The hot ozonosphere, twenty-five miles up, bends them back to earth, forming the first abnormal zone. Waves reflected from the earth in the first abnormal zone make the second abnormal zone; but what causes silence between them, where one would expect some noise?

Gutenberg ascribes this silent band to upper atmosphere absorption. However, Schrödinger's first major paper (1917) showed that high altitude sound absorption increases with frequency, so if Gutenberg were correct, low frequencies should predominate near noise ring outer boundaries. This is not borne out by recent records.

Refraction and dispersion theories provide a satisfactory explanation of the phenomena. A critical sound ray, which goes to infinity in the hottest layer of the ozonosphere, limits the number of rays bent earthward into abnormal zones. A small temperature gradient below the hottest layer spreads a sound spectrum on the earth, with higher frequencies landing farther from the blast.

E.F.C.

Abnormal Audibility Zones in Long Distance Propagation through the Atmosphere. By Everett F. Cox. *J. Acous. Soc. Am.* 21: 6, January, 1949.

Astatine

Astatine (the name comes from *astatos*, which means unstable in Greek) is the element of atomic number 85, a heavier homolog of iodine in the periodic system. It does not exist in nature because it is radioactively unstable but can be prepared by bombarding bismuth with alpha particles and was first obtained in this way in 1940 by Corson, McKenzie, and Segrè. The pressure of war work prevented the investigation of the chemical properties of astatine at that time and the subject has been resumed lately by the authors of the present paper. Unfortunately, all the work has to be carried out on the tracer scale because the longest-lived isotope of astatine known (At^{210}) has a half-life of only eight and a half hours. Nevertheless, many chemical properties can be investigated by the methods of radiochemistry. The analogy between astatine and iodine has been recognized but also several characteristic differences. The minus one, the zero, and at least two positive oxidation states have been characterized. The main methods used have been solvent extractions, electrochemical procedures, and coprecipitation.

E.S.

Chemical Properties of Astatine. I. By G. L. Johnson, R. F. Leininger, and E. Segrè. *J. Chem. Phys.* 17: 1, January, 1949.

Jets

One step in evaluating a rocket propellant is to determine its exhaust velocity from a standard rocket nozzle. To do this it is necessary to calculate the change in heat

content during the expansion associated with the drop in temperature, and the recombination reactions that may occur. It is usually assumed either that the gas composition is "frozen" while expanding at chamber conditions, or that it varies while expanding so that it remains in chemical equilibrium at each temperature and pressure. Recombination reactions generally liberate heat, and the second assumption results in a figure defining a higher performance which in many cases exceeds five percent. The true state of affairs actually lies between these two assumptions and is governed by the kinetics of reactions.

A detailed analysis has been made of the time-temperature pattern during flow through a nozzle for two typical cases. Approximate rate constants for the decomposition of nitrogen oxide into nitrogen and oxygen were employed, together with the time-temperature relations, to show that this equilibrium corresponds essentially to the frozen case for a nitric acid-aniline propellant system. High temperature kinetic data for the recombination reactions that occur in flames are unfortunately scarce. As more of such information becomes available, it should be possible to classify propellant systems in terms of frozen and equilibrium processes and predict more accurately the conditions governing performance.

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Chemical Reaction during Adiabatic Flow through a Rocket Nozzle. By David Altman and S. S. Penner. *J. Chem. Phys.* 17: 56, January, 1949.

Bond Energies

In the ionization chamber of a mass spectrometer, ions are produced by the impact of electrons, accelerated from a hot filament, upon the molecules of the compound being studied. In the process electrons are dislodged from atoms in the molecules, leaving positively charged ions. These ions are deflected by a magnetic field in the mass spectrometer to a degree varying with their respective masses, which results in their being resolved into a mass spectrum. The electron energy at which an ion first appears in the mass spectrum (its appearance potential) is thus equivalent to the minimum energy of electron impact for the production of that ion from the compound being studied.

If the fragments produced by electron impact are not excited, then this appearance potential is the sum of a bond energy (the energy which binds the atom in the molecule) and an ionization potential (the energy necessary to separate the electron from its atom in the molecule). The appearance potentials of ions from the simpler hydrocarbons were measured with a Consolidated Type 21-101 mass spectrometer at the Beacon Laboratories of The Texas Company in the hope of determining the hydrocarbon bond energies. Bond energies computed from these appearance potentials are larger than chemically plausible. This leads to the conclusion that in ionization of hydrocarbons by electron impact, a nonequilibrium process, the fragments are produced in excited states, especially from larger molecules.

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Hydrocarbon Ion Appearance Potentials. By J. J. Mitchell and F. F. Coleman. *J. Chem. Phys.* 17: 44, January, 1949.