a great deal which is useful for the production of such low temperatures as may be attained by mechanical means and the book is therefore of interest for research of a more academic nature.

Since the value of a book dealing with a rather specialized subject depends so greatly on the detailed nature of the information presented, the following brief description of contents is given. After a short introduction dealing with general principles involved in gas separation the author reviews in Chapter I the gas mixtures of greatest importance from the industrial point of view. As a preparation for the problems involved in the separation and therefore of primary importance for the design of the separating plant, the equilibrium of vapor-liquid systems (binary and ternary) is treated in Chapter II. While the discussion is presented in an entirely adequate manner some readers will no doubt find it necessary to consult more detailed texts. For instance, although frequent use is made of the phase rule no explicit statement of it is made. This chapter also contains useful equilibrium diagrams for a number of gas mixtures (pp. 44–59). The methods of gas separation and a discussion of the pertinent thermodynamical principles are presented in Chapters III and IV, and in Chapter V refrigeration as applied to gas liquefaction is treated in detail. The remainder of the book is concerned with the separation of special gas mixtures the most important of which is air. Chapters VI to IX are devoted to a discussion of the types of separation plants, the efficiency of various separation methods and the effect of the non-binary character of air, with especial reference to the extraction of rare gases from the atmosphere. The final chapters, X to XII, deal with coke-oven gas, the production of methane and helium and the separation of olefines from cracker gas.

In summary the reviewer feels that this book should be very useful in its field of application and would be more so if greater emphasis had been placed on experimental data.

ATOMS

The World and the Atoms. By C. MOLLER and E. RASMUSSEN, with a foreword by NIELS BOHR. Translated from the second Danish Edition. 193 pages and 40 figures. D. Van Nostrand Company, 1940. $2.75.

THAT "The World and the Atoms" gives to its readers an admirable account of the fascinating discoveries of modern physics and of the important basic concepts to which they have led is in itself a sufficient recommendation of this most enjoyable book. It is perhaps equally noteworthy that the complementary nature of theory and experiment, so essential for the progress of physical science, is more than adequately expressed. The development of atomic physics starting from the discovery of radium and culminating in the contemporary researches into the atomic nucleus is traced in a very logical and understandable manner—with no mathematics more complicated than multiplication. It is unfortunate that the date of writing prevented more than a brief mention of cosmic radiation.

While no serious fault is to be found with the translator's version the substitution of *brass* for *messing* (facing page 78), *sodium* for *natrium* (Fig. 14) and *tungsten* for *wolfram* (Fig. 21) would have been preferable. Fig. 27 contains a misprint in that the last element of the radioactive chain pictured should be an isotope of *lead* and is therefore *stable* rather than *stabbe*.

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SPECIAL ARTICLES

THE PROTECTION OF MICE AGAINST INFECTION WITH AIR-BORNE INFLUENZA VIRUS BY MEANS OF PROPYLENE GLYCOL VAPOR

SINCE our earlier report on the germicidal action of certain glycols dispersed as fine droplets (aerosols),[1] we have found that the vapors of these compounds exert a rapid and highly bactericidal effect on air-suspended bacteria.[2] Our studies show that the lethal action of glycol aerosols is due principally to the liberation of gas by rapid evaporation of the aerosol droplets. When employed in the gaseous form the amounts of glycol required for effective air sterilization are much smaller than when the substance is introduced as an aerosol. Continued accumulation of evidence indicates that propylene glycol is the agent of choice for this method of killing air-borne bacteria because of its high bactericidal activity and low toxicity for the body as compared with other glycols.

In order to test the action of propylene glycol vapor on influenza virus it was first necessary to devise a simple and effective means of recovering this virus

[1] O. H. Robertson, E. Bigg, B. F. Miller and Z. Baker, SCIENCE, 93: 213, 1941.

[2] O. H. Robertson, E. Bigg, B. F. Miller, Z. Baker and T. T. Puck, *Transactions of Assoc. of Amer. Physicians.* In press.

from the air. The only data we have found in the literature on this subject are in a paper by Andrewes and co-workers,[3] in which a very brief statement was made to the effect that by the use of bactericidal mists, presumably NaOCl, they found that a few viruses, including influenza, were susceptible to the mist action as judged by their reduced infectivity for mice. No mention was made of the method of testing. Since the most direct and convincing method of determining the antiviral effect of propylene glycol vapor would be protection aaginst air-borne infection, experiments were undertaken toward that end. That spontaneous experimental infection with influenza virus from infected to normal animals does occur by the aerial route has been shown by Andrewes and Glover[4] in experiments with ferrets. Eaton's[5] observation that normal mice may contract influenza from close contact with infected mice provides suggestive though not conclusive evidence for droplet infection.

Our experiments consisted in exposing 5 to 10 gram mice in a 60 liter glass-walled chamber to mouse-adapted influenza virus[6] (the PR8 strain of Francis[7]) in the form of a fine mist produced with a Graeser atomizer.[8] The virus, consisting of dilutions of finely ground infected mouse lungs suspended in broth containing 20 per cent. normal horse serum, was sprayed into the chamber in quantities of 0.2 to 1 cc. The mice were exposed to the virus mist for periods of time ranging from 5 minutes to 1 hour. Exposure of several hundred mice to sprays of 10^{-2} dilution of the virus resulted regularly in extensive consolidation of the lungs and death within 4 to 10 days. Less numerous tests with higher dilutions of virus have shown that pulmonary lesions are produced constantly with amounts as small as 10^{-4} but not all the animals succumb to the infection at this dilution. Still higher dilutions produced pulmonary lesions occasionally, but no deaths.

Experiments on the protective action of propylene glycol vapor were carried out as follows: Mice were placed in a chamber into which propylene glycol vapor was introduced in concentrations of 1 gram of propylene glycol to two to three million cc of air.[9] Then 0.2 to 1 cc of a 10^{-2} dilution of the virus was sprayed into the chamber and the mice exposed for periods of 15 minutes to 1 hour. All these animals remained well, whereas the control mice similarly exposed to the same suspension of influenza virus alone died within 4 to 10 days of influenza and showed extensive consolidation of the lungs from which the virus was recovered. In other experiments the test mice were killed after 6 to 8 days to determine whether they had been completely protected against infection. A protocol of one such test is shown in Table 1. In this particular experiment the mice were shielded from the spray during the introduction of the virus. They were kept in the chambers for 30 minutes. The fact that mice in the propylene glycol atmosphere were exposed in many instances directly to the influenza virus spray, yet failed to contract infection suggests that the interaction between vapor and virus droplets is exceedingly rapid and may approach the rate at which the glycol vapor kills bacteria suspended in air.[10]

TABLE 1

PROTECTIVE ACTION OF PROPYLENE GLYCOL VAPOR

	Amount of virus sprayed into chambers	Result
32 mice in chamber containing glycol vapor 1 : 2,000,000	0.39 cc 10^{-2} dilution	All remained well; killed 8th day; lungs normal*
35 mice in control chamber	0.37 cc 10^{-2} dilution	All died 6–10 days with extensive consolidation of lungs

* One mouse showed a small area of consolidation about one mm in diameter in the left upper lobe.

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PROPERTIES OF THE ISOLATED MACROMOLECULAR COMPONENT OF NORMAL CHICK EMBRYO TISSUE[1]

STUDIES on the ultracentrifugal isolation of the equine encephalomyelitis virus[2] revealed the presence

[3] C. H. Andrewes, *Lancet*, 2: 770, 1940.

[4] C. H. Andrewes and R. E. Glover, *Brit. Jour. Exp. Path.*, 22: 91, 1941.

[5] M. D. Eaton, *Jour. Bact.*, 39: 229, 1940.

[6] We are indebted to Dr. Thomas Francis, Jr., and Dr. Frank Horsfall, Jr., for supplying us with this strain of virus. Their methods for preparation of the virus suspensions have been used in these experiments.

[7] T. Francis, Jr., SCIENCE, 80: 457, 1934.

[8] J. B. Graeser and A. H. Rowe, *Jour. Allergy*, 6: 415, 1935.

[9] The methods employed will be described in detail in a subsequent publication.

[10] When these experiments had been largely completed, the senior author received a manuscript by Drs. Werner Henle and Joseph Zellat, in which they reported the protection of mice against air-borne influenza virus by means of propylene glycol aerosol. These authors adapted the technique previously described by us (SCIENCE, 93: 213, 1941) to their particular experiments with the virus.

[1] This work was aided by the Dorothy Beard Research Fund and by a grant from Lederle Laboratories, Inc., Pearl River, N. Y.