

sodium hydroxide by progressive replacement and hydrolysis of sodium zeolite. The sodium hydroxide, in turn, brings soil aluminum into solution as aluminate. On continued washing, the alkalinity is reduced. With this progressive reduction in OH-ion concentration, proportionally larger amounts of aluminum hydroxide are formed, accompanied by a corresponding reduction of the soluble aluminate. This, together with the almost complete dispersion of the clay colloids at these alkalinities, renders the soil practically impervious to water or air. As an example of such a soil we cite the case of an Arizona date orchard soil which before leaching was high in salines and gave a reaction of pH 8.8. After leaching out most of the neutral salts it showed a reaction of pH 11.05. The excess of aluminate over aluminum hydroxide is at a maximum at this latter reaction, but as the leaching operations were continued, the precipitation of aluminum hydroxide progressively increased with the lowered OH-ion concentration, and the soil finally became impermeable. Where "black alkali" soils (soils carrying sodium carbonate) are being reclaimed by leaching, the "freezing up" occurs as soon as the excessive alkalinity has been reduced to the precipitation point of aluminum hydroxide. Percolates from many "black alkali" soils have been examined and all show appreciable amounts of soluble aluminum as aluminate.

In our investigations to date we have obtained soluble aluminum by dialyzing black alkali soils. We have reproduced the "freezing up" phenomenon by the action of aluminum chloride solutions on an alkali soil of pH 10 in which the precipitation of aluminum hydroxide was produced by the reaction of the alkali within the soil. This was demonstrated by standing one-inch glass tubes of alkali soil in beakers of aluminum chloride solution of different normalities, noting the rate and height of capillary water movement, by the quantitative determination of the aluminum hydroxide deposited and by measuring the pH of the soil at varying heights in the soil column. Similar experiments were made with silica sand to which calcium carbonate and sodium carbonate had been added and similar results were obtained.

We further demonstrated the "freezing up" properties of aluminum hydroxide by mixing sodium aluminate with a neutral soil, placing in percolators, saturating with water, allowing the whole to stand several days for the reactions to come to equilibrium, and then percolating with water. In this case the precipitation was brought about by reducing the alkalinity of the aluminate. We have also determined the precipitation range of aluminum hydroxide by electrometric titration experiments and studied the properties of the aluminates formed. These experi-

ments not only showed a high solubility for sodium aluminate but also indicated that the solubility of calcium aluminate was appreciable at reactions usually found in alkali soils.

Further work has been done which correlates certain well-known peculiarities of aluminum hydroxide with soil behavior under reclamation. For example, if pure aluminum hydroxide is precipitated in a cold solution the precipitate is colloidal and filters very slowly. If, however, the precipitation is made in a hot solution, it is more granular and filters readily. When alkali soils are leached with cold water, they usually "freeze up" in a very short time. It has been found that, if these same soils are leached with hot water, they do not "freeze up," but percolate indefinitely.

If pure aluminum hydroxide is allowed to become perfectly dry it loses many of its colloidal properties which can not be restored fully by wetting or by pulverizing. We have shown that, if a "black alkali" soil is leached with pure water until it becomes impermeable and then dried out and cultivated, it takes water much more readily. The practical significance of this phenomenon is emphasized.

A complete discussion of this work, together with the numerical data obtained, will appear soon as Technical Bulletin No. 11 of the Arizona Agricultural Experiment Station.

W. T. McGEORGE

J. F. BREAZEALE

P. S. BURGESS

ARIZONA AGRICULTURAL EXPERIMENT STATION,
TUCSON, ARIZONA

THE ACTIVATION OF MOLECULAR HYDROGEN BY ELECTRON IMPACT

THE activation of molecular hydrogen by electron impact has been carried out under conditions in which the energy of the impinging electrons was known. The measurements were made in a four-electrode tube containing filament, grids and plate in the usual manner. A cylinder of copper oxide surrounding the space between the grids gave the activated hydrogen an opportunity to react. The water formed was frozen out in a liquid-air trap. The resulting pressure decrease was determined as a function of the accelerating voltage applied to the electron stream leaving the filament, and it was found that a sharp decrease in pressure occurs when electrons of 11.4 volts energy impinge on hydrogen molecules.

At the same time current-potential curves were taken by the Franck method and a kink in this curve occurred at the same voltage at which the pressure in the apparatus began to decrease.

The latest results of spectroscopy show that the

hydrogen molecule has a resonance potential at 11.6 volts. The present results therefore show that hydrogen molecules can be made to react at ordinary temperatures with copper oxide after they have been brought into their first higher quantum state by electron impact.

A detailed account of these experiments will be given in another place in collaboration with W. P. Baxter and R. H. Dalton.

GEORGE GLOCKLER

GATES CHEMICAL LABORATORY,
CALIFORNIA INSTITUTE OF TECHNOLOGY

THE NATIONAL ACADEMY OF SCIENCES

At the autumn meeting of the National Academy of Sciences held in Philadelphia on November 8 and 9 the following papers were presented:

New proofs of solar variation: C. G. ABBOT.

Various critics having recently expressed themselves as unconvinced of the validity of the proofs of solar variation either in long or short intervals, it occurred to the author to test the matter in a new way.

The difficulty which the critics find inheres in the fact that the observer is situated underneath the ocean of atmosphere whose influence in diminishing the intensity of solar radiation must be allowed for. Since the atmosphere contains variable constituents, critics are doubtful as to whether the apparent variations of solar radiation are really solar or are due to atmospheric variations which the observer is unable to eliminate.

If the observer were situated on the moon, with no atmosphere interposing, accurate direct measurements of the intensity of solar radiation, when compared from time to time, would furnish true indications of the solar variability. Similarly, if the observer underneath the atmosphere of the earth could restrict his measurements to instants when the transparency of the atmosphere is identically the same, such a selective series of observations would also give the true solar variability.

The author attempts to realize this latter condition, in the first place by confining data to months of the same name in successive years. In this way temperature variations of the apparatus, the surroundings, and the atmosphere are minimized, and possibly yearly periodicities in the sensitiveness of the apparatus are eliminated. Secondly, the measurements are chosen always with the sun equally high above the horizon, so that the thickness of the air traversed is the same. Thirdly, days are selected in which the total atmospheric humidity as observed spectroscopically is identical. And fourthly, days are selected when the apparent transparency of the atmosphere as indicated by observations at different air-masses is nearly identical.

The author exhibited results for the month of July in the years 1910 to 1920, as obtained at Mount Wilson, Calif., and results for the twelve months for the years

1920 to 1925, as obtained at Mount Montezuma, Chile. Both series indicated real variations of the sun which were in close agreement with the variations already found for corresponding days by solar constant measurements. Both series indicated that higher solar radiation prevails at times of numerous sunspots.

Forty years of Blue Hill Observatory: Precipitation.
E. B. WILSON.

A Pneumatic-drive method for measuring the fatigue of metals at high frequencies: L. J. BRIGGS and D. H. STROTHER (introduced by George K. Burgess).

The vibration of a flat bar with free ends mounted on pivots at its nodal points is maintained by a pneumatic drive, consisting of nozzles ending in flat discs which are mounted adjustably near the nodal points. The air escaping through the narrow space between the disc and the flat bar causes a reduction in pressure in this space, so that the bar is forced toward the disc. This force (which varies with the distance between disc and bar) operating in conjunction with the elastic restoring force and the inertia of the system keeps the bar in vibration at its natural frequency. The extreme fiber stress may be computed from Rayleigh's theory of a free bar in vibration if the amplitude and the dimensions of the bar are known. Alternating fiber stresses of 15,000 lbs./in.² at frequencies of 200 cycles per second have been continuously maintained in duralumin bars until failure occurred near the center of the bar.

Note on the thermodynamics and kinetics of gaseous explosive reactions: F. W. STEVENS (introduced by George K. Burgess).

A condition under which the gaseous explosive reaction may run its course at constant pressure, greatly simplifies the processes of the explosive reaction, as it simplifies those of the ordinary reaction, by eliminating a number of variables: A constant pressure insures a constant concentration of the initial gaseous components the zone of the reaction is entering. This condition is found to result in a constant linear rate of propagation of the zone of reaction within the explosive gases; a constant reaction process within, and hence a constant temperature gradient across this zone; and a constant temperature and composition of the reaction products as they leave this zone. To secure a condition of constant pressure under which the explosive gaseous reaction may run its course is, therefore, to bring its processes and hence the experimental methods for their study and analysis to a degree of simplicity and precision comparable to those met with in the study of the gaseous reaction at constant pressure and temperature below their ignition point.

This favorable condition for the gaseous explosive reaction—a constant pressure—may be closely realized in practice by holding temporarily the explosive gases within a soap-film container and firing the bubble from the center. This simple device functions as a bomb of constant pressure and thus provides the complement to the bomb of constant volume in the relation $p v = nRT$.