

effect of the new law, and have received a healthy stimulus, which has not been without its effect on the general financial and industrial condition of the country. Even the wood-alcohol interests, which opposed the passage of the bill so strenuously, have not suffered as severely as they declared they would; for wood alcohol, which is one of the standard denaturants required by the regulations, will be increasingly in demand with the wider utilization of denatured spirit.

It is possible to-day to obtain denatured, high-proof spirit for 35 to 40 cents a gallon, depending upon the locality in which the purchase takes place and upon the quantity bought. In New York city, for instance, denatured spirit can be purchased for 36 cents a gallon in five-barrel lots.

These figures are not discouraging, though they hardly permit the present general use of alcohol for fuel for motor purposes in competition with petroleum and gasoline at, roundly, 15 and 20 cents a gallon respectively. They indicate that the future of fuel alcohol is quite as promising as its more conservative advocates claimed prior to the legislative action. There can be no doubt that the price of the denatured spirit will decrease with the development of its industrial utilization, with the wider application of wastes to distillation, and with the growing familiarity of the farmer and the manufacturer with the subject.

Shortly after the alcohol bill became a law, the Department of Agriculture appointed a commission to conduct a series of investigations upon alcohol engines and the use of alcohol in ordinary internal-combustion motors. An interesting preliminary report, to be followed, before long, by a more elaborate account of the investigations, has recently been published. It presents much interesting data and substantiates, in general, the results obtained in Europe and the deductions to be drawn from them. The conclusion, previously arrived at by other investigators, that practically any explosive engine is adapted to the use of alcohol, but that the motor designed specially for alcohol will give superior results, is substantiated. One interesting fact is brought out which, perhaps, has not received a great deal of attention hitherto. This is that the possible margin of inefficiency is much higher in the alcohol engine than in other internal-combustion engines. With good management the consumption of alcohol in an engine not especially designed for the purpose can be brought as low as 1.23 pounds per brake horse-power, though the fuel consumption in the same motor may increase to nearly twice this minimum amount without apparent defect in the operation of the engine. This fact serves excellently to emphasize the necessity for using the specially-designed alcohol motor in order to obtain the best results with this fuel.

The prospect of producing denatured alcohol on the farm economically has been greatly brightened by the recent passage of a bill amending the Free Alcohol Act. Under the latter there was no adequate provision whereby denatured alcohol could be produced on a modest scale, as it was required that the pure spirit be removed from the still in barrels to denaturing warehouses. The amendment makes it permissible to transfer the pure spirit to denaturing warehouses by means of pipe lines or tank cars. Furthermore, it is provided that at distilleries producing alcohol for denaturation only, and with a capacity of not more than 100 proof gallons per day, bonded distillery warehouses may be dispensed with, and the alcohol may be stored in cisterns or tanks and denatured without removal to a denaturing warehouse. Both of the amendatory provisions will be of service in reducing the cost of manufacturing tax-free spirit, and the second will render its production practicable on a far smaller scale than was possible under the original law.

A great deal of independent experimentation has been carried out in all parts of the country for the purpose of discovering or demonstrating the possible use of various waste materials for alcohol production, and valuable data have been obtained in this way. Contrary to expert opinion, it is held by government officials and others familiar with the conditions, that under the law as it now stands, the farmer can successfully distill and denature alcohol from his produce or wastes on a small scale. Speaking recently on this topic, Internal Revenue Commissioner Yerkes declared that there were absolutely no limitations as to the size of a distillery which may be operated under the law. He declared, furthermore, that there are in existence at the present time over a thousand distilleries, of which the daily spirit-producing capacity is less than 30 gallons each, and that many of these plants were installed at an outlay of less than \$200. We believe, however, that the successful solution of the problem of farm distillation on a small scale lies not in the use of a low-capacity still by the individual farmer, for the utilization of the produce or wastes from his own land, but is to be found in the communal still, operated jointly by a number of indi-

viduals or conducted by a distiller and operated on shares, the distiller being paid for his work in the resulting spirit itself, somewhat as the old-time miller received payment for grinding the grain, in flour. Even if small distilleries can be installed at a comparatively low cost, alcohol can be distilled economically and profitably only when the production is continuous and on a larger scale than is possible on the average farm.

Prior to the passage of the present law the American literature of industrial alcohol was, naturally, extremely limited, and strange to say, this is true to-day of England, despite the fact that the latter country has had tax-free alcohol for many years. Recently a number of books have appeared, dealing with different phases of the subject, and providing in many instances excellent means for the education of the layman and proving of value even to the expert. Among these we call attention to "Industrial Alcohol, Its Manufacture and Uses," a practical treatise, recently issued by the publishers of the SCIENTIFIC AMERICAN, and described at greater length elsewhere in this number.

#### THE EVAPORATION OF SOLID METALS AND THEIR COMPOUNDS.

The evaporation of metals at ordinary temperatures, which has long been conjectured from their characteristic odors, has recently been clearly demonstrated by several methods.

Zenhele's method is as follows: The metal is placed in a saucer in an air-tight glass vessel which also contains a piece of chemically pure silver foil, suspended horizontally above the metal under investigation at a distance from 1-25 to 4-10 inch. Silver was selected as the material of the foil because it does not oxidize rapidly and exhibits considerable affinity to non-metals. Its effect is to increase the evaporation from the other metal by absorbing the vapor as it is formed, so that the volume of the containing vessel never becomes saturated.

Many experiments were made, with copper, lead, iron, zinc, the non-metals sulphur, selenium, tellurium, and phosphorus, the metalloids arsenic and antimony, and various oxides, hydrates, sulphides, and haloid and oxygen salts. In nearly every case the silver foil was more or less affected. Usually a golden tint, resembling that of an alloy, gradually extended inward from the edge until it covered the entire surface, but every color of the rainbow appeared in the course of the experiments. The metals were employed in the form of plugs, most of the compounds were powders obtained by precipitation, and some of the oxides were formed by roasting.

Weeks or months were required to produce a distinct effect with most substances, though a few days or even hours sufficed in some cases. The metalloids and non-metals, having a greater affinity for silver, acted more energetically than the metals. Phosphorus made the foil brittle throughout.

Among oxides the most rapid evaporation was shown by those of zinc, iron, chromium, uranium, and bismuth. Analysis of the foil that had been exposed to the vapor of zinc revealed the presence of 2 per cent of that metal. In most other cases the fact of evaporation was confirmed by simply determining the increase in weight of the silver foil.

No evaporation from quicklime or carbonate of lime was detected, while the sulphides of arsenic, antimony, tin, and barium evaporated very rapidly, comparatively speaking. Both sulphur and zinc were detected in the silver foil that had been exposed over zinc sulphide. In many cases the colors which occur on polished silver exposed to traces of sulphureted hydrogen were observed.

The haloid salts of lead, mercury, zinc, iron, and the alkali metals also acted very energetically, the iodides evaporating more rapidly and the chlorides more slowly than the bromides. With the haloids of silver, however, the order was reversed. The silver foil was completely corroded by long exposure over lead iodide.

The metals of the alkalis and alkaline earths were easily detected in the foil by the color of the blowpipe flame. In some cases in which the balance gave no result the presence of foreign metals in the foil was detected by the production of characteristic colors with appropriate reagents—potassium ferrocyanide for copper, iron, and uranium, sodium molybdenate for tin.

When copper, nickel, or aluminium was substituted for the silver foil no effect was observed. Gold was affected by the vapors of the oxides of zinc and mercury, but by no other substance.

The presence of moisture in the air of the vessel increased the rapidity of evaporation, and the water of crystallization of certain salts, including cobalt sulphate and chrome alum, had a similar effect. Rarefaction of the air also quickened the evaporation and the silver foil was attacked sooner in small than in large vessels. Evaporation was also favored by reducing agents such as hydrogen and alcohol vapor, but was not affected by covering the vessel with yellow

glass to exclude the chemically active rays of light.

Elevation of temperature had no visible effect, probably because it promoted to the same degree the formation of vapor and the decomposition of the silver compound.

The golden metallic hue which was the first effect in nearly all cases, even when the substance under investigation was a compound, suggests an alloy of the silver with the other metal; and as the sulphides of arsenic, antimony, and tin produced colors indicating combination of sulphur with the silver, it seems probable that the vapors of compounds were dissociated as a result of their extreme rarefaction. This view is supported by the fact that the less stable of two related compounds attacks the silver more than the other. For example, the bicarbonate and the thio-sulphate of sodium acted more quickly than the carbonate and sulphite respectively. Compounds that dissociate at low temperatures, such as hydriodic acid and oxide of mercury, also acted very quickly.

There is probably some connection between the evaporation of solid bodies and their long-known action on photographic plates. Many substances exert such action not only immediately after exposure to sunlight, but after they have long been shielded from light of every kind, and some of them affect the plate both when in contact with it and when separated from it by a layer of air. Zinc affects the plate at a distance of 1-3 inch, but magnesium and aluminium act more rapidly. Other substances possessing this property are wood, paper, leather, silk, cotton, shellac, and various metals.

The results of numerous experiments make it appear very probable that these effects are caused by invisible metallic radiations. These radiations are apparently subject to the law of gravitation, for when a metal plate is placed horizontally between two photographic plates the effect is confined almost wholly to the lower one of the latter. If the three plates are placed vertically in a centrifugal apparatus the photographic plate which is farther from the axis than the metal plate is more strongly affected than the other.

Streintz attributes this radiation to the agency of the so-called electrolytic pressure (which has been measured in the case of certain metals) and finds it proportional thereto. In the series platinum, gold, lead, iron, cadmium, zinc, aluminium, magnesium, the metals are arranged in the order of increasing electrolytic pressure and increasing effect on the photographic plate. According to Streintz, the effect of the electrolytic pressure is to expel positive ions which affect the plate, ionize the air, and leave the residual metal negatively electrified.

It appears probable, therefore, that evaporation, autophotography, and radioactivity are nearly related and are common to a great many metals and their compounds.

#### THE CURRENT SUPPLEMENT.

The current SUPPLEMENT, No. 1631, opens with an excellent article by Mr. Robert H. Chapman, of the United States Geological Survey, on the Deserts of Nevada and the Death Valley. In the management of wireless telegraph stations where open and closed oscillation circuits are compounded to form coupled systems for the efficient radiation of electric waves from an aerial wire, it is often necessary to determine with precision the frequency of the surging oscillations and the length of the emitted waves. This can be done by means of the ondiameter or electric wave meter. Mr. A. Frederick Collins, in the current SUPPLEMENT, explains very clearly the principle of the ondiameter's operation and its application in wireless telegraphy. Mr. Charles P. Steinmetz's excellent paper on light and illumination is concluded. Richard Lee writes on coal mine gases. The inundation of Salton Sink, and the formation of the great new lake in the Imperial Valley of California as the result of the diversion of the Colorado River, is very interestingly discussed by Mr. Arthur P. Davis, with the help of many excellent illustrations. Baron Suyematsu concludes his eloquent summary of the ethics of Japan. That the Romans were very good mechanical engineers has been proven by more than one striking discovery. How true this is may be gathered from an instructive article in the current SUPPLEMENT on an ancient Roman pump, which shows that long ago the Romans were very familiar with natural laws. On July 13 next the earth and Mars will be in opposition. At that time the much-discussed surface-markings of the planet will be observed. For that reason the very excellent article by the Abbé Moreux, director of the observatory at Bourges, on "The Planet Mars as Revealed by Recent Observations" may be considered a good preparatory discussion of a subject which will soon be dilated upon in the daily press. The abbé writes not only on observations of his predecessors, but on his own work. Sharp and clear illustrations accompany his offering. Interesting, too, is a report on the testing of railway spikes prepared for the New York Central and Hudson River Railroad.