The brine was added and upon the efficiency of the stirring operation.

The cost of this treatment is low, since the final increased adhesive only contains from 3 to 4 per cent, by weight, of NaCl. Any ordinary grade of salt seems to work satisfactorily.

The final viscosity can be varied to a large extent by small changes in the brine concentration. This is shown by the steepness of the curves in the neighborhood of the "original viscosities." This brine concentration, however, can be controlled very well in practice by the use of a standard hydrometer, since it is not at all difficult to read the latter to one-tenth of a degree, which corresponds to one-tenth of one per cent of NaCl.

The treated adhesive does not seem to be affected by age. Samples out of contact with the air have been kept and observed for over a year and show no appreciable change in adhesive power, and no loss of viscosity. After several months a flocculent sediment often settles out, but this apparently has no effect on the adhesive quality or the viscosity.

Samples of corrugated container board made in both laboratory and factory, with the treated adhesive, also have remained unaffected by age for a period of more than one year.

SUMMARY

I.—The desirable properties of water-glass for use as an adhesive are, in general, a function of the viscosity.

II.—A method is described of increasing, to the extent of 25 per cent, the volume of adhesive water-glass by the addition of brine, without impairing the viscosity and other desirable properties of the adhesive.

III.—This method involves the practical application of certain phenomena of colloid chemistry, such as coagulation and peptization.

ON THE DISTILLATION OF AMMONIA

By B. S. Davisson

Department of Soil Technology, Ohio Agricultural Experiment Station, Wooster, Ohio

Received August 8, 1919

The distillation of ammonia from an alkaline solution into standard acid and titrating or nesslerizing to determine the ammonia has long been in practice. Many procedures and forms of distilling apparatus have been suggested for transferring the ammonia into the standard acid, but all have one or more objectionable features.

A prolonged study of nitrogen methods made in connection with the biological studies of this laboratory1 has involved the use of many different kinds of distilling apparatus. Both water- and air-cooled condensers have been used and, while many satisfactory determinations were made with air-cooled condensers, an apparatus suitable for the distillation of ammonia from an alkaline solution into standard acid should possess a water-cooled condenser. The ordinary Kjeldahl distilling rack, although water-cooled, has many undesirable features, especially when small amounts of nitrogen are being determined. The solubility of the soft glass still head and adapter ordinarily used together, with the adsorption of ammonia by the block tin condenser, led to the abandonment of this type of apparatus. The one found most satisfactory for careful research work has been described.2 It is made of Pyrex glass with only one rubber connection which does not vitiate the results. The scrubbing device for removing entrained alkali is sufficiently satisfactory for use with N/100 solutions. This apparatus, however, is not entirely suited for general routine analytical work. A scrubbing device and an adapter have been devised for use with block tin condensers, thereby overcoming the most objectionable features of the ordinary Kjeldahl distilling rack. By using these devices with good tin condensers, proceeding as outlined below, it is easily possible to obtain an accuracy of less than 1 per cent with 5 mg. of nitrogen.

We desire to recommend here that the apparatus as finally adopted, i.e., the all-glass apparatus or block tin condensers with the new scrubber and adapter, be used in connection with the methods described from this laboratory. While the Mitscherlich distilling apparatus was found satisfactory in this laboratory for determining nitric nitrogen, it may not prove equally so in other laboratories. The procedures for using the distilling apparatus, as recommended, in connection with the determination of nitric nitrogen and total nitrogen are given below.

PROCEDURE FOR DETERMINING NITRIC NITROGEN

The procedure3 previously recommended is followed with the exception of the distilling apparatus, which is replaced by that described above. The cooled condenser is used for the first 20 min. of moderate boiling, after which it is drained and the boiling continued, more rapidly, for 20 min. longer. The receiver is then removed, cooled, and titrated.

PROCEDURE FOR KJELDAHL NITROGEN DISTILLATION

The procedure followed in most laboratories consists in distilling through a water-cooled condenser until about 150° cc. of distillate have been collected.

1 This Journal, 7 (1913), 821; 8 (1916), 896; 10 (1918), 600; 11 (1919) 306; Ann. Mo. Bot. Gardens, 6 (1919), 1.
3 This Journal, 11 (1919), 465.
4 Loc. cit.
The major portion of the ammonia passes over in the
first few minutes but the prolonged distillation is
necessary in order to remove the last traces of ammonia
from the condenser. Benedict found that the last
traces of ammonia could be rapidly removed from the
condenser by steaming for a short time, thereby
lessening the time necessary for a distillation. He
recommends draining the condenser after 15 min. of
boiling and continuing the boiling until the receiving
solution is slightly warmed.

Benedict's recommendation has been followed for
two reasons, both to remove quickly the last traces
of ammonia from the apparatus, and to keep the volume
of solution in the receiver as small as possible, i.e.,
about 110 cc., in order to reduce the hydrolysis of the
indicator salt. The length of time of a distillation
recommended by Benedict was found to be insufficient
to remove the last traces of ammonia from the boiling
solution. We have, therefore, adopted a different
procedure. The solution is distilled slowly for the
first 20 min. with cooled condenser, during which time
about 80 cc. of distillate are collected. The condenser
is then drained and the distillation continued for 15
min. longer with somewhat more rapid ebullition.
The receivers are then removed, covered to prevent
the absorption of carbon dioxide, cooled and titrated.

During the slow distillation with the cooled condenser
the ratio of ammonia to steam passing over is much
greater than with rapid boiling, yet the rate of distil-
lation of ammonia is about the same. The steam
passing over after the condenser is drained condenses
in the receiving solution until the acid solution be-
comes hot, after which it passes out of the solution
thoroughly scrubbed of any ammonia which it carried.
That the ammonia is completely recovered by this
method of distillation is shown by the data in Table
1. The figures were obtained by digesting pure solu-

tions of ammonium sulfate with 15 cc. of concentrated
sulfuric acid, 0.5 g. copper sulfate, and 5 g. of potassium
sulfate and distilling with 50 cc. of strong alkali (am-
monia-free) into N/50 acid. The volume of solution in
the receiving flask is kept small by this method of
distillation and at the same time the solution in the
distilling flask is not reduced in volume. The above
procedure has been found entirely satisfactory for
the amounts of nitrogen which are encountered in
total nitrogen determinations.

| TABLE I—THE RATE OF DISTILLATION OF AMMONIA |
|-----------------|-----------------|-----------------|
| Nitrogen Taken—5.045 Mg. | CONDENSERS COOLED | CONDENSERS DRAINED |
| First 10 Min. | Next 10 Min. | Next 15 Min. | 35 Min. |
| Mg. | Mg. | Mg. | Mg. |
| 3.872 | 0.990 | 0.177 | 5.039 |
| 4.513 | 0.546 | 0.033 | 5.092 |
| 4.618 | 0.426 | 0.105 | 5.030 |

A REVIEW OF THE LITERATURE OF EMULSIONS

By Arthur W. Thomas

Department of Chemistry, Columbia University, New York, N.Y.

Emulsions have been the subject of lively comment in chemical
literature for the past twenty years. No general theory for
emulsification has been elucidated, although many have been
proposed from time to time, only to be shown subsequently
to apply to special cases. There has accumulated, however,
a mass of arbitrary data which can be profitably applied.

An emulsion is a heterogeneous system consisting of one liquid
dispersed as tiny droplets in another liquid. It has been de-
dinitely established that three phases are essential for the forma-
tion of a stable emulsion: (1) Liquid A, (2) Liquid B, and (3)
an emulsifying agent. The two liquids must be immiscible,
or nearly so, in one another. The common types of emulsion
are those wherein water constitutes one of the liquid phases,
and we recognize two main types: (1) A liquid (oil, for in-
stance) dispersed in water, and (2) water dispersed in oil. The
factor which controls the type of emulsion, i.e., whether water
or oil is the external phase, is the nature of the emulsifying agent.

In general, if the emulsifying agent is more easily wetted by
water than by oil, then water will be the external phase and oil
the dispersed phase, while if the emulsifier is more easily wetted
by oil than by water, the reverse will be true. Or, as Bancroft puts it:
If the surface tension between Liquid A and the emul-
sifying agent is lower than the surface tension between Liquid
B and the emulsifying agent, Liquid A will be the dispersing
and Liquid B the dispersed phase. Since the emulsifying agent
is almost always recognized as a colloidal substance, it is fairly
safe to say that a hydrophilic colloid as emulsifying agent will
emulsify oil in water and a hydrophobe colloid will emulsify
water in oil. This latter statement is subject to modification,
however, which will be considered later.

There is a very simple and reliable method of determining
the type of emulsion. Upon addition of an emulsion of oil-in-
water (i.e., oil dispersed phase and water external phase) to
water, it will disperse. Similarly, a water-in-oil emulsion will
mix with oil. In short, an emulsion will freely mix or dilute
with more of its external phase, but not with more of its internal
phase.

Robertson suggested a method of staining with Soudan III
(a fat-soluble dye). He stated that if Soudan III is sprinkled
upon the surface of an oil-in-water emulsion the red color will be
confined to the oil droplets and a mass of discontinuous red
specks will result, whereas when sprinkled on the surface, a
water-in-oil system will become uniformly red. This test has
lately been severely criticized, and it has been shown that
Robertson was led into misinterpretation of his olive oil-water-
NaOH emulsions. He claimed to show critical concentrations
leading to emulsions of water-in-oil. This has since been shown
to be highly improbable.

OIL-IN-WATER EMULSIONS

There are three main classes of this type of emulsion:

1. The emulsifying agent is an electrical charge on the oil
particles, probably due to selective adsorption of the OH-
ion of water by the oil particles.
2. The emulsifying agent is a water-soluble colloid.
3. The emulsifying agent is an insoluble, or very slightly
soluble colloid.

There are many cases also where a combination of two or
even three of the above may function as emulsification agents.

1. ELECTRICAL CHARGE AS EMULSIFYING AGENT—These emul-
sions are the simplest. They are identical with those observed