

the refractivity of the solution was observed. It was found that the refractivity of the water varied from day to day very slightly, the maximum deviation being 1' (one minute) in the reading of the scale of the instrument which affected the refractive coefficient only in the fifth decimal place. This slight variation was evidently due to slight change of temperature and partly to errors of experiments.

Gladstone and others have found the refractive equivalent of potassium atom = 8.1 and of hydrogen in acids = 3.5. The refractive equivalent of hydrogen in water and other nonionizable substances is 1.5, but the value for hydrogen in strong acids is 3.5.¹ The difference between the refractive equivalents of 2 atoms of potassium and two atoms of hydrogen is therefore $16.2 - 7 = 9.2$. By similar lines of reasoning as indicated in the case of molecular solution volume we can expect the difference between the refractive equivalents of potassium dichromate and chromic acid, on the supposition that its formula is $H_2Cr_2O_7$, to be 9.2. By actual experiments we find the difference to be $82.6 - 73.2 = 9.4$. If the formula of chromic acid be H_2CrO_4 we should get the same difference between the refractive equivalents of potassium chromate and chromic acid (H_2CrO_4). By experiment we find it $52.2 - 39.5 = 12.7$ in place of 9.2. The formula of chromic acid is therefore $H_2Cr_2O_7$ and not H_2CrO_4 . This is also the conclusion arrived at from the study of volume relations.

Thus we see that two most important physical properties of chromic acid in solution are in support of the formula $H_2Cr_2O_7$, which also seems to be the more probable one from various other investigations.

In a subsequent paper, some other physical properties will be discussed.

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NOTE.

A Bottle for the Iodimetric Titration of Copper.—Since L. W. Andrews² first described the use of iodate as a substitute for many iodimetric determinations, the method has been extended and is finding additional uses constantly. In technical practice particularly, the application to copper ores as described by Jamieson, Levy and Wells,³ and by Brostrom⁴ is finding much favor; in this method, there is formed hydrocyanic acid—a feature that militates against the use of the original shaking bottle as described by Andrews because of the pressure developed in shaking and the consequent forcible ejection of particles of liquid on removing the

¹ LeBlanc, *Z. physik. Chem.*, 4 (1889); Gladstone, *Phil. Mag.*, 15 (1870).

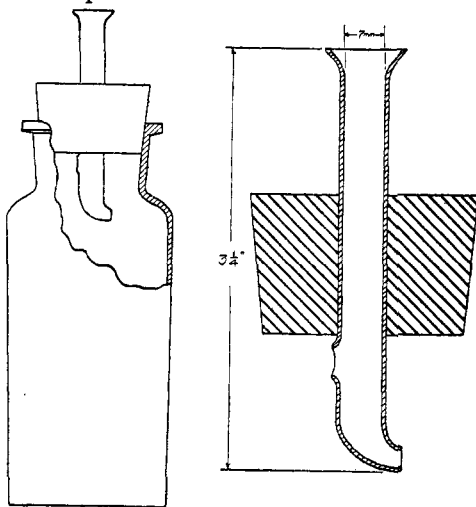
² THIS JOURNAL, 25, 756 (1903).

³ *Ibid.*, 30, 760 (1908).

⁴ *Eng. Mining J.*, 98, 215 (1914).

stopper between additions of iodate: on the other hand, the use of a simple open Erlenmeyer, as used in the Southwest copper district, limits more than desirable the freedom in shaking: both difficulties may be overcome by replacing the glass stopper by a two-hole rubber stopper, through which pass two glass tubes, 5-6 mm. in diameter and about 8 cm. long, one of the tubes being widened at the top to serve as an inlet for the iodate solution, the other serving as an outlet for vapor, their length preventing loss by ejection during shaking.

With a little additional trouble, a somewhat more efficient modification may be constructed: this is illustrated in the accompanying sketch. The tube is 7-8 mm. in diameter, flared above, narrowed and curved below, and provided with a blowhole just below the cork. This side hole acts not only as the pressure vent but also serves the purpose of washing the last drop of iodate down during the shaking without the use of a wash bottle.



This bottle has been in constant use by students for copper ore analyses in this laboratory for over a year and found quite satisfactory: besides its convenience, it saves the time required in removing the stopper or in shaking so very cautiously. The only objectionable feature is the action of chloroform or carbon tetrachloride on the rubber stopper if allowed to stand overnight: during titration the stopper is protected by an aqueous film and shows no deterioration even after long use.

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THE ADDITION COMPOUNDS OF PHENOLS WITH ORGANIC ACIDS.

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It has been shown by the author in a recent communication¹ that *strong* organic acids (such as trichloroacetic acid) will combine directly with

¹ Kendall, *THIS JOURNAL*, 36, 1722 (1914).