of the oxygen. As the experimental results given in this article prove definitely that pressure has no measurable effect on the rate, we are forced to conclude either, that the two above cases do not exist, or that the chemical reactions are rapid in comparison to the rate of diffusion of the hydrogen peroxide. The latter hypothesis agrees very well with the experimental results obtained by J. Teletow.[1]

Pressure would also have no appreciable effect on the reaction if an active platinum compound were formed directly from the union of platinum and hydrogen peroxide and not from platinum and oxygen, even if the rate of union were *not* rapid.

Summary.

The chief results of this article are: A method has been worked out whereby rates of reaction may be measured under high gas pressure.

It has been experimentally determined that the catalytic decomposition of hydrogen peroxide by colloidal solutions of platinum, palladium, iridium, gold and silver is unappreciably affected by increasing the pressure of oxygen gas above the reaction mixture from 1 to 200 atmospheres.

This investigation was carried out in the chemical laboratory of the University of Heidelberg during the years 1905–6, under the direction of Prof. Bredig to whom my sincere thanks are due for friendly and valuable advice.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
October 9, 1907.

A METHOD FOR THE SEPARATION OF IRON FROM INDIUM.

BY F. C. MATHERS.

Received December 16, 1907.

One of the most difficult steps in the purification of indium is its separation from iron. Winkler[2] obtained a separation by the fractional precipitation of the sulphide, the indium sulphide being less soluble than the iron sulphide. A more satisfactory method was devised by Bayer,[3] who treated a solution of the mixed chlorides with sodium sulphite. Basic indium sulphite is precipitated from this solution upon boiling. The precipitate, after filtration, was dissolved in a solution of sulphurous acid and basic indium sulphite was again precipitated by boiling. This solution and reprecipitation was repeated several times to completely purify the indium. The Bayer method was tested in this laboratory, but gave unsatisfactory results. Weselsky[4] treated the chlorides of indium and iron with sulphur dioxide or sodium thiosulphate and then

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[1] Dissert., Heidelberg, 1906.

[2] J. pr. Chem., **94**, 1 (1865).

[3] Bayer, Lieb. Ann., **158**, 372 (1871).

[4] J. pr. Chem., **94**, 443 (1865).

with barium carbonate, which precipitated indium hydroxide, together with traces of iron and zinc. Meyer[1] treated the material that contained indium and iron with sodium carbonate until neutral and then with a solution of potassium cyanide until the precipitate that first formed was redissolved. The solution thus formed was diluted with 10 volumes of water and was boiled. This decomposed the potassium indium cyanide and indium hydroxide was precipitated while the iron remained in solution as potassium ferri- or ferrocyanide. This method was found, upon trial, to give fair results. The indium, however, is not completely precipitated by boiling, considerable amounts of it being found in the filtrate. The precipitate is very gelatinous, difficult to wash, and often passes through the filter paper before the washing is completed. For these reasons the method is not satisfactory. Some quantitative results obtained in this laboratory with the Weselsky method follow:

Indium oxide present.	Indium oxide precipitated by dilution and boiling.	Indium oxide precipitated from the filtrate with ammonium hydroxide.
0.0320 gram	....	0.0022 gram or 6.8%
0.0545 gram	0.0528 gram or 96.8%	0.0014 gram or 2.5%

Dennis and Geer[2] have proposed the removal of the iron by extracting the ferric sulphocyanate with ether. This method has been applied to the removal of iron from nickel, cobalt, copper, aluminum, etc. Indium sulphocyanate, however, is quite soluble in ether and for this reason indium is always present with the iron in the ether extract. The labor involved in recovering the indium thus dissolved constitutes a serious drawback in this method, which is otherwise very satisfactory and yields an indium that is free from iron.

Several other methods have been suggested for the separation of iron and indium, but those cited above seem to have been the ones most generally used and to have been the most satisfactory.

The method here proposed for the removal of iron from indium is the precipitation of iron from nitroso-β-naphthol. This reagent[3] quantitatively precipitates cobalt, copper, and iron, but does not precipitate aluminum, lead, zinc, or nickel. Experiment showed that indium also was not precipitated, and this led to the development of the following method of separation:

A solution of the indium chloride or sulphate containing a small quantity of iron was evaporated to a volume of 20 to 25 cc., was neutralized with ammonium hydroxide and then an equal volume of 50 per cent. acetic acid was added. The iron in these solutions was precipitated with nitroso-β-naphthol dissolved in 50 per cent. acetic acid. The solu-

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[1] Meyer, Lieb. Ann., 150, 137 (1869).

[2] This Journal, 26, 437 (1904).

[3] Ilinski and Knorre, Ber., 18, 2728 (1885); Knorre, Ber., 20, 283 (1887).

tion may be either hot or cold when precipitated, but it should stand several hours before filtering, and should be cold when filtered. The residue is washed with 50 per cent. acetic acid and finally with water. Before using this method the bulk of the iron must be removed by some other method. Since the precipitate of iron with nitroso-β-naphthol is very bulky, 0.05 gram of iron is about the maximum quantity that can easily be handled on a 12 cm. filter paper. The indium precipitated by electrolysis from a solution containing indium sulphate and quite large amounts of ferric sulphate and strongly acidulated with sulphuric acid, contains only small amounts of iron. This metal can then easily be freed from the iron that it still contains by precipitating the iron with nitroso-β-naphthol. Colorimetric analysis of the indium, after the precipitation of the iron by this method, showed that the content of iron was very low. This small amount of iron[1] could easily have been introduced into the solution during evaporation by the dust from the air. Quantitative determinations of the iron remaining in the indium gave the following results:

Indium oxide taken. Gram.	Ferric oxide added. Gram.	Nitroso-β naphthol used. Gram.	Ferric oxide still present in the indium oxide. Gram.
0.3148	0.0328	5.0	Less than 0.00005
0.1738	0.0262	4.0	" " 0.00005
0.2184	0.0197	3.0	" " 0.00005
0.3061	0.0262	2.5	" " 0.0001
0.2142	0.0262	2.5	Very faint red

Some indium remains in the residue with the iron and a second precipitation will not remove all of it. The indium in these residues can easily be detected with the spectroscope. The total quantity of indium that is lost in these iron residues is, however, quite small, as is shown by the following data:

Indium oxide taken. Gram.	Ferric oxide added. Gram.	Ferric oxide obtained from First precipitation. Gram.	Ferric oxide obtained from Second precipitation. Gram.	Indium oxide in ferric oxide in First precipitation. Gram.	Indium oxide in ferric oxide in Second precipitation. Gram.
0.3061	0.0262	0.0286	0.0273	0.0024	0.0011
0.1520	0.0262	0.0283	0.0273	0.0021	0.0011
0.2142	0.0262	0.0281	0.0266	0.0019	0.0004

Cornell University,
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SOME NEW COMPOUNDS OF INDIUM.

By F. C. Mathers and C. G. Schluederberg.

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This paper describes the preparation and properties of four new compounds of indium: the perchlorate, the iodate, the selenate, and the caesium-selenium alum.

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[1] Stokes and Cain, This Journal, **29**, 409 (1907).