

obtained on two samples purchased at a city grocery and supposed to be pure milk :

	1.	2.
Specific gravity milk.....	1.0282	1.0263
“ “ “ serum .....	1.0257	1.0234

The specific gravity of the serum indicated in one case ten per cent. and in the other twenty per cent. of added water. The amount of added water calculated from careful determinations of the total solids and of the fat was very close to this, being 9.8 per cent. for the first sample and 19.6 per cent. for the second. The method is easy to carry out and should prove to be of considerable value.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.  
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## DETERMINATION OF CALCIUM AND MAGNESIUM IN ASHES.<sup>1</sup>

By J. K. HAYWOOD.

Received March 15, 1899.

THOSE who have had any considerable number of ash samples to analyze according to the method adopted by the Association of Official Agricultural Chemists, cannot help having been struck with the extreme difficulty of determining calcium and magnesium. The whole trouble consists in washing the voluminous precipitate of basic acetate of iron and phosphate of iron, which is not only so bulky as to be troublesome, but also commences to run through the filter soon after washing is begun.

The following work was undertaken with the idea of showing that this washing can be entirely done away with, without seriously affecting the accuracy of the results. To do this the precipitation of the phosphoric acid and iron from the solution of calcium and magnesium was made in a 500 cc. flask, the solution then cooled to room temperature, made up to the 500 cc. mark, and *well shaken*. 250 cc. of this solution were then filtered off through a dry filter, keeping the funnel covered to prevent evaporation, evaporated to a small volume, ammonia added to get rid of any small traces of iron that might have dissolved in

<sup>1</sup> Read at the meeting of the Washington Section, March, 1899.

the liquor (nothing like the large amount that comes through the filter when the precipitate is washed), and the solution again filtered. The manganese is removed with bromine and ammonia, and calcium and magnesium determined in the filtrate. It will be noticed that this method does not correct for the volume occupied by the precipitate of basic acetate of iron and phosphate of iron, and it was to show that this correction is immaterial that the following work was undertaken.

For purposes of analysis three powders were prepared : one containing approximately ten per cent. of lime, three and five-tenths per cent. of magnesia, and 86.5 per cent. of sand ; two containing twenty per cent. lime, five per cent. of magnesia, and seventy-five per cent of sand ; and three containing thirty per cent. of lime, nine per cent. of magnesia, and sixty-one per cent. of sand. Ten grams of each powder were dissolved in hydrochloric acid and filtered to a volume of 500 cc., aliquot portions being taken for analysis.

Analyses of the above powders showed the following per cents. of calcium and magnesium oxides :

	I.	II.	III.
Lime.....	9.81	19.74	29.78
	9.85	19.66	29.86
	<hr/>	<hr/>	<hr/>
Average .....	9.83	19.70	29.82
Magnesia.....	3.69	5.28	8.90
	3.71	5.26	8.90
	<hr/>	<hr/>	<hr/>
Average.....	3.70	5.27	8.90

Aliquot portions were again taken from the solutions prepared as above and phosphoric acid was added to each portion, amounting in the case of solution I to five per cent. of the total amount of powder used, in the case of solution II to ten per cent. of the total amount of powder used, and in the case of solution III to twelve per cent. of the total amount of powder used. Enough ferric chloride was added to precipitate all phosphoric acid, and these portions analyzed according to my method mentioned above, with the following results :

	I.	II.	III.
Lime.....	9.80	19.72	29.52
	9.76	19.80	29.54
	<hr/>	<hr/>	<hr/>
Average .....	9.78	19.76	29.53

	I.	II.	III.
Magnesia.....	3.75	5.21	8.95
	<u>3.82</u>	<u>Lost</u>	<u>8.93</u>
Average .....	3.79	5.21	8.94

showing practically the same results as those obtained above when no volume of a precipitate was neglected.

In the case of solution III a rather extreme case was next tried by adding enough phosphoric acid to correspond to twenty per cent. of the original powder. The results were :

III.			
Lime .....	29.74	Magnesia .....	9.19
	<u>29.90</u>		<u>9.21</u>
Average .....	29.82		9.20

In my work last year on the official ash sample, which contained 9.83 per cent. of phosphoric acid, the calcium and magnesium were determined according to the above method with the following results, in triplicate :

Lime .....	11.94	Magnesia .....	5.83
	11.94		5.75
	<u>11.97</u>		<u>5.77</u>
Average	11.95		5.78

as against an average of lime 11.62, magnesia 5.74, by the other chemist engaged in the work.

The results obtained arranged in tabular form were :

No. 1.			
	Lime.	Magnesia.	
Before adding phosphorus pentoxide .....	9.83	3.70	
After adding five per cent. phosphorus pentoxide .	9.78	3.79	

No. 2.			
	Lime.	Magnesia.	
Before adding phosphorus pentoxide .....	19.70	5.27	
After adding ten per cent. phosphorus pentoxide .	19.76	5.21	

No. 3.			
	Lime.	Magnesia.	
Before adding phosphorus pentoxide .....	29.82	8.90	
After adding twelve per cent. phosphorus pentoxide .....	29.53	8.94	
After adding twenty per cent. phosphorus pentoxide .....	29.82	9.20	

## OFFICIAL ASH.

	Lime.	Magnesia.
Washing precipitate .....	11.62	5.74
Not washing precipitate.....	11.95	5.78

In the case of ashes which contain a larger per cent. of phosphoric acid than that included in the limits of this paper, a small correction may be necessary for the volume occupied by the precipitate. On account of lack of time I will reserve the investigation of this subject for a future paper.

## THE EFFECT OF DI-IONIC ELECTROLYTES ON THE SOLUBILITY OF TRI-IONIC ELECTROLYTES WITH DIFFERENT IONS.<sup>1</sup>

BY ARTHUR A. NOYES AND EDWARD S. CHAPIN.

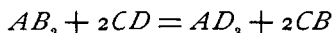
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### I. THE OBJECT OF THE INVESTIGATION.

THE theory of the effect of one di-ionic electrolyte upon the solubility of another with different ions has already been developed by Noyes<sup>2</sup>, and confirmed by our researches<sup>3</sup> and those of Noyes and Schwartz.<sup>4</sup> The solubility of tri-ionic electrolytes in the presence of other electrolytes with an ion in common has also been investigated.<sup>5</sup> The solubility of tri-ionic electrolytes in the presence of other electrolytes with different ions has, however, heretofore not been considered, except from a purely theoretical standpoint. The object of this article is to discuss theoretically a special case of this phase of solubility effect, and to communicate experiments, which confirm the theory. The special case chosen is the solubility of calcium hydroxide in the presence of ammonium chloride, in which case a weakly dissociated substance, ammonium hydroxide, is formed by metathesis.

### 2. THEORY OF THE SOLUBILITY EFFECT.

Consider a solution of any di-ionic electrolyte,  $CD$ , which is saturated with a tri-ionic electrolyte,  $AB_3$ . In accordance with the reaction



<sup>1</sup> Read at the Boston Meeting of the American Chemical Society, August 25, 1898.

<sup>2</sup> *Ztschr. phys. Chem.*, 27, 267.

<sup>3</sup> This JOURNAL, 20, 751.

<sup>4</sup> *Ibid.*, 20, 742.

<sup>5</sup> *Ztschr. phys. Chem.*, 9, 623; 26, 152.