NOTES.

Notes on the Paper by Hiltner and Thatcher.[1]—The method proposed in the paper is a modification of the Sachs-Le Docte modification of Pellet's "instantaneous aqueous diffusion method."[2] The device of weighing any convenient quantity of pulp and adding thereto the proper proportionate quantity of a mixture of water and lead acetate solution, first suggested by Walawski in 1894, has been practiced in this laboratory for the two seasons past. In 1899, or earlier, a special burette was obtained, the same being made to order for the purpose, after a drawing and description devised and wrought by Dr. G. L. Spencer.

The ideas contained in the paper that are new, other than those mentioned above, seem to be principally in regard to the allowance to be made for the liquid matter in the beet pulp, and the means of determining the amount of allowance to be made. It seems that the authors of the paper are in error:

First, because they base their corrections on the percentage of water in the beet, instead of on the percentage of liquid (juice) in the beet. The substances (sugar, etc.) dissolved in the water contained in the beet must necessarily increase the volume of that water as calculated from its weight at a given temperature. (See p. 309).

Second, because their determinations of water contained in beets, as reported on pages 308 and 309 are higher than is indicated by previous results of determinations of the amount of fiber contained in beets. For example, if in Table I we make the following additions, we obtain totals that are too high.

	Per cent.	Per cent.	Per cent.	Per cent.
Average water	84.64	83.05	82.10	81.25
Average sugar	9.00	11.00	13.00	14.00
Average non-sugar (calculated)	2.25	1.94	2.29	2.47
Total.....	95.89	95.99	97.39	97.72
Difference (marc).....	4.11	4.01	2.61	2.28

The non-sugar is here obtained by calculation from the percentage of sugar, assuming a purity coefficient of 80 in the first

[1] See this Journal, **23**, 299.

[2] See Spencer's "Handbook for Beet-Sugar Chemists," p. 151.

case and 85 in the other three cases. As little as 4 per cent. of marc is possible, but 2.61 per cent. is doubtful, and 2.28 per cent. still more so. Making the same calculations from data given in Table II, we obtain :

	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Average water	81.74	82.00	84.51	83.27	81.89	81.21
Average sugar	12.70	11.90	8.60	11.80	12.30	13.60
Average non-sugar	3.18	2.98	2.15	2.95	3.08	3.40
Total	97.62	96.88	95.26	98.02	97.27	98.21
Difference (marc)	2.38	3.12	4.74	1.98	2.73	1.79

The percentages of non-sugar given in this table are calculated, assuming a purity of 80 for the juices of the beets.

From the data obtained in these two tables, the authors conclude: "All of these figures indicate that for beets, most of which contain between 8 per cent. and 14 per cent. of sugar, 83 per cent. might be assumed as an average water factor without there being a variation in any individual case of more than 3 per cent."

In the case of pulp having 83 per cent. of water, 26.048 grams of it contain 21.62 grams of water measuring 21.62 Mohr's cc. at 17.5° C. Assuming a purity coefficient of 80, a beet containing 8 per cent. of sugar would contain 10 per cent. of soluble solids, while one containing 14 per cent. of sugar would contain 17.5 per cent. of soluble solids. If a solution be prepared for analysis by mixing 26.048 grams of pulp with 78.38 Mohr's cc. of water measured at 17.5° C., we would have in the two cases :

	Beets containing 8 per cent. sugar. Grams.	Beets containing 14 per cent. sugar. Grams.
Water in pulp	21.62	21.62
Soluble solids in pulp	2.6048	4.5584
Water added	78.38	78.38
Total	102.6048	104.5584
Percentage of soluble solids in the mixture	2.54	4.36
Specific gravity of the liquid in the mixture	1.00992	1.01714
Volume of the liquid in the mixture, Mohr's cc. at 17.5° C	101.60	102.80

Working by this method, therefore, the volume of the solution would be 1.6 to 2.8 per cent. too great under the conditions of these two examples. The soluble solids materially increase the volume of the solution.

The ordinary manner of arriving at the allowance to be made in analyses by this method is to assume an average juice content for the beets, and allow for the volume of the assumed quantity of juice of average density.

In the case of beets containing 95 per cent. of juice. 26.048 grams of pulp contain 24.7456 grams of juice, or 23.60 cc. when the juice is 12° Brix, and 22.84 cc. when the juice is 20° Brix.

In case of 90 per cent. juice, 26.048 grams of pulp contain 23.4432 grams of juice ; or 22.36 cc. and 21.64 cc. of liquid in the cases of 12° Brix and 20° Brix juice respectively. Assembling these data in the form of a table we have :

VOLUME OF JUICE CONTAINED IN 26.048 GRAMS OF PULP.

	12° Brix. cc.	20° Brix. cc.	Means. cc.
95 per cent. juice....	23.60	22.84	23.22
90 per cent. juice....	22.36	21.64	22.00
Means	22.98	22.24	22.61

A quantity of liquid of 16° Brix that measures 22.61 cc. at 17.5° C. weighs 24.0944 grams and contains 3.8550 grams of solids. 23.6 cc. of liquid, 12° Brix, weigh 24.7456 grams and contain 2.9694 grams of solids. 21.64 cc. of liquid, 20° Brix, weigh 23.4432 grams and contain 4.6886 grams of solids.

If 26.048 grams of beet pulp of the qualities just described be mixed at 17.5° C. with water equivalent to 100 cc., less the volume of liquid contained in the pulp, mixtures of the following compositions and properties will be obtained :

	Beets containing 95 per cent. of juice of 12° Brix. Grams.	Beets containing 90 per cent. of juice of 20° Brix. Grams.	Beets containing 92.5 per cent. of juice of 16° Brix. Grams.
Water contained in pulp.....	21.7762	18.7546	20.2394
Added water................	76.40	78.36	77.39
Soluble solids in pulp.......	2.9694	4.6886	3.8550
Total....	101.1456	101.8032	101.4844
Percentage of soluble solids in the mixture..............	2.94	4.61	3.80
Specific gravity of the liquid in the mixture............	1.0115	1.01814	1.01491
Volume of the liquid in the mixture, Mohr's cc. at 17.5° C...................	99.996	99.989	99.993

The quantities of water added in the first two cases, vary approximately 1 cc. from the last mean case. If we use 77 cc. in each case as directed by the Sachs-Le Docte method, irrespective of the quality of the beets, we have errors as follows in two extreme cases:

	Beets containing 95 per cent. of juice of 20° Brix. Grams.	Beets containing 90 per cent. of juice of 12° Brix. Grams.
Water contained in pulp	19.7965	20.6300
Water added (Sachs-Le Docte)	77.0000	77.0000
Soluble solids in pulp	4.9491	2.8132
Total	101.7456	100.4432
Percentage of soluble solids in the mixture	4.86	2.80
Specific gravity of the liquid in the mixture	1.01914	1.01094
Volume of liquid in the mixture in Mohr's cc. at 17.5° C	99.83	99.35

If we take the other two extremes, we have for

	Beets containing 95 per cent. of juice of 12° Brix. Grams.	Beets containing 90 per cent. of juice of 20° Brix. Grams.
Water contained in pulp	21.7762	18.7546
Water added (Sachs-Le-Docte)	77.0000	77.0000
Soluble solids in pulp	2.9694	4.6886
Total	101.7456	100.4432
Percentage of soluble solids in the mixture	2.92	4.67
Specific gravity of the liquid in the mixture	1.01142	1.01838
Volume of the liquid in the mixture in Mohr's cc. at 17.5° C	100.60	98.63

In these extreme cases the error varies from 0.17 cc. to 1.37 cc.; or rather, from 0.6 cc., too great a volume, to 1.37 cc., too small a volume. The increase of the volume of the water contained in the pulp, due to matter dissolved in it, is not appreciably lessened when the liquid is diluted to 100 cc. It therefore seems that the error attending the use of the Sachs-Le Docte allowance of 23 cc. for the liquid contained in the pulp will not be greater than that attending the method of Hiltner and Thatcher. This is especially true when 26.048 grams of pulp are mixed with 177 cc. of water instead of 77 cc.

In the case of beets that are both very rich and very dry because of their conditions of growth or storage, the proportion of water to be added to a given weight of pulp should undoubtedly be increased.

The balance mentioned on page 314 I believe to be the "Steinke Matador, Pracisionswaage ohne Benutzung von Gewichten." We have tried this balance in this laboratory for the purpose mentioned and have found it to be wholly inaccurate and useless for this purpose.

On page 309, the authors of the paper are led to make an unjust criticism of the method proposed by Walawski, because of a typographical error made by us in the translation of Sachs' paper. Walawski recommended the addition of a weight of water equal to 3 times the weight of the pulp and not 3.6 times the weight of the pulp as stated.

In the closing paragraphs of their paper, the authors describe an application of their method to the analysis of beet juices, which needs a word of comment.

They state that "A water factor of 85 per cent. was adopted." This implies that the beet juices were assumed to contain 15 per cent. of total solids, which corresponds to a specific gravity of 1.06133. 26.048 grams of juice of this density measure 24.54 Mohr's cc. at 17.5° C. At 30° C. the specific gravity would be somewhat less; the volume would be approximately 24.63 Mohr's cc. It is difficult to understand how the excellent comparative results would have been obtained by the authors of this paper by allowing only 22.14 cc. for the increase in the volume of the mixture due to the beet juice.

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DIVISION OF CHEMISTRY, U. S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.,
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