To illustrate that; if for instance the total production of a milling division up to January 12 should be 460,000 barrels instead of the expected 540,000 barrels production up to January 12, 1918, equals the magnitude of

$$FG^1 = \frac{460,000}{540,000} = 85 \text{ per cent. (Fig 2),}$$

which is the total actual production up to January 12 expressed in percentage of the total expected production up to *that date*. The other 15 per cent. are a *deficit* which can only be equalized through an *accelerated production rate* during the rest of the time which is available for production. Whereas:

$$\frac{460,000}{1,620,000} = 28.4 \text{ per cent.}$$

is the production of the milling division expressed in per cent. of *the total* production in barrels expected at the *expiration date* of the total time interval in question. Both instances are easily recognized in the diagram and read off on the right-hand scale. The left-hand scale in the diagram gives the *actual* number of barrels of flour *produced*. Through this graphical method all the different functions which are at work during the total production period are easily analyzed and are thus made available to the executive for rapid information and decision.

In the following one simple case of the design of such a diagram (Fig. 3) is given with the statistical data. Given:

Expected Uniform Average Weekly Production Rate: 270,000 barrels.

Time: 6 weeks.

Total Expected Production at the End of Sixth Week: 1,620,000 barrels.

ACTUAL PRODUCTION, PER WEEK ENDING

Actual Production During the Week Ending in Barrels		Cumulative Barrels
January 5	227,000	227,000
January 12....	233,000	460,000
January 19....	211,000	671,000
January 26....	237,000	908,000
February 2 ...	231,000	1,139,000
February 9 ...	246,000	1,385,000

The actual production line shows that the production during the entire period has been about 15 per cent. behind the expected output. Suppose, to show the universality of the diagram, production would have been according to the next table:

Actual Production During the Week Ending in Barrels		Cumulative Barrels
January 5	170,000	170,000
January 12....	430,000	600,000
January 19	No production. Strike	600,000
January 26....	430,000	1,030,000
February 2 ...	320,000	1,350,000
February 9 ...	200,000	1,550,000

If these facts are plotted (as shown by light dotted line) the diagram will give the following analysis: On *January 5* only 60 per cent. of the expected output was produced.

On *January 12* the production rate was above normal and therefore the intersection with the "above normal line" indicates that 10 per cent. more than expected was produced.

On *January 19* the mills were not in operation on account of labor trouble. The parallel line indicating no production.

On *January 26* again about 95 per cent. of the expected output up to date is produced.

In this way all actual production phases against time and requirements, expected deliveries or needs can be graphically analyzed.

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THE SPECIFIC CONDUCTIVITY OF WATER EXTRACTS OF WHEAT FLOUR[1]

THE attention of cereal chemists has long been attracted to the development of methods for determining the grade of flour and meals. As early as 1884 Girard[2] suggested a procedure for estimating the proportion of fibrous structures in a cubic millimeter of the material. Vidrödi[3] (1893) called attention to the close parallelism between the grade of Hungarian wheat flours and the percentage of ash which

[1] Published with the approval of the Director as Paper No. 123 Journal Series Minnesota Agricultural Experiment Station.

[2] Girard, A., *Ann. d. Chim. et de Phys.*, 6 ser., 3, 293, 1884.

[3] Vidrödi, *Ztschr. angew. Chem.*, 1893, 691.

they contained. Various other tests have been proposed for this purpose, and the most successful may be summarized as follows:

(*a*) The percentage of ash.

(*b*) The relative proportion of fiber and debris, as suggested by Girard[2] (1884), Buchwald[4] (1913), and others.

(*c*) The content of pentosans, as indicated by Koning and Mooj[5] (1914).

(*d*) The relative change in color resulting from the addition of water and subsequent exposure to the air, a procedure making use of this color change having been patented by Hein[6] (1910).

(*e*) The catalase activity, as developed by Wender and Lewin[7] (1904), Miller[8] (1909), and others, and discussed in a paper by the writer[9] (1918).

(*f*) The comparative color of the dry flour, particularly after compression on a slab, the procedure being commonly known as the Pekar test.

The percentage of acidity, and of the soluble proteins and carbohydrates ordinarily diminishes with increasing refinement and "grade" of wheat flour. There are many exceptions to this rule, however, due to unsoundness of the wheat, or decomposition of certain flour constituents subsequent to milling, which may result in increasing the percentage of one or all of these groups of substances. The ash content is apparently more generally employed for detecting the relative grade of wheat flour than any other tests mentioned, with the possible exception of color. The latter is objectionable as a test because of the difficulty of expressing the results numerically. While certain instruments have been suggested for this purpose their use is not common.

The almost universal use of the ash content in this connection suggested to the author that variations in these mineral constituents might be accompanied by corresponding variations in the electrical conductivity of water extracts of the flours. This could be postulated, if Swanson's (1912) suggestion that the principal inorganic elements of the ash, potassium and phosphorus are present in part in the water extract as potassium phosphate is correct. To ascertain whether or not such a relation existed, a series of flour samples was collected from a Minnesota flour mill, representing each of the flour streams. There were five break flours, three sizings flours, seven middlings flours, two tailings and three low-grade flours, in addition to the patent, clear, and red-dog flours marketed by the mill. These were employed in the conductivity studies because they afforded a progressive series from the standpoint of grade, with wide differences between the extremes. With the assistance of Miss Anna Peterson the effect of several variations in the technique and method were studied, and it was observed that the temperature at which the extraction was conducted was of greatest significance. The conductivity of extracts maintained at 40° during the period of extraction was materially greater than that extracted at 0°. With a certain flour these values for $\kappa \times 10^{-4}$ at 30° for extracts prepared at 40° and 0° were 4.82 and 6.00 respectively. The proportion of flour to water in the mixture during extraction was of importance, and a ratio of 1 part of flour to 10 parts of water was deemed most satisfactory. The treatment of the extract must be uniform and there was the least variation in the results when the extract was clarified by centrifuging for a few minutes, followed by filtration of the supernatant liquid. If the suspension of flour in water was placed in the conductivity cell without first filtering it, the conductivity gradually increased as the flour particles settled out of suspension. The period of extraction was of less significance than was anticipated, and 15 minutes' continuous shaking in a thermostat at the desired temperature

4 Buchwald, J., *Ztschr. ges. Getreidew,* 5, 50, 1913.

5 Koning, C. J., and Mooj, W. C., Jr., *Chem. Weekblad,* 11, 1064–66, 1914.

6 Hein, G., German Patent 250,413, November 13, 1910.

7 Wender, N., and Lewin, D., *Oester. Chem. Z.*, 7, 173–175, 1904.

8 Miller, M., *Ztschr. ges. Getreidew.*, 1, 194–200; 214–222; 238–244, 1909.

9 Bailey, C. H., *Jour. Biol. Chem.*, 32, 539–545,

yielded an extract of practically the same conductivity as 1 hour's extraction.

The method adopted in testing the series of flour samples was essentially as follows: 10 grams of flour were shaken up with 100 c.c. of carefully prepared conductivity water in a Jena glass flask, and the mixture maintained in an ice bath at 0° for one hour. During this time the flask was shaken vigorously every 10 minutes. The contents of the flask were then placed in a tube and whirled for about 5 minutes in a large centrifuge. The supernatant liquid was filtered, returning through the filter until clear, and clear filtrate placed at once in the conductivity cell. The latter was immersed in a water thermostat at 30° and brought to temperature. The conductivity was determined in the conventional manner, the usual and necessary precautions being taken to insure accurate results.

The series of conductivity measurements shown in the following table were made with the collaboration of Mr. E. H. Doherty. The samples have been classified by groups as they are known to the miller. If these are rearranged in order of their ash content it will be found that with the exception of one group, and a single member of another group, the conductivity parallels the ash content. The group which presents the exception is the break flours, four of the five having lower conductivity values than would be expected from their ash content. The large proportion of variation in this group of flours suggests the operation of some factor in the break flours which does not appear in the other flours. The only other variation from the otherwise uniform parallelism between the percentage of ash and conductivity of the water extract is found in the third low grade. The conductivity here is lower than would be computed from the ash content. The data at hand do not indicate the exact reason for these relatively small deviations.

The possible value of this test of flour grade is indicated by this preliminary investigation. The determinations can be made with ease and speed when the equipment is assembled, and the technique acquired. We propose to carry

SPECIFIC CONDUCTIVITY OF FLOUR EXTRACTS AT 30°

Grade of Flour	Conductivity $\kappa \times 10^{-4}$	Ash, Per Cent.
First break	6.15	0.41
Second break	5.69	.34
Third break	5.78	.34
Fourth break	6.83	.91
Fifth break	9.56	1.50
First sizings	5.25	.53
Second sizings	5.49	.58
Third sizings	6.91	.71
First middlings	4.61	.38
Second middlings	4.51	.39
Third middlings	4.50	.38
Fourth middlings	5.18	.44
Fifth middlings	5.25	.53
Sixth middlings	6.11	.62
Seventh middlings	6.30	.67
First tailings	7.71	.97
Second tailings	9.18	1.27
First low grade	6.72	.79
Second low grade	7.59	.93
Third low grade	7.53	1.07
Patent	5.21	.45
Clear	7.71	.90
Red dog	14.98	2.53

the study farther when research of this character can properly be resumed. In the interval it seemed advisable to present these findings, that they may be applied if the method proves to be as well suited to this purpose as appears at this time.

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THE NORTH CAROLINA ACADEMY OF SCIENCE

THE North Carolina Academy of Science held its seventeenth annual meeting at the State Normal College, Greensboro, on Friday and Saturday, April 26 and 27, 1918. The executive committee met at 2:10 P.M. on Friday and passed on the business matters of the academy. The reading of papers was begun at 2:45 P.M. and continued until 5 P.M., when adjournment was had. At night owing to the absence of President W. A. Withers, due to serious illness in his family, the presidential address on "Gossypol" had to be omitted. How-