cast the unanimous ballot of the Association for Mr. Grottman for three years.

On motion of Mr. Carswell the Secretary was instructed to cast the ballot for Mr. Cross as Director to succeed the President.

Adjourned until 9 A. M. next day.

FRIDAY MORNING SESSION.

President Aderhold in the chair.

January 6, 1905.

"THE ACIDIMETER AND ITS APPLICATION TO CHEESEMAKING."

Prof. W. J. Carson, Wisconsin Dairy School, Madison, Wis.

When we speak of acidimetry as applied to milk, whey or curd, we mean the process of determining the degree of sourness by means of a standard alkali solution. That an acid will neutralize a base and vice versa, is a well known law to our chemists, but it is only recently that this act of neutralization has been taken advantage of in the process of cheesemaking. Since lactic acid plays such an important part throughout the whole stage of cheesemaking, it has become extremely important that an accurate and speedy test for determining the acidity of milk, whey and curd at the time of setting, dipping, milling, and salting be adopted. With the introduction of the acidimeter a long felt want has been supplied, and I believe one of the most important changes brought about in the process of making since the introduction of cheddar cheese.

Until recently we have been making use of the rennet and hot iron test as a guide to the acidity of the milk and curd, but during the past summer and throughout the present dairy course the acidimeter has been in constant use in the cheese department of the Dairy School, and so far as I am aware this is the first that the acidimeter has been applied to Wisconsin cheesemaking.
Lactic acid is due to the presence of bacteria which act upon milk sugar, and approximately speaking, one part of milk sugar is broken down into four parts of lactic acid. As the acid is formed it enters into combination, chemically, with the paracasein of the milk forming what is known as paracasein monolactate, and the ability to form fine strings on hot iron is due to the presence of this latter compound. If the curd takes on too much acid a compound known as paracasein dilactate is formed, and as the secondary substance is less soluble it will not string on hot iron to the same extent as when the curd is working under normal conditions. Therefore the hot iron merely indicates the degree of chemical change that has taken place in the curd, but when we speak of measuring acid by inches, the expression is very misleading.

Nor is the rennet test any more accurate than hot iron. While comparing the use of the acidimeter and rennet test for setting the milk, I have noticed on several occasions that with the latter, the milk seemed to be "coming down" rapidly while the acidimeter showed no marked change. This was more noticeable in the case of milk working under abnormal conditions,—containing gassy fermentations for instance and when milk of this nature was set according to the rennet test, the whey invariably stayed on too long, the result being a corky or whey soaked curd, as well as causing a severe check to the development of acid.

The accompanying chart will show the manner of construction and the pieces of glassware required, for the acidimeter. Since any alkali is neutralized and consequently weakened in strength by CO₂, when exposed to the air, it has been found necessary to keep the bottle containing the alkali tightly corked. But in order to have the alkali syphon over into the burette, air pressure is necessary. Therefore a smaller bottle (4 oz.) is partly filled with a strong alkali through which the air passes causing CO₂ to be neutralized before it enters the larger bottle. Indicator is added to this smaller bottle, the purpose being to indicate when the alkali has become neutralized. A fresh solution should be added as soon as the contents of the bottle has become colorless. By opening the pinch cock attached to the piece of rubber tubing leading to the burette, the air passes through the smaller bottle, where it gives up its CO₂ into the larger bottle through the piece of glass tubing connecting the two, and by force of pressure the alkali is driven over into the burette.

The alkali is made up of such a strength that one ce. of the
solution will exactly neutralize .01 of a gram of lactic acid, and when 10 cc. of milk is used the percentage of acidity may be read directly from the burette by noting the number of cc. of the solution required to bring about a permanent change in color. This solution which is made from a definite weight of caustic soda or potash and distilled water should be 111/1000 in strength or 11/1000 stronger than a deci-normal solution. Alkali of the latter strength could be used but the operator would be required to have in mind a certain formula to enable him to arrive at the percentage of acidity which is as follows:

\[ \text{C. C. alkali} \times 0.009 \times 100. \]

There is practically no difference in the trouble of making one or the other solution, and as some of our makers are not adepts at figuring decimals the use of the former solution simplifies matters very much. If for example, 10 cc. of milk be used and 4 cc. of alkali are necessary to produce a permanent pink color the acidity of the milk would be .4 because 1 cc. of the alkali solution neutralizes .01 of a gram of lactic acid, therefore 4 cc. of alkali would represent .04 of a gram of acid. But this .04 of a gram is the amount in 10 cc. of milk. Therefore 1 cc. of milk would contain 10 times less or .004 and in order to get the percentage 100 cc. of milk would contain 100 times .004, which equal .4 acidity.

Phenolphthalein is the best indicator to use in testing the acidity of milk, but as carbonates interfere with the detection of the endpoint in neutralization when using phenol, every precaution should be taken to prevent the solution from absorbing carbolic acid gas. The indicator requires to be made accurately, and if the operator has been in the habit of using say three drops for each test he should aim to use about the same quantity each time. Any person can make the indicator with little care in weighing and measuring the proper proportions of its contents. It is made in the proportions of .2 of a gram of phenolphthalein (a cream colored powder) to 50 cc. of absolute alcohol and 50 cc. of distilled water. All of these can be obtained from the druggist, and twenty-five cents worth should be sufficient to do a full season, if carefully handled.

There are many strong points in favor of the use of the acidimeter and I have already mentioned the chance of error in setting milk with the rennet test. I have used the acidimeter for
the past three years and I have never yet been mistaken in my
calculation as to the time my curd should be dipped. Any prac-
tical cheesemaker knows that if he sets his milk expecting that
the whey will be ready to run in say three hours he should cook
accordingly and aim to have his curd firm in that time. But
if for some reason the acid does not come on he has to hold
that curd one or one-half hours longer, the result is detrimental
to the quality of the cheese as well as being very annoying to
the maker. Now this will not occur with the acidimeter pro-
viding the strength of his alkali is right and he has not made a
mistake in reading his burette.

The amount of acid on the milk at the time of setting should
be such that the curd will remain in the whey 2 3/4 to 3 hours.
From .19 to .21 acidity will usually give this result. As the
temperature of the milk has no effect upon the test when using
the acidimeter, it is not necessary to wait until the milk is heated
to a setting temperature before making a test for acidity. In
he spring of the year .19 of acidity will be found sufficient for
setting and .2 to .21 in the fall. The slight variation in the
amount of acid from season to season at the time of setting is
due to the acid condition of the casein. As the acidity of the
milk varies with the percentage of solids, the milk will usually
contain a higher acidity in the fall.

If a test of the whey be made after cutting the curd it will
be noticed that there is a smaller amount of acid than at the
time of setting, usually .11 to .12. This is due to the acid re-
action of the casein which is precipitated in the curd, and also
to the time that is in combination with the casein being liberated,
which has the power of neutralizing a portion of the acid salts
in the whey.

One of the strong points of the acidimeter is its usefulness
to determine the rate of cooking. If the first whey shows .11
acidity this indicates that acid will come on slowly and the
curd should be cooked accordingly, but if the whey shows .13
or .14 acid will develop rapidly and therefore the curd should
be cooked faster. Up to the time of the introduction of the
acidimeter we have had no guide as to the rate of cooking.

At the time of dipping the curd should show about .01 less
acid than at the time of setting. This is a pretty safe rule to
follow. But if the whey has been partly drawn down the per-
centage of acid should be about .01 more than had the milk
at the time of setting. After the curd has been piled the whey
should show about .28, but if it shows .30 or over the acid will
come on rapidly and the curd should be cut into finer pieces, but the high piling should not be attempted.

For milling, the drippings from the curd are taken. From .7 to .85 acidity is sufficient for milling. When curd is working under normal conditions it may be milled as soon as it contains .7 per cent acidity, but if the curd happens to be gassy or a firmer cheese is intended, a higher acidity is required.

Curd having good body and flavor may be salted when the whey running directly from the curd shows .1 per cent acidity. Gassy or weak bodied curds should have from 1.1 to 1.2 per cent acidity.

A great many makers are under the impression that salt when applied to the curd checks the development of acid. The following table is the average of a number tests which show that for some reason or other the acid from the drippings is less after salting than before, but it will also be seen that a much greater per cent acidity is contained in the cheese after being taken from the press than at the time of salting. The reason that the whey shows less acid after salting than before may be due to the fact that the whey is clear after salting, and therefore the turning point is much more easily detected.

\[
\begin{align*}
\text{Acidity of drippings at salting} & \quad 1.03 \\
\text{Acidity of drippings one-half hour after} & \quad .85 \\
\text{Acidity of drippings from the press} & \quad 1.04
\end{align*}
\]

Strictly speaking the work of the cheesemaker consists in making conditions favorable or unfavorable for the formation of lactic acid in the curd. Therefore with a reliable test in the hands of a skillful maker, which will show the exact amount of acid in the curd at any given time, should tend to bring about a uniformity in the quality of his cheese from day to day. Not only would there be uniformity in the individual maker’s cheese, but by all makers setting, dipping, milling and salting with the same percentage acidity we should then have a uniformity throughout the state. Uniformity in quality of our cheese is something we lack very much at present but I believe this is due to a large extent to the lack of uniformity in our system of making. The sooner we become familiar with and adopt the most improved methods of making, the sooner will we have that marked improvement in quality which we are all so anxious to obtain.

In summoning up the advantage of the acidimeter they may be given as follows:
The acidity of any can or vat of milk can be determined at any time as temperature, time, etc., have no influence on the test. There is less waste of milk and curd. By knowing the percentage of acidity of the curd it serves as a guide to cooking. There is less danger of acidy cheese. It brings about uniformity in quality. The main disadvantage will be to get a standard alkali solution.

DISCUSSION.

Mr. Moore: I would like to know why the Farrington alkali test could not be used as well.

Mr. Carson: Well, with the Farrington alkali test you understand that you have to make your solution every day.

Mr. Moore: Yes, but you avoid that weakening of the solution that is unavoidable with this liquid, do you not?

Mr. Carson: That is unavoidable with this liquid?

Mr. Moore: Yes, unless you have the apparatus that you have indicated there.

Mr. Carson: Well, with the Farrington apparatus, you have to have a burette just the same and you have to make up your alkali solution and it would not work, it would not be sufficiently accurate.

Mr. Moore: I think the Farrington book on testing says the alkali solution will not retain its strength more than one day, but one winter at the dairy school we had a student very carefully mix up a solution every day for a week, and we put up some of the milk and used some of the solution each day to see how much change there was, and we did not find any perceptible change, I think. Now, amongst the creameries we find the use of what we call the Motion test, or the acidimeter and the Farrington alkali test, and I know that amongst the creameries that we usually preferred the use of the Farrington test; the use of the Farrington alkali tablet to this solution, the solution gets weak from the action of the atmosphere, unless you have some such apparatus as this, and its delicate nature makes it apt to get broken, and I think at the weigh room that the Farrington alkali test used in the different systems would be much to be preferred and more quickly done than this test.

Mr. Carson: I cannot very well, see how you can apply the
Farrington alkali tablet to this, because Professor Farrington claims himself that this solution will not retain its strength, and in our experiments with the four year students this semester we have found that that has been the result of every one of the students. I mean when they are made up.

Mr. Moore: We did not find that to come out true.

Mr. Glover: I would like to ask if his is the tenth normal solution?

Mr. Carson: No, our solution is not tenth normal, it is 11/1000 stronger and by having it at that strength, we avoid the difficulty.

Mr. Moore: I would like to ask what pipette you use.

Mr. Carson: Ten cc. pipette.

Mr. Glover: I cannot see why the Farrington alkali, if above normal, made up of the same material, why that should deteriorate any more in strength than this, if kept under the same conditions. Why should the alkali in this tablet fail in this solution any more than in the other solution?

Mr. Carson: The instrument is so constructed that the air does not come in contact with the solution, the carbonic acid of the air is utilized before it passes in.

Mr. Glover: What objection do you have to making up the solution each morning, the Farrington?

Mr. Carson: We find when we make up the Farrington solution, it loses in strength very quickly.

Mr. Glover: I say, make it up every morning.

Mr. Carson: That is quite a work for the cheesemaker to make it up every morning.

Mr. Monrad: I was just going to answer Mr. Glover that the percentage of air will be so much greater if we make up a small quantity and have to measure off the water for the solution and also in the hurry of the work you are liable not to get in all the salt. I have used tablets and I prefer the solution prepared, and as to Mr. Moore saying that it is a costly and troublesome apparatus to use, my experience is not that. I have found that when I put it in in several creameries, that when we placed it on the shelf in the proper corner, there is no need of breaking them any more than your pipette and it is much handier than to make up the other.

Mr. Glover: I am not complaining about that in the least, but I have had some experience in finding that a great many of these solutions get weak, even if tightly corked, and when you begin to advocate the use of this system of testing the acid in
the cheese, it must be done with caution. Now, for instance, Professor Carson I think mentioned that when he put in this phenolphthalein or this indicator, as it is commonly called, and then added the alkali to this solution, or to the milk, it changed to a pink. Now, some makers will carry it a great deal farther. It is a little training they ought to have in the use of this before they could go and do it in the factories and use it; if you put in by mistake one centimeter more than others, the sample gets another color, they fail to note the right acid color, they should have a piece of paper with the right kind of color to bring that to each day so as to be a guide; it does not make any difference whether deep or light pink, but it must be the same each day in order to be intelligent. Then we should be very, very careful to know that our solution is correct, it is so very easy for it to become weak. I have found in creameries that if we are going to use it at all, we must use it with great care or it will not do us any good.

Mr. Berg: It seems to me that anybody that starts to use that test who is not in the habit of using it, ought to use both tests, or all three, the rennet test and also the hot iron test to compare, so that he knows where he is until he has learned to use this acid test, and I think that will overcome these defects.

The Chairman: That is a good suggestion.

Mr. Monrad: That is good advice, but I want to say to Mr. Glover that while it is perfectly true, there is always an element of difference in the eye and there may be color blindness. You know men sometimes cannot work on railroads on account of color blindness, but what I mean to say is, it will help in this way, that a comparison between my reading and Mr. Scott's reading will not be the same, but each of us will work in our factory and find out what to his eye is the right degree, but when we come to compare this cheese in different factories, then the element that Mr. Glover pointed out comes in, because unless we have all the same eyes, we will certainly not read the test exactly alike, but it is perfectly true also about the solution.—I want to emphasize what Mr. Glover says, that if you do adopt the test, you must be very careful and we must have that apparatus so as to prevent the air from coming in. We buy a gallon of solution,—as they use it in the factories, they would leave the cork out for hours and then they will go on and say, "Oh, pshaw, there is nothing in the test." So I think it is a timely warning; but, on the other hand, we must not condemn the test.
it is a great thing, I experimented with it a good many years ago and gave it up, because I could not make it correspond to the rennet test, but it is certainly the most reliable of the two, and when we have the authority of Professor Dean or Professor Carson and all these other instructors who say it is worth a great deal more than the cost, I will say that if we apply it with care I would cordially recommend the test to the Wisconsin cheesemakers.

Mr. Glover: I also recommend it, but I cannot help throwing out this caution, which I did, I have had so much experience in finding so many imperfect solutions. Now, let me make a suggestion to you—we have a Dairy and Food Commissioner in the state, and we also have a dairy school; now, I believe that it is practical and it is possible for either of these institutions to supply the cheesemakers with a standard solution. The Minnesota Dairy and Food departments are doing it, it will add one more duty to the department, and we hope to get them some money this winter and more men, and I believe it will be a good thing if the Dairy and Food Commission or dairy school would supply the cheesemakers of this state with a standard solution.

A Member: I got my formula from Professor Barr of Canada. I used the acidimeter about three months this summer and I calculate to have it put up in quart bottles and thereby I think I save a great deal of strength. Where you get it by the gallon, I think you are liable to lose strength. I think if we get the formula from some reliable person that has used it and get it in quart quantities, it will last that much longer.

Mr. Anderson: I had a little experience with this alkali test last summer, but I found when I made up a solution it gave trouble, it was not reliable at all, at the same time when I kept it corked, it lost its strength, the test did not come out right at all, and rather than to have the trouble to make a solution every morning, I went back to using the rennet test, but I see now, if we could have that solution as indicated we could find out at all times the strength of the alkali solution, and that we would know what we are doing, and I think it would be the best of the tests.

Mr. Carson: We have a number of cheesemakers here that are attending the dairy school, I would like to hear from them; they have been using it in the dairy school.

Mr. Rhodes: We have been using the acidimeter in connection with the rennet test and the hot iron, and we find that the
acidiméter is more accurate than either the hot iron or rennet test.

Mr. Maker: I would like to ask Mr. Carson what would be the cost of an apparatus like that?

Mr. Carson: It depends on where you buy it. If you go and buy it at one of the supply houses, the Creamery Package Company have it for sale now, they would charge about five dollars for it, but you can buy the ingredients, and the whole thing all together will not cost you more than $1.25 to $1.50.

Mr. Mason: I went to our druggist in our city and I had him put up one last summer, I think he charged me a little over $3, but we could not get the solution accurate enough so that I could make any use of it.

Mr. Luchsinger: I would like to ask Professor Carson whether this test or the Farrington test either are used at the dairy school in connection with the manufacture of any other than the cheddar or so-called American cheese.

Mr. Carson: No, but I am just putting one in use in the Swiss cheese department and I believe the time is coming when it will be used just the same in limburger and brick cheese as in American cheese making, because I believe the amount of acidity in the milk or whey has the same effect in foreign as in American cheese making.

THE MANUFACTURE OF DOMESTIC CHEESE.

Prof. John Michels, Madison, Wis.

Mr. President and Members of this Association: I felt complimented when asked by your worthy Secretary to address this intelligent and progressive body of cheesemakers upon the subject, The Manufacture of Domestic Cheese. It was with some reluctance, however, that I persuaded myself to accept his request, because a good many, no doubt, will look upon the manufacture of a rather soft, fast ripening cheese as an innovation scarcely to be tolerated in a state which has hitherto been such an exclusive manufacturer of the firmer kinds of cheese. This feeling was intensified when I recalled the time when my place was beside the cheese vat from one season’s end to the other,