Iowa State College
of Agriculture and Mechanic Arts
Official Publication

VOL. XIX JUNE 9, 1920 NO. 2

HUMIDITY MEASUREMENT AND CONTROL IN THE BAKERY

By C. H. BAILEY

BULLETIN NO. 45

ENGINEERING EXTENSION DEPARTMENT
AMES, IOWA

Published weekly by Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa. Entered as second-class matter, and accepted for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized September 23, 1918.

Humidity Measurement and Control in the Bakery

By C. H. Bailey*

When water is exposed in a dry atmosphere, it gradually evaporates, or changes from a liquid to a vapor. If this evaporation takes place in a closed space, the air in the space finally takes up all the water vapor that it can hold. We say that the air is saturated, or has a 100% humidity. Warm air will hold much more water vapor when saturated than will cool air. Thus air at 32° F. can hold only about one-sixth as much water vapor as the same volume of air at 90°. Relative humidity is the amount of water vapor in the air compared with the amount the air can hold when saturated, at the temperature in question, expressed as a percentage.

HOW HUMIDITY IS DETERMINED.

Humidity can be determined in a number of ways. One of the most accurate methods is by the use of wet and dry bulb thermometers. It is generally known that evaporation will occur more rapidly in a dry than in a moist air. It is also common knowledge that evaporation is a cooling process. If these two facts are joined in a single statement, we find that evaporation from a moist surface in a dry air will result in more cooling than when such a moist surface is exposed in a humid atmosphere. The relation is so exact that if we place a moist wick about the bulb of a thermometer and observe how much the latter is cooled by evaporation, the humidity of the air can be calculated.

In practice this measurement is best carried out by means of an instrument known as the sling psychrometer. This consists of two thermometers mounted in a metal frame which is provided with a handle so that the frame can be whirled. A round wick is slipped over the bulb of one thermometer and tied. This wick is then wet with clean, pure water, and the instrument is whirled until constant readings are obtained. Usually the first reading is taken after about a minute, and every half minute thereafter until the temperature of the wet bulb no longer changes. Care must, of course, be taken to keep the wick moist. When the readings become constant both thermometers are read, and the difference between the two is calculated. By consulting tables which are supplied, the humidity of the air can be ascertained. To illustrate, suppose the temperature of the dry

*Address delivered at the Third Bakers Short Course, Iowa State College, March 1-4, 1920.

bulb was 82° F., and that of the wet bulb was 77° F. The difference or depression of the wet bulb is 5°. On consulting the tables we find that a wet bulb depression of 5° in a temperature of 82° indicates a relatively humidity of 80%. That is, the air in this case is holding 80% of the water vapor which it could hold if saturated.

Another and somewhat more convenient instrument for measuring humidity is the hair hygrometer. In this instrument, a strand of long, carefully cleaned human hair is mounted in such a way that as it shrinks and stretches with increases and decreases in humidity, these changes in length are communicated to a needle which moves across the face of a dial. The latter is graduated in percentage of relative humidity, and the instrument is thus easy to read. It must be checked up occasionally by means of the wet and dry bulb instrument, and corrections made by means of the adjusting screw provided for the purpose.

HOW HUMIDITY IS RECORDED.

Recording instruments are made by placing a fountain pen arrangement on the needle of the hair hygrometer, and providing a clock-works to rotate a paper chart across which the pen moves. This draws a line on the chart which indicates the humidity at each instant of time. Usually the clock rotates the chart in one week, at the end of which time the used chart is removed and new one inserted. This gives a permanent record of the humidity at all times, in the space where such an instrument is placed.

There are two other methods sometimes used in determining humidity (a) the dew point method, in which the temperature at which a "dew" first appears on a polished surface is determined and from this the humidity can be calculated, and (b) the chemical method in which the water vapor in a known volume of air is absorbed and measured. These are not so generally employed as the wet and dry bulb, and the hair hygrometer methods.

SIGNIFICANCE OF HUMIDITY IN THE BAKERY.

There are least five locations in the modern bakery where humidity is of sufficient significance to justify attention. These are (1) the flour warehouse, (2) the dough room, (3) the proofing chamber, (4) the bread-oven, and (5) the cooling room for bread.

The flour warehouse must be dry, that is, have an atmosphere of low humidity, if flour is to be stored in it for any considerable time. It should also be light, and well ventilated. Under these circumstances flour may lose moisture, but this need not concern the baker; on the other hand, under such conditions of storage the flour will generally absorb more water in doughing than it loses as the flour ages.

In the dough room the humidity should be in the neighborhood of 80% to prevent crusting of the dough surfaces. When dough crusts it not only results in an undesirable physical condition which will give a streaky bread, but in these dry surfaces fermentation does not proceed normally. Hence we are apt to have an uneven fermentation in the mass of dough which will communicate itself to the loaf.

Proofing chambers should also be relatively humid, probably 75% to 80% at a temperature of 90-95°. Care must be taken here not to have the humidity too high, however, since water may condense on the cooler dough surfaces, particularly if the dough is cooler than it should be at the time of placing it in the proofing chamber.

In the bread oven humidity often determines the extent of spring or oven expansion which is secured. The humidity is raised to the proper point (a) by evaporation from the dough, and (b) by the introduction of water vapor in the form of low pressure steam. There are no satisfactory instruments for conveniently indicating oven humidity, and the baker's judgment must be employed. The "feel" of the air when the hand is momentarily inserted, and the way in which water vapor rolls out the peeling door and condenses just above it on the outside of the oven are indexes to the oven condition.

Finally, in cooling bread, some care should be given to bringing this about without too much drying or evaporation. In cold weather a wholesale bread bakery may find it profitable to raise the humidity of the air in the cooling room. This is especially true where bread is being cooled for wrapping or packing for shipment.

CONTROL OF HUMIDITY IN THE BAKERY.

In the summer the atmosphere is often sufficiently humid that no attention need be given to the humidity of the dough room. In cold weather, particularly in our northern latitudes, the outside air contains so little water vapor that more must be added by some means. When the dough room is small in proportion to the quantity of exposed dough, evaporation of water from the latter will raise the humidity considerably. Much the same thing results if a cloth or tight cover be placed over the troughs, when the relatively small quantity of air beneath the cover becomes saturated through evaporation from the dough.

Water may be exposed in pans or troughs, and the humidity increased considerably through evaporation from this source, particularly if the water is heated. There are devices on the market in which this principle is employed; these have the objectionable feature of heating the air in their vicinity, and care must be taken to provide some means of circulating the air, or the dough room will have an uneven temperature.

An elaborate system is sometimes installed which washes, humidifies, and warms the air which is admitted to the dough room. A water curtain is produced by a battery of spray nozzles, through which the air is drawn, the water being warmed if necessary by steam jets. The dirt and impurities washed from the air collect in the bottom of the air-washer and can be flushed out at intervals. The water not vaporized can be pumped back through the nozzles a second time. The washed and humidified air is drawn through a radiator where it is brought to the proper temperature, and here more water vapor can be added if necessary. In the hot summer weather the water spray serves to cool the air to a temperature below that of the outside atmosphere, and thus maintain the dough room at the same temperature, as well as humidity, the year round. From such an air conditioning device large galvanized iron ducts convey the air to the rooms where it is desired. Such rooms frequently have no direct connection with the outdoor air.

COST AND OPERATION.

Such an air-conditioner is obviously expensive, not only in first cost, but also in operation. Something simpler than this is necessary for the small dough room. There is a device on the market that is being used in a number of bakeries, which is relatively simple, and can be installed at a moderate cost. In it, water is fed by gravity in a small stream against the center of a rapidly revolving vertical disk, which, by centrigual force throws the water in a fine mist from the outer edge of the disk. A grid rim with a large number of fine teeth assists in breaking up the water sheet. Here it is caught by a strong current of air produced by a fan behind the disk, and projected forward into the air of the room. Only part of the water thus fed in is vaporized, the remainder dripping into a metallic basin whence it is piped to the drain. The normal supply of water is from 10 to 16 gallons of water per hour, and about 1/8 horse-power is required for operation.

CONTROL.

A section of ash wood cut across the grain is attached to a deflector in such a way that as the humidity of the air rises, the water is turned from the grid into the drain. In this way the action of the machine is reduced as the humidity reaches the desired point, which renders it more or less automatic in operation. It is claimed that one such device to each 10,000 cubic feet of air space is sufficient.

Since evaporation of water is a cooling process, it follows that the air laden with water vapor which is thrown out by this machine will be materially cooler than the air of the room and

will thus tend to cool it. In the winter months it may prove necessary to feed warmed water into the humidifier, while in the summer this cooling may be desirable.

In the proofing chamber the humidity is generally raised by introducing small jets of low pressure steam. Care must be taken in such instances to distribute these jets so uneven heating will not result. The humidity should be as high as possible without condensing on the dough, since under these circumstances the dough will warm through more readily.

HIGH PRESSURE VAPOR.

In the bake oven it is common practice to introduce steam at a pressure of 10 to 15 pounds for a short time just before introducing the dough, and sometimes for a few minutes thereafter. Mr. Beattie (Proceedings of the Short Course for Bakers, Dunwoody Industrial Institute, 1919) called attention to the increased cost of introducing a given quantity of vapor at a higher pressure, and stated further that the steam would shoot just as far into the oven at 10 pounds as at 15 pounds pressure. To pass in a given quantity of water vapor, a larger pipe and opening must be used with lower pressures. From discussion of this subject it appears the concensus of opinion that in a properly built oven steam need be introduced only at the front of the oven, whence it will distribute fairly evenly through the rest of the baking chamber.

Every baker must consciously or otherwise give attention to the item of humidity in the manufacturing of bread. Recognition of this as an important factor may aid in improving the quality and in securing that uniformity of product which is the ambition of every good baker.