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## The Baking Temperature of Bread

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## THE BAKING TEMPERATURE OF BREAD

O. B. READ

The purpose of this investigation is to study the temperature of a loaf of bread during the baking process.

In the study of fermentation and its application to the rising and baking of bread the questions arose; how high a temperature is attained inside the loaf, is the rise of temperature uniform, or are there points of rapid change. It was thought as the boiling temperature of alcohol was approached or passed some noticeable temperature change might occur. Also that as the crust on the bread was formed and became more rigid thus having a tendency to exert pressure on the inside of the loaf, a rise in temperature would be noted. It was also desired to determine as the condition known as "done" was reached whether or not a marked rise of temperature might occur.

In looking over the literature nothing was found concerning these points. Much was available concerning the oven temperature surrounding the loaf and only a few references as to the temperature of the crumb during the baking.

In order to determine whether there were such variations an attempt was made to record the temperature changes in the center of the loaf and near the surface. So far the major part of the trials have been recorded from home baked bread. A thermometer especially prepared by the Taylor Instrument Company for this type of work was used. It was inserted in the loaf at the time it was put in the oven so as to extend to the center of the loaf and yet be quickly and easily read without removal. Another thermometer was inserted just below the surface of the loaf. At intervals of a few minutes the oven was opened and the thermometers read. Another thermometer was used to take the oven temperature. The usual baking time was one hour.

A few of the results are given here in tabulated form. They show the temperature readings together with the time intervals. From this is calculated the change of temperature between readings and the average rate of change per minute during the intervals.

The average oven temperature was 173°C. In only one trial was the temperature of the loaf found to be above 100°C. Usually it was from 1° to 3° below the 100°C mark at the end of the bake.

For several minutes after the loaf was put in the oven the center thermometer showed but little change of temperature, it being that of the optimum rising temperature of the bread. When the oven temperature had had time to penetrate to the thermometer whether near the surface or at the center, the temperature rose rapidly with an increasing rate until it reached about the boiling point of alcohol when the rate rapidly decreased to about one fourth the maximum rate. From there on the rate of rise slowly and steadily decreased until the end of the bake period.

The reason assigned for the temperature of the loaf not going above 100°C is the rapid evaporation of water from its surface, due to the large heat of vaporization of water. As the heat of vaporization of alcohol is not so large as that of water and the quantity of alcohol is so small this seems hardly sufficient to cause the sudden drop in the rate of temperature rise noted near its

*Records from the Center Thermometer*

TEMPERATURE	TIME INTERVAL	VARIATIONS	VARIATION PER MINUTE
26.6° C.			
57.2	13. Min.	30.6°	2.3°
76.6	5.	19.4	3.8
90.5	5.	13.9	2.8
96.1	5.	5.6	1.1
96.6	15.	.5	.1
35.0° C.			
46.0	8.	11.	1.4
57.0	7.	11.	1.6
68.3	7.	11.3	1.6
76.7	2.	8.4	4.2
82.8	6.	6.1	1.0
90.	7.	7.2	1.0
94.	8.	4.	.5
100.	5.	6.	1.2
51.4° C.			
58.3	5.	6.9	1.3
71.1	5.	12.8	2.6
87.7	5.	16.6	3.1
93.	10.	5.3	.5
98.8	10.	4.8	.4
40. ° C.			
62.8	12.	22.8	1.9
87.7	5.	24.9	4.9
96.1	23.	8.4	.4
97.2	10.	1.1	.1
26.6° C.			
27.2	15.	.6	.05
35.	5.	7.8	1.5
48.9	5.	13.9	2.8
56.1	5.	7.2	1.4
65.5	5.	9.4	1.8
76.6	5.	11.1	2.2
85.5	5.	8.9	1.8
94.	5.	8.5	1.7
98.8	5.	4.8	.9

*Records from the Surface Thermometer*

TEMPERATURE	TIME INTERVAL	VARIATIONS	VARIATION PER MINUTE
65. ° C.			
93.	13.	28.	2.1
97.	5.	4.	.8
98.	5.	1.	.2
99.	5.	1.	.2
99.	15.	0.	0
70. ° C.			
82.	8.	12.	1.5
85.	7.	3.	.4
87.	7.	2.	.3
92.	8.	5.	.6
95.	7.	3.	.4
96.	13.	1.	.08
30. ° C.			
40.	5.	10.	2.
53.	5.	13.	2.6
78.	5.	25.	5.
80.	5.	2.	.4
86.	5.	6.	1.2
88.	5.	2.	.4
91.	5.	3.	.6
95.	5.	4.	.8
98.	10.	3.	.3
99.	5.	1.	.2

boiling point. Experiments show that moist starch grains begin to disintegrate at about 75°C and nearly all are broken up by the time the temperature reaches 90°C. As this noticeable temperature change occurs at about the temperature of the maximum rate of starch disintegration it is more likely that the change is due in some way to the cooking of the starch rather than due to the alcohol vaporization. Owing to the fact that the specific heat of water and carbon dioxide are quite constant from 0°C to 100°C neither of them could be responsible for this change.

Further investigation would be necessary to determine whether the heat conductivity of moist raw starch and cooked starch might influence this variation of temperature change.

The rigidity of the crust does not occur until near the end of the bake when the outer surface of the bread is approaching the caramelization temperature of starch which is about 200°C. This apparently has no effect on the interior temperature of the bread.

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