The Influence of Mill Fumigants on the Baking Quality of Flour

Review of Tests Conducted with Carbon Bi-Sulphide, Hydrocyanic Gas and Sulphur to Ascertain their Effect on the Flour

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From time to time the influence of mill fumigants on the quality of flour comes up for discussion. Sulphur dioxide, carbon bi-sulphide and hydrocyanic gas have been recommended as good fumigant materials. More recently high temperature has been used successfully. In the present article we shall confine the discussion to the results of baking tests of flour treated with the three mill fumigants named, and in our next, deal with the influence of the high temperature treatment.

Results of Fumigant Tests.

A few years ago we treated some wheat and flour with carbon bi-sulphide to destroy the grain weavil, and, while it is quite probable that the material was used in larger quantities than would be the case in fumigating a mill, it is true that both the wheat and flour were so badly affected that they were utterly useless for break-making purposes, even after they were exposed to the air for some months. This experiment led us to carry out some experiments with carbon bi-sulphide and other mill fumigating materials.

In these experiments three samples of five pounds each of an 85 per cent Manitoba flour were treated in a confined space with carbon bi-sulphide, hydrocyanic acid gas, and sulphur. The quantity used in each case was approximately the same as would be used per cubic foot in fumigating a mill. It was fully expected that the sulphur would be very injurious in its effects, but for the sake of comparison it was included in the tests. The flour was left in contact with the gases for twenty-four hours. After exposing to the air for another twenty-four hours, it was baked according to the method used in all our flour testing work. In this work we use 12 ounces of flour for each loaf of bread, and the dough is made with water in which the yeast, salt and a small amount of sugar is placed.

The hydrocyanic acid treated flour rose well and handled in every way similar to the normal flour. The carbon bi-sulphide and sulphur treated samples did not rise well, and this was especially true of the sulphur treated sample. Great difficulty was experienced in making dough from the latter, as it was very sticky and fluid-like. In the early part of November, two months from the time of the fumigation of the flour, a second baking was made of the samples, and two and a half months later, that is, towards the end of February, a third baking was made. The results of these baking trials are recorded in the following table. The yield of bread is given in grams, and the size of loaf in cubic centimeters. The colour, texture, and general appearance of the bread was scored in percentage of the normal sample, which was marked at 100.

TABLE I.

85 p.c. Manitoba Hard Flour.

Flour.	Gluten.	Absorption.	Yield of Bread.	Size of Loaf.	Colour.	Texture.	Appearance.
			Baked Sept. 24th.				
Normal	36.43	61.8	500	2660	100.	100.	100.
Sulphur	x....	60.6	500	1730	poor	poor	not good.
Hydrocyanic acid	36.00	61.8	500	2670	99.5	98.	100.
Carbon bi-sulphide	36.90	61.1	510	1650	90.0	poor	not good.
			Second Test, Nov. 8th.				
Normal	36.43	63.5	512	2670	100.	100.	100.
Sulphur	x....	55.9	476	1850	poor	25.	poor.
Hydrocyanic acid	36.20	63.5	501	2700	101.	101.	103.
Carbon bi-sulphide	36.67	63.5	503	2290	90.	30.	75.
			Third Test, Feb. 23rd.				
Normal	36.43	67.7	501	2490	100.	100.	100.
Sulphur	x....	54.7	485	1920	95.	40.	50.
Carbon bi-sulphide	36.67	63.5	520	2170	96.	50.	75.

xFlour so soft and stringy it could not be washed.

The bread made in the first baking from the hydrocyanic acid treated flour was equal in volume, but the colour and texture was not quite so good as that from the normal flour. The bread from the sulphur treated flour was so poor that it was thought best to mark it "poor" than to try to express the difference by figures.

The figures showing the results of the second baking indicate that the gases have passed off from the flour, and that it is improving. The flour treated with hydrocyanic acid, however, gave better results than the normal.

This work was repeated with very similar results. The experiment was also repeated with an Ontario winter wheat flour. The results form table No. II.

TABLE II.

Straight Grade Ontario Flour.

Flour.	Gluten.	Absorption.	Yield of Bread.	Size of Loaf.	Colour.	Texture.	Appearance.
			Baked Sept. 27th.				
Normal	30.10	47.3	476	1620	....	....	....
Sulphur	x....	41.4	467	920	....	....	....
Hydrocyanic acid	30.07	47.3	474	1610	....	....	....
Carbon bi-sulphide	29.33	47.1	477	1400	....	....	....
			Second Test, Baked Nov. 8th.				
Normal	30.10	47.6	478	1620	100.	100.	100.
Sulphur	x....	47.6	481	1220	....	....	....
Hydrocyanic acid	30.07	47.6	471	1720	100.	99.	101.
Carbon bi-sulphide	29.33	47.6	479	1430	98.	90.	95.
			Third Test, Baked Feb. 24th.				
Normal	30.10	50.0	481	8120	100.	100.	100.
Sulphur	x....	42.9	452	1330		sickly white.	
Carbon bi-sulphide	29.33	48.8	473	1720	100.	90.	99.

xFlour so soft and stringy it could not be washed.

It is evident that the hydrocyanic acid treatment did not in any way destroy the bread, in fact, in some cases it would almost seem to have improved the flour; whereas, the carbon bi-sulphide and sulphur treatment did injure the flour. The loaves were smaller, darker in colour, poorer in texture and in general appearance, in fact, they were so poor in these respects that it was practically impossible to make any comparison with the other breads. The results indicate that the injurious effects of the carbon bi-sulphide were leaving the flour, as there was improvement in the quality of the loaf of the second and third bakings. The flour worked normally in the mixing and during first rising, but was lifeless in the later stages, and would not spring in the oven. The sulphur treated flour and a half months it was still an unsaleable flour anda half months it was still an unsaleable flour for breadmaking purposes. As it was evident that the hydrocyanic acid had not injuriously affected the flour, it was decided not to include this flour in further tests. In the case of the soft winter wheat flour, the treatment with sulphur and carbon bi-sulphide was even more injurious, while hydrocyanic acid had no injurious results.

To further study the effects of the various fumigants upon the flour we determined total proteids, gliadin, or alcohol soluble proteids, and water soluble proteids. The results are as follows:

	Total Proteids %	Gliodin or Alcohol sol. Proteids %	Wat'r Sol'ble Proteids %
85 p.c. Manitoba Hard Flour:			
Normal flour	12.0101	6.5762	1.7123
Sulphur Treated flour	11.9677	6.7277	2.7871
Carbon bi-sulphite treated flour	12.0348	6.4949	1.7860
Hydrocyanic acid gas treated flour	12.0086	6.5612	1.6665
Straight Grade Soft Flour:—			
Normal flour	9.0893	4.6624	1.5314
Sulphur Treated flour	8.9645	5.2156	4.4544
Hydrocyanic acid gas treated flour	8.9957	4.9112	1.5096

From the above figures it is evident that the hydrocyanic acid and carbon bi-sulphide treatment did not materially affect the proportionate quantity of the proteids soluble in alcohol, or water, but in both the hard and soft flour the sulphur treatment did increase the amount of water soluble proteids very materially. This is especially true of the soft flour, and doubtless accounts for the soft sticky gluten and the very poor results got in our baking trials with soft flours. The water soluble proteids were also increased slightly by the carbon bi-sulphide treatment, both in the hard and soft flours, but more particularly in the latter.

We also studied the effect of the fumigants on the bacteriological life of the flour, but found practically no reduction in the germ life of the hydrocyanic treated flour, a slight reduction with the carbon bi-sulphide, and a great reduction in the sulphur treated flour.

The acidity of the flours was also influenced, more particularly, as would be expected, by the sulphur fumes, and possibly it is this factor, together with its effects on the gluten, which most seriously injures the sulphur treated flour.

From the above results, it is very evident that carbon bi-sulphide would be very much more injurious to flour than hydrocyanic acid. The results were not continued long enough to ascertain how long the carbon bi-sulphide treated flour would be in getting back to normal condition, but the experiment was discontinued because it was felt that if

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