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## Disintegration of green Missouri fire clay bodies at low temperatures

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## Disintegration of Green Missouri Fire Clay Bodies At Low Temperatures.

### Object:

Several years ago in the Ceramics Lab. of the Missouri School of Mines some A. P. Green Ozark Clay test pieces were left in a drier for a period of about seven months at a constant temperature of 110°C. At the end of this period it was noticed that these specimens had disintegrated and crumpled down to a powdered mass.

The object of this experiment was to repeat the former test and see if the clay would disintegrate and if so why. We also wished to find if by drying at higher temperatures for a shorter length of time would these specimens disintegrate.

There was no literature of this subject or any subject which closely related this one.

### Materials And Apparatus:

This test was run on A.P. Green Ozark Plastic Fire Clay. The same test was made of A.P. Green Empire Flint Fire Clay, # 9 Tenn. Ball Clay, and North Carolina Kaolin So that a comparison of their results could be made against the results of the Ozark Clay.

The test bars which were to be dried at a constant temperature of 110°C for several months were dried in a low temperature electric drier. Those to be dried at 200°C and above were dried in a Hoskins Electric Furnace (110 volts--18.1 Amps.).

The latter furnace could not be held at a constant temp. lower than 400C. In order to be able to dry bars at 200C. and 300C. a resistance had to be added in order to cut down the current entering the furnace. This was accomplished by connecting a Carbon-Arc Resistor (24 Amps.) in series with the variable rheostat on the furnace. With this apparatus the heat entering the furnace could be accurately controlled to a furnace temp. of as low as 200C.

The dried bars were broken on a hand made modulus of rupture machine.

#### PROCEDURE:

The clays were ground to a fineness of thru 8 on 20 mesh. They were mixed with water to a stiff mud consistency having the following water of plasticities: Ozark - 17.4; Ball Clay - 15.5; Empire - 19.3%; and Kaolin 16.3%. Each batch was pugged thoroughly so as to evenly distribute the water through out the mass. The test bars were formed into 6 in. bars in a brass bar mold. After the bars were formed they were placed on pallet boards and left to thoroughly air dry.

One set of these bars was placed in the low temp. drier and left to dry from 1 to 69 days at 110C. Bars were drawn at 1 day, 49 days, and 69 and their modulus of rupture taken. The second set was placed in the Hoskins furnace and the temperature slowly brought up to 200C and held for three hours; then brought up to 300C and held for three hours; then brought up to 400C and held for three hours; and finally brought up to 500C and held for three hours. After each constant drying of 200, 300, 400, and 500C four bars were drawn out, cooled in a desiccator, and broken on the hand made modulus of rupture machine. All data was recorded.

Temperature readings on Ozark specimen dried at IIOC  
from I to 69 days.

Month----Day----Reading

Feb.	7	IIOC
"	II	"
"	I4	"
"	I8	"
"	2I	III
"	25	"
"	28	II4
March	4	II3
"	7	I23
"	II	II3
"	I4	"
"	I8	II0
"	2I	"
"	25	"
"	28	"
April	I	"
"	4	"
"	8	"
"	II	"
"	I5	"
"	I7	"

Temperature rise in drying Empire, Ball Clay, and Kaolin specimen.

Note: Readings were taken in degrees centigrade and  
at exactly 15 minute intervals.

<u>Reading No.</u>	<u>Reading</u>	<u>Reading No.</u>	<u>Reading</u>	<u>Reading No.</u>	<u>Reading</u>
1	32	23	191	66	487
2	58	24	187	67	496
3	85	25	197	68	499
4	108	26	219	69-81	500
5	130	27	240		
6	150	28	281		
7	171	29	296		
8	183	30	301		
9	189	<del>30-41</del>	304		
10	195	42	297		
11	200	43	286		
12	200	44	319		
13	201	45	367		
14	201	46	387		
15	201	47	394		
16	201	48	397		
17	201	49-61	400		
18	201	62	395		
19	201	63	390		
20	201	64	431		
21-22	201	65	467		

Temperature rise in drying Ozark specimen.

Note: Readings were taken in degrees centigrade  
and at exactly 15 minute intervals.

<u>Reading No.</u>	<u>Reading</u>	<u>Reading No.</u>	<u>Reading</u>	<u>Reading No.</u>	<u>Reading</u>
1	85	27	205	67	472
2	111	28	203	68	481
3	128	29	238	69	498
4	146	30	278	70	500
5	167	31	288	71-72	500
6	178	32	298		
7	183	33	303		
8	187	34	305		
9	194	35	303		
10	202	36-44	301		
11	210	45	295		
12	219	46	290		
13	219	47	323		
14	220	48	379		
15	222	49	409		
16	222	50	428		
17	222	51	433		
18	222	52-63	435		
19	222	64	420		
20	222	65	417		
21-26	222	66	453		

Ozark Plastic Fire Clay

Mod. of Rup. on Ozark bars dried at 110C for specified no. of days.

<u>Spec. No.</u>	<u>1 day</u>	<u>23 days</u>	<u>49 days</u>	<u>69 days</u>
I	576	690	788	792
2	594	712	750	798
3	620	600	675	815
4	550	563	750	805
5	550			
Average:	574	591	741	802

Mod. of Rup. of Ozark Bars of special dryings of 200C, 300C, 400C, 500C. for three hours each.

<u>Spec no.</u>	<u>222C</u>	<u>301C</u>	<u>435C</u>	<u>500C</u>
I	<del>525</del>	300	450	413
2	600	300	450	487
3	503	285	420	525
4	510	307	510	525
5			427	
Average:	528	298	451	487

Empire Flint Fire Clay

Mod. of Rup. on dried test bars dried at constant temperatures.

<u>Spec no.</u>	<u>110C</u>	<u>201C</u>	<u>300C</u>	<u>400C</u>	<u>500C</u>
I	112	30	41	44	45
2	120	35	38	36	46
3	118	39	46	39	41
Av:	117	35	41	40	44

79 Tenn. Ball Clay

Modulus of Rupture on dried test bars dried at constant temp.

<u>Specimen No.</u>	<u>110C 24 hr</u>	<u>201C 3 hr</u>	<u>304C 3 hr</u>	<u>400C 3hr</u>	<u>500C 3 hr</u>
1	257	25	31	34	33
2	269	29	29	30	35
3	273	30	34	28	36
Average:	266	28	31	31	35

North Carolina Kaolin

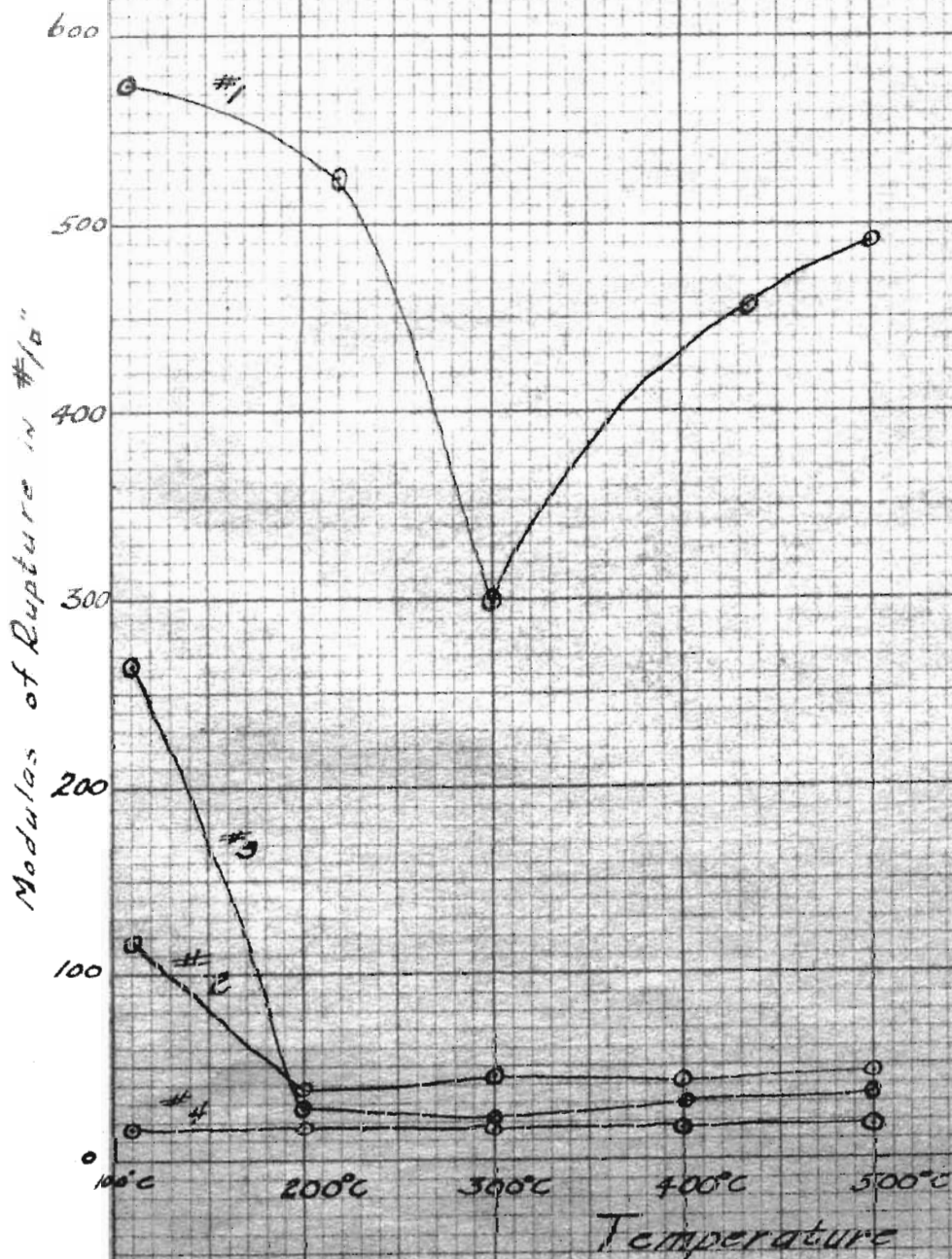
Modulus of Rupture on dried test bars dried at constant temp.

<u>Specimen No.</u>	<u>110C 24 hr</u>	<u>201C 3 hr</u>	<u>304C 3 hr</u>	<u>400C 3 hr</u>	<u>500C 3 hr</u>
1	18	19	22	21	23
2	16	20	18	20	17
3	17	17	19	18	16
Average:	17	18	19	19	18



Curves:

- \*1 - Ozark Plastic Fire Clay
- \*2 - Empire Flint
- \*3 - "9 Tenn. Ball Clay
- \*4 - North Carolina Kaolin



Specimen put in drier and left all  
semester at constant temp of 110°C.

Modulus of Rupture in  $\frac{\text{psi}}{10}$

800

700

600

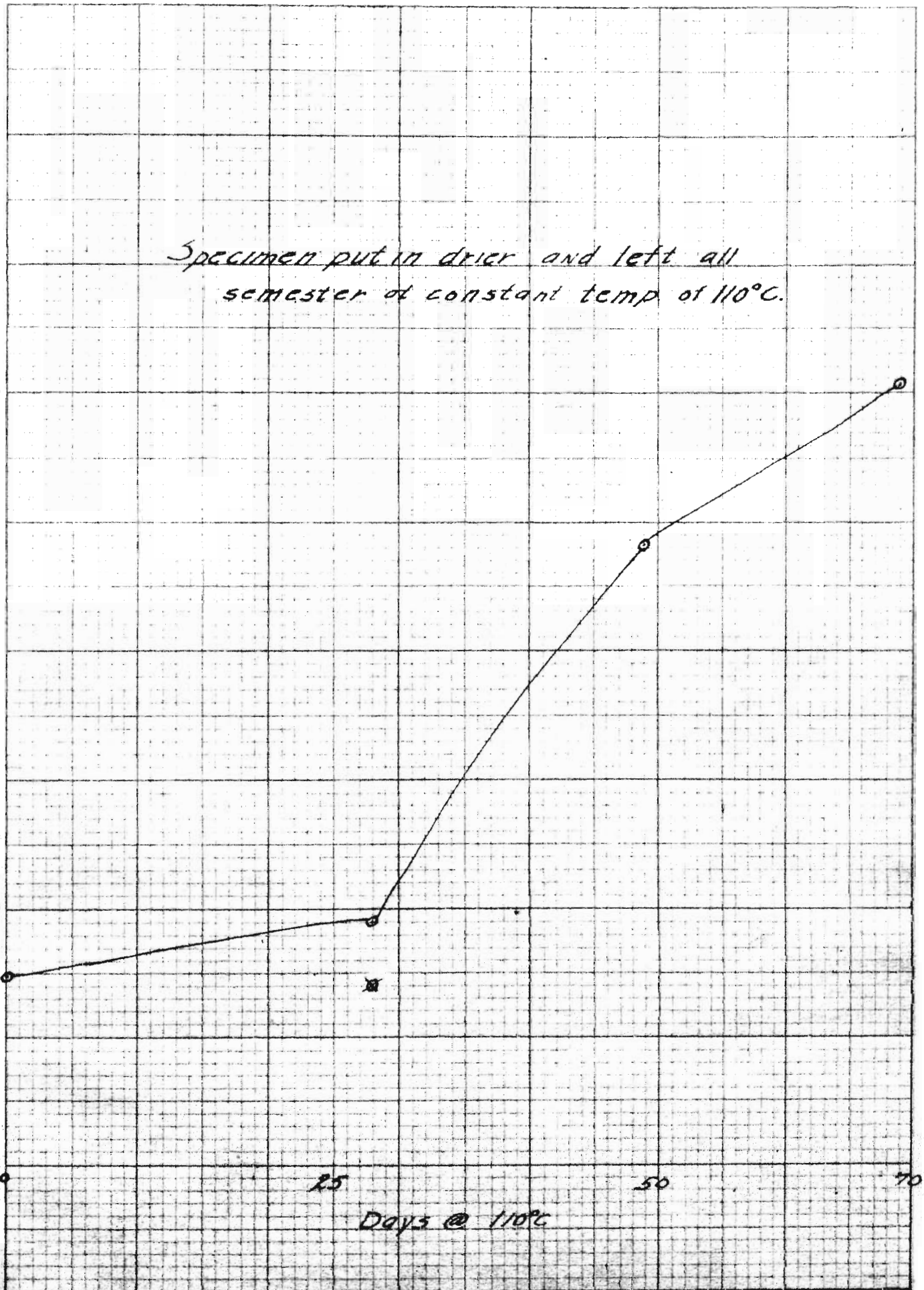
500

25

50

75

Days @ 110°C



### Discussion and Conclusion:

The Ozark Clay used in this experiment was undoubtedly different in some respect to that used in the experiment several years ago. We did find, however, that Ozark has a very unique quality as compared to other clays. In other clays, such as Empire, Tenn. Ball, and North Carolina, there is no physical breakdown upto 500C. In Ozark we see that there is a physical breakdown at 300C. If in an industrial operation this condition were incountered for any length of time, the brick would probably be very badly kiln marked.

Nearly all clays contain some kaolinite which decomposes at about from 480C to 650C. It is very possible that Ozark contains some other subatance as pyrophyllite which decomposes at a much lower temperature. There is also a possibility that it contains pyrite which oxidizes and forms acids that would tend to break down the bond between the grains.

This experiment showed that by drying Ozark bars at 110C for a long time that they increased in mechanical strength. This does not seem very possible and these results were probably due to some experimental error.