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**CANADA**

**DEPARTMENT OF MINES AND TECHNICAL SURVEYS**

**OTTAWA**

**MINES BRANCH INVESTIGATION REPORT IR 60-121**

**MEASUREMENT OF KILN CONTACT TIME  
AT FREEMAN CORPORATION,  
CAP DE LA MADELEINE, P. Q.,  
NOVEMBER 18, 1960**

by

**G. G. EICHHOLZ**

**MINERAL SCIENCES DIVISION**

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MEASUREMENT OF KILN CONTACT TIME AT FREEMAN  
CORPORATION, CAP DE LA MADELEINE, P.Q.,  
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G.G. Eichholz<sup>\*</sup>

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SUMMARY OF RESULTS

The contact time of the rotary kiln, used for roasting ilmenite ore by the concurrent process, has been measured anew under changed conditions of operation. Silver-110 was used as the radioactive tracer and a complex contact time pattern was determined for kiln operation on November 18, 1960. In this test more rapid rotation of the kiln than that used in the tests of January 28, 1960 resulted in some dispersion of the active charge, which could be followed by observation outside the kiln wall. The main peak indicated a normal residence time of 5 1/3 hours in the kiln, but so much material appeared ahead of the main peak that the mean effective residence time was just over four hours. No explanation is offered for the considerable short-circuiting in the kiln, which was observed.

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## INTRODUCTION

In January of this year the contact time of the rotary kiln at the Freeman Corporation at Cap de la Madeleine, P.Q. had been determined during tests on the roasting of ilmenite ore conducted by Quebec Iron and Titanium Corporation (Q.I.T.) (see Report IR 60-12). Since then conditions of operation have been varied somewhat and the cooperation of the Mines Branch staff for further measurements of this type had been requested. One attempt at measuring contact times during test runs at the end of May had to be abandoned because of difficulties in kiln operation. Another run proved more satisfactory and at the request of Mr. B. Bernard of Q.I.T. the writer, accompanied by Mr. J.V. Krzyzewski, went to Cap de la Madeleine on November 17-18 to determine the effective contact time.

## TEST PROCEDURE

The method of measuring the kiln residence time duplicated closely that employed in the previous test. Fifteen millicuries of silver were used as the active source. This material had been dissolved in nitric acid solution in Ottawa and made up to 100 ml. Samples were assayed under the Geiger counter probe of an EA-135SP portable survey meter. The Geiger probe was supported by some perforated bricks and shielded by an improvised castle built up of a pile of bags of ore. The sample container was a copper pan,

the bottom part of a Tyler screen set. It was found to hold about 8 lb of the "coarse" fraction of the charge or about 6 lb of the "fine" fraction. A SUIH survey meter was used to check dosage levels and a portable scintillometer was available to follow the movement of the active charge in the kiln. Film badges were issued to the men bagging the kiln products. The kiln is shown diagrammatically in Figure 1.

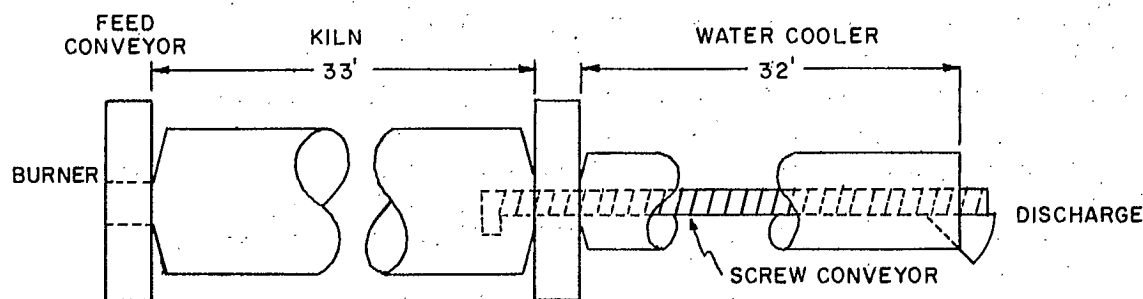


Figure 1. - Diagram of Kiln

The kiln is 33 ft long, oil fired. It is followed by a cooler in which the charge is moved by means of a screw conveyor, which has a total length of 38 ft 4" and protrudes into the kiln. The kiln is charged by means of a bucket conveyor and the feed-end temperature was held at 1200°C, considerably higher than in the January tests. The charge rate used was 500 lb Allard Lake ilmenite ore, about  $\frac{1}{2}$ " in size, mixed with 300 lb anthracite fines, per hour.

The kiln rotated at a speed of 1.3 rpm (1 rev. in 45 seconds), double that of the January test. The cooler rotated at a speed

of 2.22 rpm. The bed depth was estimated as 10-12 inches and the estimated contact time was 5-7 hours. The product was screened in a perforated drum at the discharge end of the cooler, so that two products were obtained, a "coarse" and a "fine" fraction. The coarse fraction amounted only to about 150 lb/hr, leaving a larger quantity of "fine" samples. Both fractions were collected and bagged. Samples for counting were taken from the top of each bag; as the times recorded were those of completion of filling of each bag, this introduces a slight, though unimportant uncertainty in the sample time for the coarse fraction.

The radioactive feed material was prepared by mixing the active solution carefully and in stages with about seven pounds of the ore. A small portion of the active solution was also used to tag a separate sample of the anthracite. The radioactively labeled charge was introduced into the feeder hopper at 9:40 a.m. A small fraction of the active charge dropped below the bucket elevator where it was still detectable several hours later; however, most of that activity had disappeared by dilution by late evening. The main active charge was located from time to time from the outside of the kiln by means of the scintillation counter. It was found to enter the kiln quite rapidly and travelled about 3 feet in the first twenty minutes. The rate of travel then decreased, reaching a figure of about 4.5 ft/hr. At the same time the activity was observed to spread out gradually from a very narrow zone at first to a zone several feet long after a

few hours. By noon the active charge passed the centre of the kiln; by 2:50 p.m. it was observed to leave the kiln and to enter the feed screw of the cooler. In the cooler it spread out further, passing the mid-point around 4:05 p.m. and leaving the discharge end from 5:0 to 5:20 p.m.

The samples were counted at 15-20 minute intervals. The results are plotted in Figure 2 for the coarse fraction and in Figure 3 for the fine fraction. The difference from the January results is very striking. Instead of the very sharp peak then observed, a fairly sharp peak has been obtained this time, which is preceded by a very steady rise in activity. Some strong activity was observed very early, especially in the fine fraction. Unfortunately the earliest fine samples were not retained for counting, thus early activity was ascribed to fine dust being blown over the bed by the kiln draft. Magnetic separation of samples around 12 o'clock showed a proportionately greater activity in the non-magnetic, coal fraction, but the rate of magnetic to non-magnetic activity remained steady and there was insufficient evidence to indicate that much of the coal may have ridden over the top of the ore.

Sampling and counting were stopped at 10 p.m. The most active material was segregated and six small drums were taken back to Ottawa, for further disposal at Chalk River. The dosage level on contact was around 1 mr/hr. The kiln area was checked for possible contamination. The remaining slightly active ore will be used at the Q.I.T. plant, where it will be greatly diluted with inactive ore.

18/11/60

cpm

FIG.2-FREEMAN TEST NO.2

COARSE FRACTION

3000

2000

TOTAL ACTIVITY

1000

0

FEED  
TIME

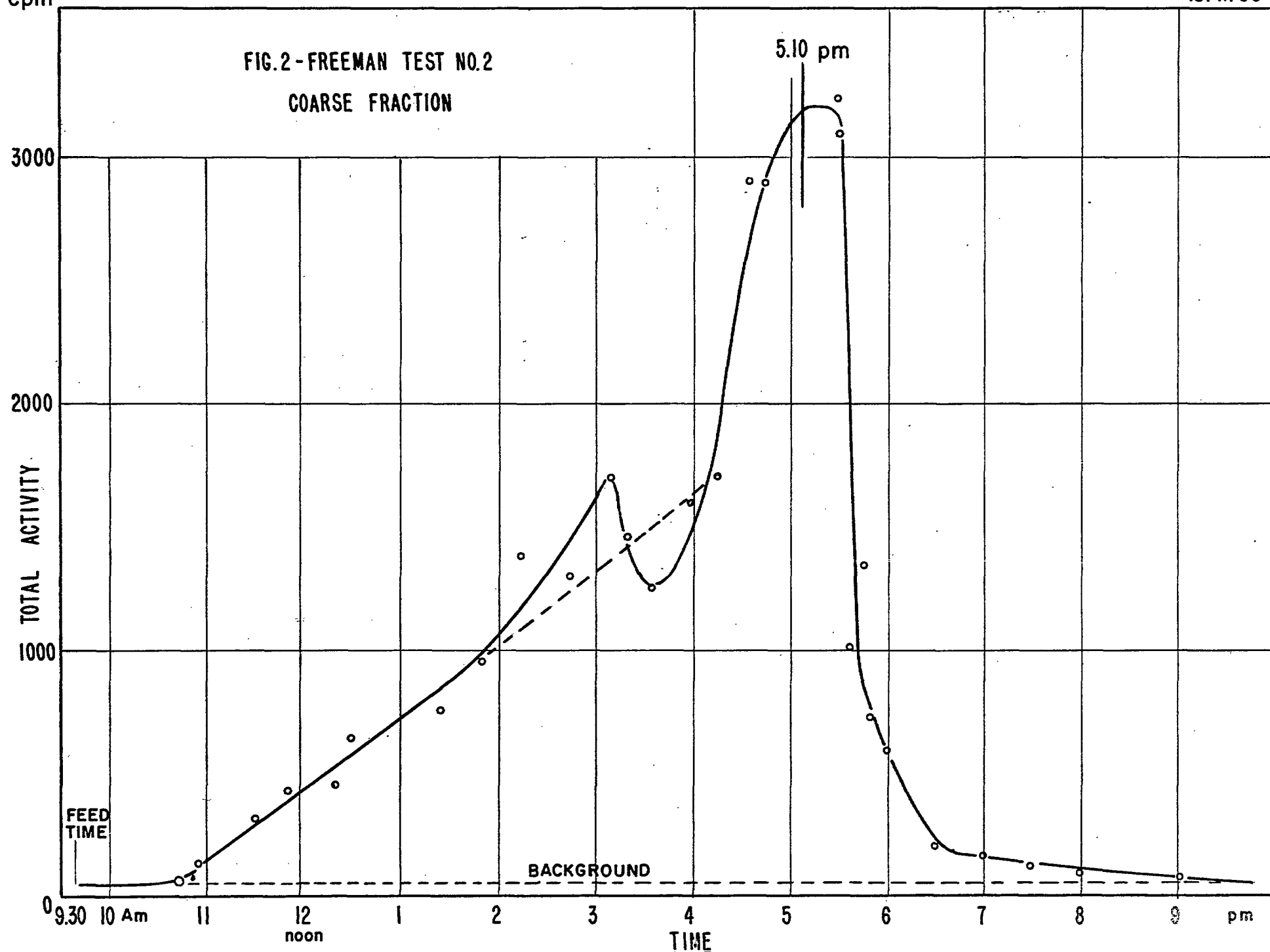
BACKGROUND

5.10 pm

9.30 10 Am 11 12 noon 1 2 3 4 5 6 7 8 9 pm

TIME

15



cpm

FIG.3-FREEMAN TEST NO.2.  
FINE FRACTION

3000

2000

TOTAL ACTIVITY

1000

0

BACKGROUND

5.10 pm

FEED  
TIME

9.30 10 Am

11

12

1

2

3

TIME

4

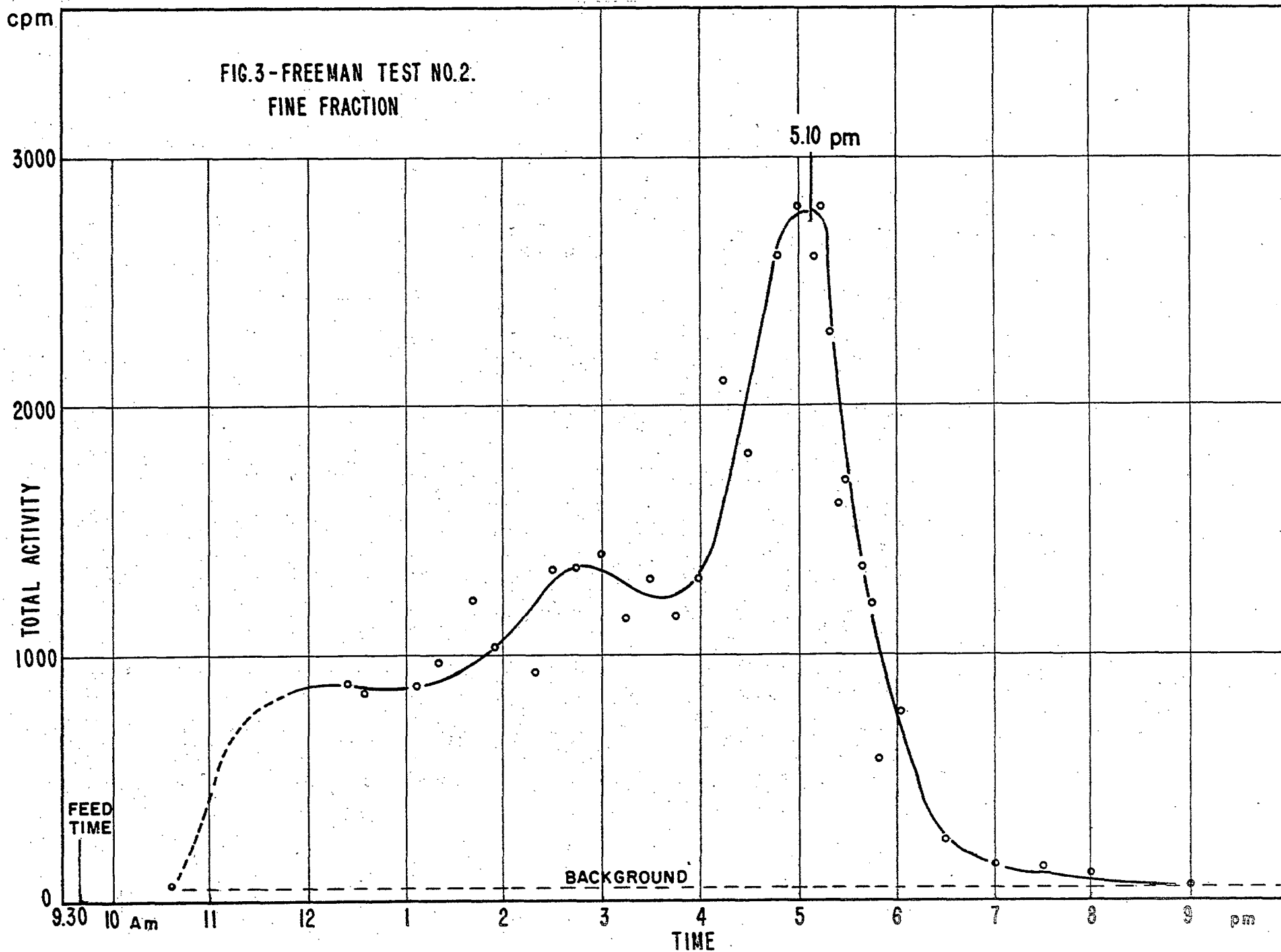
5

6

7

8

9 pm



## DISCUSSION OF RESULTS

Inspection of Figures 2 and 3 shows essential similarities in their overall appearance; in both cases there is considerable activity appearing in the samples well ahead of the main peak which is centred around 5:10 p.m. This peak corresponds closely to the predicted contact time and to the arrival of the gross activity detected by the external scintillation counter. For this peak the mean total time in the kiln plus cooler works out to be 7 hr 35 min. If one subtracts from this the time of transit through the cooler, about 2 hr 20 min according to the scintillometer, the contact time for this portion of the charge was about 5 hr 15 min. However, the area under the peak, and hence this portion of the labeled feed, represents only about half the total active product detected. For instance, in Figure 2 the area under the main peak, above the 4 p.m. line, is practically equaled by all that which had been counted before 4 p.m. In Figure 3 there is a high "shelf" which represents at least as large a portion of the total active charge as that indicated by the remainder of the curve. The fluctuations in count rate appearing on the "shelf" may not be significant because of scatter and should probably be ignored in view of the general rising trend prevailing at that early stage of the test.

This early or "premature" portion is in striking contrast to the clean regular peak observed in the January test. The appearance of the small, early peak in Figure 2 even suggests

a distinct shorter contact time, but again this peak may have no separate reality and the dotted line in Figure 2 probably is a better representation of the surprising linear rise in the count rate, well ahead of the regular peak. The centroid of the area under the curve, therefore, results in a total, effective residence time from 9:40 a.m. to 4:05 p.m. Subtracting again 2 hr 20 min for the cooler transit time leaves a mean effective kiln contact time of 4 hr 5 min, over an hour less than the time expected.

The nature of the apparent short-circuiting in the kiln is not too easy to explain. Whereas it was expected that the hot air blast might have carried the very fine dust over the surface of the bed this effect is insufficient to explain the overall results, especially for the coarse fraction. As the kiln was barely inclined it is hard to see how so large a fraction could have rolled ahead of the main portion of the active charge. On the other hand, the steep fall-off of the main peak and rapid disappearance of all active material from the kiln militate against any true dispersion in the bed.

Both the main and subsidiary peaks appeared almost simultaneously in both fractions. This rules out most effects which would depend on particle size segregation. Further tests may be required to settle this particular problem, in particular the short-circuiting by the very fine particles may have to be investigated further. The drop to background in the sample count rate by 8-9 p.m. indicates that little, if any, of the material recirculated or was trapped in the lining.

The procedure for the radioactive tracer test itself has become almost routine and it is recommended, that for future contact time measurements on this particular kiln the engagement of a commercial operator or consultant be considered.

The cooperation of Mr. H. Freeman and his staff is gratefully acknowledged.

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