CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

OTTAWA

MINES BRANCH INVESTIGATION REPORT IR 59-110

MEASUREMENT OF THE RESIDENCE TIME OF A ROTARY KILN WITH RADIOACTIVE TRACERS

by

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NOVEMBER 26, 1959

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G.G. Eichholz*

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INTRODUCTION

Radioactive tracers have been shown on previous occasions to provide the quickest and most convenient means of determining residence times of kilns and furnaces. For that reason this method has been adopted in the present case, where an oil-fired rotary kiln was employed in the conversion of hydrated alumina to alumina. Mr. G. Viens of the Extraction Metallurgy Division was in charge of the tests which were conducted on behalf of the Aluminum Company of Canada, who also supplied the material.

The kiln has outside dimensions of 14½ ft in length and 25 in. in diameter. The speed of rotation and inclination of the kiln can be adjusted to give the desired residence time. The feed rate during the test was 60 lb/hr.

Silver-110, half-life 270 days, was selected as the tracer isotope, both because it adheres readily to most mineral powders and also because it was at hand in the laboratory.

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TEST DETAILS

The active silver was made up as a dilute silver nitrate solution, containing about 2 millicuries total activity. This solution, about 15 millilitres, was mixed thoroughly with about $\frac{1}{2}$ lb of hydrated alumina powder, taken from the feed material. The mixture was added to the feed at 3:05 pm on November 18, 1959. The movement of feed along the feeder screw into the kiln was such that the time required for the active charge to enter the kiln completely was probably between 5 and 7 minutes.

Half-hourly samples were taken at the discharge end of the kiln until 7:30 pm.

The samples were adjusted to constant volume and the activity determined with a scintillation counter on November 19. The results have been plotted in Figure 1.

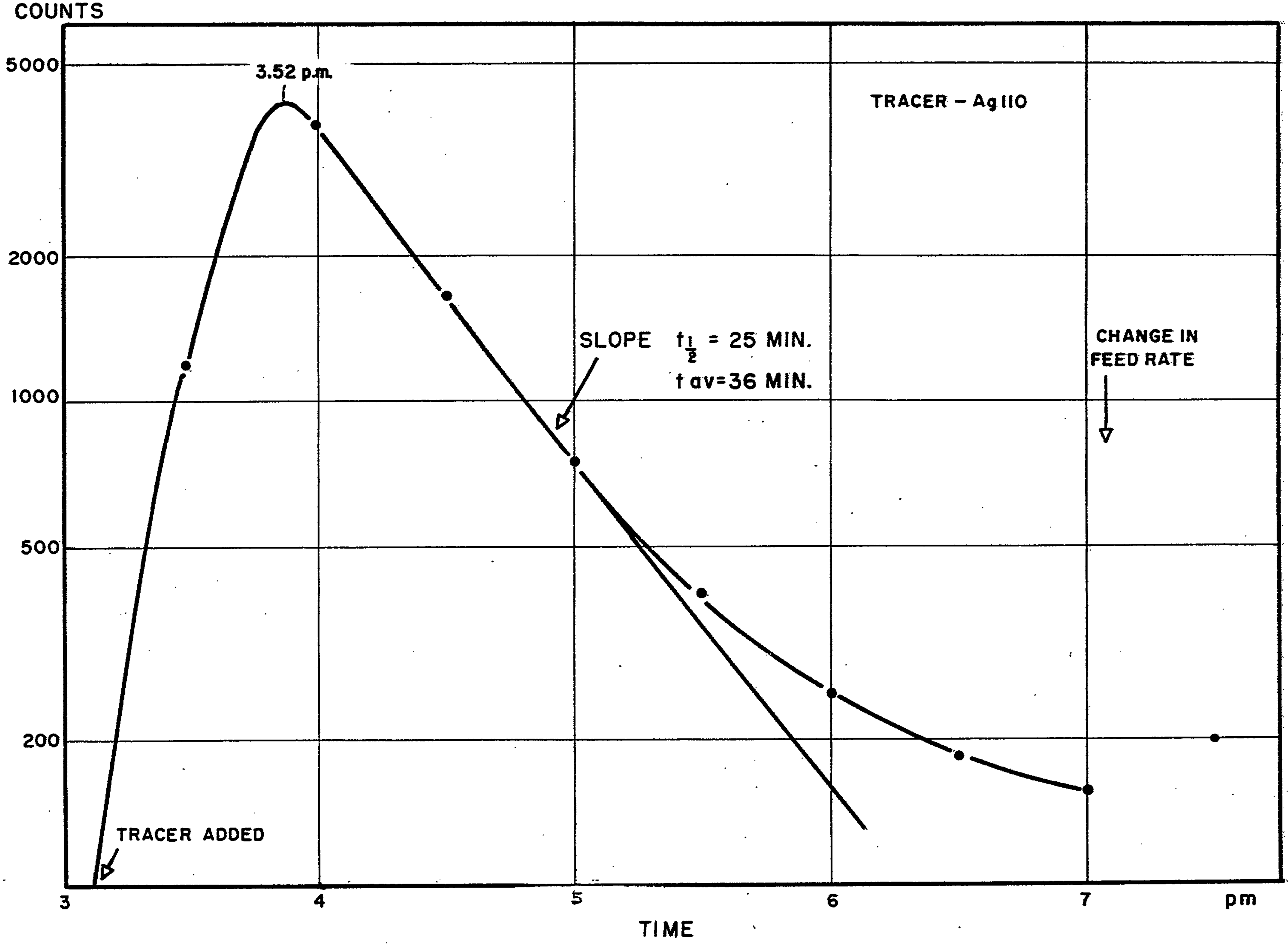

FIG. 1 – TRACER TEST : KILN PRODUCTION OF Al_2O_3.

CONCLUSIONS

It is seen from Figure 1 that a well-defined peak was reached around 3:52 pm. The precise time was not established, because of insufficient samples in the rising limb of the curve. Assuming that most of the charge entered the furnace at 3:09 pm, one obtains an approximate transit time for the undispersed part of the charge of 43 minutes.

Because of the inherent uncertainties in establishing the starting time and time of arrival of the peak of activity, a more satisfactory method of establishing contact times is to derive them from the slope of the falling limb of the activity plot. Because the amount of activity arriving at the discharge end of the kiln depends on the total activity left distributed in the furnace at any instant, the decrease in activity ("decay slope") should follow an exponential law. From the decay slope one can then calculate the average residence time which is equal to 1.44 times the "half time" (time required for the activity to fall to half its initial value). In the present case the half time derived from the curve was 25 minutes and for the average residence time 36 minutes.

No reasonable explanation can be offered at this time for the very slow component which became evident in the last few samples. This may represent some fraction of the charge which adhered to the feed screw or alternatively some adhesion to the kiln lining in cracks and pores.

The level of activity proved to be much higher than necessary and 200-250 microcuries of silver-110 would seem to be sufficient for any future tests on this kiln.

The radiation dosage levels were monitored throughout the test and the feeder trough was checked for possible contamination at the end of the test.

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