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FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

TECHNICAL MEMORANDUM NO. 1 OF 1967.

COMBUSTION TESTS ON NATAL AMMONIUM WASHED NUTS AND MIDDLINGS.

By:

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1. OBJECT OF TESTS:

At the request of the Anthracite Producers' Association* comparative combustion tests were carried out on anthracite nuts, washed at a specific gravity of 1.45, on anthracite middlings of the s.g. range +1.45 - 1.60 and on mixtures of these two materials.

The object of the tests was to compare the relative effectiveness of these fuels and to observe any possible adverse effects, resulting from an increased ash content and the presence of a high proportion of dull material.

It can be stated at the outset that all products tested behaved satisfactorily and that no serious adverse effects were noticed.

2. PRODUCTS TESTED:

A consignment, consisting of anthracite nuts, washed at s.g. 1.45 and the discards of the washing process was received from the colliery. The discards were floated at the Institute at s.g. 1.60 and the following combinations of washed nuts and middlings were tested:

A. Washed anthracite (-1.45 nominal), as received.
B. 80% of material A, 20% of D.
C. 50% of A, 50% of D.
D. Middlings, of s.g. range +1.45 - 1.60.

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* c.f. letter JCV/AT/166/T.4/F.6, of 27/7/1966

The main characteristics of these fuels are presented in Table No. 1.

TABLE NO. 1.

Fuel	A	B	C	D
S.G.Range, Composition	-1.45	80% A,20% D	50% A,50% D	+1.45-1.60
Volatile Matter (%)	10.1	10.0	10.2	9.6
C "	80.5	78.6	75.0	71.0
H "	3.3	3.5	3.3	3.0
Ash "	8.0	10.1	13.4	18.0
Moisture "	1.4	1.3	1.4	1.4
Calorific Value lb/lb.	14.25	13.88	13.31	12.46

3. COMBINATION AND TEST EQUIPMENT:

The test fuels were burnt in the following appliances:

(a) Wellstood Kitchen Range, type 104.

This is a well designed insulated range, equipped with a heavy heat conserving and equalising top plate which can be covered by two hinged insulated bolsters.

The built-in hot water boiler was connected to the Institute's test water system, consisting of a well insulated storage tank (of 100 litres capacity) and a circulating pump. The difference in flow and return water temperatures during a test is 1°C to 2°C. The initial weight of the water in the system was 103 kg in all tests.

The stack temperature and the CO_2 and CO content of the flue gas are determined. At the end of each test, the ashes and the material still on the grate are drawn (separately), quenched and analysed. Since the quantity of fuel fired is recorded, an

exact .../

exact determination of the quantity burnt can be carried out and stack losses and losses due to unburnt carbon in the ashes calculated.

In all tests, the fire was kindled with 30 gram woodwool, 0.5 kg of firewood and an initial charge of 1.188 fuel, the subsequent firing rate was 1 kg every 20 minutes for the first hour, thereafter 0.5 kg every 20 minutes.

The draught was maintained at 1 mm water column.

(b) Fulham Mk II fire place.

This is the standard instrument for determining the ignition and radiation characteristics of a fuel. The grate is loaded with 0.4 ft^3 of fuel, which is ignited by a gasburner supplying heat at the rate of 7,000 B.Th.U in 17½ minutes.

The total radient heat output over a hemisphere and the radiation in a specific direction are recorded.

(c) Free standing brazier.

This is a box-grate 12 in x 12 in x 5 in deep; the grate is charged with 1 kg firewood and 7.8 kg fuel. The radient heat is observed in the manner indicated under (b) above. The weight of the matter remaining on the grate after 24 hours is determined so that the actual quantity burnt can be assessed.

4. TEST RESULTS:

a) Wellstood Range.

The main data obtained with the four test fuels are indicated in Table No. 2.

Table No. 2 .../

TABLE NO. 2.

Test Results, Wellstood Kitchen Range.

Type of Fuel		A	B	C	D
Stack loss	%	13.0	14.2	15.5	16.65
Loss by carbon in ash	"	4.1	5.6	6.5	12.55
Combustion efficiency	"	82.9	80.2	78.0	70.8
Burning rate	kg/hour	1.089	1.220	1.232	1.537

Oven Temperature, with circulation: above 300°C for all fuels.

The efficiency obtained was very good for all fuels, though the low ash fuel gives the highest efficiency, which decreases progressively with an increase in ash content. A rather unexpected phenomenon is that the burning rate increases with the ash content to such an extent that notwithstanding the lower calorific value of fuel D, and the lower efficiency attained here, the heat output is slightly higher than for fuel A.

This is further indicated by figure 1, which illustrates the temperature rise of the water in the hot water system. The differences in the rate of increase are, however, slight. Fuels C and D produce a yellow deposit on the walls of the combustion chamber.

b) Ignition and Radiation, Fullham Fireplace.

The test results are given in figure 2. The differences during the first hour can hardly be called significant. In the period thereafter, the heat output of all fuels is roughly the same, apparently here as well the lower calorific value of D is compensated by a faster burning rate.

c) Combustion in Brazier.

The test results are given in figure 3. Apart from the fact that the radiation from the washed product (A) lagged during the first hour (which may be a spurious result), all fuels behaved similarly during the next 3 hours.

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The total quantity of fuel burnt (out of a total of 7.8 kg), as determined by weighing the residue in the grate after 24 hours, was as follows:

Fuel	A	B	C	D
Quantity burnt, kg	4.716	5.397	6.325	6.286
(Potentially combustible (Matter kg	7.176	7.012	6.860	6.390

The two fuels of high ash content were burnt to a remarkable extent. Since no observations are available for most of the period, it is unknown whether the rate of heat release during the later stages of the process was of a useful magnitude. A further experiment could have been performed to settle this point, but no more test fuel was available.

5. CONCLUSIONS:

The experiment indicated that anthracite middlings of medium to high ash content can be burnt satisfactorily in various appliances. The lower calorific value and efficiency of the fuels of high ash content are largely compensated for by a higher burning rate, so that within the range of ash contents investigated, e.g. 8% to 18%, the heat output remains approximately the same.

(SIGNED) G.A.W. VAN DOORNUM.
CHIEF RESEARCH OFFICER.

PRETORIA.
9/1/1967.

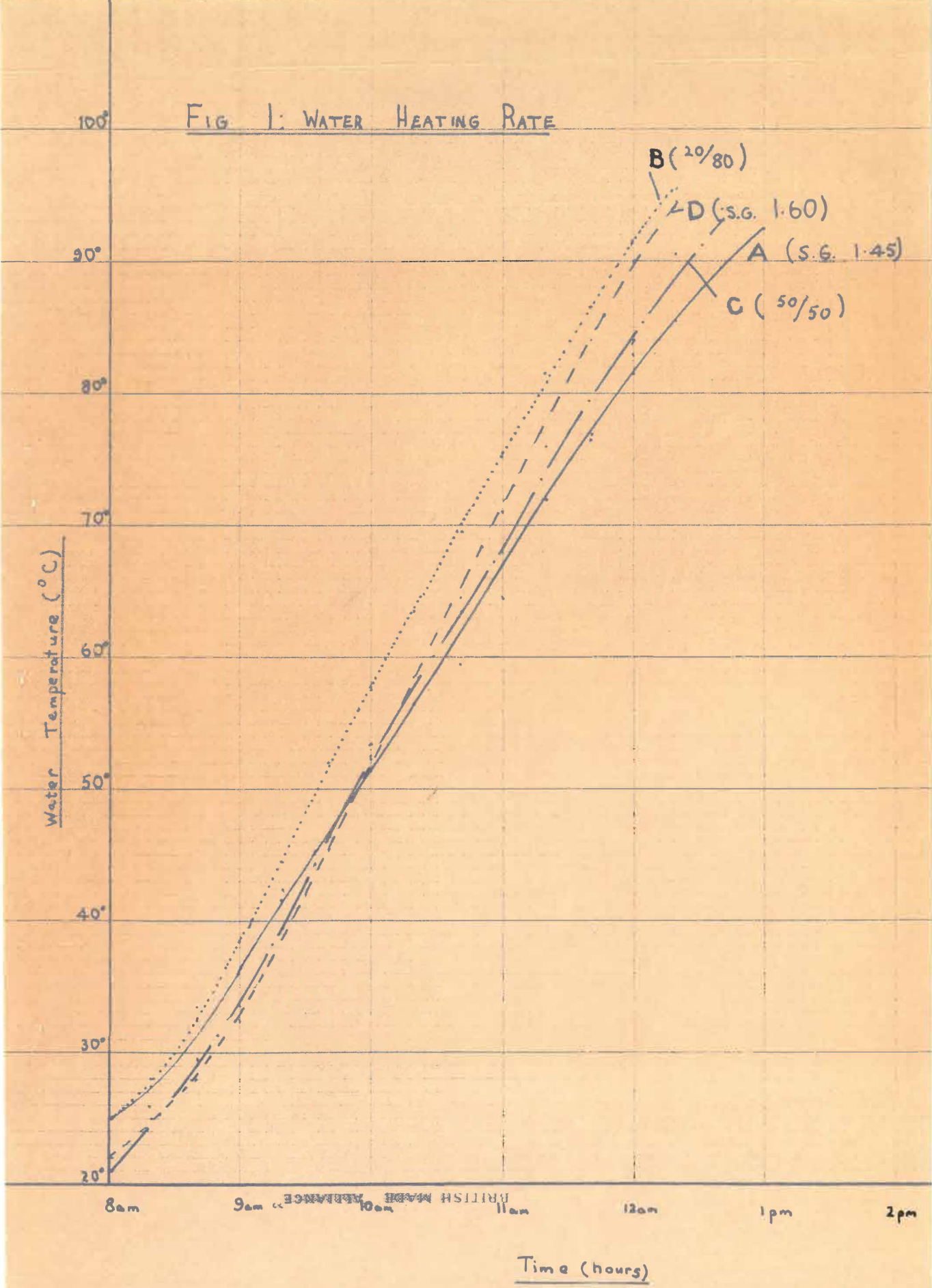
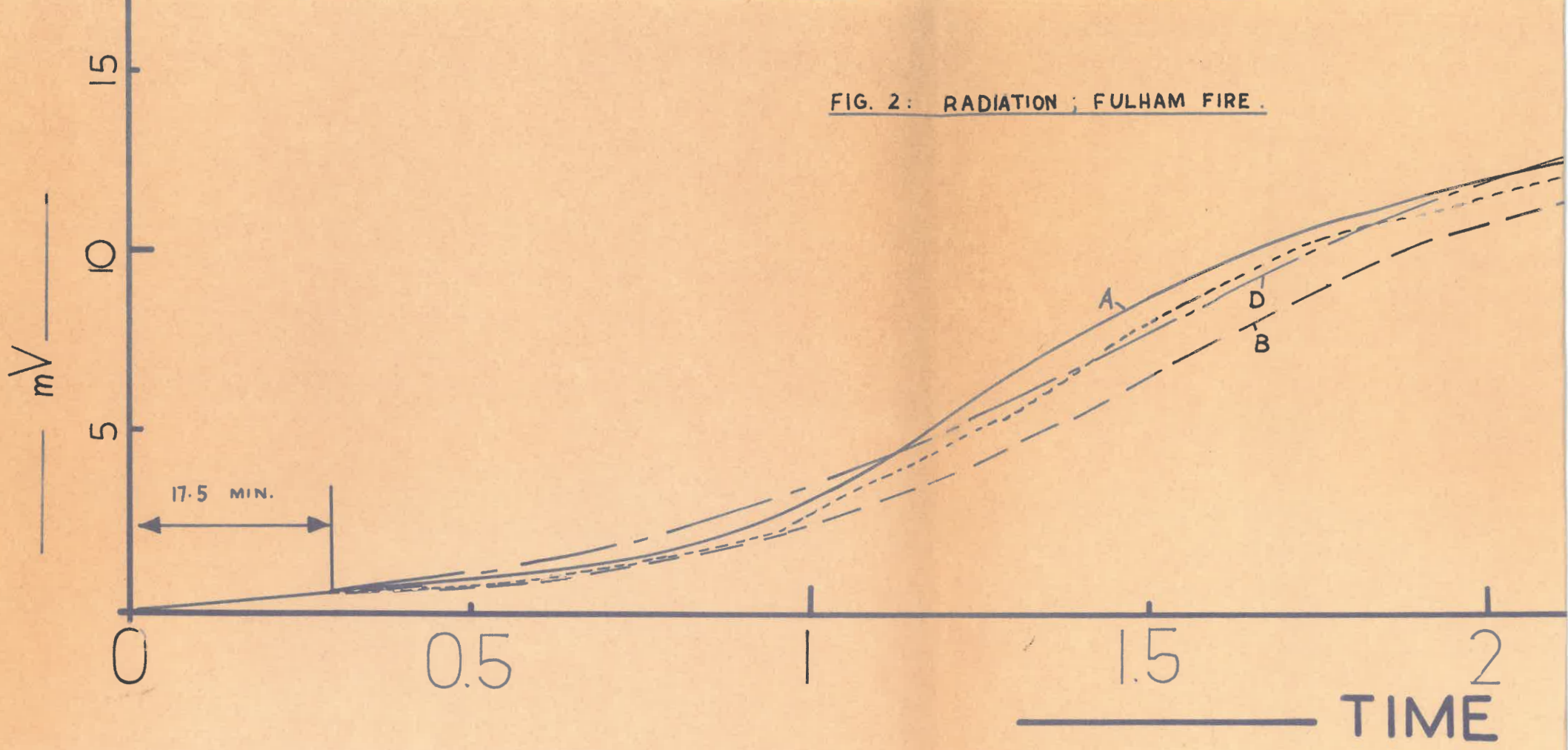


FIG 1: WATER HEATING RATE
B (20/80)
D (S.G. 1·60)
A (S.G. 1·45)
C (50/50)
100°
90°
80°
70°
60°
50°
40°
30°
20°
Water Temperature (°C)
8am
9am
10am
11am
12am
1pm
2pm
Time (hours)

FIG. 2: RADIATION ; FULHAM FIRE.



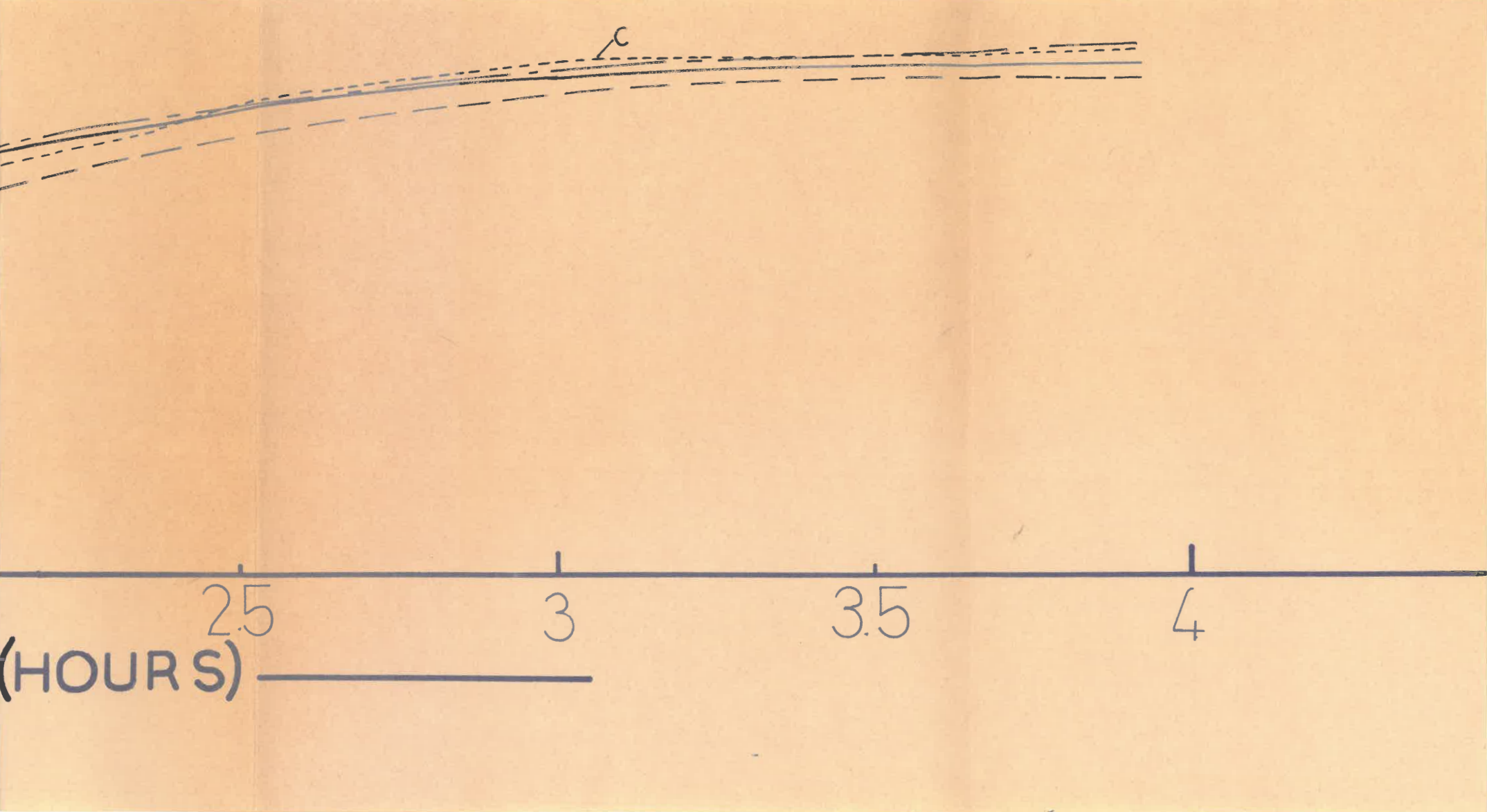
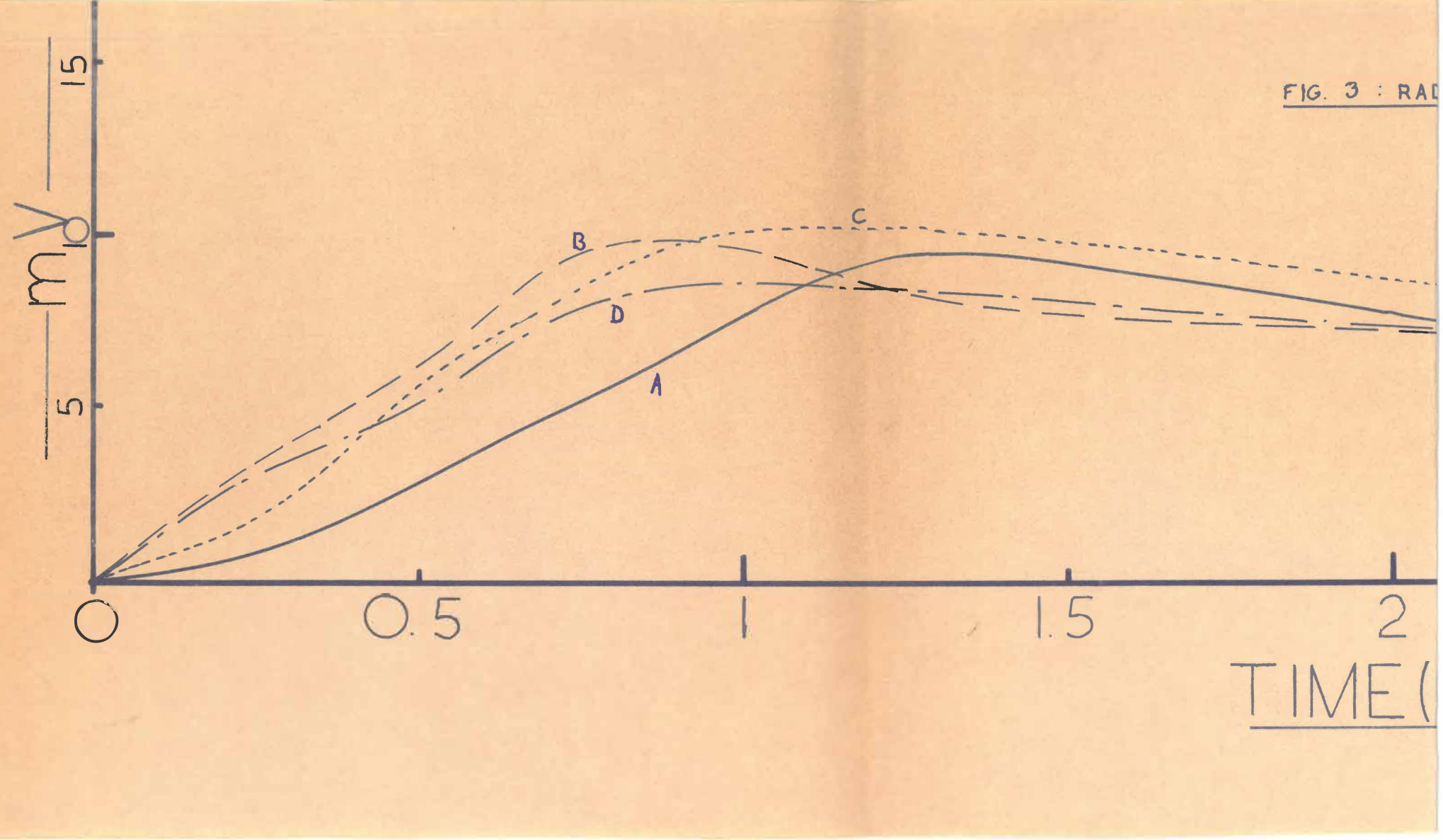
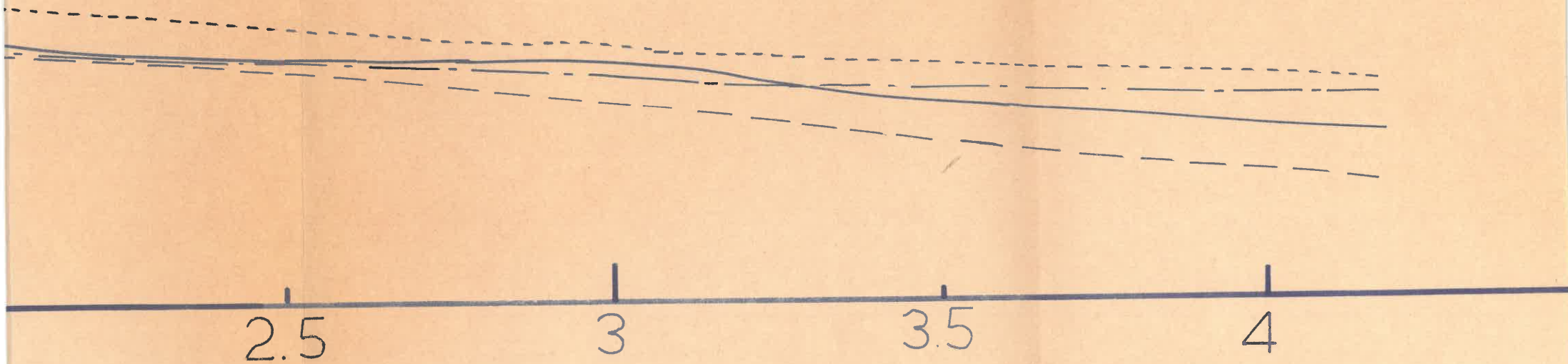

C
2.5
3
3.5
4
(HOURS)

FIG. 3 : RAD



DIATION ; BRAZIER



HOURS)