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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE
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SUITABLE LIMITS TO THE RESPONSE OF HEAT-SENSITIVE FIRE DETECTORS TO AVOID FALSE ALARMS

by

R.W. Pickard and D. Hird

SUMMARY

The setting of heat-sensitive fire detectors must be such that false alarms are not given under normal ambient temperature conditions. This report discusses the relation between maximum temperature variations and detector setting.

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1. Introduction

It has been shown[1] that the time for a heat-sensitive fire detector to operate depends more on its "setting" than its sensitivity. The "setting" for fixed temperature detectors is the nominal operating temperature and for rate-of-rise detectors[2] the minimum rate-of-rise of air temperature for which compensated operation occurs. The operating time under fire conditions may thus be reduced by reducing the setting, the permissible lower limits of which depend upon the maximum likely ambient temperatures and ambient temperature variations.

Ambient conditions are likely to vary considerably where industrial processes involving the generation of heat are concerned, and it is important that this should be taken into account when siting and setting fire detectors if the best response is to be achieved with freedom from false alarms. Such applications however, are likely to require higher settings than are necessary in office or domestic accommodation where the highest temperatures and ambient temperature variations are likely to be due to the introduction of portable heating appliances. Tests have been made to determine suitable lower limits for the "setting" of detectors, to take into account these conditions.

2. Choice of heating appliance

The maximum temperature and temperature variations are likely to occur directly above a heating appliance. Since a detector head would not be mounted near a fixed appliance it was decided to use the highest-rated portable convector heater in common use, rated at 3 Kw. and to place this in a small room such as would be used as a single office, small reception room or similar occupancy.

3. Experimental

The experiments were carried out in a room 12 ft x 8 ft 6 in. x 8 ft 6 in. (880 cu.ft) with a flat ceiling. A 40 S.W.G. chromel-alumel thermocouple was mounted 2 in. below the centre of the ceiling and directly above the 3 Kw heater. The door and window were closed. Variations in air temperature over a period of 10 minutes were recorded automatically (Fig.1). During this time, the air temperature rose from 66°F (19°C) to 119°F (48.5°C).

4. Discussion

To avoid false alarms, a detector should not operate when exposed to the time-temperature curve shown in Fig.1, since these conditions are possible without a fire. The operating times of detectors have been been determined at a number of constant rates of rise of temperature, and so that Fig.1 can be related to those results the average rates of rise of air temperature for various periods of heating have been calculated from Fig.1 and are shown in Fig.2. Thus if a detector takes longer to operate at a given rate-of-rise of temperature than shown by Fig.2 it is unlikely to give false alarms in normal occupancies. Although these rates-of-rise of air temperature are likely to occur at a detector during the development of a fire, they will be sustained for longer times than if they were due to a heating appliance. These conditions therefore impose a limit on the "setting" of detectors and it is necessary to examine how the performance of detectors might be expected to compare with the suggested limiting conditions.

5. Fixed-temperature detectors

Temperatures of 46°C (3) and 50°C (4) have been suggested as reasonable upper limits in which work can be carried on regularly. Further, Fig.(1) shows that under severe conditions of heating a temperature of 50°C might be reached. It would seem reasonable, therefore, to assume that a fixed-temperature detector with a nominal operating temperature of 50°C is perhaps the most sensitive detector of this type likely to be used in practice. Fig.3 shows how the operating time of such a detector, which has a sensitivity(1) of 20 seconds, might be expected to vary with rate of rise of air temperature. For comparison the suggested minimum times are also shown. It can be seen that the operating time is greater than the minimum time for all rates of rise of temperature over this range.

6. Rate-of-rise detectors

The operating temperature of rate-of-rise detectors decreases as the rate of rise of air temperature to which they are subjected increases above a minimum level(2). It is not possible therefore to set a limit to the sensitivity of this type of detector from the maximum ambient temperature likely to be reached. However, the performance of a rate-of-rise detector can be predicted(2). Fig.4 shows the operating times which might be expected from two rate-of-rise detectors. One is designed to operate as a compensated detector down to rates of rise of temperature of 6°C per minute, operating on a temperature limit of 50°C at lower rates. The other operates as a compensated detector at very low rates of rise of temperature, so that in effect it behaves as a fixed temperature detector with an operating temperature of 20°C over the range of rates of rise of air temperature considered.

It can be seen from Fig.4 that while both detectors operate in a time greater than the suggested minimum at rates of rise of air temperature above 10°C per minute, the detector which has a very low setting may prove too sensitive at lower rates of rise.

7. Conclusions

Since the operating times of heat sensitive detectors depend largely on the "setting" of the detectors, these should be as low as possible without giving rise to false alarms. Minimum operating times for detectors over a range of rates of rise of air temperature have been suggested which represent a reasonable lower limit for the "setting" of detectors for normal occupancies. It has been shown that a fixed temperature detector with an operating temperature of 50°C would be expected to operate in a longer time than the minimum over the range of rates of rise of air temperature considered. Some rate-of-rise detectors, however, may not satisfy the conditions over the whole range.

References

(1) Hird, D., Pickard, R.W. and Ross, W. Thermal tests on some heat sensitive fire detectors. F.R. Note No.275/1956.

(2) Pickard, R.W. A study of the operation of rate-or-rise heat sensitive fire detectors. F.R. Note No.248/1956.

(3) Annual report of the Chief Inspector of Factories, 1954. H.M.S.O.

(4) Model Code of Safety Regulations for industrial establishments, International Labour Office, Geneva, 1949.

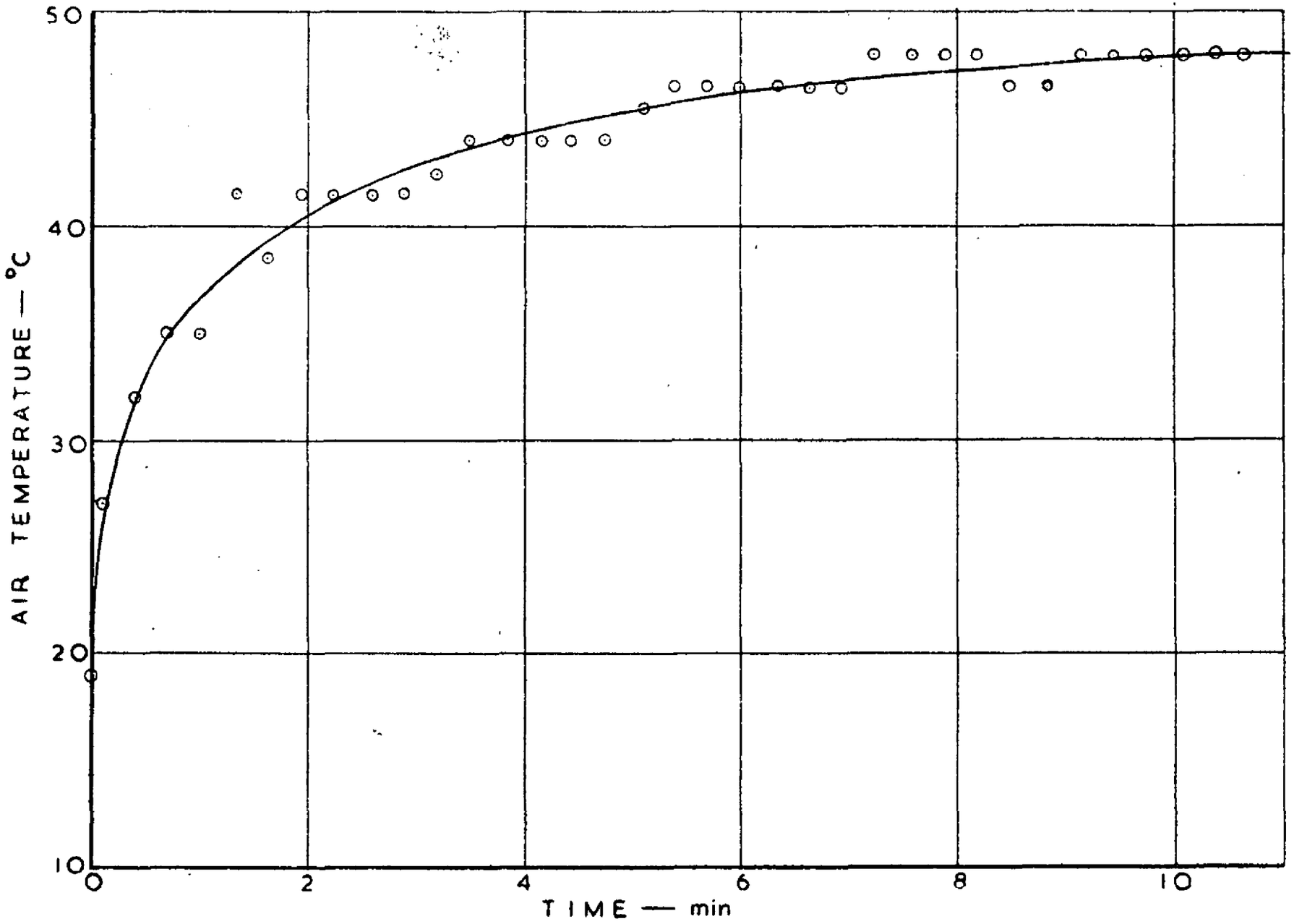

FIG. 1. VARIATION IN AIR TEMPERATURE

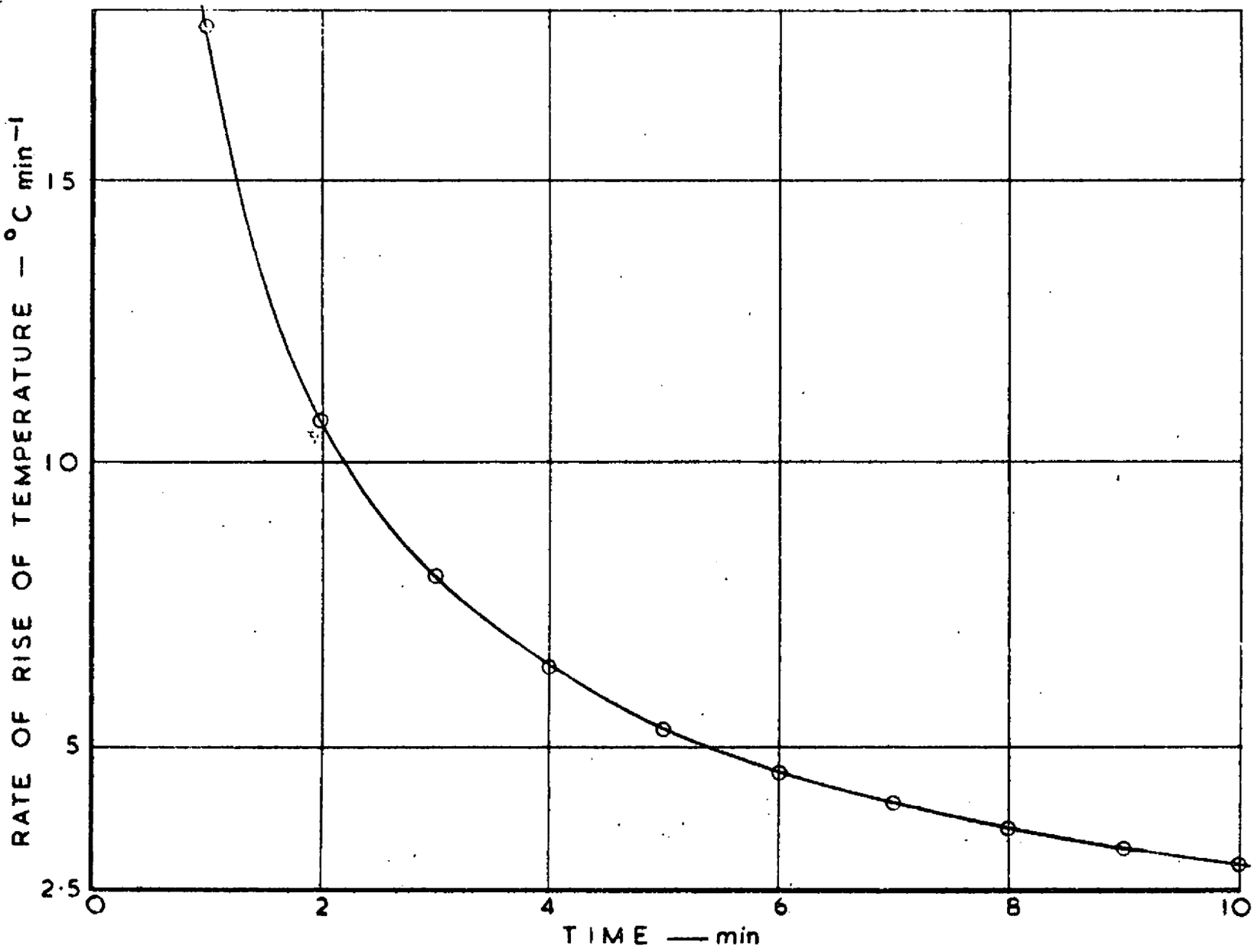

FIG. 2. AVERAGE RATE OF RISE OF AIR TEMPERATURE

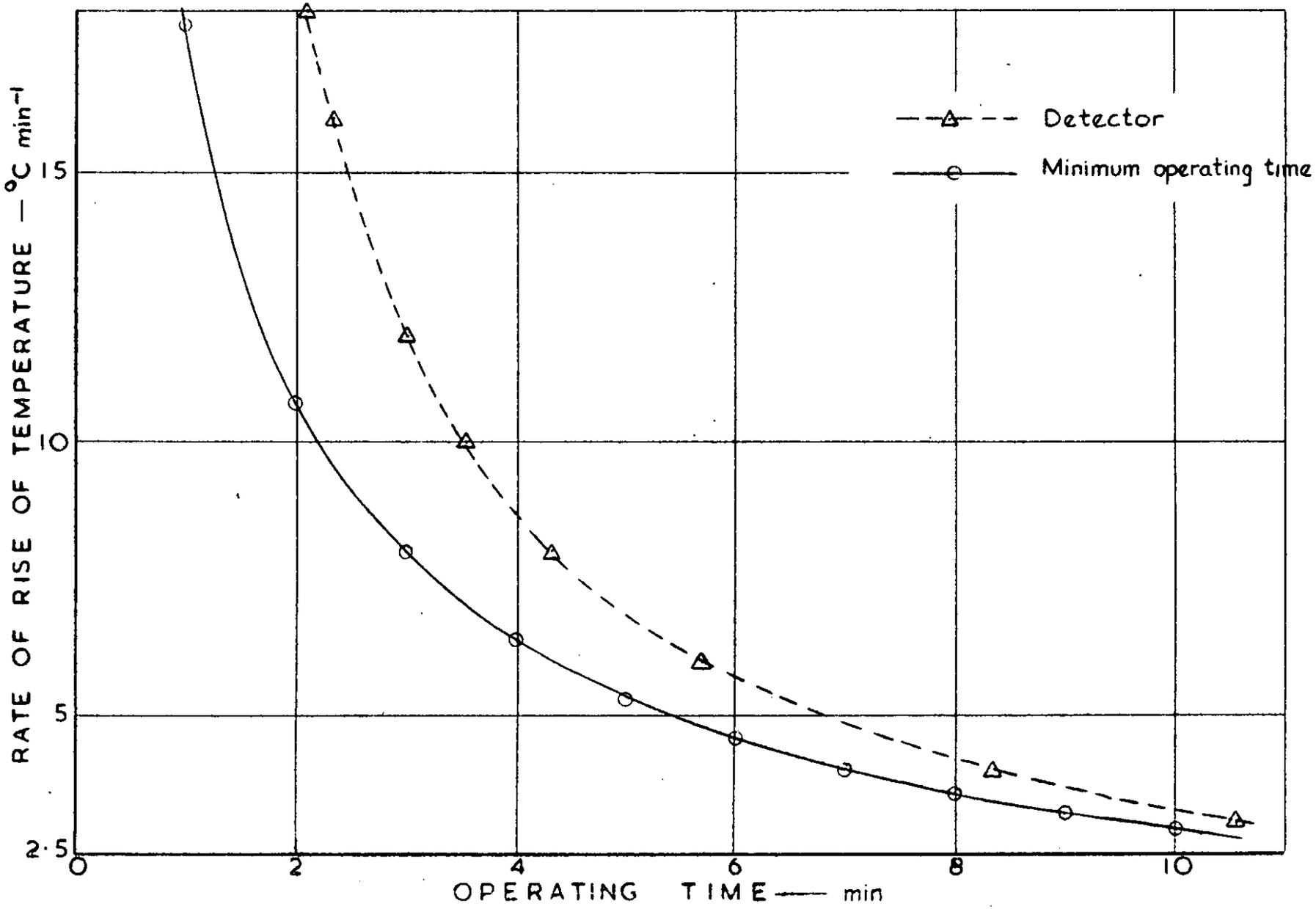

FIG. 3. OPERATING TIME OF A FIXED TEMPERATURE DETECTOR WITH A NOMINAL OPERATING TEMPERATURE OF 50°C

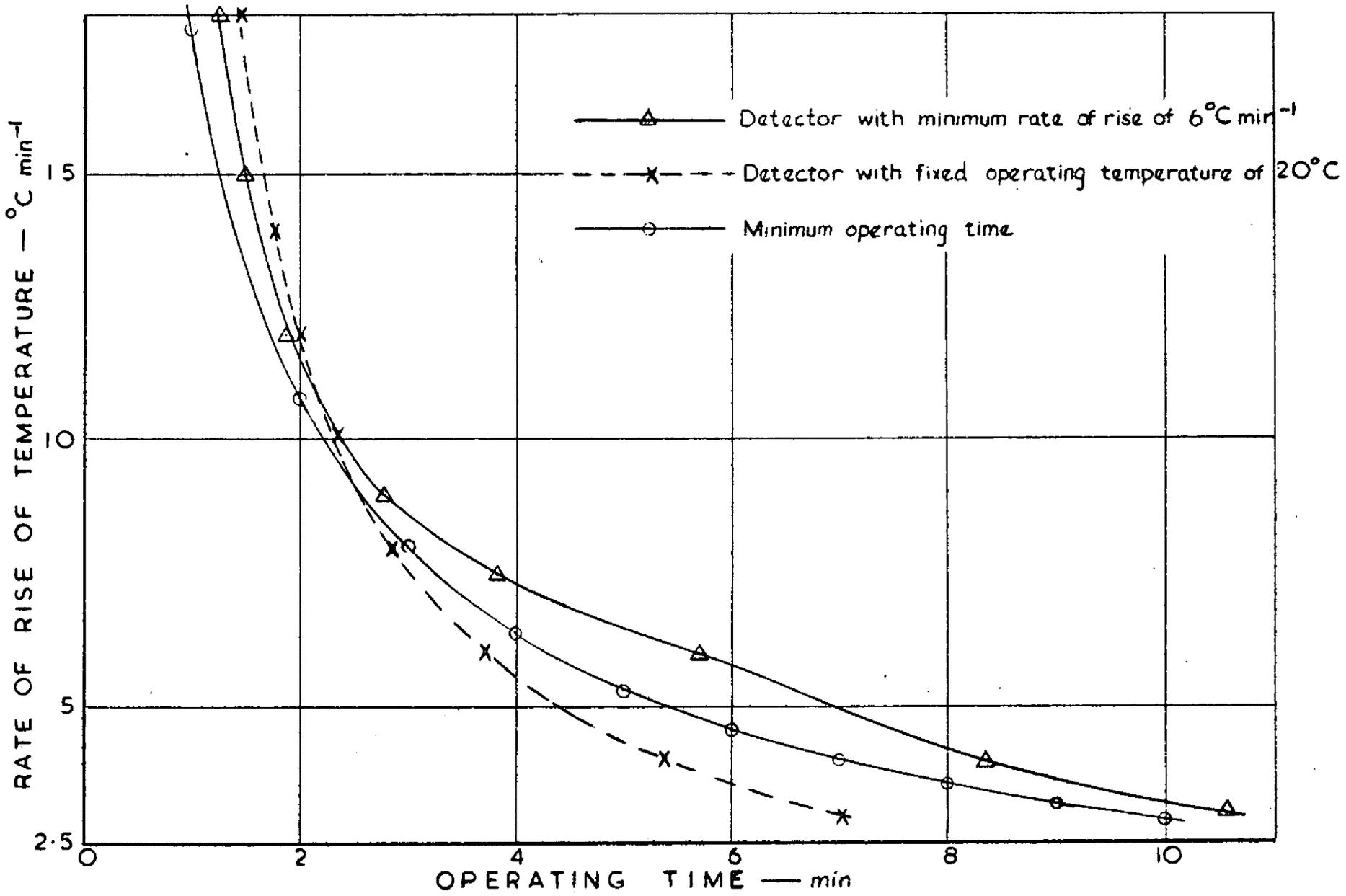

FIG. 4. OPERATING TIME OF RATE OF RISE DETECTORS