NOMOGRAM FOR THE FIRE DANGER OF FLUE PIPES

by

MARGARET LAW

February 1968.
NOMOGRAM FOR THE FIRE DANGER OF FLUE PIPES

by

Margaret Law

Summary

An equation and a nomogram are given for the temperature of a panel at different distances from a heated pipe.

Crown copyright

This report has not been published and should be considered as confidential advance information. No reference should be made to it in any publication without the written consent of the Director of Fire Research.

MINISTRY OF TECHNOLOGY AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION
NOMOGRAM FOR THE FIRE DANGER OF FLUE PIPES

by

Margaret Law

1. Introduction

In their report "The Heating of Panels by Flue Pipes" Lawson et al. give calculated and measured temperatures of panels spaced at different distances from flue pipes of solid fuel stoves maintained at various temperatures. Their results can be used to estimate the temperature of a panel near any heated pipe and with the introduction of flue pipes for oil fired domestic heaters, for example, it is convenient to have a simple chart or nomogram relating panel temperatures to pipe temperatures.

2. Equation for temperature

Fig 25 of the report gives equilibrium panel temperatures $\Theta_p$ for different values of flue pipe temperature $\Theta_f$ and configuration factor $\phi$. This family of curves can be represented approximately by the equation

$$\Theta_p = 0.105 (\Theta_f)^{1.3} \phi^{0.5}$$  

(1)

where $\Theta_p$ and $\Theta_f$ are in °C.

Deviations of equation (1) from the curves of Fig 25 are within the range of variation of the temperatures measured experimentally.

The report shows that for flue pipes which are long in relation to their distance from the panel

$$\phi \sim \frac{1}{n}$$

where $nR$ is the distance of the panel from the axis of the flue pipe

$R$ is the radius of the flue pipe

and the length of the pipe exceeds $2nR$.

Using this approximation for short pipes errs on the safe side.

Thus equation (1) may be written

$$\Theta_p = 0.105 \Theta_f^{1.3} n^{-0.5}$$  

(2)

It is more convenient to give spacing from the panel to the surface of the pipe, rather than to the pipe axis, and to describe it in terms of the diameter rather than the radius.
Equation (2) then becomes

\[ \Theta_p = 0.105 \Theta_f^{1.3 (2N + 1)^{-0.5}} \]  

(3)

where ND is the distance between the panel and the surface of the pipe and D is the diameter of the pipe.

The report shows that if the maximum possible flue pipe temperature is maintained for only \( \frac{1}{2} \) hour, as could be the case for a solid fuel heater, panel temperatures would be only about 0.7 of the equilibrium temperatures given by equation (3).

i.e. \[ \Theta_p = 0.073 \Theta_f^{1.3 (2N + 1)^{-0.5}} \]  

(4)

3. Construction of Nomogram

Taking logarithms of equation (3) we obtain

\[ \frac{1}{2} \log (2N + 1) + \log \Theta_p - (1.3 \log \Theta_f + \log 0.105) = 0 \]

giving the determinant

\[ \begin{vmatrix} \frac{1}{2} \log (2N + 1) & 0 & 1 \\ \log \Theta_p & 1 & 1 \\ \frac{1}{2} (1.3 \log \Theta_f + \log 0.105) & \frac{1}{2} & 1 \end{vmatrix} = 0 \]

i.e. for the N scale \( x = \frac{1}{2} \log (2N + 1) \), \( y = 0 \)

for the \( \Theta_p \) scale \( x = \log \Theta_p \), \( y = 1 \)

for the \( \Theta_f \) scale \( x = \frac{1}{2} (1.3 \log \Theta_f + \log 0.105) \), \( y = \frac{1}{2} \)

To give equation (4) the nomogram is only altered on the \( \Theta_f \) scale

i.e. for the \( \Theta_f \) scale \( x = \frac{1}{2} (1.3 \log \Theta_f + \log 0.073) \), \( y = \frac{1}{2} \)

The Nomogram is given in Fig 1.

References


Use left hand scale for equilibrium conditions. Use right hand scale if pipe temperature is maintained for only 1/2 hour.

Example: -
A flue pipe of temperature 450°C at 4 pipe diameters distance gives an equilibrium panel temperature of 100°C

FIG.1. NOMOGRAM FOR THE FIRE DANGER OF FLUE PIPES