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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

# THE EFFECT OF HEAT ON
# ASBESTOS CEMENT FLUE-PIPES

From time to time shortage of materials and other considerations lead to proposals for the use of asbestos cement flue pipes for kitchen boilers and other heating units. Sometimes pipes of this material have become defective after short service, either by cracking or by spalling, a form of explosive disruption. This note describes the results of an investigation of the suitability of asbestos cement flue pipes for use with appliances burning solid fuel, and makes observations of the failure of some pipes in service.

British Standard 835: 1948 (Asbestos cement flue-pipes, heavy quality) contains a warning regarding the susceptibility of asbestos cement to damage if subjected to high temperatures or flame impingement. It states that the internal temperature of these pipes should not be allowed to exceed 500°F, nor should flame be allowed to impinge directly on the material; it countenances the use of heavy quality pipes for slow-combustion heating and cooking appliances provided that the first 6 feet of flue-pipe and fittings leading from the outlet of the appliance are made of metal. An amendment to the Standard (December, 1950) states that asbestos cement pipes are not suitable for open fires or appliances in which bituminous coal or other fuel which burns with a long flame is used. The Standard thereby seeks to guard against high temperature, flame-impingement, and the effect of fires in the flue itself. It will be clear that the use of long-flame fuels in appliances with asbestos cement flue-pipes is contrary to the recommendations of the standard.

## Scope of experiments

The laboratory experiments were designed to show the severity of the conditions to which asbestos cement flue-pipes might be exposed in service, and to indicate the probable behaviour of the material under these conditions.

A number of typical small boilers and an open fire, each equipped with a heavy-quality asbestos cement flue, were run with non-coking, long-flame, bituminous coal and slack at the maximum possible rate of fuel consumption. The temperatures reached in the gas and flue were recorded.

In other experiments complete pipes, and semi-annular sections of pipes, were exposed to heat from a gas flame or by radiation, to determine the intensity of heating that is necessary to cause spalling. Observations were also made of the conditions under which cracking occurred.

From these tests the following conclusions were drawn:

(i) Asbestos cement flue-pipes, as received from the manufacturers, will spall violently if subjected to strong heating such as would occur at the outlet from an appliance being operated at the maximum rate on long-flame fuel or during a fire in the flue.

(ii) If the moisture content of the pipe is reduced below 2.5 per cent of the dry weight of the pipe spalling does not occur, but will occur if the moisture content is again raised above this value, provided the pipe is not saturated with moisture, a condition unlikely in service. The pipe is most likely to spall when it is in equilibrium with air at about 70°F and 60 per cent relative humidity, typical of climatic conditions in this country.

(iii) An asbestos cement flue erected over a boiler in normal use generally has a moisture content less than the critical 2.5 per cent required to cause spalling, but this may not be true of the upper parts of a flue which normally do not attain high temperatures e.g. a living room flue over an open fire.

(iv) Heating of asbestos cement flue-pipes at 600°C or above is likely to cause cracking owing to weakening of the material and the onset of permanent shrinkage at about this temperature.

Behaviour in service

Many instances of failure of asbestos cement flue-pipes in service have been investigated, and the following notes typify the behaviour of the material when it is over-heated, as in flue fire:

A fire in a flue of heavy quality pipe which caused ignition of adjacent combustible material by radiated heat also produced considerable deterioration of the internal surface of the pipe. Another similar instance caused splitting of the topmost section of the flue pipe and reduced the internal surface of the pipe to a weak and powdery state. No spalling occurred in either flue.

On one estate over thirty chimney fires in living room flues were reported in twenty months. In many cases severe spalling of the pipe occurred, generally in the roof space, and was sufficiently severe in two instances to produce penetration of the heavy quality pipes.

Many instances were investigated where cracking but not spalling had occurred to heavy quality pipes. The damage was generally associated with a flue fire and cracks as long as 2 feet had been experienced. In one district where the local authority removed the asbestos cement boiler flues after a number of house fires had been attributed to them, inspection of the pipes showed that about a quarter were severely cracked, generally in areas which appeared to have been severely overheated as might be expected with a flue fire.

In another district in which heavy quality pipes were connected to slow combustion stoves, the outer surface of the pipes was found to be flaking off from that part of the pipe in the roof space. The damage was not due to flue fires, but was attributed to carbonation of the inner surface by flue gases accentuated by the radial temperature gradients and varying moisture content.

Conclusions

It is concluded as a result of the laboratory and field investigation that asbestos cement flue pipes, even those of heavy quality, are not reliable if used with open or solid fuel appliances in which long flame fuel is burnt.

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