Black dust in gas pipework

What is 'black dust' in pipework – and what should you do if you come across it? Gas Safe Register's Technical Team have the lowdown.

Black dust, or sulphidation as it's also known, is a phenomenon caused by the presence of hydrogen sulphide (H_2S), which is a colourless, toxic and flammable gas. H_2S is the compound that gives rotten eggs their distinctive smell but is a naturally occurring constituent in many natural gas reservoirs and gas fields. There is a potential risk to health and, in high concentrations, H_2S may lead to stress cracks in gas pipelines and plant.

Why does the presence of black dust in heating systems matter?

Even where H_2S levels are within allowed tolerances, it can react chemically with the copper gas pipework in homes and businesses under certain situations and form a film of copper sulphide (Cu_2S) on internal pipework walls.

The thickness of the coating depends on the amount of H_2S in the gas; and the thicker the coating, the less stable it becomes, often flaking off and breaking down to form black dust. When copper sulphide breaks away, different sized flakes may be seen in the pipework and/or at appliances – it looks like small graphite-like flakes and, when first formed, it has the appearance of small platelets with a metallic sheen.

The platelets are quite brittle and break down easily to become dust, particularly in a fast-moving gas stream – hence the term black dust. These flakes are then carried in the gas flow to the appliances, potentially blocking filters, gas valves, injectors, pilot lights, etc.

The presence of copper sulphide can result in a loss of heat output from the appliance, increased servicing, component and appliance failure. In extreme cases, excessive build-up can completely block the pipework.

The Gas Safety (Installation & Use) Regulations 1998 (GSIUR), particularly Regulation 7(2), Protection against damage, states: *"A person shall not install a gas fitting if he has reason to suspect that foreign matter may block or otherwise interfere with the safe operation of the fitting unless he has fitted to the gas inlet of, and any airway in, the fitting a suitable filter or other suitable protection."*

This regulation is only applicable to the installation of appliances and there is no legal obligation on gas engineers to fit filters or provide other means of protection when copper sulphide is encountered during maintenance visits. Gas Safe Register's advice, however, is to explain the situation to the customer and provide advice on the solutions available.

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You might assume that the 'flakes' are the result of debris and contamination in the gas network being brought into the domestic pipework. Although this can happen, it is uncommon – and black dust is usually formed in the copper pipework itself.

Several factors may influence sulphidation in copper – however, bear in mind that only the first four of the following examples can realistically be modified in an attempt to try and minimise or eliminate the problem – and even then only in new installations.

A limit of 5mg/m³ of hydrogen sulphide is imposed on the gas entering the network by the gas transporters under the Gas Safety (Management) Regulations. This places a duty of care on transporters to ensure that the content and characteristics of the gas comply with these regulations – including hydrogen sulphide (H_2S), sulphur, oxygen, and the hydrocarbon and water dewpoints.

The natural gas transporters must ensure that suitable and sufficient tests are carried out to confirm that the gas carried in their networks conforms to the requirements, and keep records of those tests.

- The appliance output and the flow rate of gas through the pipework
- The choice of pipework material
- The orientation and size of the pipework
- The rate of production of Cu_2S, which affects the subsequent deposit stability
- The H_2S content of the gas
- The size of the appliance injectors, or burner units
- The presence of traces of oxygen and water in the gas
- The temperature of the copper material in contact with the gas.

The effects of black dust

Once Cu_2S has become detached from the pipe wall and transported in the flow of gas to the appliance, the effects can be:

- Collection of deposits in multi-port injectors, possibly leading to poor combustion – this applies particularly to gas fires
- Deposits building up within gas control valves, leading to boiler or other appliance malfunction
- The pilot light (flame) losing its 'shape', causing cooling of the thermocouple and thermo-electrical valve (appliance) shutdown
- Small amounts of gas letting by are also possible where deposits affect the integrity of a valve seating.

An appliance may also become under-gassed where an inline filter has been fitted and not maintained sufficiently, or when a filter integral to the gas valve itself becomes blocked. This can result in inefficient combustion and instability of the flame.

Gas fires and combined gas fire/back boiler units appear to be particularly susceptible to the effects of sulphidation.

There does not seem to be a uniform pattern or timescale to the sulphidation process: in rare instances, the effects of sulphidation become apparent immediately but typically it takes three or more years before problems arise.

Black dust in gas pipework continued

Safety implications
The safety implications of sulphidation are not considered to be significant. However, it may aggravate other defects such as inadequate chimney/flueing or ventilation arrangements, and may result in the release of combustion products containing higher levels of carbon monoxide (CO).

Uniform corrosion arising from sulphidation of copper gas pipework does not appear to result in a significant risk of pipework failure – the rate of corrosion by H_2S and removal of copper is reported to be extremely low. Copper has to react with H_2S to form a deposit that might flake off in due course. The gas flow needs to be fast enough to cause these flakes to travel with the gas to a collection point, where they may then accumulate and interfere with appliance operation.

Let-by of gas as a consequence of sulphidation has been extensively studied by the HSE, which established that the quantities of gas that may be let-by because of the build-up of Cu_2S deposits on a gas valve does not produce any significant safety risk.

At the time of writing, there have been no reports of fatal or non-fatal incidents in Great Britain that can be attributed to sulphidation.

There can be other minor effects of traces of H_2S in gas, including the corrosion of glass-fronted fires (mainly an aesthetic problem), and a small increase in acidic flue products, which also are unlikely to cause any safety issue.

As with all appliances, it is important to stress to the consumer or responsible person for the premises, eg, landlord, the need for proper and regular servicing of appliances.

The phenomenon does not affect every installation, but best practice is to assume the worst and to take preventative action on all gas installations where copper pipe is used in areas where black dust is suspected or known to affect copper gas pipework.

How to deal with black dust in heating systems

New and existing installations

Fitting filters
When copper pipework is used, consideration may be given to fitting filters to the inlet of all appliances.
Note: Filters should be placed at the inlet of the appliance and not at the outlet of the meter. This is because sulphidation usually occurs after the meter (stainless steel construction) and within the consumer's internal pipework, so by placing a filter at the meter outlet, any deposits would not be captured. This would also ensure that any sulphidation from older copper service pipes is also captured.

This method has been used successfully in parts of UK, and installing filters at the appliance installation stage is a preferred option both for the aesthetics and costs of fitting retrospectively.

Filters are not recommended for appliances without flame supervision devices.

Consideration also needs to be given to the possible effects of reducing the operating pressure to appliances beyond the accepted design specification (normally 1mbar for natural gas).

Therefore, care needs to be taken in determining adequate filter sizing to ensure filters will be able to collect H_2S deposits formed between service intervals, without causing an excessive pressure loss.

It is good practice to install a pressure test point immediately upstream and downstream of each filter to allow the operating pressure to be determined under full load conditions, and also enable the condition of the filter to be checked – a high differential pressure across a filter would indicate it is blocked or full.
If subsequently the accumulation of deposits is found to cause too great a pressure drop, then increase the frequency of servicing, after discussing with the responsible person.

Filters should be removed and cleaned periodically, perhaps during the annual service visit or more often in worse-affected premises.

As an alternative to copper pipework, other materials, for example corrugated stainless steel tubing (CSST) may be used, which will avoid the risk of sulphidation on the installation pipework.

Existing installations

Retro-fitting filters to appliances
When retro-fitting filters, the same principles apply and consideration needs to be given to the possible effects of reducing the operating pressure to appliances beyond the accepted design specification (normally 1mbar for natural gas).

Blow through using air
After ensuring the safe decommissioning of the installation, the open-ended pipework can be 'blown through' using air to remove any existing deposits in the pipework. This operation should be undertaken with the gas meter safely isolated (to ensure no air can enter the transporter's network) and all appliances removed. Take into account the need to collect any blown-through material, and to take care of the premises and the associated smell that will result from the operation.

Following this, the gas meter and appliances will need to be reconnected, tested for gas tightness and re-commissioned accordingly.

This will generally extend the time between remedial actions.
Note: Take care not to apply excessive pressure to the pipework that could adversely affect the integrity of the gas installation. For this reason, where appropriate, consideration also needs to be given to the requirements of strength and gas tightness testing, as described in relevant industry standards. Avoid high-pressure air compressors.

Where the problem occurs as a result of copper components in an appliance, such as pilot supplies, etc, consult the appliance manufacturer to determine whether non-copper alternatives are available.

Under no circumstances should non-approved modifications be undertaken.

Maintenance of filters
It is important that any installed filters are cleaned as part of the appliance service. If filters are not maintained at appropriate/regular intervals, the build up of H_2S in the filter will increase resistance of the gas flow to appliances. This may cause the operating pressure under full load conditions to become too low, causing under-gassing and potentially adversely affecting safe combustion. ■