Copper Development Association

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Dezincification Resistant Brass

Information sheet **36**

Introduction

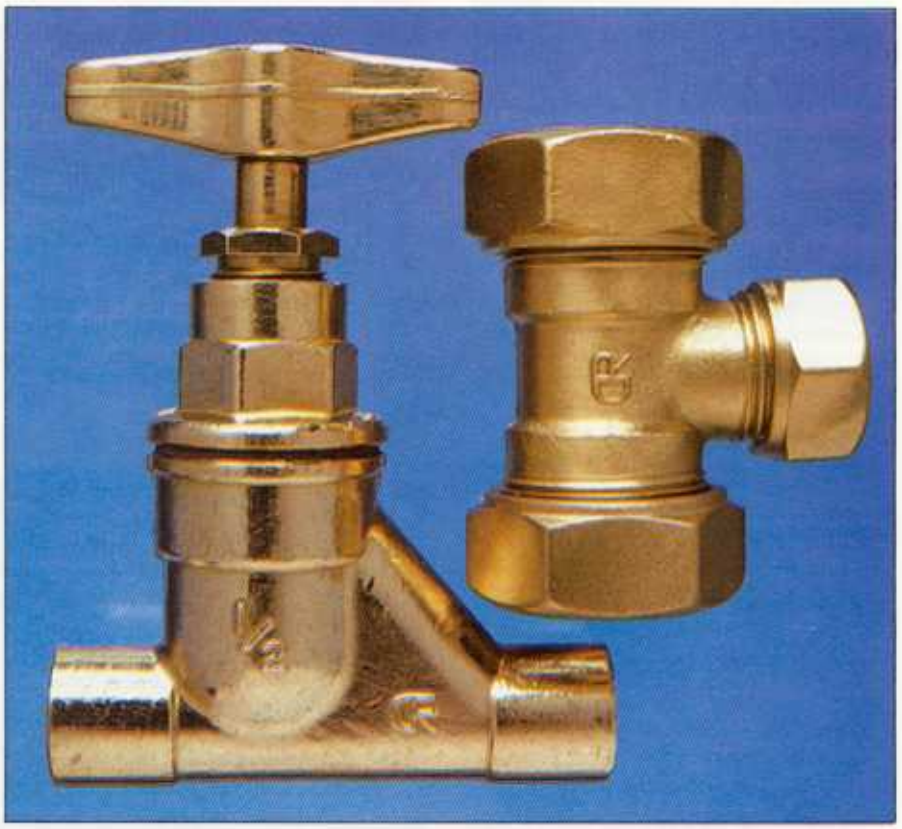
Copper and copper alloy tube and fittings are the preferred materials for use in water distribution systems in buildings because of the ease of installation they afford and the reliability of the installed system. Copper tube, selected from the appropriate sections of BS 2871 has proved its reliability.

For fittings such as joints, bends, stop-cocks and taps, normal duplex brass gives excellent service in contact with most UK potable waters and, in the form of machined or hot stamped components, is the preferred choice on grounds of economy and performance.

In some areas of the UK however, the presence of otherwise harmless impurities in the potable water makes it aggressive to duplex brass producing a form of attack known as dezincification. In such waters, zinc can be leached from normal brass and although the occurrence of dezincification is small, local water authorities in sensitive areas recommend the use of materials resistant to this form of corrosion.

In 1980, BS specifications were issued for a new type of brass, which combined the economy and convenience of duplex brass with the high corrosion resistance typical of more expensive materials. This new brass meets the demanding criteria set by consumer authorities and has received full approval for use in contact with aggressive potable water and also for use underground where contaminated soil waters have to be considered. Dezincification resistant brass is now finding widespread use in these and other applications.

The problem of dezincification, the nature of the dezincification resistant (DZR) brass and the applications for which it is best suited, are outlined.



What is Dezincification?

In certain areas, the local water supply is aggressive to conventional duplex brass water fittings and can cause a selective leaching of the zinc from the brass which may eventually result in leakage or even fracture. The fittings can also be partially or completely blocked by a soft, white "meringue" corrosion product containing basic zinc carbonate. This is easy to distinguish from lime scale deposited by some hot "hard" waters which is much harder and more dense.

Which Supply Waters in Britain can cause Dezincification?

Generally "hard" water supplies do not cause dezincification.

This type of corrosion is found in certain "soft" water areas containing critical combinations of chloride content, temporary hardness and pH described in BNF MP 491 (1).

Since water authorities may obtain their supplies from a variety of sources and may vary the areas served, it is not possible to give an accurate geographical indication of susceptible areas. The possibility that particular water supplies may cause dezincification should be checked with the local water authority operations controller.

In areas where the water supply is aggressive, dezincification can occur in pipeline fittings such as stopcocks, tees, elbows and connectors. It is accelerated by increased temperature and the fittings in a domestic hot water system are therefore more susceptible than those in the cold water system.

It does not occur in terminal fittings such as taps nor in closed loops such as the primary circuit of a central heating system.

Dezincification Resistant Brass

Dezincification resistant brass (DZR brass) is now specified in BS 2872 for forging stock and forgings and in BS 2874 for rods and sections other than forging stock. The alloy, designated CZ132, is made to a carefully controlled composition. This is selected to give the hot malleability typical of conventional brass to aid manufacture, whilst ensuring that after a mandatory heat treatment the material will satisfy the requirements of the dezincification resistance test described below.

The symbol above is used on water fittings to show that they have been manufactured to be dezincification resistant and will satisfy the requirements of the BS dezincification test.

A duplex brass fitting showing the soft, white 'meringue' corrosion product basic zinc carbonate, which is severely restricting water flow.

Examples of DZR brass fittings showing the Dezincification Resistant brass symbol.

(Yorkshire Imperial Fittings)

The Dezincification Resistance Test

As specified in BS 2872 & 2874, this is an accelerated test under severe dezincifying conditions involving a closely controlled 24 hour exposure to hot cupric chloride solution. After this exposure the measured depth of dezincification must not exceed 100 μm (0.004 in.) in stampings (forgings), forging stock or machining rod measured in the transverse direction. This acceptance criterion is three times as severe as that adopted for tests of the same type in other countries. It ensures that there will be no problems with dezincification throughout many years service life.

Manufacturers generally carry out this test in their own laboratories. Independent testing can, when required, be carried out by the BNF Metals Technology Centre, Grove Laboratories, Denchworth Road, Wantage, Oxon, whose results are accepted by the National Water Council.

DZR Brass components fitted to a domestic hot water cylinder. (Peglers Ltd.)

Conventional brass (CZ 122) after exposure to the dezincification test. The photograph (x 50) shows the considerable depth of dezincification attack with extensive porosity to a depth of 1 mm from the surface. (Delta Extruded Metals Ltd.)

Dezincification Resistant Brass (CZ 132) after testing. At a magnification of x 50 there is no evidence of attack. (Delta Extruded Metals Ltd.)

Uses of Dezincification Resistant Fittings

Dezincification resistant or immune fittings should always be used in underground applications and in the manufacture of assemblies of plumbing fittings (such as hot water heaters, cylinders and boilers) which may be distributed to any district.

When the local water supply is known to be aggressive, all line fittings in the domestic hot water system should be of DZR brass and it should preferably be used for cold water supply pipe fittings as well. DZR brass is not required for central heating primary circuits or for terminal fittings such as taps.

Quality Assurance

Dezincification resistance is assured by close control at all stages of manufacture, from casting and production of brass rod to shaping and heat treating the fittings themselves. Precise control of major alloying elements is essential, coupled with exclusion of undesirable impurities. Periodic checking of components after heat treatment by the use of the dezincification test ensures that not only is the composition correct but the specified heat treatment has been effectively carried out.

The presence on fittings of the BSI Kitemark besides the name or brand of the manufacturer indicates that the production of the components has, at all stages, been under a quality control scheme assessed and approved by the British Standards Institution. Under this scheme, periodic checks on components are carried out by the BSI laboratories to confirm their confidence in each registered manufacturer. In addition to these marks, the manufacturer also adds the mark to show ability to pass the test requirements for dezincification resistant brass.

The BSI Kitemark of Approved Quality Assurance

Soldering DZR Brass

The use of conventional soft soldering techniques is entirely satisfactory. If, however, DZR brass is reheated above a temperature of 550°C, the corrosion resistant properties will be affected. Silver soldering should not therefore be used unless the components joined can be heat treated after joining under the controlled conditions given in the standard so that the whole assembly, including the filler material, will satisfy the requirements of the dezincification test. Ordinary brass brazing spelter will not normally pass the test.

DZR Brass Underground

It is now stipulated in model water byelaw 16a that all underground fittings, irrespective of the type of water supply, should be resistant to or immune to dezincification. This is because of the possibility of location in corrosive soils and the difficulty and expense of location and rectification of fittings if dezinification does occur.

Dezincification Resistant Brass for Marine Application

Recent experimental work by the BNF Metals Technology Centre (2) has shown that the dezincification resistance of CZ132 alloy is maintained in sea water high in chlorides and other aggressive agents. Use in a fully submerged sea water filter for one year resulted in less than 20 μm (0.0008 in.) of corrosion of CZ132 compared with five times as much on naval brass (CZ112). Lloyds Register of Shipping Yacht and Small Craft Department now have no objection to the use of DZR brass in through-hull fittings.

Molten DZR brass is sampled before casting for analysis by X-ray fluorescence spectrometry – a high speed precision technique. (IMI Rod & Wire Ltd.)

Historical Background to the Development of DZR Brass

Two types of brass are in common use. The higher copper brasses generally contain over 63% copper and have a single-phase (alpha) structure. These are used particularly for their good cold forming properties as in deep drawing or in tube drawing. For optimum hot working properties, required for manufacture of water fittings by hot stamping, brasses of a lower copper content with a duplex (alpha - beta) structure are used.

Dezincification was first recognised as a serious problem in the alpha brass used for ships condenser tubes but alloying additions were developed which made the material immune. The same additions do not succeed with the duplex brasses because of the presence of beta phase as well as the alpha.

Dezincification first became a recognized problem with duplex brass water fittings in the late 1950s, when certain water authorities banned the use of duplex brass fittings, after experiencing rapid blockage of hot water fittings as a result of dezincification. Research carried out by the British Non-Ferrous Metals Research Association (now BNF Metals Technology Centre) in collaboration with the Copper Development Association and the British Waterworks Association (now the National Water Council) established the relationship between the composition of supply waters and their liability to produce dezincification. The number of areas affected was not large and the problem was overcome by manufacturers developing ranges of fittings in copper or gunmetal which are immune to dezincification and could be specified for use in the areas concerned.

Later developments in the water supply industry, involving new large-scale schemes for water abstraction and treatment and facilities for interchange of water between different supply areas, revived concern about the risk of dezincification in water fittings. In 1969 the brass industry, together with BNF, set up a further programme of research aimed at developing a brass suitable for manufacture of water fittings by hot stamping but resistant to dezincification. Over the next five years this research established the range of alloying additions and the heat treatment that would provide a brass which, at the hot stamping temperature, would contain sufficient beta phase to forge satisfactorily but could by subsequent heat treatment, be converted to an all-alpha structure protected against dezincification. The laboratory work was followed by practical evaluation of the material in a wide range of waters and is described in a paper by J E Bowers and colleagues (3). Their work culminated in 1980 in the publication of amendments to BS 2872 and 2874 defining the composition, mechanical properties, heat treatment and dezincification testing criteria for forgings and extruded bar in CZ132.

The results of standard tests of the acceptability of these fittings show them to be completely safe for handling potable water.

Many manufacturers now make fittings of dezincification-resistant brass CZ132 and most popular types and sizes of fittings are available from stock. High standards of quality control are required to ensure that the composition and heat treatment are correct and it has been agreed between the National Water Council (NWC), National Brass Founders Association (NBA) and the Copper Tube and Fittings Manufacturers Association (CTFMA) that fittings in dezincification resistant brass made to these standards should carry the identification mark.

Some Relevant British Standards

Materials

BS 2872 : 1969 Copper & Copper Alloys: Forging Stock & Forgings (including 1980 Amendment AMD 3282)

BS 2874 : 1969 Copper & Copper Alloys: Rods & Sections (other than forging stock) (including 1980 Amendment AMD 3283)

BS 2871 : 1972 Copper & Copper Alloy Tubes: Part 1 – tubes for water, gas and sanitation.

Fittings

BS 864 – Capillary & Compression tube fittings of Copper & Copper Alloy, Part 2 (This covers fittings for domestic purposes used with copper tube to BS 2871 Part 1). Part 3 – Compression Fittings for use with polyethylene pipes.

BS 1010 – Part 2 – Draw off taps and above-ground stopvalves.

BS 2879 – Draining taps (screw down pattern).

BS 5154 – Copper alloy globe, globe stop and check, check & gate valves for general purposes.

BS 5156 – Screw down diaphragm valves for general purposes.

BS 5433 – Underground stopvalves for water services.

British Standards are published by the British Standards Institution and obtainable from BSI Sales Division, 101 Pentonville Road London N1 9ND.

References

1) "Dezincification in supply waters" BNF MP 491, 3rd Edition 1982, BNF Metals Technology Centre, Wantage, Oxon.

2) "The use of dezincification resistant brass in sea-water". H S Campbell & R Francis, BNF Report CN 272, January 1982.

3) Development of a hot stamping brass resistant to dezincification, J E Bowers, P W R Oseland & G C Davies – Brit. Corr. J. 1978 Vol. 13, No. 4, pp 177–185.

Acknowledgements

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