THE SUITABILITY AND USE OF STAINLESS STEEL FOR PLUMBING APPLICATIONS

Special BSSA Report - February 2003

INTRODUCTION

This Special Report provides a synopsis of a research project carried out by the British Stainless Steel Association (BSSA) on the suitability and use of stainless steel tubes and fittings for internal plumbing applications. The research was carried out in the U.K. and the results were compared with those from other European countries, primarily Germany, France and Italy. It was conducted by Mr A. Chimmalgi of Sheffield University Management School and was sponsored by the Nickel Development Institute [NiDI], Coventry Tubes and Lancashire Fittings.

STAINLESS STEELS

Stainless steels are corrosion resistant steels, which are protected by the formation of a self-repairing passive oxide film. The resilience of this layer increases with chromium content and also with the addition of molybdenum. The presence of nickel encourages the formation of a crystalline structure called austenite, which aids ductility and formability. The standard stainless steel alloys used in plumbing applications typically contain 17-18% chromium and 8-12% nickel. The most commonly used grades are BS EN 1.4301 (304), 1.4307 (304L), 1.4401 (316) and 1.4404 (316L).

Stainless steel water tubing
(Photo courtesy of Coventry Tubes)

ADVANTAGES OFFERED BY STAINLESS STEEL

Stainless steel offers a wide range of benefits to the architect and designer of plumbing systems:

Material Benefits

- Stainless steel has a very low general corrosion rate in water and no corrosion allowance is required.
- It can withstand very high flow rates - in excess of 40m/s.
- Combining corrosion resistance with high strength allows reduction in section diameter, wall thickness and weight, making it quick and easy to install.
- It is ductile and, using the appropriate tooling, is not difficult to bend and cut.
- Stainless steel pressfittings, in particular, are easy to use for joints, and ideal for installation in areas with limited space and access or where the use of heat would be a problem.

Environmental Benefits

- Stainless steel can be used in all types of water. Leaching of constituent alloys falls well within the limits allowed for products in contact with drinking water in public supply.
- It has excellent resistance to the full range of potable waters (including the various chloride levels) covered by the European Drinking Water Directive.
- Stainless steel installation is clean and, if properly carried out, does not contaminate the system and reduces flushing times.
- No heat is required to form a joint or a groove, reducing fire hazards. Therefore hot work permits are not required.
- Stainless steel is fully recyclable.

Economic Benefits

- The expected lifetime of a stainless steel system is more than 50 years, longer than is typical for competing materials.
- Stainless steel requires no additional coating.
- No maintenance is required after installation, reducing system down time, replacement and maintenance costs over the life-cycle of the installation.
- Although initial costs may be higher than for competing materials, such as copper and plastic, the

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economic benefits of using stainless steel increase over time.

- At the end of its useful life, stainless steel is fully recyclable and retains a higher residual scrap value than ordinary steel.

Aesthetic benefits

- Stainless steel installations blend well with modern architecture and interior design.
- Stainless steel systems do not require painting and can be left visible to the eye.

EUROPEAN REGULATIONS

In recent years the use of stainless steel for plumbing systems has grown, especially in Germany and Japan. The market share of stainless steel for plumbing applications in Germany is estimated to be around 12%. This is forecast to increase as a result of the revised German standard DIN 50930, which prohibits galvanised steel plumbing or allows it only where the water pH is high (above pH 7.5/7.6). The standard, which is likely to become a 'European EN standard', also creates certain restrictions on copper as a plumbing material. By contrast, 316-grade stainless steel can be used without limitation. These regulations, when implemented across Europe, will have greater impact in the U.K. in material selection for plumbing applications.

USE IN SCOTTISH HOSPITALS

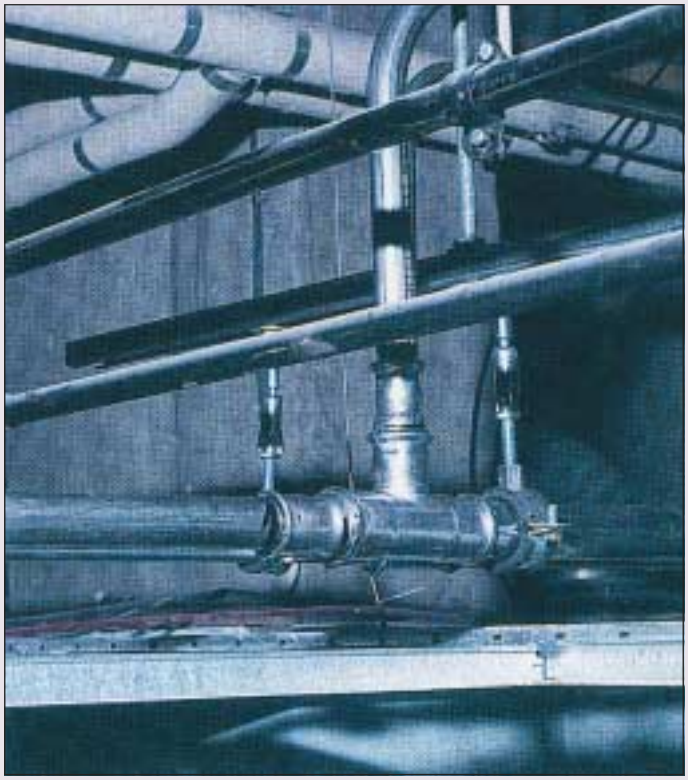
Stainless steel has been used for plumbing installations across the U.K., but has been of particular importance in Scottish hospitals. The following quotations from the Scottish Hospital Technical Note 2 Version 1 (SHTN) explain some of the reasons for the growing popularity of stainless steel installations:

> This SHTN addresses the problems experienced by the NHS in Scotland in consequence of the corrosion of copper pipework systems. Despite extensive research, the absolute cause of the corrosion is not yet understood, but enough is understood to allow the conclusion to be reached that copper pipework in Domestic Hot and Cold Water (DHCW) services in hospitals in many areas of Scotland, where the water is soft, and contains high levels of sediment, has a high propensity to failure[1].

The Technical Note elaborates this basic conclusion in more detail:

- Since 1983 it has become evident that corrosion of copper piping within DHCW services in many Scottish hospitals and other Healthcare Premises (HPs) is a serious problem.
- This corrosion, which takes the form of localised pitting or 'pinhole' attack to the wall of the piping, may be unique to institutional buildings, and with slight variations, has been found to be predominant in soft water regions throughout Scotland. Other countries in mainland Europe have experienced similar problem, with Northern Ireland and Wales recently identifying corrosion within HPs.
- Although this form of attack has not as yet resulted in a catastrophic form of failure, it does lead nevertheless to a severe shortening of a system's useful life, with a noticeably growing incidence of repair work and disruption to the operation of a hospital as the extent of pipe failure and water leakage increases.
- Several Scottish hospitals which have suffered serious pipework corrosion have now been re-piped using alternative materials for the pipework system.
- The approved alternative materials are, at this time, the austenitic stainless steels, the polyvinyl-chloride (PVC) plastics, polybutylene and crosslinked polyethylene (PE-X) [2].

Interviews conducted as part of this project have indicated that these stainless steel installations are performing well, both in terms of leakage prevention and reduced maintenance. The Scottish experience suggests that stainless steel will be particularly well suited for installation in other regions of the U.K. with similar, soft water conditions.



Stainless steel press fitting pipework in a Scottish hospital ceiling (Photo courtesy of NiDI)

CURRENT PERCEPTIONS IN THE MARKET PLACE

Primary research was carried out as part of the project, to assess what determines the choice of material for plumbing applications. Stainless steel was compared with other materials in common use, especially copper and plastic. The following views emerged from a questionnaire and personal interviews, which targeted Architects, Consulting Engineers, Plumbing Contractors and other important decision-makers:

- Although copper dominates the U.K plumbing market, none of the respondents believed that it

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would retain its current market share. 83% believe plastic, and 64% believe stainless steel will gain in future importance.

- According to 59% of respondents, in recent years stainless steel has gained greater acceptance among architects and builders as a material for plumbing purposes, and has the capacity to gain further market share.
- All respondents rated stainless steel highly in regard to low operating costs, fire resistance, bacteria resistance, leaching, hygiene, ease of cleaning, durability, corrosion/leakage, resistance to stains and aesthetics.
- By comparison, copper is rated highly for its lower initial cost, high residual/ scrap value, ease of fabrication, compatibility with other materials, easy availability, recyclability and low repair costs. Plastic is rated most highly for its low weight.
- Stainless steel is viewed as the most expensive material, followed by copper and plastic. The cost difference between stainless steel and copper reduces when the diameter of the pipe increases.
- In larger installations, the overall difference of installing a commercial plumbing project was reckoned to be minimal between copper and stainless steel, when pipework is joined using a pressfit system.
- For domestic plumbing purposes, the majority of respondents stated that plastic is more suitable with its simple pushfit systems, followed by copper.

COST ANALYSIS

It was evident from the survey that stainless steel plumbing systems are for the most part more expensive in terms of initial cost than copper or plastic.
To examine this cost difference in more detail, the cost of copper tubes and copper alloy fittings were compared with those of three different manufacturers of stainless steel. Copper was found to be much cheaper in the smaller diameter (15mm to 22mm) pipes and fittings. The gap in price between copper and stainless steel decreased in the middle range of diameters (28mm and 35mm). The price of stainless steel nearly equalled, or was sometimes lower than copper, in the largest diameters (42mm to 108mm).

It was apparent from the survey that this pattern is applicable not only to the U.K, but to other European markets. It was also apparent from the survey, that discounts for plumbing products depend largely on the quantity of the purchase, rather than the type of material, implying that the discount structure for copper, plastic and stainless steel products is similar.

Despite the higher initial cost, stainless steel often enjoys life cycle advantages compared with other materials. Even though the initial costs are slightly higher for stainless steel plumbing materials, the gap in installed cost can be reduced by using a fast and efficient method of jointing (see photo). Low maintenance, system downtime and replacement costs can then make stainless steel cheaper over the complete life cycle of the installation.

INSTALLATION

The most efficient and cost effective method of joining stainless steel pipework is by pressfitting. This involves clamping the fittings around an integral polymeric seal using an electro-mechanical tool. This technique takes less time and less manpower for a large installation than other jointing methods, and hence is a popular choice for hospitals and other large, public and commercial buildings. As this method is also flame free, quick-to-joint and low weight, the installation cost can be substantially reduced, compared with other techniques.
Where other techniques may be more suitable for a specific

A pressfitting tool clamping an Inoxpres fitting
(Photo courtesy of Lancashire Fittings)

design or installation, stainless steel products and systems are readily available, namely:

- Compression fittings (single ferrule and double ferrule)
- Capillary fittings

Lancashire Fittings compression, capillary & press fittings
(Photo courtesy of Lancashire Fittings)

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For optimum performance from stainless steel products, care must be taken throughout the design, installation and testing phases.

Detailed information can be obtained from the following publications:

Plumbing Applications

Domestic hot and cold water systems for Scottish Healthcare Premises Scottish Hospital Technical Note 2, (*Version 1)*, NHS Scotland, Property and Environment Forum, December 1999, internal guidance note, not available for sale or distribution outside NHS Scotland

Piping Manual for Stainless Steel Pipes for Buildings No 12 008, published by Japanese Stainless Steel Association and Nickel Development Institute [NiDI], 1987, available f.o.c. from NiDI (address below)

Stainless Steel Plumbing, published by Nickel Development Institute [NiDI], 1997, available f.o.c. from NiDI (address below)

Public Water Supply

Applications for Stainless Steel in the Water Industry IGN 4-25-02, SCI © 1999, available from WRc, cost £10

Operational Guidance and Code of Practice[OGCP] for Stainless Steel Products in Drinking Water Supply, SCI © 2002, available in pdf format from the BSSA web site www.bssa.org.uk/fpauth/services/pubs.htm

CONCLUSIONS

The research has demonstrated a growing interest in stainless steel as a plumbing material, especially in Germany, based upon both economic and environmental benefits.

Stainless steel plumbing products have significant potential for greater use in the U.K., especially in regions where the water is soft with a low pH value. Use in Scottish hospitals has demonstrated the effectiveness of stainless steel systems.

Stainless steel offers a range of benefits, with particular importance attached to its hygienic properties, its resistance to corrosion and low maintenance. This makes it an attractive choice when considering the life cycle cost of an installation. Stainless steel does not require painting and blends in well with modern interior design. It is also fully recyclable.

Stainless steel is particularly suited to large-scale installations in segments of the commercial and public sector, such as hospitals, children's and old people's homes, prisons, schools and hotels; in other words where there is a health & safety issue and the properties of stainless steel plumbing materials can be used to their full potential.

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[1] *Domestic hot and cold water systems for Scottish Healthcare Premises* Scottish Hospital Technical Note 2, (*Version 1)*, NHS Scotland, Property and Environment Forum, December 1999, p.7, quoted by permission.

[2] ibid, pp.8 & 9

This report has been prepared by the British Stainless Steel Association in association with the Nickel Development Institute [NiDI], Coventry Tubes Permatube Ltd and Lancashire Fittings Ltd.