UK WATER INDUSTRY RESEARCH LIMITED

BRASS FITTINGS AS A SOURCE OF LEAD & NICKEL IN DRINKING WATER – LONG TERM LEACHING STUDIES

Executive Summary

Background

This report is one of two presenting the findings of Stage 2 of the UKWIR Project "Brass Fittings – A Source of Lead in Drinking Water" and of the associated UKWIR Project "Nickel Leaching Characteristics of Brass Fittings". This Report presents the findings of experiments undertaken to determine the effect of the addition and cessation of phosphate dosing on brass fittings deployed on long-term test rigs, and a laboratory study comparing the effect of chlorine or chloramine dosed water on lead and nickel leaching.

Objectives

The overall objectives of the projects are:

1. To assess the contribution of brass fittings to concentrations of lead and nickel in drinking water.

2. To assess the effect of phosphate dosing on lead and nickel leaching from brass fittings.

3. If lead levels are considered elevated by brass fittings, to inform how this might affect the development of national and local strategies to reduce lead levels in drinking water.

4. To provide evidence/information to inform discussion about the suitability of the present UK norms for the lead content of brass fittings.

5. To provide evidence/information to inform discussion about nickel leaching.

Conclusions

Lead and nickel yields from fittings

One of the specific questions set out in the project objectives was 'what effect are existing brass fittings (taps, stop taps, meter casing) having on lead concentrations in drinking water (both as individual fittings and cumulatively)?'

This research has found that some individual brass fittings or groups of fittings can routinely yield a few µg/l of lead or nickel after periods of stagnation. It has identified situations where, following stagnations of 8 hours, individual brass fittings as well as combinations of fittings yielded masses of lead or nickel capable of exceeding their respective PCVs of 10 µg/l and 20 µg/l if drawn into a one-litre Random Daytime Sample (RDS) at the kitchen tap.

These situations are:

- leaching from new fittings during the first week of use;
- apparent seasonal effects of higher water temperature;
- the switching of supply from long-term phosphate dosing to non-phosphate dosed water;
- re-connection to a water supply after a prolonged period of standing empty;
- longer periods of stagnation of up to two weeks prior to sampling.

The nickel leaching characteristics of the brass fittings showed many similarities to those observed for lead during long term testing and experimentation on phosphate dosing. Notably, among the nine fittings included in the long term tests (taps, connectors, water meters, stop taps and ferrule), the UK 'low lead' tap yielded the smallest quantity of lead among the nine fittings, but was one of the highest for nickel yield.

The long term testing of identical brass fittings in phosphate-dosed and non-phosphate dosed hard and soft waters has shown that phosphate dosing exerts a strong effect in reducing both lead and nickel leaching. The effect is apparent within 24 hours of installation and over the long term. Experiments to switch from long-term exposure in non-phosphate dosed to phosphate-dosed water found yields of lead and nickel reduced sharply within 24 hours and stabilised after a week or more to levels close to those observed on the permanently phosphate-dosed test rigs. The decline in lead yield following exposure to phosphate was between 80% and 97% across the different models of brass fitting at both hard and soft water sites.

The cessation of phosphate dosing resulted in a rapid increase in lead leaching within days and stabilisation at much higher yields in as little as one week.

The initial yields of lead observed from new brass fittings on non-phosphate dosed hard and soft water supplies were generally the highest observed throughout the study. In most cases, they fell quickly reaching stable values after a few weeks. However, lead yields then increased from some fittings at the soft water site. Comparison of yields and water/ambient temperature data from this site indicated that rising water temperature might be the causal factor. Nickel yields from some fittings also rose. A peak in lead yields at the hard water site was also found to coincide with a peak in summer temperatures.

The cessation of phosphate dosing through brass fittings that had previously been maintained on phosphate-dosed water over the long term (up to 18 months at the soft water site), caused lead yields to rise and exceed those of the corresponding fittings that had been on non-phosphate dosed waters long term. When this study ended, some two months after cessation of phosphate dosing, the yields were still higher.

Chloramine vs chlorine

The limited experimentation undertaken, involving six 16-hour laboratory stagnations of replicate groups of stop taps identified some statistically significant differences in leaching behaviour between different forms of chlorine residuals for both lead and nickel. Five treatments were applied using hard and soft water: a control (no treatment), non-phosphate dosed chlorinated, non-phosphate dosed chloraminated, phosphate-dosed chlorinated and phosphate-dosed chloraminated.

Lead

- Among non-phosphate dosed treatments no significant differences were found between the hard water chlorinated and chloraminated groups or soft water chlorinated group and their respective controls. However, the concentrations in the soft water, non-phosphate chloramination treated group exhibited statistically significant differences in lead leaching with values being lower than in the soft water control or chlorinated groups and the corresponding hard water non-phosphate, chloramination group.

- For both soft and hard water, lead concentrations were statistically significantly lower in the phosphate-dosed groups than in the corresponding controls and non-phosphate dosed groups. Differences between the phosphate dosed groups in soft and hard water were not found to be statistically significant.

Nickel

- Concentrations of nickel between groups of fittings were statistically significant, by being lower in soft water than in hard water, for all control and non-phosphate dosed chlorinated and chloraminated groups. Differences between hard and soft water were not statistically significant for the phosphate-dosed groups.

- In hard water, nickel concentrations in the chlorine dosed group, without phosphate treatment, were statistically insignificant to the control. However, concentrations found in the chloramine dosed groups, without phosphate treatment, were statistically significantly lower than in the control or chlorine dosed groups. Concentrations in the hard water, phosphate-dosed groups for both chlorine and chloramine treatment were statistically significantly lower than in any of the other groups, but differences between these two groups were not found to be statistically significant.

- In soft water, nickel concentrations found in both chlorine-dosed groups (with and without phosphate) were not statistically significantly different to the control. The concentrations of nickel in both chloramine-dosed groups (with and without phosphate) were significantly lower than other groups, but differences between them were found not to be statistically significant.

Recommendations

Research has identified situations where brass fittings could yield elevated levels of lead and nickel in Random Daytime Samples (RDS) that may either contribute to or cause PCV failures. Water companies when investigating causes of PCV failures at customers' premises should consider the potential contribution of brass fittings.

Low lead brass fittings (<0.25% lead) have been shown to yield less lead than corresponding 'high lead' brass fittings (2.0% to 3.5% lead). However, the low lead taps tested did yield relatively high quantities of nickel. It was also found that the relatively high lead brass ferrules (up to 6.0% lead) were relatively low yielding. Any consideration about changing the lead content requirement for fittings used in the UK, needs to examine the issue holistically with regard to leaching of other metals of interest from brasses and the performance characteristics of finished products.

It was demonstrated that phosphate dosing reduces leaching of nickel and zinc in addition to lead. If removal of phosphate dosing is being considered then the potential impact on water quality compliance for other metals of interest must also be considered.

It was shown that high yields of lead and nickel come from new brass fittings, fittings that have been empty of water for some time and from fittings that have held stagnating water. Flushing before use is recommended for these situations.

The limited experimentation comparing chlorinated and chloraminated treatments, found some statistical differences in leaching characteristics between each form of chlorine residual and types of waters, which could warrant further investigation.

Benefits

This study on the contribution of brass fittings to lead and nickel concentrations in drinking water at customers' taps has:

- Increased our understanding of how brass fittings may contribute to lead and nickel concentrations in drinking water;
- Provided information on types of fittings to avoid the costs of installing and then replacing fittings that are contributing to elevated levels of metals;
- Assessed the likely impact that brass fittings may have if plumbosolvency treatment is removed;
- Informed future assessment of the potential risks to lead and nickel compliance from brass fittings; and
- Provided information to better inform and improve investigations carried out by water companies following failures of lead (or nickel) standards or carry out other risk assessments related to lead levels in drinking water.

For further information please contact UK Water Industry Research Limited, 8th Floor, 50 Broadway, London, SW1H 0RG quoting the report reference number