Private Water Supplies

Aluminium – Guidance for Local Authorities

Description and Background

Aluminium is a metal element, abundant throughout the Earth's crust. In private water supplies it can occur naturally or be introduced as part of the treatment process. Aluminium salts are widely used in water treatment as flocculants to reduce organic matter, colour, turbidity and micro-organism levels, although flocculation is a comparatively unusual treatment process to be found in private water supplies (it is, however, common on larger public ones).

Naturally occurring aluminium can also be present in private water supplies, at concentrations in excess of the regulatory standard. This is usually in a combined form, either as an inorganic salt or complexed with organic material such as humic acids. Aluminium is more likely to be leached from soils where water pH is low, which unfortunately does include many supplies in upland areas in Scotland.

Drinking water comprises only a small proportion of the route by which humans ingest aluminium, with food being the major source.

Health Significance

Aluminium is abundant in a range of foodstuffs, and drinking water is likely to be only one of a number of ingestion routes. A potential link between aluminium and Alzheimer's disease has long been suggested but not proven. WHO do not set a health based guideline value but do suggest that residual aluminium concentrations should be minimised with 100μg/l being achievable in larger supplies and 200μg/l (which is also the regulatory standard) in smaller ones.

Risk Assessment and Monitoring

The Private Water Supply regulations require monitoring for aluminium where it is used in water treatment as a coagulant. In practice this will apply to very few private water supplies.

Natural aluminium is potentially more of an issue, however, and it would be prudent to monitor for this in any upland supply where water has a low pH or where other samples on similar supplies in the area have contained significant concentrations of aluminium. Research by BGS [1] suggests that aluminium is likely to be found in significant concentrations in groundwaters across the Highlands and Southern Uplands of Scotland.

Aluminium is relatively easy and cheap to analyse for, and it would be sensible to include it in any general suite of metals analysis.

What if it fails?
When this parameter fails there is unlikely to be any acute health issue for consumers in good health, however if any doubt, health advice should be sought. If there is a coagulation treatment process, this should be the initial focus of any investigation and sampling before and after the process may be beneficial.

Check the following:

- Operation of any coagulation process
  - Correct coagulant dose used
  - Coagulation is being attempted at correct pH (around 6.1 for aluminium sulphate)
- Data from any neighbouring supplies to check the scope and extent of any naturally occurring aluminium
- If the presence of natural aluminium is suspected, consider additional sampling to better define the extent of failures

Options for resolving at source
These are likely to be limited as aluminium is ubiquitous in the environment, although if multiple sources are present it may be worth sampling each to see if some are contain lower concentrations of dissolved aluminium than others.

Treatment
Where coagulation and filtration processes are present, these should be optimised to reduce any residual aluminium to well below the regulatory standard. Any naturally occurring aluminium present in the supply will also be removed at this stage.

Where there is no existing treatment, a number of options are possible:

- Ion Exchange
  Cationic ion exchange resins can be used to selectively remove aluminium. These resins need to be periodically re-charged using chemicals, and this is best carried out by a competent contractor. Some companies offer a replacement service whereby the ion exchange filter is exchanged for a new one and the exhausted filter removed and regenerated off-site.
- Adsorption
  There is evidence that adsorption onto activated media contained within a filter may offer an effective solution for removal of natural aluminium. A carbon media is typically used, but others are available. Removal efficiency will vary between media, even between types of carbon, so specialist advice should be sought. Whatever media is used, some sort of backwash facility will be required and the media will eventually become exhausted and require replenishment.
- Precipitation
  It may be possible to precipitate aluminium out of the water by adjusting the pH. This will require raising the pH to around neutral, probably by dosing an alkali such as lime or sodium carbonate. A filtration process with an effective wash system will be required to remove the precipitate. The precipitate will probably take the form of a gelatinous solid, which has the potential to block filters, making this a less ideal treatment method, but one which may be worth trialling where water chemistry allows and a suitable filter is already present.

- Reverse Osmosis Membrane (RO)
  This is the preferred option for removal of aluminium as it offers complete reliability with minimal use of chemicals. Membrane treatment involves forcing water at high pressures through fine porous sheets (the membrane). Membranes come in differing pore sizes, with increasing pressures (and therefore pumping costs) required as pore sizes decrease.

  Reverse Osmosis (RO) membranes will remove most ions dissolved in the water. Operating costs can be quite high and a percentage of water is lost in the waste stream. Disposal of the concentrate (waste stream) may be problematic as chemicals removed from the water are concentrated here.

  RO membranes are well established as point of use treatment on private water supplies. Some pre-treatment (coarse filtration) may be required to remove sus[ended solids prior to the membrane. Even then, membrane fouling can be a problem, especially where the water contains a large amount of natural organic matter or salts such as calcium, magnesium, sulphate or chloride. Cleaning an RO membrane is possible, but costly and requires chemicals and expertise that may be beyond the scope of most private water supply users.

  However, issues such as fouling of the membrane and disposal of the waste stream may need to be considered. Low pressure RO units lose a significant proportion of the incoming water flow as waste, which may be an issue where water resources are tight. Additionally, RO will remove almost all natural salts dissolved in the water, rendering it almost equivalent to distilled water. Although this level of purity may seem superficially attractive, it does mean that the water may not taste very palatable to consumers. It will also make the water highly corrosive to many plumbing materials, and this should be borne in mind. Re-mineralisation of the water is possible using special filters after the RO unit. Specialist advice should be sought in the consideration and siting of point of use RO treatment.

FAQ Fact Sheet for Owners and Users
To be developed if necessary

References / Further reading

[1] Macdonald, A M, Fordyce, Fm, Shand, P And Ó Dochartaigh, B É. 2005.
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