WATER PURITY – MYTHS AND CHALLENGES

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INTRODUCTION

Water purity is a complex term and is often approached in a subjective manner.

What are we talking about: water contamination or perhaps environmental pollution? In the United States, the EPA defines "pure" water as water free from all types of bacteria and viruses. In the UK drinking water has to be "wholesome". But there is more to purity than just that.

Water is a compound made up of hydrogen and oxygen, so pure water would be water that contains nothing but hydrogen and oxygen. However, pure water of this sort does not normally exist except in the controlled environment of a laboratory. Even in a laboratory pure water is hard to come by. For example, bacterial contamination of purified water can cause major problems in the laboratory. Even if organic and inorganic chemical impurities are removed down to the limits of detection, bacterial growth can still occur, even though very pure water provides an extremely harsh environment with apparently negligible nutrient content. To avoid metallic contamination of the water, laboratory water purifiers are constructed using plastics. The bacteria can use these materials that are in contact with the pure water as a carbon food source to sustain them, and then when they die they release further contaminants into the water. If this bacterial growth is not minimised, it can cause significant difficulties in the day-to-day operation of the laboratory.

WHAT DO PEOPLE MEAN BY "PURE WATER"?

From a drinking water standpoint, most references to "pure water" emphasise bacteria content and not the chemical contaminant concentrations.

There is no such thing as pure water. The very concept of 'pure' water is misleading. Pure water does not exist in nature. Water is the universal solvent. Even as it falls to earth as rain it picks up particles and minerals in the air. And as soon as it hits the ground it captures minerals from the soil and rock upon which it lands and then makes its way into streams and rivers.

Most water will contain certain ions, such as calcium and magnesium, even if it is just a trace amount. These minerals are the ones that define whether water is hard or soft, and they play a role in taste.

Water supply companies achieve healthy water by identifying the unhealthy contaminants in their water and then taking action to remove them. Consumers can further purify if they wish.

The public discussion about water will switch from the notion of 'pure' to 'healthy'. 'Healthy' water is attainable, whereas pure water is not. And just what is healthy water? 'Healthy' water has a pH that does not adversely affect human biological processes; the optimum appears to be between pH 7 and pH 8. Harmful contaminants such as disinfection by-products eg trihalomethanes, and any harmful chemicals or metals, whether man made or naturally occurring, have been identified and removed with the appropriate treatment.

WHAT DOES A WATER SCIENTIST MEAN BY "PURE WATER"?

From a water scientist's perspective, water purity is considered within the context of its anticipated use. Drinking water should be wholesome and meet all regulatory requirements whereas water destined for use by industry, agriculture or horticulture should be "fit for use". The quality standards are determined for the most part by the user. In the case of environmental waters they would be expected to have achieved good (ecological) status as described in the EU Water framework Directive.

WHAT IS REQUIRED TO DETERMINE ACHIEVEMENT OF THOSE CRITERIA?

In order to determine if water has achieved the required standards the following measures are required. There must be:

- Appropriate evidence based quality standards
- Appropriate risk based monitoring and testing
- By accredited laboratories
- With competent technical staff

All these need to be reviewed at appropriate intervals.

Examples of evidence based quality standards include World Health Organisation's drinking water standards and UK Environmental Quality Standards.

EUROPEAN DRINKING WATER DIRECTIVE

This Directive (98/83/EC) concerns the quality of water intended for human consumption and forms part of the regulation of water supply and sanitation within the European Union. The Directive protects human health by laying down healthiness and purity requirements which must be met by drinking water within the Community. It applies to all water intended for human consumption apart from natural mineral waters and waters which are medicinal products.

In setting contaminant levels the Directive applies the precautionary principle. For example, the EU contaminant levels for pesticides are up to 20 times lower than those in the WHO drinking water guidelines, because the EU directive not only aims at protecting human health but also the environment.

WHO CONTAMINANT LEVELS

The WHO contaminant levels are already set so that there would be no potential risk if the contaminant was absorbed continuously over a person's lifetime. EU drinking water standards and cases where these standards are temporarily exceeded by a small margin should be interpreted in this context.

WHO specifies health related guideline values rather than one fixed blanket limit, irrespective of substance toxicity.

For example WHO states "Because of their low toxicity, the health-based value derived for AMPA [1] alone or in combination with glyphosate is orders of magnitude higher than concentrations of glyphosate or AMPA normally found in drinking water under usual conditions. The presence of glyphosate and AMPA in drinking water does not represent a hazard to human health. For this reason, the establishment of a formal guideline value for glyphosate and AMPA is not deemed necessary." This also applies to metaldehyde where many millions of pounds have been spent trying to remove totally harmless levels.

SAMPLING AND TESTING

Within the UK there exists a risk based regulatory sampling and inspection system for both drinking water and environmental waters and aquatic emissions.

The analytical laboratories are accredited to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories.

In addition Drinking Water Laboratories are required to comply with the Drinking Water Technical Standards (DWTS) issued by the DWI (in England and Wales) and DWQR (in Scotland). DWTS is necessary in addition to ISO 17025 to ensure fit for purpose results.

These standards also set out the required competencies of people involved in determining if the necessary standards have been met. Demonstration that the competencies have been achieved and verified by a third party can be done by gaining relevant profession accreditations such as Chartered Chemist (CChem) status within the Royal Society of Chemistry. Other scientific based professional registers accreditations include those granted by the Science Council.

The Professional Registers consist of the three designations below:

Chartered Scientist (CSci) is a well-established award, with over 15,000 scientists having achieved it since its launch in 2004. Candidates will typically be in senior scientific or managerial roles, qualified to at least QCF level 7 and applying their knowledge in their roles.

Registered Science Technician (RSciTech) is a new award to provide recognition for those working in technical roles.

Registered Scientist (RSci) is a new award to provide recognition for those working in scientific and higher technical roles.

WATER SECURITY

Water quantity as well as quality (purity) has also to be taken into account when considering water security or sustainability.

For water to be considered renewable it has to be used at less than the regeneration rate. In other words, renewable resources are limited. The faster you use them the quicker they run out. As demand for water rises combined with increasing urbanisation, alternatives to removing water from the environment have to be considered.

"the reliable availability of an acceptable quantity and quality of water for health, livelihoods and production, coupled with an acceptable level of water related risks"

Mike Muller, Graduate School of Public and Development Management University of the Witwatersrand South Africa

The options for increasing water availability in urban areas include:

- Rain water harvesting
- Aquifer recharge
- Affordable sanitation
- Desalination and similar processes
- Reuse and recycling

There are existing regulatory quality standards for:

- Drinking (potable) water standards
- Environmental standards
- Environmental emissions

While there are no regulations covering the quality of reused water, the British Standards Institute (BSI) has produced some guidelines for both greywater and rainwater reuse. For the first time, guidance introduces embedded water quality parameters for water reuse applications. Compliance with these parameters is designed to ensure public health is not compromised.

The guidelines in BS 8525 have taken the standards included in the Bathing Water Directive and developed values based on detailed research into specific applications where greywater is to be used.

The guidance recommends that whilst frequent water sampling is not necessary, it is good practice to observe water quality during maintenance checks. There is more detailed information in the Environment Agency publication *Greywater for domestic users: an information guide.*

The Water Sciences Forum within the RSC role in ensuring water purity and water security is non-partisan and to act as an "honest broker."

Water Scientists should identify the evidence needs and gaps, enable debate, and help influence policy.

CONCLUSION

Water Purity means "not harmful." Scientists and technologists cannot impose solutions on citizens which guarantee water purity. Water Policies need to be based on sound science and evidence to be successful. Consumers, citizens, politicians and scientists must all work together to achieve success.

Reference

1 Aminomethylphosphonic acid