SOFTENERS / ULTRAFILTRATION

Base exchange softeners are the type most used in residential applications. The term "base" refers to the cationic nature of the ion exchange process were the hardness cations calcium and magnesium are exchanged for sodium cations. This is not a complete process however as hardness in water has two characteristics Permanent Hardness and Temporary Hardness. Simplified all temporary hardness can be removed while all permanent can only be removed to a degree in the base exchange softening process dependent on the ration of sodium ion to total cations. Thus, base exchange softening is not a complete process. Hardness leakage can be minimised by increasing the excess of salt used in the regeneration process above that required for theoretical chemical balance.

Please refer to Greenpaper 2017/01 for a more complete review of hardness in water and softening using the base exchange process.

"Softener" notes attached have a more "hands on" approach to the whole subject of softening water.

Water to varying degrees of hardness is unfortunately a way of life in many parts of the United Kingdom with the perceived view that a water softener is required to improve the water supply.

But is it?

For sure there are some benefits but at what cost and / or inconvenience.

Before considering further what are the guidelines on sodium content in UK potable water supplies?

The Water Supply (Water Quality) Regulations currently sets the limit of sodium (as Na) at 200 mg/l.

Rule of thumb is base exchange water softener exchanges 46 mg/l for every 100 mg/l of hardness (Total Hardness expressed as calcium carbonate ($CaCO_3$). Thus, for a hardness of 400 mg/l plus the sodium already present in the water supply the mandatory limit is exceeded. However, even if the hardness content is lower there are still disadvantages in softened water.

Fundamental disadvantage is softening is but one process. It exchanges hardness ions calcium and magnesium for sodium within the limits of ionic balance without addressing the other issues in modern day water supplies.

As nature intended when man was created and evolved the human body was equipped to drink water wherever it could be found, the exception of course being the oceans. It is only mankind's "improvements" that has frustrated this. Those great innovators the

Victorians introduced water treatment to central supplies and even more importantly sewage treatment. But since then and steadily worsening mankind has been "improving" the quality of life with insecticides, pharmaceuticals, synthetic materials and detergents. And in other less developed parts of the world there are the "benefits" of these advancements without the basic infrastructure legacy of our forefathers.

Advantages	**Disadvantages**
Household appliance life	Leaching of toxic metals (lead etc)
Limescale elimination	Not suitable for beverages
Softer and brighter clothes	cooking
Minimal hair and skin dryness	baby formula
Easy lathering	pregnant women
	pets
	plants and vegetation
	High sodium (Na) content
	Low essential minerals
	Poor taste
	Does not treat heavy metals
	odour
	taste
	chlorine
	chlorine by-products
	organics
	THM's
	VOC's
	TEP's
	bacteria

SUMMARY

Healthy adults should only consume small amounts of softened water per day, this should also exclude any water used for cooking, pregnant women should avoid softened water while new born babies and infants should not be exposed neither should pets.

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ULTRAFILTRATION

First adapted and developed in Japan in the late 1990`s primarily as an efficient and compact water treatment technology addressing the limited real estate of that nation it was developed further in the jungles and rainforests of Asia Pacific as an effective water filter with excellent bacterial rejection capability.

Today, routinely many millions of litres of wholesome, potable water are produced worldwide by this technology with 5 log spores, cysts, bacteria, and virus rejection without the need for intrusive or residual chemical additives.

Essentially an ultrafilter is a low operating pressure molecular sieve of pore size 0.01 ~ 0.03 μ (micron – equivalent to 1/1,000,000 part of 1 metre).

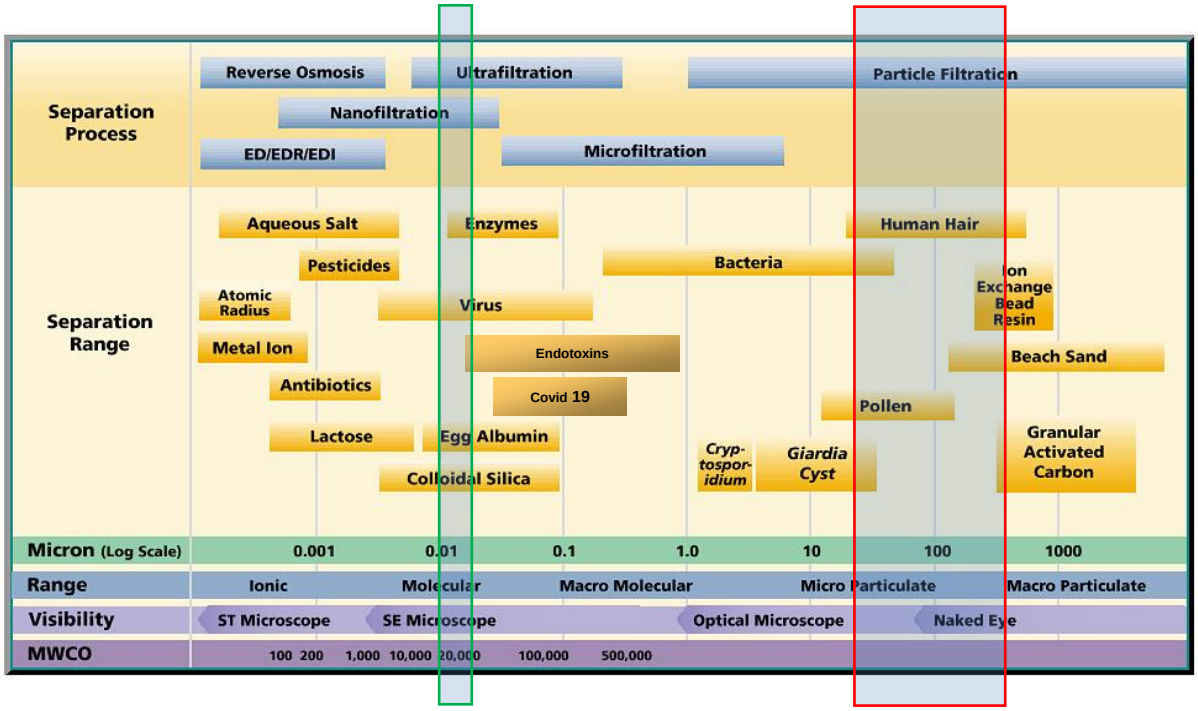

Fig #1 Filtration Spectrum

In Fig #1 the GREEN shaded area covers the filtration range of Portable Well ultrafiltration modules any item to the right of this is removed by the membrane. RED shaded area is the general range of typical filtration equipment. Note performance of Ion Exchange Bead Resin (Softener) and poor performance.

Ultrafiltration has no ionic exchange capability.

For non-potable water supplies and to some extent potable water supplies also are the unseen hazards even in aesthetically clean water.

Fig #2 illustrates these with a level of turbidity and colour that are purposely visible since this is not always the case. In UK borehole and other untreated water sources are examples. Pathogenic bacteria need not be the results of man's activities. Agricultural or wild livestock are major contributors.

Fig #2 Unseen Hazards

Colloidal matter (colloids) are the major causes of turbidity which is defined as "the light scattering" capability of water while colour is defined as "the light absorbency" capability of water. There is no correlation between these. Turbidity is measured as NTU's (Nephelometric Units) while colour is measured in °Hazen.

Visual inspection is potentially confusing a turbid water may have no colour while a highly coloured water may not be turbid.

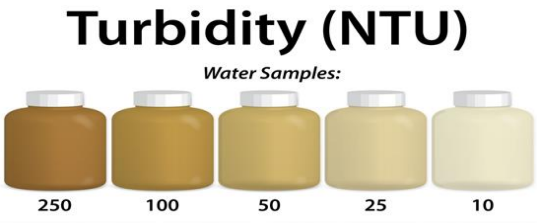

Fig #3 Turbidity / Colour Illustration

Turbidity measurement is a key test of water quality with most UK utility company's and indeed the World Health Organisation (WHO) regarding <1 NTU as ideal. UK Water Regulations however do not apply a statutory limit but advisory <1 NTU not to exceed 4 NTU. However, in rural areas or private water supplies Turbidity while discouraged is not an active parameter.

Ditto colour which is regarded as subjective. However, colour can directly affect taste and odour.

Drinking water with higher turbidity levels increases the risk of gastrointestinal upset, even disease due to bacteria and viral attachment to suspended solids, that also shield against chlorine disinfection.

Further factors in turbidity and colour presence include THM's (Trihalomethanes) and VOC's (Volatile Organic Components) being the byproducts of the chlorination process.

In UK water utility company's chlorinate water supplies first for disinfection at the water treatment works and second to provide a detectable and measurable amount of chlorine at the discharge from the works to "protect" both the distribution system and its contents on the journey to the end user.

There are two unfortunate effects of this admirable goal:

1) Destruction of bacteria, cysts and spores is contact time governed
2) Byproducts due to the presence of organic compounds, trace detergents or solvents

Chlorination of water supplies is generally carried out utilizing the Breakpoint Technique whereby chlorine usually in the form of Sodium Hypochlorite (NaClO) is dosed until the desired residual value is achieved. Fig # 4 illustrates this.

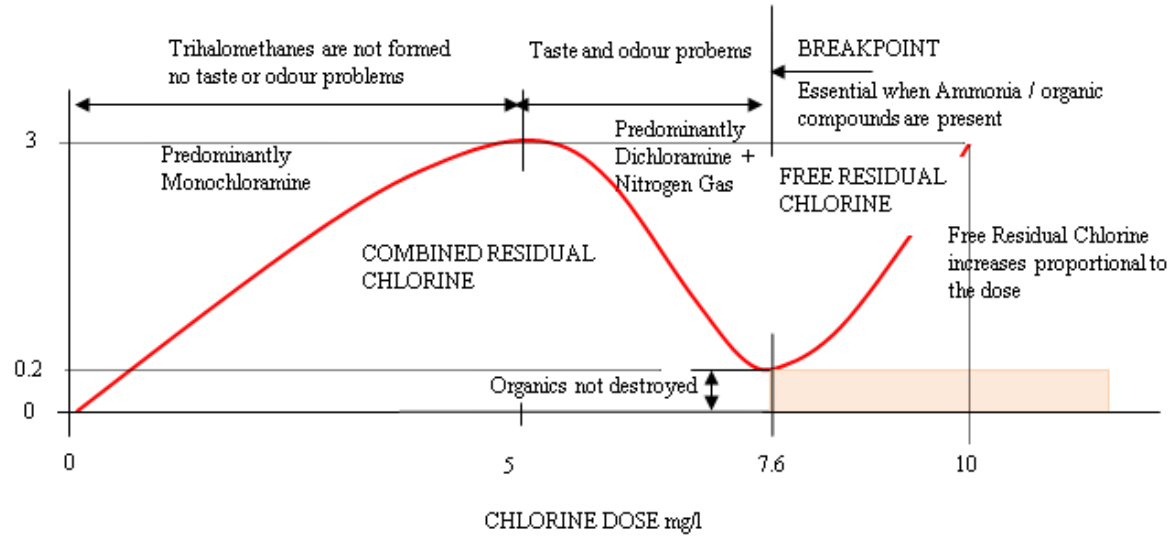

Fig #4 Breakpoint Chlorination

Agent	Contact Time	
E Coli (Bacterium)	<1 minutes	
Hepatitis (Virus)	~ 16 minutes	
Giardia (Parasite)	~ 45 minutes	
Cryptosporidium (Parasite)	~ 15,300 minutes (10.6 days)	

Fig #5 Approximate Bacteria Kill Contact Time

Item 1 Fig #4

The accepted parameter for the presence of pathogenic bacteria in water supplies is to test for *e coli* since this has the lowest contact time required to achieved destruction. 0 count per 100 ml is mandatory. It is only the presence of *e coli* that triggers further and longer cultures to establish the presence of other more resistant species. Of the 10 outbreaks of gastroenteritis in UK investigated between 1992 and 1995 identified as caused by the public water supply all were due to *Cryptosporidium*.

Item 2 Fig #4

When ammonia compounds are present which, they are in virtually every water source globally chlorination produces chloramines. These are troublesome from the formation point of dichloramine past the breakpoint after which trihalomethane predominate.

Fig #5 illustrates pathogenic presence tests for pathogenic bacteria with the differing contact times required for species other than e coli.

Fig #6 illustrates this graphically with Public Health Certification being above the acceptance criteria while UF performance being below.

Rejection of the UF membrane being illustrated by arrow deflection.

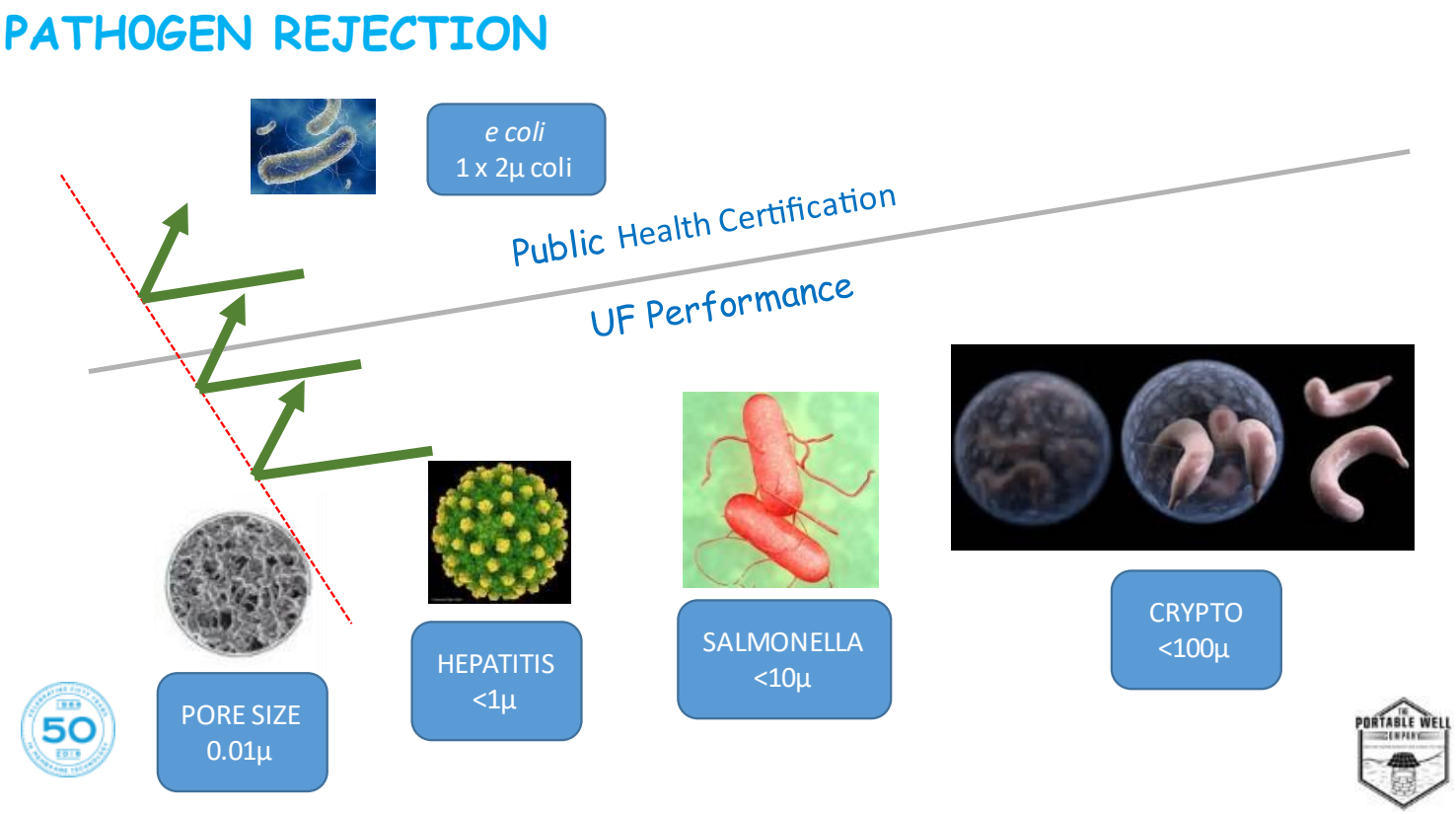

Fig #6 ULTRAFILTRATION CAPABILTY

Ultrafiltration has been tested and proven extensively throughout the world and particularly in developing countries. In Tunisia, North Africa where more than 7,000 communities live not only off grid but follow a nomadic life style it has been proven at oasis and shallow wells surrounded by sparse grazing as the Fig #7 results illustrate.

	Well	Treated
E coli	>100	0
Enterocoques Intestinaux	3	0
Clostridiums Sulfite Reductors	>100	0

Certified Public Laboratory Data

Fig #7 Menzil Temime – Tunisie – Agricultural Well

For fast response disaster relief ultrafiltration has been very effective. When the Adnan Sea tsunami struck in 2005 the complete UF based with integral power generation was designed, built, delivered and working within six days. Feed water was contaminated with swamped sewage works, decaying rubbish and corpses both human and animal

Fig #8 UF Self Contained Water Treatment Plant

Fig #9 illustrates the Head of Red Crescent, Bandar Aceh demonstrating that the water produced was safe to drink.

Fig #9 Disaster Relief UF Skid in Use

AquaSharon

WHOLE HOUSE SYSTEM

In the United Kingdom public water supplies are provided by utility companies with statutory obligations. They provide an excellent service but modern living, perceptions and preferences do intrude. Primarily, source water is treated to satisfy the broad church of customers within the general remit of "wholesome, potable water".

The most common application of residential water treatment in UK is water softening predominantly of the base exchange type.

However, mankind's steady march to "improve" his quality of life does impose side effects becoming more intrusive in water supplies.

A very recent example brought about containing the coronavirus pandemic is the monitoring of sewage for the presence of the responsible virus now being deployed to identify the "hot spots" and spread of the contagion. Its far to early to say whether its detection in sewers is in any way connected with the spread or even whether it is infectious when water borne but it does indicate how water supplies are affected.

AquaSharon address' the whole spectrum of providing wholesome and potable water beyond the remit of the utility companies with the added capability beyond the base system of personal choice and preference. Its base unit comprises:

Colloidal Filter	Colloidal particles
	Dust / grit / sand (Partial Turbidity)
	Distribution system particulate contamination
Activated Carbon	Dechlorination
	Trichloromethane's (THM's), Volatile Organic Compounds (VOC's), Colour, Taste, Odour
Ultrafilter	Residual Turbidity, Organics, Colour, Taste, Odour
	Pathogenic Bacteria – absolute removal