New Developments in Chloride Toxicity

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The release of chlorides into the environment is the greatest potential constraint to the future development of the salt industry. It will affect not only the deicing business, but the water conditioning and pool salt business.

The chief sources of chloride release into the environment are the erosion of chloride bearing rocks; agricultural runoff; wastewater from various food and chemical industries; consumer water softening; pool salts; effluent wastewater from water treatment facilities and; road deicing operations.

The current US water Quality criteria were designed to reflect the latest scientific knowledge on the extent of all identifiable effects on health and welfare of biota including plankton, fish, shellfish, wildlife, plant life, shore lines, beaches, esthetics, and recreation expected from the presence of pollutants in any body of water, including ground water;

The US Environmental Protection Agency (EPA) chloride toxicity criteria were established using a limited number of species in a distilled water-based medium. This resulted in conditions that do not reflect the real environment under consideration. When the water quality criteria were established, the EPA was unaware of the extent and the role of water chemistry on chloride toxicity. As a result, except where challenged, current standards do not reflect the mitigating impact of water hardness on chloride toxicity. This paper will describe the work the Salt Institute is supporting to expand species testing and to include the impacts of water chemistry on chloride toxicity.

The federal regulation of chloride salts has been highly inconsistent. Monitoring parameters have varied from total dissolved solids to changes in conductivity to specific ionic species such as chloride, sulfate, etc. Often, federal regulators would completely ignore previously established state standards.

In 1998, the US EPA established national guidelines for chlorides. For acute toxicity criteria, the level was set at 860 mg/L and 230 mg/L for chronic. Many states adopted these standards, while others did not.

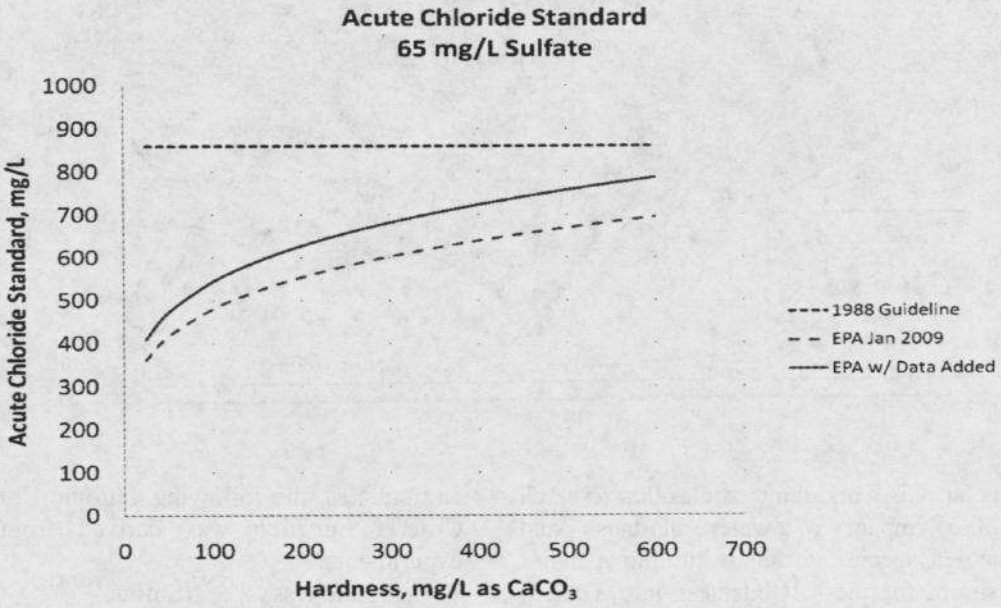
In 2008, the EPA worked with the state of Iowa to develop state-specific chloride standards. Fortunately, the EPA recognized that the original 1988 guidelines suffered from many inconsistencies and needed to be revised. The EPA even helped finance the initial study work. To start with four species very sensitive to chloride (water flea - C. dubia; fingernail clam – Sphaerium simile; planorbid snail – gyraulus parvus, and; Tubificid worm – Tubifex tubife) were chosen. In addition to the standard tests, additional analyses to determine the effects of water hardness on chloride toxicity of C.dubia were carried out.

When only a limited number of species are tested, particularly if they are highly sensitive, there is a tendency to very negatively influence the final toxicity figure. A lower number of species tested also means a lower level of confidence in the results. Testing many more species, particularly those that are present in the environment being evaluated will provide greater confidence in the end result and will be more pertinent to the location in question.

As a result of this thinking, the initial Iowa results were immediately followed by an additional series of tests on a far greater number of species, funded by the Iowa Water Pollution Control Association and others including the Salt Institute in order to supplement the EPA data. These tests resulted in a 20% increase in EPA derived numerical standards. Because the US EPA does not plan to revise the National Criteria, many states may adopt the Iowa standards.

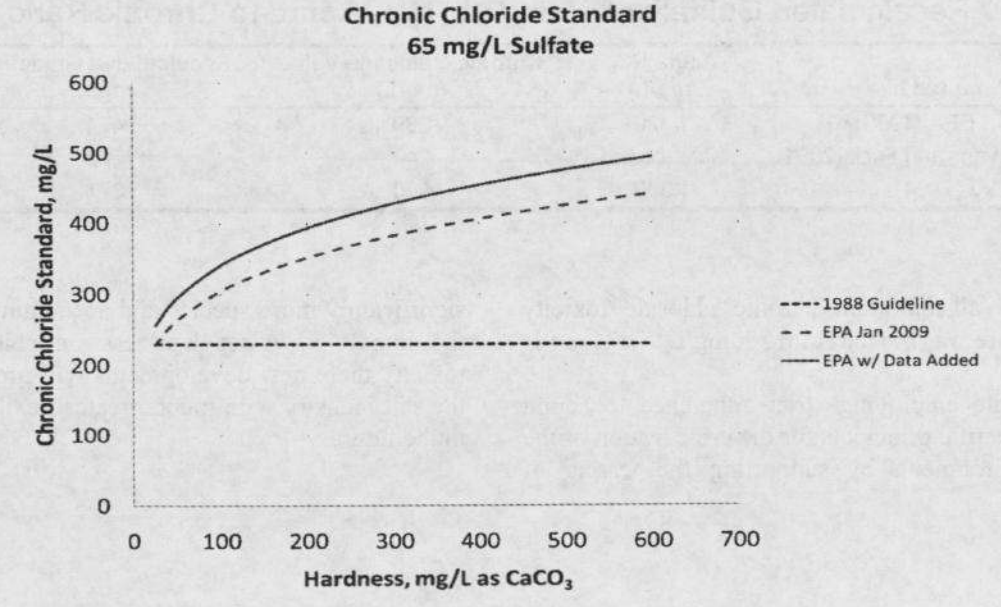
For example, in order to reflect a situation closer to their natural waters, the state of Kentucky recognized the effect of water hardness on chloride toxicity and adopted a higher 600 mg/L chronic limit. The state of Wisconsin developed standards based on their own lab toxicity test data resulting in figures of 760 mg/L for acute and 395 mg/L for chronic toxicity,

The following is a typical response of acute chloride toxicity to hardness and increased species testing:

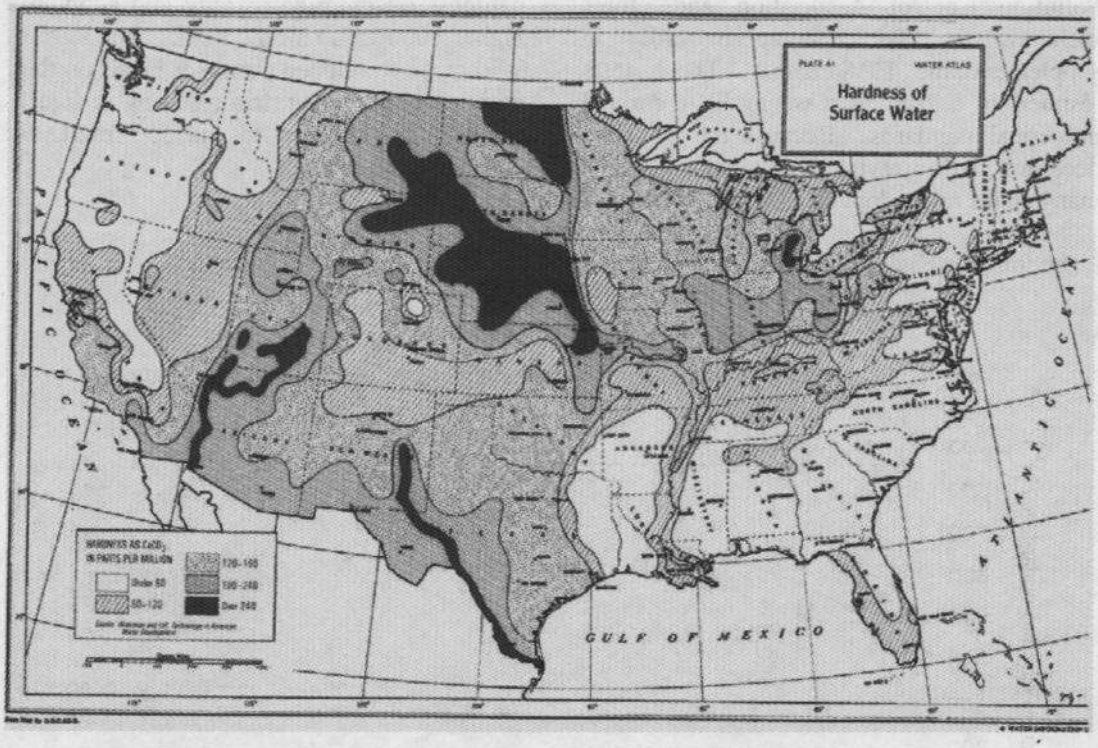


As can be seen, there is an increase in the toxicity figure as the hardness increases (blue line). There is also an increase due to added species tested (red line).

From a practical point of view, the chronic toxicity figures are most important. Here is a typical response of chronic chloride toxicity to hardness and increased species testing:



As can be seen in the following map, many of the major markets in the US are characterized by hard water and thus should have their chloride toxicities recalculated.



Thus far, this work demonstrates that research on the impact of water hardness and expanded species testing is turning a major constraint for the salt business into a much more manageable issue for the future. In order to account for the impact of hardness and sulfates, the following Chronic Chloride Criteria Equation was derived from the experimental data:

$177.87(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452}$ = Chronic Criteria Value (mg/L)

The following is a summary of the impact that experimentally-derived data has :

Recalculated Guidelines Using the New Acute-to-Chronic Ratio

Reported by	Acute HC_5 (mg/L)	Chronic Guideline Value (mg/L)	Recalculated Guideline (mg/L)
US EPA (1988)	1,720	230	474
Evans and Frick (2001)	Not reported	240	502
EVS (2004)	1,369	180	377

The all-important chronic chloride toxicity figure was moved from 230mg/L to 474 mg/L

While employing strict adherence to sound scientific principals for the preservation of the environment, by supporting the testing of significantly more species and accounting for the impact of water hardness on chloride toxicity there new developments will provide the salt industry with much greater flexibility in the future.