# Purified Water for Slurries

Ever since colloidal silica was first introduced to the precision investment casting industry, the importance of using purified water has been evident. But why is it so important? What purification method should be used and how do you control it?

## Background

Colloidal Silica

A colloidal silica binder is produced by suspending micro-fine silica particles in water to form an aqueous mixture. Each silica particle is surrounded by ions to create a negative charge on the surface. The charge around each particle maintains particle separation by repelling one another. For binder stability, it is important to sustain this negative charge and concentration of particles.

By introducing unwanted ions, this protective charge will be reduced. Once the charges are reduced sufficiently, the silica particles will no longer repel each other and will instead start to agglomerate. This will reduce the surface area and number of particles available for bonding. Shells made from this slurry would have lower strength, resulting in performance issues (i.e., cracking, spalling, bulging, etc.).

Tap Water

Tap water contains many different minerals (ions):

- Hydrogen carbonate ($HCO_3^-$)
- Chloride ($Cl^-$)
- Sulfate ($SO_4^{2-}$)
- Nitrate ($NO_3^-$)
- Sodium ($Na^+$)
- Potassium ($K^+$)
- Calcium ($Ca_2^+$)
- Magnesium ($Mg_2^+$)

Although treated according to strict local regulations, tap water often contains these ions at different levels at any given time.

In addition, it is possible that microorganisms can be found in the water supply. This is often caused by poor housekeeping, especially in lines/hoses or storage containers. Microorganisms (i.e., bacteria, fungi, algae) have a detrimental effect on colloidal stability. They secrete a low pH substance during metabolism. Therefore, any contamination by microorganisms should be prevented.

*For more information on detection methods, analysis and treatment for bacteria, refer to R&R Tech Tip: Eradicate & Prevent Bacteria.*

## Water Purification Methods

It is important to understand the differences between purified water types. Demineralized water, often referred to as deionized water, is different than distilled or disinfect water. The differences are determined by the technique used to purify the water:

- Distillation
- Deionization (Ion-Exchange)
- Reverse Osmosis
- UV-Disinfection

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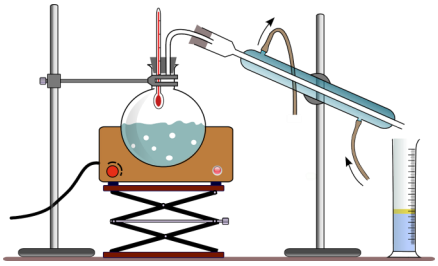
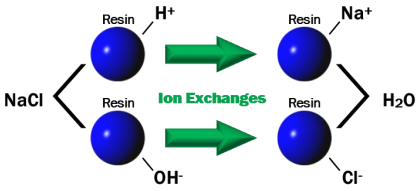


Distillation

During distillation, water is purified by cooking and re-condensation, whereby all minerals are removed. Also, organic contaminants (i.e., bacteria, viruses, etc.) are essentially removed.

✓ Benefit: Ultra-pure water, no microorganisms present

X Drawback: Energy and time consuming on a large scale

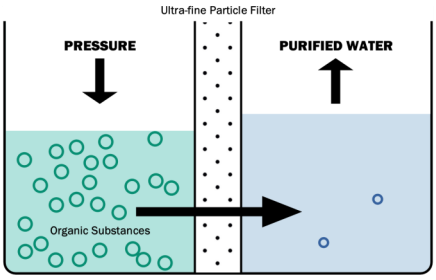



Deionization (Ion-Exchange)

During deionization, an ion exchange resin replaces all positive ions with hydrogen ions and all negative ions with hydroxide ions. Hydrogen and hydroxide together form water. After a large portion of the ions are removed, this water is practically identical to distilled water, except microorganisms are not removed.

✓ Benefit: Pure water, least energy consuming

X Drawback: Presence of microorganisms in water

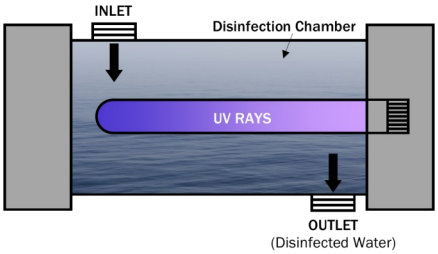



Reverse Osmosis

During reverse osmosis, water is forced through an ultra-fine particle filter, removing anything bigger than a water molecule. It removes organic substances (i.e., bacteria, etc.) as these are the largest particles. Ions are removed to a lesser extent as some are similar or smaller in size to a water molecule.

✓ Benefit: Removes microorganisms and large ions

X Drawback: Residue of small ions, energy consuming, failing filters




UV-Disinfection

During UV-disinfection, UV light provides an effective inactivation of microorganisms through a physical process. When bacteria and viruses are exposed to the wavelengths of UV light, they are rendered incapable of reproducing and infecting.

✓ Benefit: Eliminates infection by microorganisms, cheap and easy to install

X Drawback: No removal of minerals/ions

## Choice of Water Purification Method

Although technically a good solution, a water distillatory is not often the preferred method to purify water due to its process complexity and energy consumption. Ideally, a combination of an ion exchanger and reverse osmosis is used, but this also comes with excessive costs.

The preferred choice is typically deionization by an ion-exchange resin. In this case, precautions must be taken to prevent the possible presence of microbiological organisms.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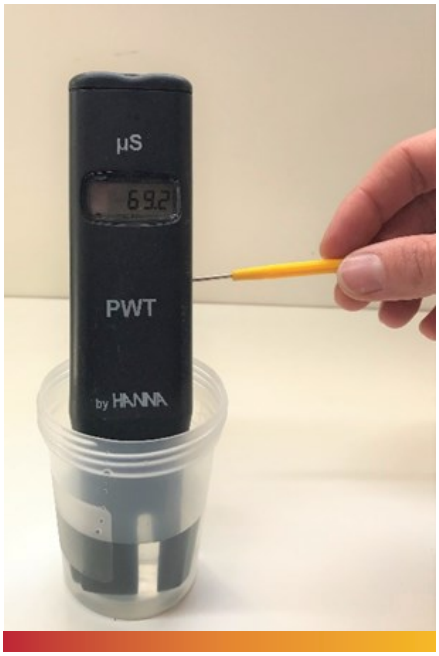



## Water Quality Control

Once produced, the quality of the purified water should be guarded. A simple conductivity test can be implemented in any shell room.

## Conductivity Testing

Conductivity is the measure of water's capability to pass an electrical flow. This ability is directly related to the concentration of ions in the water. The electrical conductivity value of a component is expressed in siemens per meter. Purified water is not a good conductor of electricity and therefore, conductivity results will be low.

*The acceptable conductivity limit for deionized water in a shell room is <5 µS.cm (micro or 10.-6 Siemens).*

The Hannah Instruments HI98308 Pure Water Tester is an affordable conductivity tester for deionized water.

Calibration

1. Submerge meter in HI7033L 84 µS.cm buffer solution.
2. Measure temperature of buffer solution.
3. Adjust dial on side until the specified conductivity at set temperature is displayed.

Tester is now ready to analyze a water sample.

Outsourcing

Many foundries choose to outsource the production of deionized water. In this case, it is important to check the following with the manufacturer:

- Method of deionization
- Maximum allowable conductivity levels
- Quality control
- Packaging material
- Opaque containers
- If recycled, method of cleaning/disinfection

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