OMAX® Water Quality Requirements for OMAX JetMachining® Centers

Introduction

We currently offer four types of water treatment systems to our customers: reverse osmosis, water softeners, closed loop, and the filtration equipment that is incorporated into the OMAX equipment itself. Water has many unique properties; its ability to dissolve a wide variety of materials is one of them. In its pure state, water is one of the most aggressive solvents known. Called the "universal solvent", water will virtually dissolve everything exposed to it. Pure water has a very high-energy state and, like everything else in nature, seems to achieve energy equilibrium with its surroundings. It will dissolve the quantity of material available until the solution reaches saturation; the point at which no higher level of solid can be dissolved. Some of the contaminants found in water include: gases, metals, minerals and organic materials.

The quality of the water used by our JetMachining Centers plays a very important role in the life of certain UHP components, such as: the orifice, on/off valves, seals, check valves, high pressure plumbing & plungers. Most sensitive is the high-pressure orifice. In order to perform high quality cutting, the orifice needs to be able to create a high quality jet that is directed through the center of the mixing tube. In the orifice of the nozzle, water is accelerated to speeds between Mach 2 and 3. Solids in the water can create a multitude of problems for the orifice. These solids can be classified into two groups, dissolved solids and suspended solids. Particles suspended in the water impact the edge of the orifice and can chip it. This results in poor jet quality and subsequently poor cutting capability and lowered mixing tube life. Solids that are dissolved can precipitate out of solution onto the entrance of the orifice. Over time a ring of the precipitate builds up around the orifice. Eventually, a portion of this ring breaks and damages the orifice or disrupts jet quality. The time it takes for this to occur can vary between a few hours to hundreds of hours.

Absolutely pure water causes problems with high-pressure components. Since the water is so pure, a high potential exists for the water to dissolve materials that it comes in contact with. As impurities are removed from the water, it becomes more aggressive. Seeking to replace the removed impurities with what it contacts, the amount of dissolution that takes place is determined by the solubility of the materials. Subsequently, excessive water treatment can be detrimental to components in the high pressure water system.

A balance between pure water and untreated supply water needs to be arrived at. Ultimately, the cost of water treatment must be compared to the costs resulting from shortened component life and cutting equipment downtime.

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Important Water Quality Indicators

pH

The relative acidic or basic level of a solution is measured by pH. The pH is a measure of hydrogen ion concentration in water. The measurement of pH lies on a log scale of 0 to 14, with a pH of 7.0 being neutral. A pH of less than 7 is acidic and pH greater than 7 is basic. Since pH is express in log form a pH of 6 is 10 times more acidic than 7. The pH of the water is an important factor in determining the solubility of components in the water. It is recommended that the pH of water fed to the OMAX be held between 6.5 and 8.5.

Total Solids

Total Solids (TS) is the sum of Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) in water analysis. TDS & TSS are comprised of organic and inorganic components. In general surface water supplies tend to have a higher percentage of suspended solids while ground water typically has a higher percentage of dissolved solids.

Suspended Solids

Particulate matter consists of silt, sand, virus, bacteria or color causing particles that are not dissolved in water. Particulate matter is usually responsible for the aesthetic characteristics of water such as color, or parameters such as turbidity. Particulate matter can have detrimental affects on UHP components. Material such as sand or silt can greatly reduce the expected life of seals, plungers, check valves, on/off valves and orifices. If pump inlet filters are frequently being plugged, there is a good chance that there is a high level of suspended particles in the water.
If an installation has a large amount of suspended solids a multi-stage filtration approach should be taken; a 20 micron filter should be installed at the water source followed by 5 micron, then 1 micron and finally a sub micron filter such as .2-.45 mircon.

Dissolved Solids

Dissolved contaminants are mostly ionic atoms or a group of atoms carrying an electric charge. They are usually associated with water quality and health concerns. The inorganic substances dissolved in the water separate into positive and negative ions. Cations are positively charged ions and anions are negatively charged ions. The dissolved solids, in particular calcium, magnesium, iron, silica, sulfate and manganese, are responsible for the scaling that takes place on the orifice and other components. The various types of dissolved solids will be discussed at length below.
Specific Impurities

Water Hardness

The presence of calcium and magnesium ions in a water supply is commonly known as “hardness”. It is usually expressed in units of milligrams per liter (mg/l) or parts per million (ppm) of calcium carbonate. It can also be expressed as grains per gallon. 1 gpg is equal to 17.1 ppm or 17.1 mg/l. Hardness can also be calculated from measurements of calcium and magnesium using the following formula. Hardness, mg equivalent/l of Calcium Carbonate
= ([Ca, mg/l]*2.497) + ([Mg, mg/l)*4.116).

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Hardness	Level	Classification
Mg/l or ppm	gpg	
0-17	<1	Soft Water
17-60	1-3.5	Slightly Hard Water
60-120	3.5-7.0	Moderately Hard Water
120-180	7.0-10.5	Hard Water
>180	>10.5	Very Hard Water

The main problem associated with hardness is scale formation. Calcium and magnesium are two of the largest contributors to scale formation because they tend to be the most prevalent naturally occurring metal ions in water. On average, magnesium accounts for about a third of the hardness in water. Due to the scaling effect of calcium it is recommended that calcium levels be held below 17 ppm. In analyzing our database of customer water reports, it was found that the magnesium concentration in the water is approximately 40% that of the calcium on average. Multiplying the suggested calcium concentration above by this ratio results in a recommended magnesium level of 6 ppm. Since water softeners are effective at exchanging calcium and magnesium ions with sodium ions, the amount of calcium and magnesium in the water is a primary factor in determining if the customer requires a water softener.

Iron

Iron, which makes up 5% of the earth's crust, is a common water contaminant. It can be difficult to remove because it may change valence starts - i.e.: change from the water-soluble ferrous state to the insoluble ferric state. When oxygen or an oxidizing agent is introduced, ferrous iron precipitates out of solution as ferric iron. Ferric iron can create havoc with valves, plumbing and water treatment equipment. If water contains more than .3 mg/l iron it will cause staining. Certain bacteria can further complicate things. These iron-reducing bacteria can form a rusty, gelatinous sludge that plugs up equipment such as filters or RO feed lines etc. RO manufacturers typically recommend that combined iron levels be below .05ppm in RO feed water. Soluble iron can be removed with iron filters, softeners or lime softening. Insoluble iron is removed by iron filters, lime softening and multimedia filtration. To a certain degree softeners and ultra filtration also work. Iron levels should be held below .3 ppm and .05 ppm if an RO system is going to be used. A water softener will remove low concentrations of the ferrous iron while multi-stage particle filtration should remove ferric iron. If the combined concentration of iron and manganese exceeds 6 ppm, other or additional methods should be considered to remove the iron. Potassium permanganate filtration can also be used to remove the iron, but if an RO System is going to be used with polyamide membranes, the RO feed water will need to be pretreated.

Manganese

Although manganese behaves like iron, much lower concentrations can cause water system problems. However, manganese does not occur as frequently as iron. Manganese forms a dark, almost black precipitate. If water contains more than .05 mg/l manganese it will cause staining. Manganese bacteria form a black slimy sludge that can plug filters and foul water treatment equipment. A water softener is effective at removing manganese provided the combined concentration of manganese and iron is less than 6 ppm.

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Sulfate
Sulfate is a problem in the presence of scaling cations such as calcium or magnesium. In high concentration it can be corrosive to copper alloys and can intensify problems with sulfate reducing bacteria. A value of 200 ppm is the recommended maximum level. Since water softeners do not remove sulfates from water, an RO system is suggested for installations in which the sulfate concentration is greater than 200 ppm.

Chloride
Chloride salts are common water contaminants. At high concentrations it can interfere with certain water treatment methods. Chlorides also corrode metals and contribute to stress corrosion cracking in stainless steels. Chloride levels in the water should be held less than 100 ppm. This value was selected because it does not affect many customers, and it is low enough that it should not cause corrosion problems. Locations with chloride levels greater than 100 ppm should be considered candidates for an RO system.

Chlorine
Chlorine, because of its bactericidal qualities, is important in the treatment of most municipal water supplies. It is usually monitored as free chlorine (C12) in concentrations of .1 to 2 ppm. Chlorine can damage Reverse Osmosis (RO) membranes. RO feed water needs to be pretreated to remove the chlorine. It can be removed from the water be using a Granular Activated Carbon (GAC) filter. Therefore, it follows that a GAC type filter should be part of the RO system in order to eliminate the chlorine from the RO feed water.

Silica (Silicon)
Every water supply contains some silica. Silica naturally occurs at levels ranging from a few ppm to more than 200 ppm. It is one of the most prevalent minerals in the world. Silica can form scale or deposits on components, which is very difficult to remove. Silica chemistry is complex. An unusual characteristic of silica is its solubility. Unlike many scaling salts, silica is more soluble at high pH ranges. Silica can be present in natural waters in a combination of three forms: reactive (ionic), non-reactive (colloidal) and particulate. Ionic silica is not a strongly charged ion and is difficult to remove by an ion exchange method. However, when concentrated to levels about 100 ppm, ionic silica may polymerize to form a colloid. Colloidal silica is still too small to be removed by a particle filter but can be removed by ultra-filtration. Colloidal silica can lower the efficiency of RO systems. The recommended silica level is 10 ppm. The silica level is a primary factor for determining if an RO system is required or not. RO systems are an effective method of removing silica but the recovery of product water vs. silica concentration needs to be addressed on a case by case basis due to the low solubility of silica. If effluent concentrations of silica become too great it will foul the membranes of the RO system.

Bacteriological Presence
In some case it is necessary to have an indication of bacterial contamination at some customer sites prior to installing our equipment. The primary concern is bacteria that thrive on iron, manganese or sulfur in the water. These bacteria form biofilms that raise havoc with water treatment equipment. These bacteria aggressively adhere to the plumbing components of the water source. In general, if the site has iron content greater than .5 to 1.5 ppm iron or .05 to .15 ppm manganese, testing the water the water for bacteria is suggested.

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The following table shows the water quality indicators that a customer's water should be tested for. All indicators except total solids and pH are listed as maximum values that should be present. The pH is listed as a range and total solids is asked for in order to determine how often the customer will have to change filter elements.

Quality Indicator	Value
Total Solids (TS)	*
Total Dissolved Solids (TDS)	< 250 ppm
Calcium	< 17 ppm
Magnesium	< 6 ppm
Iron	< .3 ppm
Manganese	< .05 ppm
Chloride	< 100 ppm
Sulfate	< 200 ppm
Silica	< 10 ppm
pH	6.5 to 8.5

*No recommended specifications at this time.

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