A **PowerBoss** White Paper

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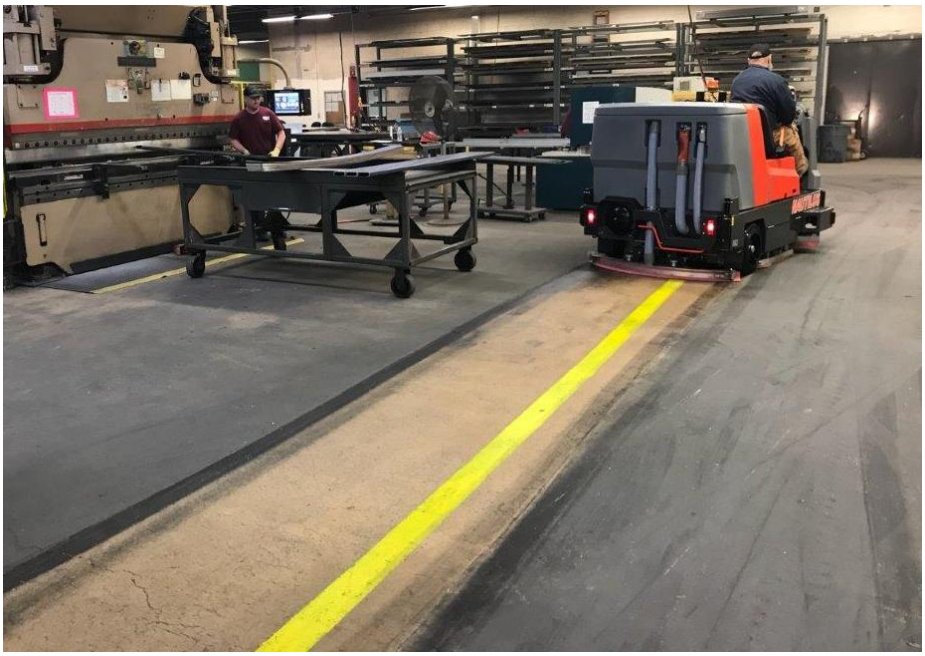
Hot Water Cleaning



The Science of Hot Water Cleaning

The abundance of water as a resource only makes sense that it would be a solvent used in the cleaning process. However, the water molecule that scientists call H_2O has some characteristic properties that makes water by itself a poor cleaning agent.

For most people, there is an inherent understanding that hot water would clean better than cold water. This white paper will explain the science behind water as a cleaning agent and what makes hot water cleaning more effective.

Contents

Water: A Sticky Molecule

Water, described by scientists as H_2O, is a simple molecule consisting of one atom of oxygen, and two atoms of hydrogen. With all its simplicity, water is subject to complex interactions. Understanding the properties of water can help us optimize the use of water as the main vehicle for use in cleaning.

Key Terms:
Water Molecules, H2O,
Hydrogen Bonding,
Surface Tension, Viscosity,
Surfactants,
Engineered Water

Water molecules are attracted to each other and like to stick together through a chemical bonding process called hydrogen bonding. (Figure 1).

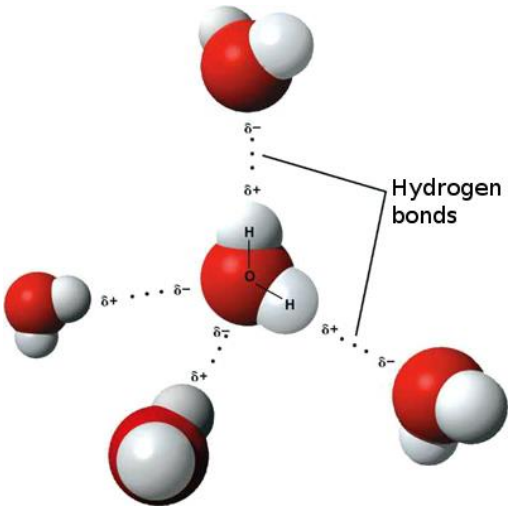


Figure 1: water molecules and hydrogen bonding

The Surface tension of a solution is a property that scientists use to measure the propensity of a fluid to spread over a surface. Water has an inherently high surface tension because the hydrogen bonding between individual molecules is quite strong. This can be observed when water is poured on a surface and tends to "bead up" on the surface. Scientists reference water having a high contact angle with surfaces (figure 2).

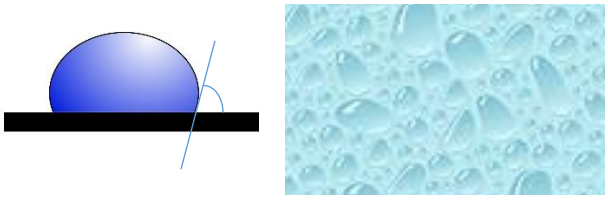


Figure 2: water beads on surfaces

High surface tension makes water by itself a very poor cleaning agent. The propensity of water molecules to be attracted to each other through hydrogen bonding makes it difficult for water to penetrate and suspend soils on surfaces.

The most common method to overcome the effects of hydrogen bonding and the consequent high surface tension of water is to introduce tiny amounts of a special compound scientists call a surfactant (surface-active-agent). The surfactant interferes with the hydrogen bonding and dramatically lowers the surface tension of water allowing it to spread across a surface (Figure 3). Modern day soaps and detergents function this way.

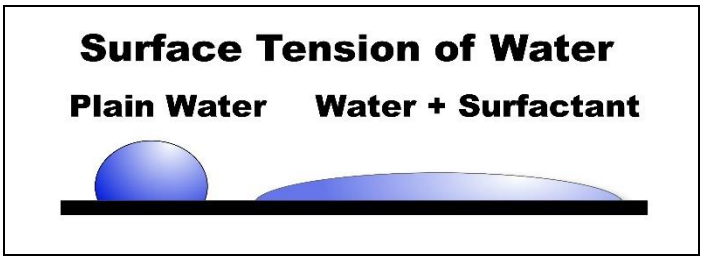


Figure 3: breaking hydrogen bonds with surfactant

What Happens When Water is Heated

When water is heated, the heat energy causes water molecules to oscillate rapidly. This rapid molecular motion causes the hydrogen bonds to weaken and the distance between the water molecules to increase. This is why solutions are less dense at higher temperatures.

More importantly, as water is heated, surface tension (measured in dynes/cm) goes down as the temperature increases. For water, increasing the temperature from 0° C (32° F) to 80° C (176° F) results in an approximately 17-20% decrease in the surface tension (Figure 4).

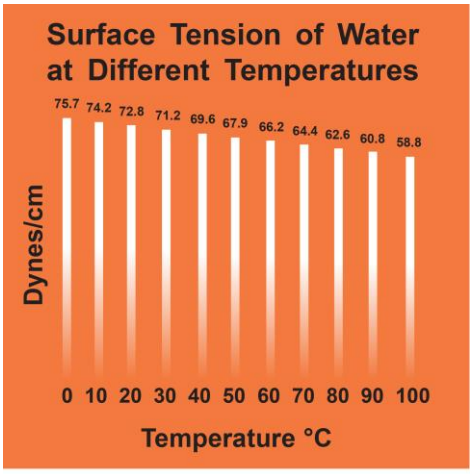


Figure 4: Surface tension and temperature

The relationship between surface tension and temperature is one of the main reasons why hot water cleans better than cold water.

The ability of hot water to more rapidly dissolve and disperse substances can be observed in a simple demonstration showing the difference between how a dye disperses in hot water compared to cold water. Imagine the dye as soil being more rapidly dispersed in the hot water (Figure 5).

The water surface tension and temperature relationship is one of the main reasons why hotter water will always clean better than cold water.

Cold Water 32° vs. Hot Water 180°

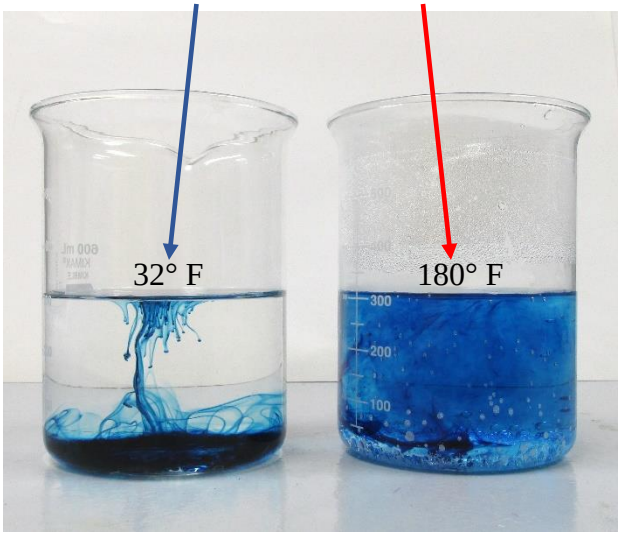


Figure 5: Dispersion in cold vs. hot water

Optimizing Cleaning with Hot Water

Hot water for use in scrubbing floors has two distinct advantages over cold water as follows:

1. **Surface Tension Reduction:** As water is heated, the corresponding surface tension of the water is reduced. The lower surface tension of the heated water make it easier to penetrate and lift soils from surfaces.
2. **Viscosity Reduction:** As temperature increases, the thickness (viscosity) of a fluid decreases. When cleaning industrial floors, we often expect to encounter soils of an oily or greasy character. Hot water melts grease and reduces viscosity of oils. This allows for easier dispersion and suspension when using automatic scrubbers to clean heavily soiled floor surfaces.

How Hot is too Hot

When water is heated, it begins to vaporize as the water approaches its boiling point of 212° F (100° C). At the boiling point, steam is created as the vaporization rate of water is at its maximum. When hot water is used to clean surfaces with an automatic scrubber, it is advantageous to keep the water below the boiling point to minimize excessive vaporization. Water heated to 160-180°F seems to offer the right balance between high efficiency cleaning without excessive steam generation.

Is Detergent Necessary

Use of a detergent for hot water cleaning is optional. For many soils, customers may find that hot water combined with aggressive agitation and pickup using an automatic scrubber is sufficient for their cleaning needs. Using a low foam detergent can further reduce the surface tension of heated water resulting in improved cleaning performance.

When using a detergent, caution should be exercised, as many detergents are not designed for use with high water temperatures. Some detergents will cloud out at elevated temperatures and become insoluble in the solution. This makes the detergent less effective and may cause clogging of filters.

For scrubbers, always use a low foam detergent to maximize recovery tank efficiency and extend vacuum motor life.

For automatic scrubbers that utilize higher temperature water, a special low foam detergent designed for use at high temperatures is recommended.

Is it Green

Using energy to heat water solely for cleaning would usually not be considered green. However, a novel approach is to utilize the heat generated to operate an automatic scrubber to passively heat the water. This idea of using the heat byproduct of combustion to heat the water is a green feature of this type of scrubber. Further, using heated water allows for reducing or eliminating the need for a chemical detergent.

If a detergent is used, a product that is third party certified as green could be an option.

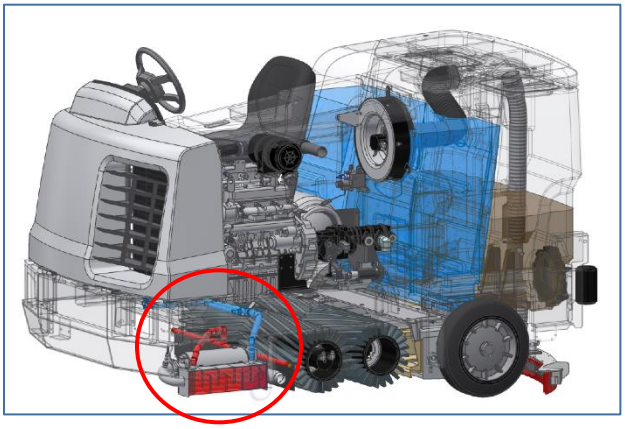


Figure 6: Passive heating of water from engine

What about Engineered Water

In recent years, marketers have coined the term “Engineered Water” to describe devices that claim to convert water into an effective cleaning agent. The devices use electrical energy passed through water to generate ozone or other chemical solutions. One type of device uses ordinary salt (NaCl) to generate separate solutions of Sodium Hydroxide and Hypochlorous Acid. One solution is marketed as a general purpose cleaner, the other a disinfectant/sanitizer.

While the chemistry of these devices is well understood, it should be noted that the generated

solutions have little impact on the surface tension of water, possibly suggesting limited effectiveness as cleaning agents.

Another device sold by scrubber manufacturer Tennant Company, is an “add on” to the company’s scrubbers. Referred to as ec-H2O™, it claims to convert water into a cleaner using electrical energy similar to the process above without the use of the salt. Part of the explanation is that passing ordinary tap water through the ec-H2O™ device creates nano-bubbles in the solution that aid in the cleaning process. The scientific literature does reference the use of nano-bubble solutions in cleaning.

The solution produced appears to have minimal impact on the surface tension of water.

Tennant readily acknowledges that ec-H2O™ is not meant for oily and greasy soils.

Conclusions

- Using hot water to scrub floors can offer improved cleaning results with or without the use of detergents.
- Hot water cleaning is particularly useful when encountering greasy/oily floors. The reasoning is the lower surface tension of water at higher temperatures and the viscosity reduction of grease/oil residues.
- This phenomenon allows the water to penetrate and disperse the soils for easy pickup by the scrubber.
- Hot water cleaning effectiveness can be further enhanced when using a low foam detergent that is recommended for high temperature use.