Your System in Winter
In this article I would like to explore the effect of Winter and changes in temperature on your system. What are these changes are and how they impact on pressure, flow, controller calibration and battery life.

I will touch on some of the solutions for protecting your system against frost together with what controllers can offer.

Frozen hoses, pumps and the resulting poor water flow can seriously impact on your business and earning potential. Also remember that as water freezes it expands which could result in split hose lines blown connectors and even damaged RO membranes. This mean serious consideration needs to be given to how you will protect the system and your earning potential It is not a good idea just to hope for the best.

What I will not be covering but something you should consider is water dropping on to surfaces below freezing and prevention of slip hazards.

To start lets look at some of the things a change of temperature will effect.

- Hose wall expansion
- System pressure
- Water flow
- Pump current draw
- Battery life .

The amount of pressure and how fast it will build up is dependent on the pump and the expansion rate of the hose wall. The warmer the hose the faster it will expand increasing the ID of the hose this can mean pressure can be quick to build up with greater flow. The pump is does not have work hard to overcome a restriction.

As air temperature falls the hose wall expansion rate is affected, the hose may take longer to expand to its normal ID. In turn the pump will have to work harder to overcome this restricted ID and produce pressure. Remember the harder the pump works the higher the current draw from the battery.

The slower hose expansion rate can mean that flow is reduced. Often in low temperatures I hear people talk of lower flow rates. The tendency is to turn up the flow rate on the controller however this may just mask the cause of the issue. Increasing the flow rate means the pump will draw more current. Recalibration of the controller is a better solution and takes a few seconds.

What is the effect on the water?

Viscosity. (Technical explanations on line). For our purposes Viscosity is the thickness of a Liquid or liquid based product. Water has a low viscosity as it is thin and normally flows easily Oil in comparison has a high Viscosity it is thick and flows slowly.

Temperature will affect the viscosity of both water and Oil for example as they are heated the viscosity is lowered allowing the oil to circulate freely around your engine and lubricate it.

Water is effected by temperature in the same way in the summer months you may find that flow rates are higher than in winter due the fact the water is thinner and will flow faster.

More noticeable, is that in winter water viscosity changes as the cooler air temperature effectively makes the water thicker meaning the water will flow slower. Imagine the difference in pouring a cup of coffee against a Slush puppy which in effect is liquid ice.

The Viscosity of water in your system will affect the pressure as;

1. The water is moving slower and 2. The hose walls will expand slower. Combined these two effects will make your system slower to pressure up in winter than in summer. Depending on how your system is set up together with the calibration and flow settings some may see no change or at least it is so slight not to be an issue.

Others may find a noticeable drop in water flow in the winter months caused by this change to the Viscosity (thickness of the water). The remedy is quick and easy – recalibrate the controller to take into account this slower water and the change in pressure dynamic.

So how does re calibration of the control help?

If we look at why the controller is calibrated in the first place the answer becomes clearer. Calibrating the control to a pump/system allows the control to know the normal operating pressure of the system when water is flowing. Stopping the flow means that this pressure rises as the pump pushes against the restriction. The control seeing this change stops the pump DE. The lower the calibration figure the faster the control switches the pump. In summer with low viscosity water flowing easily pressure builds quickly so we want the control to respond quickly to changes when flow is stopped.

As temperature falls the water viscosity changes as does the hose wall expansion rate with the expansion slower. This can make pressure build slower as the pump has to over come these changes.

The control seeing this will DE the pump at a relatively low flow rate or you may see the pump cycling and effecting flow rate. Recalibrate the control increasing the calibration figure. This means the control will be slower to stop the pump allowing you to maintain the same flow rate as before.

The pump will have to work slightly harder in cooler temperatures to push the water through the hose line. Increasing the calibration will not have an impact on this it simply allows the pump longer to build pressure.

They may be a marginal difference in current draw because the pump will run slightly longer before the control dead ends it. The difference may be 1/2 a second or so. In the scheme of things the difference in terms of current draw are barely noticeable.

However if to overcome the poor flow rate the user can just turn the controller up, this will increase the pump speed and in turn draw higher current from the batteries than recalibration of the control.

What is the effect of colder temperature on the battery?

Battery capacity (how many amps it can hold) is reduced as temperature goes down, and increases as temperature goes up. This is why your car battery dies on a cold winter morning, even though it worked fine the previous afternoon. The standard AH rating for batteries is at room temperature, 25 degrees C (about 77 F).

At approximately minus 5C (22 degrees F), battery AH capacity drops to 50%. At freezing 0C (32 degrees F), capacity is reduced by 20%.

The charging **voltage** to recharge your battery also changes with temperature. A higher charging voltage is required in lower temperatures. EG at -40 C, 2.74 volts per cell are required (16.4 volts). At 50C only 2.3 volts per cell (13.8 volts) would be required.

Battery **Thermal mass** means that because they have so much mass, they will change internal temperature much slower than the surrounding air temperature. A large

insulated battery bank may vary as little as 10 degrees over 24 hours internally, even though the air temperature varies from 20 to 70 degrees.

Be aware however that a discharged battery can be more likely to freeze than a charged one. This is due to electrolyte in the battery becoming thinner and more watery making freezing more likely.

Taking into account changes and factors already mentioned above current draw is likely to be slightly higher in cold weather. Changing the frequency of charging to ensure the battery is always at maximum capacity is advisable in winter. Also batteries can loose up to 5% of their capacity is just sitting. If you are leaving a battery idle for a long period, connecting it to an intelligent charger will extend the life of the battery.

Insulation

Depending on your location you may see more or less days and nights with temperature at or below freezing. Each year around September/October the forums start to buzz with how to protect a system. So in what ways can you protect the system?

• Insulation
• Install electric heaters
• Install a hot water system
• Use of a pump box
• Removal of Pump and hose lines from the vehicle over night
• Garage the Vehicle in a heated garage

There are many types of insulation materials available that can help reduce the effect of frost. It may be that you consider this a good way forward followed by boarding out the van over the insulation.

Be aware that it's is the ambient temperature in the van that will dictate if the system freezes. So although the temperature in the van will fall at a slower rate than external temperature due to the thermal mass of the insulation and vehicle it will still fall.

So what else can be done? If Insulation alone may not be enough we could consider some type of heater. I have heard of people installing aquatic heaters in the tank. The question here is how do we power them? Can they keep 500, 600 + litres of water above freezing?

Looking at the current draw per hour of these types of heaters is important as you are looking to heat a large volume of water all be it by a small amount in effect we are looking to keep water above 2C. Online you will find a number of mathematical equations and formula explaining water density. I intend to keep this as simple as possible.

So to heat one litre of water by one degree over an hour will require 252 watts of energy
or : -

21 amps an hour if running from a 12V power supply
1.2 amps an hour if running from a 240V power supply

Note: The following figures are an example, Cost are likely to vary system to system:
Approximate cost per month as follows we are using 252 watts for say 8 hours a day during a cold period. So the calculation is (Watt Usage * Hours/Day * Days/Mo.) / 1000 = Kilowatt Hours use.

Remember we have only heated one litre of water by 1C in this time. To heat a 350 litre tank will take far greater energy and cost. It would require 88,200 watts to heat

350 litres1C an hour.

In reality it is very unlikely you would you need to run the heater for 8 hours a day or every day. The Figures give an indication as to cost of these types of heater.

You can of course install a heater in the back of the van and run a power cable out to the van using an extension lead. Clearly this has implications as to security of your vehicle (you may have to leave a door open) and the issue of trailing cables on the ground at night. I would suggest in reality this method would only really work if you can garage the vehicle.

Some will choose to have a pump box and detachable reels this allows both the pump – battery and hose lines to be protected indoors and away from frost. This can be a useful way of protecting part of the system. Consideration must then be given to how you protect the tank of water.

Use of a hot water system means you have the availability of hot water all year round. There are many testimonials to hot water being useful on first cleans and hard to shift dirt. This being because the hot water cuts through hardened dirt and grease far easier than cold.

The next advantage is the warm water can help reduce the risk of freezing plus you can leave hose reels and equipment in the van as the warm water will help to keep these frost free.

It is worth remembering at this point that hot water freezes quicker than cold. Hot water seems to freeze faster than cold water, known as the Mpemba effect. The effect was named after the Tanzanian student who in 1963 noticed that hot ice cream mix freezes faster than a cold one. The effect was first observed by Aristotle in the 4th century BC, then later Francis Bacon and René Descartes (see link).
http://www.iflscience.com/chemistry/hot-water-freezes-faster-cold-and-now-we-knowwhy

The above seems to suggest than that having a hot water system in the van will actually make freezing more likely. We must take into account that the Mpemba effect is taking place because the Hot water is no longer being heated. Also the starting temperature of the water can have a greater or lesser effect.

The answer here is to either reduce how fast the water looses its heat or provide a way to occasionally reheat it. This can be done with a relatively small change in the temperature then combined with water recirculation.

We come then to diesel and gas water heaters. Both will provide an excellent basis for your hot water system for cleaning use. But how do we use them to protect against frost?

This is where the Spring manufactured V11 hot water controller comes in.....
The hot water controller connects to a temperature sensor in the cold-water tank which it uses to control the pump and a heater unit. To prevent your system from freezing you must place the end of the hose back in the water tank to create recirculation. When placed in frost mode, if a low temperature (2 degrees C or below) is detected, the system is placed into heated recirculation by energising the pump and the heater. Supplied with full wiring kit, all fuses and fuse holders, temperature sensor and instructions.

- Copes easily with demanding daily use
- Extends life of resin cartridges
- Controls water flow accurately (0-99) and dependably
- Dead End detection saves battery power and extends pump life
- Displays battery voltage
- Unit is sealed to IP64, stopping water ingress

• Easy to use and simple to install
• Temperature sensor
• Displays and monitors hot water temperature
• Provides information to allow hot water WFP

The latest generation V11 hot water/frost protection controller is suitable for Use with both Diesel and Gas water heaters:

Note: For models purchased after December 1st 2013. (V9 and V11 Frost protect units purchased prior to this date are suitable for use with Diesel heaters only)

NOTE: The controller has a pre-set recirculation rate of 10 when in frost mode. (with frost mode active the control will start the pump and send a start signal to a diesel heater when water temp is 2C) Gas heaters are ignited by Water flow generated by the pump and will require a higher recirculation flow rate.

The controller has a variable recirculation rate that can be set by the user in frost protection mode. This allows for a wide range of water heaters to be used including those where the heater ignition is dependent on water flow rate.

Recommended flow rate for diesel heaters is 10; other heater types may require a higher flow rate.

Note: Consideration must be given to ensuring escape of waste gases, please ensure adequate ventilation when using diesel or gas water heaters.

Simply activate the frost mode set you water recirculation rate and walk away with peace of mind that your system is protected. The principle is simply to prevent freezing by means of slight heating of the water between 2C and 4C plus circulation.

Further information can be found at http://www.springltd.co/node/91

In summary then there is a need to think ahead and prepare for the winter months. Protecting your system and earning ability can depend on it. The last thing you want is to turn up to a job and find hose lines frozen and poor water flow rates.

Although not covered here consideration must be given to van system with RO membranes as should these freeze, it is likely they will need replacement. We have touched on some of the issues and solutions whichever method you choose think ahead and be prepared.

THE WCA
Window Cleaners Association