TECHNICAL BULLETIN

System Minimum Water Content

Many of you will often be faced with the question from the customer about what is the minimum system water content that is best for our chiller. Or why do we suggest a Buffer tank solution on our ***Ecologic*** and ***Ecolean*** chillers when Carrier does not.

Minimum System water content

There should be a minimum water volume in a system in addition to that in the heat exchangers or the water system becomes very unstable. This results in overcooling or overheating in the conditioned space. On the equipment it results in chillers cycling on and off quickly and often it is only the timers that limit the number of starts per hour on each compressor that by default allow the system to operate. On cooling coils the control valves are not able to modulate and drive either open or closed causing the conditions in the space to be to hot or to cold.

On large systems (over 400kw) there is normally enough water volume in the system with just the water distribution pipe work and heat exchangers.

V is minimum system water content N is Cooling capacity at minimum load step
Z is the length of the anti recycle timer. dt is the delta of the controller dead band

$$V = \frac{N \times 60 \times Z}{4.18 \times dt}$$

Example a WA200 at standard conditions gives 184kW at full load, minimum load step is 25% compressors can start 10 times per hour and the delta on the control dead band is nominally 2°C

$$V = \frac{(184 \times .25) \times 60 \times 6}{4.18 \times 2} = 1980lt$$

The 1980lt would represent the required total water volume of the system and is NOT the size of the buffer tank needed.

On Small Systems such as the EcoLean range where there is only one compressor the formula is adjusted to reflect the building demand. The value N becomes is not the minimum capacity of the chiller but that of the system. For example a EAC035S at standard conditions gives 32kW the system demand is 75% of the design. Z changes to n the minimum compressor run time for Ecolean this is 1min

$$V = \frac{32 \times 0.75 \times 60 \times 1}{4.18 \times 2} = 172lt$$

To calculate the increase in water temperature that takes place while the unit is stopped.

For example a unit running 1min and then stopped 5 min (6min between starts)
DT is the delta temperature change in the water system.
N is the cooling demand. A it time the unit is off. V is the minimum water content

$$DT = \frac{\mathbf{N \times 60 \times A}}{\mathbf{4.18 \times V}}$$

Using the same WA200 as above

$$DT = \frac{46 \times 60 \times 5}{4.18 \times 1980} = 1.67°C$$

Unit start times vary because of the type and number of compressors in each circuit

As a result when running at minimum load when you have 2 or more compressors in a common circuit if the first compressor has run and just stopped and cannot start as it is on its anti recycle timer the next available compressor can start. This can significantly reduce the minimum system volume requirement.

EcoLean

EAR & EAC 0091 to 0431 6min between starts (1 compressor per circuit)
EAR 0742 to 0812 6 min between starts (1 compressor per circuit)
EAC 0742 to 0812 3min between starts (2 compressors per circuit)

EcoLogic Nominal time between starts in minutes

	40E	45E	65E	75E	100E	110E	90D	130D	150D	200D	230D	300D	370D
Std					**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**
Stdplus					**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**
LN					**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**
HE	**6**	**6**	**6**	**6**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2**
SLN	**6**	**6**	**6**	**6**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2**

Note that on some of the Ecologic range there may be 3 compressors per system but some are started as pairs. The above table accounts for this.

Carrier in their sales literature for the Aqusnap range make a big play on the fact that they do not recommend a buffer tank. **In the IOM they do in fact say a buffer tank should be utilised when the system water volume is small**. Carrier detail nominal Cooling capacity x 3.5 for small systems and x 2.5 for larger systems for the system water content.
The Pro-Dialog controller also resets the Chilled water set point upwards as the number of starts increases (Auto-adaptive algorithm). This also reduces the requirement for a buffer tank but if the chilled water design set point is 6°C the reset condition may be 14°C or higher so the building design conditions are lost as the chiller reset the conditions.

Carrier found through testing that the water system temperature can increase upto 8°C in the off cycle before it starts to impact on the space temperature. Based on this they have allowed the Pro Dialog control system to re schedule the start delay timers on the compressors. This then stops the compressors cycling on and off frequently (which is what you want to prevent with a buffer tank) and is the reason why Carrier say a Buffer tank is unnecessary. If using the above water flow calculation formula you change the value of **dt** to 8 you will find that you can duplicate Carriers calculations.

You have two choices with both the ***EcoLean*** and ***EcoLogic*** units

1. Offer the same as Carrier, all ***EcoLean*** and ***EcoLogic*** models have the choice of a no Buffer vessel hydraulic kit only. This includes all the same components as is in the Carrier offer.
2. Using the above information explain to the customer that his design conditions can move upto 8°C from the design set point with the Carrier system. Promote the LENNOX ***EcoLogic*** and ***EcoLean*** solutions to offer a buffer tank and use the formulas to show the movement in design water conditions is the off cycle.

Often you will find that going with 2 first would win you the project and if not you can always offer the same as Carrier.

Finally the above can be used as a justification as to why we do not have a integral buffer tank on all the ***EcoLogic*** range. The larger capacities generally serve large systems that have enough water content in the system with out needing a Buffer tank.