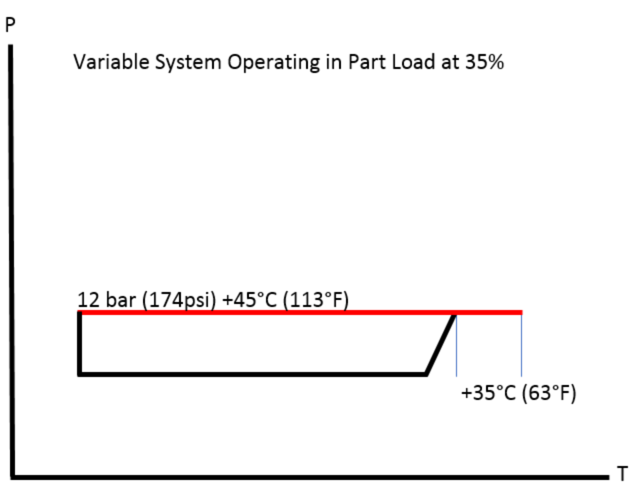
Introduction

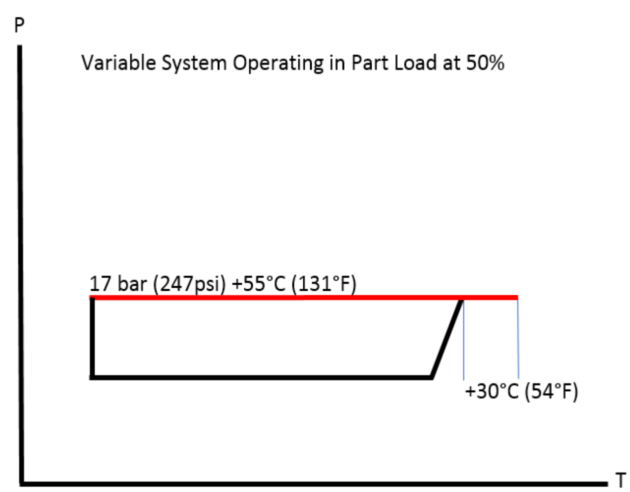
The first element that should be established in this paper is that solar assisted cooling is only compatible when partnered on systems with a variable capacity ability. As such, the reader should hold at least a basic understanding of the variable capacity technology. If this is not the case, we would strongly recommend the reader takes steps to grasp, at the very minimum, a familiarity of such (in particular the compressor and logic controls) prior to reading further into the information below. *Important* – experience attests that a lack of understanding on how the variable system differs from the hoary fixed speed system, will almost certainly result in the reader failing to comprehend or appreciate the thermodynamics and/or physics of how solar cooling realizes the additional efficiency.

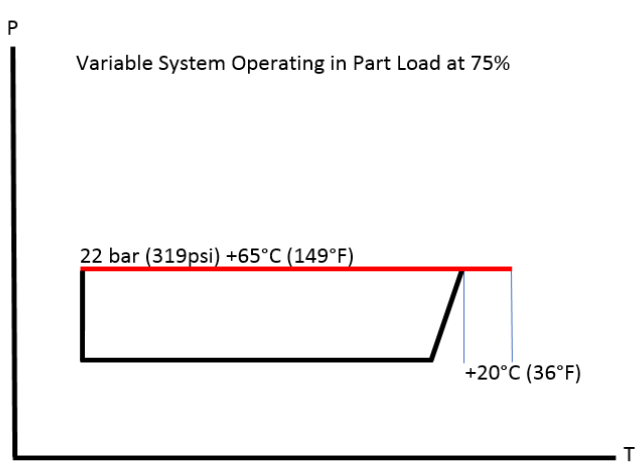
Preconception #1: Solar thermal adds heat to the refrigerant, which in turn, the condenser is required to remove

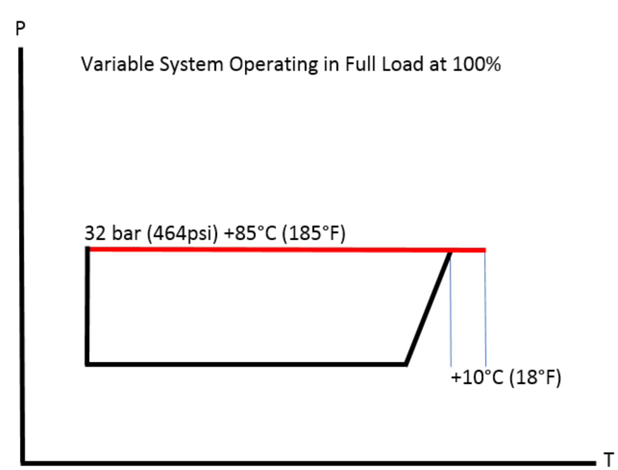
The reality is, there is no 'additional' heat added. This claim aside, the fact remains that the variable speed or modulating system's built-in logic controls safeguard the system against the thermodynamic boundaries being breached. In the majority of cases, the logic controls are designed to recognize and meter the thermal energy in today's modern systems. This is accomplished via a thermistor sensor rather than through the previous method of using a pressure transducer, with the logic control required to calculate the temperatures. This control logic then modulates the required compressor's speed accordingly and as such, the process allows the solar array to replace an element of the heat that would normally be generated by the compressor/s.

The diagrams below illustrate examples of how the solar heat energy impacts the refrigerant cycle:









Solar thermal correctly integrated into the cooling process of a modulating system, along with true thermodynamic logic controls, will operate efficiently with most refrigerants. The added benefit derived from the renewable, readily available thermal energy may vary in comparison to the above illustrations, dependent on the refrigerant in use, along with the normally anticipated variables within any cooling system.

The condenser transfers heat from the refrigerant to the ambient air. The rate of heat transfer in a condenser is a function of its design properties, mass flow of the refrigerant, pressure, condensation temperature and the temperature and saturation of the refrigerant.

The solar thermal supported system retains the above process. The single difference now being that on a system with the ability to modulate, the method increases the refrigerants temperature following the discharge from the compressor, while maintaining the pressure generated via the compressor. Thus, improving the ΔT at the condenser point with a lower energy consumption at the compressor.

The alternative being a compressor working harder to raise the pressure, subsequently raising the condensation temperature, along with an increased condenser fan speed.

Preconception #2: Heat = Pressure

Some consider the heat to be essentially an unwanted by-product of the pressurization process, this is factually incorrect. The reality is that pressure is the unwanted, although a necessary pre-condition. Without heat the cooling effect could not, nor cannot be achieved. Pressure and heat are collectively vital sources in the refrigerant process; but it is also important to comprehend that in the modern-day modulation system, the thermodynamic method is vital for efficiency improvement and therefore these two factors rarely align for prolonged periods. To further emphasize this point, the vast majority of today's VRF/VRV/MDV systems are manufactured without a single pressure transducer linked to the operational logic controls. These are now predominantly thermistor sensors.

Preconception #3: Solar thermal HVAC works, but is only viable in high ambient temperatures

Although it is generally accepted by those who have an understanding of variable refrigerant technology, that a solar thermal assisted system would be beneficial in high ambient temperatures due to the ΔT benefits, a common misconception is that this would not be the case in *the* considerably more temperate or 'normal' ambient environments.

Consider this: When the sun is available, the thermal collector continues to provide thermal energy to the refrigerant. The variable system's logic control recognizes this fact via thermistor sensors as if this added heat is provided by the compressor. *For example*: To achieve the required ΔT (liquid production) the system's logic control measures data supplied via the thermistor sensors located at the condenser, let's postulate that this specifies an increase in compressor demand, which on this occasion equates to a discharge temperature of say 65°c (149°F), along with the equivalent mass flow via the compressor. The temperature generated from the compressor and the solar array combined however, is say 70°c (158°F), maintaining the mass flow. The condenser logic sensors reasonably assume that the discharge temperature and subsequent mass flow is born only from the compressor output. The reality is that the actual temperature discharged from the compressor may only need to be 40/45°c (104/113°F), with the expected mass flow, due to the solar thermal supplementation. As such, the logic control may conceivably communicate to the compressor to slow down or maintain its position dependent on the available solar input, whilst maintaining mass flow of the refrigerant from the compressor.

The temperature generated via the compressor is determined by the logic to have increased, allowing the compressor to reduce its load, while actually providing a ΔT in line with what would normally be achieved with the compressor working at a higher energy consumption rate. Ultimately this results in an improved liquid refrigerant mass flow through the metering device, with an observed, measured and recorded reduction in energy consumption. In essence reduced flash gas or as in the majority of cases - zero flash gas. Video

Of course, pressure remains an important and always required component in the liquification process. In today's modern thermodynamically determined systems however, pressure is monitored in the main to ensure system protection, but rarely measured in relation to impacting the logic of the control's decision-making procedure.

The solar assisted cooling system produces efficiency gains by allowing the compressor to slow down to stages as low as its lowest possible design point, due to the utilization of the same method.

Pre-Conception #4: A solar thermal array cannot produce efficiencies on a cooling system during the hours of darkness

The sheer nature and design of the technology, dictates that the solar thermal collector would generate zero additional heat energy following the discharge from the compressor during the hours of solar blackout. Consequently, it would be reasonable to surmise there are therefore zero additional efficiencies gained during this period.

To the contrary, the efficiencies achieved are now derived from the opposite effect, with the solar array now acting as an oversized condenser, dissipating an element of the refrigerants heat prior to the condenser. The solar panels essentially reverse their role, again resulting in an improved liquid refrigerant mass flow through the metering device, delivering an observed, measured and recorded reduction in energy consumption.

Conclusion

The patent owner has so far developed installations on 6 continents, across 47 different countries over the last four years. kWh data covering a multitude of differing ambient conditions has been observed and recorded. Although it should be noted that an element of this data was collated by the owners of this patented solution, most were completed by the end user themselves, through their own in-house evaluation of this technology.

Case studies and/or data covering a number of high profile end users including, Cummins, Mercedes Benz, Toyota, DHL, Spar, British Ministry of Defense, Sodexo, Cable & Wireless, Hard Rock Resorts and Intel, along with many more individual or multiple corporations has been compiled, most of which are available on request.

If for any reason this paper has some way failed to satisfy any existing or further thoughts, considerations or preconceptions of solar thermal HVAC, please do not hesitate to request a zero-cost evaluation system to be installed at your facility. The patent owners guarantee; in the unlikely event that the system fails to deliver to pre-agreed projections or indeed to your expectations, it will be removed at zero cost to the user. *Terms and conditions on application*.

Alternatively, please feel comfortable in requesting a visit to an existing installation, you will be more than welcome to affix any level of measuring device (i.e. power/pressure/thermal) to the system in question and where required and if indeed possible you will also be given the opportunity to converse privately with the patent owner's clients directly.

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SolX Energy Ltd