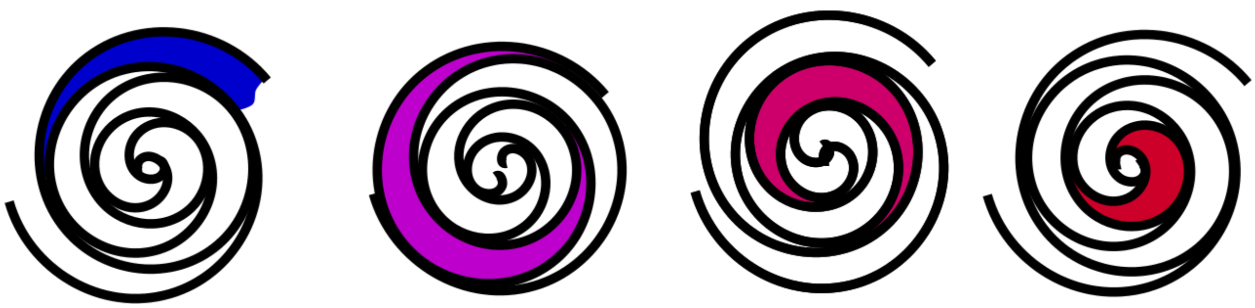
Arkaya Themac Website

Arkaya has developed thermodynamic system for the THEMAC model with 3 things in mind

1) Increased efficiency and reliability
2) Smaller upfront cost with wide adaptability
3) Ease of operation and greater monitoring capabilities

Increased Efficiency and Reliability

Arkaya Thermodynamic System efficiency is increased as it uses the scroll technology compressors. Scroll technology is a considerable improvement on the older technologies namely of Piston and Reciprocating type compressors.
The clearance volume which is required in piston and or reciprocating technology is not required in scroll compressors. This provides a greater efficiency, the spinning wheel axis allows for it to create small pockets with the fixed wheel and in these pockets is where the gas is compressed. This phenomenon is illustrated in the below image which showcases the different stages of compression seen in a scroll compressor.

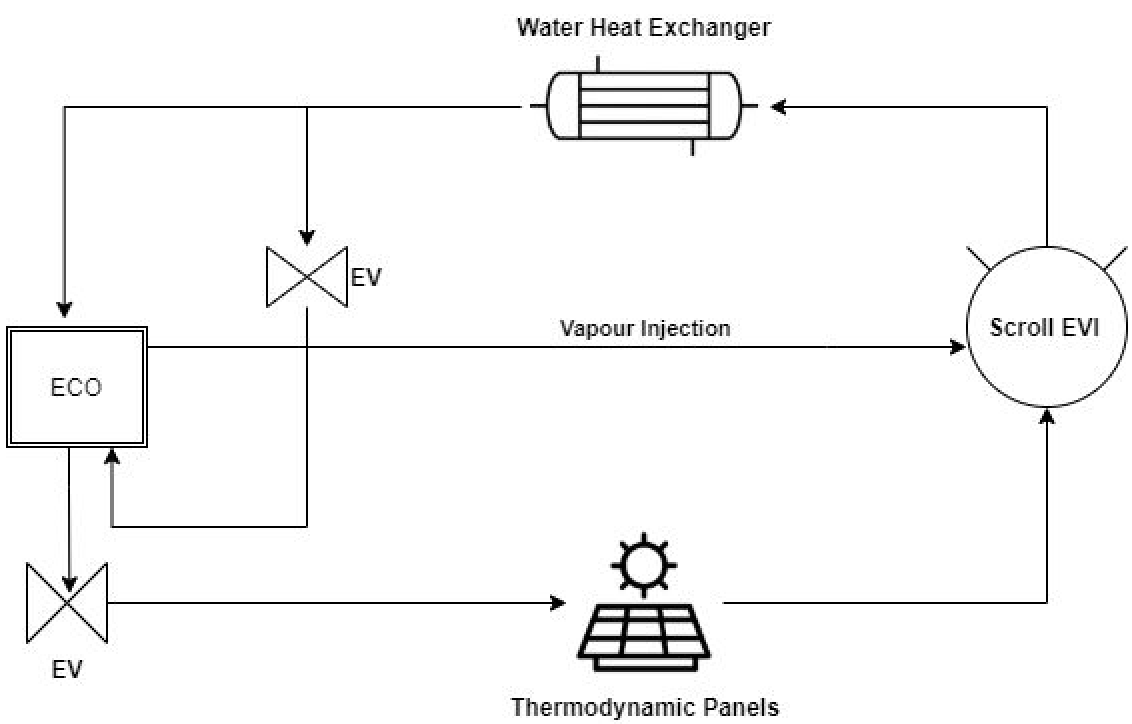


Reliability: Thermodynamic system for the THEMAC model has also made use of the vapor injectection technology to enhance reliability under adverse conditions such as harsh winters. Vapour injection technology allows for vapor to be injected in the compressor through an additional port whilst the compressor is in the middle of the compression cycle.
This technology is especially beneficial under adverse environmental conditions which normally cause pressure drops and this is frequently accompanied by inability for correct flow to be delivered resulting in malfunction.
This has posed a serious threat to operation of heat pumps effectively. Previously mechanisms in place resulted in lower heating/condensing temperatures being attained which are unsatisfactory, or systems set to not run when temperatures get close to zero or freezing. Generally the lower temperatures are accompanied by higher temperature demand to cope with greater heat loss in the house and also increased heating output requirement.

The user or the designer finds themselves in a situation that for longevity of the product its application needs to be altered or it needs to be linked with a back up system such as a boiler. Most common belief found amongst individuals not wanting to go for heat pumps is either the inability to function in lower temperatures and/or lack of support.
Both issues are overcome with the use of vapour injection technology, it ensures longevity of the system through management of pressure and flow required by the system.

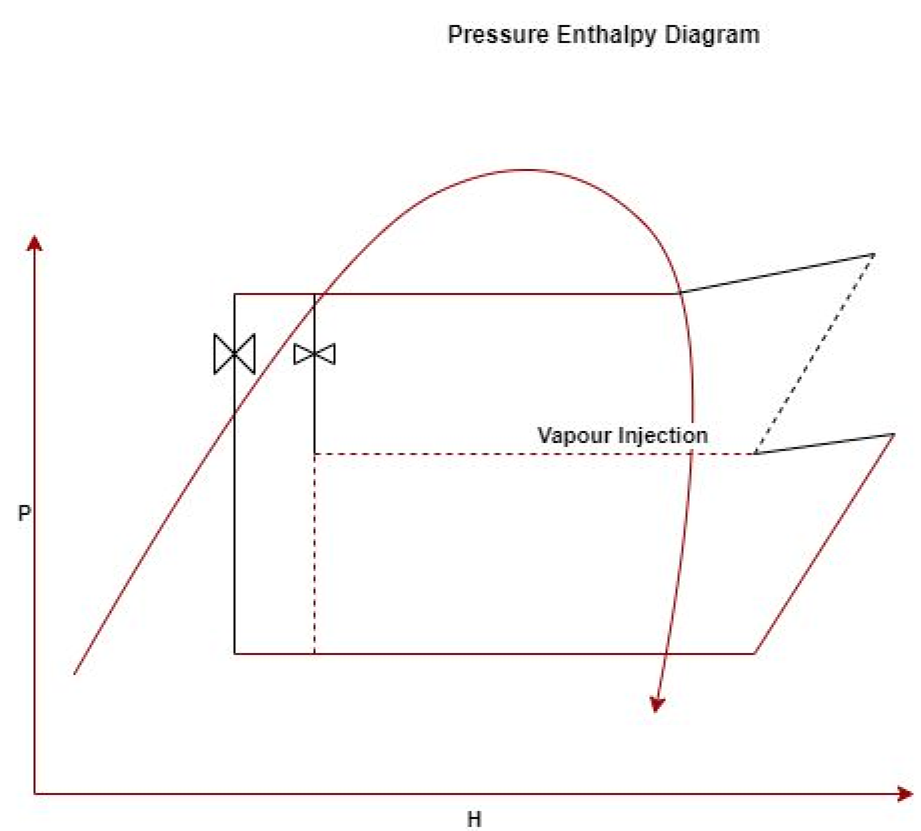
The vapour injection technology also ensures that higher temperatures can be achieved even under harsh winter conditions without compromising the comfort.
The working principle for the vapour injection is simple, the outcoming hot refrigerant from the water heat exchanger is divided into two flow streams. One flow stream pressure is reduced by throttling whereas the other pressure is still maintained high. The reduced pressure in one stream accompanies a reduction in temperature.
The temperature and pressure difference in the two streams allows for exchange of heat and as such allows for compressors to be injected with more gas required for smooth operation ensuring that the flow is maintained and as such smooth operation is maintained. A simple diagram below showcases this phenomenon.

Arkaya Vapour Injection Thermodynamic System



The efficiency is also increased through this simple exchange of heat between the two streams, as this allows for the compressor to have a reprieve allowing it to compress in two stages as opposed to one. This vapor injection effect is somewhat similar to compression being performed by 2 individual compressors.

Below the cycle is showcased on a pressure enthalpy diagram, it can be seen by the additional cooling effect created due to this exchange of heat between two streams which results in greater performance due to additional heat gained through the environment



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Returns On Investment

Reduced Upfront Cost: THEMAC model of thermodynamic systems had early indicators on how to set about achieving better returns. This all originated from close inspection of heat pump technology traditionally used. Heat pump systems traditionally would only make use of laws of heat transfer by the means of air or ground. This works well but both technologies have their advantages and disadvantages. The air heat pump however is considered to be more ‘affordable’ compared to ground but does not guarantee a good seasonal performance in exchange. Whereas Ground source with better seasonal performance forces one to a greater

upfront cost with a very intrusive installation process to follow and on a lot of occasions a site may not be suitable in the first place.
The two challenges were aimed to be overcome through an approach of making use of the most abundant source of heat in the environment, the Sun, whilst making sure that the material and installation cost could be reduced and kept at a minimum.
This is achieved due to the flexibility offered by thermodynamic panels which allow for heat transfer to be radiant as well as convective whilst the air heat pump only relies on convective heat transfer. The practical use of thermodynamic panels can be varied offering more options to the designer whilst it allows for the possibility of making significant improvements in the seasonal performance by making use of the radiant heat as well as convective.

Positive impacts of the changes made to the system to be able to run with thermodynamic panels sees a reduction in running cost as well the material cost for the system.
No requirement of fan and/or motor to run the system sees major advantages as it ensures that the material cost is reduced. Traditionally this purpose would need to be satisfied through extensive coil and fins. Whilst the running cost is reduced by there being less moving parts as there are no fans or motors required which not only reduces material cost but also reduces system reliance on greater number of electrical components.

During the design of THEMAC model of thermodynamic heat pump the focus was for the system to work with different technology such as Phase Change Material, Desiccant humidity control. The higher temperatures needed for regeneration of Desiccant can be supplied through the THEMAC model of heat pump with temperatures higher than 65 degrees achievable with the THEMAC model. The THEMAC thermodynamic system also works well with the introduction of Phase Change material as freezing and melting can slow the heat loss from a dwelling in return allowing for the thermodynamic system to run less.

Amongst other practical considerations the flexibility for the system to be placed inside the house can result in avoidance of long plumbing pipe runs. Further to this the system is also able to be placed inside in locations such as loft, next to the cylinder and with the possibility of panels to be wall mounted as well as roof mounted it allows for a wide variety of ways for designers and users to reduce the installation costs and hence the upfront investment.

Ease of Operation and Greater Monitoring Levels

The development of a new smart controller allows for system designers to fully monitor the system. This allows for the safe and efficient running of the machine. The common problems seen in systems attributing to lack of oil coming back to the compressor and or pressure drop causing restricted flow or high discharge temperature are all early signs that the system could be struggling. Currently, the technician interferes when it is too late, often requiring a replacement of a part which is very difficult. THEMAC thermodynamic system allows for early detection as well as with panels having the capability of being swapped it allows for an easy

solution of just swapping the panel if a panel is found to have a damaged path, leak or a blockage.
The designer also has the ability to isolate the leak detection tests for the panels and or the compressor due to the ability of a pump down into the box system.
Early indicators such as these can stop the system from breaking down before a technician has to come out. The system can be monitored and checked for any issues.
The benefit is twofold for the greater controls provided by THEMAC model of thermodynamic system. The user can also benefit, as it can allow the user in a number of ways.

1) Understand when it may be the most efficient time to run the system through a more interactive monitoring system.
2) Set parameters which allow the system to run more efficiently if lifestyle allows, for example running the system during cheap electricity hours or allowing the system to achieve higher temperatures when it may be favorable to do so.

Finally an automatic shutdown function, alarm function is something that can be inbuilt to allow for greater user friendliness as well as a piece of mind that the system can run for a number of years without a breakdown.
The approach behind this is to replicate the reliability of boilers and other technologies which common households rely upon.

Finally reach a stage where the heat pump system can be standalone capable of coping with adverse conditions and also to have the flexibility to be linked with different technologies and or fulfill different needs. This may include Phase change materials, desiccant controls requiring higher temperatures and also have the ability to satisfy a wide spectrum of existing builds such as old houses having oil or electric heating which may not have the same maneuvering ability which a new build can have to make system installation operation running favorable.