----- Original Message -----
From: Keith Garzoli
To: Colin Dunstan
Cc: John Pye
Sent: Thursday, November 13, 2008 9:25 AM
Subject: Re: Emailing: ANU - Solar Thermal Energy Research - Solar Thermal

Hi Colin,

Thanks for that. Just to put you in the picture, I am no longer part of the Solar Thermal Group - in fact I have essentially retired although I retain Visiting Fellowship status at the ANU. I had no part in putting together the STG website - my own belief is that comventional heat pumps have a COP of about 2 - 3 and Geothermal Heat Pumps about 3.5 - 4.5.

May I ask about your interest? Are you an Engineer, Student or do you have a company etc?

Regards

Keith

----- Original Message -----
From: Colin D <colingd@tpg.com.au>
Date: Wednesday, November 12, 2008 11:38 pm
Subject: Emailing: ANU - Solar Thermal Energy Research - Solar Thermal
To: keith.garzoli@anu.edu.au, john.pye@anu.edu.au

> *Dr Keith Garzoli and*
John Pye
Australian National University

>
> Hi Keith and John,
>
> (The top of your webpage (emailed below) lists Keith as the contact, and at the bottom of the webpage is a request to direct all contact to John...)
>

> Each COP shown in your webpage is the theoretical limit of performance of a Carnot-cycle heat pump for the temperatures you use as examples.
>
> The conventional heat pumps represented in the diagrams - each showing a compressor and expansion valve will, of course, be incapable of attaining anything like these COPs.
>
> For example, "conventional" / "commercially available" heat pumps operating between -5C and 45C are likely to have a COP around 2, not 6.3. If you add a Ground Heat Exchanger to raise the heat source temperature to 20C, and also improve the design of the heat pump, to achieve a COP of 12 (a little below the theoretical limit for the COP of 12.6) - then the COP will have been increased by a factor of 6 - not just 2, which is the result if you add only the Ground Heat Exchanger and stick with the old heat pump.
>
> If you'd like some theoretically-grounded designs for practical heat pumps to replace the "conventional heat pumps" that are limited by 19th Century design foibles, I'd be happy to assist.

>
> Kind Regards,
>
> Colin Dunstan
>
>
> Link to following webpage: http://solar-thermal.anu.edu.au/low_temp/gchp/index.php
>
>

> Skip Navigation | ANU Home | Search ANU | Search FEIT | Feedback

> Solar Thermal Energy Research

> Solar Thermal Group

> **Solar Thermal**
> Home
> Facilities
> People
> News and Milestones
> Low Temperature
> High Temperature
> Other Projects
> Associates
> Publications

> **Quick Links**
> ANU Home
> ANU Solar Home Page
> ANU Department of Engineering - Research Page

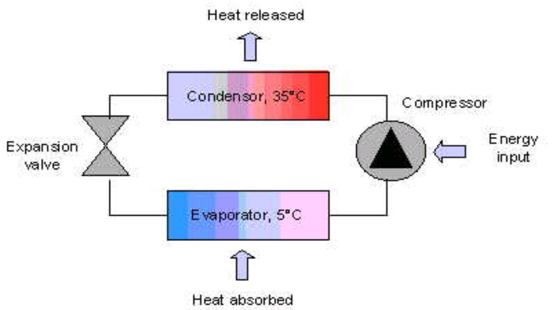
>

> **Commercial Heat Pumps**

Contact Dr Keith Garzoli, Keith.Garzoli@anu.edu.au

> This research involves heat pump technologies that may be used for minimising energy requirements in commercial building heating and cooling. It also shows how space conditioning water usage can be minimised or eliminated altogether, and how systems can be used to generate electric power for local use or for sale to the grid. Savings in greenhouse gas emissions and electricity grid augmentation may also be realised.The ultimate aim of the implementation of these technologies is to produce buildings that are greenhouse neutral, or better. This is achieved when the energy generated by the building's energy system is equal to, or greater than the energy used by the building itself.
>
> There are outstanding research and development opportunities that need to be addressed to realise the potential of these technologies.
>

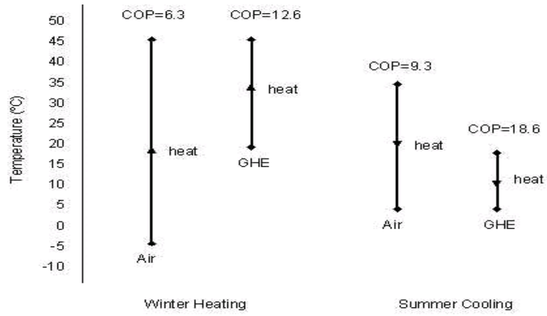
>



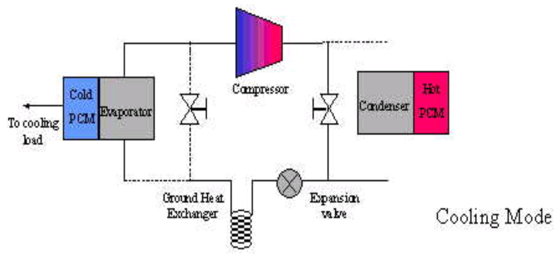
>
> *Conventional heat pump*

> Conventional Heat Pumps

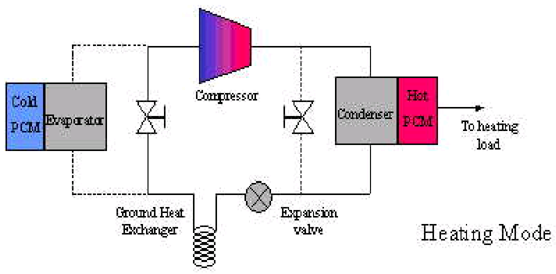
A heat pump is a device that uses energy, usually electricity, to move heat from a cold place to a warmer place. Typical examples are a refrigerator and an air conditioner.
>
> Energy is consumed in the heat pump in driving a compressor. The compressor effectively removes heat from the evaporator, adds further heat, and delivers the total heat to the condenser, hence the term "heat pump". The compressor does this by circulating a fluid called a refrigerant.
> The efficiency of heat pump systems is measured by its Coefficient of Performance (COP) which is defined as the amount of heat moved divided by the energy consumed by the heat pump in moving that heat. Since the energy put into a heat pump appears on the hot side of the device, the heating COP is always greater than the cooling COP. The COP decreases as the temperature difference between the heat source and sink increases, as one might expect.
>
> A good way to increase the performance of a heat pump is thus to decrease the temperature difference between the heat source and heat sink. This applies equally to heating and cooling modes. A performance comparison based on a heat pump with evaporating (cold side) temperature of 5°C and a condensing (hot side) temperature of 45°C is illustrated in Figure 2. In both summer and winter modes, the heat pump COP doubles with a heat sink and source temperatures of 20°C as opposed to using ambient air for heat exchange. The winter air is assumed to be at -5°C and summer air at 35°C.
>



> Performance improvement with ground heat exchange



> Using PCM and GHX in cooling mode



> Using PCM and GHX in heating mode

> Ground Coupled Heat Pumps

The addition of a ground heat exchanger (ghx) allows heat to be extracted from the ground on cold days and rejected to the ground on hot days. It usually consists of vertical pipes in the ground to a depth of about 100m, although horizontal pipes nearer the surface can be used if excavation costs are lower than drilling costs. Since the ground is very stable in temperature at depths exceeding just a few metres , a heat pump using a ground heat exchanger can be made to work much more effectively. Such a system is called a ground coupled heat pump (gchp).
>
> The properties of the soil are very important to the operation of the ground heat exchanger and this requires careful management The ground heat exchanger can be made much smaller with the use of phase change materials as energy storage in the system.

Heat Pumps with Phase Change Material

The use of energy storage with heat pumps, and in particular with ground heat exchangers, leads to large gains in performance for the heat pump.addition of a ground heat exchanger (ghx) allows heat to be extracted from the ground on cold days and rejected to the ground on hot days. Since the ground is very stable in temperature at depths exceeding just a few metres , a heat pump using a ground heat exchanger can be made to work much more effectively.
>
> The use of phase change materials allows the heat pump compressor to be about 50% smaller and the ground heat exchanger to be about 30% smaller, with large cost savings.
> There are a number of additional benefits. The heat pump can be run at constant operating conditions, thus more efficiently by design. The heat pump is always running at maximum capacity and hence best efficiency since it charges only the phase change material and does not respond directly to the varying building load. Furthermore, the heat pump can be run using cheaper off peak energy and can be used in peak shedding or peak shifting consumption strategies.
>