



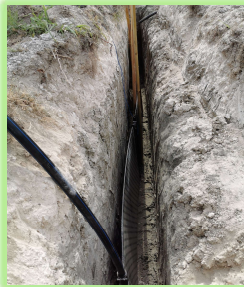
# PCM

**Phase Change Materials**  
Thermal Energy Storage

## GROUND SOURCE PCM APPLICATION

A ground source heat pump uses a ground heat exchange loop extracting heat in order to heat buildings and provide hot water. The technology extracts heat from the ground and transfers it into the heating circuit using heat pump transferring the heat it into a building.

Conventional ground loops are based on pipes buried underground in a horizontal trench or a vertical borehole. A new type vertical plate bore holes are developed like the examples below but whatever the time of loop applied the finishing of the loop will be applying grout material to prop up the pipes / plates plus exchange the heat transfer.



Ground heat exchangers are surrounded by grout material which has a direct impact on the system's thermal performance. It is vital to a suitable grout's with high thermal conductivity and the commonly use grouts are bentonite, cement, sand, graphite, controlled low-strength material, dolomite, and phase change materials.

In theory, phase change materials are the best choices of grouting but one has to be very careful what goes into the ground as quite often these heat exchanger closer or within ground water levels.

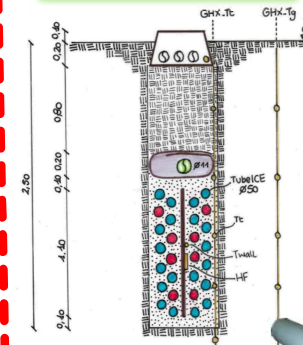
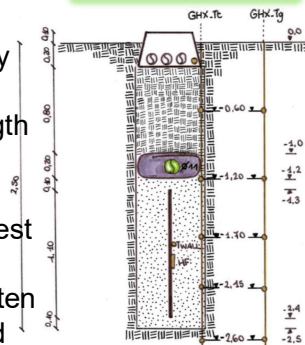
Two different formats namely a) Organic Powder PCM granules mixed with the standard grout b) HDPE material 50mm dia. X 1m long tubes housing hydrated salt based PCM as illustrated.

As both PCM concepts are applied for the same application and in different run of the ground heat exchanger circuit and therefore direct comparison with standard grout vs PCM powder and tube enhancements compared.

Actual test results indicated that for a given ground heat exchange area PCM additions improved to ground heat extraction capacity as much as 30~50% which has a direct impact on the heat pump efficiency as illustrated below.

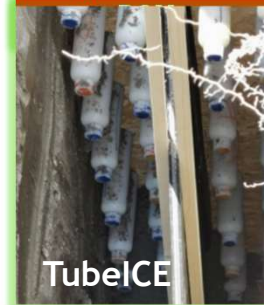
**Powder Filling**

**Container Filling**



**Organic Granule**

**Hydrated Salt**



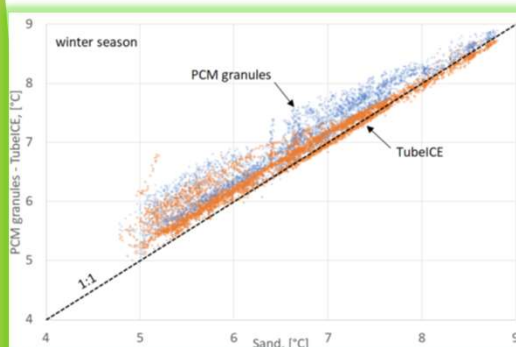
**PCM Granules**

**TubeICE**

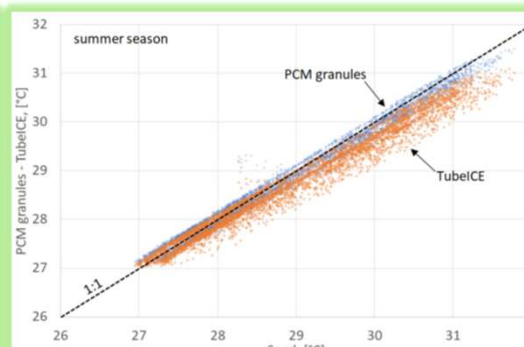
**TubeICE™**



**TubeICE Bundles**



**WINTER OPERATION**



**SUMMER OPERATION**

