WATER ENERGY DISTRIBUTORS, INC.
2 Starwood Drive Hampstead, NH 03841
603-329-8122 fax: 603-329-0285
www.northeastgeo.com

Reducing Well Pumping Energy & Operating
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GENERAL

NOTES

It should be noted various field test procedures do not accurately measure well pumping energy when the GT heat pump shares a well with domestic needs. This shared well configuration provides a substantially lower first cost as the majority of many area GT markets include domestic wells.

These field test procedures often over state the energy used by the well pump when used with the heat pump and compute a very low system COP. Mathematical allocation of the pumping power only puts the COP into a more correct range, but still leaves the home owner with a dilemma….Comfort or Energy Savings.

This memo offers discussion of that dilemma for an AGENDA item.

In recent years various field test procedures have high-lighted that basic dilemma when designing the modern geothermal open well system. The dilemma is particularly noted when the same well is used for the heat pump and various domestic needs – the heat pump is treated a just another water using appliance in the house either recycling the water to the environment via a recharge well, natural surface water or a standing column.

Considering typical annual run times only further high-lights the dilemma:

Function	Flow Rate	Pressure	Hours per Year
Heat Pump	High Flow	Low Pressure	3,000
Domestic	Low Flow	High Pressure	700
Irrigation	High Flow	High Pressure	350 (North) 850(South)

WELL WATER USE REQUIREMENTS & DILEMMA

The simple and easy solution to satisfy each of the above needs is a very large submersible pump….a convenient and successful solution, but hardly an energy efficient solution. The large pump is an effective but both an expensive first and operational cost solution.

This memo identifies several solutions to solve a low *system* COPs with "shared purpose" geothermal well water systems.

SOLUTIONS

Several solutions to the dilemma exist and several solutions are presented for our discussions. A review of various available solutions:

1. **CRC** - Add to the well pump controller a Capacitor Run Control (CRC). The CRC simply provides the well pump with a run capacitor; most pump motor

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controllers are start caps only. The run capacitor substantially corrects/increases the power factor of the well pump motor. In cases where the pump motor is fully loaded, current (amps) draw can be reduced by as much as 40%. However, when the power factor is then increased the actual kW reduction is only in the 12%-18% range. As the CRC is a minor cost increase (~$50), ***We recommend that all pump installers to provide this run and start capacitor control box, rather than the conventional "start only" capacitor control***

2. **CONSTANT FLOW VALVES & SHUT OFFS** – As various heat pump manufacturers have dual geo heat exchangers, each of those heat exchangers should be active *only* when used. This can reduce the well pumping power during those 70%-80% times of the year when single stage operation is expected. When a single stage is used the water flow through that circuit should be limited to the manufacturer's specification. Many manufacturers already require constant flow (Dole, Griswold etc.) valves on dual circuit or speed heat pumps. Constant flow valves are low cost and effective metering devices set for a specified flow rate across a broad input pressure range (typically 15 psig to 60 psig). ***We recommend all heat pump designers to employ constant flow and shutoff valves for each stage of multi-stage/speed heat pumps.***

3. **CONSTANT SPEED BOOSTER PUMP** – A booster pump only for the domestic needs and in series with the well pump is a practical method of providing the desired higher pressures at lower flow rates for the typical residential domestic needs. The well pump is usually only a 1/3 -3/4 hp motor and the booster pump is then 1/3 – ½ hp – often replacing a 1 to 1 ½ hp well pump. The well pump provides water at the high heat pump flow rates at a relatively low pressure and the same water is provided to a domestic booster pump through an isolating check valve. The booster pump then pumps up a conventional storage tank to the typical domestic 40-60 psig and shuts off when the pressure tank is satisfied. In this manner the small low pressure submersible pump provides the 3,000 hours of full load run time to the heat pump at a low pumping cost and the booster does not reduce the efficiency of the heat pump system and is only functional for the typical domestic 700-800 hours. ***We recommend the use of two-pump systems when geothermal heat pumps are used on domestic wells.***

4. **VARIABLE SPEED BOOSTER PUMP** – A booster pump for both domestic and irrigation need and is in series with the well pump as above. These booster pumps (e.g. Grundfos JetPAQ) are assembled as a single variable speed pump, check valve and pressure tank all in one unitary package. In this case the booster pump is a digitally controlled variable speed pump with the ability to pump variable amounts of water within a constant high-pressure range. As an example, if operating at a pressure range of 50 psig±10 psig, a shower would deliver 2 ½ gpm and the lawn sprinkler would deliver 20 gpm, either or both at the same pressure. The booster pump automatically speeds up or slows down to deliver the proper domestic and/or irrigation flow rates at the 50 psig. ***We recommend this type pumping arrangement for simple single, particularly small, geothermal heat pump installations*.**

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5. **<u>VARIABLE SPEED WELL PUMP</u>** – An application with multiple heat pumps, domestic and irrigation uses lends itself to a variable speed well pump. We now have five such systems in operation. When one or more heat pumps are functioning the well pump delivers a very constant 20 psig. When a domestic or irrigation need is sensed, the well pump automatically ramps to full speed until that requirement is satisfied or a domestic pressure tank is satisfied at 60 psig. Constant flow valves on the heat pumps insure the heat pumps do not experience excessive water flows during the domestic's high-pressure "ramp-up" period. ***We recommend this type pumping arrangement for multistage/multi heat pump geothermal heat pump installations.***

In terms of costs and ease of application the above methods are ranked:

Method	Ease of Application	Relative Cost	kWh Savings (typ)
CRC	Very Easy	Lowest	~15%
Constant Flow & Multi Shut offs	Easy	Low (typ +$250)	30% - 40%
Constant Booster	Moderate	Moderate (typ +$100)	50% - 60%
Variable Booster	East	Moderate (typ +$850)	50% - 60%
Variable Well Pump	Difficult	High (typ +$2000)	60% - 85%

Ranking of Methods to Increase Well Pumping Cost Efficiencies