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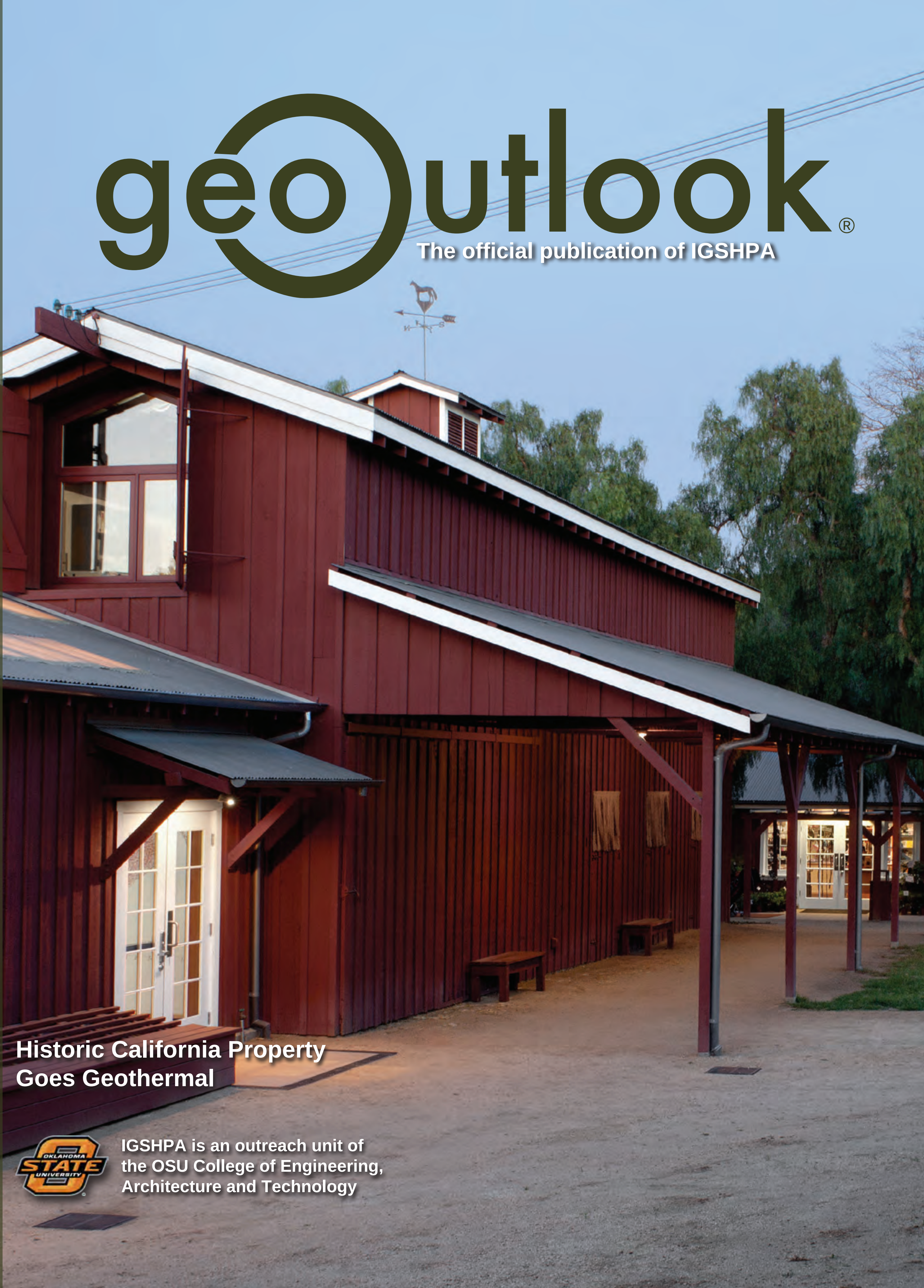

Historic California Property Goes Geothermal

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IGSHPA UPDATES

LETTER FROM THE EDITOR

By Erin Portman

Communications Specialist: IGSHPA

Working for you!

I feel as the year is flying by and I can't believe we are already in the month of June. Every year, the staff continues to look for ways to better serve our members. You will see this as we roll out the new membership structure and continue working on our course offerings. The new courses that are being developed will only continue to improve the GSHP industry and enhance the end user experience.

IGSHPA staff has been hard at work these last few months strengthening bonds with other ground source heat pump organizations, working on the new membership structure, and creating a stronger organization for YOU, our members. We continue to work on all of this to advance the IGSHPA mission of promoting the science, utility and use of ground source heating and cooling technology.

Inside this issue are articles revolving around drilling and industry best practices. You will learn about what to consider when determining drill bits for a particular soil and why the proper design of a GSHP system is imperative in our industry. I continue to learn about the industry with every new Geo Outlook that is produced.

If you have any questions, comments, or concerns about the new content and format of Geo Outlook feel free to reach out to me personally. I also welcome new writers and story ideas!

Sincerely,

Erin Portman

Here we go again!

By John Turley

Board of Directors President

There seems to be a lot of positive things happening in our industry. Both in the U.S. and internationally, GSHP's are finally getting recognition for their renewable attributes, their potential impact on carbon emissions reduction, and the associated cost savings to consumers and society.

As business picks up, IGSHPA will play an important role in the training of the new designers, installers, and inspectors that will be needed to meet the needs of the marketplace. This will continue to be possible through the hard work of staff, the Board of Directors, and our committees. IGSHPA survives on the efforts of all three. Volunteers, donating their time, extend IGSHPA's financial resources and keep members involved in determining IGSHPA's strategic direction.

Our committees never stop working. The conference committee, chaired by Jack DiEnna, is busy planning 2017 technical conference in Denver. Our Standards Committee, chaired by Lisa Meline, is putting the finishing touches on the next round of updates to the IGSHPA Standards. Chris Smith's Membership Committee worked hard last year to tackle revising membership categories to bring them in line with the IGSHPA bylaws. Marketing, headed by Brian Urlaub, was instrumental in helping Erin Portman with the new Geo Outlook format. Xiaobing Liu's Research committee is working with Dr. Jeff Spitler to put together a research track for the next conference. Training, chaired by Ed Lohrenz, is getting close to completing the Residential Master designer course. This will be followed by the GHEX course due to be completed before the end of the year.

Last year our Advocacy Committee, chaired by Terry Proffer, embarked on a new level of involvement. With the help of Cary Smith and Garen Ewbank, IGSHPA began to recruit state "liaisons" to serve as a means for getting a consistent message out at the state level. The goal is to have representatives in all 50 states. This committee will work closely with GEO, NGWA, and other groups to help move toward the "one voice" that will help our industry increase its impact.

Once again, I am asking for you to consider helping out on one of our seven committees. If you are interested in one of the committees, please reach out to the IGSHPA staff. Thanks for helping keep YOUR organization strong!

Sincerely,

John Turley

Geo 101

Understanding how a ground source heat pump system can benefit you

Perfect Partners

Ground source heat pump (GSHP) technology is an ideal investment for utility providers looking to decrease their peak loads and carbon emissions all while increasing off-peak loads and maintaining profitability.

Benefits of GSHP systems include:

- **Currently in use by utilities in many states (with potential in others) to help meet Renewable Portfolio Standard (RPS) requirements**
- **Reduce single home energy consumption emissions by 44% – 72% through the elimination of fossil fuel heating technologies**
- **Quantifiably reduce peak demand loads in terms of kW**
- **Offers potential in some areas for increased off peak energy sales & improved system load factor**
- **Potential to generate revenue while decreasing demand, through utility managed systems leased to property residents**

GSHPs can provide the utility of the future with renewable and energy efficient solutions while enhancing the customer experience as the market demand for sustainable resources grows.

For more info check out these links:

http://remagazine.coop/in-the-loop/
http://energy.gov/energysaver/choosing-and-installing-geothermal-heat-pumps

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ASSOCIATION UPDATES

IGSHPA Partners with State Level GSHP Organizations

Strides are being made to formally connect IGSHPA with state level ground source heat pump associations nationwide. Recently, IGSHPA signed MOUs with the California Geothermal Heat Pump Association and the New York Geothermal Energy Organization to help advance the industry and strengthen the bond with our industry partners.

These organizations and IGSHPA recognize we all serve common interests in promoting the ground source heat pump industry; growing the market share of the HVAC industry; training and certification of ground source heat pump installers of residential installers; and creating business opportunities for all involved in the ground source heat pump industry.

"IGSHPA, working cooperatively with CaliforniaGEO and New York Geothermal Energy Organization under the structure of these MOUs, is a great step forward in our continuing efforts to build alliances with state level organizations," says Bob Ingersoll, IGSHPA Executive Director. "The potential for application of ground sourced heat pump technology in California and New York is enormous. We look forward to working with these two organizations in making a significant impact in energy efficiency as well as lowering water usage and carbon emission reduction in those states."

CaliforniaGeo

"The MOU between IGSHPA and CaliforniaGeo represents an effort by IGSHPA to partner with all state heat pump groups and associations so that strategies, training and certification can be bolstered across the U.S," says Bill Martin, President CaliforniaGeo. "By closer contact, participation at each other's annual meetings and the sharing of newsworthy development and policies, it is hoped that coordinated effort will produce new synergy that can more rapidly advance the utilization of earth-linked heating and cooling."

New York Geothermal Energy Organization

"The New York Geothermal Energy Organization is excited to establish a formal working relationship with IGSHPA," says Bill Nowak, Executive Director of NY-GEO. "The geothermal heat pump industry holds the key to solving significant environmental and economic problems facing America's energy sector. These include responding to climate change and maintaining both the stability of the grid and electric utility revenues during the transition to a renewable future. It is important that the geothermal industry is united and well-coordinated to maximize our effectiveness in helping America meet these challenges."

International Geothermal Conference: An Interview with IGSHPA Sweden

José Acuña

Dominika Rydel

Geo Outlook Staff: Today we are speaking with José Acuña from KTH Royal Institute of Technology and Dominika Rydel from the Swedish Avanti drillers association, organizers of the first IGSHPA Sweden International GSHP Conference. José and Dominika, Thank you for taking the time to speak with Geo Outlook about the upcoming conference in Sweden! Could you start by giving us a little bit of background as to who you are and about IGSHPA Sweden?

Dominika Rydel: Certainly! I have a double Master degree in Law and have earlier mostly worked with intellectual property as well as contract law. In August 2015 I was named the CEO of the Swedish Avanti drillers association. I am also the current president at IGSHPA Sweden, a chapter of IGSHPA USA, and have been since the start of the chapter. Our offices are located at KTH Campus, Stockholm, Sweden. KTH is the oldest and largest technical university in Sweden which we believe gives a solid ground for IGSHPA to establish roots in Sweden. From here, thanks to a very close collaboration with KTH researchers, we promote the growth and advancement of the GSHP industry in Sweden and act as a liaison between our Swedish members and the larger IGSHPA structure.

José Acuña: I have since 2013 a PhD degree on borehole heat exchanger and distributed thermal conductivity tests. I have gradually and for natural reasons also become an engineering consultant in the field of ground source heat pumps. On a part time basis, I lead several research projects at KTH on deep borehole heat exchangers, advance monitoring and design of borehole fields, and aquifer thermal energy storages. I have recently built up a team of young and ambitious researchers on this subjects. Simultaneously, I am the group leader of the ground source heat pump department at the company Bengt Dahlgren, in Stockholm. I am proud to be the academic ambassador of IGSHPA Sweden and to be one of the founders of this chapter. I have been lucky to have had contact with IGSHPA for some years and it is really nice to materialize a closer cooperation through IGSHPA Sweden. My goal is to be a multiplication factor so that many more researchers, students and businesses learn and grow, through IGSHPA, in a more international ground source heat pump industry.

Geo Outlook Staff: You are here today to talk to us about the upcoming International GSHP Industry Convention which you are planning, when and where is the convention going to be held?

IGSHPA Sweden: The International GSHP Convention we are hosting will be held on the 15th and 16th of September 2016, in Stockholm, Sweden.

Geo Outlook Staff: What is the venue?

IGSHPA Sweden: On the 15th of September the event will be at the KTH Royal Institute of Technology Campus. For the 16th of September the event will take place at the Wenngarn Castle.

Geo Outlook Staff: What sort of GSHP related events and activities can we expect?

IGSHPA Sweden: For the 15th of September we will be focusing on academic and professional research presentations and discussions relating to the growth of the GSHP technology base. These will though have a practical focus. The motto of the conference is "Together, we can build bridges between the academy and the GSHP industry". The program is posted at www.energy.kth.se/gshpconference.

On the 16th of September will be a traditional drillers day (Brunnsborrardagen), hosted by the Swedish AVANTI Drillers Association's. This event has successfully been running for two decades! Drillers come together to meet and interact with other industry organizations, product manufacturers, policy makers, and real estate owners. Think of it as a premiere networking event for the GSHP industry here in Sweden! Information for exhibitors is available at www.brunnsborrardagen.com.

Geo Outlook Staff: What can attendees expect from the program?
IGSHPA Sweden: The program is a mix of technical information and country updates presented by both American and European ground source heat pump professionals. We have the pleasure to have John Turley (president of IGSHPAs board of directors) with us. John will explain what IGHSPA is for all attendees. We believe this a great opportunity to spread the voice and make IGSHPA grow. We are also happy to show the work and the nice research projects that we are working on.

Geo Outlook Staff: Is there anything special planned for the out-of-country participants?
IGSHPA Sweden: On September 15, we will be hosting a dinner at the beautiful Wenngarn Castle that all are invited to participate in. This will be a great opportunity for participants to interact and network with one another while learning about ground source heat pumps in their respective countries. This is just a first of many meetings we will organize.

Geo Outlook Staff: Who are the sponsors for the program?
IGSHPA Sweden: Program sponsors are the Swedish Avanti Drillers Association and all its 37 members, KTH Royal Institute of Technology, IGSHPA Sweden, and all participants

Geo Outlook Staff: How can GSHP enthusiasts and professionals learn more about the convention in Sweden and register to attend?
IGSHPA Sweden: Participants and Exhibitors can go to www.energy.kth.se/gshpconference and to www.brunnsborrardagen.com. They are also welcome to contact us if they have questions. We look forward to seeing you in Stockholm!

Update on ANSI/CSA C448-2016

Contributions by Muktha Tumkar, CSA Group, & Devon Calder, Toronto Atmospheric Fund

In an effort to determine how best Canada can reduce its greenhouse gas emissions and decrease energy demand, the Toronto Atmospheric Fund (TAF) recently undertook extensive stakeholder consultation and market research. The results of this effort identified that while ground-source heat pump (GSHP) technology can have an immensely positive impact on both carbon emissions and energy demand; there exists several barriers to the uptake of the technology in the region. Through stakeholder consultation, TAF identified that a lack of technical and financial data from actual retrofit cases remains a key barrier to heat pump uptake. Due to lack of real world examples, stakeholders are unaware of the steps required to retrofit their properties. The ANSI/CSA C448-2016 Design and installation of ground source pump systems for commercial and residential buildings is one means that provides technical guidance for the design and installation of such systems.

This standard has been developed by subject-matter-experts from across North America with a vision to harmonize the differences between existing resources, simplify referencing in regulations and contracts, incorporate the latest advancements, clarify compliance using standards language, and provide credibility through an accredited neutral standards development process. The bi-national committee members included leaders from industry trade & professional associations, utilities, drillers, installers, manufacturers, regulators, designers / engineers and researchers / academia and endorsed by IGSHPA's standards committee.

Questions? please contact Muktha Tumkur – muktha.tumkur@csagroup.org
To learn more go to: http://shop.csa.ca/en/canada/energy-efficiency/ansicsa-c448-series-16/invt/27014712016

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PROJECT SPOTLIGHT

Historic California Property Goes Geothermal

By: Drew Slattery

Rancho Los Alamitos is home to not only the largest ground source heat pump (GSHP) system in Los Angeles County, California; but also to an American Institute of Architects Design Award as well as two different spots on the United States National Register of Historic Places for its storied role in Southern California's regional history. The Rancho, whose full name translates to Little Cottonwoods Ranch, rests in the Bixby Hill area of Long Beach, California, just to the west of the San Gabriel River. While Southern California may be considered an epicenter for many things, the application of GSHP technology is not usually on that list. But make no mistake: GSHP popularity in the region is growing, thanks in part to properties like Rancho Los Alamitos who have stringent requirements and specific needs for their HVAC solutions.

The Rancho, recipient of several national and regional awards for the restoration and preservation of its historic buildings, has played an important role in the human development of the region dating back over 1,500 years – long before any of these buildings were even constructed. The area first served as a sacred village for the Native American tribe who inhabited the Los Angeles Basin as far back as 500A.D. Moving along in time to the 1790s and into the early 1800s, the land served as profitable Spanish and then Mexican farmland, thanks to the ample water supply provided by local springs. After the region's acquisition by the United States, the land changed hands again; this time to the illustrious and entrepreneurial Bixby Family in the 1870s. The Bixby's stewardship of the land during the late 1800s and early 1900s would lead to a productive era of tenant farming and oil extraction while the area around the property quickly urbanized. Over time, the property was divided and parceled off through various deeds and inheritances; reducing it down from a once 300,000 acre ranch to its modern day size of 7.5 acres.

Fast forward to 1968: the property was deeded over to the city of Long Beach by the Bixby family, the last private owners. Remodeling the property, the city repurposed the grounds entirely; shifting buildings from their original historic locations

Photo by: David Wakely

The entry hall of the Rancho Center, comfortably conditioned by the GSHP system, shares the rich history of the property with visitors and orients them to the property's many attractions.

Photo by: David Wakely

and use, to allow the property to serve as a community park space. In 1986, wanting to adapt the property away from park space and utilize its importance in local history as an educational tool for the community, the city handed management of the property over to the Rancho Los Alamitos Foundation. The Foundation, led by Executive Director Pamela Seager, is an organization dedicated to preserving the property's rich history and sharing it with the public.

Renovating History

An award-winning renovation effort to rejuvenate the Barns Area of the property and restore its historical accuracy and functionality was undertaken by the Foundation, wrapping up in the summer of 2012. This renovation was extensive: costing $18 million dollars in total and taking place in two phases over several years; it involved not only the meticulous restoration and repurposing of five 20th-century era barns back to their original design and use, but also moving these historic structures across the property back closer to their original locations, in addition to the remodeling of one barn to include 10,000 square feet of new construction for a learning center, exhibit room, theater, multi-purpose space, and offices.

Respected preservation architect Stephen J. Farneth-FAIA, LEED AP/Founding Principal, Architectural Resources Group (ARG) in San Francisco, California provided architectural duties for the renovation process. The end result is a sprawling and beautiful agricultural complex, museum, and garden, which stands proudly in the heart of Long Beach-looking towards tomorrow while celebrating yesterday. The museum and indeed every square inch of the property serve as a testament to local history, culture, and ecology dating back hundreds of years.

A Geothermal Solution

"We required an HVAC system which did not possess the noise and visual interruptions that are synonymous with traditional chiller/condenser systems," Pamela Seager, who has served as Executive Director of the Foundation for the past 30 years, says. In fact during the planning phases for the renovations, Seager and her team went to tour a nearby commercial property of similar size and use which had just installed a state-of-the-art air-source condenser/chiller system to test-drive the environmental ambiance and visual appeal of the system; “the noise was unbearable, as soon as we stepped out of the car” she remarks.

The reasons behind this extreme sensitivity to equipment related noise and visual distractions are twofold. The first being that the site is of great historic value; keeping the area free of excessive noise and unsightly outdoor mechanical equipment was a chief concern of the Foundation. Next is the Rancho’s physical location; the property lies adjacent to the Bixby Hill gated community, a pristine neighborhood of large high-value residential plots. These neighbors placed immense pressure on Seager and the Foundation to carry out their renovations without disrupting community life, or devaluing adjacent properties by relying on unsightly and noisy rooftop HVAC units.

A GSHP system was the obvious answer to these needs, and it came with the added bonus of decreased water consumption compared to a traditional cooling tower setup; an important and desirable feature for any HVAC system in water-starved California. An initial system was installed, however it was independently designed by a contracting engineer unfamiliar and inexperienced with GSHP technology. Due to their inexperience and lack of understanding of the components that make a GSHP system work, the system included only 2,000 feet of HDPE pipe laid in a horizontal trench just six feet deep in an adobe clay formation. Extensive system testing was undertaken upon completion and fluid reaching the pumps from the trench was measured to be at over 100 °F. This system was immediately disconnected and scrapped- along with its designer.

“This is a prime example of why it is so important to make sure that anyone designing a GSHP system is vetted and that they’ve proven that they understand the fundamentals of the technology,” Michael Burrous, President of Summit Consultants, Inc. and lead consultant on all Rancho property construction, design, and maintenance issues for 20 years says. To fill the now empty system designer’s seat, Seager and Burrous– who is an IGSHPA member, tapped Steve Guttmann of Guttmann & Blaevoet from San Francisco, California. Guttmann, an IGSHPA member and seasoned geothermal system design expert who has worked on several high-profile GSHP systems, including the Lucasfilm (of Star Wars fame) owned Big Rock Ranch office complex, settled on a 35-ton closed-loop system coupled to a vertical borefield for

The renovated barnyard area serves as the location for the loopfield; care was taken not to damage any of the root structures for the native trees.

Photo by: David Wakely

Drilling took place amongst the beautiful ecology the Rancho celebrates and preserves.

Photo provided by: Mike Meyer, Gregg Drilling

the roughly 10,000 square feet of conditioned interior space on the property.

Thermal conductivity tests were performed in the heavy adobe clay which lies under the barnyard area in front of the five historic buildings for the borefield. Formation thermal conductivity came out to 0.94 Btu/hr ft °F, while formation thermal diffusivity was determined to be 0.72 ft2/day, and the undisturbed formation temperature was 68-69.2 °F.

Mike Meyer of Gregg Drilling oversaw drilling and loop installation duties for the field. Given the thermal conductivity test results, the borefield design originally called for less total bores with more depth to each. This however, proved to be problematic, as bedrock lies at the 350 foot depth and drilling past that would not have been cost effective according to Meyer. The borefield design was then adapted to a total of 30 bores at 350 feet deep. Special adherence to site containment had to be taken during the drilling process; everything was recycled with no water on the ground. "With recent legislation,

Site containment and cleanliness was a primary concern during loopfield drilling.

Photo by: Mike Burrous, Summit Consultants

The mechanical room for the Rancho Center provides pumping and circulation duties for the building's Trane GEH units.

Photo by: Mike Burrous, Summit Consultants

this is becoming more and more prevalent and something drillers need to prepare for and become experienced in," Meyers remarks on the site containment.

In regards to the piping for the field, 22,000 total feet of one-inch SDR 11 HDPE pipe was used, relying on fused U-bends for the loops. Each bore was grouted bottom to top using thermally enhanced bentonite grout. The entire borefield connects to the two conditioned buildings and their heat pumps via one and three inch HDPE pipes which are fused to the vertical bores and connect through one centralized valve vault and manifold system, which was installed and tested by Air Connection Inc. of Santa Rosa, California. Total cost for the loop field drilling, installation, headering, flushing, and related vault work was just over $225,000.

For the heat pumps, 13 Trane Axiom GEH units ranging from one to five tons each and totaling 35 tons of capacity were chosen. The total conditioned space for the system is around 10,000 feet split between two buildings; the main Rancho Center at around 9,000 square feet and the smaller 1,000 square foot Bookstore Classroom. The smaller Bookstore Classroom has one five-ton unit all to itself in a small mechanical space, with

The Multi-Purpose room of the Rancho Center features wall murals of the local ecology painted by the world renowned artist Dugald Stermer; known for his *Time Magazine* cover portrait of President Barack Obama.

Photo by: David Wakely

The renovation process involved the careful moving of the historic structures across the property.

Photo by: Cristina Salvador Klenz

Extensive new construction was carried out below ground to turn one barn into the Rancho Center.

Photo by: Cristina Salvador Klenz

the rest of the system being housed in the mechanical room for the Rancho Center. Each building runs independently of the other, and heat pumps in the Rancho Center service individual rooms within the building and run independently as well. The system relies on air handlers and forced air delivery and is not configured to provide hot water, although Seager mentions in hindsight she wishes they would have included that in the system design. IGSHPA member and chair of the IGSHPA Standards Committee, Lisa Meline of Meline Engineering, Sacramento, California, served as consulting engineer for the project design and installation; reviewing the entire system to ensure maximum efficiency to prevent any issues from occurring down the road.

"The great thing about the GSHP system, is that it runs itself; it isn't like other systems which require full time attention" Seager says, noting how the lowered operational overhead has benefited the historic property. The high level of reliability and low maintenance cost that comes with the GSHP allow the Foundation, which relies on a combination of both public funding and private donations, to free up both resources and staff time to deal with issues related to their mission of preservation and education without having to worry about HVAC maintenance.

Editor's Note: Read more about Rancho Los Alamitos going geothermal in the July/August issue of Commercial Architecture Magazine.
http://www.commercialarchitecturemagazine.com/

Drew Slattery has been serving the Communications Department of IGSHPA as a graduate level intern since January of 2015. He is a Returned Peace Corps Volunteer who is currently pursuing a Master of International Agriculture degree at Oklahoma State University. He hopes to pursue a career in international agriculture development; strengthening food systems in the developing world, upon graduation.

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DRILLING:
What Do I Need to Know?
By: Stewart Krause – Wyo-Ben, Inc.

A number of years ago, following a CEU training session I had given, one of the participants pulled me aside and ask me what he thought was a simple question – "Who do I need to know to be a successful driller"? I thought he meant what do I need to know, however he insisted it was who he needed to know. After some thought about how many people had influenced me over my years in the drilling industry I was thinking the list would be about the size of a phone book. However, I knew that wasn't exactly what he was asking. I boiled it down to three very necessary people, a good rig guy, a good bit guy and of course a good mud guy.

Why even bring this story up? I find myself, on any given day, spending as much time revisiting drilling technology and theory as I do discussing mud technology. As all successful drillers have found, a good piece of equipment or drilling fluid will only take you so far; you must also possess sound drilling techniques. The ground source drilling industry has incorporated many different experience levels and backgrounds over the last twenty years. We run into drillers from the water well, seismic, mining, geo tech, monitor well, HDD and oil & gas industries as well as complete novices with no drilling experience at all. So when I get the call from a drilling contractor that is having trouble drilling a particular formation, I have to evaluate their experience level and adjust my questions accordingly to understand the problem. Most of the time, information comes in small pieces during one of these calls and can be difficult to extract. Simple things such as mud pump capability, drill rod size and bit type may sway the way I approach the perceived drilling mud problem.

Let's say a contractor is calling to inquire about a polymer to drill particularly nasty swelling clay. The problem is not so much getting the bit to bottom but getting the loop to go into the hole after it is drilled. The drilling is really quite easy with fast penetration rates requiring only a little mud up with bentonite to start. Then adding only water as increased volume as required and allowing the formation to provide the clay thereafter. When asked if booting was a problem he admitted they did a lot of tripping in and out to clear boots but felt they were cleaning the hole good enough. They were still having problems getting the loop down and felt swelling clay was the problem. I asked if they tripped the bit to bottom when the loop wouldn't go and he stated, "Yes and without a problem, that's how I know we're cleaning the hole". I inquired if they had measured the mud weight in the completed hole to which he replied "no".

Focus on Efficiency

I suggested we walk through the entire drilling procedure to discuss ways to make the whole drilling process more efficient. We started with the pump output and walked thru annular velocity for drilling the different formations encountered on this particular location. We also discussed simply drilling fast may not be the best for production. Slowing down the penetration rate and increasing rotational speed producing a smaller, easier to carry cutting may be a better solution. Gaining production would come from using a properly prepared drilling fluid that would allow the cuttings to be carried up the annular space without sticking to each other and the tooling. This way he could keep turning to the right rather than constant tripping to clear boots from the hole and also control the density of the drilling fluid. We discussed the effect high density drilling fluids have on the buoyancy of the loop and thus the difficulty in getting the loop to bottom.

Remember how the call started with an inquiry about a polymer to deal with sticky clay? Now we're ready to start discussing the makeup of the drilling fluid. The contractor felt there was very little change in the formation from surface to 300 feet with mostly clay or clayey sand. With that information I suggested we start with a fairly simple fluid. Beginning with treating the makeup water, a small bentonite addition and a clay inhibiting polymer. Treatment of the potable city water with soda ash to bring the pH level between 8.5 and 9 was the first step. The contractor expressed his concern about the time this process would take in lost production but I assured him once the process was in place it would take very little extra time and pay huge dividends with faster mixing plus better additive performance. I stressed the importance of measuring everything being added to the drilling fluid system to keep the system predictable.

Know Your Tools

Once the water treatment recipe was determined and the water source didn't change the onsite water pH adjustment was simply part of the process. How much bentonite should I add was the question that came up next? I suggested he mix bentonite to reach a marsh funnel viscosity of 32 to 34 seconds/quart. Using a desired viscosity as a target, eliminates water quality and additive variations to provide a very predictable drilling fluid. Giving the bentonite time to hydrate is always a concern, so using the marsh funnel can also be a valuable tool by looking at the screen for evidence of non-hydrated material. When using the marsh funnel it is important to always pour the fluid thru the screen, as anything that passes the screen will pass thru the bottom orifice thus no plugging of the marsh funnel. An added advantage any non-hydrated material will show up on the screen letting him know more mixing is required. Now choosing a polymer to help with the encapsulation of the clay for efficient hole cleaning. Early on we had discussed the two "V's" of hole cleaning, velocity or viscosity. Make the fluid fast or make it thick. Clay is generally a fairly non-erodible formation where higher annular velocity is preferred, usually 100 to 120 feet / minute. Using velocity rather than viscosity of the drilling fluid to clean the hole. So in choosing a polymer we went with a low viscosity shale inhibitor, which would allow us to keep a reasonable amount of polymer in the system without creating high viscosity. Again, the question came as to the addition rate of the polymer. I referred back to the marsh funnel and suggest he take the viscosity from 34 to 40 seconds/quart with the addition of the polymer.

Proper use of the marsh funnel system may take time to set up and test; but will save you much more than that amount down the line.

Photos provided by Dominique Durbin

This ensures enough polymer is in the system to encapsulate the cuttings, allowing them to be removed without sticking to each other or the tooling, and drop out of the fluid on arrival at the surface. The goal is not to allow the cutting to break into smaller pieces and be dispersed in the drilling fluid to be recirculated down the hole thus increasing fluid density. I then stressed the need for polymer maintenance in the system as the polymer would be used up as the cuttings are removed from the borehole. I suggested the addition of 3 to 5 ounces of polymer for every 2 or 3 rods drilled to keep encapsulation properties high. If the viscosity starts to increase back off on the additions, or if the cuttings start to stick together increase the polymer additions.

So in closing, a simple question turned into something less than a simple answer. Personally, I feel an obligation to offer the best and most complete information I can about the products we sell and sometimes that also involves the proper drilling techniques required to make them work. I enjoy being a sounding board for ideas as well as problems as it forces me to learn something every day.

Stewart has been employed by Wyo-Ben, Inc. since 1978. During this time, he has served in many different capacities involving the Oil & Gas, Mining, Environmental, Industrial, and Water Well industries. Stewart is involved in the product development and site applications of Wyo-Ben's Groundwater & Mineral products. Stewart is recognized by the Petroleum Extension Service at the University of Texas / Austin as an instructor for drilling fluids application. Stewart teaches several drilling fluid and grouting seminars each year for the Groundwater industry and is a past chair of the manufactures board of the NGWA.


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12/2015

CHINA:
GROUND–COUPLED HEAT PUMP TECHNOLOGY

By: Zhaohong Fang, Nairen Diao, & Ke Zhu
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A Chinese drilling crew installs HDPE for a commercial size GSHP system.

Photo provided by Ke Zhu

ABSTRACT

Applications of the Ground-Coupled Heat Pump (GCHP) technology in China have grown dramatically in recent years owing to the critical demands of energy conservation and environment protection for sustainable development. Research and development on the GCHP technology in China are summarized, including those in the heat transfer modelling drilling and grouting facilities for construction of the ground loops. The GCHPs for building heating and air-conditioning are extended to more comprehensive applications combined with the Ground Heat Exchanger (GHE) in foundation piles and the seasonal thermal energy storage from solar thermal collectors.

INTRODUCTION

China has experienced a rapid urbanization process over the past few decades. The improvement of the living standard has resulted in a great demand for heating and air-conditioning of the buildings. Energy consumption for building operations accounts for 22% of the total energy consumption in China at present, out of which 60% are used for heating, air-conditioning, and domestic hot water supply in buildings.

Ground-source heat pump (GSHP) systems for heating, ventilation, and air-conditioning (HVAC) have aroused a great deal of interest in China because of the growing concerns about air pollution caused by coal-fired boilers. Their higher energy efficiency is also favored in comparison with conventional air source heat pump systems. Open-loop systems with ground water pumped from wells as heat source/sink have been frequently used in northern China in recent years, but increasingly restrictive environmental regulations covering the use of groundwater and its limited availability have led to interest being focused on closed-loop systems (namely GCHP systems). Surface water heat pump systems which utilize heat from lakes, sea, sewage and industrial waste water have also become popular. Utilizing the ground as a heat source/sink, GCHP systems have been gaining increasing popularity for space conditioning in buildings due to their better flexibility and environmental friendliness.

Owing to the advocacy and incentives of the government, and also as a result of progress in research and development in this area, GCHP applications have grown rapidly in China both for residential and commercial buildings. According to national statistics, up till the end of 2014 there were more than 4000 business entities involved in the manufacture, design, and construction of GSHP systems in China; the installed GSHP capacity reached 12.85 GWt, ranking second in the world after the U.S.; and the total building floor spaces of more than 350 million m2 were served by GSHP systems.

While experiences from Europe and North America have helped in the process of developing the GCHP technologies and applications, a major distinction is the fact that most GCHP projects in China are much larger than those in Europe and North America, with a single project often serving building floor spaces of over 10000 to 100000 m2, which brings in some unique challenges. Moreover, in spite of the large scale of the applications, the overall technology used is unsophisticated in China; and there is lack of adequate legislations, standards, and training. Improvements in these regards are urgently needed.

GOVERNMENT POLICY AND INCENTIVES

Great attention has been paid to energy conservation and air-pollution control in China in recent years. Numerous laws and government decrees have been enacted to promote GSHP applications such as

- The Renewable Energy Law of the People's Republic of China, 2005
- Energy Conservation Regulations of Civil Buildings, 2008
- Instructions to Promote Harnessing the Geothermal Energy by the State Energy Bureau, 2013

The first national standard on the GSHP technology was promulgated in 2005, and it was revised in 2009. All these laws and decrees have emphasized the importance of energy conservation and greenhouse gas (GHG) emission reduction for global sustainable development, and advocated applications in China of the GSHP technologies as well as other renewable energy sources in buildings.

HEAT TRANSFER MODELING OF GROUND HEAT EXCHANGERS

Despite all the advantages of the GCHP system, commercial growth of the GCHP technology has been hindered by higher capital cost of the system, of which a significant portion is attributed to the GHE. Thus, it is crucial to work out appropriate

China's explosive growth and development in recent years has spurred a growth in GSHP adoption.

Photo provided by Ke Zhu

GSHP system control interface for a large commercial GSHP system in China.

Photo provided by Ke Zhu

and validated tools, by which the thermal behaviour of GCHP systems can be assessed and then, optimised, in technical and economical aspects. Chinese researchers have worked hard on the GHE heat transfer modelling. Our study (Man et al., 2012) on the GHE modelling follows the theoretical platform presented by Eskilson (1987) and Spitler (1999). The concept of thermal resistances and the principle of superimposition have been used in their approach for GHE analysis. Better understanding of thermal resistances of the single-borehole GHE is crucial, and their analytical solutions are especially preferred to facilitate the simulation and design.

HEAT TRANSFER INSIDE BOREHOLES

A few models of varying complexity have been established to describe the heat transfer inside the boreholes. Models for practical engineering designs are often oversimplified in dealing with the complicated geometry inside the boreholes. Taking the fluid axial convective heat transfer and thermal “short-circuiting” among U-tube legs into account, a quasi-3-D model for boreholes in GHEs has been established, and analytical solutions of the fluid temperature profiles along the borehole depth have been obtained on both single and double U-tube configurations in the borehole (Zeng et al. 2003). Borehole thermal resistance can be determined according to the borehole configurations.

HEAT CONDUCTION OUTSIDE BOREHOLES

Both the classical 1-D models of the Kelvin’s line source theory and the cylindrical source model neglect the axial heat flow; therefore they are inadequate for the long-term analysis of GCHP systems. Considering the influences of the finite length of the borehole and the ground surface as a boundary, an analytical solution to the finite line source has been used in our analysis (Zeng et al. 2002). Furthermore, the 3-D conduction around an inclined finite line source has also been studied by the Green’s function method, and an analytical solution derived (Cui et al. 2006).

PILE GHE

Foundation piles of buildings are used as part of the ground heat exchangers in recent years in order to reduce the cost of borehole fields and to save the land it requires. Piles are much thicker in diameter but shorter in depth than the boreholes. Few analytical models on the pile GHE have been seen in literature, and models for the boreholes are often used as references to give a rule-of-thumb estimation in pile GHE applications. Modified from the classical models, a new model, referred to as the "solid" cylindrical source model, is proposed, which takes the pile GHE characteristics into proper consideration. It is supposed that the cylinder is no longer a cavity, but filled with the medium identical to that out of the cylinder. So the whole infinite domain is composed of a homogeneous medium. Man et al. (2010) derived the analytical solution of the new model, which results in a simple and straightforward temperature response as:

$$\theta = -\frac{q_l}{4\pi^2 k}\int_0^{\pi} \mathrm{E}\left(-\frac{r^2 + r_0^2 - 2r r_0 \cos\varphi}{4a\tau}\right) d\varphi$$

Other models, referred to as the ring-coil model (Cui et al., 2011) and the spiral model (Man et al., 2011, Zhang et al., 2012), have also been established and solved analytically for pile GHE thermal analysis.

GROUNDWATER INFILTRATION

Groundwater filtration may exert significant impact on performance of GHEs. All of the GHE design tools available at present, however, are based simply on principles of heat conduction, and do not consider the implications of groundwater flow in heat transfer. Diao et al. (2004) have solved the combined heat transfer of conduction and advection in the vertical GHEs by an analytical approach, and an explicit expression of the temperature response has been derived describing correlation among various factors which impact on this process. It takes the following expression:

$$\theta(x, y, \tau) = \frac{q_l}{4\pi k}\exp\left(\frac{xU}{2a}\right)\int_0^{\frac{r^2}{4a\tau}} \frac{1}{\eta}\exp\left[-\frac{1}{\eta} - \frac{U^2 r^2 \eta}{16 a^2}\right] \mathrm{d}\eta$$

The influence of the groundwater infiltration on the heat transfer of pile GHEs are also studied; and a few analytical solutions have been obtained for 2-D and 3-D heat transfer around a buried coil with groundwater movement considered (Zhang et al., 2014).

Piping and valves for a large commercial GSHP system in China.

Photo provided by Ke Zhu

HYBRID GCHP SYSTEMS

Because the GCHP system uses the ground soil/rock as the heat source and sink of the heat pump, adequate attention ought to be paid to the long-term impact of the annual imbalance in heating and cooling loads of the system on the underground environment. An alternative to reduce the initial cost of the GCHP system and to improve the system performance is to employ a supplemental heat rejecter or heat source in the imbalanced GCHP systems, which is called the hybrid GCHP (HGCHP) system. Cooling towers are usually employed as the heat rejecter in cooling-dominated applications of the HGCHP (Man et al. 2008). GCHP systems with hot water supply are also designed and studied as an effective hybrid system to reduce the heat rejected into the ground (Cui et al. 2008). As for the heating-dominated applications of the GCHP systems in cold climate, hybrid systems with solar thermal collectors are also being studied, incorporating the concept of seasonal thermal energy storage, and some pilot projects of such hybrid Solar-GCHP system have been constructed in China.

TECHNICAL DEVELOPMENT: GHE Design and Simulation Software

A software package with a Chinese interface named GeoStar has been developed and spread for the design and simulation of the GHEs by our research group (Yu et al. 2002) on basis of the theoretical studies of GHE modelling. This software package is able to size GHEs to meet the user-specified minimum and maximum fluid temperatures entering a heat pump for a given set of design conditions, such as building load, ground thermal properties, borehole configuration, and heat pump operating characteristics. In addition, the modelling procedure uses spatial superimposition for multiple boreholes and sequential temporal superimposition to deal with the arbitrary heating or cooling loads of the systems. The software is suitable for simulation of the performance and energy consumption of given GCHP systems as well.

TECHNICAL DEVELOPMENT: DRILLING AND GROUTING EQUIPMENT

As GCHP applications boom in China, so does the market for bore field drilling. A large amount of "down-the-hole-hammer" drilling rigs, such as those manufactured by Atlas in the US and Bauer in Germany have been introduced into the GCHP industry in China to deal with ground loop installation in hard rock strata. Similar drilling equipment is also developed by Chinese manufacturers. In recent years grouting equipment has also been manufactured in China to meet specific needs of the GCHP applications.

Large commercial GSHP systems require large and open mechanical rooms

Photo provided by Ke Zhu

Efficiency and safety are top priorities for Chinese GSHP system mechanical rooms

Photo provided by Ke Zhu

CONCLUDING REMARKS

The ground source heat pump industry has grown dramatically in China over the last decade owing to the urgent needs for energy conservation and environment protection. The government advocacy and incentives as well as public awareness have been important impetuses for the explosion. It is crucial to develop computationally effective methods for sizing and simulating the GHEs especially for large scale applications. Various kinds of hybrid ground source heat pump systems are of great significance to construct effective and economical GCHP applications in view of the vast territory and diversiform climate in China. Besides, as drilling and installation of borehole heat exchangers constitute the greatest portion of the first cost of GCHP systems, better drilling and ground loop installation techniques will continue to be pursued in order to ensure quicker and less expensive construction of the GHEs. While lessons have been learned and experiences and know-how from North America and Europe have been tapped into, Chinese scholars and engineers have worked hard to adapt this sustainable technology to local geological, meteorological and social situations in China and to make our own contributions to achieve above goals. It is certain that the Chinese GCHP industry will keep its momentum of rapid growth; and the research and development on GCHP technology is expected to provide support for industry and contribute to sustainable development in China.

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IGSHPA China

The Chinese chapter of the International Ground Source Heat Pump Association was reactivated in January 2016, with the objectives of accomplishing the IGSHPA mission across China while providing a vehicle through which members can meet and discuss matters of mutual interest. We have 10 charter members, including one holding company, one association, one product distributor, one contractor, four individuals and two associates.

Our Chinese officer team includes: President, Prof. Dr. Zhaohong Fang; Vice President, Mr. Weidong Kong; Secretary, Dr. Ke Zhu; and Treasurer, Dr. Ping Cui. Each officer is elected and fulfills their duties, as specified in our chapter bylaws. The officers of the chapter make up the Executive Committee, which is the governing and policy-making body of the chapter, and has responsibility for supervising the activities of our chapter. The current Executive Committee advisor Prof. Dr. Nairen Diao is from Shandong Jianzhu University (GSHP research Center).

The office of the Chinese Chapter will be located inside the campus of Shandong Jianzhu University in Shenyang, China. The GSHP research center of Shandong Jianzhu University is a member of our Chapter, and they will provide office space as well as additional help in re-establishing and maintaining the Chapter.

We will organize meetings and exhibitions across China as follows:

- Regular Meetings: Chapter meetings will be held at least four times per year, including meetings on teleconference. The first meeting was on the 26th March in Jinan, China and all charter members attended this meeting.
- Special Meetings: Special meetings of the Chapter meetings may be called by the Chapter officers or by written request of 10% of the members eligible to vote in Chapter elections.
- Exhibitions: In two years, we plan to organize an international GSHP exhibition in China. We would like to invite international experts from institutes, universities, industry, and government officials etc.
- In 2017, a Chinese chapter delegation plan to visit the annual IGSHPA conference in Denver.
- We will invite speakers from the IGSHPA Headquarters to visit China and attend the Senior Forum and Exhibition for Ground Source Heat Pump Industry of China in August 2016. Also, we welcome and help IGSHPA members to participate in the Forum and Exhibition.
- The Chinese Chapter plans to conduct IGSHPA Accredited training programs in China, offered by IGSHPA Accredited Trainers. Due to the language barriers, our Chapter prefers Chinese-speaking trainers. Therefore, we will select Chinese members to take part in the IGSHPA Accredited trainings in the United States, in order to increase the number of IGSHPA Accredited Trainers who can communicate in our local language.

Geothermal Growth in China

- According to national statistics, at the end of 2014 there were more than 4000 business entities involved in the manufacture, design, and construction of GSHP systems in China.
- The installed GSHP capacity reached 12.85 GWt, ranking second in the world after the U.S.
- The total building floor spaces of more than 350 million m2 were served by GSHP systems.

IGSHPA China's leadership team in session

Photo provided by IGSHPA China

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You Can't Design on Peaks Alone!

By: Ed Lohrenz

Editor's note- This is part two in a four-part series on designing commercial GSHP systems.

"In this area you need about 200' of borehole per ton (57.6 W/m) for a vertical ground heat exchanger (GHX)." How often have you heard that from drilling contractors, heat pump installers, or even mechanical engineers?

Based on that, a project with a peak load of 40 tons would require 40 X 200' = 8,000' of drilling. (141 kW / 0.0576 = 2,248 m of drilling). Unfortunately, a system based on this "rule" will only sort of work. Many times, the project could benefit by taking the time to create a detailed, 8,760 hour energy model. Some could work well with a much smaller GHX and cost a lot less to build. Others will be inefficient and cost more to operate.

Comparing three different buildings: a church, a store and an apartment building, each with their own unique individual use and style of occupancy but with similar peak cooling loads of 40 tons (480 kBtu/hr, or 141 kW) and peak heating loads of 385 kBtu/hr (113 kW), perfectly illustrates the problem. A church is usually fully occupied only a few hours a week. The peak cooling load is driven by the occupants during those few hours. The store may be operating 12 or 14 hours per day. The cooling load is driven by high lighting levels and continuous occupancy. The apartment building is occupied almost all of the time. Monthly load profiles of each of the buildings are shown in Figure 1.

A	Church			
	kBtu C	kBtu/hr C	kBtu H	kBtu/hr H
Jan	4906	4	189734	**385**
Feb	6202	23	135120	366
Mar	12177	76	81304	312
Apr	20866	216	36614	170
May	33946	367	11152	65
Jun	52094	446	3180	5
Jul	62358	**480**	886	0
Aug	62393	465	1725	0
Sep	49245	314	5479	53
Oct	13821	121	24702	137
Nov	7571	62	86784	298
Dec	4884	6	146775	348
	330463	480	723455	385
	EFLH	688	EFLH	1877

B	Retail Store			
	kBtu C	kBtu/hr C	kBtu H	kBtu/hr H
Jan	19906	93	89734	**385**
Feb	28202	110	65120	346
Mar	30177	215	41304	240
Apr	40866	285	16614	110
May	53946	396	3152	35
Jun	82094	446	180	0
Jul	102358	**480**	0	0
Aug	102393	439	125	0
Sep	89245	360	2379	26
Oct	63821	223	9702	128
Nov	41571	135	36784	251
Dec	27884	102	76775	331
	682463	480	341869	385
	EFLH	1422	EFLH	887

C	Apartment Building			
	kBtu C	kBtu/hr C	kBtu H	kBtu/hr H
Jan	5560	25	159734	**385**
Feb	7840	83	112120	360
Mar	14177	185	71304	305
Apr	28866	260	30614	155
May	43946	329	11152	60
Jun	72094	423	8545	45
Jul	92358	**480**	7650	43
Aug	78393	447	7550	45
Sep	59450	360	8479	53
Oct	19821	169	18702	132
Nov	8690	79	66784	269
Dec	6570	22	126775	340
	437765	480	629409	385
	EFLH	912	EFLH	1633

Figure 1: Peak heating and cooling loads are identical for the buildings, but the amount of energy (kBtu or kWh) rejected to the ground annually varies significantly. The amount of energy rejected to the ground from the store is more than double the heat rejected by the church, while the heat extracted from the ground by the church is more than double the heat extracted by the store. The energy loads of the apartment are somewhere in the middle.

Heating loads are also affected by occupancy. Less heat is needed in the store when there are customers and the lights are on... they contribute much of the heat needed in the building and less is drawn from the GHX. The church is used little during the week and requires more heat from the ground.

The efficiency of the equipment installed in the buildings also directly impacts how much energy extracted from or rejected to the GHX. Heat delivered to a building includes energy taken from the ground plus electrical energy used to drive the compressors, pumps and fans. In cooling, energy taken from the building plus electrical energy used to power the compressor, pumps and fans is rejected to the ground. A less efficient heat pump extracts less energy from the ground when heating, and rejects more to the ground when cooling. Equipment efficiency directly affects the balance of energy to and from the ground. This is illustrated in Figure 2. In a cooling dominant building such as a store, the energy imbalance to the ground is greater with less efficient heat pump equipment.

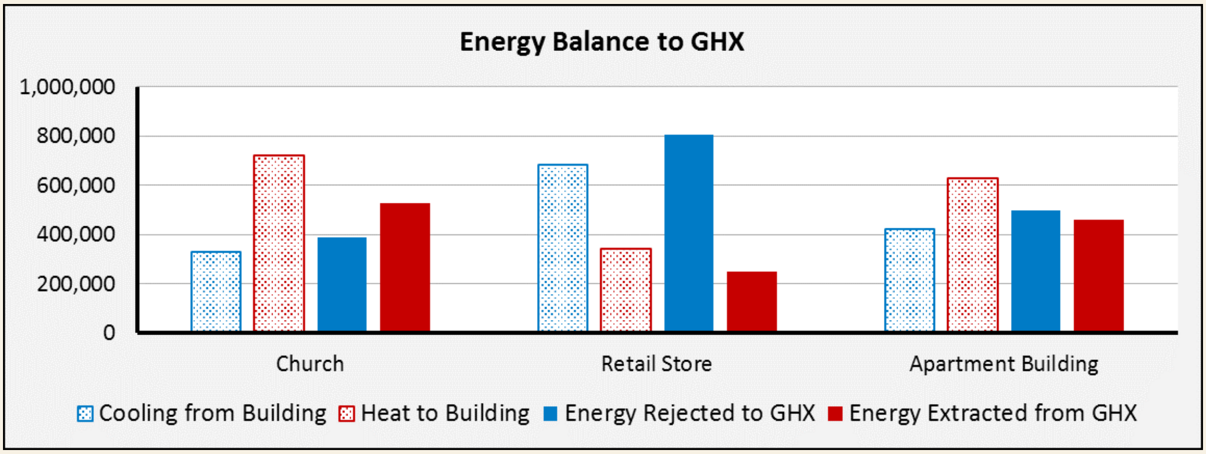

Figure 2: The graph compares the amount of energy (in kBtu) taken from each building and rejected to the ground, and the amount of energy needed to heat the building and extracted from the GHX. Energy rejected to the GHX includes electrical energy used to drive the compressors, while energy extracted from the GHX does not include the heat contributed to the building by the compressors. If the efficiency of the heat pumps changes, heat transferred to and from the GHX changes as well.

If a GHX is designed for these buildings based on 200' of borehole per ton (57.6 W/m) of peak heating or cooling load, how will they perform? The temperature of the ground around the boreholes connected to a heating dominant building such as the church will be lower than the temperature of the ground around the boreholes for the store.

For example in Figure 1 in the month of April, the amount of energy taken from the church to cool it is less than the amount of energy needed to heat it (20,866 kBtu cooling/36,614 kBtu heating), while the store cooling energy load is greater than the heating energy load (40,866 kBtu/16,614 kBtu). The system in the church extracts more energy from the GHX than it rejects to it, while the store does the reverse.

When the performance of a GHX designed based on 200' per ton (57.6 W/m) is modeled, the systems will perform very differently, even though each building has identical peak heating and cooling load. The difference in performance between the church and the store in the first couple of years is not very significant...but in time, the temperature of the cooling dominant store climbs about 2-3°F (1-2°C) each year, and after 10 years, the maximum temperature delivered to the heat pumps is over 95°F (26°C). The minimum temperature of the fluid from the GHX to the church drops about 10°F (5.5°C) over 10 years.

In both the church and the store, the efficiency of the systems drops. The store will become less efficient in cooling...the church less efficient in heating.

The apartment building, however, operates with little change in temperature, maintaining a maximum temperature of about 76°F (25°C), and a minimum temperature of about 35°F (2°C). The long term performance of the GHX for the three systems is compared in Figure 3 (next page).

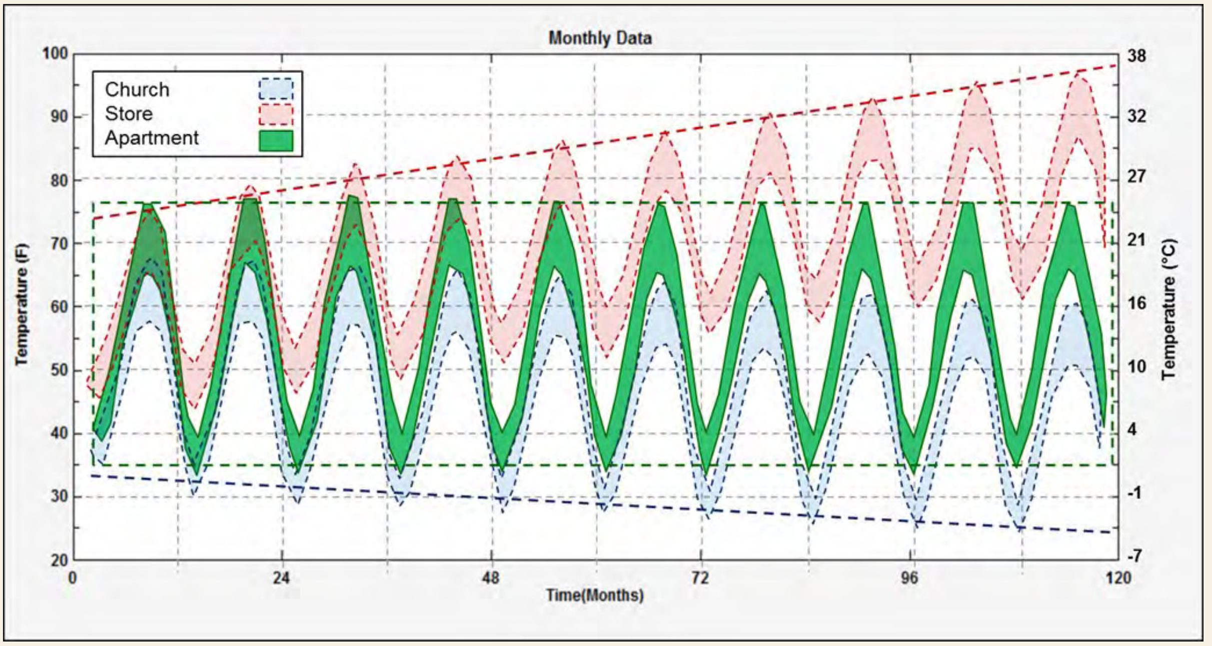

Figure 3: The graph compares the projected 10-year temperature profile of three systems with 200’ of borehole per ton (57.6 W/m). Over 10 years the maximum temperature of the fluid delivered to the heat pumps in the stores can be expected to climb to about 96°F (36°C), to the church the minimum temperature would drop to about 24°F (-4°C), while the temperature of the fluid delivered to the apartment building will remain stable, with a maximum temperature of about 76°F (25°C) and a minimum temperature of about 35°F (2°C).

To avoid long term temperature degradation of a GHX, a larger heat exchanger is needed. The monthly loads from the three buildings were used to model the performance of a larger heat exchanger. For the first GHX model, borehole spacing was maintained at 20’ (6.1 m). The number of boreholes was increased to maintain a minimum temperature of 32°F (0°C) and/or a maximum temperature of 85°F (30°C). The resulting performance for the three systems is seen in Figure 4.

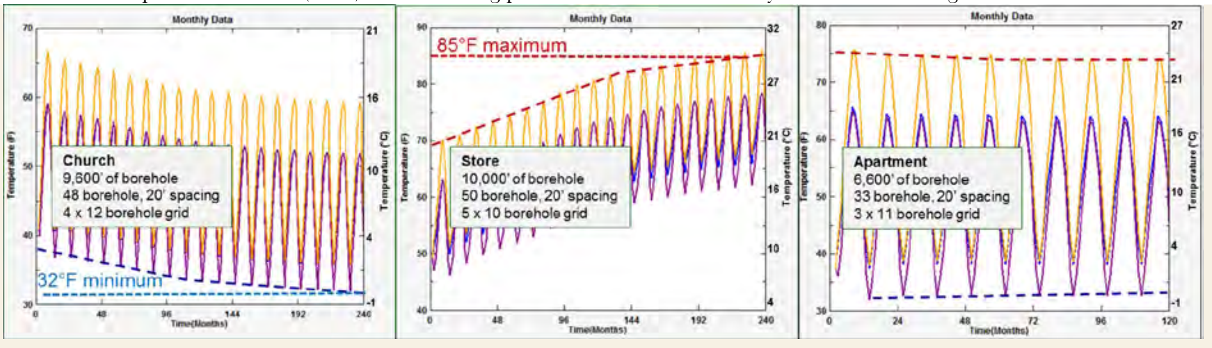

Figure 4: The GHX for the Church, Store and Apartment were modeled with 20’ spacing between boreholes and increasing the number of boreholes to maintain a minimum temperature of 32°F (0°C) and maximum of 85°F (30°C) for a 20 year prediction time.
Note that GHX modeling software currently available cannot take into account the movement of ground water over the borehole field, infiltration of rainfall and snowmelt into the earth, freezing or vaporization of moisture in the ground. Long term degradation may not be as extreme as shown in the graphs and is dependent on the geological conditions of a specific location.

	Church	Retail Store	Apartment
Total borehole length – feet (m)	9,600’ (2,926)	10,000’ (3,048)	6,600’ (2,012)
Borehole spacing – feet (m)	20’ (6.1)	20’ (6.1)	20’ (6.1)
Feet / ton (W/m)	240 (48.2)	250 (46.3)	165 (70.1)
Land area required – ft^2 (m^2)	36,800 (3,420)	20,000 (1,859)	13,200 (1,227)

Figure 5 (previous page): The table summarizes the amount of borehole required for each of the projects based on 20’ (6.1 m) spacing between boreholes.

There are methods to reduce the amount of drilling required for unbalanced energy loads without resorting to hybrid options such as a fluid cooler or auxiliary boiler. Increasing spacing between boreholes and changing borehole layout can reduce the amount of borehole required. Increased spacing between boreholes for the heating dominant loads of the church and for the cooling dominant loads of the store results in less drilling and better performance. Figure 6 shows the performance of the GHX for each of the buildings with increased spacing and different borehole layout.

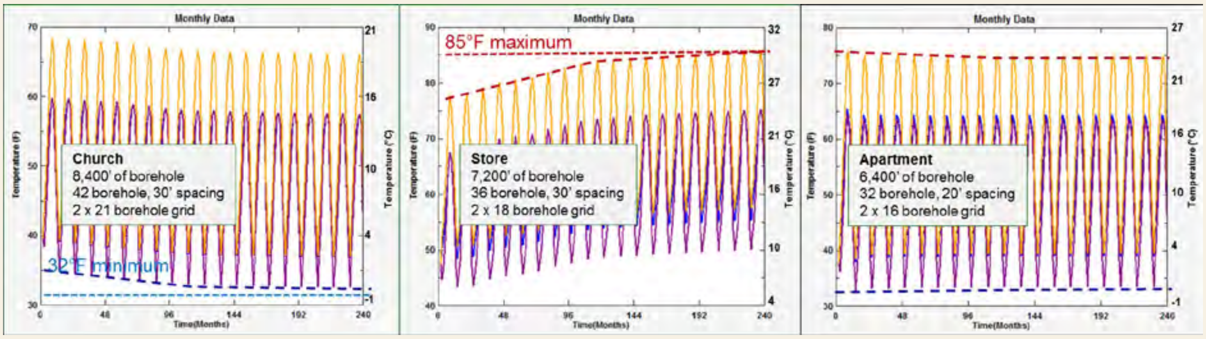

Figure 6: Increasing spacing between boreholes and laying out the boreholes in a 2 row rectangle rather than a square GHX layout results in a reduced borehole size.

	Church	Retail Store	Apartment
Total borehole length – feet (m)	8,400’ (2,560)	7,200’ (2,194)	6,400’ (1,950)
Borehole spacing – feet (m)	30’ (9.1)	30’ (9.1)	20’ (6.1)
Feet / ton (W/m)	210 (55.1)	180 (64.3)	160 (72.3)
Land area required – ft^2 (m^2)	31,000 (2,881)	26,500 (2,463)	12,800 (1,190)

Figure 7: Increasing the spacing between boreholes and changing the configuration of the borehole layout to expose more boreholes to ambient earth temperatures reduces thermal interference and improves the performance of the GHX.

Using peak loads to estimate the size of a GHX can result in a system that does work...for a while. In some it can result in a GHX that can be as much as 20% larger than necessary...a GHX that costs more, requires more land area than necessary and reduces the payback of the system. The additional cost may, however, be enough to cause your customer or client to go back to a conventional system. Alternately, a system that operates less efficiently than it should will reduce energy cost savings.

Preparing an accurate hourly energy model based on appropriate building and system information and occupancy schedules, and using it to design the GHX using proper software reduces the risk of long term temperature degradation and results in more predictable performance from a GHX.

Ed is the founder of GEOptimize Inc., a consulting firm focused on the improving the design and implementation of geothermal heat pump systems. He has worked in almost all facets of the industry since 1982, including the design and installation of residential systems, heat pump manufacturing, equipment distribution and the design and implementation of large scale and district geothermal systems.

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Conditioned Air, Clean Air

By: Paul Parker

What does the conditioned in air-conditioned really mean today? For a consumer in 1966 air-conditioned meant 72 degrees Fahrenheit on the hottest days of summer in a home where the building envelope was designed to "breathe" and the ducts were wrapped in low R value insulation. Fast forward to 2016 and 20 SEER Variable speed connected from your smart phone controlled thermostats and the building envelope is tight. Air-conditioned means something much more precise, comfortable and efficient today than in years past.

That brings me to the central point of this article. In this age of rising case numbers for asthma and allergies- why isn't air-conditioned a term that we as HVAC professionals have brought current with the needs of a vast portion of our customers? Do we not have an obligation to offer relief through cleaner air that may be lifesaving to some and life changing to others?

The Air You Breathe

Stop, take a long deep refreshing breath. Reflect for just a moment on how precious that breath really is. It is easy to take for granted, but according to some studies we take about 20,000 breaths per day. While taking these 20,000 or so breaths, our air is filtered by our nasal passages and lungs. From there, toxic compounds can directly enter our bloodstream and affect our health in long-lasting ways.

Often times in the HVAC industry, we put on our hero cape and attempt to fix our customers "conditioned air" odor or allergen issues. Do you think we find concise, easy to understand information at our finger tips? Not a chance. We find instead a tsunami of terms and conflicting hard science evidence interlaced with pseudo-science claims; air sanitation, indoor air quality, spores, particle count, duct cleaning, UV-A-B-C, odors, germs, Volatile Organic Compounds, chemicals, and carcinogens all come to mind. We mostly look away at the sheer weight of knowing that we may be likely unsafe in the very place that has come to symbolize personal safety to us most – our home. It can be overwhelming and frightening.

This air quality phobia phenomena is occurring across the world, particularly in Asia and Europe. Many of us wonder if this is a real threat to health, or if this is all hype to sell equipment. I believe we are looking at the existence of both factors. There is, however, a noticeable pattern to the swelling wave of health issues. Consider the rising rates of childhood asthma and lung cancer that are growing at an alarming pace. We know that much of our time and that of our customers is spent indoors breathing stale polluted air which is often at just the right comfortable temperature.

Healthy Air

Sanitation is commonly defined as "the promotion of hygiene and prevention of disease by maintenance of sanitary conditions (as by removal of sewage and trash)". So why now is this so important globally? Many people lead busier yet more sedentary and more stressful lives- combined with lower access to nutritious diets equals more costly illness, allergies, diseases and injuries. Costly prescriptions and even side effects from disturbed sleep patterns add up now more than ever and can lead to larger health issues over time if indoor air quality is left unaddressed. "Pay now or pay later" seems to be the prevalent thought of the public looking for relief for the issues reflected daily due in part to poor quality indoor air quality.

We as HVAC professionals are often privy to the signs and symptoms of irritants in the home. But without laboratory analysis we cannot accurately specify which irritants, and to some extent, it is better to not be responsible for this level of specificity.

Nevertheless, we do have knowledge of some of the contributing factors and general knowledge of the usual suspects. We also have access to the public and their trust which includes a moral duty to at least inform them and offer intelligent options to remediate unsanitary conditions. Our first duty is to ensure that their HVAC system is properly operating and mated to the home envelope and air distribution system.

Truly conditioned air is more than just cool or warm. A filthy evaporator coil and duct system will outweigh the most efficient air sanitation devices available. The best way to clean a duct system is to replace it, especially if it is flex duct. That is one huge draw for ductless systems — no ductwork to collect contaminates in inaccessible walls, ceilings and floors for years and years to come. I am a fan of ductless systems (pun intended). I know many hate these systems, but I don't think they are going to decline in popularity any time soon. However for most of the country, ductless is not a reality at this point.

Therefore, this article is a comparative view of types of pollutants, and types of air sanitation devices available to the industry.

Types of Indoor Air Pollutants

In the course of doing research, I found that there is a myriad of confusing terminology surrounding the issue of air sanitation. So I determined to make this subject more accessible for the "Hot Attic Heroes" who are committed to excellence for their customers every day.

The first question that came to mind in defining the problem of indoor air pollution was, "What pollutants cause the most harm?" These were the top three chosen for severity of impact on health and length of impact on health.

- Radon
- Asbestos
- Lead

While we are all deeply grateful to see less issues with lead and asbestos due to bans on the use and production of these two materials, there is still plenty of this stuff floating around to cause concerns in older homes. Some well-known health issues that are caused by these offenders include cancers, kidney failure, and learning disabilities.

The second question was, "Which pollutants are the most common?"

- Biological pollutants mostly from insect and rodent feces, mold, dander, human shed skin cells and pollen.
- Carbon soot mainly from; tobacco, candles, fireplace soot, stoves, heaters and chimneys.
- Volatile Organic Compounds (VOCs) emitted by; cleaning products, pesticides, building materials, paints and thinners
- While biologicals are pervasive indoors and out, we rarely notice outdoors pollutants other than pollen. However, in high enough concentrations indoors the airborne mold spores can produce a variety of very nasty symptoms. The symptom most alarming to me was one caused by a few different molds including the dreaded black mold (not to be easily confused with mildew) which is actual brain and liver swelling.

Types of Air Sanitation Methods

The first question that came to mind was, "Which units adequately address the great number of types of pollutants"? Which units can cause unintended harm?

- Filtration/HEPA (High Efficiency Particulate Arrestance)
- Radiation/Light
- Electrical/Magnetic
- Molecular/Ionic
- Positive Pressure Make Up Air

Filtration has been around a while with particulate effectiveness getting better over time with HEPA (High Efficiency Particulate Arrestance) level protection available. Cost and time to maintain are also factors to consider. For example, a partially clogged filter will cause higher utility usage. Also, some filters are not accessible to some homeowners making them more likely to be neglected. They also attempt to trap particles as they pass so the action is centered on the filter(s).

May help battle: Asbestos, Lead, biological pollutants, carbon soot, and Volatile Organic Compounds.

Light Radiation being used to kill off airborne organisms has the disadvantage of not trapping pollution at all. It kills airborne pathogens as they pass the bulb. Ultraviolet is used and the specific light bandwidth (i.g. ultraviolet B, ultraviolet C, etc) affects how many pathogens are killed off in a single pass. A natural example of ultraviolet light killing germs is hanging laundry on a clothesline outside. The light from the sun freshens the clothes by killing germs with ultraviolet rays. Also see molecular/ionic for a type of device that uses an ultraviolet bulb in a titanium cage to generate titanium dioxide ions.

May help battle: biological pollutants.

Electrical/Magnetic devices are sometimes seen in charged electrostatic filter media or in a grid or plate design so that air passed over a charged surface trapping particles that have an opposite charge. They can be costly and have a life expectancy like other filters.

May help battle: Biological pollutants and carbon soot.

Molecular/Ionic devices emit ions or add molecules that cause clumping of particles. They also address odors and kill airborne pathogens. One plus is that these type of units work throughout the structure as opposed to just a single point. They also don't inhibit airflow across your evaporator coil. A down side is potentially dusty walls from the particulate clumping up and sticking to surfaces such as walls. You can add an ozone generator type; which adds an extra oxygen molecule to the air. This ozone is an irritant in sufficient amounts. It is often used to treat odors in unoccupied spaces. Many caution against prolonged exposure to ozone generators. When you read about smog warnings in big cities high ozone is one of the factors used to determine those warnings. Another type uses an ultraviolet bulb to release titanium dioxide molecules. Yet another type adds an extra hydrogen molecule to the air. These units can be around $400 and up depending on square footage they treat.

May help battle: Asbestos, lead, biological pollutants, carbon soot, Volatile Organic Compounds.

Positive Pressure Make Up Air-Fresh air can displace radon filled air. A special caution against negative pressure make up air as it can draw in radon especially if you have a basement. We also haven't addressed the low oxygen indoors as a potential health concern. We use up oxygen and bringing in outside air is a way to displace our naturally occurring carbon dioxide. In some of these advanced make up air systems the exhaust air is vented through energy recovery ventilators and heat recovery ventilators thereby saving some of the lost conditioning. Outside air is also filtered and sound dampened through the system. Positive pressure make up air is much more of a consideration now that houses are being built to tighter air infiltration standards. I would recommend this type of system be used as an adjunct to one or more of the other systems mentioned here for the best air sanitation results.

Summary

If your only tool is a hammer, every problem will look like a nail. The Hippocratic Oath taken by Doctors basically states don't make the injury or illness worse by our actions. HVAC professionals should heed this oath as well. It is very clear that many of these pollutants are made worse by disturbing them. In my opinion, stirring up pollutants with a rotating brush is about the worse idea imaginable. Especially particles such as asbestos, mold, soot and feces potentially found in ductwork. I don't believe for one minute it is all vacuumed up because I have used duct cleaning equipment (as many of you have) and ended up covered in particles along with my work area. Ducts that need to be cleaned are likely at the point of needing to be replaced.

The devices that most impressed me were the Molecular/Ionic devices, with the exception of some of the ozone generators. Also impressive to me are the advanced Positive Pressure Make Up Air because this combination affects all the common airborne pollutants and requires less periodic maintenance for the equipment. There is an application for all of these devices depending on a number of factors; budget, air infiltration, humidity, type of pollution being addressed, geographical features, and location. We have an obligation to be truly and fully engaged in the discussion on this issue. Consider adding IAQ enhancement offers to every call and every install because it is the right thing to do.

Paul E. Parker is an Independent HVAC Design Consultant specializing in indoor air quailty and freelance writer based in North Charleston, SC. Paul Parker currently resides with his wife of three years, Karen, and two American Pitbull Terrier rescues. He is a proud father of two children Chris and Paulina. He attended Tidewater Community College under the Fire Science Program and completed coursework at the National Fire Academy/F.E.M.A. He has researched and written about Respiratory Health and Indoor Air Quality. He can be reached at parker.paul2014@yahoo.com or 704-231-7442.

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Can You Drill it?

By: Kevin Christensen

Editor's Note: This is the first article in a three-part series on drill bits.

I have attended many state and national trade shows and have given presentations at most, about all the choices of bits available. It still amazes me when I see or hear of a driller using a tricone to drill clay, or a drag bit for drilling sandstone. So I offered to write a series of articles to address the most common drill bits, the best formations for each and how to use them, ie. weights and rotation speeds.

Drag bits can provide drill bit solutions for a variety of formations.

Photo by: DAWA Solutions Group

The first bits we are going to look at in the series are the many styles and shapes of the common drag bit. When using a drag bit, it is very difficult to be specific on weight on bit (WOB), or RPMs because of the speed at which the soft formations can be drilled. The key to using a drag bit is to start out with higher RPMs and low WOB. Slowly increase WOB until the cuttings are coming up hole at a nice size and even flow.

Drag bits are for drilling the softest formations: clay, sand, over burdens, light gravel and some of the soft shales. These bits come in many varieties. Let's just take a 4 ¾ inch bit for an example. There is what is commonly known as a scratcher, then we have a 3 step 3 wing, 3 step 4 wing, a 4 step 3 and 4 wing, from there we go to the chevron with three or four wings also available. Let's not forget to mention all the choices of threads that are available on each of these bit. The most common thread is a 2 3/8 API male pin. We also have all the common female threads, IF, MAYHEW REGULAR, FAILING, and MAYHEW JUNOIR.

Starting off with the scratcher, this bit does extremely well in the soft, sticky clay. If not pushed too hard, this bit will cut the clay without balling up or plugging up and give nice size cuttings that are easily brought up hole. One of the most important things to watch when using any drag bit is the size and rate of your return cuttings. The cuttings should be kept to the approximate size of a penny, especially in clay. If they get bigger than that, you are possibly drilling too fast and increasing your chances of balling the bit up, or worse yet, lose cutting return all together and then the clay cuttings stick to the pipe and create a very large problem. The bad aspect of the scratcher is if you hit any hard formations at all, the carbide is usually damaged quite rapidly. It is designed strictly for soft sticky clay formations only.

Variations of steps and wings on a drag bit

Photo by: DAWA Solutions Group

The most common drag bit is the 3 wing 3 step bit. It is the fastest penetrating bit and the least expensive bit on the market. If you are in any clay formation, sands, overburdens or soft shale there is no bit that drills faster for less money per foot. The 3 wing 4 step bit performs extremely well also. By adding the fourth step you reduce the size of the cuttings-making it easier to flush them up hole. The fourth step also adds some durability to the bit in light/small gravel formations.

Adding a wing to any drag bit will increase the durability and longevity of the bit, but decrease the penetration rates. If you find yourself in a situation with a small gravel layer or any hard layer towards the bottom of the hole, that damages a 3 wing bit to the point where you cannot TD the hole, simply using a 4 wing drag bit maybe the best and cheapest way to conquer that problem.

The chevron bit was designed to drill harder formations like light gravels or shale. It performs better in these formations because it doesn't have the sharp corners of carbide like the step bit which is easily chipped or broken, reducing the penetration rate and life of the bit. The cost of a chevron is slightly higher priced than the step bit, however, I always tell drillers to look at the cost per foot, not the cost of the bit. Sometimes the cheapest bit, becomes very expensive if the life of the bit is very short. Adding a wing is also available on a chevron style bit with the same outcome as a step bit-longer life, slower penetration rates.

Variations of chevron bits

Photo by: DAWA Solutions Group

Another option in the drag bits is going with a replaceable blade system. You can get all the same styles of bits and wing count with the replaceable blade system as you can with the (one drag piece bits) but at an approximate 35% savings per bit. The wings are easily replaced when dull and unlike a one piece bit, which commonly has the carbide broken on one wing, when using the replaceable blades you can replace only the one blade that is damaged. The only negative aspect of the system is it has reduced circulation. If you have a piston pump it won't affect you very much, however, if you have a centrifugal pump the reduction will affect you considerably, especially in deeper holes.

LET'S SAVE SOME MORE MONEY

Drag bits are very easily repaired or "retipped". When getting your drag bits repaired you can generally figure on saving 50% of the cost of a new bit. The key here is to send them into your bit company before it is totally wiped out. If you do this your drag bits can be retipped many times.

The correct way to retip a drag bit is to take off the dull or broken carbide on the whole wing. Build up the wing with steel behind the carbide where it is worn away. Prepare the pocket for carbide and replace the carbide with a NEW piece of carbide.

There are a lot of shortcuts that can be taken here, starting with only putting on a new piece of carbide where the piece was broken and just sharpening the others. Another way to take a shortcut when retipping is building up the steel behind the carbide with brass instead of steel. After the bit is ground and painted you will not be able to tell. However, the life of the bit will be noticeably short. Once again the cheapest deal sometimes becomes very expensive.

Retipping drag bits can add to their lifecycle; lowering your operation costs.

Photo by: DAWA Solutions Group

NEXT UP

The next in this series I will be discussing tri- cone bits. The differences in bearings, TCI and Milltooth and the suggested WOB for both RPMs. In closing always remember.......the right bit for the right formation equals productivity which puts money in your pocket.

Until next time, keep turning to the right.

Kevin Christensen started his employment at Palmer Bit in 1977, manufacturing Red Devil bits for the big seismic boom. In 2005, he and his wife 50 percent of the company from Dick Palmer. In 2008, they designed and marketed the Diamond Devil PDC into the geothermal market. They grew from selling bits in the Williston basin to every state in the union and exporting to 17 countries around the world. In 2012 they purchased the rest of the company from Dick and presently run the company with their two sons.

CALL FOR PAPERS

IGSHPA is now soliciting presentations from the GSHP industry-at-large for the 2017 Technical/ Research Conference & Expo in Denver.

Topics may include any GSHP industry related best practice, job or project, research, or innovation.

For more information and instructions on how to submit your abstract for review, please go to http://www.igshpa.okstate.edu/conf/presentations.asp

Please call 405-744-5175 with any questions.

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Loop Design Done Right

By: Dan Bernstein

A building and its loop field are like a dancing couple: if the two do not understand and respond to each other accordingly, they are likely to careen out of control. It's the same for geothermal heat pump systems. The ground loop and the building are partners in a long term coordinated series of heat exchange activities. If they are not well matched and/or interacting properly, the heat exchange will suffer and perhaps fail.

Thankfully, the design process is well understood and teachable. Even better, recently developed software tools have turned a time consuming and complex process into a straightforward and accessible one. This article will discuss the three primary and equally important steps in commercial vertical loop field design: a) heat loss/heat gain analysis, b) heat exchanger length calculations and c) piping layout design. This article will address each step in turn while focusing primarily on the step which is most often overlooked, piping layout design for vertical borehole systems.

Step 1: Heat Loss/Heat Gain Analysis

The key – perhaps even the linchpin – of loop field design is a solid understanding of a building's heating and cooling needs. Typically, the most accurate way to assess these needs is via the use of a detailed energy modeling software tool. These tools enable a designer to input a range of parameters pertaining to the building and climate and then to calculate the heating and cooling loads for each hour of the year. A good geothermal design team typically will have at least one person well trained on using one or more of these tools. Ideally, building design and loop field design are considered long before the building or loop field construction begins.

To move forward to step 2, heat exchanger length calculations, without a detailed understanding of the building's heating and cooling needs would be like trying to compete in a dance competition with a brand new partner while wearing two left shoes and suffering from a migraine headache. It's not recommended.

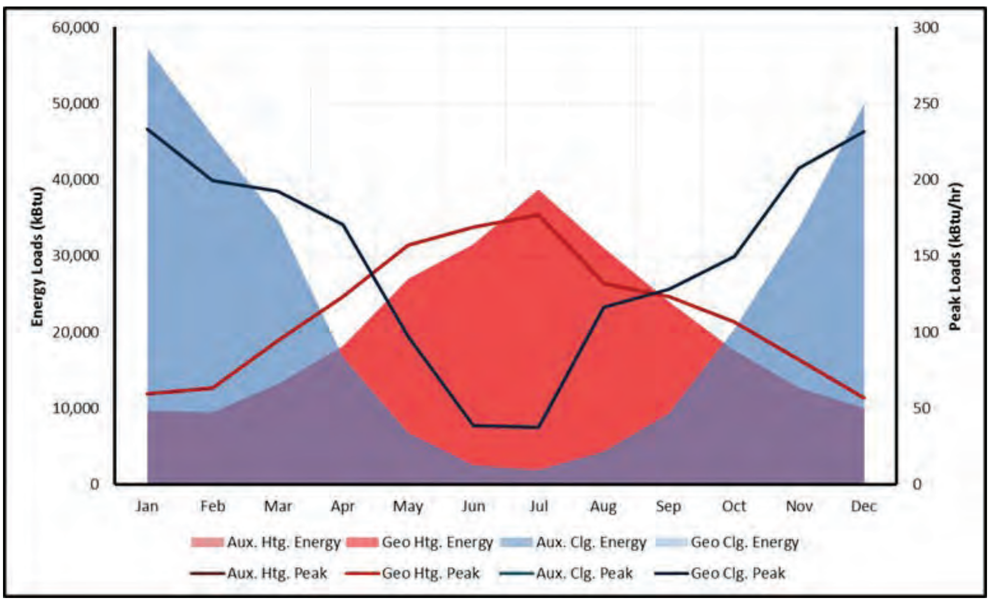

Figure 1: A Monthly Summary from an Hourly Loads Profile

The key engineering parameter for a heat loss analysis is a detailed and accurate hourly heating and cooling loads profile (that takes into account occupancy, internal, and solar gains) for the building.

Step 2: Heat Exchanger Length Calculations

The ground heat exchanger is the "engine" of the geothermal system. Its size and configuration determines how much thermal energy the coupled ground volume can absorb from and deliver to the building. Under- or over-sizing a system results in underperformance (or failure) or excessive capital costs, respectively.

Performing heat exchanger length calculations (the number of boreholes and the borefield layout) used to be a difficult and cumbersome process prior to the advent of software tools in the 1990s. Since then, commercial design tools have made designing fairly straightforward. Users enter their heating and cooling loads from Step 1; input critical parameters related to the geology (undisturbed ground temperature, thermal conductivity, land area available etc.), mechanical equipment and the like. The software tool then will calculate the necessary borehole lengths, predict system fluid temperatures and performance (COP/EER) over time. Some tools even have advanced hybrid design functionalities that allow combined geothermal/conventional hybrid systems to be designed on an hour by hour performance basis with ease.

When a designer has the resultant heat exchanger lengths in hand, the "engine" is ready. The next, and final step, is designing the transmission system for the engine that allows it to deliver the energy to and from the ground loop.

A key engineering parameter for the heat exchanger length calculation is a prediction of reasonable monthly or hourly heat exchanger fluid temperatures over an extended period of time for a given heat exchanger system.

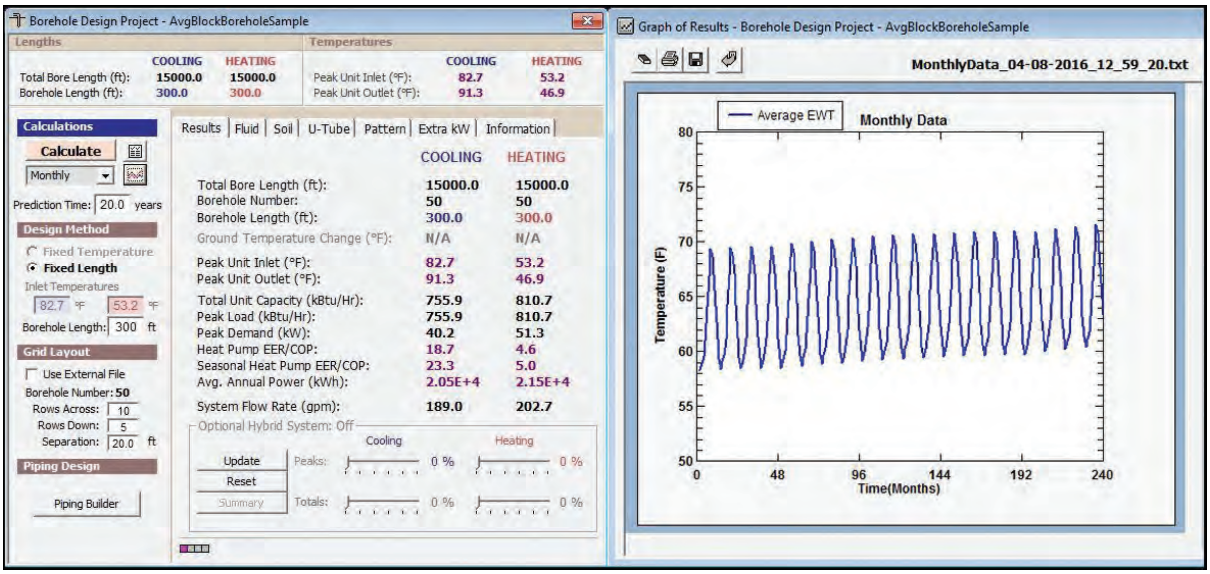

Figure 2: An Optimized Heat Exchanger Length

Step 3: Piping Layout Design

The piping system is the critical hardware component that enables the transmission of thermal energy to and from the building and ground. If a designer has calculated the proper depth and number of boreholes to meet the building loads but has not engineered an efficient delivery system to connect the loops and loop field to the building, it will not work as well as it could. Because the piping design layout is the most underappreciated aspect of the geothermal design process, the remainder of this article will focus on this crucial design step.

Fundamentally, there are three interrelated piping layout design goals:

- To ensure that the piping system can be effectively purged of air and other possible contaminants prior to system start up
- To ensure that all of the boreholes exchange an approximately equal amount of thermal energy with the soil
- To ensure that the heat transfer fluid effectively transfers thermal energy with the minimum necessary circulation pump power

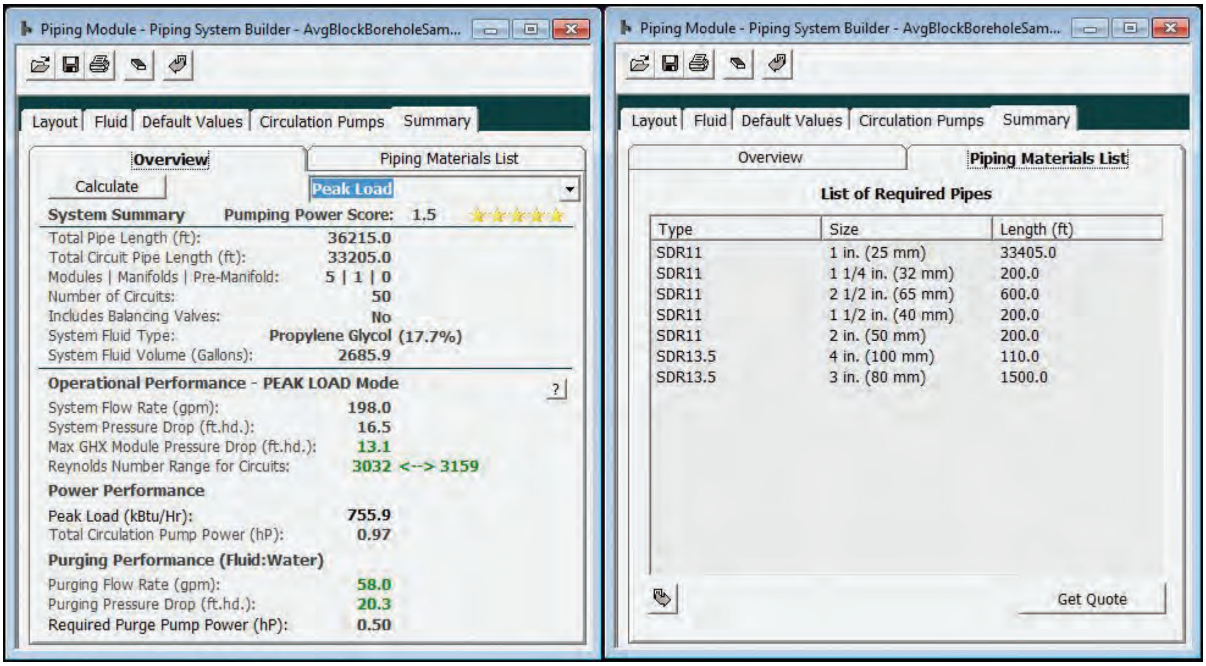

Figure 3: A Well Designed Piping System Is Purgeable, Balanced and Efficient

PURGING

Systems typically are purged prior to start up so as to remove air and other contaminants that can interfere with circulation pump performance and system operation. To purge systems, designers aim for a minimum fluid velocity that the purging fluid - typically water - needs to reach throughout every piping component in the system. Contractors then bring in a purge pump to the site, attach it to the runout pairs one at a time and purge the system.

The challenge is that some designers lack familiarity with both the reason for purging and the ins and outs of how to design a piping system that physically can be purged with readily available purge pump equipment. When purging is an afterthought rather than a fundamental design consideration, purging doesn't work properly and systems fail to live up to their potential.

The key to designing a purgeable system lies at the intersection of a number of variables including header pipe size selection, header pipe length, the number of boreholes in each supply return runout pair, the borehole separation, the diameter and the length of the borehole circuit pipe, headering pipes that have proper diameter reductions, the selection of an appropriate target fluid velocity (typically a minimum of 2 ft/second), and finally, an acceptable maximum flow rate and maximum head loss. While the number of variables is fairly large and individual selections can have significant downstream impacts, the key parameters for purging include a reasonable required flow rate and head loss for the purge pump that ensure the target fluid velocity is achieved.

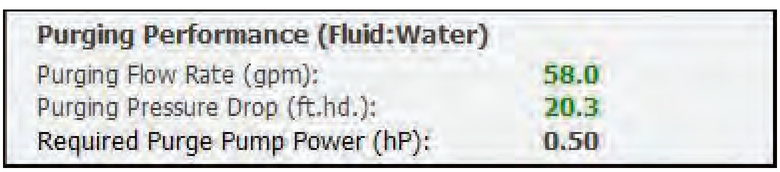

Figure 4: This system can be purged easily.

EQUAL HEAT TRANSFER

During regular operation, an optimized piping system will ensure that each and every borehole exchanges a relatively equal amount of thermal energy with the soil without requiring excessive circulation pump power. Systems that are well-designed have nearly identical flow characteristics, and hence Reynolds numbers, across all boreholes. Well-designed systems also have Reynolds numbers that are in the proper range for ensuring turbulent flow, without requiring excessive flow rates that necessitate oversized circulation pumps. For example, a properly designed system might ensure that all boreholes have Reynolds numbers in a tight range of say 3032-3159 while a poorly designed system might have a wider range of say 1618-3940.

The key engineering parameters for quantifying heat transfer equality are the Reynolds numbers and the Reynolds number range across a system.

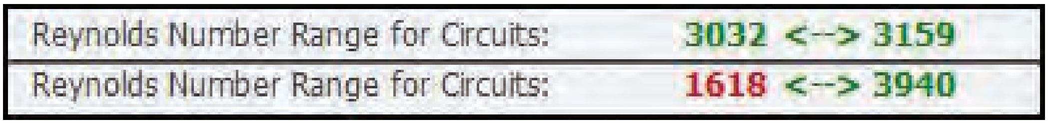

Figure 5: While the upper set of Reynolds numbers looks good, the lower set is both too low and too wide in distribution for efficient, equal heat transfer across the entire borehole system.

MINIMAL CIRCULATION PUMP POWER

A primary benefit of geothermal systems is reduced operational costs compared to conventional systems. To guarantee this benefit, it is critical that a piping system uses the smallest possible circulation pump that provides the required Reynolds numbers in the boreholes. A well designed piping system has low head loss, and requires only a small circulation pumps. For example, a typical 50 borehole commercial loop field (not including the building piping and equipment) can usually function with less than a 1 hp circulation pump.

To ensure low system head loss and a concomitant small circulation pump, a designer must select the appropriate pipe diameters for the borehole circuits and the headers and as well as an appropriate number of circuits on each supply return runout pair.

The engineering parameter for determining if a circulation pump is sized properly is the ratio between circulation pump horsepower and the peak load. Lower ratios are better.

Figure 6: A circulation pump with low horse power relative to the peak load leads to a favorable pumping power ratio and a 5 star design.

The best way to learn how to design efficient piping layouts is through practice that offers instant feedback. In years past, designers have had to rely on the time consuming combination of hand calculations, customized spread sheets, inflexible pre-defined piping design schematics and product performance data sheets to engineer systems. This method can be effective in experienced hands but takes hours and does not allow for easy "what if" modeling and exploration. Thankfully, a new generation of software tools brings to piping design what borehole length calculation software tools brought to the industry 20 years ago: a fast, efficient and accurate process for optimizing piping layout designs. These tools empower designers to avoid a range of common piping pitfalls. They also help ensure that geothermal systems provide the promised energy savings.

SUMMARY

In conclusion, competent loop field design requires three primary steps: hourly building heat loss/heat gain analysis, heat exchanger length calculations and piping layout design. By performing all three of these steps well, a designer will ensure that a loop field and its building(s) will be good partners for many years to come.

The engineering parameter for determining if a circulation pump is sized properly is the ratio between circulation pump horsepower and the peak load. Lower ratios are better.

Dan Bernstein is a founder and President of Gaia Geothermal, LLC, the developers of the Ground Loop Design (GLD) software suite. He has been working in the industry since 2001 and has provided commercial geothermal design training to engineers in dozens of countries, Dan has his master's degree in environmental policy from Johns Hopkins University and received his bachelor's degree from Pomona College while studying physics, chemistry and biology.

SPECIAL NOTICE: IGSHPA Membership and **Certification Changes**

This page details the changes which have taken place in regards to IGSHPA memberships as well as their certifications and accreditations. These changes go into effect June 1, 2016 so please make note of them.

For more information, please call 405-744-5175 or visit http://www.igshpa.okstate.edu/membership/

General Changes

- Membership and certification are now 100% independent of each other and no longer linked except for a price reduction incentive when obtaining or holding both at the same time
- All dues paying members now have voting rights, regardless of membership type or accreditation
- All participating IGSHPA committee members are now required to hold an individual or corporate membership from any sector

Certification and Membership Incentives

- Certification will be independent of membership-meaning a member does not have to be IGSHPA certified to enjoy member benefits and a professional who is certified is not required to pay membership dues to keep certification
  - HOWEVER, incentives apply to renewing both simultaneously and are listed below
- IGSHPA Certified Accredited Installers (AI) & Certified Geothermal Inspectors (CGI) will enjoy a reduced payment structure as follows:
  - $50 per year dues cost for individual membership renewal
  - $300 recertification fee every 3 years (along with required CEUs)
  - $450 total cost to renew membership and certification for 3 years all at once
- Through industry partnerships, certain certification holders enjoy a reduced IGSHPA membership renewal fee of $50 per year for an individual membership:
  - CGD (Certified GeoExchange Designer) through AEE
  - CVCLD (Certified Vertical Closed Loop Driller) through NGWA

INDIVIDUAL MEMBERSHIPS:

Level	***Non-Certified Individual Member***	***Certified Professional Individual Member***
Requirements	No IGSHPA certification or accreditation	At least 1 current IGSHPA or partner affiliate accreditation or certification
Voting Benefits	1 vote in any selected sector	1 vote in any selected sector
Annual Dues	$125	$50

CORPORATE AND BUSINESS MEMBERSHIPS:

Level	***Large Corporate***	***Small Corporate***	***Business***
Requirements	Only open to: • Manufacturers of 100 or more employees • Utility providers with 10,000 or more meters • Generation and Transmission (G&T) Providers of any size	Only open to: • Manufacturers of 100 or less employees • Utility providers with 10,000 or less meters	• Any other business related to a GSHP industry sector • Any school, educational, or non-profit entity
Voting Benefits	4 total votes	3 total votes	2 total votes
Annual Dues	$1430	$640	$420

Let's Keep it Clean!

We discuss the importance of changing filters, preventative maintenance, and maintenance activity overall in articles, training programs, and programs at conferences. However, when it comes to the water side of the GSHP equation, strainer and suction diffuser related maintenance is sometimes overlooked.

Geothermal ground heat exchangers are typically designed using High Density Polyethylene pipe (HDPE), which does not have the rust and corrosion issues that metal piping systems experience. Therefore, the need for the appropriate chemical treatment and systematic strainer blow down can be overlooked. However if the system has metal piping within the building, this cannot be overlooked. Severely fouled strainers and suction diffusers can restrict or block system flow. Untreated or improperly treated system fluid will result in contaminants in and degradation of the system leading to decreased efficiency and costly repairs.

Water side maintenance is a key issue, so pay careful attention to the following. Also, create logs of these activities, and adjust time frames between these them as dictated by your system's needs:

- Maintain chem-feeder chemical levels as necessary to insure continuous treatment
- Use the appropriate size strainer screens to control/ remove the contamination particle sizes your system is experiencing.
- Blow down and clear strainers as necessary to insure unrestricted flow.
- Check/clean suction diffusers when performing pump maintenance.

The following are examples and/or evidence of a lack of adequate maintenance resulting in poor system performance in improperly or poorly maintained systems:

Pipe removed from untreated system

Chem-feeders must continuously contain the proper chemicals at the required levels

Suction diffuser screen from improperly maintained system

3-year-old diffuser screen cap that has never seen a wrench

Phil Rawlings has more than 39 year's experience in the geothermal industry. He is the Director of Geothermal Services for Trison Construction, a Certified GeoExchange Designer (CGD), an IGSHPA Accredited Installer and IGSHPA Trainer. He is also a member of the IGSHPA Advisory Council and a member of the Association of Energy Engineers CGD Board.

All photos provided by Phil Rawlings

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- **Simplified installation, internal controller with diagnostic tools, and enhanced serviceability for easy and quick set-up and routine maintenance**
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