EMULATING GRAVITY HEATING – Biomimicry

Mother Nature teaches ….. and we hopefully learn. It's being going on from time immemorial. Foods, medicines, clothing, housing, transport, energy and whatever, we extract, adapt and utilize from natural phenomena. More recently we've put a name on it, biomimicry (imitating/emulating nature).

Hydronic heating is no exception. In fact, a century ago we had Gravity Heating Systems wholly based on the attribute of natural hydronic convection. Heated water reduces in density and rises, cooling it densifies and sinks, meanwhile giving up heat energy. Put it into a closed piping loop and you've got it. This natural hydronic convection distribution process uses absolutely no external energy. Therefore the only system requirement is providing combusted fuel energy to track heating requirements. A few "gravities" remain today (typically fuel upgraded) and are still working well. So what has happened since?

Well, a gravity heating system necessitates a relatively large boiler, piping with radiators and is functionally a rigid system. America's desire for heating flexibility and adaptability at a reduced installation cost initially became enabled by the electrical circulator (pump) introduction, about 1930 and was soon followed by finned-tube baseboard (radiation). So we have economically devised viable, extreme heating application flexibility with acceptable complication, or have we?

The hydronic heating industry has since devolved into a plethora of independent component suppliers with no designated or defined process regulatory authority and consequently no process optimization potential. In fact, the industry has both negated undesirable natural (gravity) convection effects with check-valving, ignored and not quantified nor qualified its positive attributes. This old Process Development Engineer recognizes the industry's generic "Boiler Piping Diagram" for what it is - a recommended component placement sequence with no process optimization potential provided nor available. Field installation variations follow.

Our hydronic experimentation began over 50 years ago with the construction of our then new raised ranch home. We configured a three (3) split-loop zoned FHW system with modestly pitched 1" common-piped supplies and returns. This dated, "old style" configuration has flow-checked supplies and circulators on the returns. By manually opening and adjusting the flow checks we could virtually negate circulator pump operation. We soon convective-coupled a repurposed 1935 International Heater Wood Burner (boiler) requiring no powered circulation. Further addition of valves and controls permitted selective automatic/manual operation, even with no electrical power! This is further detailed in a blog titled Our Unpowered FHW Gravity Heating System on our website.

Noting the introduction of Delta-T (ΔT) ECM Circulator (Hydronic Distribution) Technology by Taco with their "BumbleBee", we recognized its immediate potential. Having optimized natural (gravity) convention distribution elements we immediately repackaged using a dedicated "BumbleBee" with Taco "Zone Sentry" Valves. Three (3) successive systems (Betas) were installed and they performed admirably!

On our third Beta, a new, well built and insulated home, a curious phenomenon was observed. Upon delta-t differential temperature attainment, the circulator wattage rapidly decayed by 1/2 to 2/3 with a concurrent speed reduction. Variable speed (ΔT) circulation combining with our enhanced convection design provided a very noteworthy power reduction. Gravity convection was working well on contemporary smaller radiation piping, managed by delta-t circulation!

Further settings refinements on our very high mass boiler (Weil-McLain UO) aquastat (Hydrolevel 3250-Plus) lowered system operating temperatures into the 132°F to 145°F range. Applying the 3 for 1 Rule (3°F = 1%Eff.) we can presume an appropriate AFUE value increase as well. Lengthened circulation cycles were also noted, smoothing the demand curve and closely emulating the sympathetically coincident demand/fulfillment of a true natural convection (gravity) system. We have come to quip this as "doin' the low and slow", i.e. lowest water temps at lowest flow rates, emulating those old Gravity Heating Systems.

Our field work has definitely proven that you do not necessarily need the larger piping and radiation of a traditional "gravity", but complimentary delta-t smaller convective perimeter loop piping will work to a noteworthy degree. There is a real economic energy advantage to integrating a dedicated delta-t ECM circulator with complimentary zone valving, optimized convection near-boiler piping with simple perimeter radiation loops. All of our applicable retrofits use 8 to 13 watts of distribution energy, a 90% minimum reduction over ANY contemporary system! Also evidence a dramatic reduction in labor, materials and space consumption.

Now let's elaborate on further contributions of natural convection piping. Beta #3 developed a "fluke" failure on its circulator, according to Taco. They followed up by upgrading all our "BumbleBee" circulators to the new VT2218's. Thank you!

When this failure occurred it was not noted for several days until the uppermost level gradually cooled. Also this system had an IWH (Indirect Water Heater) that was providing ample domestic hot water. Only upon finally noting the error code and flashing on the delta-t circulator did the customer recognize and call. This event documents a selective fail-mode heating capability of hydronic convection, when appropriately configured.

There are three (3) "Fail-Mode Heating Capability" conditions with our Appliance:

1. **If the Delta-T ECM System Circulator fails, hydronic convective heating continues at a reduced circulation rate. Heating potential is also maximized by the 3250-Plus Boiler Aquastat incrementing operating temperature to match demand, until HI TEMP set is achieved.**
2. **Our close-coupled IWH Option is branch-looped immediately above the circulator to the lower boiler return port. We designed it purposely as a hydronic "short circuit" and acts as the priority default zone.**
3. **If you have a power outage, manually open the Taco Zone Sentry Valves as you wish to selectively but temporarily prolong heating, depending upon your particular piping heating loop attributes.**
4. **With our close-coupled Indirect Water Heater Domestic Hot Water Option you can fully draw down your stored DHW Appliance Charge to extend service heating zones by merely opening its zone valve. The internal IWH Heater Coil will automatically reverse its heating operation.**

In 2014 we packaged this experimentation into what we now call the "Neo-Gravity Hydronic Heating Appliance™". Our prior "Beta 3" referenced unit was one of them. In 2017 we filed for U.S. & Canadian Patents and received them unchallenged in 2020 and 2023 respectively. Minor improvements have been made since but our "Appliances" are all functionally identical, save manifold configuration & installation variations to suit site demands. An updated listing of Claims has been recently published, detailing our observations and performance.

Field performance of our installed appliance base has been exceptional by any measure. All alike and they perform alike in a breadth of applications, as an "appliance" should. Be assured that we are purposefully "beating up" on our Betas to qualify the attribute assumptions and performance of every component, individually and within system operation. Particularly noteworthy are now extended three to five year service increments on oil systems with no service incidents or exchanger residue.

Comparing pictorially the "Old Gravity" and our new "Neo-Gravity" you will note boiler and near-piping similarity. Notably added are the Delta-T Circulator and Zone Valves for finite distribution control. Contrast the "Neo-Gravity" with any contemporary hydronic installation containing a plethora of copper pipes, valves, fittings and you have now identified as we note "The Plumber's Playground©".

Mother Nature has come through again, replicating herself in fact. Now we have a hydronic heating "appliance", not on-site built-in-place, but pre-specified and pre-built. It emulates its forebear in being "high mass" durable, with minimal parts

and simply efficient. As we quip, “just roll it in, stand it up and stretch the pipes and wires ….. done”! Should it be called The Model ΔT?

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