Ask Jon Eakes

Radiant Heating Systems for Homes

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Radiant Heating and Convection Heating are the two primary types of ways we heat our houses. FORCED AIR HEATINGConvection heating means moving hot air -- what we usually call a forced air heating system simply heats air and moves it around the house through a system of fans and ducts. Forced air heating can use any energy source generating heat in what is commonly called a furnace. The real defining characteristic of a forced air system is that it uses household air to move the heat from the source to the destination. Look up Forced Air in the database for lots more information. RADIANT HEATINGRadiant heating has two aspects -- some heat travels by energy waves through the air and warms up any solid object it hits, just like the sun does and then room air in contact with the radiator or any surface it warms up will pick up some heat and rise upward creating some air circulation in the room. There are far more variations in radiant heating systems than in forced air systems in that the source of the energy can be anything and heat can be generated locally, as with baseboard electric heaters, or the heat can by transported around the house through water pipes in a myriad of configurations old and new. RADIANT HEAT REQUIRES VENTILATIONIn modern air tight houses it is important to take note of the fact that a radiant heating system can give the air in any room the perfect temperature, but does nothing else to help with indoor air quality -- there is no air circulation, no filtration and no fresh air change. In the days of the old cast iron radiators this lack of attention to air quality was not a problem because the houses were so leaky that the wind provided fresh air in all the rooms all the time. It is true that radiant heat can be the best system for temperature control -- but in today's houses it becomes necessary to install a whole house air change or HRV unit to deal with the quality of that perfectly tempered air. A forced air system allows both introducing fresh air and filtering the air throughout the house at the same time the air is heated. Hydronic, or water systems can be used for a small portion of the air conditioning load but if the pipes are run too cold you will get more condensation than air conditioning. Air conditioning usually requires either an open house plan that allows for ductless air conditioners, or for a full duct system such as what is used with a forced air heating system.And beware of installing ductwork for either heating or air conditioning in an attic. It is the easiest and cheapest way to add ductwork to an existing house but is almost always a problem of either condensation dripping in the summer or ice dams on the roof in the winter. Ducts simply do not belong in a Canadian attic. HALF TRUTHSThe radiant heating industry is often a bit dishonest with the air quality requirement in that by not installing ducting they can install heating for your house cheaper than the cost of installing a forced air furnace. If you really want to compare installed costs of the two systems, you must include at least the cost of a minimum air change system capable of changing the air in every room in the house.Also the radiant industry tends to claim significant cost reductions in operation compared to a forced air system. The National Research Council of Canada is currently (2011) doing some serious un-bias research on this question because there is reason to believe that there is not much of an operational cost advantage of one over the other in the task of maintaining a given temperature inside the house. The question is complicated because it is true that with radiant heating, humans tend to more comfortable at lower temperatures when they receive the radiation portion of the heat transfer directly -- and the savings come from simply keeping the thermostat a bit lower. More on this when reports become final. MY PREFERENCEAlthough you will read here about a lot of limitations on radiant systems, my personal preference for an ideal home would be radiant systems (hot water or electric) under any ceramic tiles, hydronic radiators or baseboard electrical heaters with wall mounted electronic thermostats in all other rooms and a full HRV with input or exhaust delivered to every room in the house. I might be inclined to move towards a full forced air system if several months of air conditioning were an absolute necessity; then one set of ducts with a dual use heat pump would make sense. Another element in choosing systems is how many active kids you might have. Radiant in-floor systems are slow to react

to change and if the kids are running in and out all winter long, the house could be difficult to keep at an even temperature. If the lifestyle is calmer, the slow consistency is appreciated with no swings of hot or cold. Baseboard electric heaters can react as fast as a hot air system because they interact directly with the air in each room. RADIANT SYSTEMSI am constantly getting letters from Eastern Canada asking about the "new" radiant heating -- while Western Canada has been very familiar with radiant heating for decades. There is very little that is new or un-tested in radiant heating, just regional variations and experience. Let me just rush through some of the common variations and some of their characteristics. CAST IRON RADIATORSThe old cast iron radiators are well known in Eastern Canada and although they are called "radiators" we don't think of them when we talk about "radiant heating" That big hot hunk of iron does in fact "radiate" out heat waves in all directions, warming anything solid. That is part of why they are so nice to back-up to to warm your cold back side when you come in from the snow. Leaving them open and exposed rather than covered in decorative boxes will increase that "radiant" heating. Cast iron radiators also warm the air in contact with the metal, causing the air to rise and circulate across the ceiling and down the other side of the room. Making sure that there is a free flow of air all around and out the top of the radiator will give you more room heat per dollar of heating fuel.For tips on how to get more heat out of cast iron radiators check out this database entry.The source of the heat for these cast iron radiators is a boiler, usually in the basement. It can be heated with gas, oil, propane, electricity and in the old days coal. Some solar energy systems can contribute to this heat, but cannot be the sole source for domestic space heating in Canada. Old systems, many still in operation, have no pump but simply count on hot water rising and cold water falling in the pipes -- gravity circulation. This is not very efficient and always counted on very hot water. All modern systems have lower temperatures and circulation pumps, and usually a circulation pump can be added to an old gravity system to improve its performance.One of the primary problems with hot water radiators is that air can collect in corners of the piping system and block the flow of the water. That is why every radiator has a "bleeding valve" to allow you to get rid of the bubbles -- a task that is a bit of an art. Check out the SpiroVent for a permanent solution to the problem of air in the radiators.There exist various configurations for the piping in hot water systems. The oldest and most inefficient is a single pipe that goes from radiator to radiator and finally back to the boiler. The water gets cooler as it moves along, so the first radiators are always hot and the last always cold. A little better is one pipe that runs around the house and back to the boiler with each radiator just tapping into the hot pipe and putting it back a bit further down the line. The best is a two pipe system where one hot water pipe flows around the house feeding the input of each radiation and another pipe runs all around the house receiving the cold from the radiator and going back to the boiler. This way each radiator has a much better chance of receiving water of the same temperature.On each radiator there normally is a shut off valve that allows for turning off, or turning down the water flow in that individual radiator -- a very mechanical temperature control. The general household temperature control is done by a central thermostat that controls the temperature of the boiler or the action of the circulation pump.For full modern room by room control of old or new water radiators the best system is to replace the hand valve with an electronic solenoid valve that is controlled by a wall mounted electronic thermostat. This will turn the radiator on and off in each room, giving you total zone control through the house with one central boiler. Ask a plumber about the feasibility of installing these valves in your system and the total cost -- not cheap but really comfortable and because of no more over-heating, these can save energy. IN FLOOR RADIATORSThe traditional in-floor hot water radiators are water pipes buried about 4" deep in the concrete floor. They can take 2 to 4 hours to change temperature in the room as they must heat up or cool down all that concrete mass. More light weight systems for wood floor construction have been developed that suspend the hot water pipes in the floor joist area below the floor to be heated. They will typically have a radiant barrier placed under the pipes to force most of the heat upwards. They are also relatively slow to react as the heat does have to go through all the layers of the floor, and if the top covering is a rug, there will be heat but little radiation. Some systems have been developed for tile floors where the pipes are over the floor and just below the tiles, most notably Bekotec from Schluter. The great advantage of being just below tiles is that you can accomplish the same heating

objective at a much lower temperature -- you don't have to go through a lot of non-conductive or massive material. If you are using geothermal heating you must study this system as it may permit you to not need a full back-up boiler -- a quantum jump in cost effectiveness.In areas where you want a minimum floor area heated with radiant heat, or you are in a province where electrical costs are very competitive to gas, then you might want to consider electrical radiant heat. For floors it can come in mats that can be placed under floating floors, even rugs. It can also be installed with wires that you can place to fit the shape of your room, very useful in bathrooms with lots of obstructions. If you are thinking of electrical floor heating you must take a look at the FlexTherm Green cable system -- it is not only optimized for tiles but it gives off almost no electromagnetic radiation, a new technology that protects those little kids that are playing on the warm floor very close to a lot of electrical cables. Yes you can put radiant heaters under wooden floors, but it is best to use engineered flooring in this case as it is more stable with moisture fluxuations. Alll wood is an insulator so under a wooden floor the heat transfer is radically slowed down giving a long time delay between raising the heat and feeling it in the room. Radiant heat under ceramic tiles is quick to transmit the heat, and the nature of cermaic is such that it even "radiates" heat better than wood. Radiant heat under a rug can work as well but now you have no "radiant" aspect to the heat transfer, only conduction through the flooring and then the warm rug warming up the air sitting on the rug.WALL AND CEILING RADIATORSSimilar panels can be placed on walls and ceilings, usually behind drywall. Some drywall systems even have the heating wires built right into the gypsum. Both of these do pose the serious problem of putting holes in the heating system if you want to hang pictures, plants or lights. They have all the same characteristics and limitations of floor radiant heaters. BASEBOARD HEATERSMost of us only know "electric" baseboard heaters, but they do exist for hydronic (hot water) systems. Modern stylistic hydronic baseboards are often used to replace old cast iron radiators when you want to keep the old heating system but modernize the house. Compared to the old cast iron radiators these will give off less "radiant" energy but are very efficient for the "convective" heating of the room air.Electric baseboard heaters are almost all the same as far as the heating elements go. What is different is the thermostat control. When the thermostat is mounted right on the baseboard itself, it is extremely inefficient -- but comes with very low installation costs. There is some magic that operates when you install a wall mounted electronic thermostat to control the baseboards in the room. The thermostat checks the temperature every few seconds and sends an on-off signal to the heater. If the temperature is close to the right temperature, it goes on and off so often that it never gets hot, but just warm enough to maintain the temperature. This prevents that overheating and drying effect. The heater will get to maximum temperature only when it is extremely cold outside, or you have cooled down the room and it is trying to catch up. What used to be considered a second rate heating system, becomes one of the best -- simply with a change of the thermostat. WALL MOUNTED HEATERSFrom France we have an invasion of beautiful wall mounted electric heaters. Some have fans that can give added circulation, particularly useful in a bathroom where you could use a blast of hot air on bare wet skin. Most of them are simply baseboard heaters with a classy high rise jacket. They are actually advertised as allowing you to move the heater out from under the window and put it in "better" places. Understand that these heaters come from a Mediterranean region where winter is a mild thing. Then think as to why every baseboard heater, every hot air duct in Canada is under a window? The window is the coldest part of the house and it needs more heat to avoid condensation and mold growth. Moving the heating source away from the windows may work sometimes, but more often than not opens the path to window condensation. Canadian recommendations are to even move blinds and shades forward enough to let the hot air get to the glass. These heaters work no better than any ordinary and much less expensive baseboard heater and they put the heat in the wrong place! PORTABLE HEATERSPortable electric heaters usually have a nice feature of including a fan to blow the air and have the advantage of being small and you can place them where you need a bit more heat. Do they cost more to operate than baseboard heaters? No. Electrical heating in all of its forms is about the same cost for the same heat. Is 220volts better than 110 volts -- not really. It is just that you can use a smaller wire to heat with 220 volts and you have dedicated lines that are installed by an electrician so you don't blow fuses by just plugging them in anyplace. Also, baseboard

heaters don't tip over and they last a lot longer than the inexpensive portable heaters. Many portable heaters advertise special features such as catalytic elements or thermal mass or "radiant" heat. The catalytic system can make higher temperatures while the thermal mass can spread out the time distribution of the heat and "radiant" devices deliver both convective and radiant heat. But none will produce room heat for less money than an ordinary electrical heater as all electrical devices convert electricity to heat at about the same efficiency. If you like the look or the feel of a special heater enough to pay the extra price, then fine, but don't buy them for claimed heating economies.Where they do cost more is where your household heating system is running on gas and electricity in your area is much more expensive per heating unit. 1 Btu = 0.29307 watthours. You will find BTUs on your gas bill and watthours on your electrical bill. Compare the cost of your energy sources for yourself.

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