HOME INSULATION: Usually Good!...Sometimes Bad?

Do you feel confident about your's insulation because you see lots of fluffy white or pink stuff on your attic floor? Insulation that is the wrong type or poorly installed may be robbing you of hard-earned cash, and in some cases, can result in mold or serious structural rot.

Proper insulation can have a fast financial payback. It can also increase comfort, reduce noise pollution, reduce insect/pest/dust invasion, reduce radon infiltration, reduce ice dams, and reduce mold/rot. What other investment have you made that can do all this plus earn you a 10%-40% return year after year from reduced utility costs? Another little-known benefit is that you may actually qualify for a smaller and lower cost furnace/boiler should your old one need replacing. Finally, it is not much of a stretch to think that a home with all of these advantages could also garner a bit higher selling price or sell more quickly than poorly insulated homes. Yes, insulation is good!

Bad things can happen when you have the wrong type or poorly installed insulation. Most homeowners are surprised to find out how poorly their insulation is performing and some even find that mold/rot is chewing up parts of their home:

Example: black mold covering the backside of drywall (left side of pic)

A thorough knowledge of building science would generally be required to determine exactly how to improve your home's insulation needs. Most insulation is out of sight and, sadly, even some builders/remodelers still do not understand the building science behind how to properly insulate and air-seal homes. So before you assume that **your** home is in good shape, consider the following two examples:

NEWER HOME (built1985) EXAMPLE: In 1999, a 14 year old home built by a nationally famous Twin Cities architect had to be demolished because it rotted from the inside out. I was involved in salvaging materials before demolition so was able to see inside the rotting walls to better understand what went wrong. This architect is very smart and thought she was using the most advanced insulation methods. But the residential home industry had a poor understanding of building science back then and did not realize that insulation installed in the fastest/cheapest manner presented many issues.

OLD HOME (built 1916) EXAMPLE: Though some folks contend that old homes are more durable, the picture of mold above depicts an old home that received "state of the art" basement insulation. In addition, this home was getting massive ice dams due in large part to inadequate insulation systems in the walls and attic. This was not durable, healthy or sustainable.

<u>You can judge your home's relative risks.</u> Building science knowledge is generally needed in determining exactly how you should improve your home's insulation. But you can at least judge your home's relative risk of issues. By risks, I mean the potential for damaging moisture/mold/rot or the risk of wasting significant energy due to missing or poorly installed insulation systems. Let's clarify here that your home's "insulation system" includes both "insulation" and "air sealing". Both are needed to have an effective system and this will be explained in more detail later. But first consider the following risk indicators for your home:

Risk Level	Indicator	Why this indicates a problem
Serious	Ice Dams in 2010 and/or 2011	1. Significant energy loss & higher utility costs 2. Damage to roof sheathing, siding, insulation and interior ceilings are possible
Serious	Ductwork and/or furnace in unfinished attic or running thru attached garage	1. Energy loss & higher utility costs 2. Damage to roof sheathing, insulation and interior ceilings are possible 3. Air quality issues
Serious	Ice or condensation on windows during heating season	1. Moisture/mold/rot on window frames and potentially within wall/roof system 2. Moderate to high energy loss and higher utility costs
Moderate	Attic space finished/insulated (especially if ceiling attached directly to rafters)	1. Significant energy loss & higher utility costs 2. Risk of moisture,mold & rot on underside of roof sheathing
Moderate	Rigid Insulation applied to inside surface of walls or ceilings	Moisture/mold/rot potentially in wall or ceiling cavities
Moderate	Finished/insulated Basement	Moisture/mold/rot within wall cavities
Moderate	Finished attic space with lights, fans or skylights within a sloped ceiling	1. Moderate energy loss & higher utility costs 2. Damage to roof sheathing, insulation and interior ceilings are possible

NOTE: There are many other indicators of problems but they are beyond the scope of this article

<u>Moisture problems primarily date back to changes made in the 1970's.</u>

Prior to1970, homes seemed to have few interior moisture/mold/rot issues even if they did waste huge amounts of energy. Should we just go back to those older and simpler ways? Sad mistake! Those homes were so poorly insulated that escaping heat passed through walls and ceilings as though exhaled by a giant blow dryer, eliminating moisture as it went. This was fine back when energy costs and concerns about climate change were negligible. Then the 1970's energy price shocks hit and cheap insulation became the solution. Low cost fiberglass was shoved into walls and blown into attics and the energy savings quickly paid for the costs. But we now know that keeping the heat in the house makes the outside part of the walls colder. And cold surfaces are where water vapors accumulate (think cool mirror after a hot shower). This is why that famous Twin Cities architect had her home rot from the inside out. The moisture was hidden within the walls. That architect and the rest of the residential housing industry did not learn this hard lesson until about the 1990's. And most homeowners still don't know much about these issues.

Energy is often wasted because existing insulation isn't working.
Your insulation is likely working to some degree but not nearly as well as you have been led to believe. What if you have been told your home has R-11 fiberglass in walls and R-30 in the attic? Those numbers seem fairly high given newer homes may have R-19 in the walls and R-38 in the attic. But recent studies at independent labs have shown that fiber insulation may only be performing at 50%-60% of their rated levels![1] This might mean instead of R-11 in your walls, you have R-6 and instead of R-30, you have R-19 in your attic. Those R values are widely believed to be too low given current energy price levels and risks of ice dams and other issues. Many factors cause this energy robbing condition but one primary issue is that air can flow thru and around the fibers thus grabbing heat away from the home. This means that the low *initial cost* of the fiber insulation results in a higher *on-going cost* of wasted energy . If you have existing fiber insulation, there are options to improve performance. If you need more or new insulation, careful consideration should be given to products that perform better. Skeptical? Consider shoveling snow on a cold day, why would you buy a cheap jacket that is warm looking but lets a lot of cold air in!

Getting a jacket (insulation) that actually keeps us warm.
Figuring out how to properly insulate and air seal your home depends on many factors but there are some rules that can guide you. And remember that our goal is not only to save more energy but to also do it in a way that prevents moisture/mold/rot issues.

RULE1: Air-Sealing is more important than the insulation
RULE2: Pick an insulation system where air cannot blow thru it
RULE3: Install insulation on **exterior side** of a wall/roof when/if you can
RULE4: The More Air-Sealing and Insulating, the more we must manage interior moisture
RULE5: Tightening of home requires Carbon Monoxide check

RULE 1: Air-sealing is more important than insulation.
What is air sealing? Imagine your house made only out of continuous sheets of drywall or wood. No doors/windows, chimneys or other punctures. This is a perfectly air-sealed house. There is no insulation. Heat this house in January and it would very likely use less heat than your house does now even if you have insulation. That is because most homes have enough gaps/holes in the exterior enclosure to let out huge amounts of hot air. Added up, many small gaps may be as big as an open 3'x7' entry door!

Now imagine your home having walls made only of continuous thick batts of fiberglass insulation. Basically the opposite of the air-sealing example above. There is no siding outside or plaster inside....no air-sealing whatsoever. Heat this house in January and what happens? All of the hot air will quickly flow thru the fiber insulation regardless of how thick it is. Because air can flow thru fiber insulation. See why air-sealing comes first? Yes, insulation is very important but not until the air-sealing is rigorously completed.

How is air-sealing improved for your specific home? The easiest way to figure this out is to have an energy audit completed with blower door and an infra-red camera. The top 5 air-leakage areas include:

1. Fireplaces without glass doors
2. Stairway up to unfinished attic
3. Scuttle (access) hatch to unfinished attic
4. Plumbing vent stack as it passes thru the upper floor ceiling
5. Chimney as it passes thru the upper floor ceiling

The following two nonprofits provide high quality and affordable energy audits: 1) http://www.mncee.org/ or 2) http://thenec.org/

__Helpful Hint:__ Do NOT add lighting (especially not recessed-can lights) into insulated ceilings

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[1] Fine Homebulding magazine issue 221; p19

RULE 2: Pick an insulation system where air cannot blow thru it.
There are many types of insulation and some can perform BOTH air-sealing and insulating functions. Of course they cost more and not all insulations can be used in existing homes (vs. new construction). The right insulation for your needs may be completely different than what your neighbor needs. Again, energy audits may help you pick the right insulation, though they are not perfect since they tend to focus on what's best for the 80% and not the unique 20% of homes. Rule 3 below will address a couple of those unique insulation systems. But if you wish to review general guidelines for insulating, jump to this section: Insulation Guidelines

RULE 3: Install insulation on exterior side of a wall/roof when/if you can.
Building science would define the perfect insulation system for your home as being on the outside of the walls or roof and not the typical location which is WITHIN the wall/roof cavities. This reduces interior moisture issues and provides continuous (better performing) insulation. And air-sealing becomes significantly easier since there are fewer obstructions outside the house versus inside. A hybrid option that puts fiber insulation within the wall cavity plus rigid foam on the outside is becoming more common in new construction. This hybrid method could make sense in your existing home. If you want to better understand the science behind WHY insulation on the outside of a wall is so much better, jump to the section highlighted below. Note that for simplicity, the explanation skips the hybrid option and focuses on a comparison of "Insulation Inside a Wall" versus "Insulation Outside the Wall".

WHY IS INSULATION ON THE OUTSIDE OF A WALL SO MUCH BETTER?

RULE 4: The More Air-Sealing and Insulating, the more we must manage interior moisture.
As we tighten up our homes, we must prevent the "petri dish effect." This means that a sealed container (your home) with moisture in it, will grow lots of unsavory things (mold) unless we take steps to prevent it. The basic steps you should take in priority order include:

a. Bath exhaust fan used for at least 60 minutes after each shower or bath
b. Kitchen exhaust fan used during cooking
c. Central humidification systems used as minimally as possible
d. Special moisture producing situations to address: indoor pool, 100's of house plants, etc...
e. Some very tight new homes require a heat recovery ventilator

There are many details that can be done poorly when implementing the above moisture management steps. Let's take bath fans first. Many older fans are only exhausting 20cfm of air when they need to be closer to 50-75cfm so an updated fan installed correctly may be needed. In addition, how many teen-agers will actually run that fan? So connect the fan to a motion sensor or to the light switch so that it automatically runs a minimum 60 minutes.

Central humidification is often a controversial issue. We get dry/itchy skin and bleeding noses during dry winter months so this gets very personal. But many humidification systems will pump out moisture which will quickly drive toward cold surfaces .... then the furnace sensor calls for more humidification because the earlier delivered moisture has condensed in walls/attics and on windows thus leaving the air dry again. Vicious loops happen in some homes. See the below picture of a window with condensation/ice damage:

RULE 5: Tightening of home requires Carbon Monoxide check.

Unfortunately, most homes still utilize an ancient technology for heating water. Most gas fired tank water heaters are basically open flames within your basement. And under certain conditions in winter, the exhaust fumes from these open flames can backdraft into the home bringing carbon monoxide (CO). Minor amounts of backdrafting happen in most homes and, in rare situations, the issue can be so serious that people die. Even minor backdrafting is thought to be bad for your health as low-level CO exposure brings on symptoms similar to colds/flu. Beyond just your water heater, standard cast-iron boilers and older forced-air furnaces have this risk of backdrafting too.

Panic? No! But this is serious stuff, so pause now to consider your current risks of CO and some strategies for reducing your risks:

Risk Factors for backdrafting and CO poisoning:

1. Fireplaces - using a wood or gas fireplace can create significant negative air pressure in your home which can cause your water heater (or boiler/furnace) to backdraft. If the fireplace has a vent that lets outdoor air into the home or the firebox, then risks are significantly reduced but most fireplaces do not have this “combustion air” vent.
2. Very tight Home- If you live in a newer home built to rigorous standards for air-sealing and insulation, you could have risks if any of your combustion appliances are less than hi-tech. In other words, your water heater and boiler/furnace must be “sealed combustion” units. If you see moisture condensing often on windows in winter, this is a sign you should have a “home performance audit” completed to determine if you have CO or indoor moisture issues. Homes built before 1950 are very difficult to tighten up enough to create high risks, and when they are, it is usually done by a person with significant building science knowledge and they usually ensure sealed combustion appliances are installed. Tight homes are great but they do require the proper appliances.
3. Old Exhaust pipe Systems - Maybe brother Joe or handyperson Jane installed your last (low-tech) water heater 20 years ago and did not know that code requires the exhaust pipe to join into the furnace/boiler exhaust pipe before entering the chimney. In the old days they were separate but this leaves them at greater risk of backdrafting.
4. Old furnace - in this financial recession, folks may put off certain home repairs/maintenance items. But one dangerous delay is in replacing an old furnace. Once a furnace hits 20 years old, it becomes more at risk for corrosion within the unit that can eventually lead to exhaust fumes being pushed into your home instead of out the chimney. That can mean CO poisoning. So begin having annual furnace inspections beginning at 20 years or replace that old unit with a new sealed-combustion system.

Note: the above is only a partial list of risk factors

Generally Reducing Your Risks:

If you are unsure of backdrafting risks, you can have an energy audit assess this for you. One general strategy for reducing risks (except in the most advanced-energy homes), would be installation of a “make-up air” duct in your furnace/boiler room. You may have one already as recent codes often require them. They typically will be big plastic flex-ducts that are open and allow free flowing air to enter the home. Just make sure these ducts are NOT blocked as some folks will close them off trying save energy. In addition, the filter screen on the exterior duct hood can get clogs by cotton wood seeds or other debris. Not only is this dangerous, but surprisingly, the cold air that enters from these ducts actually SAVES energy by reducing the amount of cold air that enters the home in the living areas. There is a long explanation of why this is but feel free to email me if you want the details. And finally, move toward sealed-combustion units for your water heater and furnace/boiler. Not only do they reduce CO risks significantly, they save significant amounts of energy thus paying for themselves in the long term.

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by Bob Alf, Owner of Bob Alf Construction, LLC
a St. Paul based builder/remodeler specializing in sustainable solutions for residential homeowners

INSULATION GUIDELINES

EXISTING HOMES:

Walls -empty: *dense packed cellulose*

very eco-friendly, low cost and fills air-spaces well enough to potentially achieve a 90% reduction in air flow (according to a recent Building Science Corp. study)

Walls - existing fiber insulation: *pour-in-place foam*

newer technology; foam that can be poured into wall thru 1" holes in each stud cavity and can fill airspaces around existing fiber insulation. Expensive but higher R-value and only cost effective option for improving this type of wall.

Attic - no cathedral ceilings & fiberglass insulation on the floor: *Cellulose "cap"*

The fiber insulation allows a lot of heat loss from air flowing thru it. If you don't want to remove all the fiberglass, then blow a 2"-4" cellulose "cap" on top. This will reduce the air flow thru the fiberglass. Very low cost though only a partial solution to air flow problems since some air still flows thru the cellulose fibers.

Attic - with "cathedralized" ceilings: *depends on many factors*

"Cathedralized" are generally sloped ceilings where the plaster or drywall is attached directly to roof rafters. These are complex designs to insulate properly so they often leak lots of heat and are very prone to ice dams. Building science consulting would be very beneficial with these ceilings. The goal is definitively to make the ceiling air tight so you will likely need non-fiberous insulation in the rafter cavities. This often means using pour-in-place foam. It may also be worth adding rigid foam insulation on your roof under the shingles....see RULE 3 below for more discussion on this.

Attic - no cathedral ceilings & almost nothing on/in the floor: *lay "vapor smart" plastic sheeting on floor with all seams/penetrations sealed and then blow in 12"-15"+ of cellulose. Very inexpensive, effective and eco-friendly.*

Helpful Hints:

- Ensure roof venting is maintained and improved (if possible) since this is crucial to ice dam minimization. Building science advice is very helpful on this especially with cathedralized ceilings.
- If you have a furnace and/or duct work in unheated attic spaces, you should seek a building science consultation

NEW HOMES or ADDITION TO EXISTING:

Walls: *Dense packed cellulose within walls and rigid foam exterior sheathing under the siding*
Note that foundation has exterior rigid foam insulation that should be extended fully up to the rigid wall insulation

Attics: *Dense packed rafters with rigid foam sheathing under shingles*

Want to know more about various types of insulations? See "Insulation & Air-Sealing Summary on next page:

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Insulation/Air Seal Summary

BOB ALF
CONSTRUCTION
Sustainable building solutions.

Note: code requires "vapor retarder" (VR) where possible ...often not possible in Retrofit situations. Obtain professional advice.	Cost (Matls + Labor)	Functionality: Air Seal	Functionality: Insulation- R value/inch	Eco Creds (this is a very complex topic; research your choice!!)	Comments
Fiberglass	•LOW initial •HIGH L-term	POOR	2.2 - 4.0	•Often ineffective •Moderate Embedded Energy •Disposal :won't decompose	•Reuse over layer of foam insul •Don't use in Basement •Consider Min Wool Batts
Cellulose- loose	•LOW initial •MOD L-term	FAIR	3.0	•Low embedded energy •Heavy recycled content	•Cap over fiberglass or •Deep in attic
Cellulose- dense pack	•MOD initial •LOW L-term	GOOD	3.7	•WINNER for walls! •Proven Performance •Heavy recycled content	•GREAT for closed cavities •Downside- big holes in exterior siding
Recycled Denim	•MOD initial •MOD L-Term	FAIR	3.0 - 3.7	•Heavy recycled content •Shipping energy high since bulky	•No fiberglass particulates •Careful to fit tight or multilayer, stagger seams
Rigid Foam- XPS,EPS, or Polyiso	•MOD initial •LOW L-Term	EXCELLENT	5.0 or 6.5	•XPS: high Glob Warm impact •Flame retardants in XPS/ EPS are unhealthy	•EXTruded.- exterior walls or basement walls
Foamglas Rigid	•HIGH initial •MOD L-Term	EXCELLENT	3.4	•no flame retardant issues •low Glob Warm impact •Abundant source matls •Asphalt sealer is downside	•Good for below grade •18"x24" panels unfaced •24"x48" panels faced •V high compressive strength
Pour-In-Place Foam	•HIGH initial •LOW L-Term	EXCELLENT	4.6	•NEWER: Only few years •Claim minor formaldehyde formed during injection.	•Fill walls when need to avoid big holes for cellulose •Small 1" holes drilled
Spray Foam (soy) - open	•HIGH initial •LOW L-term	EXCELLENT	3.6 - 3.8	•Approx 40% soy polyol vs. petrochemical •No CFC's or HCFC's	•New constrn friendly as cavities need to be open •about 1/2 cost of closed cell
Spray Foam (soy) - closed	•HIGH initial •LOW L-term	EXCELLENT	5.8 - 6.8	•No CFC's or HCFC's •High Global Warm impact	•Roof decks or when vapor- impermeable is req'd •easier in new constrn

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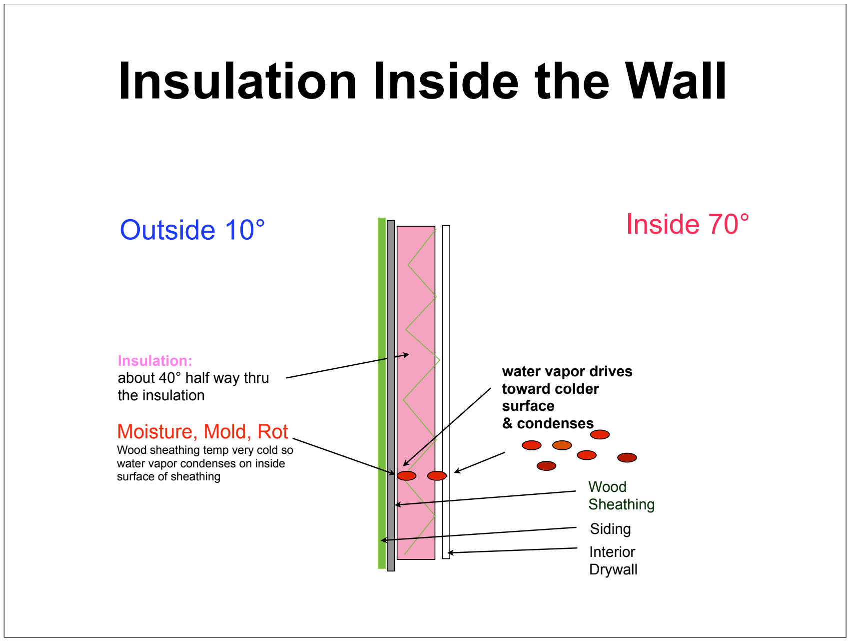

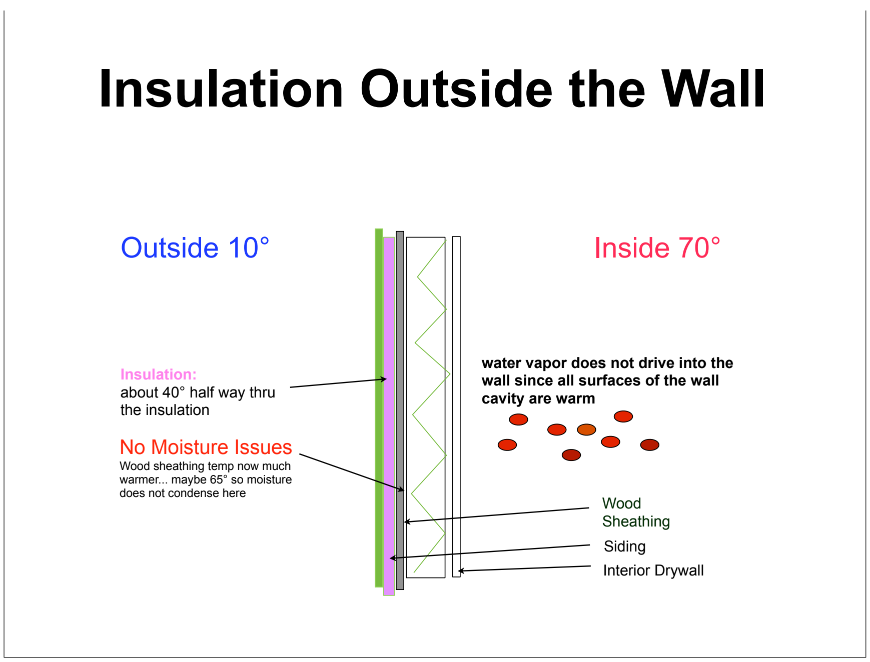

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