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The Role of Sealants & Weatherproofing in Maximizing Energy Efficiency and Thus Reducing Greenhouse Gas Output
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Reducing the use of energy generated through the burning of fossil fuels is of critical concern in today's world. The link is well established between greenhouse gas (GHG) emissions and fossil fuel combustion. While pursuing solutions such as hybrid car technology, renewable energy sources, clean coal technology and hydrogen/fuel cell power are all excellent ways to reduce GHG's, reducing the need for energy in general is the ultimate way to reduce emissions. By focusing a concerted energy reduction effort on buildings, which consume approximately 40% of all energy in the United States, is one of several strategies that, if executed properly, can reduce our energy consumption and subsequently reduce GHG's.

For many years, building envelope sealing technologies, which include not only sealants (commonly called caulking) but also more recently products such as air barriers, high performance tapes and elastomeric coatings, have been used to protect buildings from moisture intrusion and increase occupant comfort by reducing "drafts". Inherently, we all know that sealants save energy when properly installed in a building, but often folks don't know how or where to use sealants properly, not realizing the full potential of these products to reduce energy costs. However, through the use of sealants in a proper manner in conjunction with appropriate system selection and best practice building construction/operation, energy savings is all but assured.

The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) has long published several energy guides for building design and component installation in both new construction (Standard 90.1) and in existing operations (Standard 100.1). These guides have two main functions:

1. Establish evaluation criteria for selecting proper systems and components in building construction or operations
2. Establish best practice usage of products and systems to increase efficiency and reduce operational costs.

A thorough dissection of these standards, paired with research data compiled by and/or attained through experiments and studies done by the United States Department of Energy (DOE) yields what is in fact the role of sealants and weatherproofing in maximizing energy efficiency and subsequently reducing GHG's.

But, before discussing ASHRAE and best practice, discussing how sealants stop leaks is important as well as understanding how heat moves. Unlike insulation, which reduces the conductive flow of heat across a plane, sealants eliminate the uncontrolled movement of air and the heat it carries with it into or out of the building. This can be done via convective forces, those which would be caused by a force such as wind blowing across a gap or the natural tendency of higher energy warm air to flow to a cooler area or done by the inherent pressure in the building from the HVAC unit pushing air out of cracks and crevices instead of the air returns. By whatever means the air is moving, its uncontrolled movement by default means energy inefficiency.

There are several sections of ASHRAE 90.1 to focus on when considering appropriate sealant usage in the building. First is the sealing of the building envelope. Section 5.4.3.1 states the following shall be sealed with a sealant, mastic or tape (butyl tapes are preferred according to EnergyStar):

- "Joints around fenestration and door frames"
- "Junction between walls and foundations, between walls at building corners, between walls and structural floors or roofs and between walls and roof or wall panels."
- "Openings at penetrations of utility services through roofs, walls and floors"
- "Site-built fenestration and doors"
- "Building assemblies used as ducts or plenums"
- "Joints seams and penetrations of vapor retarders"
- "All other openings in the building envelope."

Per EnergyStar, this savings can be, depending on climate, structure, job quality, etc. a 25% reduction in HVAC. Given HVAC is up to 40% of the energy used in a building, this can yield a 10% reduction in energy for that building[i].

ASHRAE 90.1 also focuses on HVAC system and component assembly. Section 6.4.4, which in turn references SMACNA 90A&B states the following HVAC conditions shall be sealed in the same manner as the building envelope:

- Connection between the ducts and HVAC unit
- Connections between duct segments

– Connections between ducts and registers
– All adjustable joints in elbows, etc.
– All joints between intakes and intake ducts
– Around all intakes and the building.
– Around all ducts, etc. where they go through floors, walls, ceilings, etc.
– All similar joints in ventilation (i.e. fume hoods, etc.)

Further to this point, recent work by DOE has shown that through proper HVAC sealing, HVAC leakage rates can be cut from 14% (the current acceptable number in California) to as low as 4%, which can translate to as much as a 20% decrease in HVAC related energy consumption or 8% overall in the building[ii].

ASHRAE 90.1 also focuses on the building roof. As referred to in Section 5.5.3.3.1 high albedo coatings, primarily white, also help contribute to HVAC efficiencies due to the reduction of thermal transfer from a dark roof through the building envelope. In most all major population centers in the contiguous 48 states and southern Canada this does have a net reduction in energy consumption per DOE, which can be as high as 15% for the HVAC or 6% overall[ii].

ASHRAE 90.1 does only address primarily the construction of new commercial buildings or new building systems. However, ASHRAE 100.1 addresses the maintenance and operations of existing systems and structures. Much like 90.1, ASHRAE 100.1 recommends the sealing of the envelope, including the isolation of unused areas, fenestrations and the like in Section 6.2. And while studies to existing structures are scarce in comparison to new construction, one can safely assume that energy reduction will result from following adapted 90.1 practices in an existing structure.

Also not addressed by ASHRAE 90.1 directly (though it is implied as being present in Section 5.4.3.1) is the presence of a continuous and properly detailed and transitioned air barrier assembly. Studies again by DOE and commonly published in Air Barrier Association of America reports suggest the energy savings in HVAC from having such a barrier in place can be as much as 40%; or 16% of the overall energy use in the building[iii].

To close out, ASHRAE 90.1 coupled with a properly installed air barrier outlines practices that can result in up to an overall 70% reduction in HVAC-related energy consumption in buildings or 28% overall reduction in energy consumption (Note: the savings numbers are not accumulative).

It also needs noted that further enhancements to improved ventilation effectiveness, pollution source control and other indoor air quality (IAQ) improvements (addressed in ASHRAE 62.1) are beyond the scope of this document. However, sealing the building to minimize undesired air flow will inherently also impact IAQ in a positive manner as the system in place will be able to operate under “more ideal” conditions and thus operate more as it was intended, flushing the air to insure IAQ.

To summarize, the effective and best practice use of sealant technologies in construction is all but required to maximize potential energy savings and subsequent GHG reduction. Only when coupled with overall good construction practice and smart system selection can maximum energy efficiency be achieved in structures. In the best case scenario, as much as a 28% reduction in consumed energy can be achieved through proper building sealing techniques, which in turn correlates into a similar reduction in the GHG emissions associated with the building’s operation.

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[i] http://www.energystar.gov
[ii] http://www.ornl.gov/sci/roofs+walls
[iii] http://www.abaa.org