COLD CLIMATE HOUSING RESEARCH CENTER
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Promoting and advancing the development of healthy, durable and sustainable shelter for Alaskans and other circumpolar people.

New Home Study for Cook Inlet Housing Authority

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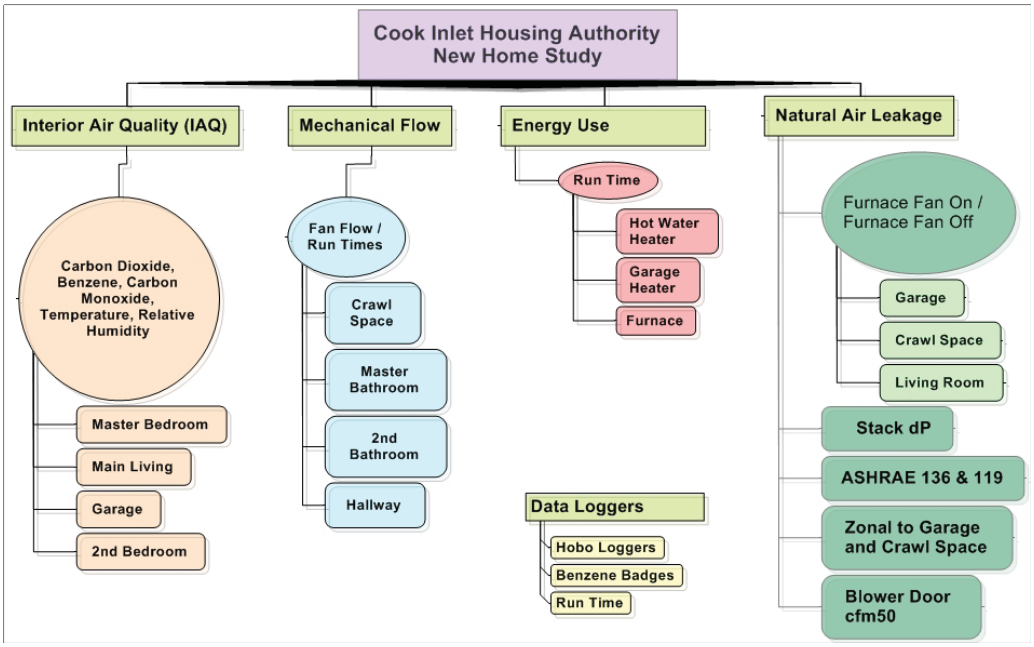
Four recently built Cook Inlet Housing Authority homes were studied for mechanical system performance. Two boiler-heated homes and two furnace-heated homes were monitored during 2006 to determine if they performed as designed regarding energy efficiency, homeowner comfort, indoor air quality and humidity control. The boiler heated homes were 2-story homes with the boilers providing domestic heat and hot water. The other two homes were 1-story with furnaces for domestic heat and standard domestic hot water tanks. One home was ventilated with a Heat Recovery Ventilator (HRV).

Results Summary

Temperature/Relative Humidity: Both of the furnace-heated homes had higher temperatures and relative humidity than the boiler homes. Both furnace-heated homes with passive crawlspace ventilation had higher humidity levels than boiler heated homes with crawlspace fans. Relative humidity levels were highest during the summer months, so there was little chance of condensation, but mold could become a problem.

Inappropriate fan settings, running fans too much or too little was a common problem with humidity controls and indicated a need for better homeowner understanding of how they operate.

Maximum Depressurization and Zonal Pressure Tests: Any device that exhausts air from a tight house can compete with the normal venting of combustion products from combustion appliances. This depressurization can lead to backdrafting and spillage which can be potentially harmful or deadly. Depressurization can speed the entrance of radon and other soil gases into the house, increase air infiltration through the building shell, and cause moisture damage. Continuous depressurization may be caused by forced air systems or whole-house ventilation systems. Direct-vent boilers do not have these issues.



Flow Chart showing the format used to gather data on temperature, relative humidity, carbon monoxide, heating run-times, ventilation fan run-times, air quality and much more.

Related Topics:

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Furnace, Boiler, and Water Heater Use: The modulating boiler-heated homes efficiencies ranged 92-98%. The furnaces had efficiencies in the 80% range. In boiler homes, base fuel use, which includes cooking and clothes drying as well as heating domestic hot water, was significantly less than the measured water heater use in the furnace homes.

Conclusions and recommendations

Due to the very small sample size, it is not possible to make any general statements about performance based upon house characteristics. Instead, this report describes the observations and measured performance in specific homes.

Ventilation

None of the homeowners was very knowledgeable about the "how's and whys" of their ventilation systems. Some fans were left on indefinitely, others never used, and the HRV was inappropriately programmed. The separate "whole house fan" appeared to be an unnecessary extra, as the main bath fan was used much more consistently.
Heat recovery ventilation provides a balanced, tempered air, and good distribution of air throughout the house. Smaller and simpler systems should help reduce the installation cost. As natural gas prices continue to rise, the value of heat recovery of an HRV will become a stronger incentive to utilize them.

The mechanical exhaust ventilation in the crawlspaces appeared to work well at controlling relative humidity and little venting was necessary during the heating months, reducing energy costs. A heat recovery ventilator could also be used to adequately ventilate the crawlspace, thus eliminating the need for a mechanical exhaust fan. Exhaust fans depressurize the home relative to attached garages and crawlspaces and have been found to increase pollutant transfer from garages and crawlspaces. Distribution of fresh air, especially to bedrooms has also been reported to be insufficient as well.

The practice of venting bathroom fans through the attic has the inherent problem of freezing the damper shut, making the bathroom fans inoperable. Venting bathroom fans down into the crawlspace and out of doors could alleviate this problem.

Mechanical Systems

Although this study was not able to make any adjustment for occupant loads. Domestic hot water energy use appears to be significantly higher for homes with stand-alone water heaters.

Some of the homes had furnace duct work in the attic. This practice is not only an energy penalty, but can lead to other problems such as ice damming and is strongly discouraged.

Leaky duct work in the crawlspace can lead to significant pressure imbalances in the home, as well. Proper specifications and commissioning on duct sealing and pressure balancing requirements would lead to better functioning forced-air heating systems. These issues are eliminated when utilizing a hydronic heating system, such as that employed on some of the homes.

The limited monitoring of fuel use and AkWarm comparisons indicate that furnace heating systems in ranch houses appear to be oversized by 50% to 117%. A smaller sized furnace may be more appropriate, especially if the installation savings could be put towards an electrically efficient furnace fan motor which has much lower electrical costs and the ability to provide optional low speed ventilation. The boilers also seem to be oversized, but because they are modulating boilers the penalty is not a significant an issue.

Airborne Pollutants

The significant carbon monoxide levels in these houses is cause for further study. Of the three homes where CO monitors were installed, one home had very high CO spikes, and another had lower but still significant levels. In the home with the highest levels, the CO was attributed to a gas cook stove. It may just be that in small tight homes, electric stoves are a better option.

Living area and bedroom temperature and relative humidity in all homes were usually within design parameters of 65-70°F and 30-50% RH. However, both of the furnace heated homes had higher temperatures and relative humidity than the boiler homes, with an average RH of 49% and summertime RH averaging 60-70%.

Crawlspace temperature levels in all homes averaged about 65°F while relative humidity averages ranged from 39-78% . Both furnace-heated homes with passive crawlspace ventilation had higher humidity levels than boiler heated homes with crawlspace fans.