Residential Ventilation

INTRODUCTION

Adequate ventilation is vital for a healthy house and healthy inhabitants. Unwanted moisture and exhaust from household appliances must be expelled from a house. Fresh outside air must replace the expelled air.

This document explains some of the different types of ventilation used in residential homes, the problems with inadequate ventilation, and the solutions to improving air quality through adequate ventilation.

TABLE CONTENTS

1. Common of Residential Vents

Drier Vents - Expels a large volume of hot moist air.

Water Heater Exhaust Flue - Expels fumes from the combustion of natural gas.

Furnace Exhaust Flue - Expels fumes from the combustion of natural gas.

Sewer Vent Pipe - This vent take air into the sewer pipes as waste flows down and out of the house. Without a functioning sewer vent pipe, sewer gas can enter a house.

Bathroom Vent – Expels moist air.

Kitchen Hood – Expels moist air from cooking.

Chimneys – Expels exhaust fumes from wood or gas.

Fresh Air Intake - As air is vented out of a house, fresh air is needed to replace the expelled air.

Roof Venting - Cools the attic in the summer. Expels moisture. Helps keep the roof deck cold in winter.

2. Moisture

The primary enemy of a healthy home is unwanted moisture. Moisture can break down building materials, cause rot, and fungal growth leading to health problems.

All air has moisture. Moisture in air is needed for healthy living; however, too much moisture is bad for a house. Humidity is the measurement of water in air.

Elevated moisture (humid air) will condense on colder surfaces. If the air temperature and humidity are right, condensation can occur. When the temperature and relative humidity are known values, the dew point can be determined. The dew point is the temperature to which air must be cooled to be come 100% saturated.

Given the three measured values of:

1. air temperature,
2. humidity, and
3. surface temperature

conditions can be evaluated if condensation will occur. Any surface that is at or below the dew point would have moisture if the air is allowed to come in contact with the cooler surface.

Rule 1: Cool air cannot hold as much water as hot air.

Rule 2: When hot air cools, the air becomes more humid. If it continues to cool it may become fully saturated and water will condense on colder surfaces.

After a hot humid day, the temperature of the air cools during the night. Dew (or condensation) is formed on all surfaces.

3. Condensation

While good in nature, condensation within a house normally creates undesirable problems.

When the indoor humidity is not controlled, and the outside temperature is cold, water can form on the inside of a house as condensation. Over a period of time the water can destroy windows. If the window is below freezing, the condensation shows up as frost or ice.

4. Interior Water Staining

Water stains on the underside of a ceiling are either from inside moisture or an outside leak. Vaulted ceilings with skylights are nice, but condensation can be a problem if this type of roof structure is not carefully built, and inside humidity is not controlled.

If indoor humid air comes in contact with the outer colder material within the roof or wall system, moisture will condense within the system. If enough moisture condenses, water will drip from the ceiling.

If this process takes place when the outside temperatures are very cold, the moisture within the roof system might not be water. It might be frost.

If the process of forming frost within a roof system takes place over a long period of time, the build-up of frost can be extensive.

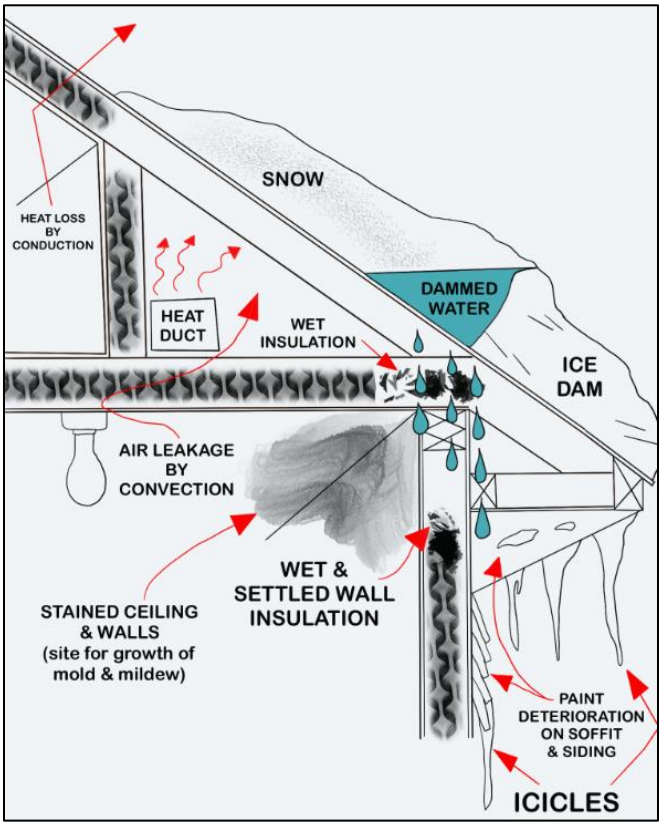
When the temperatures within the roof system warms above freezing, there may be a thaw that creates a dripping effect that may be mistaken for an outside leak.

5. Ice Dams

Adequate ventilation is necessary to reduce ice dam formation. If an attic is not vented adequately the roof may melt the snow up high on the roof and it may refreeze at the lower edge of the roof.

An ice dam occurs when snow on a roof melts, drains to a lower elevation, and freezes, causing a blockage in the flow of melt water.

Once an ice dam is formed, additional melt water can pool on the roof causing water to flow under the roofing materials and enter the structure. Roofs are primarily designed to direct water away and off a structure. A sloping roof may not be detailed or constructed to hold ponding water.



6. Uneven Snow Melt

Spotting a ventilation problem usually consists of spotting unwanted staining on the inside and uneven melting on the outside.

Warm spots on the roof that prematurely melt snow faster in some areas compared to the surrounding areas on a roof can be a sign of trouble within a structure. The underside of a roof deck should be uniformly cold in winter.

When snow melts it should uniformly melt and drip off of the roof.

7. Frost Buildup in Attics

During cold weather, warm moist air that enters an attic can condenses on colder surfaces resulting in droplets of water or moist materials. During extreme cold temperatures the condensation is in the form of frost. If the flow of moist air into the attic and cold conditions are not altered, the build-up of frost can be excessive and continual. It is a matter of air temperature, humidity, and surface temperatures.

Frost can build up in the attic uniformly and more concentrated at air leaks. When the temperature rises above 32 degrees at the frost location, that frost melts and it can appear as a leak. The water rushes out and then stops. This "leak" can be excessive when the temperatures dramatically change, as is common during the warming up a cold house where the temperature has been substantially reduced when owners where not home for extended periods of time.

Frost build-up is most common above heat sources such as light fixtures, kitchen stoves, fireplaces, bathrooms, fans, and improperly vented exhaust fans. When the frost melts, this "leak" is most commonly found dripping out of those heat sources. This is a common problem in Minnesota and Wisconsin.

8. Dryer Vents

A good dryer vent expels warm moisture from a house before it can condense.

It is not a good idea to heat a house with dryer exhaust. Dyer exhaust has lint and too much moisture. It must be exhausted to the outside. Dryer vents must not vent into an attic or crawlspace. Venting into an attic or crawlspace creates moisture problems.

Problems with dryer vents usually become noticeable quickly when they malfunction because of the volume of water transmitted through a dryer vent. Lint can clog a vent. Snow can block a vent. When a vent is constricted or blocked, the dryer continues to attempt to dry clothes pumping unwanted moisture into the house.

9. Bathroom Vents

Bathroom vents are required to be vented to the outside, not within the attic space. The attachment of the duct from the fan to the roof penetration should be air-tight and insulated. If the vent leaks warm moist air into the attic it can cause condensation around the opening or the underside of the roof deck.

The photo below shows a vent that had come loose from the roof deck. The roof deck was delaminating above.

10. Kitchen Vents

A typical kitchen stove produces a significant amount of steam from boiling and other cooking processes. The moisture created in cooking should be adequately expelled to the outside. The photo below shows a disconnected kitchen vent. The discoloration within the rafter space that had the penetration was extensive.

The discoloration was upward from the penetration indicating hot air rising form the pipe. Significant discoloration around a penetration and running down from a penetration could indicate a leak. Roof penetrations are common culprits for leaks, so the distinction needs to be made if the moisture is coming from within the house or from outside the house.

11. Chimneys

Older chimneys are difficult. The flue must be held back from combustible materials so not to cause a fire, and the penetration through the roof must be watertight. The flue expels warm moist exhaust from combustion appliance, so it is carrying moisture within the pipe as well.

Modern, high efficiency furnaces have separate intake and exhaust. The PVC exhaust pipes are run through a wall or roof at mild temperatures making the penetrations simpler.

12. Natural Gas Exhaust

Natural gas is considered a clean burning gas because the exhaust contains less carbon dioxide than coal. However, exhaust gas is not clean.

Natural gas still produces harmful exhaust gas that must be expelled to the outside. Natural Gas is composed of primarily methane. Methane burns with a clear blue flame. The chemical reaction for the complete combustion of methane is shown below:

methane + oxygen → carbon dioxide + water + energy

$$CH_4 + 2\,O_2 \rightarrow CO_2 + 2\,H_2O + \text{energy}$$

The combustion must have oxygen. Therefore, air intake must be provided for the combustion. For this reason, furnaces and water heaters are supplied with some means of fresh air intake. The fresh air intake can be a designated pipe connected directly to the unit or a separate large duct that supplies fresh (cold) air to the furnace room.

The combustion of methane gas creates three things:

1. Carbon dioxide,
2. Water and
3. Heat energy.

The carbon dioxide is a harmful gas that must be exhausted out of the house. Water is also produced. For this reason, ice formation can often be seen on the exhaust pipe of a combustion system in cold weather climates.

Without knowing the exact running time of a water heater, the exact amount of carbon dioxide and water vapor cannot be calculated. A typical residential water heater might produce two quarts of water within an hour of continued use.

A malfunctioning exhaust system becomes a moisture problem and a dangerous carbon dioxide problem. The picture below shows a disconnected water heater exhaust stack in the attic. The roof was dry above the pipe and discolored away from the penetration with frost beyond.

13. Attic Ventilation

Hot air rises. A typical house will have moisture within the living spaces. As it rises, it finds its way into an attic. There are air leaks around the following items:

1. Lights,
2. Attic hatches,
3. Fans,
4. Mechanical heat ducts
5. Mechanical air return ducts
6. Chimneys
7. Other ceiling penetrations.

Different vent pipes are run through an attic. Warm moist air must not be allowed to leak into an attic and fill an attic.

When condensation is present on the underside of a roof structure, any and all sources of warm moist air need to be closely looked at to further refine where the moist air is from and how it gets into the attic.

Also, the amount of ventilation within the attic should be inspected and evaluated.

To adequately vent an attic there are all several types of commonly used attic (roof) vents. There are:

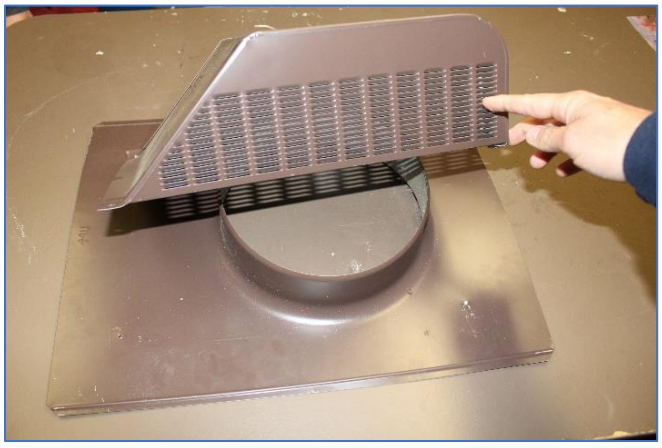
1. Box vents (turtle vents)
2. Turbine vents
3. Ridge vents
4. Soffit vents
5. Gable vents

There are code requirements on the amount of total vented area required.

14. Box Vents

A typical residential house will have a sloped roof with box (turtle) vents along with soffit venting.

A slant-back box vent is composed of a lower and an upper section that are connected to each other. Rainwater is prevented from entering the roof as the bottom section of the vent has a water-tight raised interior flange. The construction of the box vent makes it very difficult for water to enter a roof.



15. Ridge Vents

Ridge vents are continuous vents at the peak of the roof. They should not be mixed with box vents as this can short free flow of attic air. Ideally, the attic should exhaust air through the peak and intake air through the soffit. Mixing of different types of vents could short the flow of air by drawing air from a nearby vent.

The photo below has two problems.

1. There are two different types of vents next to each other. One could be an intake for the other.
2. The ridge vent on the peak is actually on a ridge that is located down slope from an upper roof. The ridge vent is an opening in the roof meant for air to flow out. Rain running down the upper roof may enter the ridge vent if the flow of water is too fast. A ridge vent should be kept far from any source of water flow.

16. Blocked Vents

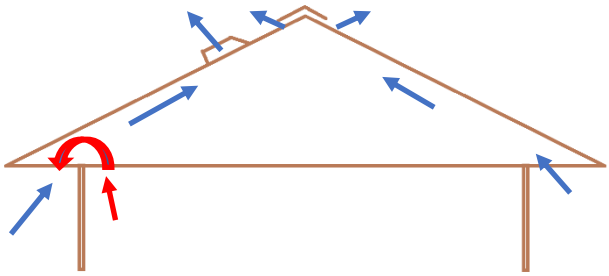
Unfortunately, winter snow blocks many of the ridge vents and box vents in snow regions. When attic ventilation is needed most, they can be blocked by snow.

The following photo is of a Minnesota roof in January with blocked turtle vents. It might be a long time until the roof vents are clear.

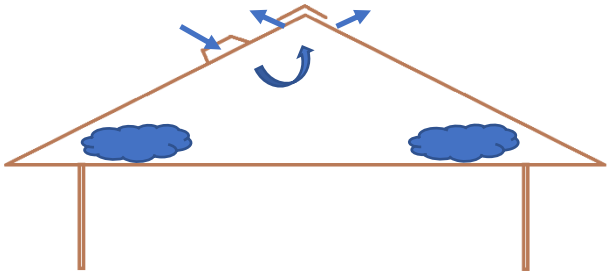
17. Soffit Vents

Soffit vents are meant to draw air into the attic. The air within the attic is meant to exit at the higher elevation. The simple diagram below shows air entering the attic at the soffit and exiting the attic at the ridge. Modern roofs are more complicated than a simple gable roof, but the concept is the same.

The red arrow represents an attempt at venting something through the soffit. This is never a good idea. The exhaust may exit the roof but can be drawn back into the attic.



The diagram below shows the same roof with a short in the attic ventilation. For several reasons a soffit vent may be more restrictive in drawing air into an attic than at an adjacent upper vent. The end result is dead air space that may become a problem.



The photo below is of a soffit that deteriorated due to interior moisture within the attic. The deterioration was not from a roof leak. The water was coming from within the house, entering the attic, and not flowing out of the attic space. This was a ventilation problem.

18. Insulation Baffles

Soffit vents are no good if they are blocked by insulation. The photo below shows baffles that are placed within the rafter spacing to prevent the soffit vents from being blocked by insulation.

Insulation baffles are necessary to keep the soffit vents open, however, even the best vented attics are no match for disconnected exhaust ducts that run through an attic.

19. Conclusion

Many things can go wrong with venting. In general, unwanted moisture and exhaust from powered household appliances must be expelled, and fresh air must be added to an interior for a healthy house and healthy inhabitants.

There are code requirements for adequate venting. In general, if the code rules are followed, the problems associated with venting typically do not develop.

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