mmid

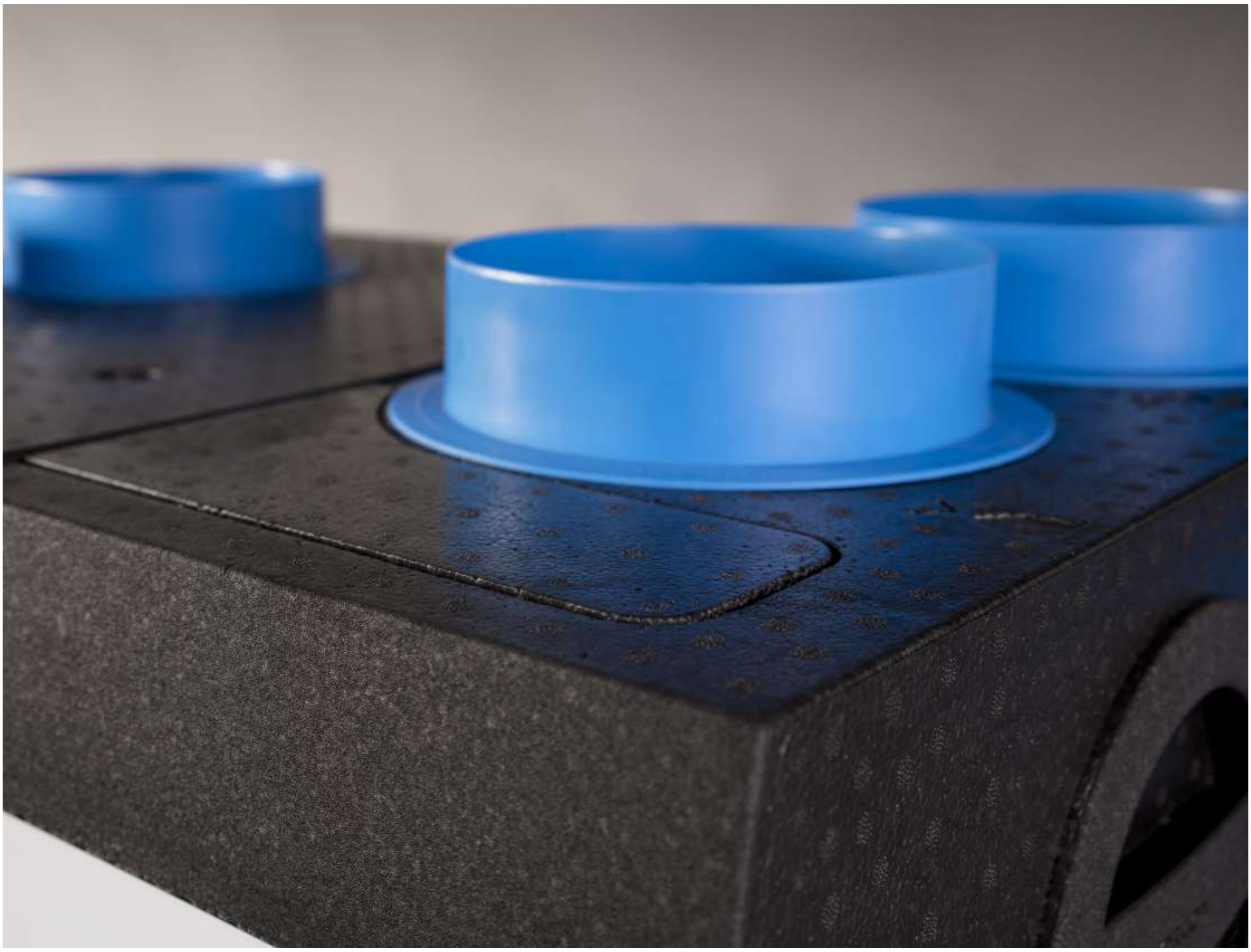
Ventilation System Design: 8 Best Practices

In the last twenty years, MMID has developed many ventilation systems following the approach of Integrated Product Development. In this article, MMID's eight best practices regarding the design of (residential) Heat Recovery systems are explained, based on knowledge from one of our experts.

→ Based on an interview with senior designer Eric van der Voort

1. Using expanded polypropylene (EPP)

EPP is a Styrofoam-like material but with a higher quality. Its properties are ideal for the ventilation business, offering rigidity, moldability, strength, and stiffness at a relatively low price and low weight. EPP is a good heat insulator, which is necessary for Heat Recovery ventilation systems to separate warm and cold air. It also lends itself to the creation of smooth surfaces (unlike steel constructions) which are necessary to ensure an efficient and aerodynamic flow path for the air to move through your system. EPP is foam-like, which means that sealings can be integrated into parts by creating small edges that can seal against another part, creating airtight connections. EPP is recyclable into regular PP. One of the downsides of EPP is that it has larger tolerances due to its specific production process, which must be considered during engineering.



By eliminating the need for steel and the need for separate parts with EPP, important factors in the ventilation industry, such as weight and ease of use, can be improved upon. An initial investment into an EPP tool is necessary to start producing parts from the material. The benefits start outweighing the cost of the investment if a company sells a couple of thousand units per year in comparison to a steel alternative. Apart from the different production processes EPP also lends itself to more engineering solutions since it is an easy material to design with. Wall-thickness can be greatly varied, and even undercuts can be created into your part.

2. Focusing on noise reduction

When developing a ventilation product, EU regulations regarding noise reduction must be considered. Noise is one of the biggest issues in the building industry of machines and devices since people are conscious of sounds, especially at night. Therefore, a quiet system is a valuable selling point in the ventilation industry.

When designing your product, there are three main sources of noise to be considered:

1. Radiating noise from the unit directly, caused by the inside noises (ie. air flow, rotating fans) leaking through the housing of your product.
2. Duct noise going to the separate rooms in the house, caused by the air flow inside the ducts and the noise from the product that is transferred into the duct system.
3. Vibrations from the product that are transferred to ducts, walls, etc and eventually generate sound.

In general, noise should first be prevented at the source, which typically is the two fans. Make sure they are built-in correctly with enough room for the air flow to establish. If a scroll is used around the fan, make sure the cut-off point or nose is not too close to the fan blades, as this can cause a clearly audible sound at a specific frequency (BPF: blade-passing frequency).

Radiating noise can be reduced by adding a heavy (ie. steel) enclosure around the product that keeps the noise inside. Noise attenuating materials (ie. closed cell foam layers) could be added, but for the frequencies that are typical in these types of products, the foam thickness required is often too big. (Unfortunately, EPP is not a good noise reduction material!)

For some part, the duct noise is depending on the installer of the ducting and out of your control. However, preventing noise from the unit going into the ducts is always best and can be optimized by having a smooth and aerodynamic air flow through your product, with little restrictions / hard edges that can cause turbulence and thus noise. Also, the placement of components within the product can help or worsen the noise going into the ducting system. The heat exchanger for example, can be used as a noise

damper by placing the fan "behind" it, as seen from the house.
Somewhat contradictory, duct noise can be worsened by improving the radiating noise of your product, as the noise is kept within the product and is thereby likely to travel into the ducts. This is a trade-off that is not easy to solve.

Finally, transfer of vibrations of the product to its surrounding should be prevented as much as possible by "decoupling" it from the ducting system and wall / floor. Flexible hoses / connectors, vibration dampers, springs, etc can be used for this, but should be engineered correctly to damp the specific vibrations from your product.
Also here, vibrations should first be prevented at the source; the fixation of the fans to the main structure of your product should have the correct dampers to reduce vibrations in the product, although some fans on the market don't require separate damping anymore.

Noise reduction is especially difficult at the end of the design process (when the product design is almost fixed), so it is wise to take it into account from the start. And noise is also difficult to predict or simulate. That's why it is important to also test it early in the design process with a realistic "proof of concept" model.

3. Suppliers and sourcing of components

When designing a ventilation system, the key components will have to be bought from suppliers, such as the fans, dampers, the heat exchange unit, filters, and sensors & controllers. In MMID's opinion, it is better to buy high-quality products. Through trial and error, we have a good list of sources that we can get our components from. This is also true for your custom designed EPP parts, which require a production process that is not so widespread as regular injection molding. When sourcing these components, it is important to understand what to ask for to achieve what you want.

4. Being conscious about trade-offs in efficiency and noise

EU regulation dictates that your building product must have an energy label to enter the market. These range from A++ (very efficient) to G (not efficient). The market is competitive regarding this label and manufacturers strive to get a high rating. To get a label, two things are measured about the ventilation system; heat efficiency (how well heat is recovered in the system), and energy efficiency (how much electricity the fan uses to achieve a certain output). These efficiencies can be conflicting and design choices early in the process will set the balance for the final product.
Next to efficiency, ventilation units will also be tested on noise levels, which is an important selection criterion for builders and installers. The choice of fan and method of building it in is a trade-off between noise and efficiency and should therefore be considered carefully.

5. Being aware of leak tightness

Air tightness is another important factor of your heat recovery ventilation product and regulations dictate that it must be above certain limits. Your product can 'leak' air in two ways:

1. External leakage: air leaks from inside the housing of the product to its surroundings.
2. Internal leakage: air leaks from one internal flow path of the product to the other.

In the worst-case situation, 'dirty' air from the house contaminates the 'clean' air that is being brought in.

Air leaks are a result of small gaps and openings in the housing and the different pressures that exist inside and outside of the product. Understanding where large pressure differences arise and which gaps are critical, is an important step in solving any air leak issues.
EPP comes into play here, since it is an ideal material to create tight seals, both between EPP parts and with other components in the product.

Another type of 'tightness' is for the water being formed in the heat exchange unit during wintertime, which needs to be drained via a tube to sewage. This condensate is typically collected inside the product in a 'drip tray'. It is possible to use EPP for this drip tray if it is given a special treatment that will make it watertight.

6. Thinking about the installers / service technicians

When designing a ventilation system, its installation and service must be kept in mind.

The installer is probably the user that will interact with the product most. If you take into consideration how to unpack the unit, how to mount and connect it, how much space it takes up, and how to set up the interface, you can make the installation process a lot easier and faster. This is valuable to the installer, but also for the owner of the building since less installation is beneficial cost-wise.
Ease of service / maintenance can also be valuable, especially in larger housing projects. Considering the accessibility of key components and service parts can make a big difference here and might just offer the winning specification compared to your competitors.

7. Thinking about the end-user

Another user of the product is the person living or working in the building in which your product is installed. This user typically has minimal interaction with the ventilation system. Besides adjusting the level of ventilation and changing out the filter every 4 – 6 months there is not much to do. However, people still don't change the filters because they either don't know how to or because it is too complicated to do. This means that, as a designer, this process must be made as easy as possible.

Another thing relevant to the user is the rise of smart products and the Internet of Things (IoT), which can also be implemented in ventilation systems. On the one hand there are sensor-control options, central or per room, where the ventilation is adjusted automatically based on humidity, CO2, air quality, presence, temperature, or time of day. And on the other hand, there is IoT, allowing the product itself and the sensors to be tracked and operated from a distance.
The downside to this kind of automation is that residents might not be able to follow why the product is doing something and might even dislike it. Therefore, we keep the ventilation systems simple as of right now and give control to the owner. The most important thing is that people trust their technology.

8. Using a basic layout

Most of our clients know what they want from their ventilation system but are not sure how to achieve their goals. What MMID does, is to start with a well-thought-out layout of their desired system, based on several key decisions regarding size & weight, efficiency, noise, frost protection & bypass functions, ducting & installation configurations, and service. From this layout, additional features and functions can be added and a final design can be made around it.
This way of working ensures that the most important topics are considered first, before focusing on the details and add-ons.
Nowadays, products such as ventilation systems and heat pumps are essential for houses and buildings to reduce our use of energy as much as possible. By making smarter and more integrated products, we reduce waste and make for a better living and working experience in buildings that are pleasant to live in.

Ready for teaming up?

Contact Nynke Daane and let's talk about ambitions.

→ nynke.daane@mmid.nl
→ +31 (0) 15 213 6736