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Can Smoke Extraction and Ventilation be Combined?

Extraction of smoke from buildings

To achieve the objective of protecting humans, property and the environment, legislators in Germany rely on the Model Building Code by which, in practice, they burden project owners with the obligation to install building safety systems - equipment that will, if ever, be actuated only in the case of a fire but invariably causes high costs.

A project owner intending to erect a building has the duty to provide equipment that will prevent the propagation of fire and smoke, facilitate the evacuation of humans and animals, and promote effective fire-fighting. To reduce the cost of such equipment, planners and contractors often attempt to combine smoke exhaust and ventilation functions in a single system. In a configuration of this type the smoke exhaust and ventilation functions are ensured via smoke exhaust dampers or modified fire dampers approved by the building supervisory authorities. This solution, although widespread in commercial practice, is inconsistent in both content and form with applicable building supervisory requirements. In a word, such systems fail to provide building safety since they lack the ability to trigger a damper closure via a fusible element.

A central requirement stated in all building supervisory approvals for smoke extraction fans but often noted only too late by planners and equipment builders is the following: “In smoke exhaust systems fitted with smoke exhaust dampers, smoke exhaust fans shall not serve ventilation purposes.” The rationale for this rule lies in the very absence of a “fusible element” triggering feature, i.e. it refers neither to an operating defect of the smoke exhaust dampers within the smoke extraction system nor to the function of the smoke extraction fan itself. In practice the non-conformaty will often be revealed only at the acceptance stage, resulting in a flutter of anxious last-minute communications with the smoke exhaust fan manufacturer.

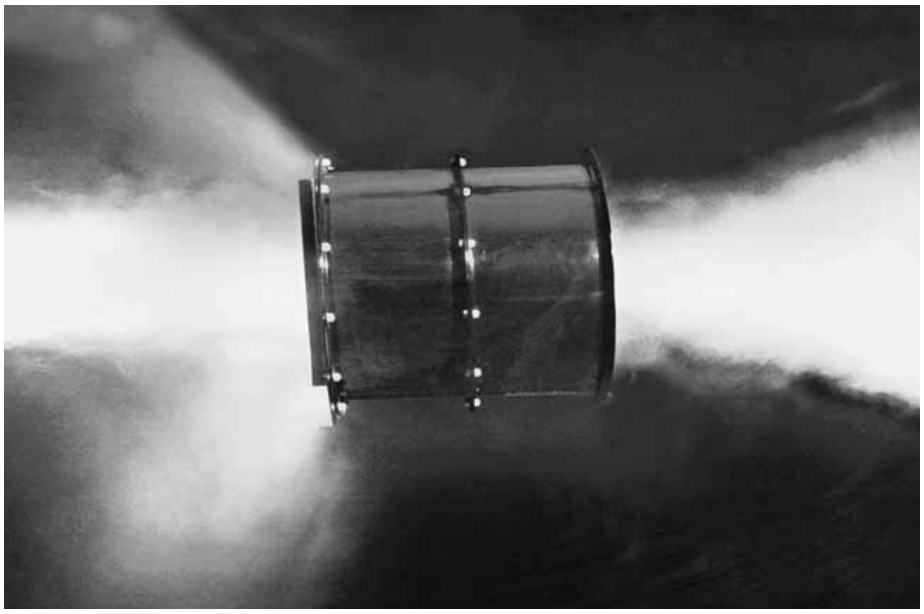

Fig 1: Smoke exhaust fans are the heart of each smoke exhaust system.

A smoke exhaust fan (Fig. 1) is quite capable of extracting spent air. This applies without limitation, as long as the fan is not connected to a duct system which incorporates a smoke exhaust damper. It may thus extract air directly, e.g. from an industrial workshop or manufacturing facility. The rule, applicable across brands and manufacturers, relates exclusively to the interaction between the smoke exhaust fan and a smoke exhaust damper operating within the system (Fig. 2).

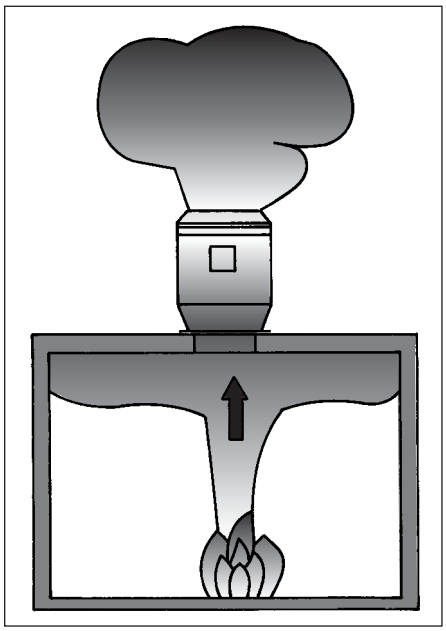

Fig 2: Smoke extraction through a smoke exhaust roof unit with open inlet

The reason for the above qualifying clause is that the damper systems used to ensure fire safety differ from their counterparts employed in smoke exhaust installations. Here, and only here, lies the reason for the above proviso, and the basic differences between the systems must be viewed from this perspective.

Fire damper

A fire damper (Fig. 3) is normally open. It closes only in the case of a fire, after being triggered by a fusible element, to maintain the safety of the building in case of a fire. This, precisely, is the main reason why smoke extraction via the ventilation system will not work. The fusible element causes the damper to close at around 90 to 100° C. Once the damper has fully closed (if not earlier), smoke can no longer be extracted to the outside via the ventilation system. Another reason lies in the fact that ventilation systems are not rated to carry hot products of combustion. Key components such as V-belts, motors, duc-

ting, and even duct mounting elements are not designed for the resulting loads.

Normal damper position:
- Open

Damper closing action is triggered by:
- fusible element or early detection via in-duct smoke sensors

Damper safety position:
- Closed

Smoke exhaust damper

Smoke exhaust dampers are normally closed, opening only when there is smoke to be extracted. Obviously, they will therefore not allow spent air to pass through in ventilation mode. Fitting a smoke exhaust damper in an "open" state for ventilation or air extraction purposes would, in fact, void its approval granted by the building supervisory authorities.

But if a smoke exhaust damper has two possible safety positions, how come it cannot be used in a ventilation system? For the simple reason that it can only ensure building safety if triggered by a fusible element, i.e. independently of the electricity supply in the case of a power failure.

Accordingly, approval documents for smoke exhaust dampers contain the unmistakeable rule in section 1.2 that "...smoke exhaust dampers are not suited to serve as fire dampers ..." It follows that, under current approval regulations, smoke exhaust dampers are not approved for ensuring building safety, given that they may be "OPEN" in their safe position where a fire damper must be "CLOSED.

Normal damper position:
- Open

Damper opening action is triggered by:
- smoke detectors or in-duct smoke sensors controlling an actuating motor

Damper safety position:
- Open or closed

Other options

One means of combining the smoke extraction and ventilation system is fairly costly and requires considerable building space. Depending on the smoke exhaust scenario, it involves the arrangement of a fire damper and a smoke exhaust damper in a bypass configuration (Fig. 5) to meet both requirements within a single system.

Alternative solution

A so-called combination damper, combining the functions of a fire damper and smoke exhaust damper, may prove a more cost-efficient approach.

Smoke exhaust damper with ventilation feature = combination damper

The combination damper must provide the "fusible element" triggering function without making use of just such a fusible device. To ensure building safety, it must be able to close fully autonomously under any mains supply fault condition, up to and including a 100% power failure.

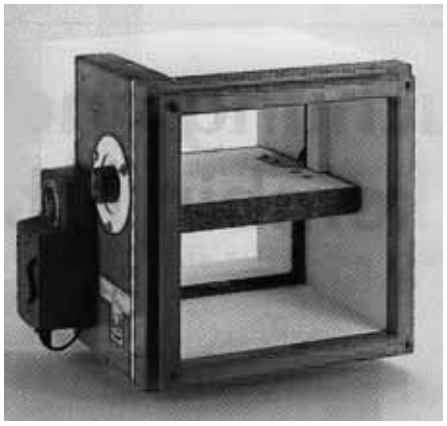

Fig 3: Fire damper

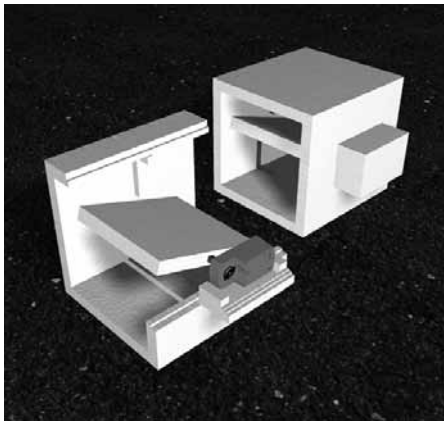

Fig 4: Smoke exhaust damper

Normal damper position:
- Open in ventilation mode
- Closed in smoke exhaust mode

Closing action:
- provided by actuating motor

Opening action:
- provided by actuating motor

Damper safety position:
- Open or closed / 90 minutes fire resistance rating

One manufacturer of fire safety dampers, Strulik, has commissioned the Technical University of Munich to test such a "combination damper" and has applied for an approval by the German Institute of Building Technology.

The electric actuating motor of these dampers uses an additional power supply arranged within the motor unit or in its immediate vicinity. As a result, the combination damper will move to its CLOSED position in the case of a mains failure. It can thus meet both building safety needs, i.e. that of being OPEN in ventilation mode and CLOSED for the smoke exhaust function.

The damper also meets the additional requirement of being capable of opening and closing 10,000 times under load (at 1500 Pa underpressure). Triggering is achieved via smoke detectors.

Example of a combination damper application

A smoke exhaust system with a ventilation capability covers a defined fire compartment having multiple smoke zones. Combination dampers capable of operating in fire damper and smoke exhaust modes are mounted in the smoke exhaust ducts.

A smoke alarm detected by smoke sensors is triggered in one of the smoke zones. In the relevant area of that smoke zone the damper position changes to CLOSED, preventing both incoming and outgoing airflows. It follows that the fire dampers too must be actuated by electric motors as this is the only way to seal off all wall penetrations. Following this change in setting, all combination

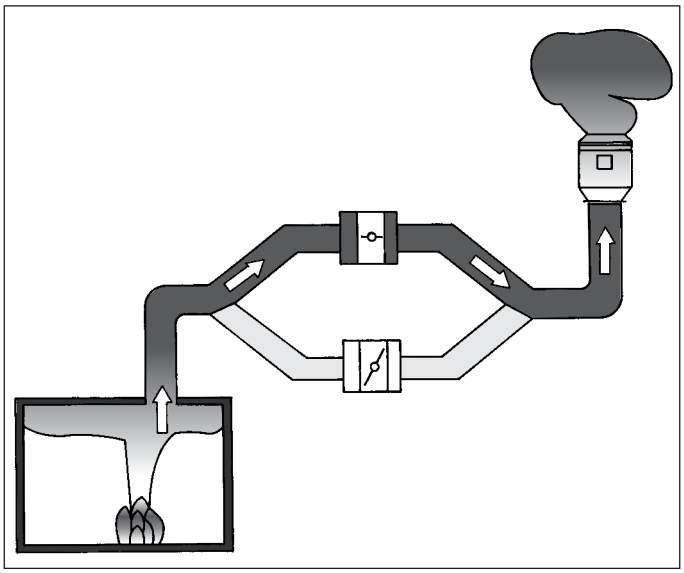

Fig 5: Fire damper and smoke exhaust damper in a bypass configuration

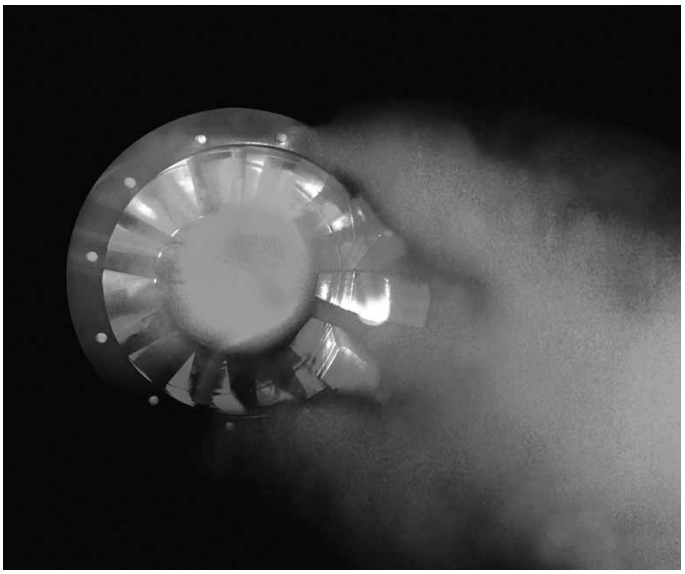

Fig 6: A ventilation system must not be used for smoke extraction

dampers served by the detector group of that smoke zone (and required to operate in smoke exhaust mode now) as well as the make-up air dampers are set to OPEN.

The above illustrates the importance of minute planning and a precise definition of all possible scenarios as early as during the system design stage.

Once this type of combination damper has gained building supervisory approval, the approval documentation of fan manufacturers may soon contain a paragraph such as the following: “Smoke exhaust fans may be utilized for ventilation duty if the duct system is equipped not with smoke exhaust dampers, but with approved combination dampers capable of exercising the function of both a fire damper and smoke exhaust damper. Same applies in smoke exhaust systems without damper technology, e.g. for the direct extraction of spent air from industrial workshops”.

It is important in this context that the combination damper should always be planned in conjunction with a smoke exhaust system. All associated components such as smoke exhaust ducts and their mountings must be rated accordingly. A combination damper cannot be fitted in a ventilation system to operate the latter for smoke exhaust purposes (Fig. 6).

Although the term “cold smoke” has recently gained currency, e.g. in connection with sprinkler protection, a ventilation system can never serve smoke exhaust purposes. Since neither the term nor the associated equipment are conclusively defined anywhere, the use of a ventilation system for smoke exhaust purposes lacks any technical foundation.

Summary

The system type described above, in conjunction with a safe and certified combination damper, will greatly help to bring down capital outlay. It makes it easier for operators and investors to raise the safety standard of buildings within a more favourable cost range and will save human lives effectively in a worst-case event.

Glossary

Combination damper: A combination smoke exhaust damper which can be equally used for ventilation and smoke exhaust purposes. (No standardized terminology exists to date). In Germany, the abbreviations “Kombi-EKR” or “RKU” are used for these devices.

Extraction of “cold” smoke: This term does not derive from any accepted standard or code. No uniformly defined temperature range is stated anywhere in the literature. The concept is often used in the context of smoke extracted from building areas following sprinkler activation. It must not be mixed up with smoke exhaust technology. Only the sausage, ham and meat smoking industries have filled the term with physically documented meaning, referring to smoke temperatures between 20 and 35° C (source: Rahn, Eichelberger Co.)

Fire damper: A damper designed to provide building safety by closing off the fire-affected zone (compartmentization principle). Referred to as “BSK” (Brandschutzklappe) in the context of German standards and codes.

Mechanical smoke exhaust system: A smoke exhaust system is said to be “mechanical” wthen relying on a drive motor to perform its functions (e.g. fans). Such systems are designated “MRA” (maschinelle Rauchgasabzugsanlage) in German engineering terminology.

Natural smoke exhaust system: A natural smoke exhaust system is one whose extraction function is based solely on the thermal buoyancy effect (e.g, relying on domelights or louvers). In German-speaking countries, the abbreviation “NRA” (natürliche Rauchgasabzuganlage) is used for such systems.

Smoke: Depending on the cause of the fire and the type of burning material, smoke may contain noxious substances which enter the human body as we breathe and damage the surfaces of the lungs. For instance, the combustion of plastic facing or paneling products may result in the formation of carbon monoxide, hydrochloric acid or cyanide compounds. A headache is the typical initial symptom, but effects may include loss of consciousness or death as intoxication progresses.

Smoke exhaust damper: Damper performing smoke extraction functions and designed for use in a smoke extraction system. Referred to as “ERK” (Entrauchungsklappe) in the German typology.

Smoke/heat exhaust system (SHE): Referred to as “RWA” (Rauchwäremeabzugsanlage) in a German standards and design context.