Gemini

NTNU

SINTEF
Publications
Gemini index
Index

Tunnel filters make fire rescue work easier

Christina Benjaminsen
Photo: NBL

Electrostatic filters, originally installed to remove asphalt dust, have proven to be extremely useful when fires break out in tunnels. The filters absorb the soot particles and improve visibility for evacuation and rescue work.

Tunnel fires are critical and dangerous situations. Smoke often hinders efficient evacuation and fire fighting efforts.

Norway has among the most tunnel metres per person of any country in the world. This makes the transport system more efficient and reduces the strain on the environment, but it also increases the problems related to fires in tunnels. Comprehensive international research concerning security in tunnels is currently in progress, and the Norwegian Forensic Laboratory at SINTEF is heavily involved.

"Fires in tunnels can be critical and directly life threatening," says senior scientist Kristen Opstad. "Fires can be frightening on their own, but in practice it is the emission of smoke which first creates critical situations."

In the worst case scenario, bad visibility in a tunnel makes it impossible to remain in the tunnel and makes evacuation and rescue work extremely difficult. Therefore, this work should begin as soon as possible, especially in larger fires. What happens in the first 30 minutes of a critical fire ultimately determines the success of a rescue operation.

It is during this phase that electrostatic filters are so useful, according to Opstad. "Burning vehicles emit large amounts of smoke and electrostatic filters absorb a lot of the soot particles which are generated."

The filters don't reduce the fire or absorb poisonous smoke, but they improve the visibility to such a degree that evacuation and rescue work can be carried out. The

Hell Tunnel near Trondheim and Oslo's Ekeberg Tunnel are among the first Norwegian tunnels to have the filters installed.

The effect charted

Statens Vegvesen (the Norwegian road authority) has commissioned the SINTEF Group, which is located in Tiller, to conduct laboratory simulations as well as full-scale research in the Ekeberg Tunnel, to chart the effect of electrostatic filters in tunnel fires.

The laboratory research was carried out with the help of a test rig, which consisted of a steel cylinder, 20 metres long and 60 cm in diameter. An electrostatic filter was mounted some distance inside the cylinder along with instruments to measure smoke density, visibility, poison contents, and energy conversion.

A fire source was connected to one end of the cylinder and the smoke produced was sucked through the cylinder and filtered before finally disappearing into a smoke hood.

The fire source used in the research simulation, consisted of heptane or heptane as a supplement to smoke-producing materials typically found in vehicles. Heptane consists of pure hydrocarbons and, to a large degree, gives the same reaction as a petroleum-based fire. The analysis, which was carried out on the smoke and dust which was accumulated in the hood, showed that the filter had a positive influence on the visibility. During the tests, the conditions improved on average by 70%.

Full-scale on-site experiments were carried out in the Ekeberg Tunnel in Oslo. A VW Passat was filled with 26 car tyres and ignited using petrol. After a few minutes the car was completely enveloped in flames and a large amount of smoke completely filled the surrounding tunnel area. After 10 minutes the fire had been extinguished, but smoke was still being produced. The scenario was followed by four video surveillance cameras, which measured the air visibility. The result from this fire research confirmed the results from the laboratory research.

Three-part system

The filter is divided into three connecting units, each with its own function. The air in the contaminated part of the tunnel is first sucked up in a separator. This sorts out the coarse parts, such as rubbish, pieces of asphalt and soft drink bottles. Afterwards, the remaining air passes through a mechanical filter which removes smaller loose substances such as sand and pebbles. Finally, the remaining gasses and dust particles, with a magnitude of 0-10 μ, are sucked into the filter, where they are charged with the help of the high current. These particles are attracted by a plate, which has the opposite charge, and are collected here.

The filters start automatically. The contamination in the air is measured using an infrared beam. This communicates with a sensor which starts the filters when necessary.

Limitations

The laboratory tests and on-site research both showed that an improvement in visibility was considerable when the visibility was 10 metres or more. When the visibility was less than 10 metres, however, the effect was less or non-existent.

The tests also showed that the filter's saturation point for absorption is reached after it has been in operation for about 30 minutes. Cleaning then becomes necessary.

Contact at SINTEF: Kristen Opstad
Tel.: +47 73 59 10 72
E-mail: Kristen.Opstad@energy.sintef.no

Gemini fakta

Norwegian Product

The electrostatic filters are developed and produced in Norway by the Oslo-based firm Clean Tunnel Air - International (CTA).

The filters are made of aluminum and non-corrosive steel. The cables and mains system, which are insulated with ceramic material, have a high-voltage tension so there is no danger of short circuiting or flash fires.

According to the producer, adapting the filter to a tunnel is no problem either. The filters are supplied as standard modules and assembled according to the requirements. Installation requires an increased tunnel height, but this significantly reduces the demand on resources compared to the alternative air cleaning system "Bypass", which consists of a separate parallel ventilation tunnel with jet fans.

The tunnel security system has generated international interest for its technical safety and economic value.

The filters have recently been installed in the Elbe Tunnel in Germany, while several tunnels in South Korea are next in line.