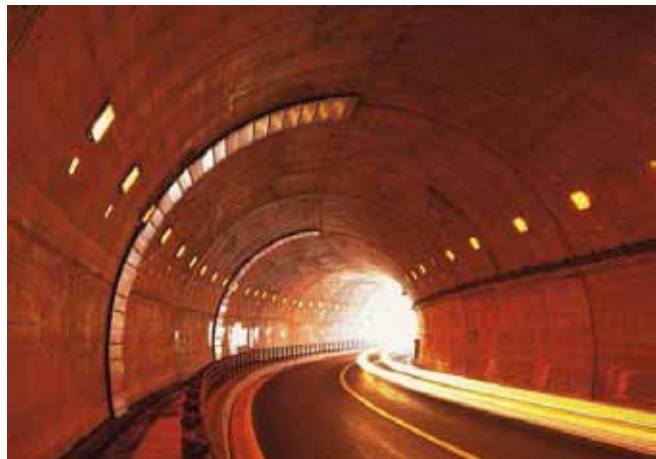


# Application Note

## Gas and Fire Detection in Tunnels

### Introduction

A tunnel is a confined space which may require a controlled atmosphere to guarantee a safe and healthy environment for temporary transit. The air pollution basically comes from the passing through traffic. Therefore one can differentiate tunnels based on their source of emission: there are road traffic tunnels, railway tunnels, utility tunnels and tunnel construction. These different



applications have different requirements concerning which gases to be monitored and which gas monitoring technology to be applied. Besides explosion protection from combustible gases there is the potential hazard of accumulation toxic gases. The most common counteraction is controlling the ventilation and warning of danger.

Further more the detection of open fire and flames is a very important issue and in the focus of many safety revamps. Fire in tunnels due to recent accidents is the most deadly hazard reported in the past.

### Market segments

- Traffic and Transportation
- Building and construction
- Utility management

## Tunnel boring, construction

The construction phase is a special application with special requirements. Tunnel boring machines (TBM) are an expensive asset which needs to be protected and down-time is costly and has to be avoided whenever possible. Some sediment may contain natural gas, basically methane ( $\text{CH}_4$ ), which will disperse into the tunnel when set free. The methane can form an explosive atmosphere when diluted with the air in the tunnel atmosphere. A spark or a hot surface could potentially ignite the cloud. To prevent such explosion infrared hydrocarbon detectors monitoring for methane are installed in order to switch-on countermeasures.



Natural gas can also contain a certain amount of hydrogen sulfide ( $\text{H}_2\text{S}$ ).  $\text{H}_2\text{S}$  is a toxic gas with a low limit value. The human nose can only smell  $\text{H}_2\text{S}$  in very low concentrations and only for a limited time. For dangerous high concentrations the sense of smell is insensitive. The  $\text{H}_2\text{S}$  detection is done with electrochemical sensors. They are sensitive and suitable for this application. The detectors will alert workers from toxic gas emissions and increase ventilation rate.

Early fire detection on the TBM can be achieved by carbon monoxide (CO) detectors measuring in the lower parts-per-million (ppm) range. Even smoldering or overheated parts start to emit CO and could be detected before an open flame is developing. Open fire and flames are detectable by optical flame detectors or CCTV flame cameras.

If an air caisson or overpressure system is been used at the TBM a gas monitoring system will measure the oxygen ( $\text{O}_2$ ) and carbon dioxide ( $\text{CO}_2$ ) concentration in the pressurized area. Based on the physiological requirements volumetric or partial pressure measurement of oxygen concentration can be chosen from Dräger sensors.



Drilling and blasting construction sites could have exhaust emissions from diesel power generators and diesel vehicles. Nitrogen oxide (NO) or nitric dioxide ( $\text{NO}_2$ ) are typical toxic emissions present with limit values to be monitored. The ventilation need can be controlled by nitric oxide measurement equipment to assure a healthy workplace and protect workers.



## Traffic tunnel

Many road traffic tunnels use active ventilation to remove the exhaust from the driving through vehicles. If carbon monoxide from gasoline-motor-vehicles is of concern a CO gas monitoring system can provide an input for the ventilation control. Such systems are been installed worldwide in short underpasses up to long tunnels.

If an effective amount of diesel vehicles pass though the tunnel a nitrogen oxide or nitrogen Dioxide monitoring (NO or NO<sub>2</sub>) can be requested in addition.

Fuel can leak from vehicle tanks or been spilled during an accident. The liquid fuel could enter the water draining system besides the road. The liquid is flammable and the generated hydrocarbon vapours are potentially combustible. IR detectors for hydrocarbon vapours will detect and alarm such a situation in traffic or railway tunnels. These combustible vapour requires immediate action to prevent a fire and an explosion.

Open fire and flames on vehicles, load or after accidents are detectable by optical flame detectors or CCTV flame cameras in regular distances.

## Challenge

A tunnel is an extreme environment with challenging requirements. Moving traffic and the ventilation cause a strong airflow swirling up dust and gas clouds. Dirt, dust and splash water has to be retained by suitable protection not to contaminate the sensing devices. Dust and splash guards have to be service regularly to keep the performance up.

The monitoring devices have to be vibration resistant and should be able to handle fast air-pressure fluctuations generated by the passing vehicles or trains.

The gas detectors are often mounted on the tunnel side walls in small niches to be protected from damage. The distance between measuring points is about 300 meter. It is advantages to make the detectors accessible from the maintenance or escape tunnel for ease of maintenance and calibration on the detectors.



## Dräger Solution

PIR 7000 optical infrared detector for methane monitoring

PIR 7200 optical infrared detector for carbon dioxide

PIR 3000 optical infrared detector for methane monitoring

PEX 3000 Catalytic bead detector for methane

Polytron 3000/7000 Polytron XPTOX with DrägerSensor for  
carbon monoxide CO, hydrogen sulphide H<sub>2</sub>S, nitrogen oxide NO, nitric dioxide NO<sub>2</sub>  
and oxygen O<sub>2</sub>

DF 1300 IR, DF 1700 UV, DF 2300 UVI optical flame detectors

DF 5000 CCTV imaging camera for flame detection

## Dräger Advantage

- IP65 rated transmitters and sensors
- IR transmitter in SS316
- Corrosion resistance
- Hydrophobic/dust filters
- Fast responding to gas exposure
- Digital interface for long distances with multidrop capabilities HART, LON, Profibus, FF
- Two wire 4...20 mA including supply for about 1000m distance
- Long lasting electrochemical sensors
- Most reliable flame detection by CCTV camera



## References

Herrenknecht AG Germany; Tunnel boring: all gases.

DURAG Group Hamburg Germany: CO Monitoring in tunnels.

Herrentunnel Lübeck Germany: CO detection Polytron 3000.

Traffic Tunnels in Norway, Netherlands/Belgium, France, Germany, Spain, US



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