

TUNNEL VENTILATION - A CFD PERSPECTIVE

Enhancing Tunnel Ventilation and Fire Safety with Advanced CFD Tools



Tunnels, especially in alpine regions, have long been symbols of engineering innovation. However, several incidents have exposed critical shortcomings—particularly in fire scenarios—where poor ventilation has resulted in tragic outcomes.

Why Traditional Ventilation Methods Are Not Enough

In the past, natural airflow caused by vehicle or train movement was thought to be adequate. Today, that assumption no longer holds. Fires in tunnels demand controlled smoke management and fresh air circulation, especially in two-way tunnels where fans and extractors must be carefully configured to avoid mixing of smoke with the fresh air in the evacuation paths. It requires dedicated 3D fluid flow studies for smoke and air movement, keeping in mind the presence of train or vehicles and the boundary conditions at the portals and shafts.

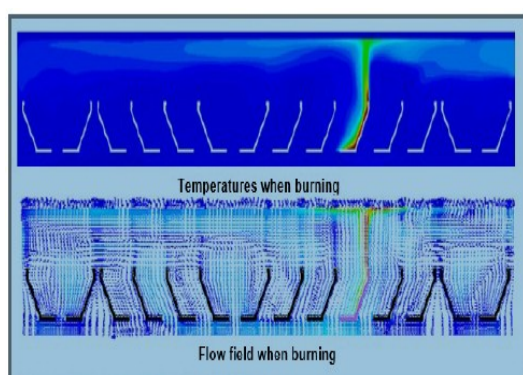
The Role of Weather and Tunnel Geometry

Tunnel safety design is complex in hilly terrains where tunnel portals are often at different altitudes and at the different sides of the hill. Weather conditions at each portal can vary significantly, impacting air pressure and natural airflow. In such cases, fans and extractors have to function taking account of the different pressures and airflow conditions at the two portals. Safety protocol for fan settings will have to be dynamically adjusted to suit the weather forecast.



High Fire Loads Demand Extra Caution

The increasing volume of traffic—often including fuel container trucks—demands heightened safety considerations in tunnel design. In the event of a major fire, particularly one exceeding 200–300 megawatts, the intense heat can cause irreversible damage to the surrounding rock structure. One of the fundamental safety criteria in tunnel engineering is how quickly the tunnel can be restored to service after an accident.



While urban tunnels may offer alternative routes during closures, tunnels in mountainous or remote regions often serve as the only viable passage. These tunnels may also hold strategic importance—such as during winter months or in border areas. In such scenarios, damage to the rock surrounding the tunnel could make reconstruction impossible, forcing a permanent rerouting that may not even be feasible in rugged terrain.

Fluidyn's Expertise in Tunnel Ventilation

With over 25 years of experience, Fluidyn has provided solutions for both urban and mountainous tunnels. Our in-house developed software **Fluidyn-VENTUNNEL** offers advanced 3D CFD modeling for optimizing tunnel ventilation based on traffic and environmental conditions.

For fire safety design, **Fluidyn-VENTFIRE** models smoke movement and heat radiation from fires ranging between 6 MW and 300 MW. It supports design strategies to ensure:

- Safe evacuation path planning
- Preservation of tunnel integrity
- Faster post-incident reusability.

Stay tuned for our next webinar on Tunnel Ventilation, coming this September! Dive deep into design strategies, safety challenges, and simulation insights.

For consultations, software demos, or technical support, contact us at contact@fluidyn.com or visit www.fluidyn.com

Upcoming Webinar on Process Optimization:

Mathematical simulation tools are the backbone of modern industrial process & equipment design across all sectors- Chemical, Pharmaceutical, Mechanical, Energy, Construction, Aerospace, Defence and more.

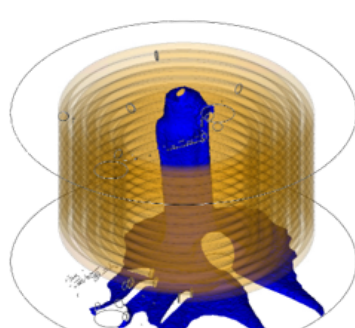
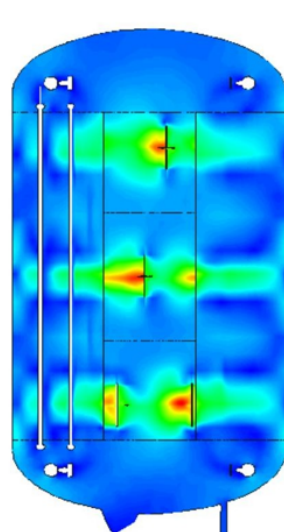
Fluidyn is organizing a technical webinar on the advanced mathematical simulation software in modern industrial process and equipment design. Our eminent panel of experts will share practical insights, real-world case studies, and demonstrate how simulation-driven design can drive efficiency and ensure regulatory compliance while minimizing risk and cost.

Webinar Date: 14th August 2025

Time : 3:00 PM to 4:30 PM IST

- Process/ Equipment Design by coupled Flow & structural dynamics modelling.
- Custom models for distillation column, spray dryers, condensers/ evaporators & separators.
- Root cause analysis through Simulation & AI - Failures, accidents, Fire, Explosion.

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Fluidyn attends Air Pollution Roundtable - 'Advancing Clean Air Solutions' at Delhi

Fluidyn is honoured to have participated as a technical panellist at the Roundtable on 'Air Pollution – Advancing Clean Air Solutions', organised by ASSOCHAM and WRI India on 24 July 2025 at New Delhi. Mr. Krishnaprasad, Director-Envirorisk, Fluidyn shared industry-level perspectives on air pollution and potential solutions, policies, and frameworks for its mitigation. Also strategies for enabling clean construction practices were discussed.

The closed roundtable gathered experts and decision-makers from Central and State Government offices, Industry partners, Technical Institutions, Solution Providers and Innovators.



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