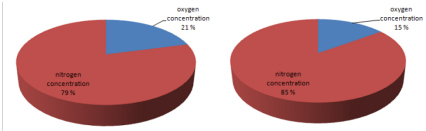
Hypoxic air technology for fire prevention

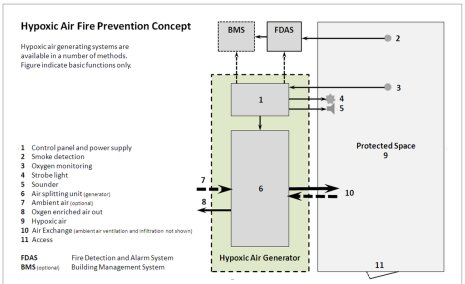
Hypoxic air technology for fire prevention, also known as **oxygen reduction system**, is an active fire protection technique based on a permanent reduction of the oxygen concentration in the protected rooms. Unlike traditional fire suppression systems that usually extinguish fire after it is detected, hypoxic air is able to prevent fire. In a volume protected by hypoxic air, a normobaric hypoxic atmosphere is continuously retained: hypoxic means that the partial pressure of the oxygen is lower than at the sea level, normobaric means that the barometric pressure is equal to the barometric pressure at the sea level. Usually a 5% of oxygen molecules contained in the air is replaced by the same amount of nitrogen molecules: as a consequence a hypoxic atmosphere containing around 15 Vol% of oxygen and 85 Vol% of nitrogen is created. In a normobaric hypoxic environment, common materials cannot ignite or burn[1]. Thus, considering the fire triangle, a fire cannot occur because of the lack of oxygen. The phenomena of fire prevention at higher oxygen concentration than the oxygen concentration required for extinguishing of established fire, has been observed and exploited for decades. Igor (Gary) Kotliar was the first to extensively explain the physics and to devise premixed hypoxic air for improved safety of applications for fire prevention, from 2001 onwards.



Composition of normal air vs. hypoxic air

Design and operation

Air with a reduced oxygen content is injected to the protected volumes to lower the oxygen concentration until the desired oxygen concentration is reached. Then, because of air infiltration, the oxygen concentration inside the protected volumes rises: when it exceeds a certain threshold, low-oxygen air is again injected to the protected volumes until the desired oxygen concentration is reached. Oxygen sensors are installed in the protected volumes to monitor continuously the oxygen concentration.



Hypoxic Air Fire Prevention system - Concept

The exact oxygen level to retain in the protected volumes is determined after a careful and accurate assessment of materials, configurations and hazards[2]. Tables listing ignition-limiting oxygen thresholds for some materials are available in the fire safety literature. Alternatively the ignition-limiting threshold is determined by performing a proper ignition test described in BSI PAS 95:2011 - Hypoxic air fire prevention systems. Specification.[3]

Smoke detectors are installed in protected volumes because, similar to gas suppression systems, hypoxic air does not prevent smoldering and pyrolyzing processes.

Air with low oxygen concentration is produced by hypoxic air generators, also known as air splitting units. There are three different types of hypoxic air generators: membrane-based, PSA-based and VSA-based ones. VSA-based hypoxic air generators have usually a lower energy consumption compared to PSA-based and membrane-based ones. Hypoxic air generators can be located inside or ouside the protected rooms. Hypoxic air systems can be integrated with the building management system and can include systems to recover the heat generated by the hypoxic air generator that, otherwise, would be wasted[4].

Air with low oxygen concentration is transported to the protected volumes through dedicated pipes or, more simple, via an existing ventilation system. In the latter case, dedicated pipes or ducts are not required.

Combined use of hypoxic air for fire prevention

Hypoxic air fire prevention systems can also be used for puproses other than fire prevention, for example:

- Training
- Health
- Preserving artefacts and objects from degradation or oxidation
- Preserving food from deterioration.

Combining fire prevention, indoor climate and reduction of artefacts/food degradation is a completely new approach for a fire safety system.

Applications

The benefit to prevent a fire instead of suppressing it makes hypoxic air suitable especially for applications where a fire would cause unacceptable damages and even fire suppression is not acceptable. Unlike traditional fire suppression systems, dedicated pipes or nozzles are not necessarily required so applications where the installation of a traditional firefighting system would pose severe problems can be easily protected against fire with hypoxic air.

Hypoxic air for fire prevention suits best for:

- Data centers / ICT facilities
- Storages for high value items
- Archives
- Freezer and cool storages
- Large warehouses
- Heritage applications

The reduction of artifacts degradations and food deterioration is a plus for applications like food warehouses, storages and archives.

The inherent simplicity of hypoxic air systems facilitates integration of sustainable building design and fire protection engineering.

Effects on health

Hypoxic air is considered to be safe to breathe for most people[5]. Medical studies have been undertaken on this topic. Angerer and Novak's conclusion is that "*working environments with low oxygen concentrations to a minimum of 13% and normal barometric pressure do not impose a health hazard, provided that precautions are observed, comprising medical examinations and limitation of exposure time*"[6]. Küpper et al.[7] say that oxygen concentration between 17.0-14.8% does not cause any risk for healthy people by hypoxia. It also does not cause risks for people with chronic diseases of moderate severity.

Usually the oxygen level in hypoxic air applications is more or less the same to the oxygen level at 2700 m of altitude or in aircraft cabins.

Hypoxic air is to be considered clean air and not contaminated air when assessing oxygen depletion hazards.

Applicable standards and guidelines

- BSI PAS 95:2011 - Hypoxic air fire prevention systems. Specification[8]
- VdS 3527en:2007 - Inerting and Oxygen Reduction Systems, Planning and Installation [9]

External links

- Hypoxic Air Venting for Protection of Heritage [10]
- Test Methods for Hypoxic Air Fire Prevention Systems and Overall Environmental Impact of Applications [11]
- Fire Protection Requirements for ICT rooms - Best Practice Document [12]

References

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[3] "PAS 95:2011 Hypoxic air fire prevention systems. Specification" (http://shop.bsigroup.com/ProductDetail/?pid=000000000030203949). BSI. .

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[11] http://www.cowi.no/SiteCollectionDocuments/cowi/no/menu/Rapporter/Hypoxic_air_fire_prevention_systems.pdf

[12] http://www.terena.org/activities/campus-bp/pdf/gn3-na3-t4-ufs104.pdf

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