newsletter

Combustion products

In Germany alone, according to the loss statistics, over 200,000 fires occur in a year, a figure corresponding to a fire every two or three minutes. Over EUR 1 billion are lost through fire damage to people's homes, and quite apart from the personal injuries involved, the substances generated by combustion themselves present a significant hazard to the environment.

Fires and their reaction products

In Germany alone, over 600 people a year lose their lives in fires, with over 6,000 others having to live with the consequences of injuries sustained in fires for the rest of their lives. Burns are rarely the cause of the victims' deaths. Four out of every five die from the effects of the substances fires generate. In most cases, the potentially fatal hazard is attributable to the rapid spread of smoke containing combustion products, which may have acutely toxic (poisonous) effects.

In investigating and evaluating fire damage, not only the risk to human beings is to be considered, but also the risk of damage to the environment as a consequence of the fire.

Pollutants in the smoke

The process of combustion is a complex one both chemically and physically, and is influenced by a large number of factors, among them the nature of the material that is combusted and the conditions prevailing in the environment. The energy discharged by combustion can result in the generation of further products of pyrolysis and "cracking", from which new compounds are created in the flames. It follows that the largely uncontrolled combustion of what were originally unproblematic substances can give rise to many different products, some of them toxic, environmentally hazardous or corrosive in their effects.

Quite apart from the damage done by the flames and heat emanating from the primary fire scenario, the combustion products often have far-reaching effects on human beings, animals and plants, as well as on buildings, equipments and inventory, not to mention air, land and water.

As well as insoluble particles (soot and ash) and evaporated liquids (water used in fighting the blaze, liquid raw materials and products) fumes from fires contain predominantly gaseous substances. The composition of the fumes from the fire and their constituent elements vary considerably depending on the type of flammable materials and the conditions prevailing at the time of the fire, being influence particularly by the supply of oxygen and the temperature of the blaze.

Combustion products are generally divided, on the basis of their chemical nature, into two categories – organic and inorganic.

Inorganic combustion products

Carbon dioxide (CO_2) is produced by the combustion, in oxygen from the air, of organic matter containing carbon. It presents a hazard to living beings in that it displaces oxygen from the air breathed in and hence has the effect of suffocating them. Being heavier than air, the gas accumulates close to the ground, so that, in the event of a fire, a space fills up with carbon dioxide from the ground upwards and so cuts off the escape route.

Carbon monoxide (CO) is produced from combustion in the absence of oxygen. The gas itself is toxic and inhibits the uptake of oxygen in the blood. Lacking any odour or taste, human beings are practically incapable of detecting its presence. After only a few breaths, CO brings on unconsciousness and its toxicity renders death an inevitability.

Hydrogen chloride (HCl) and its precipitation (hydrochloric acid) can be produced by the burning of materials containing the element chlorine, of which PVC is an example. Hydrochloric acid is highly corrosive on contact with the skin and irritates the eyes and the mucus membranes of the respiratory passages. Depending on relative humidity, hydrogen chloride can act on metallic surfaces to trigger a progressive process of corrosion on buildings, equipment and machine parts.

Oxides of nitrogen (NO_x) are generated by the incineration of products containing nitrogen, such as melamine resin (in chipboard) and isocyanates (present in foam insulation). When combined with water (e.g. water used to extinguish fires), nitrous oxides produce acids (nitric acid) which are both corrosive and toxic.

Sulphur oxides (SO_x) are produced by the burning of materials containing sulphur, one example being vulcanised rubber. When combined with water (such as the water used to extinguish fires), sulphur oxides produce acids (sulphuric acid) which are both corrosive and toxic.

Organic combustion products

Polycyclic aromatic hydrocarbons (PAHs) are typically produced by the incomplete combustion of any organic material in the absence of oxygen (pyrolysis). Many PAHs are categorised as carcinogenic, mutagenic substances that impair fertility and have embryotoxic effects.

Dioxin: Polyhalogenated dibenzodioxins and dibenzofuranes (PHDDs/PHDFs) result from the incomplete combustion and pyrolysis of compounds containing halogens in combination with organic substances (e.g. through the burning of PVC). Dioxins can cause damage to the skin (chloracne), and impair the functioning of the immune and nervous systems. Consequential damage resulting from dioxins can result from the accumulation of it in body fat, manifesting itself in liver damage, impaired fat metabolism and cancers.

Aromatic compounds: Aromatic hydrocarbons occur in the form of benzene, toluene, styrene, aromatic oxidation products (phenol) and halogen derivatives (chlorobenzene). In smaller concentrations, aromatic compounds are generally irritating in their effects, becoming narcotic as the concentration increases. Benzene is toxic to the blood and nervous system. Aromatic compounds can be a cause of chronic illness. They can cause lasting damage to the bone marrow, blood and nervous system. There is evidence of benzene having mutagenic and carcinogenic effects.

Special hazards from the burning of plastics

Plastics are crucial in assessing the hazard potential of products from the combustion of consumer items in daily use (such as furniture, household articles, packaging materials, etc.) or of building materials (insulation material, etc.). Plastics that present no hazard whatever in day-to-day use often manifest characteristics that can markedly exacerbate the already negative effects of a conflagration when it occurs. In the event of a fire, the combination of plastics' typical characteristics can significantly accelerate and intensify the fire to a greater degree than other materials.

It particularly needs to be borne in mind that, in the qualitative assessment of the reaction of plastics to fire, the category "fire resistant" is frequently misunderstood as being the same as "non-combustible", which can result in a technically quite erroneous assessment. In point of fact, the term "fire resistant" should in any case be translated as "combustible".

Further fire hazards

Some fumes from fires are themselves inflammable gases. In this case, there is the risk of their exploding at certain stages in a fire's progress. Under certain environmental conditions the ignition of the fumes can have an effect similar to that of an explosion, resulting in a backdraft or flash-over. If this occurs, a total loss can generally be assumed. As the affected area is usually regarded as ruined, the fire brigades' rescue efforts will from then on prioritise the protection of neighbouring buildings.

Information for the underwriter

The effects of smoke and of the combustion products it contains are often underestimated. As well as being hazardous to human health and to the environment, combustion products present a considerable and potentially catastrophic risk of loss of material assets or damage to them.

One well-known example of this was a fire in a warehouse in which chemicals for agricultural use were stored (El Dorado Chemical Company, USA), when 570 tonnes of ammonium nitrate combusted and the resulting toxic gases and risk of explosion meant that, as a first step, 1,000 people had to be evacuated from an area of five square miles, followed, as a second step, by the evacuation of 70 thousand more.

Smoke from fires carries combustion products and their corrosive and toxic elements a long distance from the seat of the fire – up to sixty miles away in the case referred to. Contamination with combustion products can result in repair costs well in excess of the financial losses consequent on the primary fire damage.*

** Ref.: "Brandfolgeprodukte" ("Combustion products") in "S+S Report" (issue 12/2009).*

Contact

AssTech GmbH
Postfach 1211
85766 Unterföhring bei München
Telephone + 49 89 3844-1585
Telefax + 49 89 3844-1586
info@asstech.com
www.asstech.com