Protection, prevention and environmental impact of fire in a tire storage

SNCP experience feedback report

Fire in a tire storage facility equipped with a sprinkler system

Environmental impact on air and water

Abstract

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Réf : SNCP/REX-ENV/03-2007/S

Analysis of smoke and extinguishing water from a fire in a tire storage facility equipped with an automatic sprinkler system.

A series of extinction tests[1] on tire storage facility fires and a study on atmospheric smoke dispersion were carried out by SNCP (the French Association of Rubber Manufacturers) between 2005 and 2007 in order to update and enhance knowledge concerning fire hazard management and associated potential environmental impacts. These tests[A] and study[B], performed by CNPP (the French National Centre of Prevention and Protection) provided information on smoke and extinguishing water from fires in tire storage facilities.
The object of this document is to summarize available information on fires in tire storage facilities controlled by an automatic water extinguishing system (sprinkler type).

I. *Tire thermal characteristics*

Table 1: Representative tire thermal characteristics

	Average
Flash point[2]	280°C
Temperature of inflammation[3]	340°C
Temperature self-inflammation[4]	470°C
Net calorific value[5]	30 MJ/Kg

Notes :
- values in table 1 result from tests[C] performed in 1992 by CNPP at the request of SNCP.
- the net calorific value, is a value by excess.

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(1) Mid-scale and full-scale tests.

ISO 8421-1 Standard:
(2) Minimum temperature where, in definite conditions, a liquid produces enough inflammable vapors to produce a flame when approaching a source of ignition.
(3) Minimum temperature where liquid's vapors (or by extension a heated solid which would produce vapors) keep on burning.
(4) Minimum temperature to which fluid vapors (or by extension a heated solid which would produce vapors) can blaze up without providing any energy.

(5) NF M07-030 Standard :The net calorific value is the quantity of heat that the unit of weight or volume of acombustible can release, when complete combustion occurs. It is expressed in Megajoules/kg or British Thermal Unit/pounds (MJ/kg or BTU/lbs) for solids and liquids and in Megajoules/m^3 for gases (MJ/m^3).

2. *Smoke*

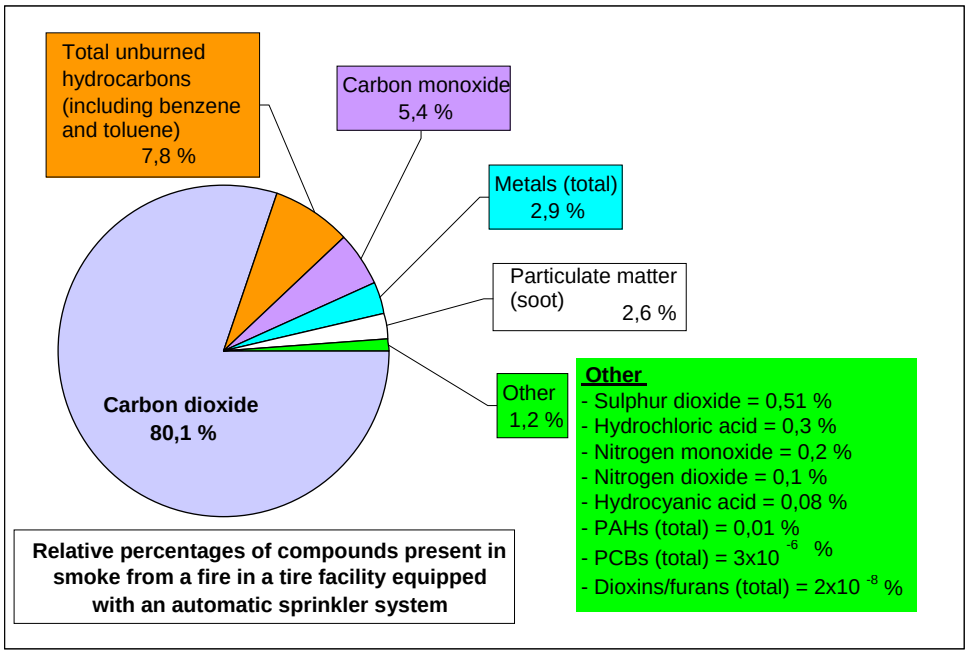
Characteristics of smoke emitted during a fire in a tire storage facility controlled by a sprinkler system are given in the table below.

2.1 Smoke characteristics

Table 2: Average smoke composition at the emission point (fire controlled by sprinkler)

Compounds assessed	Production rates (g/kg of burnt tires)
Carbon dioxide	626
Carbon monoxide	42
Nitrogen dioxide	0,75
Nitrogen monoxide	1,6
Sulphur dioxide	4
Hydrocyanic acid	0,6
Hydrochloric acid	2
Total unburned hydrocarbons (including benzene and toluene) (in toluene equivalents)	61
Particulate matter (soot)	20
Metals (total) (Aluminum + Zinc > 99,9%)	22,74
PAHs[1] (total)	0,093
PCBs[2] (total)	$2,16 \times 10^{-5}$
Dioxins/furans (total)	$1,9 \times 10^{-7}$
Compounds assessed but not detected (< analytical detection threshold)	
Formaldehyde, Hydrobromic acid, Acrolein, Ammonia, Tin	

Diagram 1: Relative percentages of compounds present in the smoke at the emission point (fire controlled by sprinkler)



[1] HAPs: Polycyclic aromatic hydrocarbons
[2] PCBs: Polychlorinated biphenyls

Composition of smoke depends directly on the conditions of combustion:

- temperature directly influences the proportion of carbon monoxide (CO): temperature rises => quantity of CO decreases ;
- oxygen contribution has a direct influence on the quantity of soot and CO: more oxygen provided to combustion => quantity of CO increases and soot decreases.

A tire fire controlled by sprinkler system is characterized by greyish smoke with high levels of water vapor and low levels of soot, which for the most part is mechanically sprayed down by the sprinklers into the extinguishing water. Automatic spraying serves to cool the fire to a large degree, and compounds resulting from incomplete combustion (unburned hydrocarbons and carbon monoxide) are produced at a higher rate than for uncooled fires (uncontrolled fires).

As for any fire, various compounds are emitted, including irritating, asphyxiating and toxic agents. According to current knowledge, smoke emitted during a fire controlled by sprinklers is composed of:

- mainly carbon dioxide,
- in small quantities, unburned hydrocarbons, carbon monoxide, soot (particulates) and certain metals (zinc and aluminum),
- in very small quantities, sulphur dioxide, nitrogen compounds (nitrogen monoxide, nitrogen dioxide, hydrocyanic acid), hydrochloric acid and PAHs,
- in trace quantities (concentrations comparable to those of in ambient air) PCBs and dioxins/furans.

Aside from the presence of sulphur dioxide, smoke from tires in tire facilities is thus similar to that from polymer fires. Tires are in fact comparable to a fuel such as coal.

2.2 Impact of smoke

As for any incomplete combustion of hydrocarbons, smoke from fires in tire storage facilities can be hazardous if inhaled at high concentrations. This smoke may result in acute or sub-acute intoxications, mainly due to the asphyxiating and irritating substances it contains:

- irritation and blocking of upper respiratory and pulmonary tracts by soot particles,
- suffocation caused by acid vapors (especially sulphur and nitrogen compounds),
- intoxication by carbon monoxide, or by the interaction between carbon monoxide and hydrocyanic acid.

Taken together, these phenomena may lead to coma or death by asphyxiation during intense exposure.

On the other hand, the quantity of smoke emitted during a fire in a tire storage facility controlled by a sprinkler system is weak and would have no notable effect on the exposed population. **The dispersion of the smoke would thus not require establishing a danger zone around the facility**. In the case of the use of ESFR sprinkler system (extinguishing mode), the quantity of smoke emitted during the fire is even weaker and the potential impact of the smoke is limited to the inside of the storage facility.

3. *Extinguishing water*

Characteristics of the extinguishing water resulting from a fire in a tire storage facility controlled by sprinkler system appear in table 3.
In the absence of specific regulatory limits for discharge of fire extinguishing water, the concentrations of the various compounds detected were compared to limits for releases into surface water by industrial facilities (French regulation[D] covering restrictions on air and water emissions, waste disposal, chemical storage and soil contamination).

Only three of the detected compounds exceed the authorized release limits into surface waters : suspended solids (SS), chemical oxygen demand (COD) and fluoranthene (PAH). **Note that these release limits are used for daily releases from industrial facilities, while fire extinguishing water is an accidental release for a limited time.**

Thanks to the quick activation of sprinklers, the quantity of tires burning during such a fire is very low. **The quantities of compounds emitted in extinguishing water during a fire controlled by a sprinkler system are overall compatible with the limits established for releases into surface water from facilities (continuous releases).**

Table 3: Characteristics of fire extinguishing waters (fire controlled by sprinkler)

Parameters or compounds assessed	Units	Concentration in extinguishing water	Concentration limits for surface water releases
Basic parameters			
pH	pH unit	6.45	5.5 -8.5
Conductivity	µs/cm	998	Not specified
Suspended solids (SS)	mg/l	**115**	**35**
BOD_5 Biochemical oxygen demand, 5-day	mg/l O_2	23	30
COD Chemical oxygen demand	mg/l O_2	**343**	**300**
Kjeldahl nitrogen	mg/l	10.7	30
Metals			
Mercury and its compounds	mg/l	0.00028	0,05
Zinc and its compounds	mg/l	1.23	2
Manganese and its compounds	mg/l	0.18	1
Aluminum and its compounds	mg/l	0.20	5
Iron and its compounds	mg/l	2.09	5
Anions			
Nitrate	mg/l	3	30
Sulphate	mg/l	111	Not specified
Polycyclic aromatic hydrocarbons (PAHs)			
Naphthalene	µg/l	346	1500
Acenaphthene	µg/l	15.8	50
Anthracene	µg/l	44.4	1500
Fluoranthene	µg/l	**55.7**	**50**
Benzo(b)Fluoranthene	µg/l	7.3	50
Benzo(k)Fluoranthene	µg/l	6.2	50
Benzo(a)pyrene	µg/l	11.7	50
Benzo(g,h,i)perylene	µg/l	2.7	50
Indeno(1-2-3-cd)pyrene	µg/l	7.5	50
Compounds assessed but not detected (< analytical quantification threshold)			
Basic parameters : Total phosphorus, Total hydrocarbons			
Metals : Cadmium, Lead, Nickel, Arsenic, Copper, Tin and their compounds - Total chromium - Chromium VI			
Anions : Cyanide, Fluoride			
Polychlorinated biphenyls (PCBs) : PCB28, PCB52, PCB101, PCB118, PCB138, PCB153, PCB180			

4. *Conclusion*

In the event of a tire storage facility fire controlled by a sprinkler system, smoke emitted in the environment would have neither reversible, irreversible nor lethal effects on a close population, and would thus not require establishing a danger zone around the facility. Furthermore, the discharge levels into surface waters generated by the extinction of such a fire are overall compatible with authorized daily release limits into surface waters for a facility whereas fire extinguishing water is released accidentally, hence occasionally, and for a limited time.

5. *Bibliographic references*

[A] Campagne d'essais concernant l'extinction d'incendie de stockages de pneumatiques. « Essai avec installation d'extinction par sprinkleurs. Analyse des fumées et des eaux d'extinction » - Rapport d'essai n° PE 05 6903-1 – 6/02/2006 – CNPP.

[B] Modélisation de la dispersion atmosphérique des fumées d'incendie pour différents scénarios d'incendie de pneumatiques – Rapport d'étude n° CR 07 7371 – 16/05/2007 – CNPP.

[C] Compte rendu d'essai n°PE 92 4404-P1 «Etude prévisionnelle d'un incendie de stockage de caoutchouc», CNPP – 3/12/1992.

[D] Arrêté ministériel du 2 février 1998 (modifié par l'arrêté du 24/11/2006) relatif aux prélèvements et à la consommation d'eau ainsi qu'aux émissions de toute nature des installations classées pour la protection de l'environnement soumises à autorisation – Journal Officiel de la République Française n° 283 du 7 décembre 2006.