SNCP
SYNDICAT NATIONAL DU CAOUTCHOUC ET DES POLYMÈRES

ETRMA
EUROPEAN TYRE & RUBBER manufacturers' association

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

SNCP experience feedback report

Fire in a tire storage facility lacking a sprinkler system

Environmental impact on air and water

Abstract

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Analysis of smoke and extinguishing water from a fire in a tire storage facility lacking 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 lacking an automatic 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.

[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 a combustible 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*

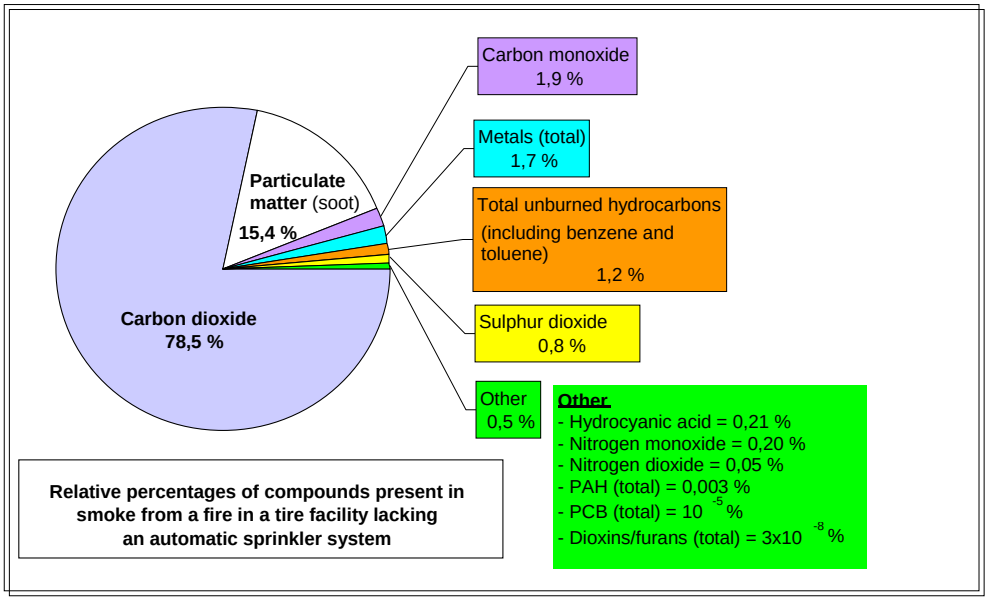
Characteristics of smoke emitted during a fire in a tire storage facility lacking a sprinkler system are given in table below.

2.1 Smoke characteristics

Table 2: Average smoke composition at the point of emission (uncontrolled fire)

Compounds assessed	Production rates (g/kg of burnt tires)
Carbon dioxide	1450
Carbon monoxide	35
Nitrogen dioxide	0,9
Nitrogen monoxide	3,2
Sulphur dioxide	15
Hydrocyanic acid	4
Total unburned hydrocarbons (including benzene and toluene) (in toluene equivalents)	23
Particulate matter (soot)	285
Metals (total) (Aluminum + Zinc > 99,9%)	31,9
PAHs[1] (total)	0,0633
PCBs[2] (total)	$2{,}66 \times 10^{-4}$
Dioxins/furans (total)	$6{,}44 \times 10^{-7}$
Compounds assessed but not detected (< analytical detection threshold)	
Formaldehyde, Hydrochloric acid, Hydrobromic acid, Acrolein, Ammonia, Tin	

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



[1] PAHs: 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 .

An uncontrolled fire involving tires is characterized by thick black smoke due to the high soot level. As for any fire, various compounds are emitted, including irritating, asphyxiating and toxic agents. According to current knowledge, smoke emitted during an uncontrolled fire is composed of:

- mainly carbon dioxide and soot (particulate matter),
- small quantities of carbon monoxide, sulphur dioxide, nitrogen compounds (nitrogen monoxide, nitrogen dioxide, hydrocyanic acid), unburned hydrocarbons and certain metals (zinc and aluminum),
- very small quantities of PAHs,
- trace quantities of PCBs and dioxins/furans, the latter in slightly higher quantities than found in ambient air.

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 risk for exposed population is low** but must nevertheless be supervised if the smoke plume does not disperse or if it is folded back by the wind towards residential areas. A fire generalized throughout an entire tire storage cell can in a “worst case” scenario, in conservative atmospheric dispersion conditions, lead to reversible effects (coughing, respiratory irritation ...) which stop at the end of exposure to smoke.

3. *Extinguishing water*

Characteristics of the extinguishing water resulting from a fire in a tire storage facility lacking a sprinkler installation 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 four of the detected compounds exceed the authorized release limits into surface waters: suspended solids (SS), chemical oxygen demand (COD), phenol index and zinc. **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.**

Table 3: Characteristics of fire extinguishing water (uncontrolled fire)

Parameters or compounds assessed	Units	Concentration in extinguishing water	Concentration limits for surface water releases
Basic parameters			
pH	pH Unit	7.15	5.5 -8.5
Conductivity	µs/cm	1029	Not specified
Suspended solids (SS)	mg/l	**275**	**35**
BOD_5 Biochemical oxygen demand, 5-day	mg/l O_2	9	30
COD Chemical oxygen demand	mg/l O_2	**390**	**125**
Kjeldahl nitrogen	mg/l	9.25	30
Total phosphorus	mg/l	0.3	10
Phenol index	mg/l	**0.8**	**0.3**
Total hydrocarbons	mg/l	1.5	10
Adsorbable organic halogen compounds	mg/l	0.2	1
Metals			
Zinc and its compounds	mg/l	**16.2**	**2**
Manganese and its compounds	mg/l	0.23	1
Aluminum and its compounds	mg/l	0.24	5
Iron and its compounds	mg/l	0.24	5
Anions			
Sulphate	mg/l	144	Not specified
Polycyclic aromatic hydrocarbons (PAHs)			
Acenaphthene	µg/l	0.36	50
Anthracene	µg/l	1.05	1500
Fluoranthene	µg/l	1.65	50
Benzo(b)Fluoranthene	µg/l	0.27	50
Benzo(k)Fluoranthene	µg/l	0.18	50
Benzo(a)pyrene	µg/l	0.49	50
Benzo(g,h,i)perylene	µg/l	0.43	50
Indeno(1-2-3-cd)pyrene	µg/l	0.26	50
Compounds assessed but not detected (< analytical quantification threshold)			
Metals : Cadmium, Lead, Mercury, Nickel, Arsenic, Copper, Tin and their compounds - Total chromium - Chromium VI			
Anions : Cyanide, Fluoride, Nitrate			
Polycyclic aromatic hydrocarbons (PAHs) : Naphthalene			
Polychlorinated biphenyls (PCBs) : PCB28, PCB52, PCB101, PCB118, PCB138, PCB153, PCB180			
BTEX : Benzene, Toluene, Ethylbenzene, Xylenes, (o,m,p) Isopropylbenzene			

4. *Conclusion*

In the event of a generalized fire throughout the totality of a tire storage unit, smoke emitted in the environment would have no irreversible or lethal effects on the exposed population, and would thus not require establishing a danger zone around the facility. Furthermore, of the compounds and parameters assessed in the extinguishing water, only four of them (SS, COD, phenol index and zinc), exceed the authorized daily release limits into surface waters for an industrial facility whereas fire extinguishing water is released accidentally, hence occasionally and for a limited time.

5. *Bibliographic references*

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[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.