VÉDELEM TUDOMÁNY
KATASZTRÓFAVÉDELMI ONLINE TUDOMÁNYOS FOLYÓIRAT

Jozef Svetlík, Linda Makovická Osvaldová

TEMPERATURE ON CAR DOORS EXPOSED TO FIRE – PRE-TEST

Abstract

Fires of passenger motor vehicles are a part of life. They can be seen in the streets at any hour, and most often happen when the vehicle is parked. The article deals with the effects of simulated fire on the structural elements of cars (doors) while recording the temperatures and the flow of radiant heat. The experiment was carried out in a fire room and verified the methodology of evaluating the behavior of car doors under thermal stress caused by a fire from a liquid spill. The results of experiments can serve as a basis for the car fire simulations in both enclosed and open spaces.

Key words: car fire, temperature, experiment

HŐMÉRSÉKLET VIZSGÁLATA A TŰZNEK KITETT AUTÓAJTÓKON-ELŐMÉRÉS

Absztrakt

A személygépjármű tüzek oltása gyakori tűzoltói feladat, amely bármelyik pillanatban bekövetkezhet. Leggyakrabban a parkoló járművek gyulladnak meg. A cikk egy szimulált tűznek az autók (ajtók) szerkezeti elemeire gyakorolt hatását mutatja be, miközben rögzíti a hőmérsékletet és a sugárzó hő áramlásának adatait is. A kísérletet egy tűzgyújtásra alkalmas helyiségben végezték el, ahol ellenőrizték az autóajtók viselkedésének értékelési módszertanát a folyadékkibocsátás okozta tűz hőterhelése alatt. A kísérletek eredményei megalapozzák a zárt és nyílt térben történő további tűzszimulációkat autó esetén.

Kulcsszavak: gépjárműtűz, hőmérséklet, kísérlet

1. INTRODUCTION

Car fires are a global problem. In the case of such fires, a great deal of research can be done, ranging from monitoring fire parameters [3,4,5,6], carrying out simulations [1,2,7] to detecting the causes of fires. One of the main causes of a car catching fire is fire spread from a nearby external source. A fitting example is the car fires in parking lots in front of supermarkets and hypermarkets. Standards for the position and width of parking places are becoming increasingly benevolent and the risk of fire spreading from one vehicle to another is quite high. Experiments regarding fires of passenger cars have been carried out in the Department of Fire engineering, Faculty of Security Engineering, University of Žilina, in order to identify and validate some of the facts relating to burning. The experiments can be seen in Figure 1.

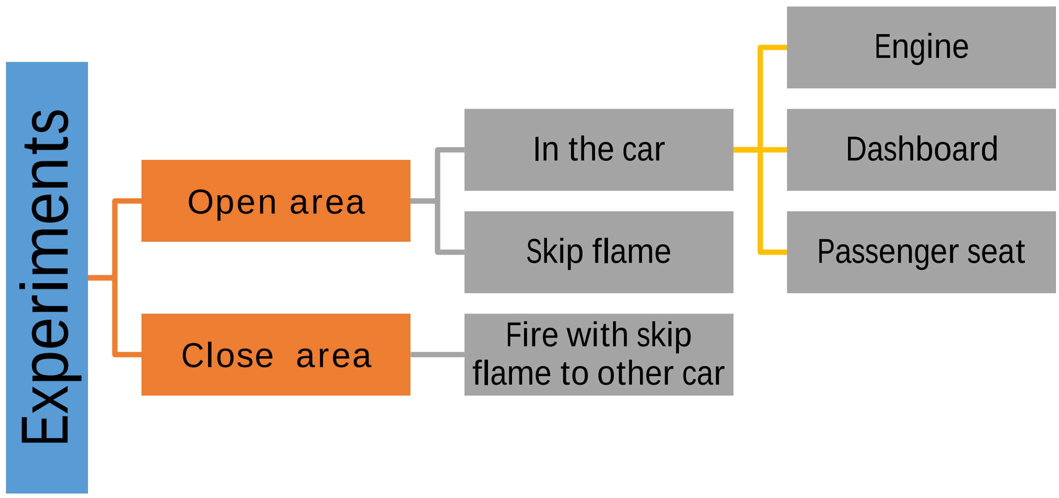

Figure 1 - Fire experiments on cars [5,6]

Flame spreading from one vehicle to another was a part of this experiment. Based on the results of indoor and outdoor experiments, the requirement to determine the limiting parameters of fire spreading between vehicles needed to be specified. Therefore, another test was carried out, not with the whole vehicle, but with only some of its parts - the doors.

2. METHODOLOGY OF THE EXPERIMENT

Theis experiment focused on the thermal stress the car door is exposed to in the case of a fire at a car park or parking garage. Based on previous practical experience from other experiments, we found out that the flame tends to spread along the flammable design elements of the car (Fig. 2). Due to its specific character, the experiment was carried out in the fire room of the VVUÚ a.s., Ostrava Radvanice, which is a test laboratory of the company. Only the results of preliminary experiments verifying the measurement methodology are published in the Article.

Figure 2 - Fire spreading in an open area

The experiment was carried out according to the diagram in Figure 3 (view from the top).

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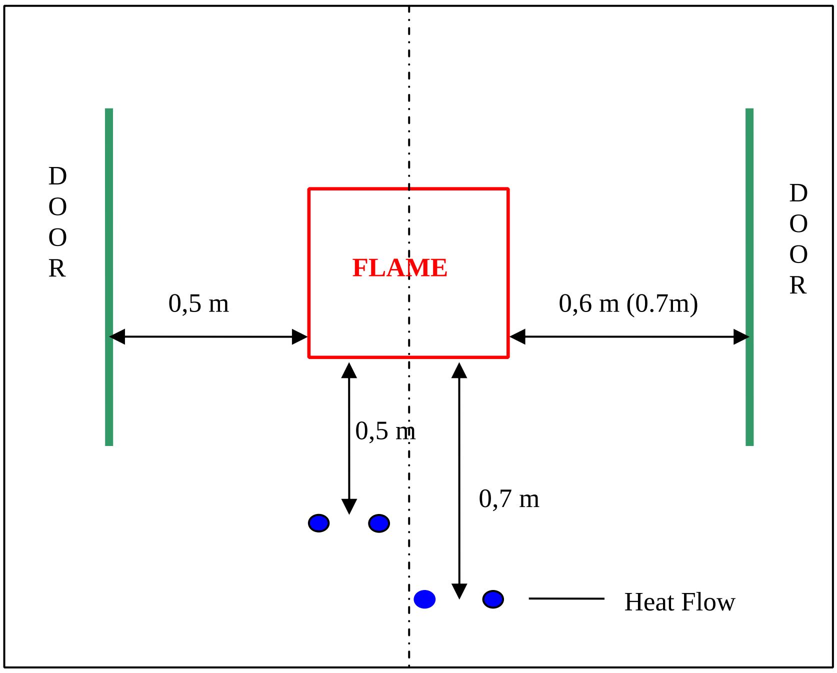


Figure 3 - Experiment

The burning temperature and the temperature of fumes was measured by NiCr-Ni thermocouples with a temperature range of -100°C to 1400°C. The location of the temperature sensors is shown in Figure 4. The locations of thermocouples were as follows:

- Temperature sensor T0 - located in the rearview mirror area,
- Temperature sensor T1 - on the upper edge of the door in the vertical axis of the door
- Temperature sensor T2 - next to the door handle from the side closer to the vertical axis of the door,
- Temperature sensor T3 - on the upper edge of the door in the vertical axis of the 2nd door,
- Temperature sensor T4 - on the coupling between the upper and lower part of the door, in the horizontal axis of the window,
- Temperature sensor T5 - placed next to the door handle from the side closer to the vertical axis of the door.

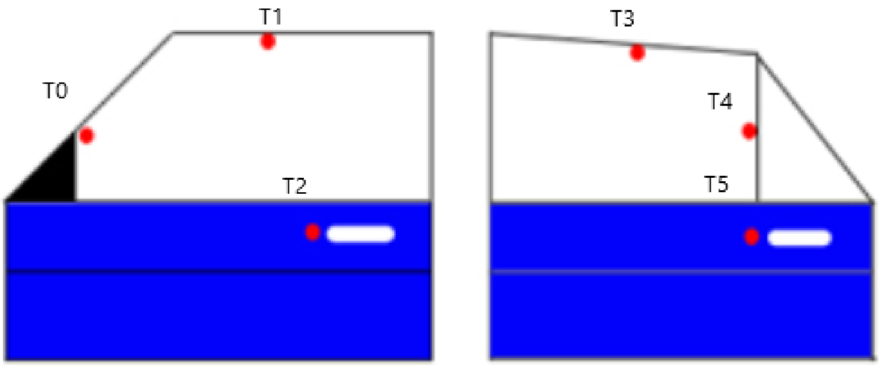


Figure 4 - Positioning of the thermocouples on the doors

Figure 5 - Position of the door and the ignition source before the experiment

A 0,5 m x 0,5 m x 0,2 m tank filled with automotive petrol BA 95 (20 liters) was used as an ignition source in the fire simulation. A solution of 66% water and 33% petrol was used as the coolant of the tank. The object of the study was the thermal stress (temperature) of the door on the surface and the possibility of their flare-up from the radiant heat in a fire. The position of the door and the ignition source is shown in Figure 5.

After initiation, temperatures were monitored and recorded according to the methodology prepared for these experiments. To provide relevant data and measurement results, the external influences (wind, airflow, humidity, etc.) were limited to the lowest possible extent. Experiments were carried out in a fire room (an enclosed space). The effects of such a wind-free environment can be observed in Figure 6 - the flame rises directly up.

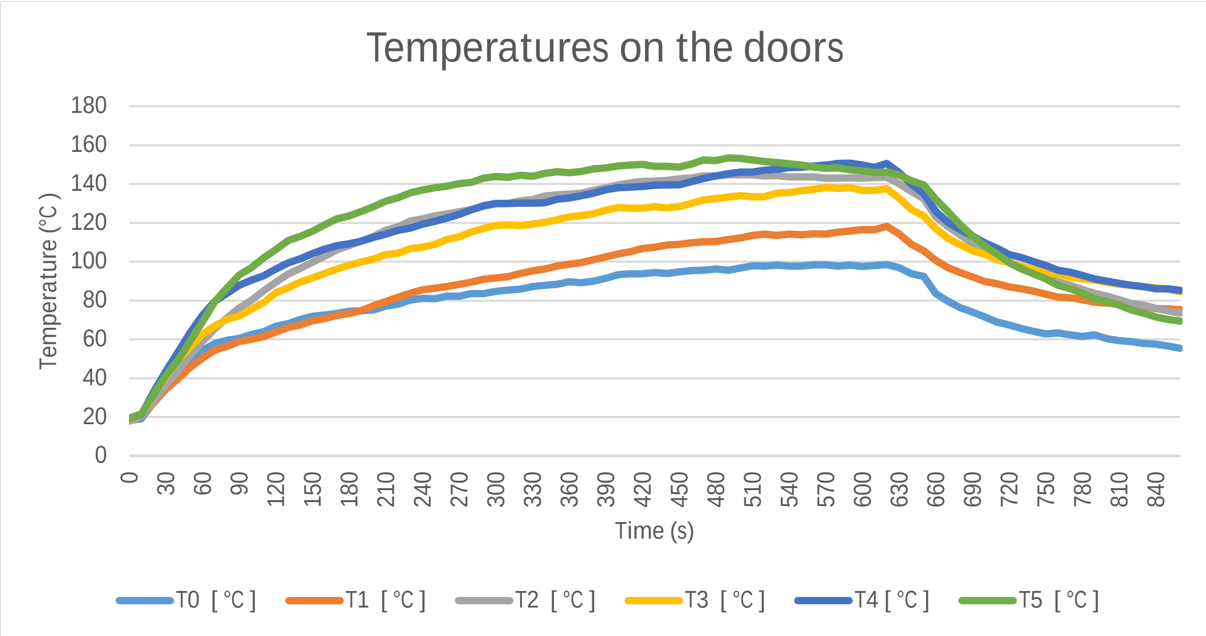
3. RESULTS AND DISCUSSION

After initiation, the room was closed and values were measured. Entering the area during the simulation was only possible using protective equipment.

Figure 6. Flame-burning of the source on the door, window level

The measurement took 860 seconds and it was influenced by the fuel consumption in the tank.

Results can be seen in Graph 1.



Graph 1. Temperatures on the door – initiation between the windows

Based on these results, where the temperatures in the door area did not even reach 160 °C, the ignition source was moved to the car floor position. The petrol BA 95 (20 liters) was used again as the ignition source.

The temperature results can be seen in Graph 2.

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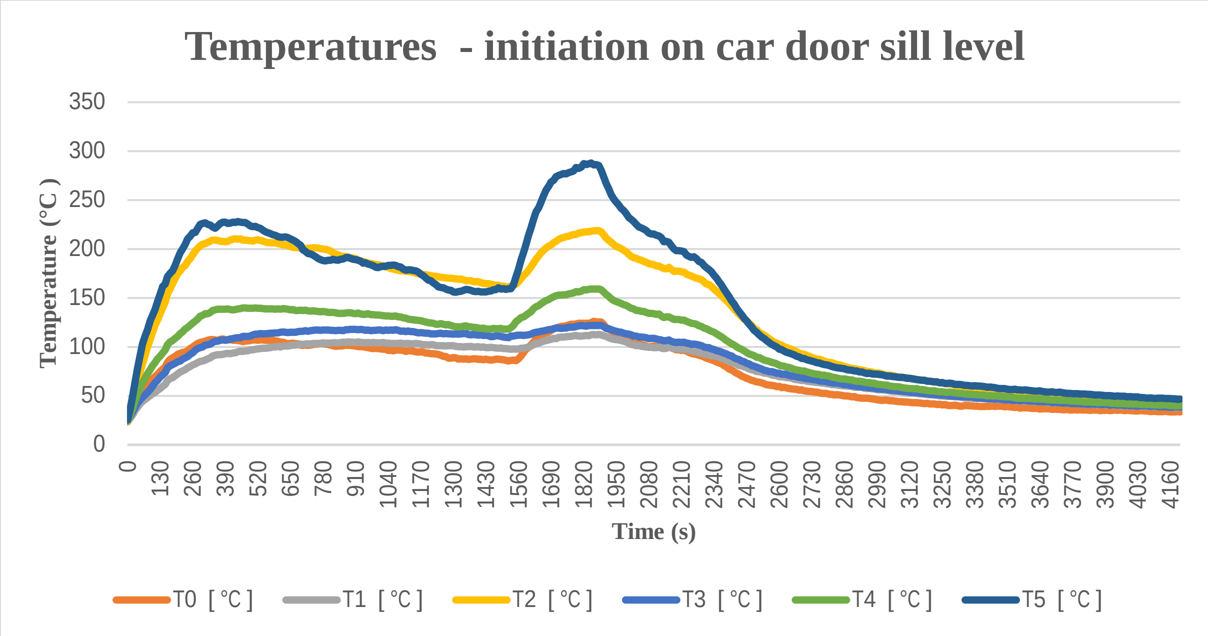

Graph 2 - Temperatures on the door – initiation on car door, windowsill level.

Based on the results of the second measurement, a change can be observed. There are two curves showing an increase in temperature. By about the 25th minute, the air in the room had been consumed and the intensity of burning started to decrease. However, when the entrance door opened, the temperature rose sharply and the maximum temperature of 286 °C was reached in the 32nd minute. Subsequently, the temperature gradually decreased as the fuel burned away.

The experiments were conducted under ideal conditions. A windproof environment and enclosed space simulated the conditions of a car parked in a garage, but that is not suitable for interpreting the results for the external environment. In these simulated conditions, both experiments were limited by the amount of air in the space, which was gradually consumed. The thermal stress of the door was even and was not influenced by lateral air flow, which in real-life scenario is one of the factors of the flame spreading from one vehicle to another. However, based on real outdoor fires, other phenomena, besides thermal stress, can be observed and these cannot be directly anticipated and described. One of them is the initiation of fire by pieces of plastics falling off the burning vehicle as well as leakage of operating fluids.

4. CONCLUSION

Both experiments represented pilot trials to measure the fire parameters of passenger cars. Though in both cases there was no direct initiation, the experiments showed the way that a car body next to a fire reacts when exposed to the thermal stress of a fire. Based on these results, the methodology was verified, as well as the need to measure the heat flow in a fire. This contribution presented a method of measuring the individual values of the fire parameters and the thermal stress of the car, which can be used in practice in future fire simulations as well as when identifying their causes.

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