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FIRE OF PERSONAL MOTOR VEHICLE

Pożary samochodów osobowych

Summary

Passenger vehicle fires are part of everyday life. Every year an increasing number of such fires and the damage growth contribute to increasing the intensity of the survey causes the development of fire vehicles and vehicle behaviour during combustion. The resources available for research during a fire are given to a group of Japanese scientists who published their findings in the journal "Fire Safety Journal." The research was aimed to drive sedan category. Authors summarize the results in four types of experiments; where then describe the temperature, heat flux, and deformation phenomena achieved in a fire. Europe, similar research done on the car and its products, but that information and the measured data wasn't publishing.

The article presents the results of experimental burning of cars in real life. Under real conditions in the experiments considered standing vehicles on 4 wheels in a horizontal position, and measured the initial environmental conditions (weather conditions). The solutions of grant tasks were performed 10 trials in 5 experiments. For each test was initiated by the fire in the engine compartment and passenger compartment, which were dealt with several sub-tasks. The main task was to describe the sequence of initiation of combustion in the engine compartment with a focus on measuring the temperature during combustion. Another sub-task was to investigate the flame skipping from vehicle to vehicle when stopped in the parking lot, and the interior and exterior. During the tests were measured in the temperature dependence of burning time. The results were then used in a computer simulation of fire development in cars.

Abstrakt

Príspevok predstavuje výsledky experimentov horenia osobných motorových vozidiel v reálnych podmienkach. V rámci riešenia grantovej úlohy bolo vykonaných 10 skúšok v 5 experimentoch. Pri jednotlivých skúškach bol požiar iniciovaný v motorovom priestore a priestore pre cestujúcich. Ďalšou čiastkovou úlohou bolo sledovanie preskoku plameňa z vozidla na vozidlo pri státí na parkovisku, a to v interiéri, ako aj v exteriéri. Počas skúšok boli merané teploty v závislosti od času. Výsledky bol následne využité v počítačovej simulácii rozvoja požiaru v osobnom motorovom vozidle.

Keywords: fire, temperature measurement, course of fire, personal motor vehicle
Kľúčové slová: požiar, meranie teplôt, priebeh požiaru, osobné motorové vozidlo

Introduction

The aim of the experiments was to observe the course and development of individual fire phases of chosen fire types of personal motor vehicles. Also other authors deal with this type of experiments (testing materials) regarding fire in personal car.(MANGS, J. – RAHKONEN, O, 1994) And with the measurements to secure needed data for the program system enabling computer fire simulation of personal motor vehicles. With the fire simulation it is possible confirm the use of fire extinguishing tactics and use it within the location of the fire causes.

Experiments

In the last two years several tests were carried out that focused on the fire development in engine bay of personal motor vehicle:

- ***Experiment A*** – **experimental fire of vehicle AUDI 80** – fire simulation with initiation in engine bay,
- ***Experiment B*** – **experimental fire of vehicle KIA Ceed** – three experiments, fire simulation with initiation in engine bay, under dash panel in inside space and in the interior on the passenger´s front seat.

Further the observation concentrated on the temperature measurements and spark-over from one vehicle onto another:

- **Experiment C – experimental fire of vehicle BMW 318i and KIA Ceed** – fire simulation of a moving personal car on free space, its consecutive shut down and spark-over onto a neighbouring car (three individual tests)
- **Experiment D – experimental fire of vehicles RENAULT 19 Chamade and FORD Escort CLX in closed space** – fire simulation of personal engine fire in closed space with spark-over onto a neighbouring parked vehicle with fire initiation in engine bay (two individual tests).

The last aim of the experiments was to record the whole process of temperature curve by complete fire of personal motor vehicle:

- **Experiment E – experimental fire of vehicle FIAT Regata** – simulation of complete car fire on free space,
- **Experimental fire of vehicle KIA Ceed** – figures measured during the experiment of spark-over.

Experiments were carried out in conditions simulating real conditions by burning of personal motor vehicles, which occur by technical defect on the vehicle. (APVV „POMOV“)

Experiment conditions

The tests of experiment A, B, C and E were carried out in exterior. The space for tests was a concrete area with the size 5x8 metres. In the area of the test apart from the measurement and protection agents of equipment (protection against radiant heat) there were not any flammable materials.

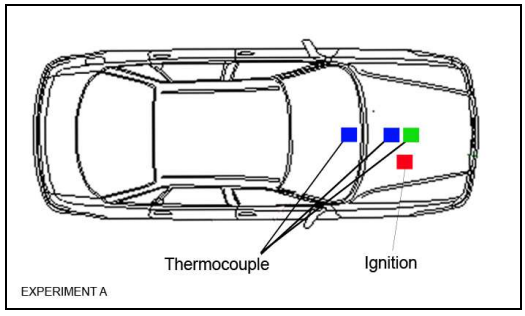
Experiment D was realised in experimental fire tunnel with controlled external air supply. The tunnel was made into a stone massif (that is from non-flammable material).

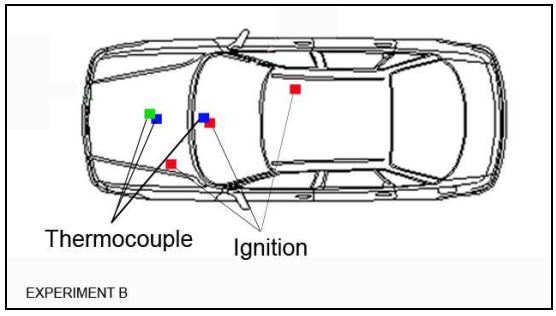
In case of level measurements in closed space the measurement station was in parallel measurement tunnel separated by a wall from the testing tunnel.

The realisation of experiments required security of safety in the area of safety against fires, as well as in the area of safety at work.

The course of experiments

The personal cars were engineering with self-contained body shell, functional engineering groups. The vehicles were secured against movement with park braking system. The fire initiation proceeded in engine bay and in the space for passengers through open fire. The individual points of initiation can be seen on the Picture 1.





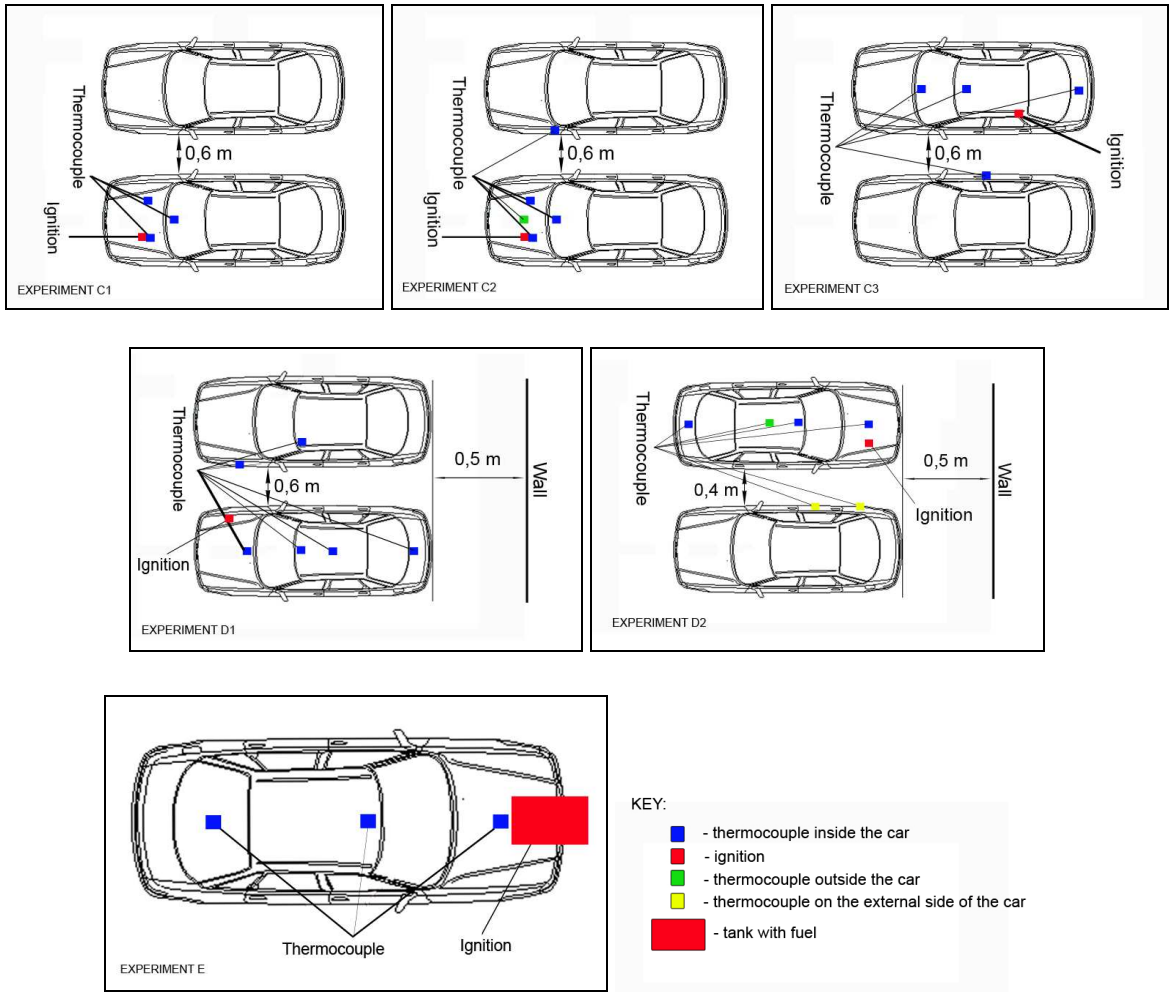


Fig. 1. Places of ignition by experiments and the thermocouple placement

Experiment A

The aim of the first test was mainly to verify suggested methodology of temperature measurements by fire of personal motor vehicle. Simulated fire was initiated in the engine bay of the vehicle. A square felt with the size 3 x 3cm was used; it was impregnated into 5 ml of petrol that was put into the part above suction tube of the engine. For initiation of the fire a flame from torch was used, with which the felt was lit. The lid of the engine space was during ignition (initiation of the burning) open and after ignition it was closed.

Experiment B

The second experiment of the observation of fire course of personal motor vehicle was divided into three partial tests. The first test was observation of the fire course in engine bay. The second represents initiation in the space of dash panel and the third on the passenger seat. The ignition was done with the help of open fire through impregnated fabric as in experiment A.

Experiment C

The experiment was aimed at the development of fire in a moving car. By individual partial tests two cars were used. The first test represented simulation of fire development in engine bay by moving car with a speed of 86 km.h^{-1}. For wind simulation a mixed flow fan was used. The second part of the experiment was the fire initiation in engine bay and regulation of radiant heat through mixed flow fan towards neighbouring standing car in distance of 60 cm. The third experiment was a complete fire and a spark-over onto a close standing vehicle. The distance was adjusted based on the result from previous test for 50cm.

Experiment D

Fire in experimental tunnel was divided into two separate tests. In both cases it was a simulation of spark-over from vehicle onto a vehicle. The position of vehicles in the tunnel is visible on picture 2. Vertical side distance between vehicles was 60cm. After reaching temperature decline on the neighbouring car the test was stopped and the vehicles were exchanged. The distance between vehicles was lowered onto 40cm.

Experiment E

It represented complete fire of personal motor vehicle on outside area without fire-fighting crew intervention. The initiation started in a bath filled with fuelling (mixture of petrol + diesel) which was pushed under the engine part of the car. Through this a fire was simulated and initiated via burning puddle created by propellants.

During all experiments the temperatures were measured via Ni-Cr thermocouples (Type K) and basic levels of outside environment (temperature, air humidity etc.). The initiation of vehicles was carried out through fabric burning that was impregnated in car petrol. In case of initiation in engine bay the engine bonnet was closed. (POLEDŇÁK, P., 2010)

Results and discussion

Primary aim of the tests was measurement of temperatures by burning that will be consequently confirmed by computer simulation. Individual temperature curves can be seen on pictures 2-6.

Results – Experiment A

The experiment lasted 11 minutes and 36 seconds. By temperature decline in engine bay the experiment was finished. The temperatures were measured in three places – in engine bay, above front engine bonnet and in passenger cab (in middle panel of dash panel). Complete temperature course can be seen on the picture 2.

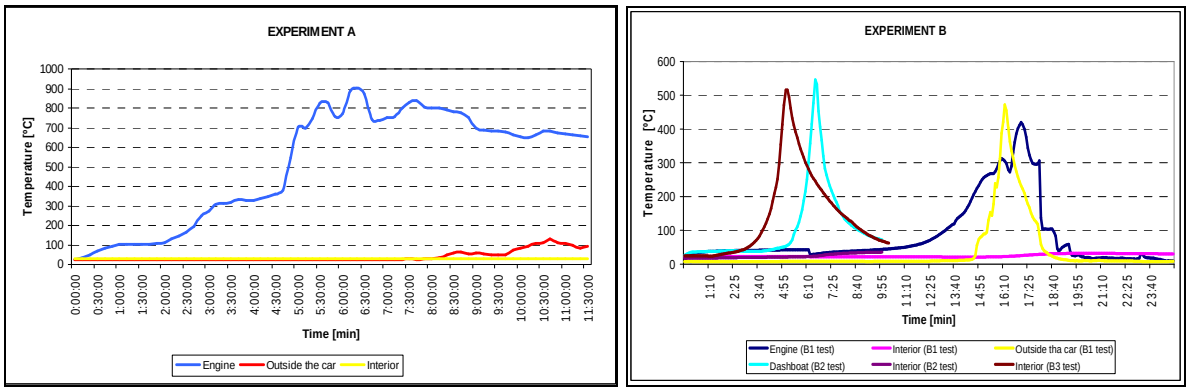


Fig. 2. Temperatures by experiment A and B

The temperature in engine bay reached value of 840 °C. The temperature in the space above engine bonnet slightly rose above 100 °C. During the whole experiment it did not come to significant temperature rise in the space for passengers.

Results – Experiment B

By tests of Experiment B three places of initiation were chosen. It was engine bay (B1), dash panel (B2) and passenger front seat (B3). In engine bay were reached temperatures only about 400 °C, which was achieved by sealing of thermocouple into plastic. By initiation in the space of dash panel the fire itself was extinguished by use of oxygen in the space. It was the same also by test B3.

Results – Experiment C

The experiment C consisted in performing three partial tests. By C1 the place of initiation was engine bay by simulated drive by speed 86 $km.h^{-1}$. The fire course was enormously slower and the temperatures in the space reached in the 8th minute only 225 °C. The initiation by the test C2 was also in the engine bay. The wind direction was lateral with speed 10 $km.h^{-1}$. On the second vehicle during test was not shown temperature rise (Picture 4).

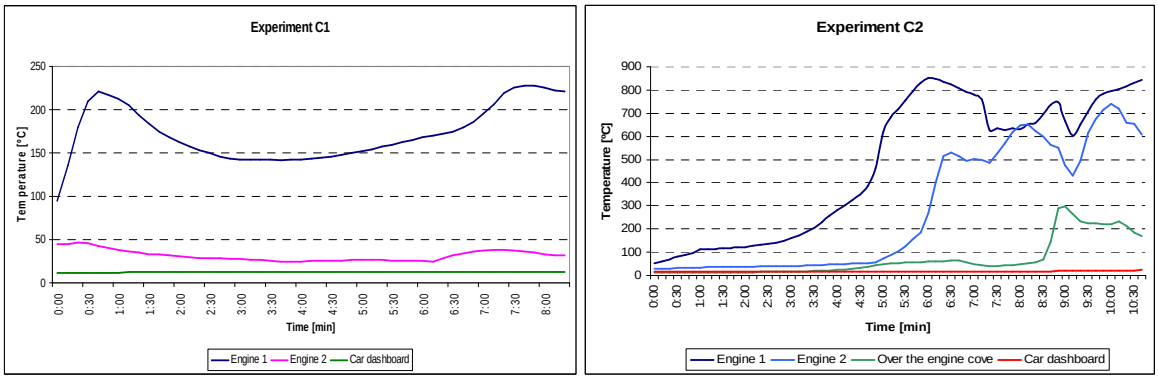


Fig. 3. Temperatures achieved by experiment C1 and C2

The test C3 linked to the test B3, whereas the spark-over from burning vehicle standing next to the not burning vehicle was observed. After initiation in the space for passengers (Picture 1) the window was left open on the burning car. From the side of the second car. During the fire the second car was lit, however not via radiant heat but through a flying piece of plastic plinth of doors onto the front door of the second vehicle. Temperatures measured by thermocouple on the B-pillar reached during measurement max 63°C which is insufficient temperature for initiation. The measured temperatures can be seen on the Picture

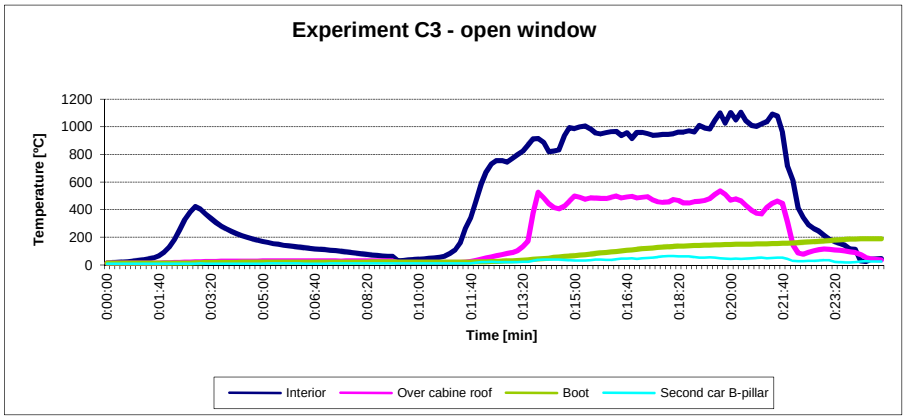


Fig. 4. Temperatures by Experiment C3 – spark-over

By this experiment it was confirmed that the blast of air in engine bay significantly influenced the first phase of fire in personal motor vehicle. The temperatures by simulated drive did not reach even 250 °C, what is by majority of flammable material the flash point. After fan switch off at the beginning of the 4th minute in C1 the temperature started gradually rise, however after repeated switch on onto max power (in 7th minute) it declined again.

Results - Experiment D

The experiments D1 and D2 were different from previous by space. They were performed in closed experimental tunnel by which burning in closed space and spark-over in closed space was simulated. The vehicles position can be seen on the Picture 1. By first test the temperatures in engine bay reached more than 900 °C and in interior more than 800 °C in the 39th minute when the extinguishing started what can be confirmed also by the decline of measured levels in measured points. [4] After vehicle extinguishment both cars were turned

(see Picture 1) and the test was repeated. By second test the vehicles in the space were left to a complete burn down and the time of test was more than 140 minutes. The interior temperatures achieved 1080 °C. In the luggage boot the rise of temperature was from cca. 400 °C onto 780 °C in the 58th minute (Picture 5)

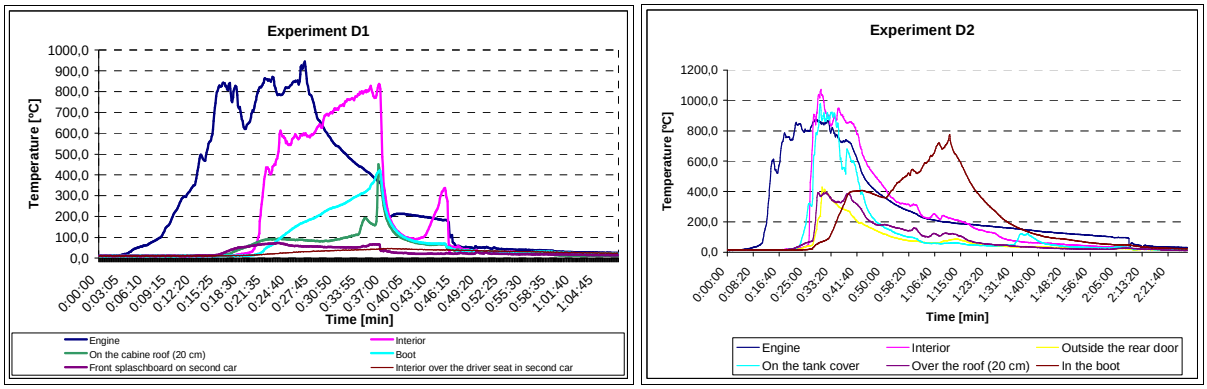


Fig. 5. Temperatures by experiment D

Results – Experiment E

The last big test was a simulation of complete fire of personal motor vehicle. In this case the initiation was different from others. The car was lit through container with flammable liquid (Picture 1) pushed after initiation under the engine bay. The temperatures by fire were measured in engine bay, in car interior and in the luggage boot. By experiment was anticipated faster rise of temperature by burning and overall faster course of fire, which however was not confirmed and the temperature curves copied temperatures measured by previous tests (at least in engine bay). The maximum temperatures reached 1100 °C approximately in the 23rd – 27th minute of burning. As in previous cases, so in this experiment the highest temperatures were measured in car interior. The complete temperature course is on the Picture 6.

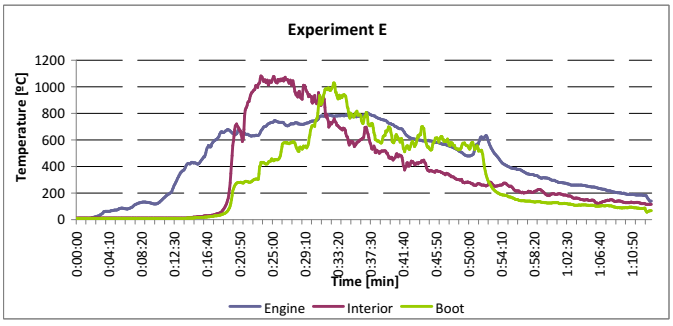


Fig. 6. Temperatures measured by experiment E

Conclusion

Fires of personal vehicles are everyday reality in road traffic. The authors as the most likely place of fire start assumed engine bay of the car that was most used for fire initiation. This argument came out from facts:

- in engine bay are installed individual parts of car system (braking system, fuel system, electric system etc.);
- regular business interruption in this space;
- amount and variety of flammable material in the space;
- the inability to control space visually and that way prolonging the phase of free fire course;
- the presence of moving part and components with higher service temperatures [3].

The aim of the experimental fire tests of personal motor vehicles was:

- to note temperature course by car burning
- to verify the possibility of spark-over from burning car onto standing cars,
- to verify the influence of moving car onto the fire development in engine bay,
- to set the phases of fire burning of personal motor vehicle.

From presented tests can be summarised that the fire in engine bay is into a certain time limited fire – there is no transfer of flame into the cab of driver, the temperatures by burning reach max 800 up to 1100 °C and that is also in closed space and the course of fire is significantly influenced by gas exchange in the space of the fire – mainly in the primary phase of fire (in closed space came to flame extinguishment after initiation and closing of the space)

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