THERMAL LOADING OF THE SKIN DUE TO SIDE AIRBAG DEPLOYMENT

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Abstract

Airbags have already shown their effectiveness to prevent or reduce injuries during impacts. This applies to driver and passenger airbags as well as to side airbags. Nevertheless there can be negative influences on the occupant such as Out of Position or other cases of inflation induced injuries. In a few cases thermal effects during airbag deployment to the skin have been reported[1,2].

The purpose of this investigation is to present some tests about airbag/skin interactions due to thermal effects during side airbag deployment. For such an investigation, different airbag modules were used to compare the heat loading to the skin depending on bag and inflator characteristics.

After installing and testing of a test setup to deploy modules with a defined position of the venting, PMTO´s were exposed to the modules to see the interaction of the gas with the skin.

The examination of the skin was made by the University of Heidelberg.

Introduction

There are already published cases of burning effects during the restrain function of the driver airbag at frontal impacts due to the hot gas inside the bag coming out of the ventholes. In these cases, the gas was produced by an pyrotechnic inflator which normally has an average inflator output temperature of above 1300 °K. Although this gas cools down during the deployment and although the interaction of gas and skin lasts only a few milliseconds, it seems to be sufficient to get burning effects to the skin at the ventholes[1,2].

In the case of burning effects to the driver forearm during frontal impacts the probability is influenced by the parameters:

- Frequency of frontal collisions with airbag deployment
- Frequency of driving with naked forearm
- Frequency of arm position at ventholes

For the side impact with airbag deployment these parameters are different:

- Frequency of side collisions with airbag deployment
- Frequency of driver and passenger driving with naked upper arm
- Frequency and duration of arm position at venthole

Although it might be more likely to have the arm at the position of the venthole during side impacts, the probability of being exposed to the gas over the whole inflation period is very low because of the high dynamics and the different moving directions (Airbag unfolding in x-direction, Arm movement in y-direction).

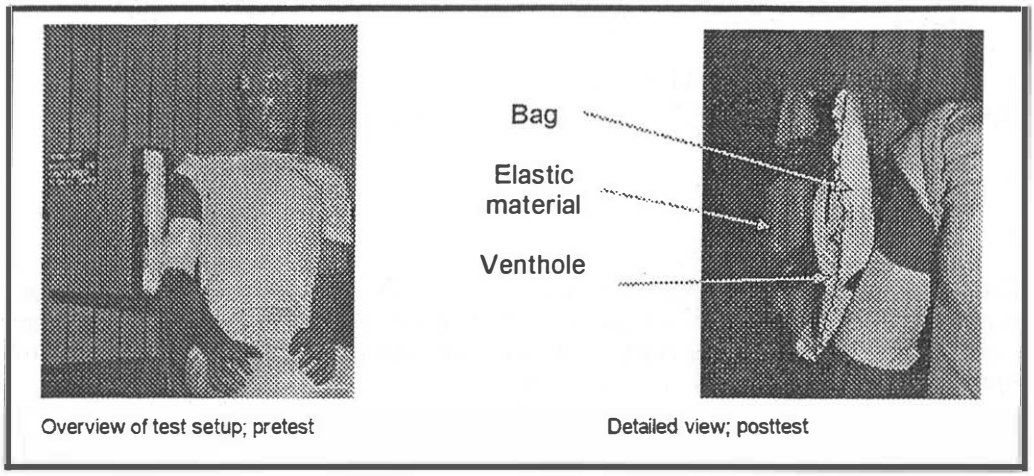
To analyze the important parameters for burning effects and to describe this in a mathematical model there has been an investigation with volunteers in which gas temperature, exposure duration, and gas velocity were varied[3]. From the scientific point of view, this investigation is extremely valuable but to predict skin burns for a certain module configuration which can be used to prove the safety of a system (which is the goal of these tests) it is not usable.

Test setup

The test setup was designed according to the following requirements:

1) Testing of complete modules (Inflator, Bag, Venting)
2) Flat bag prior to inflation
3) Ventholes at fixed position during inflation

4) Device to flatten the bag after inflation
5) Direct loading of a test surface must be possible



Picture 1: Test setup

This worst case configuration was chosen to cover all the possible situations in real world accidents.

Tests

To characterize the behavior of the setup we first made some tests with dummies. Picture 1 shows the test setup for these pretests.

After the function was proven, the following tests were carried out with a cadaver:

Test No.	Inflator	Venthole Diameter	Loaded body region
1	Compressed air	12 mm	forearm, right
2	Compressed air	12 mm	forearm, left
3	Sidebag hybrid inflator Pyrotechnic < 3 gram	35 mm	upper arm, right
4	Sidebag hybrid inflator Pyrotechnic < 3 gram	35 mm	forearm, right
5	Sidebag hybrid inflator Pyrotechnic > 3 gram	30 mm	forearm, right
6	Sidebag hybrid inflator Pyrotechnic > 3 gram	30 mm	upper arm, left

Results

Except test No. 5 no thermal effects to the skin were observed. That means that the cadaver skin shows no change. In this connection it is important to mention, that burning reactions of 1 degree (reddening) can not be shown by the cadaver skin[4].

In test No 5 the gas impacts the skin perpendicular and the venting stays exactly at the same position during the whole inflation time.
For this worst case skin changes were found that correspond to a burning degree of 3 over an area of a circle with about 30 mm diameter.

Conclusion

The test that were performed showed, that the probability of getting burned in the area of the sidebag during a side collision is very low.

On the one hand the airbags are designed to avoid any interaction between the ventholes and the arm by choosing a vent position outside the normal contact zone. On the other hand the probability of coming in contact with the vent during the whole inflation time is very low because of the intruding structure during an side impact. And even in this unlikely case, the tested modules with compressed gas inflators and hybrid inflators with a low amount of pyrotechnic have not shown any negative heat effects.

The investigation gives a good hint what is happening if an occupant skin comes in contact with the deploying airbag during a side impact. But because of the strong dependency on the module configuration it is not possible to generalize this for all inflators of this kind or even for all modules with the tested inflators.

References

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