

Water Bombs

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1 Introduction

One of very common games among children is water-balloons-war. During this game sometimes even the best thrown balloons instead of exploding simply bounce. Why is it so? That was the main question of my research.

2 Theoretical Model

The phenomenon observed when a balloon hits an obstacle is called water hammer. Water hammer is simply sudden change in fluids pressure accompanying a quick stop of its flow. Change in pressure during this phenomenon is described by Eq (1).

$$\Delta p = \rho c \Delta v \quad (1)$$

In which ρ is the fluids density, Δv is balloons velocity during the crash and c the velocity of pressure change wave in the fluid described by Eq (2).

$$c = \frac{1}{\sqrt{\rho \left(\frac{1}{K} + \frac{d}{E \cdot e} \right)}} \quad (2)$$

If the pressure inside balloon exceeds the durability of a balloon, it explodes, if not it bounces.



Fig.1 Balloon during the crash

3 Experiments

3.1 Experiment 1

The first experiment that I've conducted in this research was measuring the height from balloon had to be dropped in order to explode while hitting the ground. In order to do so I've

filled 20 exact the same balloons with 75cm³ of water and dropped them from growing heights. The average height measured in this experiment was 79cm.

3.2 Experiment 2

The next thing I did was measuring the force which applied to the balloon makes it explode. I did that by simply putting a balloon on a scales and putting growing weights on it. The average force measured in this experiment was 64 N which was equal to dropping a balloon from 74 cm. The height of drop measured in experiment 1 and calculated in experiment 2 differs only by 5 cm.

3.3 Further experiments

I have conducted many experiments to examine factors influencing explosion of a balloon such as: filling a balloon with air bubbles, filling a balloon with hot water instead of cold water, changing the surface on which balloon falls etc.

4 Conclusion

In conclusion I have determined the factors influencing the explosion of a balloon and they are:

- ❖ Velocity at impact
- ❖ Air content
- ❖ Pressure inside filled balloon
- ❖ Balloons diameter
- ❖ Fluids density
- ❖ Type of surface
- ❖ Elasticity of the balloon
- ❖ Durability of the balloon

References

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