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# Thermal analysis of solid and vented disc brake during the braking process

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## Abstract

Braking system is one of the most important components of a vehicle on the road. This system has the task to bring the vehicle to stop or slow down. Friction brakes, during the braking process, convert the kinetic and potential energy into the thermal energy (heat). The basic components of braking systems, brake discs and brake pads, in a short period of time absorb a large amount of heat release (Travaglia et al. 2014). The absorbed heat must be, as far as possible, effectively dissipated in order to ensure the normal operation of the braking system (Day et al. 1984). High temperature during the braking process may cause many problems such as thermal cracks, premature wear, brake fade and thermally-excited vibration (Lee 1999). In this study, a typical disc brake system was modeled including brake disc and pads. Using COMSOL Multiphysics 5.0, we investigated thermal behavior of two types of discs – solid and vented dics. The results show that the vented disc is a much better solution than the solid disc, because the greater amount of heat is released for the same amount of time.

**Keywords:** Brake disc, thermal analysis, heat dissipation, COMSOL Multiphysics 5.0

## 1. Introduction

As is well known, the braking system is used to bring the vehicle to stop or slow down. The kinetic energy of the vehicle is transformed into the thermal energy. Brake discs and brake pads absorb the largest part of this energy and, after that, this energy is dissipated into the surrounding (Talati et al. 2009). Currently, more than 2000 materials and their variants are used in the manufacture of brake components. A brake disc is usually made of cast iron or ceramic composites, while a brake pad is made from frictional material. During the braking process, the temperature, as a result of friction between a brake disc and disc pads, can have values in the range of 200 to 800 °C (Idusuyi et al. 2014). Heat generation is a function of vehicle mass, friction coefficient, thermo physical properties of material, velocity and rate of deceleration. Heat dissipation will occur via:

- conduction through the brake assembly,
- radiation to nearby components and
- convection to the atmosphere.

Heat dissipation through conduction on nearby components can lead to damaged seals, brake fluid vaporization, or wheel bearing damage. The total amount of heat dissipation through