

Brake dust collector with venturi suction generator for active boundary layer manipulation

Up to 85% of traffic-induced particulate matter is comprised of dust emerging from brake, tire or road abrasion. The present brake and tire dust collector can help with reducing fine dust emission into the environment. The dust collector features an air feed that blows an airstream onto the brake disc, the tire or road surface which sheds the dust containing boundary layer off the respective surface and helps with efficient collection of fine dust. For energy efficient supply of the suction needed, a venturi nozzle is used to generate a suction from the air stream at the inner rim surface of the vehicle's wheel.

Challenge

Recent studies have shown that up to 85% of the traffic-induced particulate matter of PM₁₀ (particulate matter < 10 µm) is composed of tire-, brake- or road-abrasion or by dust being stirred up from road surfaces. The problem of particulate matter thus concerns not only diesel engine vehicles, but also petrol- or electro-powered vehicles. According to studies of the Empa, the Swiss Federal Laboratories for Materials Science and Technology, the fine dust emitted by disc brakes alone, adds up to roughly a fifth of traffic-induced particulate matter in cities. Together with tire abrasion, a total of over 111.400 tons of dust is stirred up into the air per year in Germany alone. Especially brake dust is particularly dangerous in breathing air, because it is composed to a great extent of particles with a particulate matter of below 0,1 µm (ultrafine fraction of PM_{2,5} fine dust particles), and can thus penetrate lung tissue or even enter the blood stream. Additionally, due to brake disc and brake pad compositions, they contain extremely hazardous substances such as nickel, chrome and copper.

For brake dust collection various solutions exist, ranging from simple passive filter hoods to generator-driven suction devices. However, it is clear that passive devices will not be able to efficiently collect the dust and that for effective aspiration of the particle-containing boundary layer of disc brakes, existing concepts require a strong suction. This, when actively supplied by a generator, will negatively affect the energy balance of a vehicle and will inevitably lead to higher fuel or power consumption. To promptly provide the necessary suction, for instance in the case of a spontaneous braking, a respective turbine either would have to be kept running constantly or the negative pressure would have to be stored in a vacuum container, additionally leading to increased vehicle mass.

Our Solution

For the effective collection of tire-, brake- or road-abrasion, the present invention proposes a brake dust or tire abrasion collector hood that features an air feed that directs an opposing air stream onto the brake disc (s. Fig.1), or the tire and road respectively (s. Fig.2), to efficiently dissipate the boundary layer from the respective surface. Additionally, by sealing off the brake or tire area with a housing, a more effective and particularly more energy efficient removal of the particulate matter is achieved. The needed suction for sucking off the boundary layer is hereby greatly decreased.

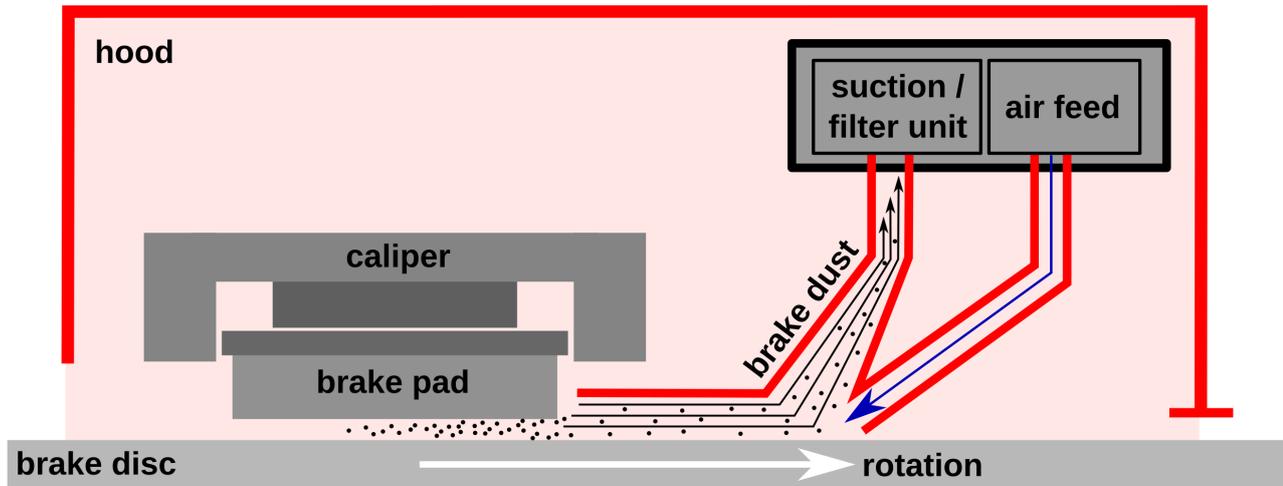


Fig. 1: Brake Dust Collector. Either the brake pad or the whole brake caliper is housed in a hood, that features an air feed that blows an air stream onto the brake disc surface to efficiently shed off the dust containing boundary layer, which can then be aspirated and channeled to a filter unit. (Source: adapted from patent application)

In order to generate the needed suction independent of consumers (e.g. pumps or turbines), a venturi effect-based suction generator in form of an air baffle inside the wheel is proposed. As such an air guide panel is mounted to the inner surface of the rim, creating a narrowing of the flow area between rim and air baffle. A drilling in the air guide panel at the narrowest spot is used to generate a suction via the venturi effect, that is sufficient to drive the dust collector described above. Thus, the necessary suction is constantly available while driving.

By providing the right amount of feed and suction volume flow, a complete collection of the brake dust particles into the filter is possible.

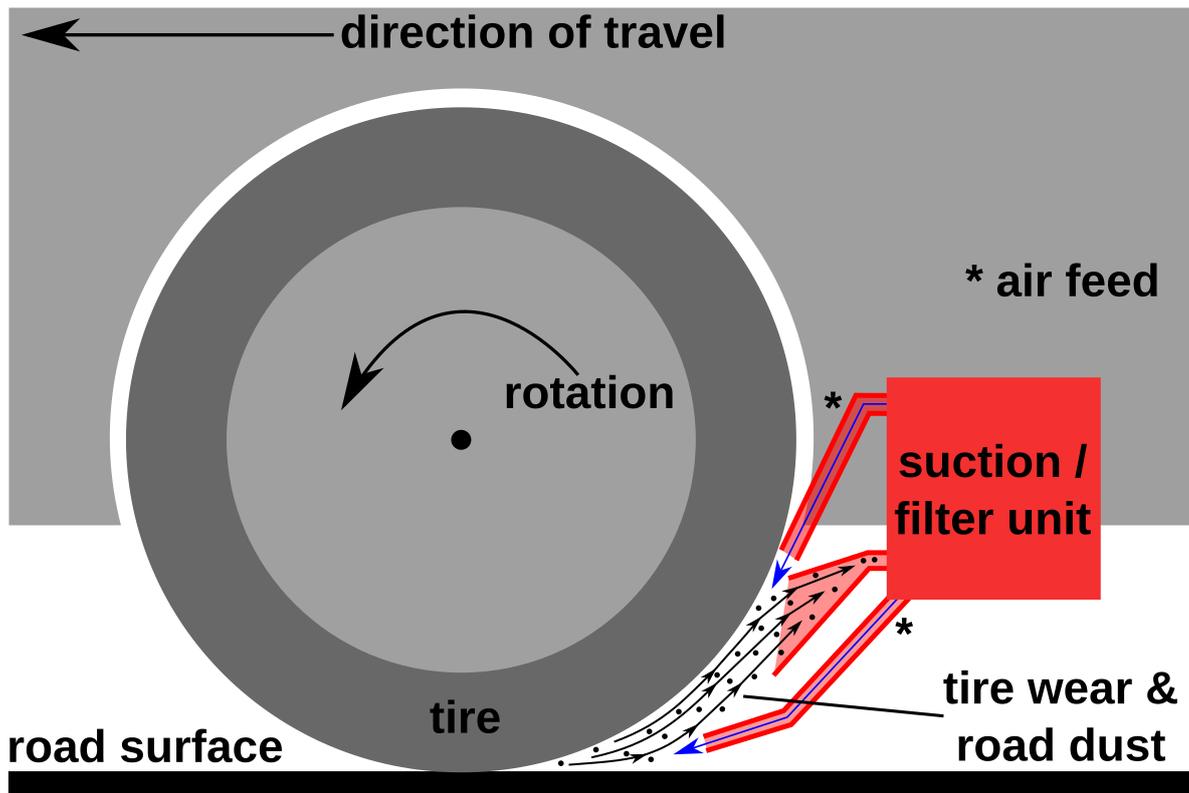


Fig.2: Tire Abrasion Collector. Similar to the brake dust collector, the air feed principle can be used to shed off the tire and/or road abrasion-containing boundary layer from the tire or road surface and collect the particulate matter. The unit is movable, to react to weather or road conditions. (Source: adapted from patent application)

For tire and road dust collection, a movable hood is proposed, that can be activated or deactivated according to weather conditions (rain, show), road surfaces (tarmac, gravel) or obstacles (curbs etc.).

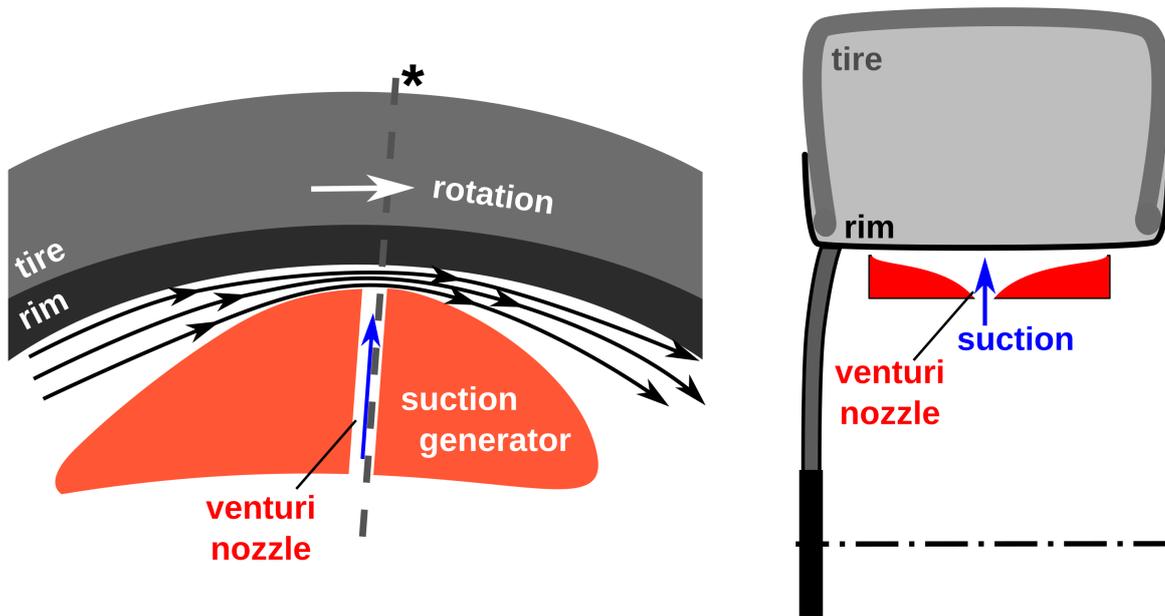


Fig.3: Venturi

Suction Generator. A) A guide plate mounted inside a vehicle's wheel creates a constriction of the flow area that can be used to create a suction via a venturi nozzle. The dashed line marked by the asterisk indicates the position of the cross section through the wheel shown in B). (Source: adapted from patent application)

Advantages

- Seal for efficient and effective collection of emitted particulate matter without contact to moving parts
- Only comparatively low negative pressure needed
- 100% collection of particulate matter-contaminated flow is possible
- Energy efficiency due to passive suction generation close to the consumer
- No impact on cooling of the brake disc
- Also suitable for internally ventilated disc brakes
- Retrofittable

Applications

- Cars & trucks (regardless of drive type)
- Rail vehicles
- Aircrafts
- Two-wheelers

Development Status

A first prototype was successfully tested in the university-belonging wind tunnel.

Patentsituation

German patent applications filed

Patent holder:
Ostfalia University of Applied Sciences – Hochschule Braunschweig/Wolfenbüttel

Related Technologies

[Brake dust filter hood with final separator and vortex generator for passive manipulation of the boundary layer](#)

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