CompEx: an ultra light composite exhaust system

Weight reduction is considered one of the major ways to meet stringent regulations for CO2 emission: lighter cars are cleaner and cheaper. Researchers at TU Delft designed the CompEx: a lightweight exhaust system of fibre-reinforced plastic

Designs of lightweight models for exhausts were always aimed at using as little steel as possible. But because the design of an exhaust is more or less fixed, this approach is hardly profitable anymore. The aimed reduction should be obtained by new materials.
Researchers at TU Delft designed an exhaust that is no longer made of steel, but of a composite material: phenolic resin reinforced with carbon fibre. This material is not only light, it is also stiff and strong enough to control unwanted vibration, and is not too expensive.

Superwool

But since composites are in essence plastics, they should be protected from the hot exhaust gasses. Therefore on the inside of the CompEx insulation is necessary. This consists of two layers of insulating material. The outer is made of Pyrogel, a material that is used in the NASA Space Shuttle. It insulates very well, but cannot be exposed to temperatures above 600 degrees. Therefore on the inside an extra layer of Superwool, a kind of tempered glass wool, is applied. This material is less insulating, but it is resistant to the hot gas flowing through the exhaust pipe.
The inner tube of the new exhaust consists of a thin-wired, fine metal stainless-steel wire. This mess holds the two insulating layers together and provides protection against the hot and pulsating exhaust gas

Noise reduction

An exhaust system of plastic weighs in itself much less that the traditional steel exhaust. However, the CompEx has a number of properties which make it possible to decrease the weight of the overall exhaust system even further.
For example, because of the two layers of insulation, the temperature right outside the CompEx stays below 90 degrees. As a result, heat shields around the exhaust become superfluous. The insulating layers also work as a strong silencer (30 to 50 decibels less). Additional silencers are therefore no longer necessary. So the CompEx combines some elements of the traditional exhaust into one integrated exhaust system. Depending on the location of the engine in the vehicle and the number of components that is no longer needed, the weight of the exhaust system can be reduced from nearly 20 up to 85 percent. From research on a sports car it is concluded that the weight of the entire exhaust system (after the catalyst) can be reduced from nearly 12 to just over 3,5 kilos. The CompEx not only saves a lot of weight, but by omitting the heat shields and mufflers also delivers more space at the bottom of the car, for the fuel tank, for example. Furthermore, because a composite exhaust system does not rust, the CompEx has a double lifetime when compared with conventional steel exhaust.
In sports cars the composite exhaust can prove its worth first, but the CompEx will also be able to find its way to passenger cars. Besides its considerable reduction of weight the CompEx has another great advantage: it can be delivered as an exhaust which is ready-to-install, or as a half-product that can be bent and adapted to the requirements of a specific car.

Helicopter

Outside the automotive industry, an exhaust that weighs less has also considerable profits for helicopters: for an AgustaWestland 136 application of the CompEx could lead to a weight reduction between 18 and 36 kilograms.
Further research should reveal the long-term behavior of the outer shell of CompEx. An even better protection of the inner insulation layer against the hot exhaust gasses is also subject of ongoing investigation. This will take some time, but since composite exhaust systems can reduce the weight of a car with at least 10 kilograms, they truly represent a solution for reducing automotive emissions.

Benefits of CompEx:

- Heat shields around the exhaust silencers and are no longer required
- Therefore, the exhaust system can be 20 to 85 percent lighter
- The exhaust takes up less space
- The CompEx is easy to fit into different types of car.

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