



Lower Rolling Resistance Through Organosilane

One out of every five tanks of fuel is used simply to overcome the rolling resistance of the tyres. This has also been confirmed by specialists at Michelin. Now, engineers at the French tyre company have developed a new “green tyre”, the Energy Saver, which has a low rolling resistance that reduces fuel consumption and therefore cuts emissions. According to Michelin, the tyre improves fuel economy by between 0.15 l and 0.3 l per 100 km.

1 New Tread Compound

The tyre manufacturer is convinced that the new tyre, which can be fitted to compact and medium-sized cars and family vans, reduces fuel consumption without making compromises in safety, driving dynamics or mileage, **Figure 1**. This is achieved by the development of a tread compound that uses only silica as a filler. Silica allows a reduction in a tyre's rolling resistance, which is a loss of energy due to friction and deformation. However, since rubber and silica have different polarities, the two substances are unable to form a natural bond with each other. For this reason, the experts used so-called organosilanes (bifunctional organic silica) as coupling agents. This organosilane technology makes it possible to further resolve the conflict of objectives between grip on wet roads, low wear and low rolling resistance. The organosilane is added to the rubber to strengthen the bond between the reinforcing filler and the rubber. In addition, the tyre manufacturer adds only a very small quantity of carbon black to the compound to blacken the tyre.

The new rubber compound, which has been patented by the French company under the name Durable Security Compound, builds up a lot of grip when the situation requires it but reduces rolling resistance by minimising grip when-



Figure 1: The new tyre can be fitted to compact and medium-sized cars and family vans



Figure 2: The tyre must be able to heat up immediately – for example during braking – in order to maximise grip

ever the driving situation permits. To do this, the tyre exploits the fact that grip between the rubber and the road is temperature-dependent. The tyre has to stay cool in order to offer minimum rolling resistance but must be able to heat up immediately – for example during braking – in order to maximise grip. **Figure 2**.

1.1 High Frequencies

Due to the addition of silica, the tread compound of the new energy-saving tyre is heated up not only by friction or ambient temperature. The compound also reacts to vibrations that heat up the tyre from within. At frequencies of several 100 kHz, the rubber compound heats up in a few milli-seconds, thus immediately providing maximum grip for the tyre. This effect benefits the driver during braking. High frequencies can also be achieved by driving fast around bends or during acceleration. The advantage is that the tyre only builds up maximum grip when it is actually required.

1.2 Low Frequencies

In urban traffic or when driving in a straight line, on the other hand, the tyre is subjected to far less vibration due to its own rolling motion. In such cases, vibrations are in the range between 20 Hz and 30 Hz. These low frequencies do not have an excitation effect on the rubber compound. As a result, the compound remains cool in such situations and the

tyre's rolling resistance is reduced to a minimum, thus saving energy and reducing wear, **Figure 3**.

2 Low Weight

The Energy Saver is approximately 800 g lighter than its predecessor. This weight reduction also has a positive effect on rolling resistance and fuel consumption. At the same time, the tyre's structure and the molecular structure of the compound increase the tyre's lifetime. According to the company, the tyre has up to 40 % higher mileage than comparable tyres. The uniform molecular structure is provided by a special mixing process. The components that form the compound are mixed extremely precisely to achieve a completely homogeneous rubber mixture. This has the effect of optimally distributing the load over the tread surface and ensuring that the tyre wears evenly and slowly.

3 Fuel Consumption

The new, low rolling resistance tyre, which is manufactured at the German factories in Bad Kreuznach and Bamberg as well as at other plants, is currently being launched on the German aftermarket. In comparative tests with competitor tyres from Continental,

***“As Little as Possible,
as Much as Necessary”***

ATZ Mr. Hoffmann, how long did the development of the new Energy Saver tyre take?

Hoffmann The actual development of a new tyre series takes between two and two-and-a-half years. Added to this is the time needed for basic and material research, as well as pre-development. These results go directly into the development process, but the work already begins three to five years earlier.

ATZ What were the performance specifications for the new tyre?

Hoffmann The main specifications compared to the predecessor generation were a significant improvement in rolling resistance and wet grip while still maintaining the same lifetime. These general requirements were, of course, made more precise for the developer in the form of detailed individual specifications.

ATZ The new Energy Saver is lighter because the new compound required less material. Where exactly were you able to save material?

Hoffmann The specific weight of the material itself plays a very subordinate role in weight reduction. Instead, material was eliminated wherever possible, for example in the bead wire area, in order to optimise weight.

ATZ Does this reduction in material not have a negative effect on the durability of the tyre?

Hoffmann Absolutely not. Our extensive experience and the test results are the key to our success and allow us to implement the principle of “as little as possible, as much as necessary.”

ATZ It is difficult to develop a tyre that not only has a low rolling resistance and therefore reduces energy consumption

and emissions but also provides excellent braking performance on wet roads. How do you resolve this conflict of objectives?

Hoffmann In order to achieve the best possible compromise between high grip and low rolling resistance, our material experts have developed a new tread compound based on our patented Durable Security Compound (DSC). The homogeneous molecular structure of this new compound is produced by a special mixing process – also developed within our company – that mixes all of the contents together in such a way as to form a highly precise, homogeneous compound.

ATZ Compared to the predecessor model, what are the improvements and by what percentage were you able to improve the tyre’s properties?

Hoffmann Rolling resistance was improved by up to 10 % depending on the tyre size and



Figure 3: The car equipped with the new tyre has a lower rolling resistance

Pirelli and Goodyear – which, according to the company, were performed by TÜV Süd Automotive (Test 05/2007) – the “green tyre” from France reduced fuel consumption by between 0.15 l and

0.3 l. This means that between 3 g and 6 g less CO₂ is emitted per kilometre. Calculated over the lifetime of a car, Michelin says that approximately 600 kg to 1200 kg less CO₂ is emitted.

In service at car manufacturers such as Daimler, Peugeot, Volvo, Volkswagen and Toyota, the new tyre from France is already helping to reduce CO₂ emission in the OEM segment.

Katrin Pudenz



Helge Hoffmann, Head of Testing and Technology Car / Truck / 4x4 Tyres at Michelin in Germany

type, and on average by 7 %. At the same time, the braking distance in the wet, from 80 km/h, was improved by 3 m. And this has

been achieved while still maintaining the same lifetime of the predecessor model Energy E3A.

ATZ Isn't a lower rolling resistance achieved at the expense of tyre grip?

Hoffmann Wet grip and rolling resistance are two parameters that represent the classic conflict of objectives in tyre design. With the introduction of silica technology in the early 1990s, Michelin laid the foundation for resolving this conflict, although it still has not been completely eliminated. Therefore, in the development of the new Energy Saver, our main focus was on separating the added potential that the developers were offering, and we took the decision to maintain the same lifetime and concentrate on improving grip and rolling resistance.

If we concentrate on a one-sided use of the potential offered – by focusing on either rolling resistance alone or wet grip alone – we can, of course, achieve much better per-

formance in each case. But we believe that this is a bad compromise and is not in the interests of the customer, even if the occasional tyre tester might see things differently.

ATZ Is an Energy Saver tyre also conceivable as a winter tyre?

Hoffmann Most definitely. And this is the case today with our tyre series that are already on the market. Both our "Alpin A3" and our "Primacy Alpin PA3" already bear the logo "Green X". That means that they are "green" tyres with optimised rolling resistance. The Alpin A3 has rolling resistance values that are only marginally higher than those of the Energy Saver.

ATZ Mr. Hoffmann, thank you for this interview.

Interview conducted by Katrin Pudenz.



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