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BMW Group sets nine records with hydrogen combustion engine. H₂R Research Car underlines the Company's technological leadership.

The BMW Group has set nine records for hydrogen-powered cars with combustion engine with its H₂R Research Car and thus again shown what this drive technology is able to offer. The records set on the BMW Proving Grounds at Miramas in the south of France strengthen the BMW Group's conviction that hydrogen can replace conventional fuels without drivers having to dispense with the dynamic performance of today's vehicles.

"Nine records herald the beginning of the hydrogen age. BMW technology has already come a long way. Now, together with politicians and the energy industry, we must turn our vision of sustained mobility into reality", stressed Professor Burkhard Göschel, Board Member for Development at BMW AG.

The H₂R Race Car not only looks a dream; its technical data are impressive too. The six-litre 12-cylinder power unit develops output of more than 210 kW (285 bhp). This accelerates the prototype to 100 km/h in approximately six seconds and gives it a top speed of 302.4 km/h (185.52 mph). The hydrogen combustion engine is based on the power unit of the BMW 760i and thus features ultramodern technologies, such as fully variable Valvetronic valve drive. Engine modifications

mainly involved the fuel injection system, which was adapted to the special features and requirements of hydrogen. The H₂R benefited from the results gained during series development of the future BMW hydrogen engine for the first premium limousine with dual-mode operation. The BMW Group is planning to launch a model that runs on both hydrogen and petrol. "We shall start delivering cars with hydrogen combustion engines during the production cycle of our current BMW 7 Series", says Professor Göschel.

The records in detail

The H₂R prototype set the following records, shown here in times measured and speed, in accordance with the FIA rules and regulations:

	time in sec	speed in km/h
Flying-start kilometre	11.993	300.190
Flying-start mile	19.912	290.962
Standing-start 1/8 mile	9.921	72.997
Standing-start 1/4 mile	14.933	96.994
Standing-start 1/2 mile	17.269	104.233
Standing-start mile	36.725	157.757
Standing-start 10 miles	21.052	262.094
Standing-start kilometre	26.557	135.557
Standing-start 10 kilometres	146.406	245.892

Published by
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Corporate Affairs
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publicaffairsletter
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The aim of establishing these records was not only to prove the potential power and performance of the hydrogen engine. The reliability of the technology used in the H₂R also demonstrates the maturity of the hydrogen-powered engine developed by BMW.

Record Car. Second, the development engineers were able to use proven BMW chassis and suspension systems that meet the strictest requirements. Third, the use of CAD technology resulted in a clearly targeted development process.



Impressive inside and out: the BMW H₂R Record Car with hydrogen engine.

Development in just ten months

The Record Car was conceived, designed and developed by BMW Forschung und Technik GmbH. The name H₂R stands for "H two Race Car", "Hydrogen Record Car" or "Hydrogen Research Car". "We had just ten months to develop the prototype", said Jürgen Kübler, H₂R Project Manager. However, short time spans of this kind are quite normal for the Company's creative engineers. Three factors helped them to meet the deadline. First, the components developed for BMW's hydrogen-powered production car of the future have reached a high degree of maturity, allowing their unproblematic adaptation for the

The "heart" of the H₂R Record Car is based mainly on BMW's top-of-the-range power unit, the petrol-driven 12 cylinder. It can run on hydrogen fuel through adjustment of engine management as well as of components of the fuel/air mixture formation. The most important structural differences are the hydrogen injection valve and the choice of materials for the combustion chambers. Contrary to the production engine with fuel injected directly into the combustion chambers, the injection valves in the hydrogen engine are in the intake manifolds. In order to achieve record speeds, the hydrogen combustion engine was designed and built for single-mode operation, running exclusively on



hydrogen. This enabled the engineers to set up and tune the engine specifically for hydrogen requirements.

The combustion properties of hydrogen are quite different from those of petrol or diesel. Under normal air pressure hydrogen burns faster than petrol, but the combustion temperature is slightly lower. Inside the engine, the high combustion speed of the hydrogen/air mixture generates a higher temperature than in a petrol-driven engine. Therefore, engine management of the H₂R was modified so that the hydrogen/air mixture is not ignited until the piston reaches top dead centre, thus ensuring maximum output. The higher combustion pressure of hydrogen has a significant advantage: more power from the same amount of energy means a higher degree of efficiency.

tank opens at a pressure of 4.5 bar. Two additional valves ensure that any leaks in the jacket around the tank, which keeps the hydrogen at the low temperature required, do not have dangerous consequences: they open up as soon as pressure inside the tank exceeds 5 bar. With this double safety system the hydrogen tank cannot burst as a result of excess pressure.

Gas pressure builds up in the fuel supply system simply because of the rising temperature of the cryogenic, liquid hydrogen in the tank and is kept at an operating pressure of approximately 3 bar by a tank pressure controller. Then the coolant in the 12-cylinder power unit warms up the hydrogen gas in a heat exchanger to ambient temperature. Additional valves monitor the gas pressure in the fuel pipes leading to the engine: cold low-temperature valves inside the tank control the removal of hydrogen. If any of the pre-flow pipes develop a leak and the supply pressure falls below 0.4 bar, the fuel supply valves close automatically, disconnecting and sealing off the tank from its surroundings.



12 cylinders, six litres, 285 bhp: the hydrogen engine gives the H₂R a top speed of more than 300 km/h.

Ultramodern safety technology

The fuel system in the BMW H₂R is based on a proven series development concept. The vehicle's tank is filled at a mobile hydrogen filling station by means of a manual tank coupling. The vacuum-insulated, double-walled tank holds more than eleven kilograms of liquid hydrogen and is fitted next to the driver's seat. There are three valves for maximum safety: the operating valve on the

Stable and light

When it came to the structure and chassis of the H₂R, the development engineers at BMW Forschung und Technik GmbH used series components from a BMW sports car, namely the monocoque aluminium spaceframe as well as the entire chassis and suspension system. High-strength structure panels made of aluminium, a particularly light and corrosion-resistant material, fill the spaces between the extra-large extrusion-pressed profiles which give the car its stable "skeleton". The result for the driver is an excellent, direct driving experience without the slightest vibration or body "tremble".

Designers gave the H₂R a truly unique body. Its proportions are reminiscent both of classic BMW race cars and record vehicles: measuring 5.40 metres in length and 2 metres in width, it is designed for optimum aerodynamics. In order to achieve record speeds, the frontal area is just 1.85 square metres and the drag coefficient a mere 0.21. At the rear a 20-centimetre-long diffuser prevents air swirl behind the car. At the same time, the side profiles and length of the H₂R ensure stable driving characteristics. Like on a Formula 1 race car, the outer skin is made of carbon-fibre-reinforced plastic, offering an ideal combination of superior stiffness and low weight: with a full tank and a driver at the wheel, the H₂R weighs just 1560 kilograms.



BMW Group and hydrogen

The wish to be independent of fossil energy has resulted in a worldwide search for the fuel of the future. To ensure both mobility that is more compatible with the environment and a smooth changeover to a long-term supply of energy, the fuel must be sustainable. Ideally, it should be renewable time and again and meet a number of economic, qualitative and quantitative criteria. Scientists and experts all over the world have pinpointed only one source of energy that comes close to this ideal: hydrogen.

Leadership due to 25 years of experience

For around 25 years, the BMW Group has worked hard in the field of research and development for international leadership in hydrogen technology. The Company provides know-how not only in engine technology, but also in the recovery, filling and storage of hydrogen.

The BMW Group advances resolutely the introduction of hydrogen as fuel of the future, establishes partnerships with other companies to develop the necessary technologies and raises awareness among decision-makers in politics and the energy industry of the need to act now.

BMW has done research on engines and vehicles run on liquid hydrogen since 1978. On May 11th 2000, BMW became the world's first carmaker to present a demonstration fleet of 15 hydrogen-powered limousines, in this case the BMW 750hL. "We focus on the combustion engine because we are convinced that our customers will continue to demand dynamic performance, motoring comfort and a long cruising range in future", says Professor Göschel.

Recent steps to develop the hydrogen industry have been encouraging from BMW's point of view. At the beginning of 2004, for example, the first General Assembly of a new body, the European Hydrogen and Fuel Cell Technology Platform (EHP), convened in Brussels. Its task is the development and use of economical, competitive European energy systems based on hydrogen and fuel cell technologies for mobile and stationary applications.

In the next ten years the EU is to provide up to 2.8 billion euros to promote an environmentally compatible hydrogen industry. Specialists of the BMW Group have been appointed to bodies such as the Advisory Council and the Deployment Strategy Panel of the EHP as well as the California Hydrogen Highway Implementation Advisory Panel. Thus, know-how is being transferred at international level – and the BMW Group is contributing the experience it has gained from more than 25 years of hydrogen research.

Further information

If you like more information on BMW CleanEnergy, please visit our website at:

www.bmw.com/cleanenergy



Dr. Helmut Panke (right), Chairman of the Board of Management of BMW AG, and Prof. Dr. Burkhard Göschel, Board Member for Development, present the H₂R at the Paris Motor Show.

Unlike fossil fuels, hydrogen's production and use can be embedded in a regenerating natural cycle. If hydrogen is produced from sources of energy, such as solar, wind and water power, it is available in unlimited quantities and practically emission-free. The BMW Group is the first carmaker in the world to gear the medium- and long-term development of its vehicles to hydrogen operation and elaborate a comprehensive concept: BMW CleanEnergy – the BMW Group's Energy Strategy. Its long-term objective is to avoid emissions and use regenerative sources of energy.



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