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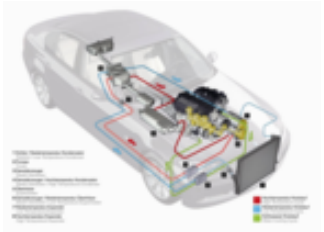
BMW Developing Steam Assist Drive Based on Waste Heat Recovery

12 December 2005



BMW's Turbosteamer. Click to enlarge.

BMW Group Research and Engineering is developing a steam-powered auxiliary drive—called the Turbosteamer—that uses the waste heat present in the exhaust gases and cooling system from a conventional gasoline engine as its source of power.

In tests with a 1.8-liter, four-cylinder engine, the new auxiliary power unit reduced fuel consumption by up to 15% while generating nearly 14 additional horsepower and 20 additional Nm of torque.

The Turbosteamer is based on the same principle as the steam engine: heated fluid forms steam in two circuits which is used to power the engine.

The primary energy supplier is the high-temperature circuit which uses exhaust heat from the internal combustion engine as an energy source via heat exchangers. More than 80% of the heat energy contained in the exhaust gases is recycled using this technology, according to BMW.

The steam is then conducted directly into an expansion unit linked to the crankshaft of the internal combustion engine. Most of the remaining residual heat is absorbed by the cooling circuit of the engine, which acts as the second energy supply for the Turbosteamer.

> *The Turbosteamer reinforces our confidence that the internal combustion engine is undoubtedly a technology fit for the future.*
>
> —Professor Burkhard Göschel, BMW Board of Management

BMW designed the components of this drive system to fit in existing model series. Engineers carried out tests on a number of sample packages to ensure that a car such as the BMW 3 Series provides adequate space. Their conclusion is that the engine compartment of a four-cylinder model offers sufficient space to accommodate the auxiliary units.

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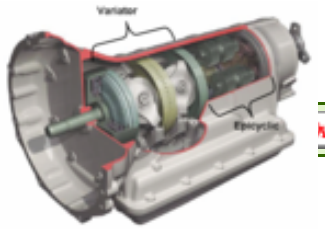

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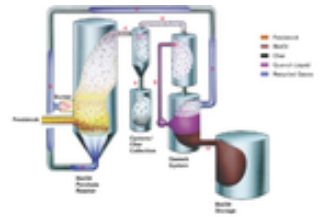

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smart Shows Hybrid, CNG, Electric Prototypes

Ongoing development of the concept is focusing initially on making the components simpler and smaller. The long-term development goal is to have a system capable of volume production within ten years.

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Tracked on Dec 15, 2005 12:49:36 PM

Comments

Thank you Professor, but sustainable mobility is also a political choice.

Posted by: westbrooks01 | Dec 12, 2005 9:01:19 AM

Awsome idea. No batteries required.

Posted by: Justin | Dec 12, 2005 10:49:35 AM

Interesting, but complex--similar in concept to high-efficiency combined cycle power plants. How does this mesh with BMW's avowed intention to include idle-stop and regen braking on all their cars? Sure seems like a lot of complexity under the hood,

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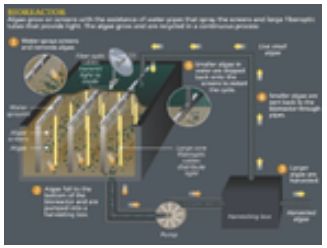
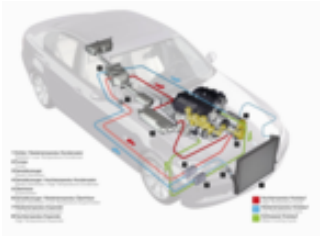


BMW Turbosteamer Steam Assist Drive



with attendant higher costs and expensive maintenance.

Posted by: Nick | Dec 12, 2005 12:38:08 PM

14 hp is plenty for idle stop and low speed use. Many steam cars were heavier than this and performed well with only 10 hp engines. The question I have is how much energy can this boiler store?

Posted by: tom deplume | Dec 12, 2005 3:25:16 PM

"Sure seems like a lot of complexity under the hood, with attendant higher costs and expensive maintenance."

Their current products are not priced for the mass market.

Posted by: Robert Schwartz | Dec 12, 2005 3:58:16 PM

And the people who buy them won't be enticed by 15% less fuel consumption.

Posted by: Engineer-Poet | Dec 12, 2005 4:53:06 PM

Some complex tradeoffs here. If there's a significant amount of high pressure steam storage, then the system offers some of the same performance features that make hybrids attractive. I.e., high torque at low speed, enabling a smaller engine, and idle stop capability. Good fuel mileage, but no regenerative braking.

Where something like this could make sense is in a plug-in serial hybrid. The engine would be undersized, delivering somewhat less than the average power needed for freeway driving. It would be run full on to extend the range of what would be mostly a battery EV.

Posted by: Roger Arnold | Dec 12, 2005 8:54:30 PM

If the engine didn't have a catalytic converter, the steam generator could be

mounted very close to the engine where it could capture even more of the engine's heat. The cat could be mounted after the steam generator but would be less effective due to the heat loss. Unlike a hybrid, this system is more effective at constant speed, high load such as driving on the freeway when the engine generates the most heat. Very reminescent of the compound turbo.

Posted by: Justin | Dec 13, 2005 2:31:36 AM

Catalytic converters add energy to the exhaust stream by burning fuel that wasn't burned inside the cylinders. It may be advantageous to use an inherently dirtier but smaller engine like a two-stroke or wankel. The small engine would be essentially an apu in which its exhaust is burned inside a larger boiler and using the steam for vehicle propulsion. Something similar was tried in the 1920s but never went into production.

Posted by: tom deplume | Dec 13, 2005 5:06:31 AM

"Catalytic converters add energy to the exhaust stream by burning fuel that wasn't burned inside the cylinders."
I don't think so. Check out the temperature drop from the manifold to after the cat.
http://www.autoblog.com/entry/1234000500071716/

Posted by: Justin | Dec 13, 2005 10:40:41 AM

Very reminescent of the compound turbo.

Exactly. Turbocompounding sure sounds simpler and lighter weight than adding a full-featured steam engine.

IIRC Scania is using it in some of their newest truck engines.

Posted by: joib | Dec 15, 2005 7:08:02 AM

Turbocompounding can't recover energy beyond expansion of gases to atmospheric pressure; a steam system can.

What amazes me is that a system like this has not already gone into diesel ships and heavy long-haul trucks. They seem ideal.

Posted by: Engineer-Poet | Dec 15, 2005 9:58:28 PM

What they should do, and maybe have, is study all possible bottoming cycles, including stirling engines (my one note theme, endlessly repeated) Stirlings are compact and highly reliable these days, and recover available energy better than steam cycles. You can arrange a multi piston stirling to receive heat at several temperatures, analogous to a multiple expansion steam engine, all blowing the stirling working gas over one turbine, which could be driving an alternator, or be geared to the engine.

Posted by: wimbi | Dec 17, 2005 2:06:56 PM

I like to believe that I pull out unobvious things from what I learn, yet I never even thought about a Stirling engine which receives heat at several temperatures.

And I become a little more enlightened.

Posted by: Engineer-Poet | Dec 17, 2005 9:30:14 PM

This system might not have gone into diesel ships, because the exhaust temperatures are already significantly lower. Diesel engines have a much higher compression ratio and a turbocharger. Both, high compression ratios and turbochargers lead to lower exhaust temperatures.
The potential gains on a gasoline engine should be significantly higher. Although, I wonder how effective this system is at mainly partial throttle operation.

Posted by: globi | Dec 19, 2005 8:38:04 AM

What's not to like? Free power with better fuel economy? Sounds good to me. Unfortunately, the extra cost to implement this sort of system is weighed against the cost of fuel. These systems were considered in the U.S. during the '70's oil crisis but cost shot them down - along with the prospect of a toxic, high pressure,

flammable working fluid under the hood. We have better fluids now, better electronic controls, and a greater need to reduce overall vehicle heat rejection. Does anyone know what fluid BMW is using here? Note that they're doing all of their engine cooling with this system.

Posted by: Heatmizer | Dec 19, 2005 10:11:27 AM

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