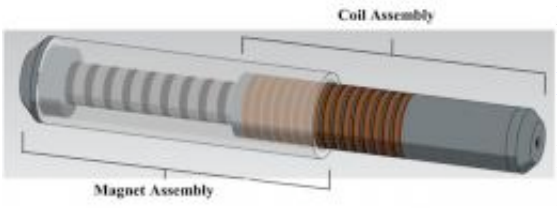
Vehicle shock absorber recovers energy from bumps in the road



March 17, 2010 By Lisa Zyga

Enlarge

In the regenerative shock absorber, a smaller magnetic tube slides inside a larger, hollow coil tube, producing a magnetic flux. The researchers estimate that, for typical driving conditions, the system can improve fuel efficiency by 2-10%. Image credit: Zuo, et al.

(PhysOrg.com) -- In the past decade, regenerative braking systems have become increasingly popular, recovering energy that would otherwise be lost through braking. However, another energy recovery mechanism that is still in the research stages is regenerative suspension systems. This technology has the ability to continuously recover a vehicle's vibrational energy dissipation that occurs due to road irregularities, vehicle acceleration, and braking, and use the energy to reduce fuel consumption.

In a recent study, Professor Lei Zuo, Brian Scully, Jurgen Shestani, and Yu Zhou, all mechanical engineers from the State University of New York at Stony Brook, have designed and tested a retrofit regenerative shock absorber that recovers a vehicle's vibrational energy. The researchers built a 1:2 scale prototype of the regenerative shock absorber, and demonstrated its ability to harvest 2-8 watts of power during typical driving conditions at a speed of about 45 mph. They predict that a full-scale system on a four-wheel car should be able to recover up to 256 watts under these driving conditions.

“For typical driving conditions, we are predicting the ability to harvest approximately 64 watts per wheel, for a total of approximately 256 watts,” Zuo told *PhysOrg.com*. “This value increases considerably when the system is used on irregular roads.”

The purpose of the shock absorber in a vehicle's suspension system is to reduce the vehicle’s vibration by dissipating the vibrational energy. About 10 years ago, researchers began looking into recovering the vibrational energy using various magnetic devices. In general, these systems work by first absorbing the kinetic energy of suspension vibration between the wheel and a sprung mass, and then converting that energy into useful electric power.

Zuo and his team’s shock absorber consists of two tube-like components: a smaller magnetic tube slides inside a larger, hollow coil tube. The coil component is made of copper coils wound around a plastic delrin tube, while the magnetic component is made of ring-shaped magnets separated by ring-shaped magnetically permeable spacers. The magnets are aligned with like-poles facing each other to produce a radially emitted magnetic flux. The magnetic tube is also surrounded by a high magnetically permeable material in order to further “pull” the magnetic flux outward. As Zuo explained, having a high magnetic flux is key to the design.

“The power we regenerate is proportional to the square of the magnetic flux across the coils,” he said. “Therefore, if we increase the flux by two times, the peak power output will increase by four times.”

When placed in the vehicle suspension, vibrations in the suspension cause the coil tube to move relative to the magnetic tube. As the copper coils move inside this magnetic field, a voltage is generated. The electricity can then be used to recharge the vehicle’s battery.

By recovering the vehicle’s vibrational energy and using it to drive the vehicle, the researchers hope that regenerative suspension system technology will be able to increase fuel efficiency and cut down on pollution. They note that, in the US, automobiles are a major source of several pollutants in the atmosphere, including 70% of the carbon monoxide, 45% of the nitrogen oxide, and 34% of the hydrocarbons. Further, fuel efficiency has lots of room for improvement: currently, only 10-16% of a vehicle’s fuel energy is used

to drive the vehicle, i.e. to overcome the resistance from road friction and air drag. The rest is lost due to braking, vibrational energy dissipation, and other forms of loss.

“Regenerative braking harvests large amount of power in a very short time, in an intermittent manner,” Zuo said. “However, the regenerative shock absorbers can harvest the power in a continuous way. On the smooth highway road, the regenerative shock absorbers can improve the fuel efficiency by 2%, and on bumpy roads up to 10% increase can be expected.”

In the future, the researchers plan to increase the energy density and efficiency of the system by further increasing the magnetic field intensity and improving the harvesting electrical circuit. The New York State Energy Research and Development Authority (NYSERDA) will provide funding to support Zuo on this research and development work.

“We believe there is still room for improvement in the overall design of the regenerative system, and we are working on such improvement under funding support from NYSERDA,” Zuo said.

More information: Lei Zuo, Brian Scully, Jurgen Shestani, and Yu Zhou. “Design and characterization of an electromagnetic energy harvester for vehicles suspensions.” *Smart Mater. Struct.* 19 (2010) 045003 (10pp). Doi:10.1088/0964-1726/19/4/045003

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- theknifeman - Mar 17, 2010
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  Why not use a lever to create greater movement for the magnetic rod instead of a direct system?
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  question: if the shock absorber is generating varying amounts of power, sometimes small, sometimes large, how is this varying output integrated into the power storage system of the car, I am a computer scientist and get a little nervous around hardware :-D
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- blento - Mar 17, 2010
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  This is something they should have done a long ago. Also install them in doors (Ford said the door opens 10000 in life of a car), install them in seats under every pasanger. Install small wind turbines on the roof for additional 5-10%. Even stearing wheel should be Gm style circa 1960.
  - report abuse
- Husky - Mar 17, 2010
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  not to mention the hole in the floorplate for flintstone propulsion when running empty
  - report abuse
- otto1923 - Mar 17, 2010
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  Here's one from MIT
  http://www.treehu...rber.php
  The one in the article sounds simpler. They want to eliminate the alternator load on the engine.
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- designmemetic - Mar 18, 2010
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Questionable estimates? energy doesn't come from nowhere. By that math each non regenerative shock absorber would be dissipating over 64 Watts of energy in the form of heat generated in the pneumatic shock absorption systems. So the question I have is if this were true what is the thermal equilibrium temperature of a non-regenerative shock absorber being heated continuously by 64 Watts of energy and does this match actual measured temp of real shock absorbers?

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- jimbo92107 - Mar 18, 2010
  - Rank: 5 / 5 (2)

  What about the energy wasted by bouncing up and down on inflated tires? Or the energy that could be harvested from the vibrations of the road and the sound of the air. What about the energy that could be harvested from light and heat beating down on the roof? What about the HUGE amount of energy wasted by not harvesting the excess heat of an internal combustion engine?

  There's a lot of potential energy that's being ignored.
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- lengould100 - Mar 18, 2010
  - Rank: 5 / 5 (1)

  I can see it now. Taxpayers complaining to their city governments "not enough potholes in the roads to keep my batteries charged!"
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- A_Paradox - Mar 18, 2010
  - Rank: 4 / 5 (1)

  jimbo,
  maybe the high frequency pressure variations [sound] coming from interaction of the tyre with the road surface could be absorbed by piezoelectric crystals arrayed on the surfaces of the wheel which face into the tyre cavity. I suppose this would require some very robust transistors or whatever to rectify the outputs from the crystals.

  For "Heat and light on the roof" I think robust photoelectric cells on the top surface should be standard features of all cars right now. In Australia this would allow us to power small extractor fans to take out the hot air which accumulates when cars stand locked and closed up in open air car parks.

  For "the HUGE amount of energy wasted ....heat .." I have read recently that at least one car manufacturer is experimenting with the use of a Stirling engine connected to an alternator to do just that: using the 'hot' side of the S. engine as a heat sink for the exhaust pipe.
  - report abuse
- Newbeak - Mar 19, 2010
  - Rank: not rated yet

  A Paradox: Is the company supplying the Stirling engine Cyclone Power Technologies (http://www.cyclonepower.com/) ,perchance? This company is researching modern external combustion engines which can run on anything that produces heat.
  - report abuse
- antialias_physorg - Mar 19, 2010
  - Rank: not rated yet

    maybe the high frequency pressure variations [sound] coming from interaction of the tyre with the road surface could be absorbed by piezoelectric crystals arrayed on the surfaces

of the wheel which face into the tyre cavity.

The amount of sound energy you could harness is negligible and certainly not worth the added weight of a conversion system.

For "Heat and light on the roof" I think robust photoelectric cells on the top surface should be standard features of all cars right now.

This makes no sense. look up 'solar constant' and do the math. If you plastered an entire car with 100% efficient solar cells you'd still get only a pittance of power at high noon on a cloudless day in summer compared to what a car needs to run.

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- DaveMart - Mar 20, 2010
  - Rank: not rated yet

  That's a lot of complexity and cost for 2% of energy in normal driving.
  The 10% for cross country and bumpy roads might make it worth while for military vehicles and off-roaders, but it might be counteracted by more difficult maintenance.
  - report abuse
- ricarguy - Mar 22, 2010
  - Rank: not rated yet

  One of the coolest things about this concept that no one has mentioned here yet is that this is a semi-active suspension, where the shock absorber would be tuned per conditions as you drive. As was pointed out, bad roads or off road is where you might get any significant power (a portion of the alternator load) out of such a system.
  Of course the big issue that many pie-in-the-sky types don't think enough about is cost: bang for the buck. If it can make any economic sense, it will very likely get done sooner or later. If it doesn't, it fails.
  Always remember the engineer's mantra: "better, faster, cheaper".
  - report abuse

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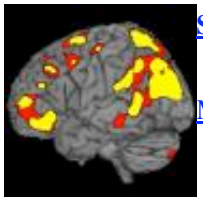

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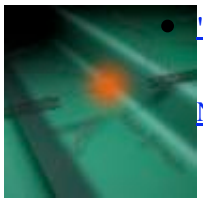

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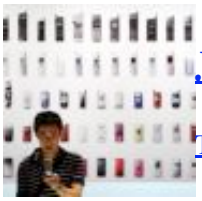

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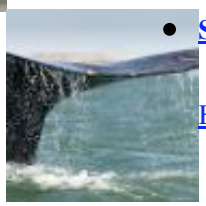

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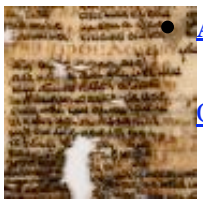

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