THOUGHT TO BE THE FIRST VEHICLE THAT USES WATER IN ALL OF ITS HYDRAULIC SYSTEMS

Purdue Students Builds Industrial Lawn Mower

WEST LAFAYETTE, INDIANA – A group of Purdue University undergraduates built an industrial riding lawn mower that's a cut above the rest.

The students created what is thought to be the first vehicle that uses water in all of its hydraulic systems, including power steering, power brakes and transmission.

Recent advances in water hydraulic systems have allowed them to perform as well as petroleum hydraulic systems. Because water offers several environmental and economic advantages over petroleum hydraulic fluid, the students teamed up to demonstrate that such a vehicle is now possible.

Recent graduates Jason Brown of Pendleton, Ind.; Dan Sellers of Bourbon, Ind.; and Dan Pitstick of Rensselaer, Ind., worked through their final semester at Purdue to build the machine. Nathan Schoonover, of Evansville, Ind, who graduated in December, also worked on the project.

Although the mower was redesigned to prove a point, it does have a practical purpose. Mowers leak some hydraulic fluid, and on golf courses that fluid can kill grass on greens that often cost tens of thousands of dollars to construct and maintain.

Jacobsen, a division of Textron Inc. of Racine, Wis., donated the Greens King IV mower, which is a 31-horsepower, front-wheel drive mower with three sets of gang mowers that are raised and lowered hydraulically.

Gary Krutz, professor of agricultural and biological engineering and the students' advisor, says water hydraulic systems only would be practical in vehicles that use high-pressure systems, such as heavy equipment used in construction, agriculture, forestry and mining. (Automobiles have hydraulic brake and steering systems, but these are not typically highly pressurized.)

Using water in hydraulic systems currently costs twice as much as using petroleum products, but that could change as more applications are found for water hydraulics.

"If all of the research and development were done, all of the major companies would be using water instead of hydraulic fluid," Krutz says. "Because the industry is in its infancy, mass production hasn't lowered the cost. But once you start mass producing the necessary parts from ceramic, fiber-reinforced plastic or stainless steel, the prices will drop."

Graduate students Louis Cassens (right) and Michael Thomas put a revolutionary lawn mower through a trial run recently near Purdue's Food Science Building. The mower uses ordinary water in place of hydraulic fluid. Research at Purdue on water hydraulic systems currently focuses on hydrostatic bearings. Hydrostatic bearings would be used in cars or industrial or agricultural equipment. "These would work well with cars in the future that use fuel cells, because you would be able to use the water in the fuel cell and in the gear box," Krutz says.

The water used in the mower isn't straight from the tap; ordinary city water contains too many minerals and impurities and could cause build-up and corrosion. Instead, the system uses distilled water that has been de-ionized to remove any electrical charges that could cause corrosion.

Corrosion also is the reason parts for water hydraulics systems have to be made of stainless steel, plastic or ceramics. But the more expensive parts would be worth it because using water in hydraulic systems makes machinery more energy efficient, saving money.

The boost in energy efficiency is due to water's lower viscosity. Viscosity is the measure of how fast a liquid flows.

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Water flows up to 1,000 times faster than hydraulic fluid at normal air temperatures. Once the machine is warmed up, water is still less viscous.

Improved viscosity means less energy is required to push the hydraulic fluid through the system, making it more efficient. An engine that uses direct gearing is 95 percent efficient; one that uses hydraulic systems is 60 percent efficient. (Hydraulic systems are used in place of gears because they offer variable speed and can be placed in different locations around the vehicle.)

By using water instead of heavier petroleum fluid, Krutz estimates the efficiency could be boosted at least 10 percent.

"That doesn't sound like much, but that would mean a savings of 500 million gallons of gasoline in the United States each year," he says. "I'm also willing to predict that the lower friction will result in less wear for the equipment."

Replacing hydraulic fluids with water won't be without problems, however. Because tighter fittings and higher quality parts are needed to prevent leaks and corrosion, water systems are more costly. Also, the reduced viscosity of water means that turbulence within the system could reduce efficiency if the parts aren't engineered properly.

Krutz predicts that costs could drop quickly if even one manufacturer decided to focus on water hydraulic systems. "All we need is for one major lawn mower company to decide to use this technology in a premium machine, and the cost would drop significantly," he says.

Stainless steel and ceramics are among the expensive materials most needed for water hydraulic systems, and as the cost of these materials drop, replacing petroleum hydraulic fluid comes closer to becoming cost effective.

"Do you remember how you used to have to replace the muffler on your car every three years?" Krutz asks. "Steel producers figured out how to make stainless steel cheaper, and the auto manufacturers began using it to make mufflers. Now mufflers last as long as most people own a car.

"This price reduction in stainless steel is also making water hydraulic systems affordable, but steel materials still require a lot of engineering work to eliminate turbulence in the system."