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Building a Better Bicycle: A Hydraulic Vehicle with Optimal Energy Utilization and Recovery Techniques

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Green technology is one of the biggest demands in industry today, as energy and environmental crises pose a major threat to humankind. The objective of this research is to formulate a viable and economically feasible solution for the next generation of human-powered green energy vehicles, with energy storage and recovery system. A relatively simple concept of hydrostatic transmission based on a pump and motor was used. Accumulators controlled by electrohydraulic valves were used for energy storage and recovery purposes. Simulations created from the multi-domain simulation software AMESim were used to validate the sizing of the hydraulic components and the performance of the transmission system. An electronic control system was also designed to control the electrohydraulic components. A bicycle used to test the hydraulic transmission was able to reach a maximum speed of 20 mph. It could store energy and reuse it when required. A regenerative system that uses braking to store energy was also successfully tested. Overall, the concept of an efficient, human-powered hydraulic vehicle is mechanically possible, and achieving economic feasibility is a topic for further investigation. In conclusion, hydraulic transmission has great potential not only for human powered vehicles, but also for other vehicles in the near future.

Research advisor Andrea Vacca says, "The bicycle developed by the Purdue team for the 2012 Parker Chainless Competition is a perfect demonstrator of the potentials of hydraulic hybrids technology for power transmission. Although hydrostatic transmissions have lower energy efficiency than pure mechanical systems (i.e., chains), the possibility of regenerative braking as well the opportunity of more comfortable pedaling makes the hydraulic technology a candidate for small power applications like human-powered vehicles."

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