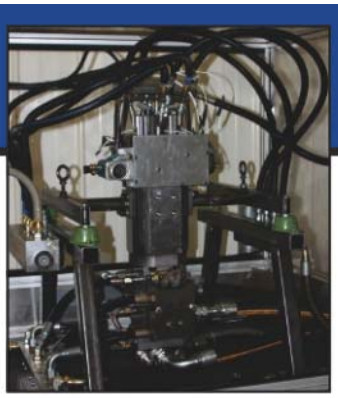
An Adaptable Power Train

Dave Drury



The ADAPT free-piston engine.

There is no doubt that the world needs reliable, efficient, and flexible sources of energy. However, power generation remains entrenched in diesel- and gasoline-powered piston engines that have changed very little, at the core, from the basic innovation years ago. These technologies are robust, well developed, and relatively inexpensive, but they are also inflexible and relatively inefficient. Given its age and inefficiencies, has the internal combustion engine reached the end of its life? Without a major breakthrough, that may be the case. Without a disruptive technology to replace it, the piston engine will keep chugging along, with only incremental changes and small increases in efficiency.

In today's energy climate, in which carbon-based fuels are arguably unsustainable and oil represents a national security dilemma, the search for alternative and diversified fuel sources has become more and more important. Diesel and gasoline have propelled this country to greatness, but it may be time for a change.

We have seen the rise of ethanol and biodiesel, both of which present technical challenges. Over the years, natural gas engines have been in vogue from time to time but have failed to stick due to infrastructure issues and cost-effectiveness. Other fringe fuels continue to be plagued with challenges as well.

Different fuels perform optimally under different conditions. Biodiesel faces handling, supply, and infrastructure issues; ethanol has received bad press for fuel economy; and natural gas faces similar problems. A common enemy to these alternatives is the engine platform itself.

A new perspective is needed

Engines can be modified, and there are technical solutions for each fuel, but the infrastructure deficiencies still loom large. Even if the required infrastructure were in place, manufacturers are not likely to produce engines specifically optimized for each fuel, which means making compromises that favor the current fossil fuels. However, if we look at the problem through a different lens, a solution to this dilemma seems possible. As a first step, variable valve actuation (VVA) shows efficiency gains in diesel, gasoline, and natural gas engines. Why not take it a step further?

We must take a critical look at the traditional paradigms and come up with something new. An example of this is Sturman Industries' ADAPT system, which combines electronic fuel delivery, VVA air control, air-injection emission control, and a digital-hydraulic approach to a free-piston engine. Using available technology, the ADAPT system allows for repeatable combustion control, which optimizes energy efficiency for different fuels. The ADAPT system also provides the variable compression necessary to sense and ignite different fuels in the same cylinder. One of the specific driving forces behind the ADAPT concept is the ability to compression-ignite anhydrous ammonia, a renewable, carbon-free, storable, and transportable fuel source.

Fuel flexibility includes ammonia

Energy storage is a hurdle for many alternative energy sources. Wind and solar have huge potential, but they do not provide energy on demand. Batteries are improving, but they still have size, weight, and cost constraints. Considering the energy sources available and the issues involved with each, flexibility will be the key to the energy future.

Ammonia is a common agricultural chemical. As a fuel, ammonia is naturally carbon-free, it can be produced with a 100 percent green electricity source, and it can store energy. The technology exists to produce ammonia with solar and wind power. Conversion of wind and solar energy to anhydrous ammonia provides an alternative energy source, and ammonia's energy density allows for transport to support mobile and stationary power generation.

Using other sources as transition fuels, the ADAPT technology is designed to run on diesel, natural gas, propane, and ammonia. This flexibility provides a solution to cost, availability, and environmental issues when choosing fuels.

The first application of ADAPT technology is in stationary power. Stationary power provides an opportunity to develop ADAPT in a controlled environment while obtaining real-time feedback on the system's performance. The current plan is to combine the technology with a novel approach to community development. Prairie Star, an off-grid community project in Berthoud, Colorado, is working with Sturman Industries to develop and pilot an ADAPT system to power four homes. The project has many phases, but the ultimate goal is to use energy from solar and wind sources, via anhydrous ammonia, to power an entire neighborhood.

The future of energy and energy storage is unknown, but what is certain is that if we do not act, then nothing will change. The old paradigms of power production and energy storage must be challenged with disruptive new ideas that create the changes needed. The ADAPT technology is that kind of idea—a new way of using proven technology that offers greater efficiency, environmental responsibility, and energy independence.

Dave Drury is a development engineer, Sturman Industries, Woodland Park, Colorado, USA (ddrury@SturmanIndustries.com).