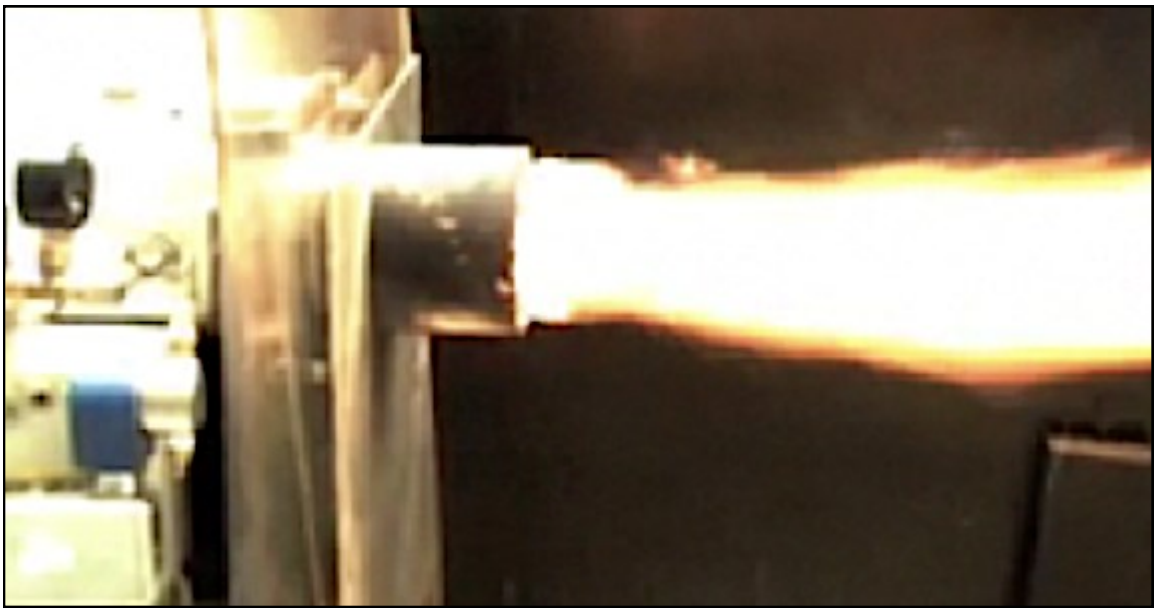
BiofuelsDigest
The world's most widely read biofuels daily

What happened? Pyrolysis breakthrough could cut drop-in biofuels cost to $2.58 per gallon

March 12, 2018 | Jim Lane



We have a breakthrough in pyrolysis to report today that could reduce the estimated cost of producing fuel from $3.27 per gallon to $2.58 per gallon.

And no one quite understands how the new process works — but it works.

“What we have achieved is process intensification – multi-fold increases in biomass throughput for a given size reactor – while preserving oil yield,” said Iowa State University’s Robert Brown, the Godfatha of catalytic pyrolysis himself.

Iowa State engineers call the process “autothermal pyrolysis.” The Iowa State University Research Foundation has applied for patent protection on the technology and has licensed it to Easy Energy Systems of Mankato, Minnesota for commercial use.

Here’s what happened

Others have experimented with adding oxygen to their pyrolyzers, but Brown said a review of the scientific literature didn’t find much success. In many cases, researchers dramatically reduced their yields of bio-oil.

As the Iowa State engineers continued to study autothermal pyrolysis, graduate student Joseph Polin decided to substitute inexpensive air for the pure oxygen used in earlier tests.

Polin found that to keep air-fuel ratios similar to the experiments with pure oxygen, he needed to feed biomass into the reactor five times faster. Brown was initially skeptical the reactor was big enough to handle so much more biomass. But it did.

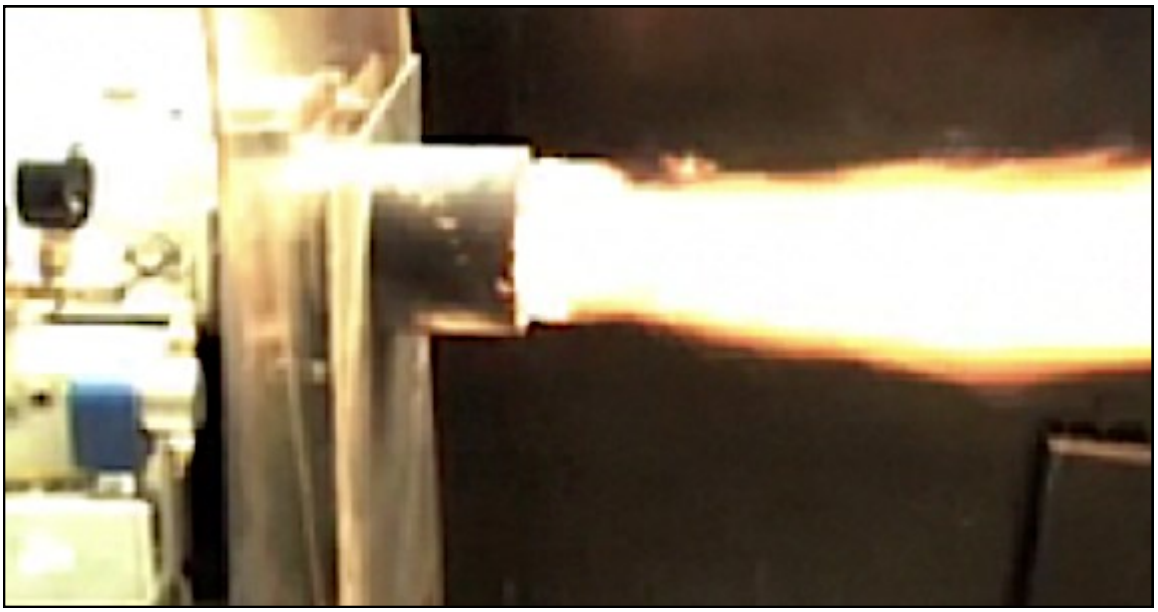
“The epiphany was that biomass throughput for a pyrolysis reactor was limited by our ability to get heat through the walls of the reactor,” Brown said. “By burning the biomass internally to generate the energy needed to drive pyrolysis, we eliminated the heat transfer bottleneck, allowing us to open up the throttle, so to speak, on our reactor.”

Here’s what we know

BiofuelsDigest
The world's most widely read biofuels daily

What happened? Pyrolysis breakthrough could cut drop-in biofuels cost to $2.58 per gallon

March 12, 2018 | Jim Lane



Brown and the engineers in his research group had worked for years to develop a thermochemical process called fast pyrolysis to produce biorenewable products. The process uses heat in the absence of oxygen to break down corn stalks, wood chips and other biomass to produce a liquid bio-oil for energy and a biochar for fertilizer.

The engineers had explored adding a little oxygen to the reactor. Brown suggested adding more and more. And that started to change everything. Now, rather than trying to improve pyrolysis by pushing more heat from outside the reactor, the engineers discovered burning a small amount of biomass inside the reactor could more efficiently provide the energy to drive pyrolysis.

Here's what we don't know

No one can quite figure out how it works.

And that's going to inhibit the design of larger-scale reactors. Specifically, plans for two autothermal demonstration plants capable of processing 50 tons of biomass per day could really use, as Brown put it, "a model that predicts the performance of these big reactors."

Here's what it isn't

Brown thought carbon monoxide and methane known to exit a conventional pyrolyzer might be burning during autothermal pyrolysis. Iowa State graduate student Chad Peterson proved him wrong using a simple computer model that demonstrated pyrolysis temperatures are too low to ignite these gases.

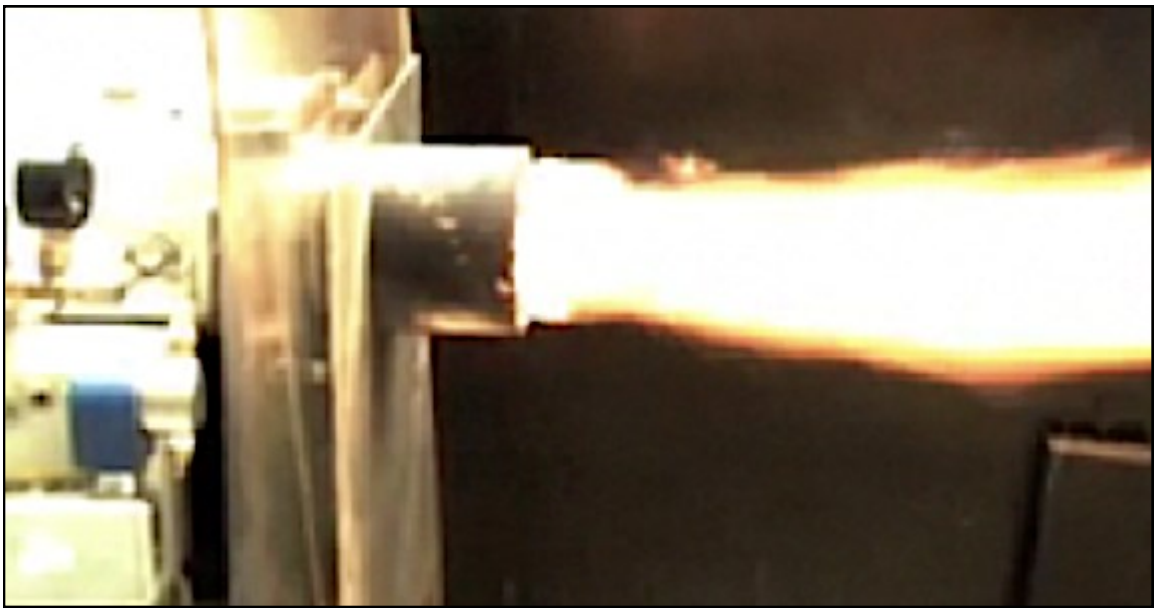
DOE steps in

To figure out what we have, the U.S. Department of Energy has come forward with a two-year, $854,039 grant to an Iowa State team to study autothermal pyrolysis and develop software tools to help design other kinds of autothermal processes. The grant from the department's Advanced Manufacturing Office is part of $35 million awarded to 24 research projects across the country. Final details of the Iowa State project are being negotiated.

BiofuelsDigest
The world's most widely read biofuels daily

What happened? Pyrolysis breakthrough could cut drop-in biofuels cost to $2.58 per gallon

March 12, 2018 | Jim Lane



Alberto Passalacqua, an Iowa State assistant professor of mechanical engineering, will lead the Iowa State project.

“First we want to figure the chemical reactions and mechanisms that make autothermal pyrolysis work,” said Passalacqua. “Then we want to develop models of the process and compare them to experiments. The final goal is to develop simplified design tools to design bigger reactors.”

The Iowa State engineers expect their design tools will be added to an open-source toolbox that is freely available to use. That could help reduce the risk of scaling up the technology for commercial use. And it could help apply the autothermal principle to other chemical processes.

The team

In addition to Alberto Passalacqua and Robert C. Brown, the research team includes Shankar Subramaniam, a professor of mechanical engineering; Mark Mba-Wright, an assistant professor of mechanical engineering; and Ryan Smith, the deputy director of the Bioeconomy Institute’s Thermochemical Research Program. The researchers will also hire one postdoctoral research associate and three doctoral students.