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FEV and Apogee launch world's first thermal-visualization tool for engine development

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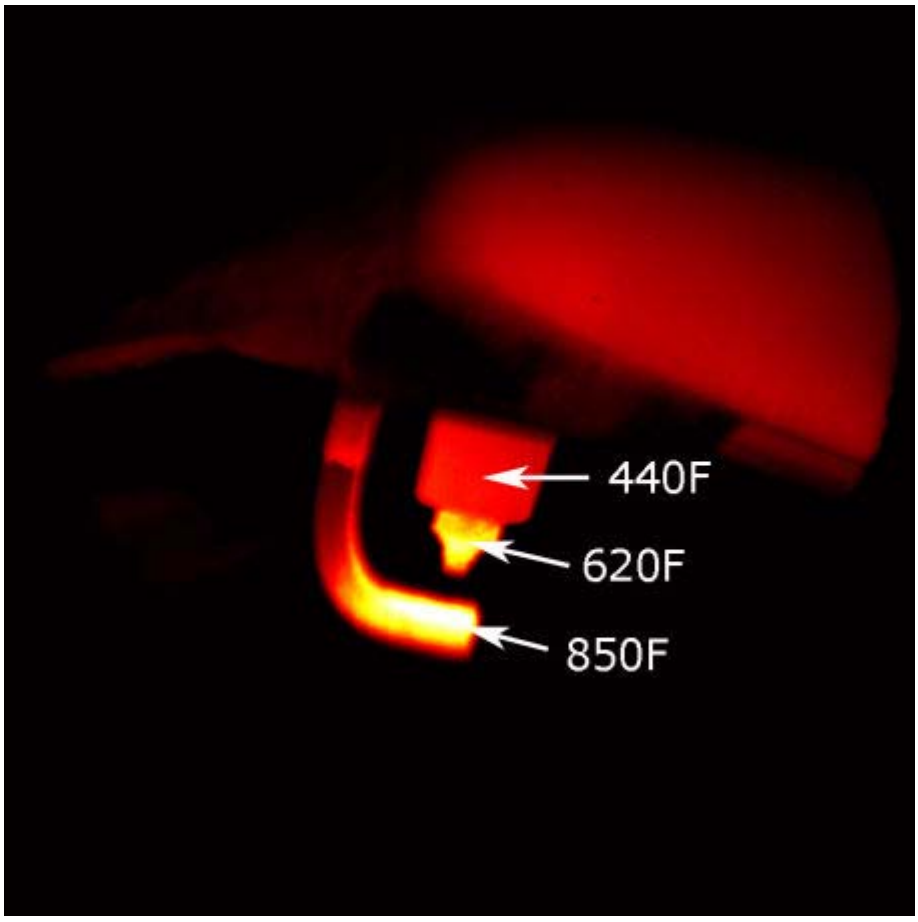

A digital image showing thermal plots at the spark plug tip taken from the FEV Apogee Thermal Visualization tool, recently launched at FEV's Auburn Hills, MI, facility.

The view through the control room safety glass is like any in a typical engine test cell—an organized jungle of wires and hoses connected to an engine humming quietly at 2000 rpm. But the live video running on the control room's overhead monitors is anything but typical.

It's a look inside the test engine's combustion chamber—large, live, and in living color. The resolution from inside this harsh environment is remarkably crisp; it appears you could reach

right in and touch the hot spark plug. There's the plug firing. There's the cloud of injected fuel curling around the plug tip, a typical issue in direct-injected gas engine development.

On the screens we see the valves opening and closing and the traces of burned gas exiting the exhaust port. Depending on the wavelength the operator selects, we can either look at a gas cloud, or through it. We see flame-propagation sequences, offered in high-speed video, or still images photographed by degree of crankshaft angle.

Captured on video for our small group of observers are highly accurate thermal plots taken at various areas around the chamber, including multiple points on the spark plug electrode. As the operator raises engine speed to 5000 rpm, we see the intake and exhaust valves rotating in their guides, as well as the injection spray flow patterns.

If this was a cable channel called Combustion TV, it would dominate the ratings. But the amazing tool is claimed by its makers to be the first and only Thermal Visualization system of its kind in the world. And OEM clients of **FEV** (its exclusive operator) are lining up to use it for unraveling various issues within their own engines.

AEI was the first media invited by FEV to see the new tool in operation. It's installed in a dedicated test cell at the company's Auburn Hills, MI, facility.

The system, which can be used to view any location within an ICE, was developed by **Apogee Scientific**, an optical-technology specialist based in Englewood, CO. Apogee and FEV collaborated on applying it to the powertrain-development space, explained Apogee's Principal Engineer, Jon Lesko.

"This tool enables engine-development teams to visually map out the combustion process and see characteristics, profiles, and phenomenon that previously could not be measured and visualized," he said. "By employing it at the research stage, you can shortcut any development problems that might occur later on, which can save a fortune.

"Or later on, if you have a production engine with a problem, you can bring it here to FEV for a quick look inside that will help you correct it."

The visualization system was designed with ample "headroom" to enable FEV to fully explore the higher compression ratios and cylinder pressures, new fuels, direct injection and boosting, additional thermal stress, and other trends driving future powertrain development, said Dr. Dean Tomazic, FEV's Vice President, Engine Performance and Emissions Division.

"One of the biggest issues involved with turbocharging DI gasoline engines is low-speed preignition," he noted. "This tool will enable us to go into the combustion chamber and identify where the onset takes place—it could be wall wetting, or piston impingement, anything where visualization and precise temperature measurements will help speed solution."

Other likely uses include developing engines with higher compression ratios and two-stage turbocharging and dual-fuel arrangements, where nozzle-tip temperatures and mixture preparation, respectively, are critical.

“Depending on how this system is set up, we can visualize the flame and fuel more accurately,” Dr. Tomazic said. “The flexibility of the tool is such that we identify and focus clearly on all these individual issues that are part of any engine-development program.

“It gives us a more simplistic way to approach design of new engines from the very get-go. That’s a big benefit,” he asserted.

With a background in optic physics, Lesko set out to create Apogee’s Thermal Visualization system by specifying the most robust components available. Most of the material used is military-grade, capable of withstanding extreme peak cylinder temperatures and pressures—even during abnormal conditions such as preignition and combustion “knock.”

“The detector originally came from a surface-to-air missile,” Lesko noted. “Some of the lens material came from the nose of a **Raytheon** AIM-9X Sidewinder (air-to-air heat-seeking missile). The lens hood itself is capable of withstanding 1800°C. A lot of the optical design work came from the astronomy field.”

Apogee developed the system’s camera and prisms, which allow the viewer to see around corners in tight confines. More than 95% of the system’s interchangeable lenses and components were custom designed for the application. All of the optical equipment is designed to fit through a conventional cylinder pressure-transducer bore.

FEV and Apogee are studying potential applications for the Thermal Visualization system beyond basic combustion engines. Lesko and Tomazic said operation of gas turbine engines, advanced turbocharger systems, and even catalytic converters are logical candidates for what may become the industry’s favorite “insiders” video program.

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