

Our injectors increase diesel fuel economy up to 30% & decrease emissions by 90%

PITCH VIDEO INVESTOR PANEL



ichortech.com Salt Lake City UT  

Technology Infrastructure Hardware Energy Automotive

OVERVIEW **UPDATES** WHAT PEOPLE SAY 68 ASK A QUESTION

Highlights

- 1 A realistic solution to combat climate change with Patents filed in over 25 countries
- 2 Average customer will see ROI in about 2 years. Works with any liquid fuel and utilizes existing infrastructure.
- 3 Geneva award winner
- 4 Reduces or eliminates costly components currently required for emissions reduction
- 5 Parent already working with industry leaders such as Mazda, Kohler, WeiChai and more.

Our Team



Trevor Bates CEO

20+ years experience in heavy equipment and class A operations. Founder 3B Diesel. Co-founder SS Heavy Haul. CEO and President of investor relations at Ichor.

The world needs an immediate solution for fossil fuel emissions. In order to solve this problem, the solution must work with all liquid fuel engines, without the need

for additional and expensive parts. RK injector technology is the fastest and most affordable solution.



Chad Webster President

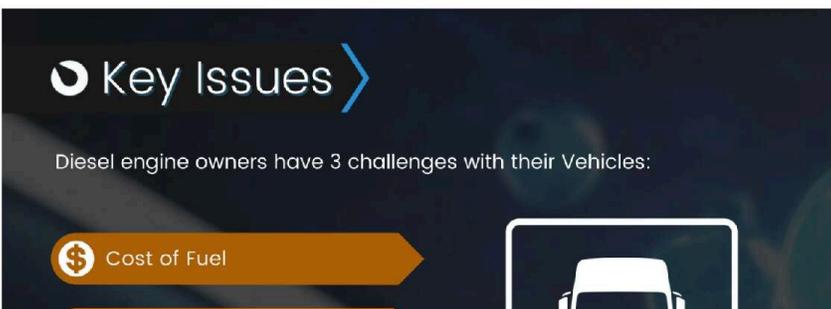
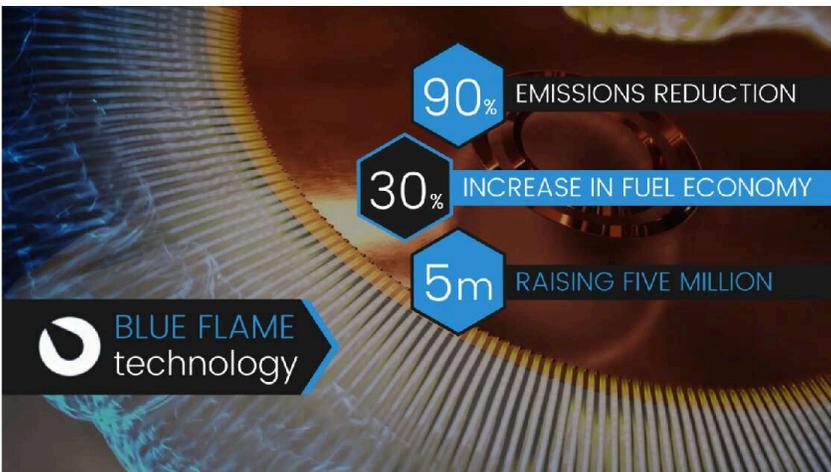
15 years research, development, and testing of oil and gas high pressure systems. Capriotti's franchise partner. President of research and development at Ichor.



Tyler Harris Vice President

15 years operations management in automotive industry and commercial real estate. Sales & customer service guru. Successful entrepreneur with various startups under his belt. President of sales at Ichor.

Pitch



Cost of Maintenance

Maintaining EPA standards



The Problem

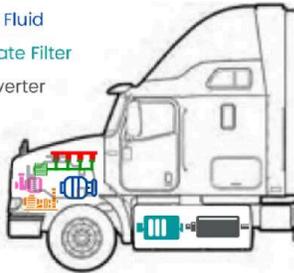
Existing systems have a number of significant drawbacks for diesel engine owners:



What if the solution is not AFTER the engine, but WITHIN the combustion process itself...

Prior Solutions Include:

- Diesel Common Rail
- High Pressure Fuel Return System
- HP Fuel Pump
- Exhaust Gas Recirculation
- Diesel Exhaust Fluid
- Diesel Particulate Filter
- Catalytic Converter



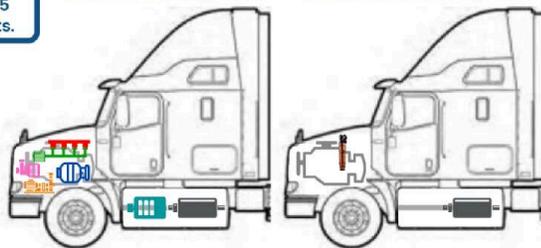
ALL focused on removing engine exhaust particulate AFTER the combustion stage

A Simple Solution

Ichor powered by RKI: Solve the problem at the engine, not after.



Old Diesel Engines: ICHOR Diesel Engines:



Additional Benefits

Not only do Ichor injectors eliminate the need for emissions components, they increase performance as well:

Reduces emissions by up to 90%



-  Fuel economy savings by up to 30%
-  Increases engine power and torque
-  Dramatically reduces maintenance costs

Where old injectors fail, **ICHOR injectors will succeed.**

	
Traditional injector	ICHOR fuel injector
 Larger fuel molecules	 Optimized atomization of fuel
 Inefficient spray design	 Customizable spray patterns
 Higher temperature combustion	 Lower temperature combustion
 Leftover fuel particulate	 Higher fuel efficiency

Market Analysis- USA

Initial target market:
 **3.9** million class 8 trucks. **\$1 BILLION**
 1% of initial target market at \$35,000 MSRP.

Future markets:

	36 million trucks registered for business.	\$14.5 BILLION
	5.55 million AG tractors currently in use.	1% of future markets at \$35,000 MSRP.

Consumer Benefits

 **2 YEAR**
 Return on investment
*Based on fuel economy savings alone.

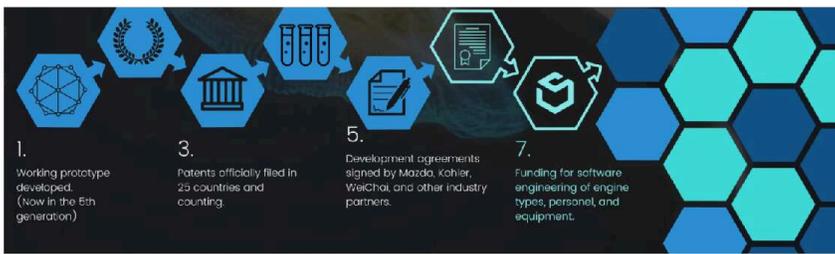
MSRP: \$35,000
 ICHOR injector Retrofit Per Class 8 Truck



A quadrant chart with 'CLEANER Emissions' at the top, 'OEM Emissions' at the bottom, 'OEM Fuel Efficiency' on the left, and 'Increased Efficiency' on the right. The origin is labeled 'Common Rail System'. A yellow dot is at 'HPDI'. A yellow dot is at 'Ducted Fuel Injectors'. The 'ICHOR' logo is in the top right quadrant.

Funding Goal: Raising \$5m to go to market

2. RFI injector prototype receives the Geneva award in 2006.
4. 6 year study of prototype completed by Powertrain Technologies Limited.
6. Funding for EPA certifications to retrofit diesel engines.



Introduction

- The RKLAB technology is a self-pressurising fuel injector, which is driven by cylinder pressure.
- By controlling the area ratio of the injector piston and high pressure plunger, extremely high injection pressures, in excess of 5000 bar may be achieved.
- The construction of the injector also allows a high number of holes within the nozzle, which can be easily configured to application requirements.
- The technology targets four main benefits:
 - Improved fuel economy / power availability
 - Cleaner combustion
 - Potential removal of after treatment
 - Removal of fuel system ancillaries
- The current effort is focusing on updating the hardware to today's emissions requirements, through the use of modern tools, including hydraulic system modeling (GT-SUITE), structural analysis of high pressure components (ANSYS), and CFD analysis of the nozzle configuration and combustion process (Converge).

- The RK Injector technology (RKI technology) is the key to unlocking high levels of Brake Thermal Efficiency (BTE) – 60% BTE target.
- At 60% BTE – the internal combustion engine is fully competitive with electric powertrains across the load/efficiency spectrum.
- The RKI system is clean burning – dramatically reducing the costs and complexity of after treatment systems.
- Significant work is being performed to optimize the combustion system around the RKI system (piston design, bowl shape) to achieve the BTE targets.
- Current design has achieved 54% BTE in engine design tests

BRAKE THERMAL EFFICIENCY

Engineering Tools

ID System Modeling

- Control system simulation
- Hydraulic system development

Rig Testing

- Control system development and testing
- Hydraulic systems testing

Development

- Internal flow characterisation
- Engine performance and cycle simulation

- Component bench testing
- Actuation sequencing
- RCM spray visualisation and combustion

Finite Element Analysis

- Injector component stress analysis
- Leakage path and conformability studies
- System assembly

Computational Fluid Dynamics

- Nozzle spray patterns
- Cylinder air motion and combustion
- Injector internal flow paths

Hydraulic and Cycle Simulation

GT Power single cylinder model with integrated RK injector model:

- GT predictive combustion model used
- Cylinder pressure activating RK injector

Study of effects of control timing on:

- Fuel mass delivered
- Injection pressures
- Generated cylinder pressures

The top graph shows Pressure (kPa) vs Time (ms) from 0 to 80. The bottom graph shows Fuel Mass (mg) vs Time (ms) from 0 to 80. Both graphs compare 'Spr' (Spray) and 'Cyl Chamber' (Cylinder Chamber) data.

The diagram shows an 'Engine Model' with 'Intake' and 'Exhaust' ports, and an 'Injector Model' with 'Fuel Injection Point' and 'Fuel Injector Nozzle'. A 'Cylinder Pressure Application Point' is indicated between them.

Spray Visualisation and CFD

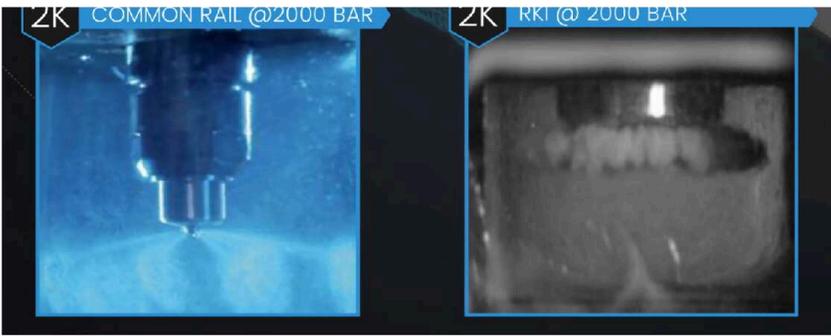
A sequence of six images showing the development of a spray from a nozzle. The top row shows the initial spray formation at Time = 0.0000, 0.0000, and 0.0000. The bottom row shows the spray expanding and interacting with a surface at Time = 0.01100, 0.02100, and 0.03000.

Spray Visualisation and CFD

A second sequence of six images showing spray development. The top row shows spray at Time = 0.04000, 0.05000, and 0.06000. The bottom row shows spray at Time = 0.07000, 0.08000, and 0.09000.

Notes:
 Experimental flow visualization does not include combustion
 Experimental results have been matched to CFD, based upon spray shape formation and fuel distribution rather than elapsed time step

Spray Pattern Comparison Results



GT- Suite System Analysis

GT-Power and GT-Suite are the primary tools used for the rapid development of the RK technology, where injection systems are modelled from inception and concept design, through to detailed design and analysis of the full injection and combustion system.

The modelling effort is currently focused on the development of our next iteration of injector design for hardware testing, looking specifically at:

- Multiple controls and control strategy
- Hydraulic system development
- Internal flow characterisation
- Engine performance and cycle simulation

RKLAB can provide "black box" GT-Suite modelling of the RKI system for engine model development.

RKLAB can provide full technical support through PTL.

CFD Analysis Overview

CFD tools have been utilised to inform design decisions in iterations of the injector hardware.

Investigations included the effects of nozzle geometry on spray patterns and interactions with in cylinder air motion, in particular within the development engine test section.

The current work effort is focused on producing a new set of guidelines and tools, from which a selection of nozzle geometries for engine fired testing of the next iteration of the RK injector, can be made.

Fuel Consumption Analysis - Fuel System Operation

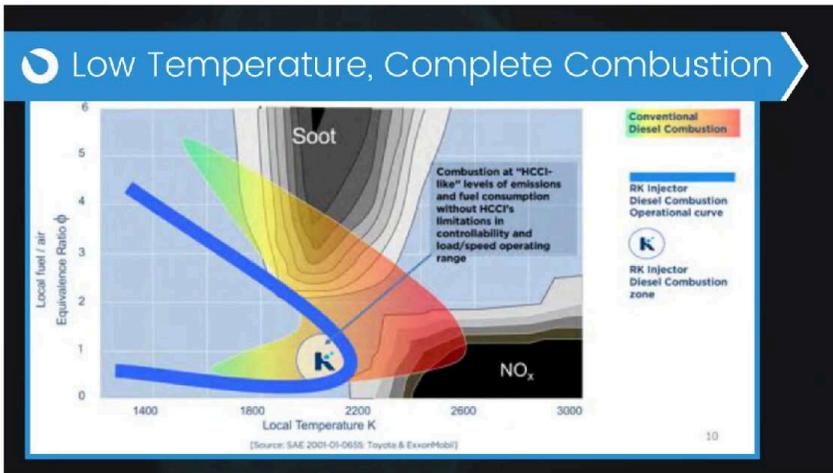
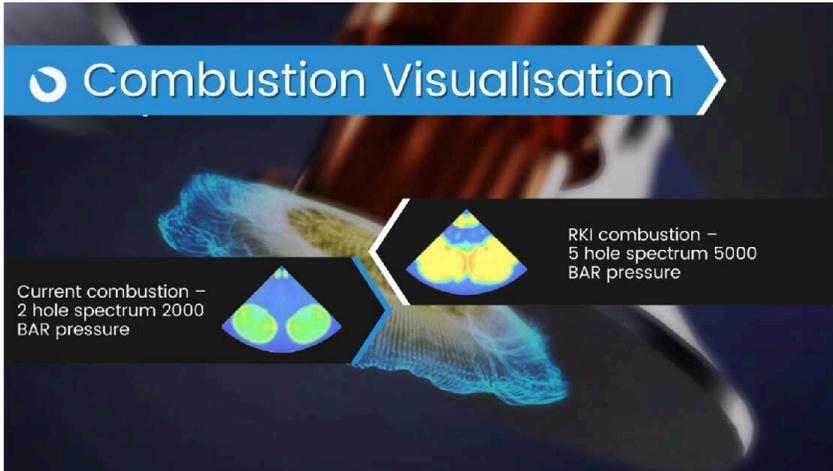
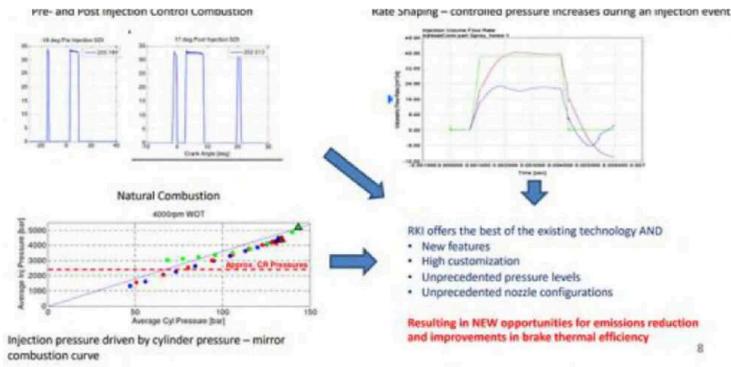
A study was conducted to further explore the thermodynamic impacts of the change in effective compression ratio which results from the injector piston motion of the RK type injector on a 1.6L HD engine.

- The study used a calibrated GT-Suite model of a production engine as a baseline to which an actuator was added which altered the engine cylinder volume by the effective change in compression ratio as the injector piston moves. This represents the potential work lost from the cylinder which is used to actuate the RK injector.
- The model calculated FMEP is based on engine speed and load, generated from experimental values. These values account for the losses associated with the common rail injection pump. Therefore the power required to drive the common rail pump must be added into the brake power result for the RK injector and the BSFC re-calculated.

The study concluded that:

- An RK type injector can provide significant increases in injection pressure, with little or no BSFC penalty (-0.3% ~ +1.2%).
- A common rail system capable of RK injector level pressures would require a step change in the technology (current max ~3500bar) and would incur significant BSFC penalties (+3.3% ~ +4.2%) from increased fuel pumping work.
- An RK type injector can improve on the BSFC of a common rail equipped engine whilst matching current technology level injection pressures (-1.5% ~ -2.4%).

Modes Of Combustion



Team at Ichor



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