

Achates Power drives opposed piston engine

American company is in talks with some Indian OE manufacturers for the use of its fuel-efficient, opposed piston engine. **Shobha Mathur** reports from San Diego.

US-based Achates Power Inc is in talks with Indian OE manufacturers for an improved internal combustion engine technology that it has designed in-house. The two-stroke, opposed-piston (OP), compression ignition diesel engine is claimed to possess the ability to enhance fuel economy, reduce greenhouse gas emissions and lower costs for running passenger cars and commercial vehicles.

Achates Power is in the process of defining projects for working with Indian vehicle manufacturers after completion of technical due diligence by prospective clients.

David M Johnson, president and CEO of Achates Power, told *Autocar Professional* on a visit to their facility in San Diego that the company visualises a huge challenge in India's transportation industry in terms of making engines cleaner. He says that despite rising oil prices, transportation of goods through commercial trucks is expected to climb further as the population grows larger and wealthier, thereby multiplying their requirements. This will trigger off large demand for passenger cars that will in turn drive the need for clean cars and the economic burden of doing it most efficiently.



David M Johnson: "Opposed piston engines will be useful for city buses with frequent start stop operation."

"So that market demand and that market dynamic is very well aligned with the technology that we are bringing, and we expect to have a number of different programmes in India and come to market in that timeframe," adds Johnson.

Achates Power is initially targeting commercial truck applications for its engine technology as this segment is the largest fuel consumer. Moreover, the company expects the highest value creation to accrue for it as well as for the customer from this market.

"In the US, trucks carry 80,000 pounds. I know that trucks in India are very heavily loaded and use a lot of fuel. If you want to carry freight over the mountain, fuel efficient engines are the best," explains Johnson.

He feels the OP engines would find useful application in buses as well with the exception of long haul transit buses.



The Achates Power engine has demonstrated fuel economy improvement of over 15 percent compared to benchmark diesel engines and a 55 percent improvement relative to comparable petrol engines.

For city buses which stop and start continuously, particularly hybrids that leverage clean fuel-efficient engines, Achates Power engines could be ideal. According to Johnson, the diesel engine market has been steadily growing over the last 20 years in

passenger cars. Similarly, between the 1940s and 1960s, commercial trucks that earlier used to run on gas and diesel globally have now converted to diesel.

As the industry further morphs towards more efficient and low cost engines, Johnson expects the company's OP engines to be harnessed for larger applications in trucks, buses and hybrids.

The company currently has fully functional engine prototypes running in its laboratory clocking close to 2,000 test hours. The engines have demonstrated their ability to comply with the most stringent EPA10 and Euro 6 emission norms.

Two dynamometers with instrumentation to record all necessary engine parameters and test cell conditions also exist in the laboratory. The fuel laboratory includes laser Doppler anemometry and laser induced fluorescence

30 SECONDS ON... HIGHLIGHTS OF THE ACHATES POWER ENGINE

THE ACHATES POWER, Inc. two-stroke, opposed-piston, compression-ignition engine is claimed to be key for the future of clean, efficient and cost-effective passenger- and commercial-vehicle transportation.

CLEAN

- Complies with the toughest emission standards in the world - EPA10 and Euro 6.
- Reduces greenhouse gas

emissions.

MORE EFFICIENT

- Eliminates cylinder head, which reduces heat loss.
- Eliminates valve train, which reduces frictional loss.
- Has a breakthrough combustion system.
- Has an advantageous stroke/bore ratio.

LOWER COST

- Has fewer components.
- Uses less raw material.

● Uses conventional materials and manufacturing processes.

LIGHTER

- Has a smaller displacement
- Eliminates components like the valve train and cylinder head.

Within the \$300 billion global market for internal combustion engines, Achates Power, Inc. primarily targets commercial-vehicle and passenger-vehicle engines.

to characterize fuel spray, and a fuel bench for mapping fuel injectors.

Johnson says the engines have demonstrated fuel economy improvement of more than 15 percent compared to benchmark diesel engines and an approximate 55 percent improvement over comparable petrol engines.

Unique powerplant

The OP two-stroke engine dispenses with the cylinder head, that reduces heat loss, eliminates the valve train, that reduces frictional loss, has a breakthrough combustion system and an advantageous stroke-bore ratio, fewer components with less raw material and leverages conventional materials and manufacturing processes, is lighter with a smaller displacement.

Achates Power meanwhile was founded in 2004 by James Lemke, a scientist who was inspired by Junker's Jumo 205/207 diesel aviation engines and aspired to make a better engine for reducing carbon dioxide emissions. The engine began running by 2005 in the laboratory using a single cylinder for research work. In real time applications however, multi-cylinder engines albeit two-stroke will be harnessed.

In the latter half of the 20th century, the advent of modern emission regulations stopped the wide-spread development of two-stroke engines for on-highway use. Historically though, the opposed-piston two-stroke diesel engine set records for fuel-efficiency and power density unmatched by other engine types. Hence, Achates Power leveraged modern analytical tools, materials and engineering methods for the development process of an opposed-piston two-stroke engine.

"Our formula is a closed

piston compression ignition two-stroke. Not using a cylinder head makes it more thermally efficient, compression ignition means we run on diesel fuel or diesel like fuels that allow high expansion ratio so they are more efficient and two-stroke allows more fuel efficiency," comments Johnson.

The USP of the engine is 40 percent parts reduction and mass reduction by 10 to 30 percent depending on design detail. It reduces CO₂ emissions with a lower engine cost of about 10 to 15 percent compared to conventional four-stroke engines. The engine design has resulted in an over 13 percent fuel consumption improvement compared to a state-of-the-art 2010 medium-duty diesel engine at the same engine-out emission level while achieving specific oil consumption of less than 0.1 percent over the majority of the operating range.

The engine contains two pistons for each cylinder and can be used with a single injector or multiple injectors varying on the design parameter.

The formula of opposed pistons, two-stroke and compression ignition when combined with modern technologies of turbochargers, modern materials and high pressure common-rail makes it a revolutionary engine, says Johnson.

The Achates Power OP engine uses different structures like cast iron, aluminium, forged steel, plastics as used in conventional engines.

Johnson says that there is a lot of commonality in Achates Power engine design and conventional engine designs that will enable its technology to be manufactured in existing plants.

"According to studies that we have undertaken regarding the tooling

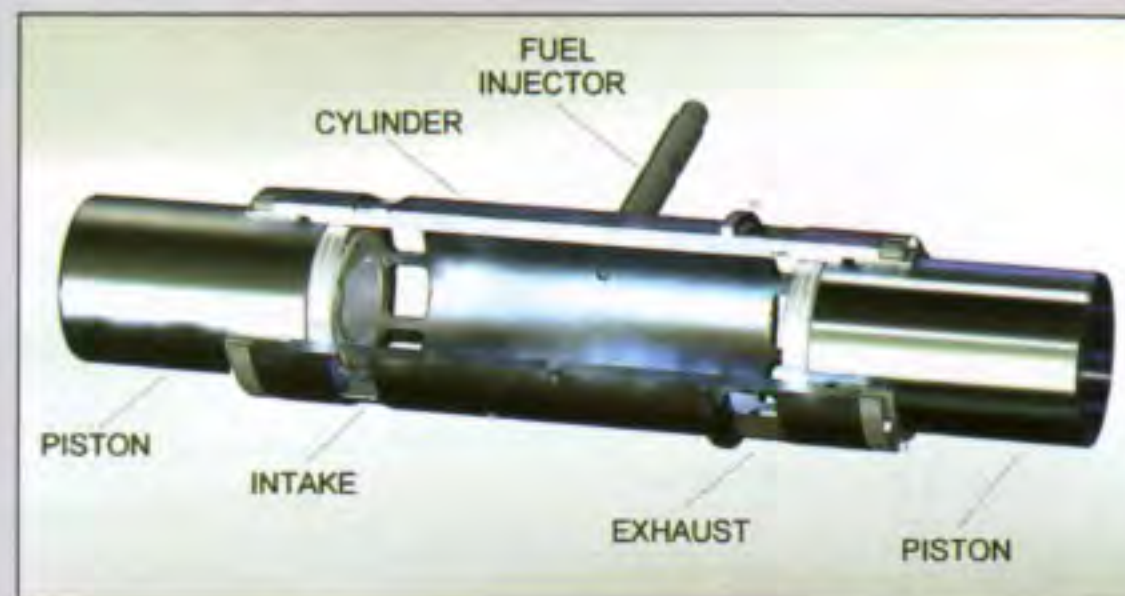
30 SECONDS ON... THE OPPOSED-PISTON ENGINE

THROUGHOUT THE 20TH century, when the utmost fuel, weight and volume efficiencies were required to propel aircrafts, ships and vehicles, an unconventional type of compression ignition engine was used: opposed-piston engines.

The two major strengths of this type of engines make them fundamentally better:

- **Opposed-piston architecture:** With two pistons per cylinder, working in opposite reciprocating action, these engines do not need cylinder heads which are a major contributor to heat losses in conventional engines. Ports in the cylinder walls replace the complex poppet valves and friction-creating valve trains of conventional engines.

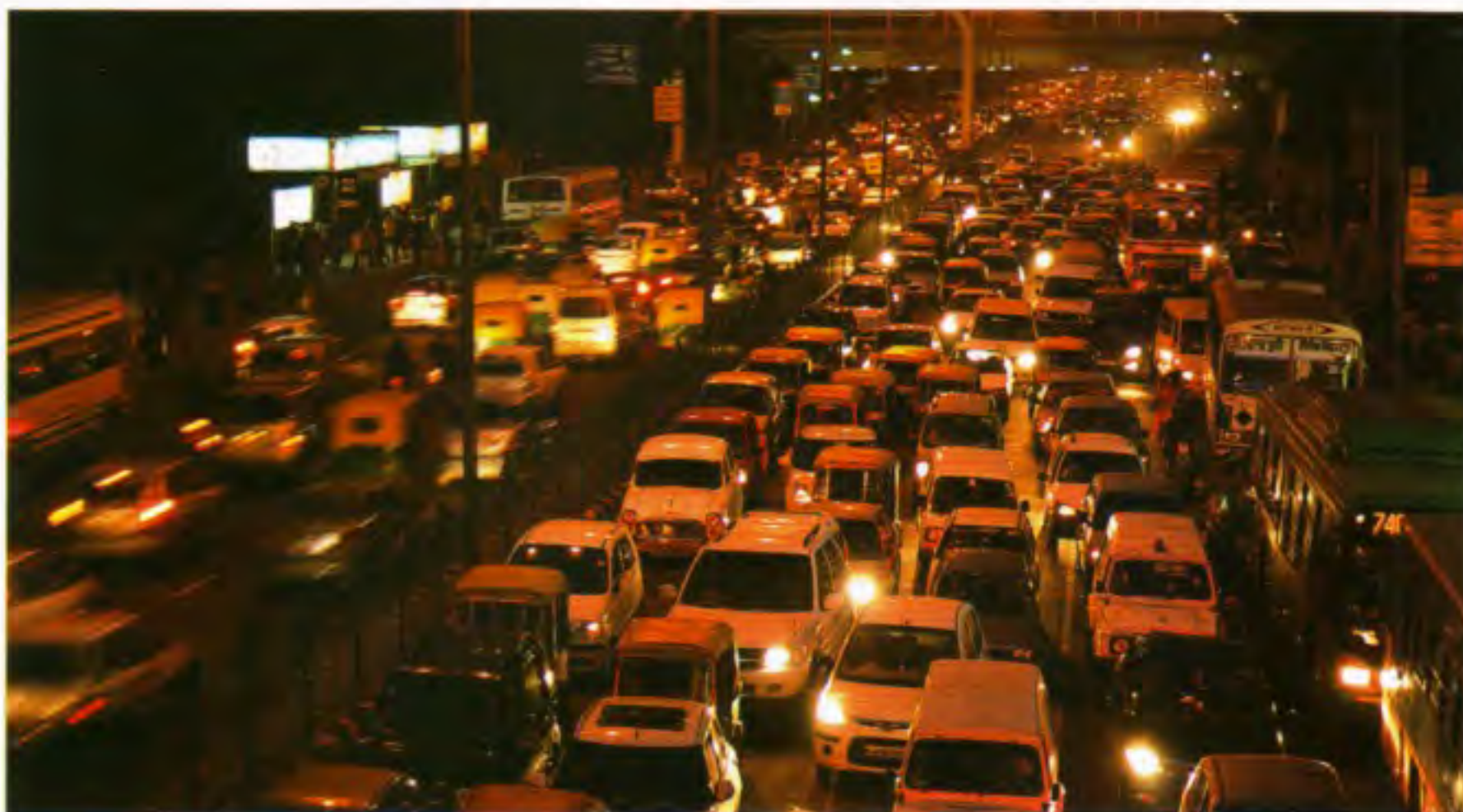
The intake ports at one end of the cylinder and exhaust ports at the



other are activated by the piston motion and enable efficient uniflow air scavenging.

- **Two-stroke combustion cycle:** A two-stroke engine produces twice as many power strokes per revolution as its four-stroke equivalent. This advantage leads to smaller displacement engines for similar performance, and lower in-cylinder pressure to lower emissions compared to four-stroke conventional engines.

In the past, these advantages were balanced by some well-documented shortcomings of two-stroke engines, which limited their scope of use. High hydrocarbon emissions (due to carburetion and over-scavenging) and excessive oil consumption (due to oil-fuel mixing in spark-ignition engines and port oil ejection in compression ignition, and direct fuel injection engines) are difficult issues to tackle in these type of engines.



Could Achates Power's fuel-efficient diesel engine be the answer to the growing demand for diesel vehicles in India?

and facilities required to manufacture our engines, we have found that it is less expensive to change over the plant to our technology than to change over the facility to the next generation of conventional technology," he points out.

While the company manufactures its OP diesel engines for developing prototypes, it has no plan to become a high volume manufacturer of engines. Instead it will focus on technology development

for transfer either to Tata Motors or General Motors.

Since the gestation cycle from concept to production of an engine varies from four to six years, Achates Power expects its diesel engines to start production by 2015-17.

Johnson says Achates Power is open to different tie-ups including technical collaborations, JVs with Indian companies or even licensing arrangements for its diesel engine technology in the long-term. ■