

achatesPOWER™ Fundamentally Better Engines®

2013 North American Medium and Heavy-duty Commercial Vehicle
Engine New Product Innovation Award



FROST & SULLIVAN



50 Years of Growth, Innovation & Leadership

New Product Innovation Award Medium and Heavy-duty Commercial Vehicle Engine North America, 2013

Frost & Sullivan's Global Research Platform

Frost & Sullivan is in its 50th year in business with a global research organization of 1,800 analysts and consultants who monitor more than 300 industries and 250,000 companies. The company's research philosophy originates with the CEO's 360-Degree Perspective™, which serves as the foundation of its TEAM Research™ methodology. This unique approach enables us to determine how best-in-class companies worldwide manage growth, innovation and leadership. Based on the findings of this Best Practices research, Frost & Sullivan is proud to present the 2013 North American New Product Innovation Award in the Medium and Heavy-duty Commercial Vehicle Engine Market to Achates Power, Inc.

Key Industry Challenges

Frost & Sullivan recognizes that the North American Medium and Heavy-duty Trucking Industry is faced with an environment where fuel costs have emerged as the single largest cost component for fleets and owner operators. Moreover, emission regulations in North America are now the most stringent in the world and are about to get more stringent with the upcoming GHG 2014-2018 regulations. Frost & Sullivan expects that the heavy-truck focused GHG guidelines beginning in model year 2014, and progressively expanding in scope through model year 2018, establish standards for emission and fuel efficiency levels at both engine and vehicle systems individually to shift industry focus towards clean and lean engines.

The need for the GHG regulation today is a combination of multiple factors. One among the key factors is the medium and heavy-duty trucks' significant impact on overall vehicle emissions in the U.S. (approximately 22 percent of all transportation related GHG emissions). Current industry standards do not define fuel efficiency for these trucks, unlike passenger cars and light-duty trucks which are regulated by the CAFE standards.

All major truck and engine OEMs have actively been pursuing a variety of technologies, including but not limited to engine downsizing, downsizing, advanced after-treatment, improvements in in-cylinder combustion and engine prognostics. The spotlight for regulation compliant powertrain systems now is squarely on developers of advanced and innovative powertrain systems that can not only ensure regulation compliance but also offer compliance solutions that feature lowest incremental upfront cost and reduced lifecycle cost.

The technology that has been recognized in this Award, though not entirely new to the automotive industry, holds tremendous potential for large-scale market adoption. The level of modernization that Achates Power has brought into the traditional opposed-piston

(OP), two-stroke diesel engine architecture is credit worthy, and has definitely positioned OP engines as a credible design-centric solution to the ever-increasing regulatory challenges of the future. Research indicates that the proprietary Achates Power (OP) engine has a demonstrated benefit of 20 percent lower cycle-average brake-specific fuel consumption and similar engine-out emission levels when compared to the leading, conventional diesel engines currently available in the market. We believe that Achates Power has managed to effectively combat factors that restrain market adoption through strong fundamental research and advanced engineering. The interface and simulation model that has been adopted for in-house testing and validation is acceptable for ironing out initial technology challenges, and Frost & Sullivan anticipates that real-time, on-road validation of these engines will foster increased market adoption.

New Product Innovation Award

The Frost & Sullivan New Product Innovation Award is a prestigious recognition of Achates Power's accomplishments in the Medium and Heavy-duty Engine Market. As an unbiased, third-party, Frost & Sullivan recognizes Achates Power for delivering excellence and best practices in their respective endeavors. The New Product Innovation Award is backed by extensive analysis; companies identified, and the quality of their innovation, product benefits, customer ROI, and customer acquisition potential are monitored and evaluated through primary analyst research. This stringent methodology positions Achates Power as a superior market participant.

Key Benchmarking Criteria for New Product Innovation Award

For the New Product Innovation Award, the following criteria were used to benchmark Achates Power's performance against key competitors:

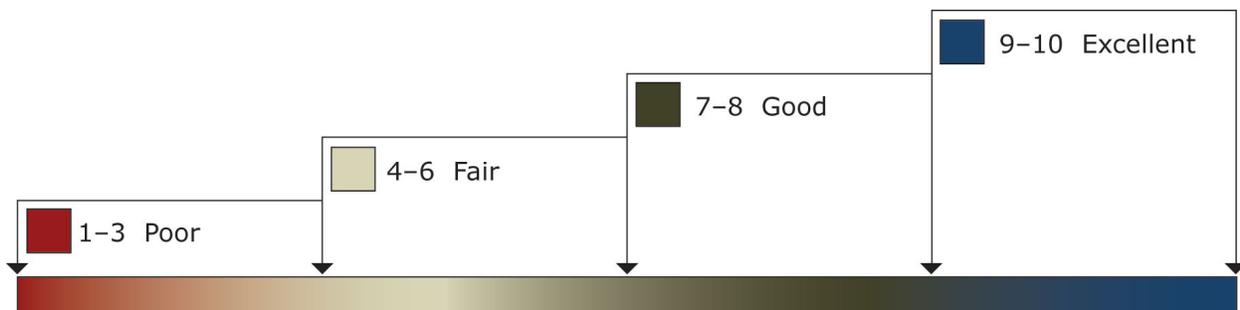
- Innovative Element of the Product
- Leverage of Leading-Edge Technologies in Product
- Value Added Features/Benefits
- Increased Customer ROI
- Customer Acquisition/Penetration Potential

Decision Support Matrix and Measurement Criteria

To support its evaluation of best practices across multiple business performance categories, Frost & Sullivan employs a customized Decision Support Matrix (DSM). The DSM is an analytical tool that compares companies' performance relative to each other with an integration of quantitative and qualitative metrics. The DSM features criteria unique to each Award category and ranks importance by assigning weights to each

criterion. The relative weighting reflects current market conditions and illustrates the associated importance of each criterion according to Frost & Sullivan. Fundamentally, each DSM is distinct for each market and Award category. The DSM allows our research and consulting teams to objectively analyze each company's performance on each criterion relative to its top competitors and assign performance ratings on that basis. The DSM follows a 10-point scale that allows for nuances in performance evaluation; ratings guidelines are shown in Chart 1.

Chart 1: Performance-Based Ratings for Decision Support Matrix



This exercise encompasses all criteria, leading to a weighted average ranking of each company. Researchers can then easily identify the company with the highest ranking. As a final step, the research team confirms the veracity of the model by ensuring that small changes to the ratings for a specific criterion do not lead to a significant change in the overall relative rankings of the companies.

Chart 2: Frost & Sullivan’s 10-Step Process for Identifying Award Recipients



Best Practice Award Analysis for Achates Power

The Decision Support Matrix, shown in Chart 3, illustrates the relative importance of each criterion for the New Product Innovation Award and the ratings for each company under evaluation. To remain unbiased while also protecting the interests of the other organization reviewed, we have chosen to refer to the other key player as Competitor 1.

Chart 3: Decision Support Matrix for New Product Innovation Award

<i>Measurement of 1-10 (1 = lowest; 10 = highest)</i>	Award Criteria					
	Innovative Element of the Product	Leverage of Leading-Edge Technologies in Product	Value Added Features/Benefits	Increased Customer ROI	Customer Acquisition/Penetration Potential	Weighted Rating
Relative Weight (%)	20%	20%	20%	20%	20%	100%
Achates Power	8.0	9.5	9.5	9.5	8.5	9.0
Competitor 1	8.0	8.0	7.5	8.0	8.0	7.9

Criterion 1: Innovative Element of the Product

The innovative element of this product relates to effective implementation of multiple design solutions that have been historically deterrent to large-scale adoption of opposed-piston (OP) architecture two-stroke diesel engines.

Firstly, it is the two-stroke operation that provides a leaner operating environment that, in turn, maintains a relatively higher ratio of specific heats during combustion. Further, the partial scavenging of exhaust gas from the combustion chamber combined with innovations in controlling the supercharger system allows optimized pumping losses for the engine.

A critical part of the engine, the Achates Power patented power cylinder system, has been designed, tested, and manufactured through an iterative validation process using computational fluid dynamic studies. Frost & Sullivan understands that a noteworthy innovation within this system is the proprietary nozzle designed to provide inter-digitated fuel plumes with desired flow rates and penetration. Research indicates that Achates Power has adopted a dual crankshaft (Junkers-Jumo style) arrangement for its cranktrain, and implemented several improvements on it to address concerns on piston and cylinder thermal management, piston ring and wrist pin component durability.

Several disparate incremental improvements encompassing key functions and design attributes of the engine represent the innovativeness of this product. Frost & Sullivan believes that successful validation of this engine and its emission and fuel efficiency metrics in a wide range of duty cycles and operating conditions by regulatory authorities and OEMs can lead to significant market adoption.

Criterion 2: Leverage of Leading-edge Technologies in Product

More than 1,200 unique innovations covered by patents and patent applications come together in Achates Power's OP two-stroke diesel engines. This indicates Achates' key focus on leveraging leading-edge technologies in developing an industry-relevant product.

Frost & Sullivan's research indicates that a number of proprietary advanced engineering improvements have been developed and implemented within this product. This, combined with developments in support industries like the precision engineering and advanced electronics domains, have enabled successful implementation of design solutions into this product.

Advanced simulation techniques have enabled port timing and stroke-to-bore ratio optimization within the power cylinder system and effectively helped in arriving at desired levels of thermal efficiency, scavenging efficiency and engine friction. Further, the air handling system uses both a supercharger and fixed geometry turbocharger, with the supercharger drive system optimized to maintain high thermal efficiency over the entire engine map. The design ingenuity of this engine is extended by the manner in which the air handling system uses the supercharger to also function as an EGR pump.

Criterion 3: Value Added Features/Benefits

The high fuel savings potential of this engine—demonstrated through their in-house tests to be more than 20 percent when compared to industry-leading, conventional diesel engines—is a key value proposition that the engine offers to Class 6-8 heavy-duty truck OEMs. In addition to this, the OP architecture engines offer a relative ease in integration with OEMs' heavy-duty truck platforms. Traditionally, OP architecture engines have been characterized by high power density and excellent balance, which Frost & Sullivan believes are benefits that are offered also by Achates Power's modernized version of the engine.

Apart from these, the OP architecture engine has been proven to feature excellent multi-fuel tolerance and performance levels, simpler architecture that results in relative ease of servicing, and high reliability once proven on the road. The North American trucking industry is experiencing a rise in alternate fuel trucks and Frost & Sullivan expects that OP architecture engines can offer both competition and partnership avenues for certain alternative powertrain solutions that are being developed for mass-scale adoption.

Advancements in powertrain engineering domains such as manufacturing of precision components, advancements in turbochargers, and developments in control electronics have heightened the efficiency and effectiveness of OP engines. Frost & Sullivan anticipates that the very same advancements can be applied to further development of internal combustion engines in the medium to long term.

Criterion 4: Increased Customer Return on Investment

According to Frost & Sullivan research, the key benefit from increased customer return-on-investment perspective is the high fuel efficiency benefit this engine potentially offers upon market adoption. Considering a typical scenario, where a conventional diesel-engine powered heavy-duty truck travels on an average 120,000 miles a year, at an average fuel efficiency of 6.5 mpg, it is estimated that the annual fuel consumption is about 18,460 gallons. This value when extrapolated with the fuel efficiency benefit the OP engine offers, can translate to 3,690 gallons of fuel saved or \$14,000 savings in fuel costs annually.

In Frost & Sullivan's opinion, from an overall trucking industry perspective, the 20 percent emission reduction potential of this engine can enable OEMs and engine manufacturers to effectively explore this technology for emissions compliance in the near future. Although the technology's fuel efficiency benefit of up to 20 percent, CO₂ reduction benefit of up to 20 percent and NO_x and particulate matter emission reductions are yet to be acknowledged by the EPA, it is expected that the approval will be taken in due course as the industry opens itself to this technology.

Frost & Sullivan expects that the recovery of the global economy and rising demand for diesel from developing countries will put upward pressure on diesel prices in North America. This, coupled with the possibility of further regulatory action on the part of regulators and legislators globally, enhances the return on investment and payback value proposition of this innovative engine platform for end users and fleet operators. It is expected that the certification of this engine by EPA and other leading agencies, coupled with active partnerships with leading OEMs and tier-1 suppliers, would result in commercialization of this engine in the medium to long term.

Criterion 5: Customer Acquisition/Penetration Potential

The OP engine architecture, as opposed to traditional internal combustion engines, has enjoyed only marginal market potential until now. The key reasons for this include unproven emission compliance features, concerns regarding reliability and durability in long-haul on-highway applications, and most importantly the strongly entrenched position of conventional, 4-stroke internal combustion engines, which is the only engine technology available in the industry from small cars to the largest trucks.

However, Frost & Sullivan research shows that the innovative technologies and features that constitute this engine platform are now receiving rising levels of interest from the

defense and commercial vehicle segments. Frost & Sullivan believes that this will initiate the market penetration and adoption of this new engine technology.

Frost & Sullivan research indicates that should fuel prices remain volatile and emission regulations get progressively strengthened, the boundaries of efficiency and effectiveness of internal combustion engines would soon be reached. This is expected to warrant OEMs and engine manufacturers looking at Achates Power's OP engine technology. Such a situation would bring this technology within the R&D focal range of every key market participant and drive its market penetration potential significantly northward.

Finally, Frost & Sullivan firmly believes that the above reasons, when combined with the rising prominence of total cost of ownership of commercial vehicles as the most important purchase criteria among fleet owners/operators, is expected to propel penetration of this innovative technology.

Conclusion

Achates Power has been recognized with this New Product Innovation Award in the Medium and Heavy-duty commercial vehicle engine market for its path-breaking efforts in modernizing the opposed-piston architecture engine. This development has been achieved through proprietary innovations, thereby positioning opposed-piston type engines on the path of steadily increasing market adoption over the medium to long term.

Based on the aforementioned criteria, Frost & Sullivan is proud to present the 2013 North American New Product Innovation Award in the Medium and Heavy-duty Commercial Vehicle Engine Market to Achates Power.

The CEO 360-Degree Perspective™ - Visionary Platform for Growth Strategies

The CEO 360-Degree Perspective™ model provides a clear illustration of the complex business universe in which CEOs and their management teams live today. It represents the foundation of Frost & Sullivan's global research organization and provides the basis on which companies can gain a visionary and strategic understanding of the market. The CEO 360-Degree Perspective™ is also a "must-have" requirement for the identification and analysis of best-practice performance by industry leaders.

The CEO 360-Degree Perspective™ model enables our clients to gain a comprehensive, action-oriented understanding of market evolution and its implications for their companies' growth strategies. As illustrated in Chart 4 below, the following six-step process outlines how our researchers and consultants embed the CEO 360-Degree Perspective™ into their analyses and recommendations.

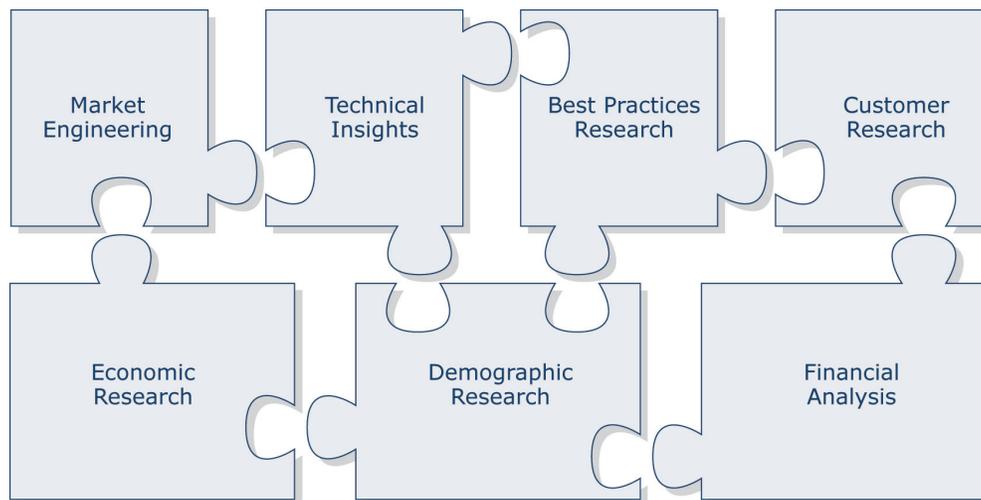
Chart 5: CEO's 360-Degree Perspective™ Model



Critical Importance of TEAM Research

Frost & Sullivan's TEAM Research methodology represents the analytical rigor of our research process. It offers a 360-degree view of industry challenges, trends, and issues by integrating all seven of Frost & Sullivan's research methodologies. Our experience has shown over the years that companies too often make important growth decisions based on a narrow understanding of their environment, leading to errors of both omission and commission. Frost & Sullivan contends that successful growth strategies are founded on a thorough understanding of market, technical, economic, financial, customer, best practices, and demographic analyses. In that vein, the letters T, E, A and M reflect our core technical, economic, applied (financial and best practices) and market analyses. The integration of these research disciplines into the TEAM Research methodology provides an evaluation platform for benchmarking industry players and for creating high-potential growth strategies for our clients.

Chart 5: Benchmarking Performance with TEAM Research



About Frost & Sullivan

Frost & Sullivan, the Growth Partnership Company, enables clients to accelerate growth and achieve best-in-class positions in growth, innovation and leadership. The company's Growth Partnership Service provides the CEO and the CEO's Growth Team with disciplined research and best-practice models to drive the generation, evaluation and implementation of powerful growth strategies. Frost & Sullivan leverages 50 years of experience in partnering with Global 1000 companies, emerging businesses and the investment community from more than 40 offices on six continents. To join our Growth Partnership, please visit <http://www.frost.com>.