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Adhesives in Transportation Series

Part III: Adhesive Opportunities & Outlook in Heavy Duty Trucks & Buses

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Part III: Adhesive Opportunities & Outlook in Heavy Duty Trucks & Buses

With half a million vehicles produced in the NAFTA region in 2015, heavy duty trucks, specialty trucks, and buses represent a small fraction of the overall land transportation by unit output. As described in Part I of this series, light vehicle unit production dwarfs that of medium and heavy duty trucks. However, the medium and heavy duty market is significant for adhesives. Composites are often used in the construction of trucks and busses, and as such, adhesives are a preferred joining method. Furthermore, the parts are much larger than those for light vehicles, which increases adhesive consumption as well. In fact, over a million gallons of adhesives and sealants were used in the production of these vehicles in 2015.

The U.S. federal government classifies medium and heavy duty trucks as having a gross vehicle weight rating (GVWR) of greater than 14,000 lbs. This includes Classes 4-8 as they are defined by the US Department of Transportation. Class 4 vehicles range from 14,001 – 16,000 pounds and, while classified as medium duty, are simply heavy duty pickup trucks and large vans. Classes 5-6, also categorized as medium duty, include vehicles with GVWR ranging from 16,001 – 26,000 pounds, such as box trucks, delivery vans, and specialty vehicles, such as emergency service trucks. Classes 7 and 8 are considered heavy duty trucks that require a commercial driver's license to operate. Class 7 ranges from 26,001-33,000, and includes many tow trucks and large box trucks. Class 8 trucks, which are over 33,001 pounds, are tractor trailers and single unit dump trucks. Production volumes and adhesive consumption in are summarized below.

Adhesive Volume and Growth Outlook in North American Medium / Heavy Truck and Bus

Segment	2015 NA Production (thousands)	Annual Market Growth 2015 – '19	Adhesive Gallons (thousands)	Adhesive Gallons / unit	Adhesive Growth	Adhesive Growth Drivers
Class 8	296	-1%	754	2.5	Above market	Fuel efficiency achieved through improved aerodynamics, which is made possible with plastics and composites. Weight reduction allows for Increased cargo carrying capability.
Class 5-7	168	4%	368	2.2	Above market	Shift from aluminum to composite in delivery trucks in order to improve fuel efficiency and lower operating costs.
Bus	37	4%	93	2.5	With market	Passenger capacity increased with vehicle weight reduction
Total	501	1%	1215	2.4	Above Market	Class 5-7 market growth, increase in adhesive consumption in medium and heavy trucks

Source: Ducker Worldwide, ASC Grow the Vertical Report, 2015; IHS, Industrial Market Insight

North American production volume of Class 8 trucks, while volatile, is greater than classes 5-7 combined, making Class 8 the focal point of many material suppliers to the industry. According to ASC's Grow the Vertical report, Class 8 truck production consumed 754 thousand gallons of adhesives in 2015, more than double the amount used in classes 5-7 combined. Class 8 trucks also use the most adhesive per vehicle produced in the segment, which is likely due to the frequent use of plastic and composite outer panels, particularly for units featuring sleeping accommodations.

Research by Ducker Worldwide shows consumption per bus produced is similar to medium and heavy trucks, despite the fact that buses have large outer panels with significant surface area that could be bonded. This is due to the fact that bus outer panels are often attached with rivets rather than adhesives. However, this is beginning to change, as manufacturers see the benefits of adhesive bonding versus self-piercing rivets for outer panes. Thomas Bus followed the lead of the aerospace and automotive industries when designing the Saf-T-Liner® C2 school bus, and replaced rivets with structural adhesives for the outer panel bonding. The company states that adhesive joints are stronger, more durable, more fatigue-resistant than rivets, and also offer better sealing and a cleaner appearance. The Saf-T-Liner® C2 is stated to significantly exceed FMVSS 221 joint strength requirements although the number of body rivets and fasteners was reduced by more than 65% versus the baseline design. Other bus manufacturers are recognizing these benefits, and are beginning to follow suit.

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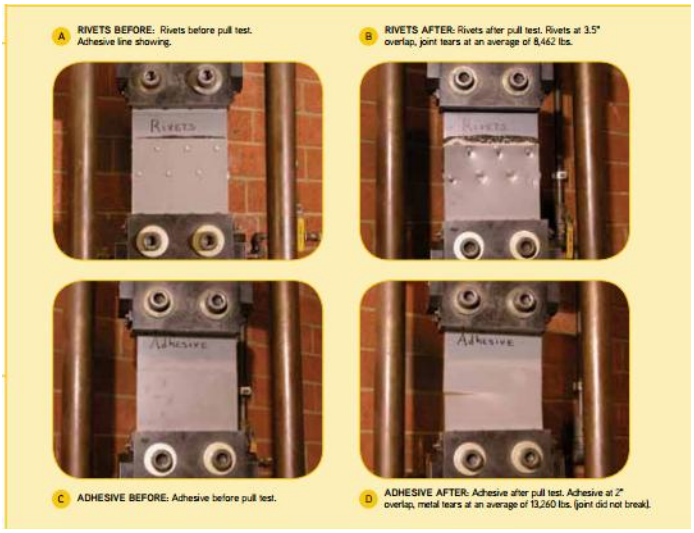

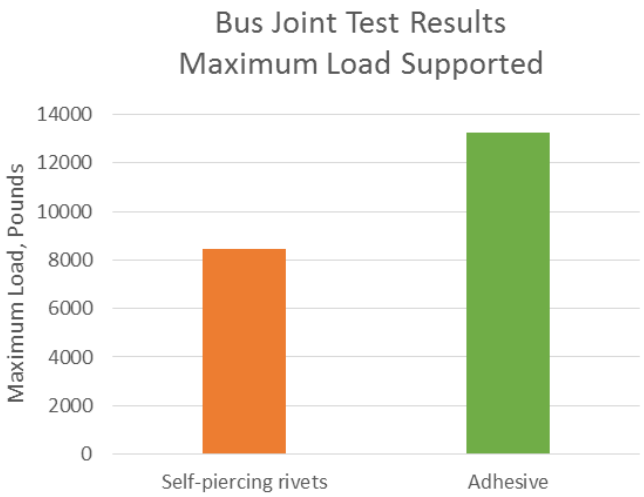

Source: Thomas Bus

Market Drivers and Trends

Customer

Because medium and heavy duty trucks are used for work purposes, such as freight movement, towing, off road construction, and specialty services (firefighting, emergency medical) they are purchased as industrial assets by companies or government entities. In general, the purchasing process is more rational than a consumer purchase, and decisions are generally made using considerations such as return on investment, annual operating cost, and total cost of ownership. As a result, initial purchase cost, fuel efficiency, and maintenance needs are important considerations in the purchase decision. In the long-haul truck segment, factors such as operator amenities, comfort, and ease of use may be considered in the purchasing process order to attract and retain drivers.

Regulatory

While medium and heavy trucks are required to meet a number of regulations, the segments are somewhat less regulated than light vehicle, particularly in the area of crashworthiness and occupant safety. Safety regulations focus on reducing the frequency of accidents, and include issues such as stopping distance and rollover prevention, and have resulted in the addition of features such as anti-lock braking and vehicle stability control. Features such as lane departure warnings are being added in order to prevent the occurrence of accidents.[1] Currently, there is no mandated performance standard for crashworthiness of truck cabs, although this is being evaluated.[2] Regulation of cab crashworthiness is likely to require significant changes to cab design and material selection, and adhesives could contribute to the solution, as they have in light vehicles.

Despite representing only five percent of highway traffic, medium and heavy trucks account for twenty percent of fuel consumption and carbon emissions of on-road vehicles.[3] Therefore, it should come as no surprise that fuel economy regulations on medium and heavy trucks are slated to increase in order to reduce overall vehicle-generated greenhouse gasses. By 2027, Class 8 tractors must be nearly 25% more fuel efficient than a baseline established in 2017. These efficiency gains will primarily come from powertrain and aerodynamic improvements, and continued use of low rolling resistance tires. Lightweight materials will be used to decrease vehicle weight, primarily in the cab structure and panels, but those weight savings allow for additional freight to be carried, which improves shipping economics, but does not improve fuel efficiency of the loaded tractor-trailer combination.

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[1] Brawner, Steve. "Truck Makers to Improve Interior Safety as NHTSA Reports Rise in Occupant Deaths." Transport Topics, February 11, 2023.
[2] Cullen, David. "OEMs offer views on heavy-truck crashworthiness proposal." Fleet Owner, June 10, 2011.
[3] Dennis, Brady. "White House sets new fuel-efficiency standards for heavy-duty trucks, vans, and buses." The Washington Post, August 16, 2016

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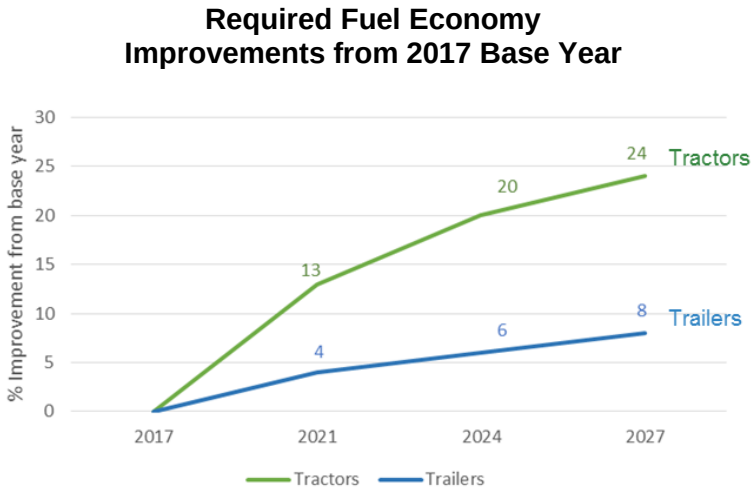

Trailers will be required to increase fuel economy as well. Since the trailer has no powertrain, and any weight removed from the trailer is added back in the form of freight, fuel economy improvements are achieved largely by improving aerodynamic efficiency and frictional losses. This includes the addition of skirts and fairings to reduce drag. Replacement of rivets by adhesives has been shown to improve the aerodynamic efficiency and durability of trailers, which according to work done by Wabash National and Lord Corporation[4], can improve fuel efficiency of the trailer by up to 1%. It is expected that the aggregation of several small improvements, such as more aerodynamic design, the addition of skirts and fairings, and possibly the elimination of rivets from the size walls, will be required to achieve the 8% increase required by 2027.

Design & Material Selection

Heavy duty trucks are manufactured using body-on-frame construction. In this architecture, the frame supports the engine, transmission, and suspension, as well as providing all of the load carrying capacities for the cargo. The cab merely rides on top of the frame, with the purpose of providing a reasonably comfortable environment the occupants and improving aerodynamic efficiency of the tractor.

Due to the structural responsibilities of the frame, it is normally constructed of high strength steel in a ladder configuration, as shown below. The frame rails are typically simple, roll-formed, C channels. The roll forming process allows for cost effective manufacture of very high strength steel, which is selected to keep weight to a minimum. Cross members can be roll formed or stamped. Assembly is very simple, and relies primarily on mechanical fasteners to attach the cross members and frame.

[4] Berg, Tom. "Replacing Rivets with Adhesives Yields Smoother Sides That Could Save Fuel" truckinginfo.com, August 26 2015.

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Typical rolling chassis featuring ladder frame, engine, transmission, suspension, and steering

Source: tfltruck.com

The truck cab rides atop the frame and provides a comfortable environment for the driver, as well as aerodynamic efficiency for the tractor-trailer combination. The cab contributes little, if anything, to the overall strength and stiffness of the vehicle. The structure of the cab is typically stamped steel or aluminum, joined with spot welds, fasteners, and adhesives. Composite or plastic panels are often selected for the hood, fenders, and fairings of heavy trucks, due to manufacturing and economic considerations. First, the large size and complex shapes required for the panels can be molded into one composite part, but might require multiple metal stampings. The cost of dies for plastics and composites, which is substantially lower than for metal stampings, is an advantage at the volumes in which class 5-8 trucks are produced, which are generally less than 10,000 units per model year. In addition, the use of lightweight materials is advantageous for hoods, as it allows these very large structures to be more easily lowered and raised when access to the engine compartment is needed. The use of plastic or composite fairings, particularly for the roof top, reduces weight of the structure and lowers the vehicle's center of gravity, making it less of roll-over risk.

Source: Peterbilt.com

Kenworth T880 5-piece plastic hood.

Source: Kenworth

Because composites and plastics are often used in heavy truck outer panels, adhesives and sealants are commonplace in the industry. Adhesives are the preferred method for joining plastic and composite panels, and sealants are used to prevent water intrusion and leaks. Assembly of hoods, such as the five piece assembly for the Kenworth T880 (shown above), is commonly done with two component acrylic, urethane, or epoxy structural adhesives. Adhesive selection is made based on the material, service requirements, and process constraints of the manufacturer.

According to the ASC Grow the Vertical report, adhesive use in truck and bus segments is poised for growth, due to both increases in unit production and usage rate per vehicle. Overall, adhesive consumption in the truck and bus segment is forecast to grow about 2% annually through 2019, slightly above unit production growth. The Class 8 truck market, which

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accounts for nearly two-thirds of adhesive use in the segment, is historically cyclical, and is expected to fluctuate over the study period, the net result being a decline of about 1% in annual unit production over that timeframe. However, the decline in unit production will be offset by an increase in consumption per unit, resulting in a modest gain in adhesive consumption in the heavy truck segment. The bus segment is expected to grow at about 3.5% per year, with adhesive use per bus to hold steady at about 2.5 pounds per bus.

From an adhesive consumption standpoint, the most exciting segment is medium duty, or specialty trucks. The ASC 'Grow the Vertical' report shows adhesives growing at a rate greater than 5% per year in this segment, due to increases in unit production and adhesive usage per truck produced.

A perfect example of how adhesives are winning new applications in the medium duty truck segment is the Utilimaster Reach cargo truck, which began production in 2011. In order to provide customers a benefit in the form of lower operating cost, Utilimaster constructed a lightweight and aerodynamic composite body that is 600 pounds lighter than its aluminum predecessor. The lightweight structure includes polyester panels for the hood, roof, sidewalls, and floor. When mated to an efficient turbo diesel engine, the combination delivers up to 35% better fuel economy than competitors. Initial customers have included UPS and FedEx, who use the truck for local delivery routes. Along with the switch to composite panels in place of aluminum, adhesive bonding replaced riveting as the primary joining method. Should additional companies follow the trend of replacing aluminum with composite for truck bodies, tailwinds for adhesive growth in this segment will build?

Summary

Production of heavy trucks and buses consume 1.2 million gallons of adhesives annually in North America. Because of increasing use of plastics and composites in medium and heavy duty trucks, the growth of adhesives in this segment is expected to outpace market growth over the next few years. Due to normal fluctuation of the Class 8 market, unit production volume is expected to grow at about 1% per year from 2015-2019. Increasing fuel economy regulation on Class 8 tractors is leading to more composite and mixed material assemblies, resulting in growth in adhesive consumption per unit. However, the primary driver for adhesive volume growth in the truck and bus market is the use of lightweight composites in place of aluminum in the medium duty segment. By replacing riveted aluminum with composite assemblies bonded with adhesives, manufacturers can provide customers with a lighter, more fuel-efficient, and aesthetically pleasing vehicle.

Increasing fuel economy regulations on trailers will be addressed largely by improving aerodynamic efficiency. This will include the addition of skirts and fairings to reduce drag. Replacement of rivets by adhesives has been shown to improve aerodynamics of the trailer, while providing benefits such as improved durability and easier repairs, to trailer owners. Similar benefits can be realized by replacing rivets with adhesives on medium duty box trucks.

In addition to the above, future safety regulations on heavy duty trucks could create significant opportunities for adhesives. Adoption of crashworthiness standards for medium and heavy duty trucks would require cabs to be stronger and more energy-absorbing than current designs. Should these regulations be put into effect, the heavy truck industry could follow the lead of light vehicle manufacturers that are using structural adhesives to meet increasing safety standards, reduce weight, and improve fuel efficiency at the same time, as discussed in Part II of this series.

Related Documents

Part I: Adhesives and Joining Methods in Land Transportation

Part II: Adhesive Opportunities & Outlook in Light Vehicles

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