

# Driveline Additives

## **Continuous Improvement**

Advances in lubricant technology hold the key to enhancing the efficiency of CVT transmissions and boosting their popularity in world markets, as Lubrizol specialists explain.

Continuously variable transmission, often billed as the global driveline revolution that never quite took in the whole world, may be poised for another resurgence in popularity. In key Asian markets, such as Japan, it already enjoys a 45 percent market share, providing a secure industrial base and an active R&D environment. In Europe and North America, where consumer resistance has limited its adoption, new technologies and increasingly strong fuel efficiency performance promise a strong challenge to those other fuel-saving transmissions, the DCT and AMT.

Schaeffler, which makes both CVT chains and dual-clutch units for DCTs under its LuK brand, recently forecast that, by 2015, sales of CVT-equipped cars would exceed those of DCT models. Not yet confirmed, though undoubtedly factored into Schaeffler's calculations, is its ambitious High Value CVT concept – a program for a low-cost CVT for small cars, achieving a fuel saving of 5 percent before hybridization.



Schaeffler's target price for the new transmission is to undercut the cost of a conventional automatic transmission. At present, according to figures from Knibb Gormezano, the production costs of a six-speed AT and a CVT are both equal, at 170 percent of the cost of a five-speed manual. A DCT is 180 percent.

"CVT is an established part of the automotive world, with the current focus undoubtedly in the Asiatic region," declared Andreas Englisch, LuK's CVT product line director, at the CTI Symposium on Advanced Automatic Transmissions in Berlin, December 2010. "Starting from these markets and sustained by new, interesting applications, a further increase in market share can be anticipated for the future."

Significantly, too, the world's cheapest car – India's Tata Nano – has adopted a CVT transmission as its automatic option. The two-cylinder, 35 hp Nano is light enough to sit on the borderline between car and motorcycle technologies. Its snowmobile-derived CVT appears to owe much to the "twist and go" dry belt CVTs that are a near-universal fit on the millions of scooters, light motorcycles and compact delivery vans built each year. This type of transmission could develop the potential to make an impact on the lower end of the car market, too.

A further strengthening of the CVT, case has just been supplied by Honda. The Japanese automaker's own CVT in its previous-generation Jazz/Fit hatchback, had been highly popular worldwide, but the second generation's i-SHIFT AMT provoked hostile reactions from commentators and customers. Now, CVT is back in a new and improved form.

### **Technical Challenge**

Dominant in the market for CVT transmissions is Jatco, majority-owned by Nissan. With a 43 percent share of global sales, Jatco's push-belt technology – supplied by Bosch VDT – is understandably the main focus of attention from both transmission engineers and their counterparts in the lubrication business.

In 2009, Jatco moved the CVT game forward significantly with a new two-stage CVT, giving a much-expanded ratio range to benefit acceleration, top speed and fuel economy. A determined challenge is being mounted by Audi and Schaeffler with their competing pull-chain technology, better suited to higher-torque vehicles, especially European diesels. Subaru, an early CVT pioneer, is now aligned with the Audi camp.

Whatever the technology, however, CVT transmissions pose lubrication challenges that are different – and sometimes even tougher – than those of the planetary automatics that we are so familiar with. "It's a tricky balancing act," says Lubrizol driveline technology manager Jim Sumiejski. "You need high metal friction so the belt grips well on the

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pulleys, but this and good anti-shudder durability tend to be opposite requirements – what works for one is detrimental to the other, so a balance needs to be found.”

The problem stems from the fact that the CVT chain or belt shares the same casing – and thus transmission fluid – as the torque converter or launch clutch; what is the optimum fluid for one may not suit the other. Lubrizol chemists have developed top-secret formulations that allow the right balance to be struck. The deliberately slippery ingredients that encourage smooth, shudder-free engagement of the CVT’s clutches would normally make it impossible for the belt to grip; yet at the interface between belt and pulley, special compounds make the combination stick rather than slide.

“Phosphorous, calcium and detergent-type chemistries have an affinity for getting onto that metal surface,” explains Sumiejski. “They form a film and help raise the friction by making it grabbier – they prevent the slipperier friction modifier components from getting into that surface and making the metal friction too low.”

## **Push-belt or pull-chain**

While many of the same issues apply to both types of CVT, the Audi-style arrangement, where the multi-link chain pulls rather than pushes, imposes some extra demands that the lubricant must be able to meet.



LuK pull-chain (above) and Jatco push-belt (above right): two CVT alternatives

Dave Whitticar, CVT specialist at Lubrizol, explains: “The difference between the chain and the push-belt boils down to the contact pattern. The push-belt has a

line of contact on the conical surface of the pulley. The chain touches the pulley with end of each of its pins, which is a three-dimensional surface – it’s more of a point contact.”

The effect, says Sumiejski, is a tendency towards micro-pitting on the pulley surfaces – meaning that a different type of fluid must be used. “You have to focus on eliminating that micro-pitting pattern – this means balancing that extreme pressure anti-wear package additive in the fluid. You’re trying to find that balance, protect the pins and not affect the other aspects of the transmission’s performance.”



***It’s a tricky balancing act – you need high metal friction so the belt grips well on the pulleys, but this and good anti-shudder durability tend to be opposite requirements.***

***Jim Sumiejski, Driveline Technology Manager***

## **Torque transmission is key**

What matters to any transmission engineer is how much torque the unit can reliably transmit, and with what efficiency. In a CVT the efficiency depends, among other factors, on the amount of energy expended in clamping the belt to the pulley to ensure it does not slip. The more the lubricant is able to enhance that grip, the more the clamping pressure can be ratcheted back and less energy is wasted through the hydraulic pump.

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"The key is the amount of torque you can transmit for a given clamping pressure," says Sumiejski. Though he is unwilling to quantify the precise efficiency gains that advanced fluids can achieve, he is clear that this is a very important avenue to pursue. "Anything that gives you just a couple of tenths of a percent just to help you meet CAFE requirements is what all the OEMs are always looking for," he says.

Whitticar is optimistic, too, about new CVT feedback loop control strategies, where incipient belt slip is detected by comparing input and output pulley speeds with the theoretical gearing ratio at that particular moment. The system will allow clamping pressure to be reduced until just before slippage is likely to occur."

Doing this allows you to operate closer to the slip limit," he says. "This will allow you to get all the efficiency that's theoretically possible without the belt slipping. The way this would help us as lubricant engineers is to allow us to sacrifice a bit on metal-to-metal friction, which can then help us on wet-clutch performance."

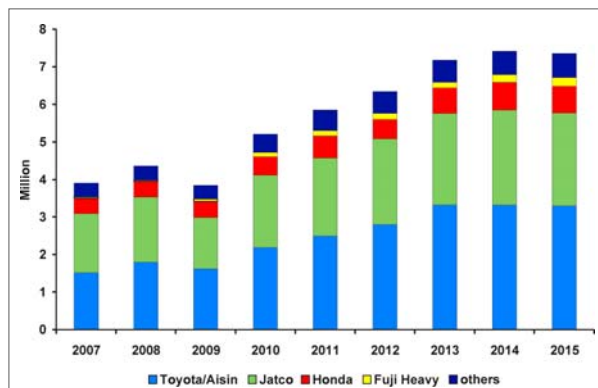
## Anti-shudder durability

As is so often the case with modern transmissions, the major mechanical components are thoroughly protected by the fluid and the only sign of a fluid nearing the end of its useful life is a tailing-off in the refinement experienced by the driver.

In the case of the CVT this can be experienced as shudder, either from the wet start-up clutch on launch or, in the case of torque converter-equipped CVTs, as a vibration on reaching highway cruising speed as the TC clutch engages. Ensuring adequate durability for the fluid elements suppressing this shudder is a key part of the molecular engineering that goes into any CVT fluid.

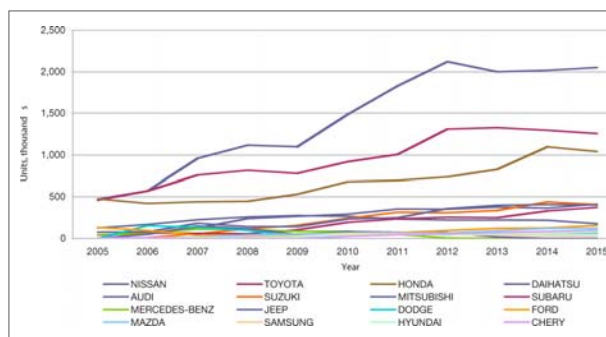
Overall, says Sumiejski, high anti-shudder durability is prominent on the wish-list of properties in the next-generation fluids that will help future CVT-equipped vehicles achieve the true low-emission potential that they have been promising for so long.

## CVT Production Volume Worldwide



Source: CSM, quoted by Schaeffler, CTI Symposium, Berlin 2010

## CVT Fitment by Leading Automakers



Source: IHS Automotive, quoted in Supplier Business Transmissions Report, 2010

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**EXPERT ANSWERS:  
LUBRIZOL SPECIALISTS  
JIM SUMIEJSKI (left) AND DAVE WHITTICAR  
GIVE THE CVT LOWDOWN**

***Why do CVT fluids have to be different than regular automatic transmission fluids?***

A CVT fluid needs to provide high stable metal friction performance to minimize clamping forces between the belt and pulley, to provide adequate anti-shudder durability for the torque converter clutch or launch clutch, and give proper anti-wear protection and strong and long-lasting anti-foam performance. CVTs are very prone to foam issues over time, due to the splash lubrication that occurs to lubricate the belt and pulleys

***How can CVT fluids help improve efficiency and cut CO<sub>2</sub> emissions?***

The fluid can help raise the metal-to-metal friction in the belt or chain's contact with the pulleys, so as to provide the most efficient operation. By raising the friction level, less clamping force is required for a given level of torque transfer, reducing the power absorbed by the hydraulic pump.

***If there were a silver-bullet solution for the perfect CVT fluid, what qualities would it have?***

We'd like to have a CVT fluid that could work both in the push-belt and the chain. It would have excellent anti-shudder durability and good metal friction characteristics that would allow for lower clamping forces, and thus greater efficiency. And, as with ATF, we are starting to look at fluids with lower viscosity that will allow for less churning losses – again, offering you a few more tenths of a percent in fuel economy.

## Introducing Lubrizol® CVT10. . .

### ***What is Lubrizol® CVT10?***

Lubrizol® CVT10 is a multi-vehicle CVTF additive package, providing suitable performance in a wide range of CVT-equipped passenger vehicles. It offers the combined applications of Lubrizol® 6372 and Lubrizol® 6373, with superior performance and support data.

### ***What is the opportunity?***

CVT10 was developed to address a growing market for CVT service fill fluids in North America, and with CVT technology being used in a wide variety of vehicles in Europe and Asia, there is also an opportunity to target a global service fill market.

### ***Who should buy Lubrizol® CVT10?***

Current customers of Lubrizol® 6372 and Lubrizol® 6373. Oil marketers supplying the installed (DIFM) service fill market.

### ***What are the benefits of Lubrizol® CVT10?***

- Since there are a lot of different types of CVTs in the marketplace, having a service-fill fluid that is comparable to genuine oils but works across multiple vehicle makes and models is becoming more important.
- CVT10 will enable customers to simplify logistics and manufacture of CVT fluids in two ways:
  - They can use one additive package to blend multiple CVT applications.
  - VM and PPD are now embedded, making it simpler to blend.
- Oil marketers and installers will need to carry fewer inventories.
- Carrying fewer fluids reduces installers' risk since it is less likely to use an incorrect fluid for CVTs.
- Stocking one CVTF for use in multiple vehicles provides better product availability.

If you are interested in learning more about Lubrizol® CVT10, contact your account manager or email us at [driveline@lubrizol.com](mailto:driveline@lubrizol.com)