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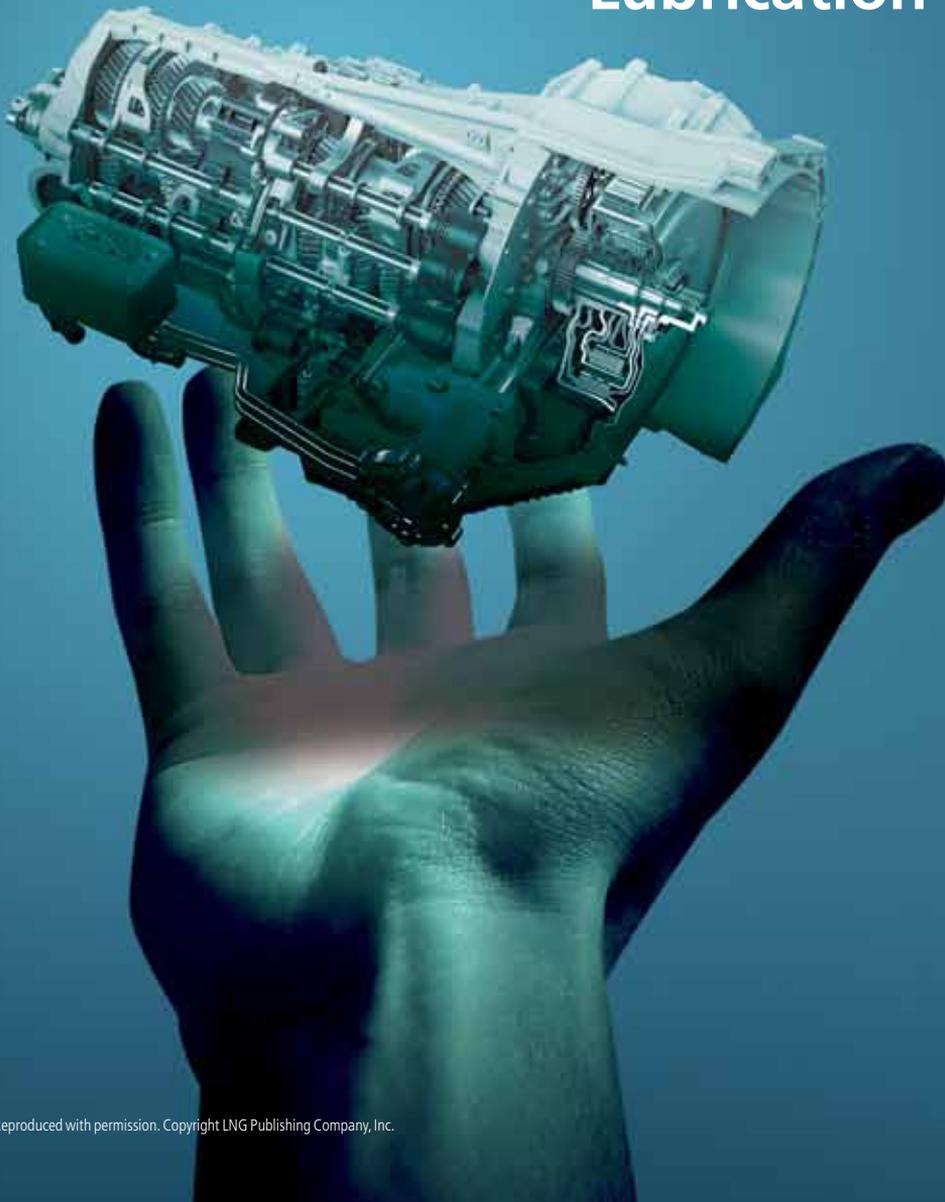
LUBES'N'GREASES

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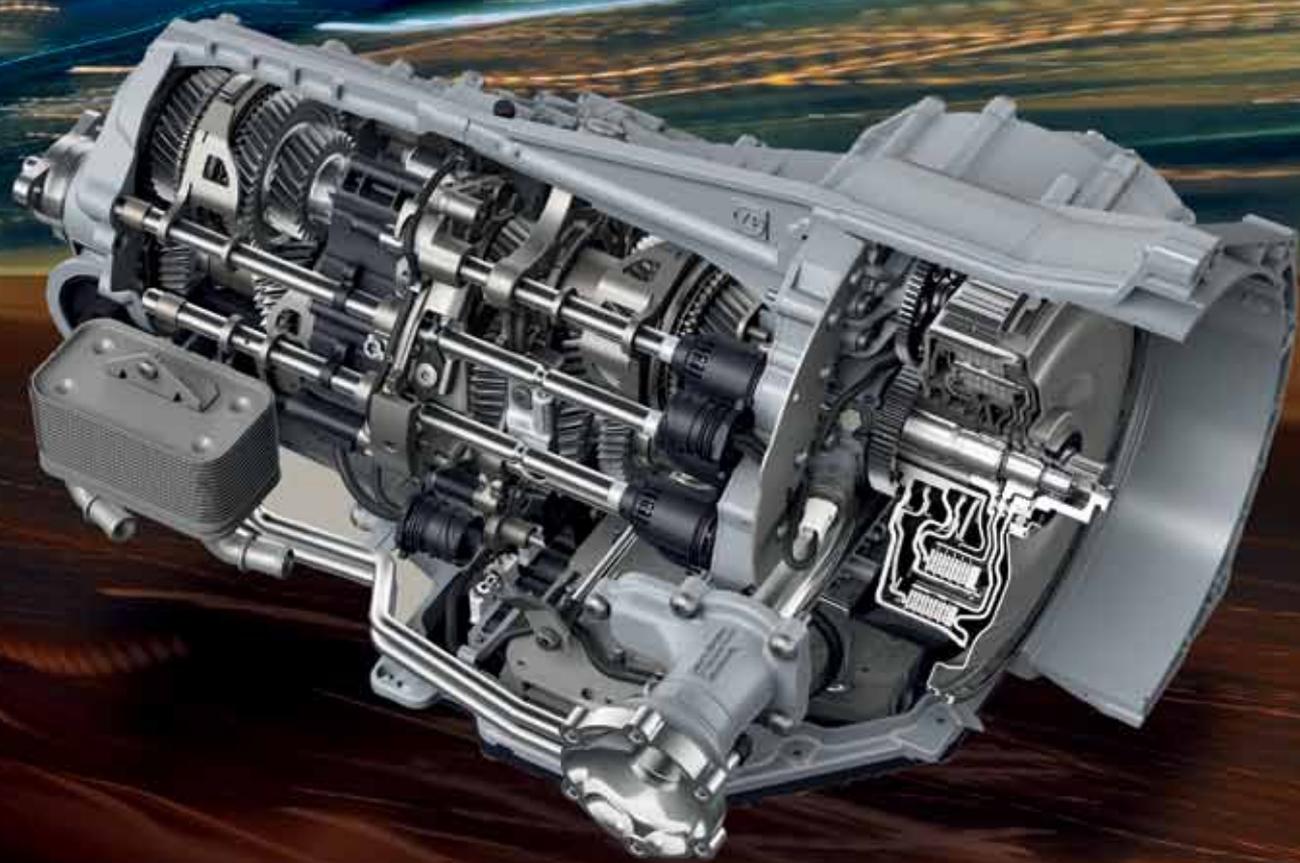
Number 26

Dual Clutch Transmission Takes Hold in Europe

Improving Railway Lubrication in Russia



THE DUAL CLUTCH



By Boris Kamchev

EUROPE'S TRANSMISSION OF THE FUTURE

For decades there were two choices when it came to transmissions in passenger cars – automatics and manuals. In recent years, however, more variety has begun to creep into the market. Pushed by the growing desire for better fuel economy – and by motorist demands for smoother rides – original equipment manufacturers have been developing alternatives.

It appears unlikely, though, that any particular design will gain global prominence. Instead, different designs seem to be more popular in different regions. In East Asia, continuously variable transmissions look like the wave of the future. North America is trending toward stepped automatics.

Still another technology is catching on in Europe – the dual clutch transmission. Proponents say its popularity is no surprise as the dual clutch shifts smoothly, is easy to drive and has a surprising combination of fuel economy and responsiveness. DCTs warrant attention from European lubricant marketers, not only because of their growing numbers but also because the fluids that lubricate them face tougher performance demands than those used in more conventional transmissions.

Rise of the Dual Clutch

Many industry analysts are publishing aggressive forecasts for the future use of DCTs, but their future looks brightest in Europe. North America and China are the world's largest car markets, and DCTs are not expected to make big inroads there. In the United States, according to auto industry consultant IHS Automotive, DCTs could account for only 8 percent of the total transmission market by 2014.

In Europe, the first car with DCT powertrain technology, the popular VW Golf R32, was intro-

duced almost a decade ago, in 2003. Since then, IHS reports, more than 3.4 million DCT-equipped cars and light commercial vehicles have been built in Europe. DCT penetration in Europe is currently about 8 percent of the continent's total car population.

By 2017, this number could easily grow to 15 percent or even more as most European OEMs already manufacture DCTs, have them under development, or have supply agreements in place to source them. Chris Guile of IHS Automotive stated that “by 2017, 15 out of every 100 light vehicles made in Western and Central Europe will feature a DCT – that's over three million cars and vans per year.” He clarified that IHS' forecast excludes vehicles manufactured in Russia and other members of the Commonwealth of Independent States.

A DCT differs from other transmission designs in that the gears are divided between two gearboxes – one for even-numbered gears and reverse, the other for odd-numbered gears. As the vehicle moves through one gear – second, for example – the other gearbox prepares the next expected gear – in this case third – so that the change can be completed in a smooth, precisely timed process.

“DCTs can fundamentally be described as two separate manual transmissions (with their respective clutches) contained within one housing, and

working as one unit,” Arthur Wetzel, ZF Friedrichshafen AG’s manager for lubricants and polymers, said during an interview. Headquartered in Friedrichshafen, Germany, ZF is a major European DCT supplier.

DCTs are usually operated in automatic mode, although many models also have the ability to allow the driver to control shifts.

Needed: A New Fluid

As the European market moves rapidly toward widespread adoption of DCT technology, OEMs and lubricant manufacturers are forging partnerships to develop fluid technologies that meet the specific needs of the various DCT applications.

“DCTs require special lubricants and additive formulations to provide the operating characteristics European OEMs and consumers demand in all passenger car segments,” said Lubrizol’s Chris Schenkenberger, regional product manager at the company’s Hazelwood, Derby, U.K. facility. “We are developing new additive formulations with balanced friction and wear performance that provides both long lubricant life and long-term DCT durability.”

He added that the company is focus-

ing on testing regimes (both field and laboratory) that validate the performance standards specified by some key European OEMs. “It will help to address specific European DCT market demands for durability, fuel economy, and driver comfort.”

Testing is a very important part of the alliance between OEMs and lubricant formulators to help ensure the development of appropriate specifications. According to ZF’s Wetzel, “To develop fluids for our company’s DCT applications, we worked together with additive suppliers and lubricant manufacturers to perform extensive testing according to our DCT fluid specifications.”

A Tough Application

Like some other transmission designs, DCTs can be wet or dry. Wet DCTs use a combined sump for gears and clutches, so a dedicated fluid that meets the needs of both applications is required. In dry DCTs, the clutches are not lubricated – only the gearbox. In a wet DCT with separate sumps for gearbox and clutches, the gearbox would use a standard manual transmission fluid, whereas the clutches would be lubricated by a DCT fluid designed for the specific clutch material.

In developing fluids for wet DCTs, formulators must deal with a variety of sometimes contradictory demands, including:

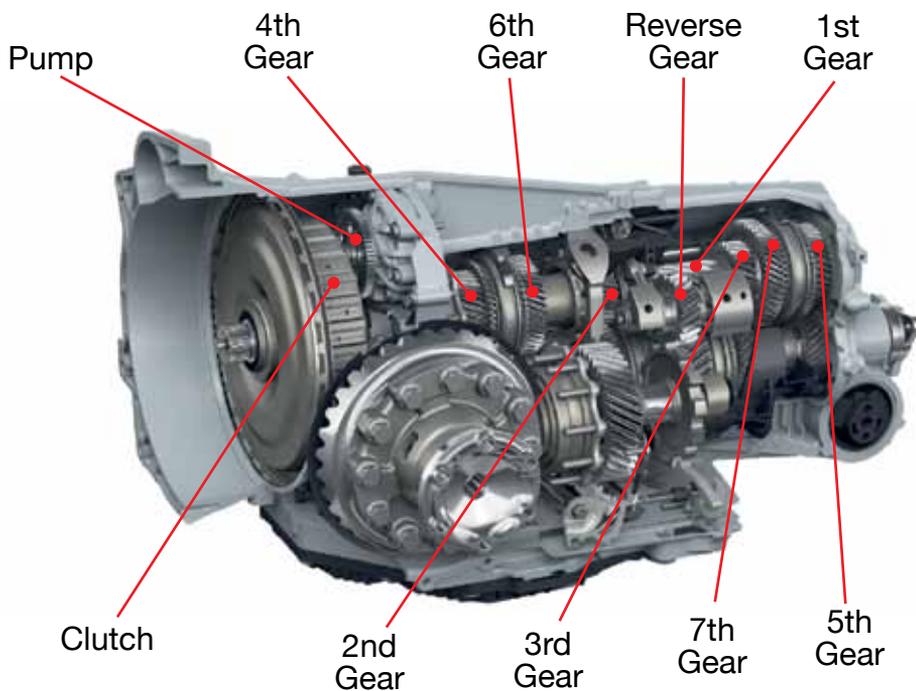
- lubrication of clutches, gears, shafts, bearings and synchronizers;
- hydraulic actuation of clutches and gear changes;
- wear and corrosion protection.

When combining the requirements into one fluid, the increased need for gear protection unbalances the classic automatic transmission fluid formulation, according to additive supplier Infineum. “The need for compatibility with state-of-the-art electronics components challenges the manual transmission fluid technology,” Skip Watts, the company’s global driveline technology manager, said during an interview.

Watts added that DCT manufacturers are currently trying to address several areas of concern: loss of friction control leading to poor clutch performance; loss of performance of control solenoids; and deterioration of electrical connections exposed to the fluid, which can lead to less than optimal response times.

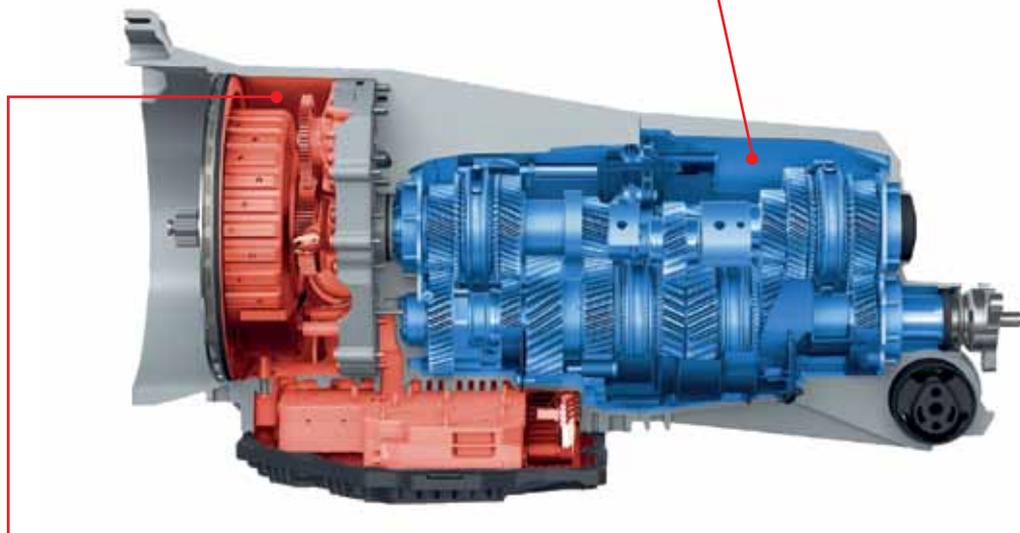
The wet clutches are the most critical components in the system, and precise control of their engagement and disengagement is essential for smooth opera-

Transmission Design



Source: ZF Friedrichshafen AG

Gear oil chamber for gear set and bevel drive



Transmission fluid chamber for clutch and hydraulics

Source: ZF Friedrichshafen AG

Separation of Oil Chambers

tion. “The additive technology must be compatible with the clutch friction material, and the lubricant must have a carefully calculated viscosity profile to ensure smooth engagement and disengagement in low-temperature conditions,” Lubrizol’s Schenkenberger observed. The additive package must also protect system components at high temperatures and under high loads.

In addition to protecting the clutches, Lubrizol says, the DCT fluid must sustain consistent launch and anti-shudder durability for the life of the transmission, estimated at two million shifts. The DCT fluid also plays a major role in controlling friction response, the key to smooth and consistent shift quality.

Synchronizer components also depend on the frictional performance of the transmission fluid for their smooth operation. Generally, the fluid must maintain a specific frictional coefficient throughout a 5,000-cycle test with no evidence of wear that can cause synchronizer clash or balk.

Other considerations are thermal and oxidative stability. According to Lubri-

zol, surface temperatures within the clutch system can reach several hundred degrees Celsius. Acidic byproducts of thermal breakdown can generate lacquers and sludge that can impair hydraulic and actuator function. DCT fluids also must protect the helical transmission gears, where stress on individual teeth is much higher than that in the epicyclic gears used in automatic transmissions.

Taken together, all these requirements clearly show the need for new and dedicated additive technology systems for fluids used in dual clutch transmissions.

Shorter Life Span

Drain intervals for wet DCTs on the market today are around 40,000 km, reports Lubrizol’s dctfacts.com. Lubrizol expects dry DCTs to follow the manufacturer’s manual transmission fluid oil drain schedule, which is normally fill-for-life. “Dry systems were introduced to reduce churning losses and, hence, improve the vehicle’s CO₂ emissions. However, some industry sources say that wet DCTs may be coming back into favor, possibly because of their higher

durability,” IHS Automotive’s Guile noted.

Some formulators are using polyalphaolefin base stocks to make DCT fluids. Lubrizol’s Schenkenberger said PAO’s strengths include excellent low-temperature performance and oxidation resistance.

“The first generation of DCT fluids was synthetic-based, requiring [API] Group IV base stocks,” he said. However, these fluids are expensive and their long-term availability could be a concern. “Today’s Group III base stocks can achieve similar levels of performance, but at a lower cost, and these stocks are increasingly available globally.”

ZF’s DCTs currently use specially developed fluids based on semi-synthetic and fully synthetic base stocks. The transmissions are mainly factory filled-for-life. “We’ve observed good clutch and synchronizer performance with regard to friction coefficient, friction coefficient stability, as well as good protection against gear wear and scuffing, bearing wear, and pitting. In addition shear, oxidation and sludging stability are

high. We also observed good compatibility with elastomers, plastic, and copper-based materials,” ZF’s Wetzel commented.

DCT advocates say that DCT fuel efficiency is a big advantage over traditional manual and automatic transmission. In theory, a manual transmission is the most fuel efficient, notes [dctfacts.com](#). “However, this depends on it being driven perfectly, all the time. Due to driver error, for example during gear changing, a DCT is more economical than a manual transmission.” This applies especially to the dry clutch DCT, according to the website. “In contrast to wet clutch DCTs, there are virtually no parasitic losses when shifting gears and maintaining clutch pressure.”

A DCT’s improved fuel economy is a result of several factors. Flexible gear ratio selection and adapted shift scheduling contribute about 6 percent, neutral in idle 8 percent, reduced torque converter losses 3 percent, and lower mechanical losses 2 to 3 percent. This all adds up to almost 20 percent fuel economy improvement over manual transmission losses, according to [dctfacts.com](#).

Wetzel said, “ZF’s seven-speed DCT for the Porsche 911, in combination with new engines saves up to 13 percent in fuel consumption compared to the five-speed automatic used before. And it is even better than a six-speed manual transmission.” ZF is currently developing a nine-speed automatic transmission.

It is still unclear what share DCTs will have in China and Asia overall, where continuously variable transmissions enjoy a large market share. CVTs have been in use for several years and are generally installed in vehicles with two-liter and smaller engines. Their advantage is that metal chains and belts continuously match engine speed and load to driving conditions. This mode of operation provides rapid shifting and good fuel economy.

There is a general lack of consensus among the Chinese OEMs on the best technology for their automatic transmissions. Infineum’s Global Driveline Manager Mike Nelson reported at the ICIS World Base Oils and Lubricants Conference in London in February that the market share for manual transmissions in China will drop by at least 10 percent over the next five years, in favor of some form of automatic, mostly DCTs and conventional planetary transmissions, and CVTs as well.

It remains to be seen whether the sporty image alone, which DCTs have established, will be sufficient to overcome some of the advantages of automatic planetary transmissions. Fuel economy, starting dynamics, smooth shifting, and factory fill-for-life fluids are some of the characteristics of DCTs that gradually are making them extremely popular among European car lovers. Whether drivers in North America and Asia will follow the trend is anyone’s guess. □