ENGINEERING INNOVATION

For 2017, MAN’s D3876 engine range has been upgraded to Euro 6c. But there’s much more to the new power plant than meets the eye. Brian Tinham explains

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### EURO 6C EMISSIONS

Emission controls first, and key to MAN’s new engine is a two-stage EGR (exhaust gas recirculation) system and a revised SCR (selective catalytic reduction) after treatment package that, incidentally, also now extends service life to match vehicle lifespan. The EGR system has essentially been re-designed such that exhaust gases are now managed via two coolers: high and one low (temperature). Combined with an improved flow design, the result is a more even distribution of cooled exhaust gas and charge air for all cylinders – together minimising NOx generation during combustion itself, without compromising power output.

Meanwhile, on the exhaust gas aftertreatment side MAN has moved to new, more highly reactive SCR substrates for its Euro 6c D38 (as well as the latest D02 and D06 diesel engine ranges). The company explains that its earlier Corundite (magnesium aluminium silicate) material has been replaced by a full extrudate of newer technology catalytically active oxides to achieve

- Improved NOx reduction effectiveness
- Better temperature stability
- Reduced system complexity

### COOLING SYSTEMS

Moving on to heat rejection, MAN points first to the fact that, as well as providing for lubrication, the oil also has a role in engine cooling. So, among new design features of the D3876 is a re-optimised oil cooler and heat exchanger aimed at preventing oil temperature spikes – including a new thermostat that provides for tighter regulation. Additionally, MAN’s new oil module now combines the oil filter, cooler and separator into a single component group, which also reduces the weight of the assembly.

As for the engine coolant loop itself, fan speed modulation (via the CAKmot) ensures that cooling fans supply just enough air to dissipate heat via the radiator – no more, no less. Advantages of this development include:

- Reduced NOx emissions
- Improved engine performance
- Reduced radiators and fans noise

### REVISED TURBOCHARGING

Turning to the turbocharging system, this sees improvements to the compressors themselves and to MAN’s well established two-stage arrangement. Looking at the turbo, the high-pressure stage has seen both efficiency and transient behaviour uprated, resulting in enhanced response (due primarily to reduced inertia), while the low-pressure stage has been re-optimised for efficiency.

The result, says the company, is faster turbo response and hence also engine agility and torque profiles. Those translate to better driving dynamics – particularly at low revs, but also at cruising speeds – while also contributing to enhanced fuel savings.

As for the turbocharging system, the principle is unchanged, involving high- and low-pressure turbines connected in series via a charge air intermediate cooler. The smaller, high-pressure charger handles low engine speed boosting, progressively augmented by the larger, low-pressure charger as engine speeds and loads increase. When engine demand is high, the low pressure charger handles most charge air pre-pressurisation, so optimising the torque band over a wide range of engine speeds.

In fact, maximum torque is now available from 930–1350 rpm. Lower engine speeds mean fuel-efficient driving in high driver ratios at motorway cruising speeds, including during sustained hill climbing. Additionally, the wide torque range works well across all axle ratios, from short axles, designed primarily for tractors, to higher geared axles typically specified for long haul tractors.

MAN says its design also results in longer service life since pre-pressurisation significantly reduces the load on each. And, in this context, the company points to another benefit of this two-stage charge air cooling, which results in reduced heat load on the high-pressure turbocharger, as well as improved power management and hence better fuel economy; and hence better fuel economy.

### OTHER INNOVATIONS

Too many to mention in detail, but among other engineering highlights of the D3876 for 2017 are:

- 140kg weight saving, top-down cylinder head cooling and domed valves (both ‘firsts’ for heavy-duty diesel), forged steel pistons and eight cylinder head screws per cylinder, fire rings for preventing oil, an encapsulated cable harness, and an on-demand air pressure management system.

Quickly looking at the lightweight aspect, MAN has put high-strength G6/450 (just iron with vermicular graphite) for the engine block and cylinder head, an aluminium flywheel housing, and plastic valve rocker cover and sump, with MAN patented spider’s web structure on the underside – which contributes to enhanced fuel savings.

### COMMON RAIL SYSTEM

Moving on to the common rail system, MAN’s D3876 features a

- Common rail
- Electronic control
- Ultra-fine fuel atomisation
- Two-stage common rail
- Variable geometry
- Multi-point injection
- Injections at every stroke

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**SPECIFICATIONS**

**D38 ENGINE SPECIFICATION**

MAN D3876: six cylinder in-line 15.2 ltr displacement
- 540hp; 2,700Nm torque
- 580hp; 2,900Nm torque
- 640hp; 3,000Nm torque

**PERFORMANCE AND ECONOMY**

THIRD GENERATION COMMON RAIL INJECTION SYSTEM:
Injection pressures up to 2,500 bar. Provides for extremely fine fuel atomisation, ensuring combustion is even more efficient.

SECOND GENERATION CHARGE-AIR SYSTEM:
High efficiency charge air cooling system with separate low temperature cooling.
Two-stage turbocharging concept reduces demands and load on individual turbines.

**EMISSION CONTROLS**

TWO-STAGE EGR (EXHAUST GAS RECIRCULATION):
Exhaust gas is cooled via two coolers (one high-temperature and one low-temperature cooling circuit).
EGR system is efficient in reducing NOx during combustion.

**RELIABILITY FEATURES**

EIGHT CYLINDER-HEAD SCREWS PER CYLINDER, meaning low liner distortion as well as even compression of the cylinder head gasket - resulting in longer service life and higher reliability.

PROTECTIVE ANTI-POLISHING RING at the top of the cylinder liner prevents combustion gases escaping between the piston and liner, so minimising oil carbon deposits. Reduced ash ingress also helps to protect the DPF (diesel particulate filter), which boasts 500,000km service interval.

**ADVANCED ENGINE FEATURES**

FORGED STEEL PISTONS: enabling high ignition pressures up to 250 bar, which optimises combustion and reduces fuel consumption. Pistons are also shorter, allowing longer connecting rods and hence optimal perpendicular con rod movement, while also minimising friction losses against cylinder walls.

TOP-DOWN COOLING: a first for a diesel truck engine, designed to deliver optimised and even cooling across all cylinders - so avoiding localised thermal stresses, while enabling high cooling output with lower coolant volumes.

**ENGINE INNOVATIONS**

DOMED VALVES: another first in truck diesel engines, designed to minimise wear on the valve seat.

LIGHTWEIGHT CONSTRUCTION, thanks to compact design and innovative choice of materials.

IMPROVED ACOUSTICS: cobweb-like ribbing on the oil sump prevents sound transmissions.

FOAM-PACKED CABLE HARNESSES reduce internal wear and prevent breaks and short circuits.

Approval for HVO (hydro-treated vegetable oil) fuels, allowing renewable diesel fuel EN 15940.
E

With the arrival of its latest Euro 6c engines, MAN has taken the opportunity to enhance the performance and driver appeal of the popular Tipmatic automated gearbox used in its TG tractors and rigid units. Brian Weatherley explains.

very good engine deserves an equally good gearbox behind it, working together in perfect harmony. That’s certainly the case with MAN’s latest Euro 6c TG chassis, which now benefits from the adoption of the new generation of Tipmatic two pedal AMT (automated manual transmission).

The familiar 12 speed Tipmatic – based on ZF’s tried and tested AS-Tronic box but with MAN’s own shift strategy software and controls – has long been a favourite with drivers and hauliers. That’s not least due to its user friendliness and low operating costs. Now the latest version comes on that tradition by being not only quicker but also more intuitive than ever before.

To improve drivability even further, Tipmatic now gains MAN’s latest SpeedShifting function, which permits rapid gear changes whatever the driving conditions and terrain. In particular, new Tipmatic works in conjunction with MAN’s electronically-controlled exhaust valve brake (EVBrake - standard on all D20, D26 and D38 Euro 6c engines) to deliver ultra fast upshifts, especially when a truck is driving uphill. MAN’s up-shift assistance (HSU) enables the Tipmatic box to change up even on tough gradients that would previously have thwarted the system as the break in engine torque and power would have meant losing too much road speed.

So how does it work? In simple terms, when you’re climbing a hill with a new TG Euro 6 chassis (tractor or rigid) equipped with the Tipmatic and HSU, when the auto box judges it’s capable of making an up shift then EVBrake operates for a split second. This creates engine back pressure, which in turn drops the engine revs – so allowing the Tipmatic auto to achieve much faster gear synchronisation. The upshot of a shorter interruption to traction force is that a TG driver can now tackle steep inclines employing a higher gear than before. This results in lower engine speeds (thereby saving fuel) and simultaneously higher road speeds. That means higher productivity across an entire journey.

Just as important, not only does the new Tipmatic auto shift more quickly, but it’s smoother too, because MAN has focused on driver comfort with its new shift strategy software.

CRAWLER GEARS

Meanwhile, as well as improving the performance of its popular 10-speed auto, MAN has also introduced an additional version called Tipmatic 12+. With two extra gears, this is now standard on all 4x2 TGX and TGS tractors powered by the D26 engine. Just like the regular 12-speed auto, it comes with the latest MAN control software and features. That said, no matter what version they have, drivers using the new Tipmatic boxes will find everything familiar in their control layout. The drive mode selector knob is still placed to the left-hand side of the driver’s seat, it also retains the previous ‘D’ position for drive, plus ‘DM’ and ‘RM’ for forward and reverse lower speed manoeuvring. In the two latter positions the accelerator pedal has greater travel for the same input, allowing for extremely precise control. However, even in normal drive the ‘feel’ of the new transmission is superb, with its control software allowing up shifts by gentle use of the throttle pedal when pulling away from rest. And, whatever the circumstances, Tipmatic always knows what shift pattern to choose for optimum fuel economy and drivability.

The control stalk, on the right-hand side of the steering column, then allows for finer tuning of Tipmatic’s gear shifts should a driver require it. There are three options. First, full auto, where the driver controls all shifts via his right foot. Second, semi auto, which allows the driver to make manual shifts via the control stalk, before the box returns to full automatic mode after a 10 second delay. And third, full manual, where the driver dictates all changes, again by pushing the steering column stalk either up or down.

The earlier load sensing function on Tipmatic is also retained, but with the addition of a new inclinometer. So, with the latest version, it is not only automatically chooses the optimum shift pattern based on the truck’s gear and weight, but also knows whether it’s starting off on a level road or a hill. In combination with the Tipmatic load sensor, the EVBrake also delivers precisely the right amount of downhill engine retardation, again automatically taking into account whether the truck is laden or unloaded. Moreover, if additional braking power is anticipated – for example, to handle hilly terrain or arduous conditions – operators can specify an optional 25 Intarder, delivering up to 4,100Nm of braking torque on the latest Tipmatic box.

OFF-ROAD EXTRAS

Meanwhile, for those drivers working off-road or in a TG model with either the D26 or D20 engine, there’s a new Rock free mode option. Operated by a dashboard switch it allows for rapid shifts between drive and reverse without harming the gearbox or clutch. This ‘rocks’ the truck back and forth, enabling easy extraction if the vehicle gets stuck in snow or on muddy ground.

Whatever the mission, the bottom line for MAN drivers is that the latest Tipmatic is even more intuitive in use and fully in tune with their driving style. Meanwhile, for operators it offers the prospect of improved fuel economy and vehicle productivity. Additionally, it delivers the peace of mind that comes from knowing that, through optimal gear selection, Tipmatic always protects the clutch and drivetrain when starting off, thereby reducing maintenance costs and eliminating any risk of accidental driver abuse. Equally significant, the standard Tipmatic direct drive auto, combined with the latest 2.5:1 rear axle ratio on TG chassis, takes full advantage of the ‘low-rev/high torque’ characteristics of MAN’s Euro 6c engine line-up. On the D20, D26 and D38 engines, peak torque is typically delivered between 900-1,400rpm – ensuring the very best fuel economy. Should the mission require it, however, an overdrive top ratio is optionally available.

While Tipmatic auto is the standard transmission on the latest Euro 6c MAN TGX and TGS chassis (with Tipmatic 12+ in the case of 4x2 tractors with the D26 engine), for those operators preferring a manual box there’s still the option of a 16-speed ZF Ecosplit. Moreover, the latest Ecosplit also features several improvements, including a newly designed alloy housing that saves 15kg and also contributes to a noise reduction of 2 dBA. For drivers, the clutch pedal effort has also been further reduced. Like Tipmatic, the latest Ecosplit synchro box can also be specified with an Intarder.

Although manual boxes remain a popular choice for heavy haulage STG operators – the Ecosplit 4 is capable of being used in MAN chassis plated up to 120 tonnes gcw – Tipmatic with an overdrive top ratio is more than capable of offering spec for STG operators operating up to 80 tonnes gcw, assuming the appropriate software changes and rear axle ratios.

### AUTOMATICALLY BETTER

NEW GENERATION TIPMATIC AUTO

- Latest SpeedShifting function incorporating EVBrake electronically-controlled exhaust brake delivers even quicker changes with maximum driver comfort
- Shorter interruption of tractive force, particularly on gradients, allows higher gears to be selected when hill-climbing - saving fuel and maintaining good road speeds
- Optimal gear selection every time protects clutch and drivetrain, maintaining maximum vehicle productivity. Additionally, for operators it offers the prospect of improved fuel economy and vehicle productivity. Additionally, it delivers the peace of mind that comes from knowing that, through optimal gear selection, Tipmatic always protects the clutch and drivetrain when starting off, thereby reducing maintenance costs and eliminating any risk of accidental driver abuse.
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