DIESEL international

DIESEL SUPPLEMENT
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HYBRIDS are ready

AT EIMA INTERNATIONAL 4E CONSULTING AND KOHLER UNVEIL HYBRID SOLUTIONS. CUMMINS AND DEUTZ PAVED THE WAY. BAUMA SHANGHAI IS THE SHOWCASE OF CONSTRUCTION APPLICATIONS

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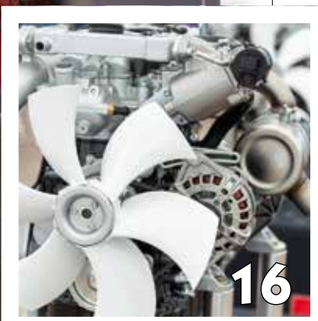


DIESEL GOES OFF-ROAD

Deutz TCD9.0. Diesel of the year 2018

UNDER THE PARIS LIGHTS

Spotlight on the Deutz stand at Intermat. At 5pm on Monday, April 23th, DIESEL was there together with Frank Hiller and Michael Wellenzohn from Deutz. The 9 liter begins its path towards a "hot" range, that of 9 liters, in the unusual 4 cylinders architecture

Intermat, Monday, April 23rd, 5 pm. After eight years Deutz gets its second nomination for the most coveted prize in the industrial engine range. After the TCD2.9 the time has come for the TCD9.0, 300 kW at 1,900 rpm and 1,700 Nm at 1,200 rpm. Frank Hiller, Chairman of the Board of Management of Deutz, and Michael Wellenzohn, Board of Management for sales, marketing and service, received the award. From Bauma Monaco, theater of the award ceremony eight years ago, to Intermat in Paris, through Bauma China in Shanghai, where the TCD9.0 was officially introduced.

German pioneer

The 9 liter displacement has always been a stranger to the German engine philosophy, more inclined to peculiar displacements such as the 10.5 liters. Among the authors of the transition to Tier 3 we find the Americans, Caterpillar, Cummins and John Deere, the Swedes, with the Scania 5 cylinders and the 6 in line from Volvo, and Fpt Industrial. Currently in this range we also find the newest creation of Man, the D1556, and Liebherr. And here another interesting page of this book opens. Deutz made an agreement with Liebherr for a string quartet that includes the 9, 12, 13.5 and 18 liters in the range from 200 to 620 kW.

The editors of DIESEL summarized the motivations that led this choice

«Innovation is the key word of the Diesel of the year. In the language of propulsion for industrial applications it can mean efficiency, power density, emissions regulations compliance or specific performances, and much 'much' more. So, what does the word innovation mean in the language of the Deutz TCD9.0?

First, a 9-litre 4-cylinder engine sounds absolutely unusual, just like the 2.9-litre and 3.6-litre Deutz engines that opened the compact engine season eight years ago, 'downsizing' the liter cylinder displacement in terms of spread to mobile applications.

For second, 9 liters is a range of displacement where Deutz is pioneer in the German ICE school. Internal combustion engines German tradition, I mean… Do you know where Rudolf Diesel comes from? And how many 'children' and followers has he in the motherland? Incidentally, what better location than la Ville Lumiere, Paris, where Diesel was born in 1858 to German parents.

The third point is focused on di-

Hiller: a look at the future

Mr. Hiller, the "Diesel of the Year" award identifies in its assignment one of the most important characteristics for each new engine: the innovation rate. Can you explain to our readers what innovation means for Deutz?

Frank Hiller

«*Innovation is one of our strengths and has always been part of the corporate culture of DEUTZ. When Nikolaus August Otto established DEUTZ in 1864, it was his revolutionary innovation - the four-stroke engine - that made the company successful. It has powered the world, and in some places it is still known as Otto engine. Since then, DEUTZ has always been a vector of innovation in terms of transmission technologies. Today, in line with this philosophy, we are working on the next chapter of OUR history, bringing electrified drive systems into the off-road sector*».

In 2017 Deutz undertook a process of diversification of its platform, I refer to gas powered engines such as G2.2 and 2.9 and the acquisition of Torqeedo. Can you describe Deutz's vision for the future of industrial engines?

«*We believe that up to 85% of mobile machinery will still work with diesel engines in 10-15 years. This is why we have just expanded our range to include the new powerful TCD 9.0/12.0/13.5/18.0 inline engines for heavy equipment delivering up to 620 kW.*

As part of the E-DEUTZ strategy, we are indeed expanding our product range to include hybrid and fully electric drives. The acquisition of Torqeedo allowed us to access 12 years of experience and cutting-edge expertise in the electric drives area. It enables us to accelerate the launch of our electrical solutions on the market in DEUTZ key segments and target the market leadership in the innovative off-highway driving system segment. Another potential area for improvement is the use of alternative fuels. The number of gas engines will increase over the next few years because of their potential in terms of emissions reduction. Our new G 2.2 and 2.9 LPG engines are two convincing solutions that are particularly suited for low load applications in materials handling and compact construction machinery aplications.

DEUTZ has also approved the latest generation of the full range of TCD engines using paraffinic diesel fuels, biodiesel and biodiesel blends».

Wellenzohn: beyond 9 liters

Good afternoon Mr. Wellenzohn, do you remember what you told us at Bauma 2016, that we would have to expect several new things? Well, you respected your words. So, can we start asking you something about the Deutz strategy, from the TCD2.2 to the 9-liter range?

«*Our announcement in Bauma, 2 years ago, was referred to our emission standard, to emission regulations and to our portfolio. This is now from 2.2 to 18 liters. We worked to combine it together with emission aftertreatment modeling, in order to serve our customers with basic engines and in addition with dedicated aftertreatment customized on the requests. We promise flexibility, and to be in time with Stage V. Talking about the 4 to 8 liters range, we certified the engines last year. From the TCD 4.1, to the 6.1, 7.8, and to the 3.6. For the sub-4-liter range, we introduced a new emission aftertreatment, but we are ready in time for Stage V, providing prototypes to our customers*».

Michael Wellenzhon

TCD9.0 is the Diesel of the year 2018. Which applications you see for that?

«*First of all, we want to thank you for awarding our engine with the Diesel of the year prize. The 9-liter, I think, considered its 4 cylinders and 300 kW is a very small pack of power density. We see applications in construction and agriculture equipment, and maybe also stationary equipment, such as for water pumps*».

2.2 and 18 liters. Will these remain the threshold of Deutz's lineup? How about the evolution and technical details of these two engines?

«*Our target is to build up engine families. The 2.2 is derived from the 2.9 so we have, out of one engine family, a range from 19 to 75 kW which is a quite big range with a lot of communality of parts, also for a wide range of applications. It also means a benefit in serviceability, in documentation and training distribution networks. The same is for the 9, 12 and 13.5 liters, which are part of the same engine family. It is in the highest inline 6-cylinder range. The 9 liters is a four cylinder, but they share a lot of parts, so we made the four-cylinder out of the 6-cylinder, with same front and back-ends. This brings the same benefits I described earlier. The 18 liters is for us now a high-end in-line engine which is, from my perspective in terms of power and price, a very competitive engine. 18-liter in-line-six is unique, and is responding to the power and torque demand of very heavy equipment, as well as in railways, or in stationary equipment*».

mensions. Call it power density, call it compactness, call it layout optimization, in any case for every OEM the size of the engine vain is an obsession. Definitely!

The Deutz answer

And how did Deutz answer this question from the world of machinery manufacturers? According to DIESEL Magazine data sheets, the depth is comparable to that of a 5-liter engine, the length to that of a 6.7 liter engine».

From a technical point of view, in fact, the winning card of Deutz 9 liters is the dimension of the sole 4 cylinders in this range. First of all depth, which along with a structural sump would match the requirements of heavy-duty tractors and the overhang of construction machinery featuring short wheelbase and narrow gauge. With its 838 mm the TCD9.0 is just about 14 percent from the average of the 5 liters on the market (from the very same Deutz to Isuzu, Jcb, Mtu and Agco Power), doing even better than Volvo TAD. The length is one meter (1,015 mm); we compare it to the Tier 7 Final approved engines of the 6.7 - 7 liter range. Deutz's TCD9.0 is the narrowest engine block, delivering an average 25 percent more power and a torque gap of more than 30 percent.

13.6 LITERS. DEERE AT THE INTERMAT

After taking its first steps at ConExpo, the 13.6 liters was shown for the first time to the European public in 2018, a few steps from Saran, John Deere Power Systems headquarters in the Old Continent. At Intermat in Paris the top of the John Deere Stage V range flexed its muscles, showing 500 kW (671 HP, to be precise) and a significant leap ahead compared to the 13.5 liters, which stops at 448 kW (600 HP). The percentage progressions are the figure on which John Deere introduces its 13.6 liters: besides power the engine shows a significant mass reduction – approx. 18%, and a better consumption curve – about 7%. At the engine launch under the California sun John Piasecki, director of marketing, sales and customer support for John Deere Power Systems, said: «Our engineers developed the new 13.6L engine to meet the power and packaging needs for a wide array of heavy-duty applications». On Intermat's eve Sandrine Couasnon, EMEA manager, marketing services and sales engineering, said: «Through each stage of consecutive emissions regulations, John Deere provided solutions that addressed key customer needs. These included increased uptime, low operating costs and flexible integration. The same applies to Stage V. For this stage, manufacturers will use DPF — a technology John Deere already has more than 900 million hours of experience using in the field».

JOHN DEERE AND CRISAFULLI. AN OASIS IN CALIFORNIA

Welcome to Blue Lagoon

A John Deere EWX4.5L Tier 4 Final 4-cylinder diesel engine drives the SRS Crisafulli DOF motor pump. The 30.5 centimeter pump, manufactured in Montana, is working in a natural reserve in California to control the lagoon water level and irrigate cereal fields

The title does not refer to the Eighties blockbuster (The Blue Lagoon) but to the natural scenario in which a John Deere engine is working. The players on the stage are the John Deere PowerTech EWX4.5L engine and Crisafulli, the American manufacturer of dredges, pumps, and portable power units, in particular the SRS Crisafulli DOF (Diesel on frame). Established over half a century ago (the firm was founded in 1966 in Glendive, Montana by Angelo, Frank and Joe Crisafulli brothers) Crisafulli supported the Cortopassi family, a olives producer. Cortopassi took a portion of their commercial production to establish a wildlife refuge. The pump water to maintain correct water levels in the lagoons and to irrigate fields of grain is the mentioned SRS Crisafulli DOF, that meets the both Tier 4 Final and Stage V emissions standards.

In John Deere classification this engine family for mobile applications features the 4 cylinders, 1.1 liters cylinder (BxS 106x127 mm), delivering 55 kW at 2.400 rpm and 304 Nm at 1.600 rpm, using common rail and waste gate valve for supercharging while keeping two valves per cylinder.

Some features of the SRS Crisafulli DOF? 30.5 centimeter pump, a rated flow rate of 22,712 liters per minute. Crisafulli manufactures trailer, vertical, submersible, slurry pumps, floating pumps and platforms and power units. The 6.000 Crisafulli customers are from Australia, Brazil, Canada, Chile, Colombia, Costa Rica, Ecuador, Egypt, France, (French) New Guinea, Haiti, Hungary, Jamaica, Japan, South Korea, Laos, Malaysia, Mali, Mexico, New Zealand, Paraguay, Peru, Philippines, Puerto Rico, Russia (Siberia), Saudi Arabia, Singapore, Thailand, United States and Venezuela. **FB**

LIEBHERR. COLMAR PLANT INAUGURATION

Willi Liebherr, chairman of the board of Liebherr-International, and the Colmar Managing Board (Jens Krug, Diethard Plohberger, Ingo Wintruff, Claude Ambrosini) officially inaugurated the D98 production plant. A four years long path that places the company on the premium brands range of the range of big displacement engines manufacturers. Liebherr D9812 is the Diesel of the year 2017. Read more aboutn this event on next DIESEL International issue, (first quarter 2019).

EIMA INTERNATIONAL 2018

Growing even more

FederUnacoma Surl, the EIMA International organizing company, has completed the layout for the exposition of the various merchandise categories in the trade fair pavilions and assigned the stands for the exhibiting industries. In September they were up 1,930

Record breaking figures for EIMA International. The exposition panel of the 43rd edition of EIMA International on the beginning of September is almost entirely set up. FederUnaComa has studied the details of the exhibition taking care of the pavilions' division by sectors and stands assignment to the exhibiting industries (that in September were 1,930). FederUnacoma is the Italian Agricultural Machinery Manufacturers Federation, formed in 2012 to replace the former Unacoma, set up in 1945. This year edition has improved the volumetric capacity and the functionality of the available spaces due to the new 28-29 and 30 pavilions. These buildings will host the machinery for the crop production, collection, first processing and preservation of the product, along with the machinery for agricultural industries.

This is the first step of a great restructuring project of the fair district which involves the building of more new pavilions and the overall retraining of spaces.

Static data figure out an increase of the external standees which reach a share of 610 representing 49 countries. Many manufacturing industries come from Europe (69 from Germany, 49 from France, 66 from Spain) but there are also industries from other continents (27 from USA, 27 from India, 141 from China).

The technologies illustrated by EIMA International are located in 14 fields of expertise and in 6 thematic salons (Components, Green, Idrotech, Energy, Digital and M.i.A), EIMA Components gathers the largest number of exhibiting companies (990) followed by EIMA Green (300).

There are also many exhibiting companies in EIMA Idrotech, the new event dedicated to irrigation and water management technologies (250 stands).

The organizers believe that the record results of 2016 (when visitors achieved a share of 285,000 from 150 countries) can be reached or even improved. **DF**

HYBRIDS TO EIMA

4E CONSULTING and Carraro Agritalia for the specialized hybrid tractor, Carraro 'Ibrido'. The downsizing of the thermal engine and the worldwide highest power density electric motor are features of this hybrid powertrain. The three-phase permanent magnets electric motor ensures maximum autonomy in electric mode to the high voltage 400V hybrid powertrain. 4E-Consulting, based in Ferrara, Italy, also developed the safety systems. I.e. the high voltage electrical circuit is set up to switch off instantaneously at any point in the event of a crash. Carraro 'Ibrido' has received two awards: the Technical Innovation of Eima 2018 and the Blue Eima Award.

KOHLER. November is the hybrid season also for Kohler. At Eima International Kohler showcases the K-FEM system (Kohler Flexible Energy Module). This time Kohler used its the 18 kW KDW1003, combined with a 48V electric motor that delivers 15 kW peak and 9 kW continuous energy. K-FEM targets applications such as vineyards and orchards tractors and professional tractors for gardening equipped with accessories, forklifts, welders and machines working on constant work cycles and low rotation speed, for example aerial platforms and excavators (which are struggling to reach the temperatures required for Dpf regeneration).
The K-FEM thus paves the way for the extension of the hybrid formula to the KDI family.

IAA HANOVER. DIESEL&ALTERNATIVE

The IAA 2018 was the border line between traditional and alternative traction systems on high and medium duty on road applications. Scania, the world's first methane-powered long-distance bus makes its debut at the IAA. The new Interlink Medium Decker bus powered by liquefied natural gas (LNG) guarantees, according to the manufacturer, a range of up to 1,000 kilometers. During IAA **Scania** also launched a new generation of hybrid vehicles for urban distribution.
New hybrid vehicles are equipped with a Scania 5-cylinder in-line 9-liter engine (can be powered by both diesel and HVO) that works in parallel to an electric engine capable of delivering 130 kW (177 hp) and with 1,050 Nm. The vehicles can also operate in fully electric mode (up to 10 kilometers), thanks to the servo systems for steering and air brake.
«*Iveco is the first manufacturer in the history of the IAA to present a stand without even a diesel engine*». This is how Pierre **Lahutte**, **Iveco Brand President**, debuted during the opening press conference held on Thursday 19 September.
«*Our exhibition*», continued Lahutte «*demonstrates that Iveco's offer of electric vehicles, CNG and LNG is available immediately and represents a viable alternative to diesel in all missions, from the transport of people in urban areas with low expenditure energy up to heavy-duty applications over long distances*».

During IAA **FPT Industrial** also presented a Diesel-Hybrid propulsion system based on its best seller engine F1A Euro VI Step D ready for the RDE (Real Driving Emissions) regulations. For the first time, this 2.3-liter engine is presented in a configuration for heavy duty.
FPT Industrial is working to develop hydrogen fuel cell technology. Hydrogen fuel cells represent a promising technology with high density capacity, potentially modular and green. Paul Bramhall

Fpt Industrial N67. Left, Deutz TCD3.6 and Kohler KDI2504 TCR.

Tractor of the year 2019. Free engines vs captive

THE SHADOW OF THE BOOT

Fpt Industrial steals the show under the hoods of Tractor of the year 2019, both as captive and free market supplier (McCormick). OEM-oriented engines also include Deutz (Landini) and Kohler (Antonio Carraro). Deutz TCD2.9, FPT N67 and Kohler KDI2504 TCR

We're in the middle of autumn, the gloomy November climate put farmers to rest, and the time of agricultural trade fairs is coming. This year it's up to Eima International. The twenty-second edition of Tractor of the Year, the most coveted prize for tractors and also a comparison arena for the kinematic chain will take place at Bologna Fairs. Two teams are on the pitch as always: captive and free market for the OEM world. Both include a large group of Italian mother tongue engines.

TRACTOR OF THE YEAR 2019 BEST UTILITY FINALIST

	CASE IH FARMALL 75A	FENDT 313 VARIO	MASSEY FERGUSON MF 6713	STEYR KOMPAKT 4115 HD
Engine	**Fpt S8000**	**Agco Power 44 Awf**	**Agco Power 4.4 Eco**	**Fpt F5C**
Cylinders/cc/vales	3/2,930/12	4/4,400/16	4/4,400/16	4/3,400/16
Nominal power kW/rpm	55/2,450	97.8/2,100	92/2.200	83.8/2,300
Max power kW/rpm	55/2,450	104.4/1,900	83/2,000	83.8/2,300
Max torque Nm/rpm	340/1,400	595/1,550	540/1,600	456/1,500
Tank capacity (diesel/AdBlue) l	82/-	210/23	153/18	115/-
Emissions	Tier 4 Interim	Tier 4 Final	Tier 4 Final	Tier 4 Interim
Transmission	12/12	Continua	12/12	24/24
Hydraulic (std/opt) L/min	47.7/-	84/110	57/98	64/-
PTO standard rpm	540	540/540E/1,000	540/1,000	540/1,000
Lenght mm	3,944	4,336	4,825	4,147
Width mm	1,527	2,320	1,795	1,584
Wheelbase mm	2,123	2,420	2,500	2,291
Mass kg	3,100	4,970	4,230	3,700
Max loud kg	4,800	8,500	8,500	6,500

	CASE IH MAXXUM 145 ACTIVEDRIVE 8	MCCORMICK X7.690 P6-DRIVE	ZETOR FORTERRA HSX 140
Engine	**Fpt Nef 4.5**	**Fpt Nef N67**	**Zetor 21647**
Cylinders/cc/vales	4/4,485/16	6/6,728/24	4/4,156/16
Nominal power kW/rpm	106,6/2,200	146.3/2,200	100/2,200
Max power kW/rpm	114/1,900	150.7/1,900	100/2,200
Max power boost kW/rpm	128,7/1,900	165.4/1,900	-
Max torque Nm/rpm	649/1,500	420/1,500	606/1,480
Tank capacity (diesel/AdBlue) l	210/39.5	320/46	270/23
Emissions	Tier 4 Final	Tier 4 Final	Tier 4 Final
Transmission	24/24	30/15	30/30
Hydraulic (std/opt) L/min	80/113	123/160/-	70/-
PTO standard rpm	540/540E/1.000	540/540E/1.000/1.000E	540/540E/1,000/1,000E
Lenght mm	4,556	5,510	5,200
Width mm	2,250	2,210	2,430
Wheelbase mm	2,684	2,820	2,590
Mass kg	5,850	7,098	4,400
Max loud kg	10,500	13,000	9,000

Two out of three for the Toty (double by Fpt Industrial), the same for specialized tractors (being the winners Same and Kohler), another double score for Fpt among the utility tractors), where we have four competitors. In the most coveted category of open field tractors we have two pure captive competitors such as the NEF 4.5-liter that equips the American from CNH, the Case Ih Maxxum 14.5 Actidrive 8, 114 kW or, if you please, 155 HP at 1,900 rpm and 650 Nm, the most aggressive of all the competitors in the three categories. You can see a clear trend towards mid-range power, without stressing the mep and overstress the pistons with excessive rpms for such applications. The other 'home made' engine bears an unusual signature, that of Zetor. Still a 4 cylinder, cylinder just over a liter, 100 net kW. Will the tractor drivers from Brno succeed in entering the free market? We witnessed at Intermat the first stirrings of Stage V, and the Bauma Monaco, the mother of all fairs, is near. The flagship of 'OEM oriented' engines is still Nef, this time with its 6.7 liters installed on the McCormick X7.690. Featuring 151 kW and 650 Nm, acceleration, transients and Hi-eScr formula could make this tractor fly high.

Utility tractors

The utility segment is a competition between Cnh, giving its odd S8000 (re-launched for small and medium Cnh tractors and power generation) to the Case Ih Farmall 75A, the F34 under the hood of Steyr Kompakt 4115 Hd and AGCO. The defending champions (who won Toty, Specialized tractors and Best Design awards last year) are represented by the Fendt 313 Vario and the Massey Ferguson MF 6713. There are no non-captive engines among the four competitors.

	ANTONIO CARRARO TTR 7600 INFINITY	LANDINI REX 4-120 GT	SAME FRUTTETO CVT 115 S
Engine	**Kohler Kdi 2504 Tcr**	**Deutz Tcd 2.9 L4**	**Farmotion Kd483**
Cylinders/cc/vales	4/2,482/16	4/2,900/16	4/3,849/8
Nominal power kW/rpm	55/2,300	76,5/2,200	78,7/2,200
Max power kW/rpm	55/2,300	82,3/2,000	83/2,000
Max torque Nm/rpm	300/1,500	420/1,600	434/1,600
Tank capacity (diesel/AdBlue) l	50/-	90/-	85/-
Emissions	Tier 4 Interim	Tier 4 Interim	Tier 4 Interim
Transmission	Continua	12/12	Continua
Hydraulic (std/opt) L/min	43/51	50/82	100/-
PTO standard rpm/min	540/540E	540/540E/1.000/1.000S	540/540E/1.000
Lenght mm	3,480	3,900	3,669
Width mm	1,350	1,478	1,369
Wheelbase mm	1,595	2,140	2,216
Mass kg	2,300	3,000	3,160
Max loud kg	4,500	5,300	4,800

Orchards and wineyards

The most lively section in the panorama of independent engine manufacturing, that of specialized, closes the grid. The trio speaks Italian, as in the best tradition of orchard and vineyard tractors: Antonio Carraro, Landini and Same.
The Ttr 7600 Infinity, which features the Kohler KDI 2504 Tcr, comes from the province of Padua, in North Eastern Italy. We find here the electronic version, equipped with chip and common rail and delivering 55 kW to meet Tier 4 Final/Stage IV thus avoiding post-treatment issues. Landini, from Reggio Emilia, enters the grid with its Rex 4-120 Gt which boasts under its hood the second free engine of the lot, the 77 kW Deutz TCD2.9L4. The Same Frutteto Cvt 115S is the captive soul of the group along with the Farmotion Kd483, showing the same performance level of Deutz.

Peter Karlsson

The 'applicationizer' showed itself during the event in Bavaria (Germany). The 3 and 4 cylinders by Hatz revealed a versatile behaviour for multiple applications.

Hatz 3 and 4 cylinders A tailor made suit

ALL YOU NEED IS 'H'... SERIES

The event hosted in an equipped quarry gave the operators an impression of the H series over the limited number of machines in which it is generally used. We've not witnessed a parade of vibrating rollers and plates, but 'pop' machines, so to speak, like wheel loaders and front loaders, multipurpose and amphibious machines, pile drivers and chippers, gensets and motor pumps

In Ruhstorf they renamed it 'Applicationizer'. Hatz gathered the trade press in front of a parade of H-series off-road and stationary applications. Hatz plays on the pitch of super-compact engines, and versatility is a fundamental prerequisite. Its coordinates are flexibility in loads and peaks management, suitability for the patchy panorama of emission standards, and the consequent possibility of diluting the price delta of technologies with simplified architectures for markets with low exhaust emissions.

After the unveiling of the 4 cylinders, the H series is enriched with a piece that extends its application horizon, allowing Hatz to build a portfolio that starts at 18.4 kilowatt and stops at 62 kW. The clear goal is entering segments which feature greater volumes than those of road construction equipment, the home of the brand from Lower Bavaria. Mini-shovels and mini-excavators could be some of the possible targets, but also some agricultural applications, for example specialized tractors and professional lawnmowers (see interview with Bernd Krüper in the box).

Reducing vibrations

Containing dimensions joins vibrations and noise pollution control. Likewise, friction reduction strategies are used to lower specific consumption.

The segmentation of the H series includes the 3 cylinders ranging from 18.4 to 46.5 kW and the 4 cylinders ranging from 37 to 55 kW.

The traditional mechanics vocation of Hatz gave way to the unavoidable electronic evolution, which drove the brand new platform since 2014: H for Hatz. 1,800 bar Bosch common rail, Wahler's external Egr, which works in tune with a mixer, a pre-cooler that lowers the temperature from 650 to 440/450 degrees in order to homogenize gas flow. Parameters and performance inputs are subject to electronic control, which also drives post-treatment timing.

Improved DPF technology

Surely DPF is not a last minute choice: the 2014 version with DPF met the diktat of Foen (Federal office for the environment) in the Swiss Confederation.

And this is exactly what makes the difference in the half-liter cylinder. The three cylinders version just features common rail and turbocharger in the T version. This is the card that Hatz intends to play to convince OEMs that don't like after-treatment, especially in the materials handling market. On the other hand, this is a reasonable choice: displacing DOC and DPF on the machine frame, along with the required protection (for example grills) while penalizing price, TCO and straining the control unit with counter-pressure signals may be an effective deterrent.

Below 19 kilowatts

Standing just below 19 kilowatt threshold and providing 130 Nm, the three cylinders is able to meet torque absorption requirements during translation and lifting operations. Hatz declares 3 dBA less, from 78 to 75. T and TI are the spearheads used to enter the so-called emerging countries, whatever they are: Egr and Doc are affected by sulphur quality, while ours are compatible with fuels containing up to 5,000 ppm of sulphur.TIC initials include Egr and Doc, while the final D (TICD) stands for particulate filter, optimized for long regeneration intervals and detachable from catalyst.

Fabio Butturi

The applicationizer

Here's a brief review of the machines we saw at work. A wheel loader demo equipped with the 3H50TICD. A multipurpose by Ladog for urban applications of municipal utilities equipped with the 4H50TIC. The FD30 RT4 front loader for heavy-duty uses by Goodsense. The Berky 6450 Amphi-King, a tracked machine for green maintenance in freshwater basins equipped with the 4H50TIC in the Opu set-up. The Jensen A 328 chipper, still equipped with the 4 cylinders in the Opu version. Then a Krinner pile driver, the KRD 60 PV, featuring the 4H50TIC Opu. We find the captive spirit of Hatz on the HEA-27TCD generator set in the TI version of the H series. Finally a motor pump, an application that will be tested in Stage V. The BBA BV150 (Bruin Buizen Apeldoorn), equipped with the 4H50TIC.

CEO Interview. Bernd Krüper

Which is the meaning of this event? What message does Hatz intend to send to the market?

First of all, we want to show media and readers that Hatz is a super-compact engine manufacturer for a wide application range and show where Hatz is going to stand now and tomorrow. As you can see here, we're talking about wheel loaders, power generators, pile drivers, multipurpose machines for municipal utilities. What emerges from this meeting is that the Hatz H-series is not limited to some applications in earthmoving.

What the next Hatz applications will be?

Hatz is a well-known and appreciated brand in the compact segment thanks to its mechanical and electronic engines. We're planning to enter applications such as small excavators, as you saw today, wheel loaders and front lifts thanks to our H series and water-cooled engines. Another interesting area is that of power generation and motor pumps. We also have some specific applications such as energy supply for batteries and peripherals.

Can we expect structural versions for specialized tractors?

We are reviewing together with some OEMs a version featuring a structural oil sump. I can't tell you more at the moment.

Right, Bernd Krüper, Hatz CEO.

What about a joint venture in China?

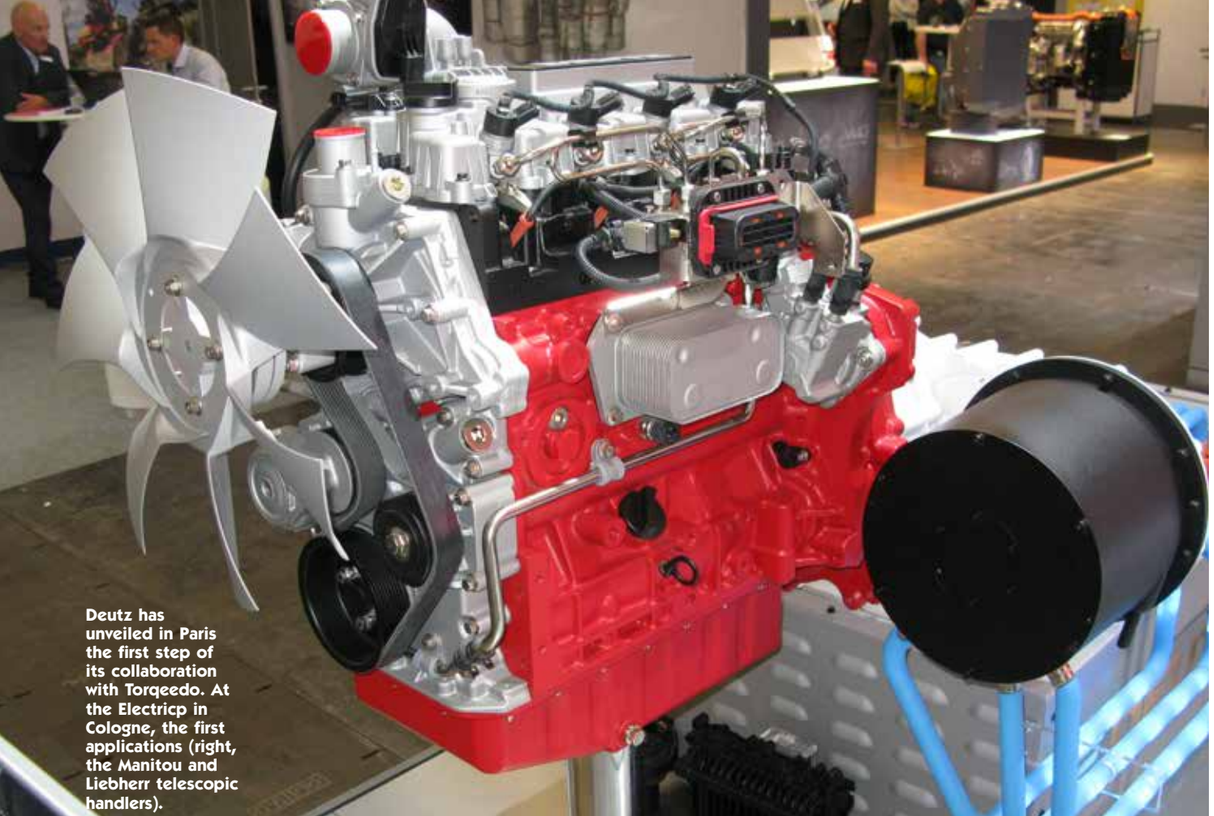
Hatz has some Chinese forklift manufacturers among its customers that use our engines for the European and American markets. Secondly, the tightening of regulations in China, Korea and Japan requires more and more complex engines with post-treatment, especially in the metropolitan areas of Beijing and Shanghai.

What about cost reduction opportunities?

The Ruhstorf plant has reached its full manufacturing capacity, even for the near future. To increase volumes in the US as in China and India we'll inevitably need to find some form of cooperation.

What can you tell us about the so-called alternatives?

As manufacturers of small diesel engines we think we can benefit from downsizing and hybrid technology. We believe in clean diesel and we are working on hybrids. We also have some ideas on gas engines that we are ready to develop.



Deutz has unveiled in Paris the first step of its collaboration with Torqeedo. At the Electricp in Cologne, the first applications (right, the Manitou and Liebherr telescopic handlers).

HYBRID SYSTEMS

Deutz (and Torqueedo) goes hybrid

PERFECT SINERGY

E-Deutz project is going on. The first result of the interaction between Torqeedo R&D and Deutz is the hybridization of the 55 kilowatts TCD2.9, Diesel of the Year Contest Win ner in 2010.

The so called E-Deutz strategy has showed its first tangible results at Intermat 2018 with a new hybrid powerline based upon the TCD2.9. A proposal which surely benefits from the acquisition of Torqeedo, an over 10 years experienced manufacturer of electric motors for yachting also renowned for its competence in the development of Battery Management System (BMS).
Thanks to the 55 kW electric motor mechanically coupled to ICE, total power doubles (the four cylinders 2.9 diesel engine is rated at 55 kW at 2,600 rpm and torque is 300 Nm at 1,600).
But it's also possible to disconnect ICE and go in full electric mode with 55 kW thanks to the 40 kWh battery.

Hybrid approach

The idea behind a hybrid drivetrain is to let the ICE work as much as possible at full power and constant speed while using electric motor to boost it in case of need (high power request or transients under heavy loads) or taking over when idling or when zero emission operational mode is requested.
So, it's possible to replace a much bigger engine (TCD 4.1, for example, has roughly the same maximum power) but with a dramatic reduction in emission and fuel consumption.
This isn't the first experience with hybrid solutions as Deutz already proposed an hybrid ICE. but it was kind of a prototypal solution. Now downsizing of ICE is more substantial and supercapacitor (extremely vigorous in power delivering but featuring less capacity and much more expensive) has been replaced by a more traditional lithium battery pack at 400 V, more suitable for applications that require less power peaks but greater autonomy.

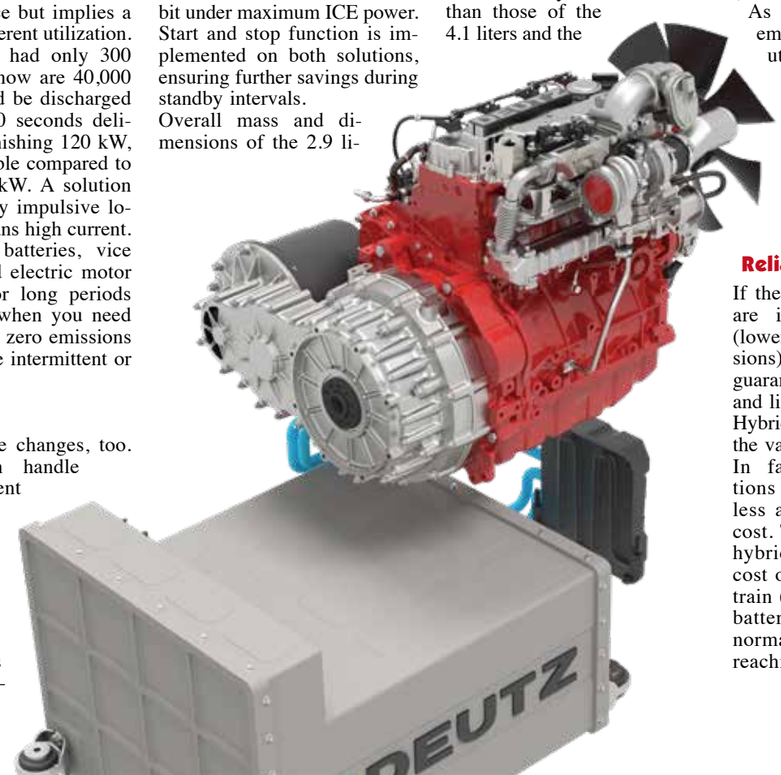
Not so much 48 V

Following Torqueedo aquisition last year and first hybrid drivetrain launched this spring, Deutz approach 48 V technology offering a new drivetrain specifically conceived for telescopic handlers et similia.
48 V is the new sensation of the year for automotive world but Deutz reinterpretation is slightly different and make it look like a full hybrid.
First, take away from a Liebherr TL 432-7 telescopic handlers its 74 kW DEUTZ TCD 3.6 diesel engine and switch to a 56 kW DEUTZ TCD 2.2, add a 48 volt 20 kW electric motor and a 10 kWh capacity battery and your hybrid telescopic handler is served.
The difference with mainstream 48 V configuration is the availability of a full electric mode.
Usually 48 V hybrid uses electric motor only to support ICE during acceleration and transient and does not drive the vehicle in full electric mode. Neither for few kilometers.
Deutz integrated a decoupler, which allows the diesel engine to be disconnected from the electrical system and provides a full electric operational mode.
A very useful functionality, for example, when working indoors.
For this application Deutz developed also a full electric telescopic handler.
No diesel engine at all, replaced by a 60 kW electric motor and a powerful battery featuring 30.5 kWh capacity.
System voltage changes to 360 V. An unavoidable choice with such power rates in order to keep the amps at acceptable levels.

The transition from supercapacitor to batteries is not a mere technical choice but implies a completely different utilization. Supercapacitor had only 300 Wh capacity (now are 40,000 Wh!) but could be discharged in less than 10 seconds delivering an astonishing 120 kW, more than double compared to the actual 55 kW. A solution perfect for very impulsive loads, which means high current. With lithium batteries, vice versa, ICE and electric motor work along for long periods or alternately when you need long periods at zero emissions or the loads are intermittent or very low.

Capacitor

Recharge mode changes, too. Capacitor can handle very high current energy recovery (even if capacity is limited) and don't risk overcharge. On the other hand, batteries can be recharged also during normal diesel use when load needs are a little bit under maximum ICE power. Start and stop function is implemented on both solutions, ensuring further savings during standby intervals.
Overall mass and dimensions of the 2.9 liters and of the electric motor are certainly lower than those of the 4.1 liters and the power rate is almost the same. (110 versus 115 kW).
As for consumption and emissions, a lot depends on utilization profile. As with all hybrid solutions, best results are achieved with long periods of use at reduced or zero load and a goal of a 15 – 20 % reduction in emission and consumption is not a chimera.



Reliability

If the advantages on the field are immediately perceptible (lower consumption and emissions), a brand like Deutz is a guarantee of quality, reliability and lifespan.
Hybridization means also rising the value of the powerline.
In fact, in many applications ICE represents more or less a 15 -20 % of the total cost. The same application in hybrid version, adds to the cost of ICE the hybrid drivetrain (electric motor, inverter, batteries and BMS) and so normally exceeds 50%, often reaching 65% of total cost.

Alberto Scalchi

Cummins goes electric, together with Brammo, Johnson Mattey and Efficient Drivetrains. Stage V F3.8 is the first diesel engine to approach the hybrid system for industrial applications.

HYBRID SYSTEMS

Cummins and the range extender

THREE WAY ELECTRIC

Cummins is capitalizing the investment made to purchase Johnson Matthey Battery Systems and Brammo.For a OEM - oriented manufacturer the first step of hybridization is offering a range extender. And now, also Efficient Drivetrains entered Cummins Electrification Division

Cummins goes electric. The first steps to acquire the necessary know-how have been the acquisition of Brammo for the low voltage battery capability and Johnson Matthey Battery System for high voltage ones. The second one, the acquisition of Efficient Drivetrains, a Californian company developing hybrid and fully electric solutions for commercial applications.
And now, thanks to its know-how, Cummins approaches OEM market with two solutions: a pure electric (BEV) and a range extender (REEV) conceived for the hybridization of electric vehicles.
That is to say, you use your vehicle as a BEV as long as you can but you are allowed to recharge batteries off-grid with the on board ICE.
Diesel engine (obviously, being a Cummins) is a four cylinder F3.8 Stage V, very efficient and with very low emission, which can deliver a 1,850 Nm continuous torque when used to charge the batteries and a 3,400 Nm peak torque when used to directly power the electric motor in parallel with batteries.

Obviously, the motor generator is also able to recover energy during passive cycles (for example, during braking) and then recharging batteries as well.

Standard batteries

Standard batteries come with thirty-five kWh capacity but, if you need more operating time in electric mode, you can combine several battery packs and get the needed capacity.
Eleven sensors monitor the health of each battery pack and temperature, equalization and control of each individual cell in real time.
Battery Management System (BMS) provides at any time SOC (state of charge) and SOH (state of health) while the safety system cut off the battery when its temperature reach critical level or current becomes excessive or when discharge or charge limit threshold is close.
Active balancing system balances cells maximizing their capacity at any time, even in the event of a progressive degradation of the capacity of one single cell.
BMS, batteries and the vehicle management system are linked through an RS-485 bus.
Diesel turns on automatically when SOC reaches 30%, to preserve batteries life (avoid too deep discharge) and keep an energy reserve always fully available. In fact, diesel engine is too small to deliver full power when needed, so it's necessary to always keep a reserve in the battery pack to ensure continuous operation when power request is very high.
Operative range depends on the utilization profile: for example, with an average duty cycle for a 20-tonne shovel we can expect a couple of hours autonomy for each 35 kWh battery pack installed. The more batteries, the more autonomy. To reduce battery wear, it's better connecting to the grid as soon as possible and reduce DOD. Charging time is just under 30 minutes with a 75 kW CHAdeMO level 3 CC 480 V supercharger. Using a level 2 AC socket charging time rises 4 to 8 hours, depending on SOC, inverter type and socket power. Fast charge and/or deep discharge can reduce battery life expectation dramatically.

Concept truck

Coming soon is also the hybridization of the new **SHELL** *concept truck. At the moment motorization is based on a six-cylinder Cummins X15 rated at 294 kW with only one axle driven to maximize efficiency. In the hybrid version, the third non-powered axle is replaced by an electric motorized axle to support ICE on long step gradient or when a more vigorous acceleration is needed.*

Next step will be the implementation of REEV in a suburban bus.
For those who need an all-electric application, Cummins completely gives up diesel engine and offers a full electric BEV scalable in various sizes depending on the different applications (for example drills, trucks for underground mines and tractors for port and airport terminals or city bus).
Data are still top secret but it looks like a real revolution for Cummins

Alberto Scalchi

8.5 to 9.5 liters industrial engines

THEY SPEAK GERMAN TOO

Deutz and Man broke into this range. That's unusual for the German school, which is permanently settled thanks to the two mentioned brands and the Deutz twin Liebherr. Cummins speeds up towards Stage V, balancing the Diesel Index of 'queen' Perkins

Among the fields 9 liters engines it's a displacement range mostly for captive applications. 9 liters are getting more and more appreciated yet. We're expecting some surprises...

Are 9 liters engines the new frontier of downsizing? Here at DIESEL we focused on the evolution of 1-liter cylinder and compact engines before and after the transition to Stage IIIB. During the transition phase from mechanical engines to electronic control we were thinking about the overtaking of compact engines (3.4 - 3.6 liters) on four cylinders, 1-liter cylinder engines. We said it again on DIESEL talking about 5 liters engines. Now it's time to focus on 9 liters displacements and around. We analyzed this range in its extended version, from 8.9 to 10.8 liters, but in the meantime engine manufacturers took a step beyond. Deutz, Cummins and Man took the 1,5 liters cylinder (with the unavoidable approximations and the exception of the unique odd, the Scania 5 cylinder) towards the official nomination as the absolute protagonist.

DEUTZ

Let's start with Deutz, whose TCD9.0 won the Diesel of the Year 2018. Thinking about the 1.5 liters cylinder, the anomaly of the German world champion is evident. We're actually talking about a 4 cylinders, and the optimization of its width and length has been discussed several times this year on DIESEL magazine, dieselweb.eu and diesel-international.com, and in the rationale that led the jury to award Deutz the prize. This is an engine coming from a four-handed score written together with Liebherr, which also gave birth to a 12 and a 13.5 liters sharing with it about 65 percent of spare parts. The 18 liters is on top of this range.

Let's go back to Deutz, which focuses on power density more than on absolute power. When it comes to kW/displacement ratio and size is a key factor (see the case of power density and relative density) Cummins is the other competitor for the first place.

MAN

But there's another 'strike' (as they say in football) coming from Germany. Man unveiled at Agritechnica its D1556, the 'heretic' from Nuremberg. The 'heresy' is not only a matter of displacement: D1556, in fact, paved the way for all its onroad versions.

Thinking of downsizing, the D1556 will replace the D2066 in the off-road segment... The monoblock leaves behind Egr for SCR only and after-treatment control integrated in the control unit (AGN). Common rail is probably going to be the same for all applications, 2,500 bar and VGT to support powers rates from 205 to 324

IF YOU NEED TORQUE...

Brand Model	CATERPILLAR C9.3 ACERT	CUMMINS L9	DEUTZ TCD9.0	FPT INDUSTRIAL CURSOR 9	JOHN DEERE PSS9.0L	LIEBHERR D964A7	MAN D1556	PERKINS 1706J-E93TA	SCANIA DC9
I.D.									
B x S mm - S/B	115 x 149 - 1.30	114 x 145 - 1.27	135 x 157 - 1.16	117 x 135 - 1.15	118 x 136 - 1.15	135 x 157 - 1.16	115 x 145 - 1.26	115 x 149 - 1.30	130 x 140 - 1.08
N, cylinder- dm^3	6 - 9.28	6 - 8.88	4 - 8.98	6 - 8.70	6 - 8.92	4 - 8.98	6 - 9.03	6 - 9.28	5 - 9.29
Max power kW - rpm	298 - 2,200	321 - 2,100	300 - 1,900	330 - 1,900	317 - 2,200	300 - 1,900	324 - 1,900	**340** - 2,200	294 - 2,100
Mep at max power bar	**17.9**	21.1	21.5	18	19.8	21.5	23.1	20.4	18.4
Piston speed m/s	10.9	10.2	9.9	**8.6**	10	9.9	9.2	10.9	9.8
Max Torque Nm - rpm	1,715 - 1,400	1,847 - 1,500	1,695 - 1,200	1,850 - 1,400	1,685 - 1,600	1,739 - 1,400	1,970 - 1,150	**2,081** - 1,400	1,827 - 1,500
Mep at max torque bar	**23.7**	26.7	24.2	27.2	24.2	24.8	28	28.7	25.2
Torque rise %	47.6	47.5	46.5	**66.2**	2.3	48	50.8	51.3	52.1
Torque at max power Nm	1,294	1,460	1,509	1,215	1,372	1,509	**1,627**	1,470	1,333
% Power at max torque (kW)	84.4 (252)	84.40 (271)	71 (213)	11.20 (27)	89.10 (282)	85 (255)	73.30 (237)	89.80 (**305**)	91.20 (268)
Work range rpm	800	700	700	500	1,200	500	750	800	700
DETAILS									
Specific power kW/ dm	32	36.1	33.3	27.8	35.5	33.3	35.8	**36.5**	31.6
Specific torque Nm/dm^3	184.6	208	188.5	212.4	188.8	193.4	217.9	**224.1**	196.6
Areal specific power kW/dm^2	47.83	52.45	52.36	37.67	48.32	52.36	52.01	**54.57**	44.28
RULES AND BALANCE									
Dry weight kg	885	708	750	870	1,044	750	860	865	970
L x W x H mm	1,119x827x1,066	1,128x704x1,166	1,015x838x1,116	1,216x883x1,007	1,271x856x1,265	1,015x838x1,116	1,414x807x1,103	1,125x791x1,068	1,235x980x1,100
Volume m^3	0.99	**0.93**	0.95	1.08	1.38	0.95	1.26	0.95	1.33
Weight/power kg/kW	3	**2.2**	2.5	3.6	3.3	2.5	2.7	2.5	3.3
Weight/displacement kg/dm^3	95.3	**79.7**	83.4	99.9	117	83.4	95.2	93.2	104.4
Power density kW/m^3	301	345.2	315.8	225	229.7	315.8	257.1	**357.9**	221.1
Total density t/m^3	0.89	0.76	0.79	0.81	0.76	0.79	0.68	0.91	0.73
Displacement/volume dm^3/m^3	9.38	9.55	9.46	8.06	6.47	9.46	7.17	**9.77**	6.99
INDEX									
TORQUE	11.1	10.4	10.3	**20.2**	11	8.5	10.9	11.6	10.4
PERFORMANCE	6.9	7.5	7.1	7.1	5.9	7.2	7.7	7.9	7.1
STRESS	11.5	12.3	11.4	**11.9**	216	11.6	12.4	13.2	11.7
LIGHTNESS	12.3	10.1	11.5	12	1.2	11.7	11.8	11.7	13.4
DENSITY	11.8	14.1	13.9	11.7	2.6	14.1	10.8	**14.8**	9.6
DIESEL	7.6	**8.2**	7.8	7.6	7.2	7.6	8	8.2	7.6

kW and 1,970 Nm torque peak at 1,150/1,300 rpm. Man used plastic for the oil sump, implemented electronic immobilizers and modular auxiliary units in order to fit alternator, air conditioning and compressor in the engine compartment layout.

LIEBHERR

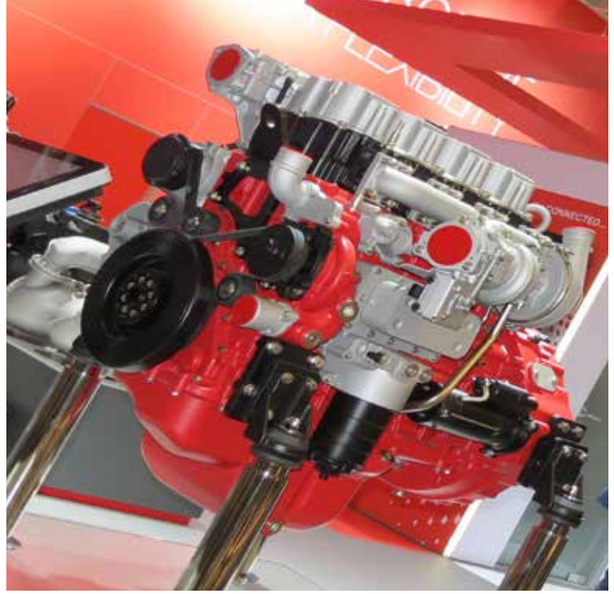
The breakthrough of German technology in the 9 liters range does not end here. The Deutz TCD9.0 has a white-painted twin, the Liebherr D964, Cologne's recent partner in the restructuring of Deutz top range, which remarket the 'string quartet' on its own brands and in the free market through its own dealer network.

CUMMINS

Now it's the turn of another protagonist, Cummins. Moving from QSL9 to L9 the 8.88 liters in red has lost two letters of its acronym but gained the 'plus' sign. The renovation of the full line made in Columbus upgraded to Stage V has cut off exhaust gas recirculation and focused exclusively on efficiency.

PERKINS AND CAT

This approach gains 8 percent in progression on power curve and 13 percent on torque curve. Cummins then focuses on performance matching Perkins' Diesel Index, which has won the top on the grid using a properly reviewed and modified Cat monoblock (as shown by the gap compared to its older brother in yellow). The 1706JE93TA wins all specific values: specific power, specific torque, areal power. Caterpillar



features the same engine block while showing different results, being more conservative and tied to the jagged captive world of Peoria. The difference in absolute terms is 42 kW and 366 Nm.

FPT INDUSTRIAL

As noted on other occasions, the 9 liters is not the flagship of the Cursor family but still maintains a good size/performance balance which is the key of its elasticity.

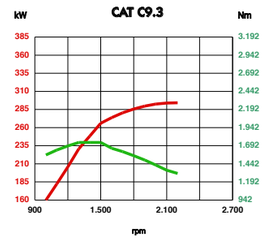
JOHN DEERE

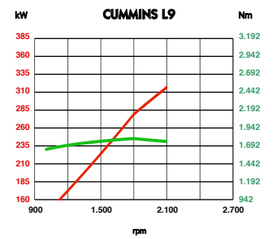
John Deere revised the top of its range introduced in 2017 in Las Vegas in a slightly oversized displacement (13.6 liters). This engine was launched in Europe at the Parc des Expositions in Paris, and will carry John Deere to Stage V. Accord-

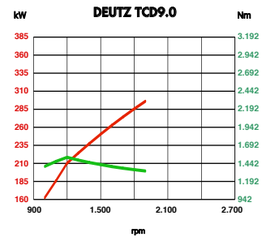
ing to our information all we can say at the moment is that stresses are contained (in line with John Deere engineering philosophy) in order to support sealing and reliability of the engine block. The volume/weight/performance ratio is not at the top for the same reason, support efficiency against increasing injection pressures and temperatures. Specific power is quite remarkable.

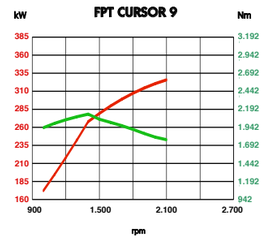
SCANIA

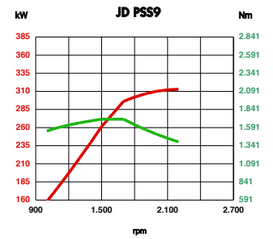
Scania looks forward to 2019 and beyond with its 'odd', leaving behind recirculation and confirming Xpi. Its 9.3 liters has what it takes to do well even in Stage V. Södertälje could exploit rotation speed and MEP to maximize the results shown under the Griffon hood.

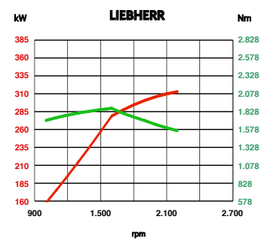


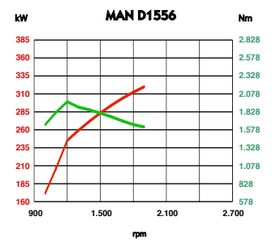


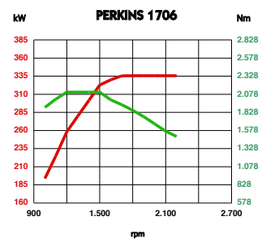


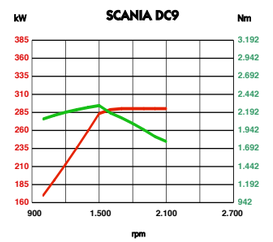












The D1556 at the Agritechnica MAN Engines stand. Below, a typical 7-11 liters diesel engine quarry application.

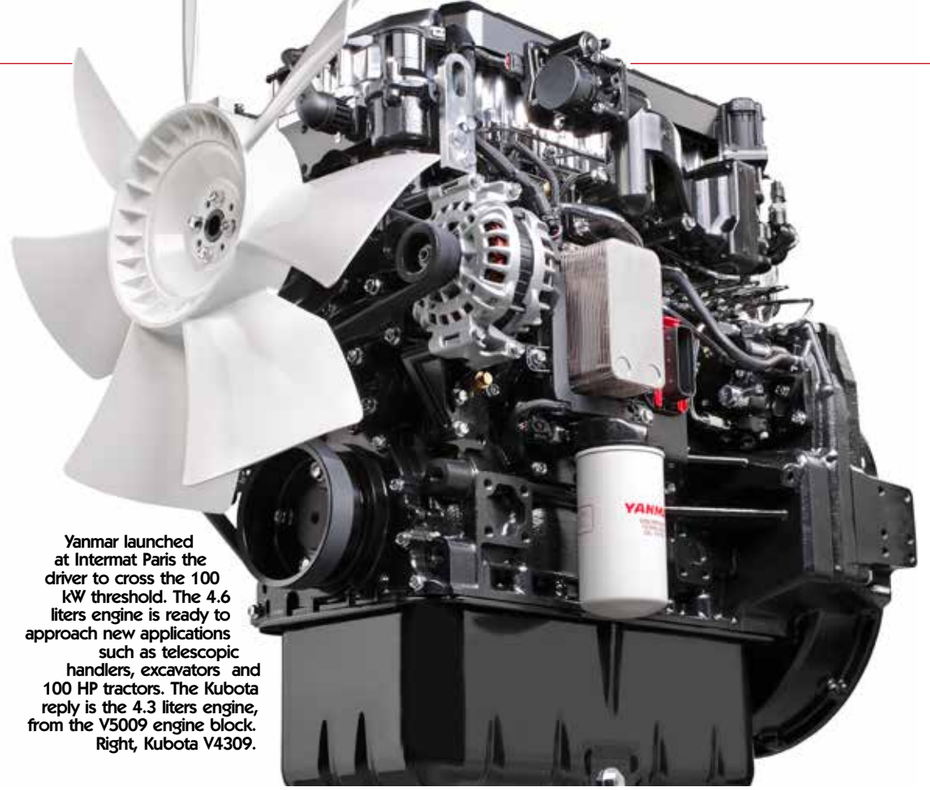
BIG IN JAPAN BE TIGHT

The well-known Alphaville lyrics sounds appropriate for this comparison. Cummins gains the DIESEL Index. The newcomer Yanmar figures are good, coming close together with Cat, Man and Perkins. The Japanese double-stage is a brave choice

The 1.1 liter cylinder is here! The oversizing of the 1 liter cylinder stands the test of new regulations and OEMs requiring compactness, compactness and, again, compactness! On one hand super-compacts populate a crowded bunch no one can miss in the range around 3.6 liters. A step above 4.6 liters we find 5 liters, naturally related to 4.4 - 4.6 displacements and reinforced by Deutz and Kubota investments in this displacement.

YANMAR

We are waiting to take proper measures to Stage V evolutions, still partly unclear, but there's a new entry in this range that could leave its mark: Yanmar. As announced for a long time, Osaka points to widen its aplication range to mobile machines manufacturers. Let's read an excerpt of the speech of Carlo Giudici, Emea Director, published on the Italian issue of DIESEL: «*Specifically, 3.8 and 4.6 derive however from a market input and meet two needs: on one hand, safeguarding the market below 56 kilowatts, avoiding to leave the upper range uncovered and vulnerable to competitors. On the other hand those engines allow us to compete in the range currently covered by 4 cylinders, 4.5 liters engines cylinders. Thanks to power rates up to 155 kW we can be a full range provider for OEMs*». And again: «*3.8 and 4.6 are definitely going to be structural. One of them will be showed at Eima in this version. The 4.6 has been developed for construction and agriculture, which are the most challenging applications*».



Yanmar launched at Intermat Paris the driver to cross the 100 kW threshold. The 4.6 liters engine is ready to approach new applications such as telescopic handlers, excavators and 100 HP tractors. The Kubota reply is the 4.3 liters engine, from the V5009 engine block. Right, Kubota V4309.

Improving turbo

Double stage. This is one of the typical benchmarks of supercharged engines clearly recognizable on the 4TN107. Double stage supercharging allows the top ratings to climb up to 805 Nm. That's a choice that fits with recirculation, supported by the geometric and proportional airflow provided by low pressure turbine, which is activated at low rotation speed, while the second one provides the final boost. Both power and torque specific curves belong to him. Its design, which is very functional to application needs (that is power density), show particular attention to size containment. Yanmar skills in after-treatment techniques are very useful, allowing the Japanese to adjust the module and optimize installation.

CROSSING OFF-ROAD APPLICATIONS

Brand	AGCO POWER	CATERPILLAR	CUMMINS	FPT	JCB	JOHN DEERE	KUBOTA	MAN	PERKINS	YANMAR
Model	**44 HD**	**C4.4 ACERT**	**B4.5**	**N45 ENT SCR**	**ECOMAX 93**	**PVX 4045 HFC93**	**V4309**	**DO834**	**1204J-E44TA**	**4TN107**
I.D.										
B x S mm - S/B	108 x 120 - 1.11	105 x 127 - 1.21	104 x 132 - 1.27	104 x 132 - 1.27	103 x 132 - 1.28	106 x 127 - 1.20	110 x 112 - 1.02	108 x 125 - 1.16	105 x 127 - 1.21	101 x 120 - 1.19
N, cylinder- dm^3	4 - 4.39	4 - 4.39	4 - 4.48	4 - 4.48	4 - 4.39	4 - 4.48	4 - 4.25	4 - 4.58	4 - 4.39	4 - 4.57
Max power kW - rpm	110 - 2,100	129.4 - 2,200	149 - 2,500	125 - 2,200	93 - 2,200	129 - 2,200	115.7 - 2,200	**162** - 2,100	140 - 2,200	155 - 2,200
Mep at max power bar	14.6	16.4	16.3	15.5	**11.8**	16	15.1	20.6	17.7	22.4
Piston speed m/s	8.4	9.3	11	9.7	9.7	9.3	**8.2**	8.8	9.3	8.8
Max Torque Nm - rpm	650 - 1,500	750 - 1,400	784 - 1,500	696 - 1,600	550 - 1,500	713 - 1,600	649.6 - 1,500	**850** - 1,400	825 - 1,400	805 - 1,500
Mep at max torque bar	19	21.9	22.4	19.9	**16**	20.4	19.6	23.8	24.1	26.8
Torque rise %	48.9	48	42.5	45.7	**49.4**	45.3	46.3	42.5	49	41.9
Torque at max power Nm	500	559	568	539	402	559	500	**735**	608	676
% Power at max torque (kW)	68.1 (75)	85 (110)	82.70 (123)	93.40 (117)	93 (86)	92.70 (120)	88.30 (102)	77 (125)	86.50 (121)	81.60 (**127**)
DETAILS										
Specific power kW/ dm	25	29.4	33.2	27.8	21	28.7	27.1	**35.3**	31.7	33.9
Specific torque Nm/dm^3	147.8	170.4	174.8	155.1	125	159	152.6	185.5	**187.5**	176
Areal specific power kW/dm^2	30.05	37.40	**43.82**	36.76	27.93	36.54	30.45	44.26	40.46	43.06
RULES AND BALANCE										
Dry weight kg	530	420	390	410	540	540	600	490	420	550
L x W x H mm	1,112x654x896	845x741x867	833x974x705	810x678x901	787x701x921	867x680x1,211	898x649x972	937x882x926	854x741x867	940x730x940
Volume m^3	0.65	0.54	0.57	**0.49**	0.51	0.71	0.57	0.77	0.55	0.65
Weight/power kg/kW	4.8	3.2	**2.6**	3.3	5.8	4.2	5.2	3	3	3.5
Weight/displacement kg/dm^3	120.5	95.5	**87**	91.4	122.8	120.5	140.9	107	95.5	120.4
Power density kW/m^3	169.2	239.6	**261.4**	255.1	182.4	181.7	203	210.4	254.6	238.4
Total density t/m^3	0.82	0.78	0.68	0.84	1.06	0.76	1.05	0.64	0.76	0.85
Displacement/volume dm^3/m^3	6.76	8.15	7.87	**9.15**	8.63	6.31	7.47	5.95	8	7
SPECIFICATION										
Injection system	common rail Bosch	common rail	Xpi	common rail	common rail Delphi	common rail	common rail	common rail	common rail 2,000 bar	common rail
INDEX										
Torque	12.4	10.8	**12.9**	8.7	9.3	8.8	9.6	9.9	11	6.1
Performance	5.5	6.3	6.6	6	5.1	6	5.6	6.8	6.7	6.5
Stress	9.1	10.4	11.1	9.9	**8.6**	9.9	9.3	10.9	11.1	11.9
Lightness	14.6	11.3	10.6	11	14.8	14.7	16.5	13.3	11.1	14.3
Density	13.5	18.8	18.6	19	14.5	13.5	15.9	14.7	**20.2**	16.5
DIESEL	6.9	7.5	**8**	7.1	6.2	6.9	6.7	7.6	7.7	7.3

X6 McCormick and FPT Industrial

The X6 series consists of three luxury utility tractors from 84 to 95.6 kW, which join the five models of the X7 series and the three models of the X8 series, totalling 11 'cvt' models from 84 to 228 kW.

As for the X7 range, the three all-around models are also available with Xtrashift powershift gearbox, but the real technological plus of the X6 series is the Vt-Drive vgt transmission entirely made in the Fabbrico factory (Reggio Emilia, the general headquarters of Argo Group) just like all other main components of the machines except the engine (Fpt Industrial) and the optional front suspended axle (Carraro).

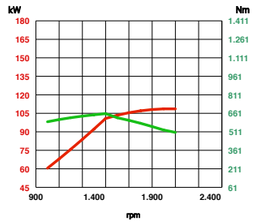
The visual impact of the X6.440 Vt-Drive is definitely positive, both for its yellow body (also available in classic McCormick red) and the compact and balanced size (5 tons net weight and 8.5 tons maximum operating weight). Under the hood we find the 4 cylinder, 4.5 liters, 95.6 kW Nef, renamed Beta Power by Argo. In line with Tier 4 Interim (Stage IIIB), this version is SCR only and DOC-ready for Stage 4 Final. Electronic management provides a 10 HP boost (7.3 kW) during translation over 15 km/h and in applications using PTO. But as already anticipated the true distinctive feature of the machine is surely the new Vt-Drive transmission entirely designed and developed by Argo Tractors (including the software).

Compared to competitors, the X6 series gearbox stands out for the limited number of components, mainly clutches, which gives obvious advantages in terms of industrial costs and operational efficiency.

The group features an hydrostatic section, which includes a variable displacement pump and an electronically controlled fixed displacement engine, and a mechanic section featuring a single epicyclic, two forward and one reverse clutches. Depending on the selected mode (Road or Field) at low speeds (from 3 to 5 Km/h) the unit works in 'pure' hydrostatic mode, while at higher speeds the hydrostatic component is progressively combined to the mechanic within the epicyclic, minimizing power absorption.

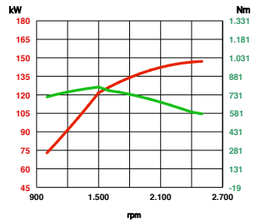
AGCO POWER

AGCO 44HD



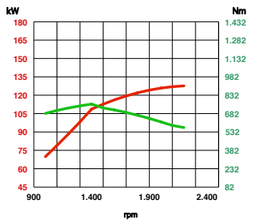
CUMMINS

CUMMINS B4.5



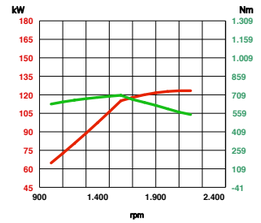
CAT

CAT C4.4



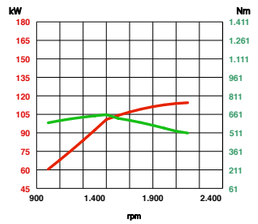
FPT INDUSTRIAL

FPT N45

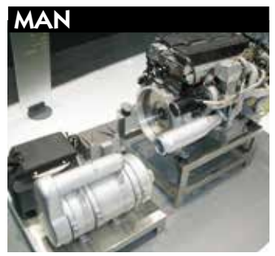


KUBOTA

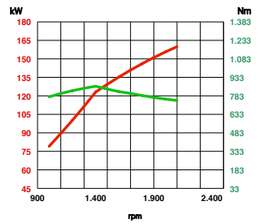
KUBOTA V4309



MAN

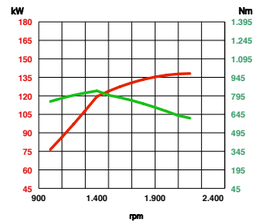


MAN D0834



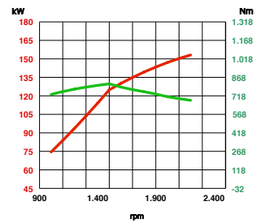
PERKINS

PERKINS 1204



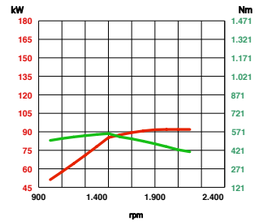
YANMAR

YANMAR 4TN107



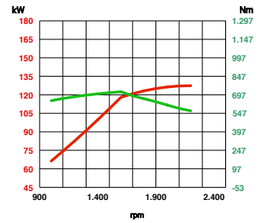
JCB POWER SYSTEMS

JCB ECOMAX



JOHN DEERE

JD PVX4045



KUBOTA

Another surprise, althought clearly foreseen by DIESEL, has the same roots: Osaka. After the launch of its 5 liters in Las Vegas Kubota confirmed bore and reduced stroke by 20 mm. Et voilà, the V4309. Its nature lies in the acronym: 4.3 liters, which fills the void between 3.8 and 5 liters. Its technical inspiration is not far from that of Yanmar. The approach is indeed specular: EGR to reduce urea consumption and maintain efficiency, DOC, DPF and SCR to meet Stage V. Specific curves lose a few percentage points compared to V5009, but the overall feeling is one of particularly compact unit, which allows Kubota to complete its range of telehandlers, forklifts and reach stakers in the low-end segment (the range above 5 liters is a Swedish monopoly). Yanmar climbed up to 155 kW starting from 90 kW. Who else is up there?

MAN

Almost no one, at least looking at power rates in Tier 4 Final, except for Man D08. Probably in a few months, following Stage V, we'll see some power tweaking upward. At the moment Man takes the lead leaving in the third place Cummins, that delivers 149 kW in Stage V edition - just six kW below and 784 Nm.

PERKINS

Perkins follows with its modified 1024, that shows increased power rate (from 129 to 40 kW) and torque (from 750 to 825 Nm).

CAT AND JOHN DEERE

Caterpillar and John Deere maintain Tier 4 Final figures (129 kW) followed by Fpt Industrial (125 kW). The above mentioned Man D08 remains an evergreen. The low-end of Nuremberg's range features 4.58 liters delivering 162 kW at 2,100 rpm and 830 Nm at 1,400 rpm. Those power rates are worthy of a 6 cylinders, while low rotation speed avoids excessive piston stress.

JCB POWER SYSTEMS

JCB is a little subdued, its 4.4 liters - the pioneer of autarchic engines does not pushes on the accelerator focusing on regularity instead. MEP at maximum torque and torque rise clearly show that this firstborn was mainly conceived for captive market, just like the next 6 cylinders from India. The stroke-increased Ecomax is definitely more attractive, just like the last born, the 3 liters, which could do well in ultra-compact range.

AGCO POWER

Agco Power also shows its captive soul, featuring just 14.6 bar MEP. When it comes to performances Nef by Fpt Industrial does not go unnoticed, even if the peak rates of 4.5 liters are slightly lower compared to its 6 cylinders brother.

CUMMINS

Also in this 'mirror' Nef is the leader of the "anti-Egr party", who also enlisted Cummins at least starting from next year, when the regulatory framework will be that of Stage V.

5 liters threshold

We naturally find in the 4.6 range the 4 cylinders in line featuring 1.2 and 1.3 liter cylinders. The TCD5.0 by Deutz was launched at Bauma 2016, while the Kubota V5009 was introduced at Las Vegas Conexpo. During a press conference Deutz announced the 5.2 liters upgrade. DOC, DPF, SCR, EGR is under observation. Regarding the TCD we quote here Michael Wellenzohn: "Number of internal ducts reduced to a minimum, well separated hot and cold parts, reduced performance loss from oil and water circuits. The engine also features a camshaft, a cross flow cylinders head, hydraulic compensation of valves clearance without maintenance". Let's see Kubota . The 4 cylinders, 1,250 cc cylinder (110x132 mm bore/stroke) and 157.3 kW was finally unveiled to the European market. Post-treatment features DOC, DPF and SCR. Egr stays in place along with a reduced amount of gases sent to the combustion chamber to preserve engine efficiency. Practically, recirculation helps reducing urea consumption while easing installation of the after-treatment module. Our Intermat reportage highlighted the younger brother of 09 series, the 4.3 liters. High performance common rail (the pressure is around 2,000 bar), waste gate with aftercooler, industrial soul showed by four hydraulic pumps supported by an auxiliary PTO. The path is clear: settle down in a key segment through a unit that relies on compactness. The main player of this game is still the MTU R4 1000, delivering 170 kW and 951 Nm (and some extra weight). Power density is outstanding. Volvo Penta comes close, featuring the same MTU cylinder size and relying on SCR- EGR without catalyst and particulate filter. Coming to supercharging variable geometry is a must to ensure homogeneous airflow without turning to double stage. Volvo shares this solution with the Jcb Ecomax. Agco Power stands out for power/weight ratio and size. Another Japanese is the Isuzu 5.2.

Kubota V5009.

Liebherr D9512

Two liters cylinder displacement, the engine that made contemporary history of power generation intensively used by Man in marine applications.
At the Liebherr Components headquarters in Bulle the 24.2 liters is still popular and capitalizes on the investment in the manufacturing lines and R&D in Switzerland and in the Colmar factory, where the D98 is assembled (see page 6). Getting a name in a saturated market like that of diesel propulsion – that has also been targeted by mainstream media - is not easy, but Liebherr is succeeding. Apart from captive market, Liebherr Components supplies Kohler-SDMO, precisely with the D98 'made in Colmar', and Krone has equipped the BigX 1180 with the same V12 we are talking about in these pages, delivering 857 kW (1,165 HP) and confidently using SCR only. The downstream simplification trump card also worked with the brand par excellence of agricultural mechanization, John Deere. Scr hardly hooks to high rotation speeds, albeit in the face of a linear power curve: soot regeneration on a combine or a forage harvester could therefore cause serious back pressure problems or requiring to force the process through diesel fuel post - injection or a coil. The V12 works at its best in the range from 1,500 to 1,900 rpm and delivers 4,700 - 4,800 Nm. On the 9000 series by John Deere Liebherr managed to take the place of Cummins QSK19 which is used on the most powerful models in the 8000 series.

Brand	LIEBHERR
Model	D9512 A7-04
I. D.	
B x S mm - S/B	128 x 157 - 1,23
N. cil. - dm3	12 - 24,24
Maximum power kW - rpm	750 - 1.800
Mep at max power bar	21
Piston speed m/s	9,4
Maximum torque Nm - rpm	4.775 - 1.500
Mep at max torque bar	25,3
% power at max torque (kW)	53,7
Torque at max power Nm³.	979
% power at max torque (kW)	100,1 (750)
Work range rpm	300
DETAILS	
Specific power kW/dm³	30,9
Specific torque Nm/dm³	196,9
Areal spec. power kW/dm²	48,58
RULES AND BALANCE	
Dry weight kg	2.195
L x W x H mm	1.879x1.210x1.434
Volume m³	3,26
Weight/power kg/kW	2,9
Weight/displacement kg/dm³	90,5
Power density kW/m³	230,1
Total density t/m³	0,67
Displacement/volume dm³/m³	7,44

John Deere and Liebherr Components

TWELVE FOR THREE

Are 24 liters strong enough for a top class harvesting machines? John Deere's answer is definitely yes. The brand of Moline chose the V12 Liebherr D9512 engine for three models of its brand new 9000 Series of self propelled forage harvester

Harder than steel

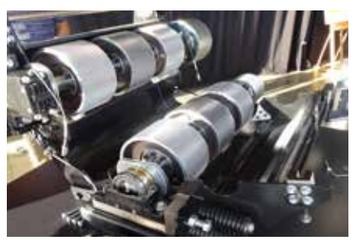
John Deere made available on the 9000 Series their Dura Line components, featuring an extremely wear resistant and smooth coating due to a special heat treatment. A proprietary tungsten carbide composition associated with particular application provides this exclusive wear-resistance performance. As stated by John Deere, chopping in the same crop conditions and chopping the same tonnage, Dura Line parts last four times as long as, or longer than, standard parts, significantly reducing time and money for replacing parts.

Dura Line parts cover nearly every wear part that does not already have a high-wear solution. The main crop flow elements are hardened and more resistant, even in tough conditions. Dura Line parts include spiral band, knife brackets, front chute, grass channel blower band, blower side liners, spout liners, and spout caps. Three packages - Dura Line Basic, Premium and Ultimate - are available to match different producer requirements.

Last August John Deere unveiled its awaited 9000 Series of self propelled forage harvesters. Brand new design, two different kernel processors, the latest version of the HarvestLab system for crop analysis, and an exceptional premiere under the hoods of three of the four new models (9700, 9800 and 9900): the V12 Liebherr D9512, a 24.2 liters, Tier 4 Final/Stage V compliant engine, delivering 770, 870 and 970 HP at 1800 rpm in the three available power ratings. A choice that was led by a clear focus on machine performance in terms of more throughput and less fuel consumption while providing maximum uptime and low cost of operation. The key of the Liebherr D9512 is the ability to provide lower engine rpm at higher harvesting component speeds, ensuring high power density and great fuel efficiency, constant maximum power down to lower engine rpm and a torque curve designed for forage harvesting applications. In numerical terms, this means that the broad maximum power range of the Liebherr V12 engine cuts off the less-efficient rpm area above 1800 rpm, while the rising torque curve down to 1300 rpm enables efficient operation of the machine in the lower rpm range. The global efficiency of this solution is also ensured by the fact that all machine component speeds are re-worked and laid out for best function in the 1400 to 1800 engine rpm range, a choice that also leads to better fuel efficiency with an optimum range from 1250 to 1600 rpm, where the engine has its lowest specific fuel consumption (g/kWh).

The header drive

One of the core technologies of the 9000 Series is the header drive, which is provided in the variable version as standard. The header speed is automatically synchronized with the feeding speed and length of chop through a hydrostatic IVT drive system, providing a smooth crop transfer from the header into the machine without blocking or disrupting material transition. A dual header drive complements the benefits of the variable header drive. While the variable header drive automatically synchronizes the pickup auger and harvester feeding speed, the dual header drive with its individual hydraulic drive of the pickup tines is speed matched with vehicle speed to ensure clean crop picking in changing conditions and windows. Tines speed up and slow down with forward speed while the pickup auger speed is still synchronized with the length of chop and feedroll speed. The 9000 Series SPFH also offer the hydraulic feedroll dampener in base. Next to the four individual springs applying high pressure on the crop mat entering the machine, the dampener supports crop compaction in uneven crop conditions and ensures smooth feeding even at the highest feeding speeds. Finally, a metal detector scans for metal in the crop mat and stops the intake in case of tripping; this device can be optionally integrated with a stone detection system that senses for knocks and abnormal feedroll movement.



The new 9000 Series design features a twin exhaust pipe. The top-model 772 12-Row Large-Drum Rotary Harvesting Unit has been designed to fully leverage the capacity of 9000 Series. AutoTrac RowSense keeps the machine in the right row, regardless of conditions, and helps maximize time in the field by improving harvest efficiency and yield quality

State of art processing

Two types of kernel processors (KP) are available for the 9000 Series, the John Deere Premium KP and the John Deere XStream KP. The 9600, 9700, and 9800 models, in particular, can be equipped with the John Deere XStream KP or the John Deere Premium KP, while for the 9900 only the heavy-duty XStream KP solution is available.

The Premium KP has a standard KP housing with grease lubrication in base. The roll diameter is 240 mm with 32 percent speed differential, but if required a 40 percent speed differential can be installed as an option. The Premium KP can mount three different rolls - Standard sawtooth, Whole crop and Dura Line sawtooth - with the latter ensuring longer lifetime and less wear. An optional crane with electric winch eases the mounting and dismounting of the Kernel Processor.

The John Deere XStream KP is specifically made for high-horsepower machines and stands for extreme kernel processing at any length of cut. The XStream KP rolls are manufactured and delivered by Scherer; the kernel processor is supplied ex factory by Scherer and fits all 9000 Series models (9600 through 9900). The XStream KP is equipped with a heavy-duty housing with KP roll quick-exchange system and pressurized oil lubrication. The roll diameter is 250 mm with 50 percent speed differential. As an option, the XStream KP can be equipped with bearing temperature monitoring. Three different rolls are available also for the XStream KP - Dura Line sawtooth, Dura Line XCut rolls and Whole crop XCut rolls. In comparison to the Dura Line sawtooth rolls, the Dura Line XCut rolls have a spiral groove sawtooth profile, resulting in a particularly efficient processing especially at long lengths of cut. The spiral groove design delivers highly processed plants and smashed kernels.

HarvestLab 3000

Also the 9000 Series may be equipped with the HarvestLab sensor mounted to the top of the discharge spout to take accurate dry matter and ingredient readings (more than 4000 measurements per second) of the crop through the sapphire glass lens as crop passes through the spout. This is the same technology forage labs use to measure dry matter. HarvestLab with John Deere Constituents Sensing measures dry matter, and has the ability to measure sugar, starch, acid detergent fiber (ADF), neutral detergent fiber (NDF), and crude protein in corn silage as well as ensiled material when used as a stationary unit. The HarvestLab used in conjunction with Harvest Monitor provides several important information including productivity in acres per hour, throughput in tons per hour, total area harvested, total crop mass harvested, yields, and dry matter. When the HarvestLab is used in conjunction with an 8000 or 9000 Series Self-Propelled Forage Harvester (SPFH) and a GreenStar display, AutoLoc functionality is automatically present. AutoLoc automatically varies the length of cut according to the desired crop-dry matter correlation settings based on the dry matter readings from the HarvestLab sensor.

9000 SERIES: THE FIVE NEW MODELS

Model	8600i	9600i	9700i	9800i	9900i
Engine	**PowerTech Psx**	**PowerTech Psx**	**Liebherr D9512**	**Liebherr D9512**	**Liebherr D9512**
Cylinders/Displacement cc	6/13.541	6/13.541	12/24.231	12/24.231	12/24.231
Maximum power HP/rpm	625/1.800	625/1.800	770/1.800	870/1.800	970/1.800
Feeding system width mm	660	830	830	830	830
Knife drum width mm	680	850	850	850	850
Knife drum diameter mm	670	670	670	670	670
Knives	40-48-56-64	40-48-56-64	40-48-56-64	40-48-56-64	40-48-56-64
Length mm	7.060	7.060	7.060	7.060	7.060
Minimum width	3.000	3.200	3.200	3.200	3.200
Pitch mm	3.060	3.060	3.060	3.060	3.060
Fuel/AdBlue capacity l	1.100/43	1.100/43	1.500/102	1.500/102	1.500/102
Unladen weight kg	16.000	18.800	18.800	18.800	18.800

Ecoforce introduction is increasing the volume of the rotary pumps produced by Stanadyne. Right, John Pinson.

Interviewing John Pinson, Stanadyne's Cto

NOT JUST FOR GASOLINE

Stanadyne is automotive oriented without forgetting the industrial. In this perspective, it is well equipped to approach Stage V. Global revenues are balanced 50% to 50% on high pressure gasoline and diesel pumps. Every year the produce 1 million gasoline pumps and 150K rotary pumps

The Cto of the company from Connecticut explains the latest strategies and future perspectives. From Stage V, to the downsizing strategy and the Ecoforce solution, but also the transition from mechanical to electronic pumps, common rail systems and electrification plans in the present and for the future of Stanadyne. All in the words of its Cto, Mr. John Pinson.

Good morning Mr. Pinson, can you talk to us about Stanadyne's strategy for the upcoming Stage V?

A patchwork of regulations across the globe which are varying the level of severity depending on the engine size and on the market. We are participating in two areas, one is the stricter standard that you find in Europe and coming also in the Far East region and have been in place in the US for a long time. So, we have a diesel common rail pump for on-road applications. This pump is suitable for 9 to 13 liters Stage V engines, and it is in production since 2014.

How about particle mass number control?

We are revising our design for a range of pressures up to 2,500 bar. These increase in pressure allows for greater degrees of freedom in particulate mass control. So, our contribution looking forward to Stage V comes through providing higher pressures. Modern engines require aftertreatment systems. When you have oil crossing over into the fuel inside of your fuel pump, the engine can burn that oil and create ash deposit in the particulate trap. So, our fuel pumps are all fuel lubricated so that they can avoid the possibility of oil crossover. Our pumps are also highly resistant to harsh fuels, like those with high sulphurous content.

What has changed in the Stanadyne strategy during the transition from mechanical to electronic systems?

We worked for long with rotary pumps and mechanical injectors technologies. RSN nozzle is a major feature in reducing emissions and noise and in improving performances of diesel engines. We still make a lot of rotary pumps in the world, so we are slowly, as the market changes, localizing rotary pump production to India. The production of rotary mechanical fuel pumps, including RSN nozzles, is rapidly increasing. That is because those markets are now experiencing the same kinds of new emissions regulations that Europe and US experienced many years ago. As we look to the European market, we see that the number of applications which can still benefit from mechanical systems is becoming less, and so now it is really isolated to small engines and eventually, I believe, those engines will go to full electronic injection systems.

Concerning the transition from a pure mechanical rotary pump application, to a fully electronic system, some markets offer a bridge (remembering the wide patchwork of emissions regulations). In India, we are able to transition agricultural equipment and some construction and gensets equipment to our electronic rotary pump solution with aftertreatment and achieve the emission standard. In other markets, the transition will lead directly to common rail fuel systems, and that is something we are working on to bring to the market probably in different segments than we participated in previously.

What about your approach to the common rail system?

Over the last many years we have developed very strong competency in pumping solutions and we have focused energies exclusively on pumps, on both the gasoline side and on the diesel side. Looking at our total global revenues, approximately 50% comes from high-pressure gasoline pumps and 50% from the diesel side of the business with a growing fraction dedicated to high-pressure diesel pumps. Common rail pumps can be used by either large Tier 1 or by customers who are directly doing their own integration activities. We focused on our core business that is common rail and high-pressure pumps. Some markets had a lack of advanced technology in high-pressure pumps so we have a family of very high-pressure pumps (all fuel lubricated). Two of those pumps cover the range of engines from approx. 4.5 liters to 18+ liters including large gensets up to 1,000 kVA and Class 8 on-road trucks. That's where we are focusing our common rail efforts today.

Can you explain to us what Ecoforce is and how it works?

Ecoforce is the name that we have assigned to a revised and updated rotary pump. Ecoforce brings the benefits of rotary mechanical fuel pumps to smaller engines. It is essentially a smaller and more cost-effective rotary pump. It functions in the same way and it also provides important emissions and performance benefits for engines under 37 kilowatts.

Figures and facts about 2017 and forecasts about 2018?

Concerning gasoline, we produce every year approximately 1 million high-pressure gasoline pumps, used for gasoline direct injection engines. We produce around 150K rotary pumps worldwide per year. This is the number that will change as Ecoforce is introduced, so these volumes should increase. We also recently extended our rotary pumps production to India and the UAE. Now we make rotary pumps in our US plant in Jacksonville, NC and in our Indian plant, which is located in Chennai, and we just opened a new assembly and test plant in Sharjah, which is outside of Dubai.

So, our forecast for global rotary pump production will rise as Ecoforce and new applications for our electronic rotary pumps come online and as we continue to expand our markets in those areas of the world that need rotary pump technology. Moving to our common rail pump technology, we currently produce approximatively 100k units per year. Looking forward to the future we have several new customer programs that we are working on. We expect them to double that value and then eventually to triple it over the next five years.

Sulfur content, a great enemy for diesel engines.

When we began approaching the common rail market, a very crowded market, we identified some open spaces in the market for us to enter. We believe that China and India and the developing world were going to need common rail soon, and we designed and developed pumps which could fit for those markets. So, the pumps that we designed have actually been designed for working with very harsh, low lubricity, high sulfur fuels, to support those environments, and then as we extended our design, we made it to support any global fuel. This is important because, if you have an international engine manufacturer, they can send the same Stanadyne pumps anywhere in the world, and without worry about the fuel quality. Speaking about diesel engines in general, since you need to have some kind of aftertreatment system for most engines, the problem that we ran into - in terms of emission standards - is that the high sulfur fuels tent to destroy modern aftertreatment solutions. This is a major problem, and then there is the particulate mass generated by oxidation of sulfur in the fuel, which can reach two or three thousand ppm. Therefore, we create pumps which are highly resistant to harsh fuels. What we see in markets is that the regulation can only step forward when fuel quality also steps forward. If we look at India, they have been pushing very hard to implement new regulatory standards but could not do so, until the introduction of low sulfur fuels, and now they are introducing 50ppm or even better fuels, which enables - in perspective of 2020 - to release a more severe NOx emissions and particulate generation regulations. So, what we see is regulations and fuel quality going hand in hand when it comes to diesel where you are regulated on NOx and particulate, which require after-treatment. We've done our part to make our pumps robust to harsh fuels, and that can generate pressure on a wide range of fuels without risk of damage. However, it doesn't completely solve the problem, because you have this sulfur content which can destroy the after-treatment systems.

What can you tell us about your electrification and hybridization projects?

Hybridization and electrification is a very important trend, and is almost always driven first by economics and secondly by regulations. For on-road applications, you can find solutions for lightly loaded applications where we are about to see a major electrification of powertrain, and if you look toward 2025, probably 70% of the world's automobile will have some form of electrification, so it is a big trend there. But still, if you look within automotive, only a few percent will be purely electric. The majority of over 100 million automobiles produced in 2025 will have electrification in some sort of hybridization instead of the complete replacement of the powertrain. You will likely see in low power applications like scooters and two-wheelers that they may be going all electric sooner, but in larger applications you are going to need some sort of IC engine at least for the mid-term.

Now, if you move to the off-road and industrial segments, we do see hybridization moving there at a different pace, but obviously looking at genset, those are never going to be hybridized, they will be only minimally electrified. Then, as you move to some fields of application, such as in certain mining applications, for the most part hybridization trends are going to be focused on utility and performance where energy recovery is possible and we see lots of evidence of this. Many people call for the death of internal combustion engine but I don't see that happening anytime soon. Instead, what I see is that ICE will adapt in order to be more suitable for hybridization, and as we have more and more electrification to powertrains they will run in different operating maps. It will drive the need for new injection systems strategies and technologies to optimize those engines for those markets. The challenge there is to understand where electrification is going, and then design fuel injection system strategies and technologies that take advantage of that».

Guglielmo Papagni

Federico Gaiazzi (third from left) and Enrico Capellino (second from left) during the official ceremony to Jomo Kenyatta University of Agriculture and Technology in Nairobi (Kenya).

FPT Industrial and Jomo Kenyatta University

ENGINE OF GROWTH

The engine is the F32, 55 kW by FPT Industrial, which runs the Idrofoglia motor pump donated by CNH Industrial to the Jomo Kenyatta University of Agriculture and Technology. The Milan Center for Food Law and Policy and the E4Impact Foundation are involved in the project

We are on the southern side of the Horn of Africa, having in the background the drought of northern Kenya and an expanding agricultural potential. FPT Industrial entered the region along with its parent company CNH Industrial and Idrofoglia, starting a project to streamline water resources in Kenya together with the Jomo Kenyatta University of Agriculture and Technology. The three Italian companies entered the field together with the Milan Center for Food Law and Policy and the E4Impact Foundation. The playground is that of the endless grasslands of Kenya, the players have an Italian passport: the 4 cylinders F32 by FPT (*Diesel of the year 2008*), the Idrofoglia motor pump (see box) and the Caprari flanged pump. The Italian triad brings in low specific consumption, feeding efficiency, calibrated water supply. The 1,400 liters/minute flow rate, consistent with hydraulic head, allows for 40-50 meters range. Spray per flow meets water requirement in an area of three hectares. To complete the football metaphor the goal does not only concern the promotion of FPT engine technology in an endemically underdeveloped region but also embraces a long-term outlook. The social impact in terms of sustainability aims to work at the roots of the production cycle in the primary industry (which is for Nairobi the flywheel of national economy together with tourism) and the living conditions of the local population and the workers involved. Within this framework CNH Industrial (27.4 billion dollars in 2017, 11.1 from agriculture and 4.4 from powertrain, which includes the 600 thousand licensed engines that made FPT the number one engine manufacturer from 2.2 to 20 liters in regulated markets) is able to line up two top players such as New Holland, which has planted its blue flag on the agricultural mechanization of the African country, and Case IH, the other agricultural branch of the group.
Open field tractors for tilling and cultivating coffee and tea plantations, specialized tractors for fruit and vegetable harvesting (the roses spreaded in the European squares mainly come from this area), combines for cereals.

FPT says

Federico **Gaiazzi**, Global Marketing Manager at **FPT Industrial**, stated: «*We are proud to support the project called 'A new engine for sustainable farming'. It represents a new opportunity for us to further bolster our values and our commitment to supporting training programs for young people and for generations to come. To this end, we have donated a complete product comprising a motorized pump and irrigation system. We have chosen this IPU (Irrigation Power Unit), equipped with an FPT F32 engine, as it is a compact and flexible solution, offering top performance with low operating costs. Today, we are donating an engine capable of contributing to a more sustainable future to the Jomo Kenyatta University of Agriculture and Technology, as well as promoting technological development in Kenya. It is a considerable challenge that we, together with our partners, have taken on board with genuine enthusiasm, and which we will continue to support with passion*».

CNH Industrial

Enrico **Capellino**, Head of Commercial Services at **CNH Industrial**, emphasized how «*CNH Industrial has continually demonstrated an in-depth understanding of responsible business management from both an environmental and social viewpoint. This has resulted in CNH Industrial being named as Industry Leader for the eighth consecutive year in the Dow Jones Sustainability Indices. This partnership is further proof of the broad range of projects we undertake throughout the EMEA region*».

Sustainable development

Livia Pomodoro, president of the Milan Center for Food Law and Policy, stated: «*Part of our mission is encouraging behavior and practices that are in line with the Sustainable Development Goals and the United Nations' 2030 Agenda. Therefore, we are proud to contribute to training a generation of engineers and technicians who will have the difficult, yet exciting, task of adapting agriculture to climate change, making advanced technology available today their own, and taking steps towards efficiency. We hope that this first project, as part of our contribution to Kenya, is part of a series of collaborations and research in this country*».

DIESEL International

Agriculture for Kenya

Quoting Encyclopedia of the Nations: «*Agriculture remains the most important economic activity in Kenya, although less than 8% of the land is used for crop and feed production. Less than 20% of the land is suitable for cultivation, of which only 12% is classified as high potential (adequate rainfall) agricultural land and about 8% is medium potential land* (…) *Kenya is Africa's leading tea producer,*

and was fourth in the world in 1999 (…) *Coffee is Kenya's third leading foreign exchange earner, after tourism and tea»* (…) *Kenya is the world's largest producer and exporter of pyrethrum (…) and also produces sisal, tobacco, bixa annatto (a natural food coloringagent), sugarcane, wheat, rice and cotton*».
«*Agriculture is key to Kenya's economy, contributing 26 per cent of the Gross Domestic Product (GDP) and another 27 per cent of GDP indirectly through linkages with other sectors. The sector employs more than 40 per cent of the total population and more than 70 per cent of Kenya's rural people*» stated FAO (Food and Agriculture organization of the United Nations).

CNH Industrial and Mühlhäuser

Hubertus M. **Mühlhäuser** *is the* **CNH Industrial Chief Executive Officer** *since17 September 2018.*
«The Board is delighted at the appointment of Hubertus Mühlhäuser, given the wealth of international experience he will bring to the role combined with his passion for, and experience in, many of the industries in which we operate», said **Suzanne Heywood, Chairman, CNH Industrial**. *«My personal thanks and those of the Board go to Derek Neilson, who has been our interim CEO during a challenging period, for his guidance and oversight. Derek will continue in his role of Chief Operating Officer, EMEA Region and President, Commercial Vehicles Products Segment» stated Lady Heywood.*
Mühlhäuser previously worked at AGCO Corporation, heading its EMEA and Asia Region businesses as well as its global engine division. He also held the position of Senior Vice President of Strategy and Integration for AGCO.

Idrofoglia. Irrigation since 1979

Sister company of Green Power under the umbrella of Epta, Idrofoglia carved out a starring space in the world scenario of irrigation machines. Idrofoglia Irrigation Systems focused on the Turbocar line, three series of fixed, rotary and hydraulic irrigation machines, and on the Turbopumps line, open, roof, roof and safety net motor pump units also available in Silent and Full-silent version.
Idrofoglia and Green Power have created a joint working group to address the critical issues related to Stage V. The reference engine manufacturer is undoubtedly FPT Industrial, the most popular units are 4.5 and 6.7 liters NEF. We met the CEO Raffaele **Brugnettini**.

Which are the peculiarities of Stage V prototype?

First of all, working cycles. Today motor pumps are used at low speed rates. Electronics will have a key role compared to the usual mechanic pumps along with exhaust gases management.

How is the motor pump market changing?

As I said, there is a trend towards lower speed rates and users are leaning towards oversized solutions compared to their real needs. Up to ten years ago the motor pump was a low tech product featuring an engine protected by a net, today the percentage of soundproof motor pumps driven by remote control systems has dramatically increased.

More than half century of experience. Patrini Giacomo designs, develops and manufactures antivibrations mounts.

Patrini Giacomo. The importance of antivibration mounts

FROM CONCEPT TO PRODUCT

Patrini's mission is not limited to filling the rows of an Excel sheet and packaging a catalogue. Patrini anti-vibration mounts feature endless customizations for any industrial application

Patrini Giacomo is located in the industrial suburbs of Milan and started its activities over half a century ago from Italy to approach the world market. The company core business is anti-vibration mounts, whose applications are endless, both related to OEMs and engine manufacturers, from self-propelled machines frames to static structures and endothermic engines, including marine and stationary applications. Established in 1965 as a key partner of SAGA department of Pirelli Antivibration Systems, the company entered the free market in 1994. In 2018, having the company manufactured 3.3 million of anti-vibration mounts in the first quarter, the time has come for a further acceleration towards "brand awareness"'.

We met the company CEO Walter Patrini.

«The need to improve the brand visibility on the market comes from the will to build further synergies with our end users. We no longer want to be seen just as a supplier of standard products. Our catalog must become a starting point to define the correct dimensions and fixings. For example, last week our Research and Development department released several brand new solutions and customizations of our standard products».

Three key words of Patrini Giacomo: customization, digitalization, Made in Italy.

«Our interpretation of Industry 4.0 aims to a status quo change in manufacturing philosophy. Once production was based on a few standards, now the user needs must become the real driving force. Moreover, what is digitalization? The management of company data to better meet the requests of end users. Made in Italy means only one thing for us: we are a specialized company which relies on third party supplies only for steel and rubber. Besides that, our manufacturing cycle is based on in-house products, except for the screws and the metal surface protection treatment, still a zero kilometer production».

Any organization change?

«Recently we implemented a new test chamber, a fatigue testing machine and a 24-channels portable instrument for triaxial vibrational detection».

How many items per year do you manufacture?

«In 2017 we produced 7.7 million anti-vibration mounts, 9% more than in 2016. The trend is growing».

Which are Patrini system logics?

«The ones I mentioned. Customers provide coordinates, dynamic parameters, rounds per minute, vibrations, then we design almost in real time a tailor-made solution. Whether it's a Kiepe locomotive, a New Holland cabin, a Kohler endothermic engine or an extractor hood».

Fabio Butturi

OEMs require an upward curve of electric power, often in extreme conditions. Vertical radiators enjoy a strong market appeal, due to the need to enclose the entire machine inside a container.

COOLING SYSTEMS

Radiators for stationary applications

ENGINE'S GLOBAL WARMING

We asked to Donato Mastrobuono, an expert in cooling systems specialized in applications for power generation since 2002, to take stock of the evolution of this industry and the changes in the approach to heat dissipation

Donato Mastrobono gained twenty years of experience in vertical radiators and cooling systems for gensets and in pressure and heat peaks brought by Tier 4 Final and Stage V. Surely he's fully entitled to express some thoughts. After all, times are more mature than ever to take stock of cooling systems. The countdown to 2019 is only a couple of days away.
Let's listen to him.

Mastrobuono's version

«OEMs require an upward curve of electric power, often in extreme conditions: high ambient temperatures, sandstorms, marine installations on platforms or at high altitudes. These conditions affect the amount of air available to disperse the thermal energy to be dissipated. Vertical radiators enjoy a strong market appeal, due to the need to enclose the entire machine inside a container. The installation inside container of high power engines requires to compact and circumscribe the room available for cooling. Dissipating high thermal power require large radiating volumes and abundant airflows, while tight spaces limit more and more these applications, frequently installed in countries where ambient temperatures reach 55 °C. Sandstorms require special accessories, such as sand traps and acrylic filters, which often cause relevant airflow losses also due to low noise request. Besides that, acrylic filters require frequent replacement, especially when working in slightly wet or rainy environment. Marine applications require appropriate materials or surface treatments for the most critical materials to maintain their characteristics unchanged over time. In this case the most used solution is that of fully tinplated core, full-inox frames and careful welding (continuous and strong

penetrating).
The products intended for Atex environments require antistatic fans (a rotary element that can generate static currents), appropriate grounding and electrical continuity between all bolted metal surfaces.

Dissipation rates

On the other hand, large - sized installations require a correct sizing of volumetric airflow rates, which at 1.500 mt altitudes show a significantly lower equivalent mass flow. In this latter case, generator tests are often carried out fully in house by the manufacturer, making a lot of difference from the thermal point of view.
A fan working effectively at 150 m does not guarantee the same dissipation rates at high altitudes. A further problem is the mechanical power absorbed by the fan: a well sized fan able to provide appropriate performances at the installation altitude and the massive flow needed for dissipation requires a correct assessments of the absorbed mechanical power (definitely greater at 0 m than at 1500 m) to be used for low-altitude tests.
In case of radiators using electric fan drive the correct power must be set in order to avoid drive overload and burnout during the test phase (at 0mt ASL).
Both electric motors and diesel engines may be subject to derating at certain altitudes.
Another critical point is the insonorization, due to the consequent load losses and the difficult installation of the panels.
I have seen several times tests where a radiator tested for 50 °C showed overheating problems at 25 °C and 50% of the load, due to soundproof panels mounted a few centimeters away from the core. At this point, you may ask what's the way to meet customers' needs.

Customers' needs

The main ingredients are basically two:
1- an adequate amount of air for the required dissipation rate, both to provide an excellent sizing of the core / exchange surface and to foresee and prevent any errors or bad installations by the user, giving him the right information; but above all, ensure the adequate airflow needed for dissipation.
In a nutshell: beware the permeability of the radiating masses and the pressure drops due to additional accessories.
2- Recognize that in rare cases high thermal power to be dissipated and ambient temperatures are not suitable for vertical radiators mounted inside the container, but require adequate room to set up a remote, low noise radiator.
The efficiency of the radiator often requires particular and careful additional connections for both the circuits to be cooled in order to meet installation and deareation needs. Liquid expansion volumes, engine connections, localization of expansion tank and engine, connections to the mechanical transmission, radiator maintenance intervals (bearings greasing, belts replacement, bearings replacement, internal circuits cleaning, radiating masses external cleaning, etc.) must be suitably calibrated.
The radiator must not only meet functional performances during the thermal test but also ensure the same functionality over time, even after the warranty period.

The use of poor materials and accessories is a critical issue. While allowing cost savings, it may compromise product durability. But when it comes to cost savings, everyone tends to turn a blind eye.

Power dispersion

The common trend is to drain power dispersion, minimizing the heat dissipated through the radiator.
Looking at the thermal balance of an engine above 2,000 kW we can analyze the amount of dissipated energy:
- about 5,500 kW generated by the fuel;
- 2,100 kW: engine mechanical power;
- 1,500 kWt: power dissipated by Exhausts;
- power to exchance (or -dissipated) for Jacket Water/High Temperature circuit: 850 kWt;
- 750 kWt (CAC-LT): power dissipated by intercooler
- Radiation and convection heat, engine + alternator: 280 kWt;
Energy in Exhaust about 1,500 kWt, while 1,900 kWt are dissipated through radiator ventilation.
So, what are we going to do?
New energy re-use systems in C-hp CCHP (but also Egr) may be of some help. They increase installation costs but ensure a brilliant heat recovery, which is converted into other forms of energy. In this case dry coolers, plate-fin heat exchangers, chillers and solar panels are involved». **Donato Mastrobuono**

COOLING SYSTEMS

Ymer Technology. Cooling systems from the cold

IN SWEDEN THEY ARE ABLE TO DO IT!

Stage V further stimulated a process that was accelerated by the Tier 4 Final. Heat dissipation requires the implementation of cooling systems. Ymer Technology operates from Sweden to provide custom solutions to off-highway OEMs for both mobile and stationary applications. We talked to Anders Felling about it

Ymer Technology has not yet reached the age of fourteen and it's been already booming. Founded in Sweden in 2005, four years later it took root in China. In 2016, it started its commercial penetration in the USA. The focus is on the off highway machinery, the expertise concerns the cooling systems.
We asked **Anders Felling**, Business unit director of Ymer technology, to discover more.

What's the core of Ymer in terms of products and markets?
The core of Ymer technology is to deliver complete cooling solutions mainly to the off highway industry; this means mainly material handling, construction, mining, agriculture, forest, to whom we offer complete cooling solutions, we do no not provide solution for on highway market, we only work with off highway industry. Then there's a second division that is called Wind Power, that delivers big cooling solutions for wind power plants to cool generators, gearboxes, electronics, etc. Turning back to off highway we are very strong in material handling, open pit mining and heavy construction machines, with an expanding market in the United States.
Our solutions are addressed to every kind of off road and stationary applications as well. Our confidence has grown from hydraulics cooling applications: the more hydraulics in the machines, the best our solutions will be. We always deliver complete solutions, not only engine cooling but also hydraulics cooling, we cool the complete pack. Our Total thermal management design includes the coolant radiator, charge air cooler, hydraulic coolers, fuel coolers, air conditioning condenser, fan shroud and cooling fan. We are specialized in machines that have hydraulics circuits such as excavators, material handling machines and mining machines.

Which engine displacements do you cover? From 2 to 16 liters or...
The typical engine displacement is from 4/5 liters to 10, but we also make solutions for 2/3 liters engines up to 56 liters as in big stationary applications.

Hamletic doubt: custom or standard?
We always do customize, we have internal engineering resources and always work on engineering so every solution is engineered and customized for the specific application and machine, such as drilling machines, material handling, construction and so on. We always design specific solutions and customize. We are working together with the manufacturer's and OEM engineers to define the cooling need and the different cooling systems to be implemented on the specific application, designing together the fans, the installation, the size, the needed isolation, both for engine and hydraulics.

What is your approach to Stage V? The new limits (PN and not only) force to increase temperatures and injection pressures. What are the strategies for

reducing the volume of radiators? Lack of space is in fact an emerging problem even among stationary applications…
All manufacturers are migrating to Stage V coming from Stage IV and Stage IV Final, some can keep the same cooling solutions but others need new ones. In order to meet those needs and manage smaller installation room onboard we provide smaller radiators that deliver the same cooling performances. When we analyze the OEM needs we can offer almost always smaller and lighter solutions.

How has the research of materials evolved to reduce weight and increase the resistance to thermal stress?
This is a good question. Of course we are using aluminium but we are also testing what we call "Netxt Generation", aluminum alloys which increase resistance to thermal stress and also corrosion with lighter solutions. The main issue is to have a correct design of air fins and turbulence to ensure the proper airflow and thermal performance; we have several designs that ensure proper cooling in a lighter package, thanks to an internal design program that we have developed in the last 15 years.
We are changing to new generation materials which have a different structure due to a different manufacturing process giving us better corrosion performance and a superior resistance to thermal stress. Also the bracing quality is another relevant factor; we are only bracing in vacuum furnaces to achieve a better quality process.

How do you deal with the problem of fan noise?
We are working a lot to change from normal viscofans to hydraulic fans and electrical fans. We have several electrical fans solutions which are smaller in diameter and make less noise, which allows to place the cooler wherever you want. You can also have 4, 5 or 6 fans per radiator and manage the cooling system to run the desired number of fans in order to control both cooling and noise and save fuel. Electrical fans also take less power from the engine. You can manage the full cooling pack; sometimes you need to cool the engine, sometimes only the oil, and you can manage those needs easily with smaller fans that also make less noise.

What about noise absorption technology evolved on machines that works in crowded environments?
Electrical fans are part of the solutions, because this type of fan can have smaller diameter and cool more, so I think that those applications will see a larger use of electrical fans in the next future. Now we are also starting to develop Thermal Management Systems for hybrid/electric vehicles that can run on battery or engine and are able to adapt to different environments and cooling needs.

Are solutions and packages for both agricultural and construction machinery available or is it better split the products?
I would say that is better to keep them split because of the design, mainly related to working cycles and visibility. We sometimes develop very peculiar solutions in order to ensure better visibility for the driver, especially in agriculture and forestry machines. Visibility is very important in those applications and we need sometimes a very particular design to meet this goal. On construction machinery cooling systems are located behind the driver, so I would say that the solution muchly depends on the visibility grade needed. Basically we have different designs for different applications. For example, forestry machines operate very close to the ground and demand greater visibility on the working area.

How (and how much, in terms of fuel savings) thermal technology can benefit OEM's TCO?
We have a complete package that includes coolant radiator, charge air cooler, hydraulic coolers, fuel coolers, air conditioning condenser, fan shroud and cooling fan. Electric fans are powered by the machine's electrical system, and although they will place an additional draw on the electrical system, they are a more efficient alternative to mechanical fans and allow to reduce fuel consumption (up to 5%) not draining horsepower from the engine. A complete Thermal Management Solution for hybrid or electric vechicles can save more 10 % of energy consumtion, when designed for the complete vehicle.

Do You interface with OEMs or engine makers to set coolant capacity, pipes and volumes?
We normally have these specifications from the engine manufacturers, sometimes we choose the best solution to the applications along with the OEMs. The cooling needs for the ICE engines are of course specified by the manufacturer and we provide the design of the solution; of course OEMs make test runs of our cooling systems. **R.N.**

GERMAN ENGINES @TH.IT

For almost six years Magni Telescopic Handlers wrote the untold history of material handling. For example, setting the record of vertical reach at 46 meters. German speaking diesel engines still rule, their names are Deutz and MTU

Italian passport, German engine.

For almost six years Magni TH wrote the untold history of material handling. For example, setting the record of vertical reach at 46 meters. German speaking diesel engines still rule, their names are Deutz and Mtu

The story of Magni Th began in May 2012, while the production started in January 2013. We are in Italy, on the Via Emilia, between Modena and Bologna, the homeland of mechanics and hydraulics. This is where the saga of another mechanics miracle of the Motor Valley begins, and his name is Magni Telescopic Handlers. Diesel International met Eugenio **Magni**, Product Manager, and Oscar **Baschieri**, Technical Manager.

What can you tell us about the agreement with Zhejiang Dingli?

The agreement dates back to January 2016. The distribution of our two electric and diesel lines of scissor platforms started in Europe two years ago. The agreement is based on a couple of projects regarding both telescopic and articulated boom platforms ranging from 16 to 30 meters. Zhejiang Dingli will manufacture the platforms in China while we'll market the machines in Europe.

Do you still hold the record for the highest working height?

We surpassed it, actually, reaching 46 metres. Another Magni record regards the strongest platform: a rotary machine featuring a maximum capacity of 8-tonne and 25 meters working height. The competition stops at 7 tons.

Which engines do you use?

Our product range is equally divided between Mtu and Deutz. We're using the Deutz 3,6-liter, 55 and 100 kW on platforms up to 25 meters, and MTU in 129, 150 and 170 kW versions on platforms ranging from 26 to 46 meters (only the HTH 35.12 features a 6-cylinders, 240 kW engine). The production is focused between 100 and 150 kW, being 25 and 30 meters platforms our bestsellers. In September 2019 we'll start to manufacture our first Stage V machines.

Which is the design logic followed by Magni when choosing an engine?

Power is crucial, because our machines have a significant mass that needs power to be moved up to 40 km/h. Other criteria are engine reliability, assistance, noise emissions and ease of operation. Speaking of MTU, the prestige of the brand is also a factor.

What about torque?

Our diesels must remain operational under any conditions. Having several hydraulic circuits connected to the endothermic engine, our platforms need the maximum hydraulic pressure to be available even at very low rotation speeds.

And applications?

The main sectors are construction, industry and mining. Other niche sectors are, for example, the drilling of vertical rock walls in Norway for safety nets anchoring, and a forestry machine equipped with a trimmer whose peculiarity is keeping the branches from falling to the ground.

Hybrid and electric?

Our market is not ready, if we don't use batteries as a counterweight there's no room on the machines for installation. Magni features Twin Energy, a kit to be attached on the back of the machine allowing an electric operational mode when connected to the power grid. **DF**

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QUOTE

DIESEL

Engines and components for OEM
Culture, technology, purposes
And market of Diesel engines
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