DIESEL
INTERNATIONAL

GOOD vibrations

CUMMINS 100 BIRTHDAY

The importance of being 'Clessie'... Cummins

FPT Industrial Tech Day - Deutz Electrip - Bergen and PSI

Comparisons: 1 liter and 2.2 liters - Diesel of the year 2019

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DIESEL SUPPLEMENT

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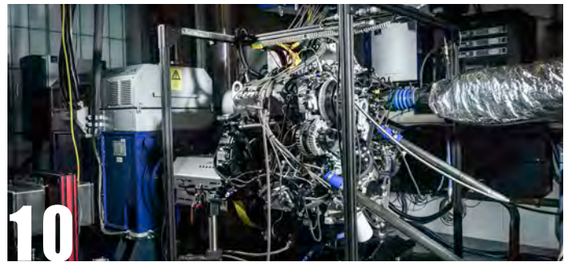
22

12

Rolls-Royce will install the first two Bergen engines with V-architecture, B36:45 and B33:45, at the C-Energy plant

34

Eima International showed a desire for hybrids, and the Carraro Ibrido and two TH demonstrators are powered by Deutz TCD2.2



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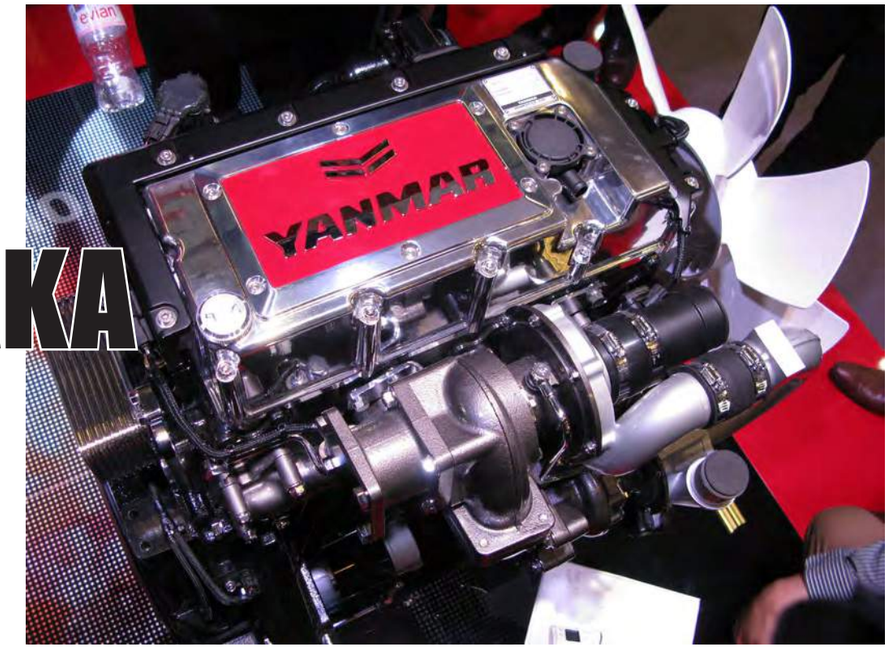
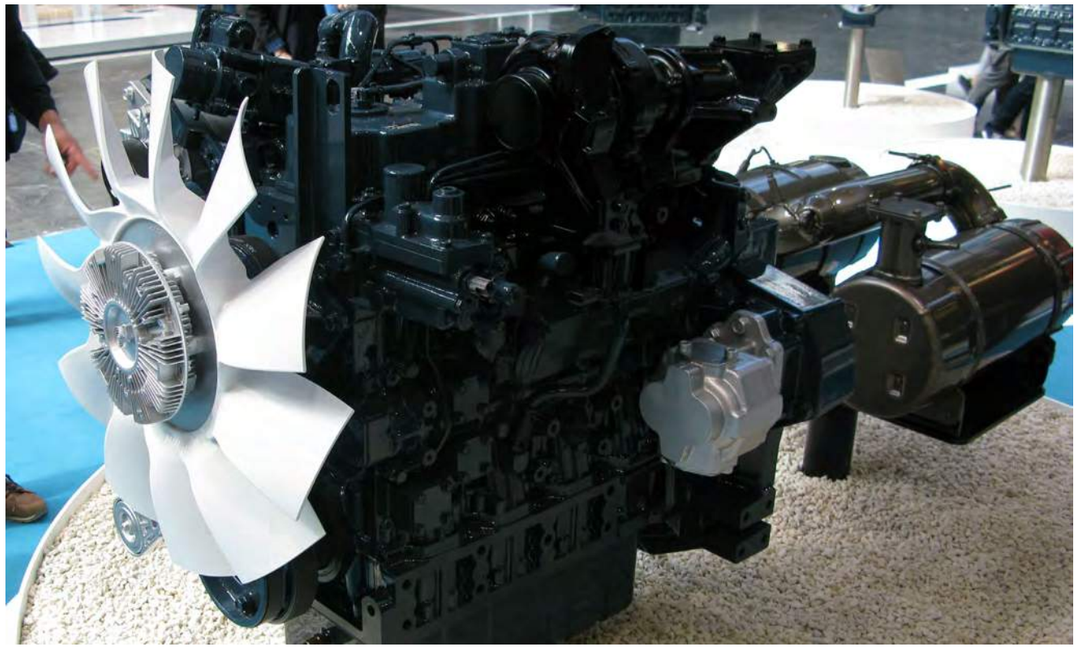
26 IBRIDO MEANS HYBRID

26. FISH-EYE
At Eima Carraro Ibrido unveiled the potential of the hybrid on the field. With Deutz and 4-e consulting

KUBOTA VERSUS YANMAR

UNDER THE OSAKA SKY





Sueto and Nakanishi,YANMAR: «EGR cooling system has been integrated into the cylinder head as well as the intake manifold. The cylinder head includes more functions related to the intake manifold and the EGR».

Yasukazu Kamada,KUBOTA: «Thanks to EGR and SCR we reached the best fuel consumption in this range. We opted for a low rate of gas recirculation, otherwise we would have to increase the cooling systems size».

Diesel of the year, fourteenth year. The prize that opens the season of Stage V will be awarded in Munich at Bauma, the 'mother of all fairs', where the endothermic engine stands in front of experts in such a way that no other place can match. Tracing a continuous line that brings together the thirteen members of the jury, the result speaks of innovation. What's the meaning of innovation? Browsing the Diesel of the year, from John Deere Powertech Plus6090 in 2006 to Deutz Tcd 9.0 last year, you can see who stands out for power density, specific curves, for having bypassed the regulatory boundaries thanks to an ultra-simplified version of the after-treatment module (which often means relying on DOC only), who broke the balance of a given displacement, who, again, has renewed the crank, the distribution, the combustion chamber.

What the keywords of future engines will be? **Density** and **reliability** are certainly two key requirements for units that will have to fight the so-called alternative and adapt to the potential role of generators within hybrid packages. It's a bit early to foresee the physiognomy of future Diesels of the year, so let's stick to the current events. Bauma is coming up, and the winner will be unveiled there. We could summarize the competition as a clash between best specific curves and a good balance between size and reliability. That's an approach that summarizes decades of research and development in the engine industry for industrial applications and takes on an even more fascinating nuance when we look at the players, Kubota and Yanmar. DIESEL wrote about it on June 2018 issue, taking the cue from the launch of Yanmar 4TN107 and 4TN101 at Intermat.

The Diesel of the year is at a turning point. The first year of the Stage V era requires us to look at internal combustion engines with a different eye. Reliability and density are the main requirements. A derby between the V5009 and the 4TN107

We called it 'The **Osaka Derby**': Yanmar 3.83 and 4.56 challenge Kubota V5009, introduced at ConExpo 2017 in Las Vegas, and V3800, a best seller. The candidates to Diesel of the year 2019 are Kubota V5009 and Yanmar 4TN107. The 5 liters threshold stands right after that of 9 liters. Like last year, the next Diesel of the year raises the bar of power density, competing with one liter cylinder in 6 cylinders configuration. A few kg less for Yanmar, peak and starting rates on Kubota side: these data reflect the almost half a liter gap between the two engines. Specific curves still award Yanmar's engineering approach. The 4TN107 proves to be brilliant, especially when it comes to power curve. Kubota however ties the torque curve, also showing a more effective power reserve and better nominal torque and power at maximum torque. Size and power density also reward the V5009.

Following a few statements made at Intermat by Yanmar and Kubota.

Yasukazu **Kamada**, General Manager Engine Division Kubota, and Daniel **Grant**, Engine Europe Business Unit Manager Kubota.

Which is the technological approach of 09 series?

«The supercharging changes: on 4.3 you find waste gate, while 5 liters also includes Vgt. We have added a fourth Pto as option. These units target the free market».

Hiroshi **Sueto**, Product planning group Yanmar, and Akhiro **Nakanishi**, Public relations group Yanmar.

What can you tell us about 4TN101 4TN107?

«These are engines intended for heavy duty applications that differ from our standard. Above all, the annual operating hours are significantly higher. The technologies we have developed for 4TN101 and 4TN107 are born from the combination of industrial know – how, under 56 kW, and marine engines know – how, which reaches up to 4,800 kW and requires particular reliability and durability». **F.B.**

EIMA INTERNATIONAL BOLOGNA

MORE THAN 300 THOUSAND

> “ It is a great success for the agricultural machinery industries„ declared Alessandro Malavolti, President of FederUnacoma

To figure out the capacity of an exhibition you have to start from the figures:**1,950 exhibitors** spread in 30 pavilions, 600 foreign manufacturers from 49 countries, **317,000 visitors** attended. Hybrids were under the spotlight last November at Eima. Kohler was there to promote the 1003 for the K-Hem, their solution to balance the thermal output and the electric boost. We also saw the Carraro Ibrido, from the 4e consulting, Deutz and Carraro Agritalia triangle. Powered by Deutz TCD2.2 3-cylinder engine, Ibrido can work in three modes: pure electrical, diesel only and, indeed, hybrid, for transport with trailer and loads. What about the other booths? Yanmar unveiled the 4.6 liter with structural sump. Deutz celebrated 22 percent growth in the third quarter of 2018. The Japanese Isuzu was part of the show, represented by its Italian dealer, Pitteri Violini. Fpt Industrial showed the compact engines family Stage V (F36 and F34) and the full line proposal for agricultural OEMs. Hatz brought to Bologna the new Silent Pack for the H-series of three and four-cylinder engines. Kubota came with its ‘babies’; among others: V1505-CR-T, Wg 1903, D902T and Wg972. Cummins was there with the 4.5 and 8.9 liters, with the 6.7 in the structural sump. John Deere and Volvo Penta showed their respective Stage V proposals. Perkins reproposed the Syncro series in the structural version, with the 2.2, 7 and 9 liters engines. Kioti Daedong showed the 2.4 and 1.8 liters, with the 1.4 for refrigerator applications. From Korea also Doosan Infracore ready for this 2019 with D18, D24 and D34 Stage V compliants. Vm Motori returned to Eima with its own 2.2, 3 and 4.5 liters, Stage V compliants. **D.F.**

Cummins Jamestown: 2 million engines

Cummins reached two millionth engine at its Jamestown Engine Plant, while also celebrating its 100th birthday this year. Jamestown is one of the ‘many hearts’ of the Cummins empire. In fact, it accounted for 14.7 percent of Cummins total engine production in 2017. Two of Cummins historical customers, Navistar and Penske Truck Leasing, are the recipients of Cummins two millionth engine.

JOHN DEERE AND KODIAK

Kodiak and John Deere came prepared to this year winter season. To ‘fight’ the snow where required, Kodiak America powered some snow blowers with John Deere PSS9.0L and PSS13.5.L diesel engines. The 13.5-liter engine is John Deere top of the range, with power levels between 298 and 448 kW, needed to move 1,361 to 4,536 tons of snow an hour and cast it up to 61 meters. Snow blowers have oil-less poly Kevlar belt drive system and are available loader-mounted.

A NEW DAWN IN TURIN

CNH INDUSTRIAL HAS A NEW ORGANIZATION CHART AND NEW FOCUS

New year and new life in the CNH Industrial headquarters. The CEO, Hubertus Mühlhäuser, moves the company forward. We are talking about the new head of the Commercial and Specialty Vehicles division, Gerrit **Marx**, which comes from relevant experiences at Daimler Trucks and Volkswagen. He is now in charge of the Iveco, Iveco Bus, Heuliez Bus, Iveco Astra, Magirus and Iveco Defense Vehicles brands. But that’s not all. Five are the new ‘beating hearts’ of CNH Industrial that represent the core activities of the company. These five operating segments will have increased responsibilities to be the key for future growth and have clear names for their leading representatives: Agriculture, led by Derek **Neilson**; Commercial and Specialty Vehicles, in the hands, as mentioned above, of Gerrit Marx; Construction, led by Carl Gustaf **Göransson**; Powertrain, that remains in the hands of Annalisa **Stupenengo** and Financial Services, again led by Oddone **Incisa**. **U.B.**

DIESEL INTERNATIONAL ‘second life’

Diesel International is reborn, or, to better say, it is stepping forward into its second life. Now the yearly issues are upgraded to four and it has a new ‘graphic suit’. The website, Diesel-International.com, never looked so beautiful. All to ensure both paper and digital readers the best access to all the news coming from the vast ‘motorized’ world.

WÄRTSILÄ 14

Liebherr and Wärtsilä worked together on the new high-speed diesel engine for maritime and offshore applications: the Wärtsilä 14 (W14). It made an appereance at the International Workboat Show in November and its aim is to serve both propulsion and auxiliary gensets, as well as hybrid installations. The engine will be available in 12- and 16-cylinder configurations, with a power output between 755 and 1,340 kW in mechanical, and from 675 to 1,155 kWe in auxiliary and diesel-electric propulsion. The first deliveries will come in the latter part of 2019.

ACHATES POWER

NATIVE GERMAN, REVIVED IN THE USA

It took the determination of the Americans of Achates Power to reintroduce in the 21th century a two-stroke opposed-piston diesel engine, the workhorse of the German company Junker during the Second World War. The idea is simple: since the endothermic engine is anything but dead, in order to face the coming years it has to be cleaner and more efficient at the same time.

That's easier said than done. Also because the endothermic engine already features a huge amount of technology, and most of the efforts are intended to carry on the process of continuous improvement (at the price of an increasing complexity) that in the last 15 years has literally transformed the endothermic engine from a simple drive unit in a power plant. Otherwise it is necessary to flip the table and propose something totally different from everything seen on a vehicle in the last 50 years.

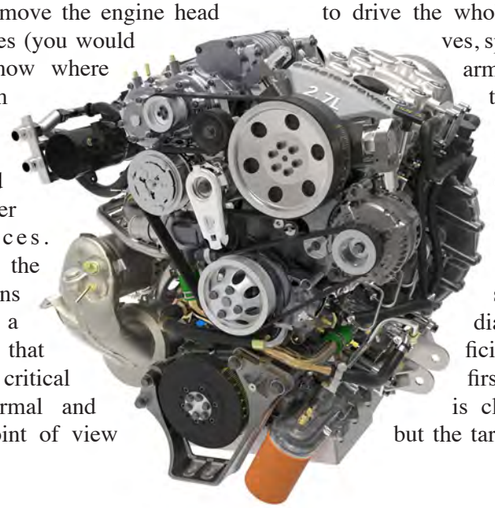
In 2004 a project conceived by a group of nonconformist technicians was born, taking advantage of the support of some investors who also love challenges to recover one of the most futuristic and solid projects of the beginning of the last century: the **Junkers Jumo 205**.

This is an outstanding 16.6 liters, two-stroke aeronautical diesel engine featuring 6 cylinders and 12 opposed pistons, aluminum crankcase and dry carter. This engine gave the inspiration to reintroduce a configuration, the one with opposed cylinders, now only used on large displacement engines mainly intended for stationary or marine applications. That's because a two-stroke diesel can deliver high specific power featuring at the same time a light and compact structure. The issue was consumption, as the legendary Detroit Diesel owners who roared in Europe under the cabin of heavy Bedford and Class 8 knew very well. Diesel but also oil consumption. The opposed pistons architecture helps reducing fuel consumption, allowing to remove the engine head and the valves (you would not even know where to put them without the engine head) and obtain better performances. Removing the head means removing a component that is always critical from a thermal and structural point of view and that loses some performance both due to heat dissipation and non optimal combustion. Valves are also a critical component, both for fluid dynamic issues and the power needed to drive the whole pack (valves, springs, rocker arms, camshafts, chains and so on). The advantages of the opposed piston configuration can be seen immediately: the efficiency of the first prototypes is close to 50%, but the target for larger displacement engines is 55%.

Greater efficiency means, for example, less CO2 and less heat to dissipate (another demanding operation in a world where every bit of efficiency is needed). The problem of oil consumption is more delicate: **Achates Power** worked hard on piston rings, that have to sustain heavy overwork because of intake and exhaust ports, and their coupling with the cylinder. In this case, the intake of fresh air and the expulsion of exhaust gases are ensured by ports placed at opposite ends of the cylinder that are opened and closed by the pistons through their alternate movement.

Besides oil consumption issues, this solution allows for an excellent filling and washing also thanks to the Roots compressor working from lower revs,

This American brand has young roots and clear ideas. The design of the opposed piston engine, which is inspired by Junkers Jumo 205, recovers the 2-stroke diesel to squeeze more power from smaller size



SOMEBODY LIKES GASOLINE

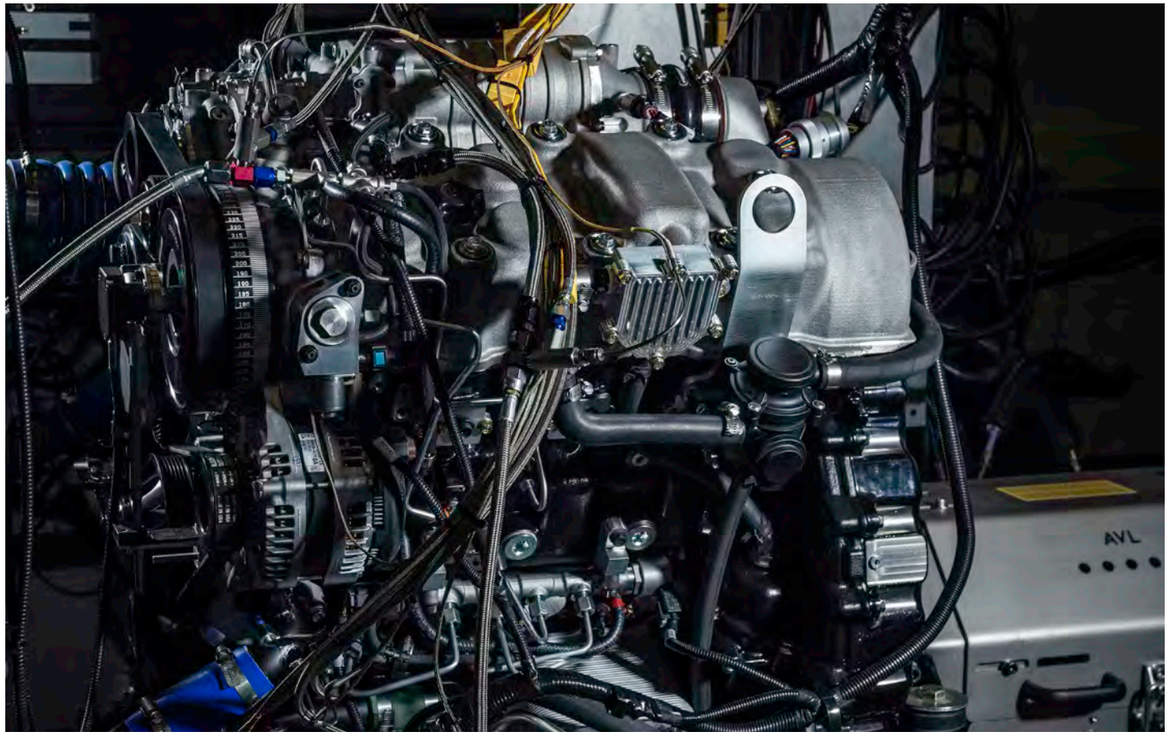
Achates offers its three cylinders also in gasoline version with compression ignition. We are talking about a 2.7 liters, of course three-cylinder, delivering 200 kW at 3,600 rpm and 650 Nm at 1,600 rpm.

The 16.1: 1 compression ratio (most likely on diesel rather than gasoline) needed to ensure ignition in all conditions and the 2.2: 1 bore/stroke ratio that allows very lean mixtures and fully take advantage of exhaust gas expansion are also interesting. Compared to the traditional Otto cycles the throttle body disappears, using EGR and by-pass valve to regulate the air-fuel ratio. The set up required special attention to the injection system with double injector per cylinder and common rail (the injection pressure was lowered to 1,200 bar and - hopefully only in the experimental phase - an additive for the lubrication of injectors is added) and to ensure ignition even at low loads (a particularly critical condition due to compression ignition and lean mixture).

Diesel and gasoline versions are both suitable for SUVs, Vans and Pick-up trucks. CAFE (Corporate Average Fuel Economy Standards) in 2025 will impose an average consumption of 54.5 miles/gallon, just over 23 km/l

THE ANCESTOR: THE 205 MODEL

The 205 was created on request of the German Air Ministry and Lufthansa as a lighter and smaller alternative to the 204, a 28.8 liter, 552 kW diesel that was widely used in those years. The displacement was reduced to 16.6 liters but technical improvements allowed to reach 440 kW and a weight of just 595 kg (power/weight ratio 1.25 kg/kW). The aluminum engine block (just like the pistons) featured intake and exhaust ports (in order to ensure optimum washing, expansion and filling) and seven crankshaft saddles (six cranks and counterweights). The centrifugal compressor was able to deliver an air flow rate 50% higher than the working volume of each cylinder at 0.35 bar. Each cylinder had two injection pumps with two injectors each, one on each side of each cylinder. The lubrication system was dry crankcase while the cooling system was water based.
In addition to the classic inertia start-up the cartridge starting or Coffman starter was used for the first time, in which a cartridge generated gases that put the pistons in motion. A 207 version was developed for high-altitude use: the use of the turbocharger brought the take-off power to 735 kW constant up to 7,000 m altitude.



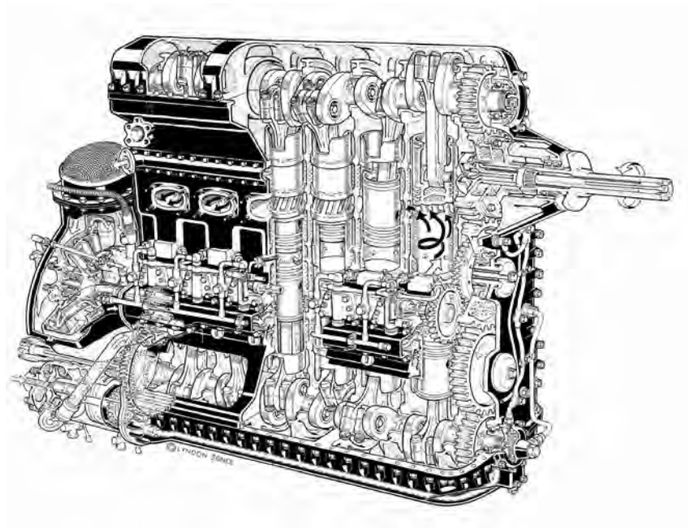
WHAT IS ACHATES POWER?

Starting from the idea of James Lemke to relaunch the old Junkers Jumo 205/207 along with John Walton, son of Wal-Mart founder, Achates gradually gathered important financial contributions (for example the Sequoia Capital fund with RockPort Capital Partners) but above all important technical partnerships.
First of all, the 2012 agreement with AVL for the development of an engine for the U.S. Army (which appreciates in particular power density and reduced thermal track ensured by high efficiency) which was followed by an agreement with Fairbanks Morse Engine (which already worked among others with AVL).
An agreement with Cummins allowed the joint development of an Advanced Combat Engine (ACE) engine as part of the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC).
Last but not least, Aramco Services Company - ASC (overseas subsidiary of Saudi Arabia Aramco) decided to work together with Achates Power in the development of an innovative 2.7 liter compression ignition gasoline engine, very suitable for Middle Eastern markets.

assisted by the air provided by the inevitable turbocharger when power load increases. But it is the same Roots compressor that contributed to the little enviable reputation of the Detroit Diesel mentioned above. So then?
Here the game changes: surely the linearity and the smoothness of the air intake and exhaust path helps to optimize the filling, while the positive pressure delivered by the turbocharger helps the Roots compressor.
Finally, a skilful refinement work and the combination with the overpressure valve and the EGR valve allowed to reach an otherwise unthinkable volumetric output. The architecture includes several intercoolers, a by-pass valve and the SCR system.
Injection relies on two fully independent injectors each driven by a common rail, mounted in opposed position on each cylinder and delivering 2,000 bar (but it is not necessary to go much further than this threshold). The **2.2 bore/stroke ratio** ensures a more than adequate use of the combustion gas energy during the expansion phase, but the linear speed of the pistons reaches suitable values thanks to the opposed-piston configuration.
All this paraphernalia deserves to be properly prototyped.
The choice has fallen upon a 1.64-liter single-cylinder engine, which delivered 53 kW at 2,160 rpm and a torque of 334 Nm at 1,390 during the bench test under medium duty conditions.
To increase displacement and power several different configurations based on two, three or four cylinders were evaluated. The choice fell upon the three cylinders, the only one able to optimize the fluid dynamics behavior since the first was penalized by a too long interval between phases (which led the turbocharger losing too much energy) while the four cylinders showed an excessive overlap between the phases of each cylinder, therefore worsening the fluid dynamics.
The result was a **4.9-liter** three cylinders engine delivering **205 kW** at 2200 rpm, **1100 Nm** from 1,200 to 1,600 rpm and 46% efficiency.
The next step was to hypothesize a 9.8 liters, three cylinders, delivering in theory 340 kW at 1,800 rpm and 2,100 Nm from 1,200 to 1,400 rpm and an outstanding 55% efficiency. The range will then be completed downwards by a 2.7 liters (both gasoline and diesel) and upwards by a 14 liters and a 200 liters (but that's another story).
Finally, costs: a simpler engine is also less expensive. It is estimated that 60% less components compared to a traditional engine can translate into a 10% cost reduction. Good news also on the emissions side: the ultra low NOx version is ready for production.

Alberto Scalchi

Compared to 2 and 4 cylinders engines, the 3 cylinders is the only one able to optimize the fluid dynamics behavior. The 4.9-liter delivers 205 kW @2200 rpm, 1100 Nm from 1200 to 1600 rpm. Efficiency? 46 percent



Ultra low NOx version is coming soon. Here the goal will be achieved with a 30 percent lower cost compared to the current engines.
On the left, the Junkers Jumo 205D.

BERGEN B36: 45 AND B33: 45

RELIABILITY AND FLEXIBILITY

ROLLS-ROYCE IN A NUTSHELL

Rolls-Royce was born as an engines manufacturer and then split in two divisions in 1971: the one that preserves the features of a luxury icon, the car with the Spirit of Ecstasy on the bonnet, and the second related to turbines for aeronautical propulsion and the co- and tri-generation.
Following a series of operations to consolidate energy asset, the company took over part of the Norwegian group Bergen and Tognum, thus inheriting MTU, which is worldwide famous for its experience in commercial boating. As part of a series of financial transactions, Rolls-Royce sold the maritime division to the Norwegian group Kongsberg in a long-term perspective to focus on the strategic assets of the military and power generation sectors. L'Orange has also been sold, in this case to Woodward. The total value of the agreement, announced on 9th April 2018, is around 700 million euros.

Peter **Headland**, Head of Customer Business at Bergen Engines: *«The Powergen market is a very important part of our business. We believe this new power plant platform will be in hight demand, especially in the Asian market where many of our cutomers have access to LNG or natural gas. The B36:45V gas engines are perfect to support variable renewable energy sources in hybrid systems like micro grids».*

Among the EU Member States, the Czech Republic has one of the highest rates of energy independence, thanks to a supply mix that provides a solid endowment of natural reserves, the national production of fossil fuels and the use of nuclear energy. The Czech Republic is a net exporter of electricity: it is no coincidence that Rolls-Royce will install the first two Bergen engines with V-architecture, **B36:45 and B33:45**, at the C-Energy plant in Tabòr/Sezimovo Ústí. The result is the extension of the installed capacity of the plant of additional 23 MWe. With 70 years of experience, Bergen perfected the V-configuration of B36:45 (Natural Gas) and B33:45 (Liquid Fuel: HFO, MDO) engines. Such operation involves a meticulous work of 'goniometer' (considering the sizes of this units) to minimize vibrations and accessory components, in view of available space, heat loss and power density, driver of engine engineering, which, from mobile applications, has involved stationary ones.

Bergen showcased the V medium speed engines at the Power Gen Asia in September: the B33:45, powered by HFO or MDO, and the B36:45 by natural gas. Two ways, synthesis fuels and gas (including LNG), that are spreading from commercial boating into power generation sector

Getting to the point, the 'ethical' balance of V-engines, in thermodynamics, can be prosaically translated into an increase in efficiency. The power per cylinder increases by 20 percent compared to the original versions of the previous series, thus achieving a full power output of **600 kilowatts per cylinder** (The biggest variant of this model, the V20, generates an output of 11,8MWe) managing to limit the levels of NOx, CO2, SOx and particulate emissions, in compliance with the en-force regulations about energy production, social acceptability and sustainability.
There is also a practical, logistic and organizational advantage for the plant. *«Delivery of four Rolls-Royce engines among other investments helped to transform the old coal fired central heating plant into a modern plant in 2015»* says Ivo Nejdl, C-Energy Director and Co-Owner: the flexibility in using these engines was the key-fact to the Czech company's request for upgrading itself to more competitive arenas both in terms of technology and TCO.
The new engines in fact allow the recovery of heat and emissions and are equipped with a sophisticated software, in addition to the **CPM**, which allows the management of different operating modes such as the Baseload or Peak Saving.
All Bergen V and L Series engines are equipped with this device allowing a clear improvement of machine's operation performance (consumption/emissions) as well as having a greater power response. Power generation plants having start-up and rump-up times below 15 minutes are generally given preference by load dispatchers, therefore such

V LINE EVOLUTION: 12, 16 AND 20 CYLINDERS

BERGEN V (50 HZ) *	B33:45V12A	B33:45V16A	B33:45V20A	B36:45V12A	B36:45V16A	B36:45V20A
N. cylinder	12	16	20	12	16	20
Stroke x Bore - S/B (mm)	330x450 - 1,36	330x450 - 1,36	330x450 - 1,36	360x450 - 1,25	360x450 - 1,25	360x450 - 1,25
Displacement dm^3	461,627	615,503	769,379	549,374	732,499	915,624
Electrical power - rpm	6,380 - 750	8,520 - 750	10,650 - 750	7,090 - 750	9,470 - 750	11,830 - 750
Torque Nm	81,178	108,407	135,508	90,212	120,494	150,522
kW/m^3 (power density)	33,34	34,80	39,60	37,05	38,68	42,64
t/m^3 (total density)	0,52	0,61	0,63	0,52	0,61	0,61
dm^3/m^3 (displacement/volume)	2,41	2,51	2,86	2,87	2,99	3,30
Electrical efficiency%	48	48,30	48,30	49	49,50	50
*** All the V-engines are also available @ 60 Hertz**						

“FAST RAMP-UP MODE”

Massimiliano **Stefanini**, from Bergen Engines.
«*To stabilize grids featuring renewable energy sources, responsive back-up power that adapts quickly to changes in demand is critical. As load dispatchers give preference to power plants with short start-up and ramp-up times, players on the spot market must often guarantee power delivery no later than 15 minutes following the request. This system is already installed in the new engines produced by Rolls-Royce Bergen Engines, both for the V and L series.*
The new engines reach full power output in less than eight minutes while maintaining high efficiency across the load profile. The Fast Ramp-up makes the system respond flexibly to any grid fluctuations and the resulting peaking, providing the required reserve capacity promptly and smoothly».

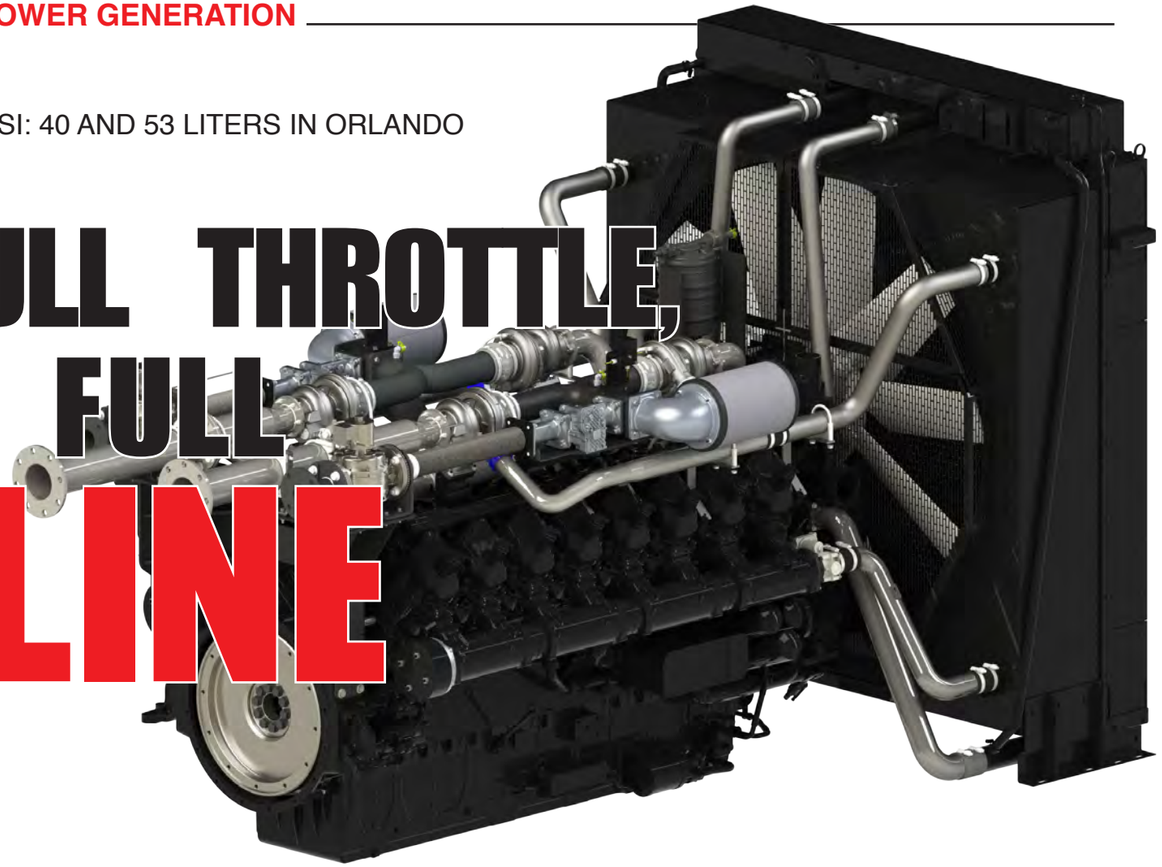
Stefanini wraps his speech up: «*Preheating warms the circuit of oil and water so they are already hot at the start of the engine.This allows accelerating the loading up*».

peculiarity is almost essential for plants powered by renewable energy sources. The Cylinder Pressure Monitoring provides a sensor in each combustion chamber: a processor encodes information about the global ignition angle detecting high pressure, knocks and misfires.
A wide range of data is monitored continuously and analysed in real time, avoiding possible inefficiencies or shutdowns that would lead to unscheduled stops: the CPM controls the timing of each valve to automatically align the combustion pressure without modifying the global ignition angle. The system does not modify the profile of the cams but only the spark ignition speed in the combustion chamber: this reduces significantly stress and vibrations on the shaft. Further protection systems for the engine and its performances are derating and, ultimately, engine shutdown. Derating foresees lowering loads by 5-15% as long as the system is re-established: a further compensation of the derating will follow the power grid needs.
The new 20 cylinder V-engine is conceptually based on the latest medium-speed Rolls-Royce 6, 8 and 9 cylinder in-line models. 12 and 16 cylinder V-engines will soon complete the range of the Group’s products and confirm - as stated by Peter **Headland**, Head of Customer Business at Bergen Engines: «*Rolls-Royce’s position as global provider of some of the world’s most efficient power plants*».
For three years now, the company has been working to satisfy the Powergen market, an increasingly significant segment for the company that aims to meet the key requirements of the latest generation power plants such as low environmental impact, low maintenance costs and start-up speed. **Roberta Ronda**

The ECC’s software has been considerably upgraded to enable fast acceleration to reach the nominal load. The result is an increase in the engine’s performance during start-up and parallel connection with the grid

PSI: 40 AND 53 LITERS IN ORLANDO

FULL THROTTLE, FULL LINE



In early December at PowerGen in Orlando (Florida) PSI announced the 40 and 53 liters that widen the top offer of stationary gas engines. PSI is an historic supplier of GM Powertrain, and has been recently acquired by Weichai. Oil & Gas market is worth 50% of PSI turnover; the other half mainly comes from stand-by stationary and material handling. **PSI** entered the Weichai orbit due to its know-how, as well as for the specific gas market. There are three main lines in the motor portfolio: automotive sector, where PSI is well introduced in the North and South American area; industrial applications are covered from 1 to 8.8 liters with gasoline units; the heavy duty line, currently under development, is instead a diesel monopoly. It starts from 4-cylinder and 6-cylinder in line from Weichai. It continues with Doosan, from the 6-cylinder, 8.8-liter to the V12, 22 liters modified by PSI. We still climb with Weichai: 32 liters, V12, which faces the 40 liters, 600 to 900 kWe Cat C3512 Epa certified, the 53 liters and the 65 liters. **Limited Time Prime Power** is being introduced to harmonize different cycles (standby, prime and continouous). Electronics uses canbus J1939. All engines are stoichiometric, applications are mainly stationary, both stand by and COP (Constant operating power).

These engines apply to mobile applications such as sweepers and forklifts (in America they supply Nacco, CAT, Doosan, Mitsubishi). Even strictly-diesel machines such as wood chippers are turning to alternative fuels. In the US, for example, the ties of tier 4 Final are bypassed switching to gasoline engines.

Paul Cleveland

At the PowerGen in Orlando, which was held in Florida from December 4 to 6, PSI introduced the 40 and 53 liters, two 12-cylinder V-shaped units - just as the 32-liter, which allow the Chicago-based company to challenge the compatriots Cat and Cummins on the big displacements ground

KOHLER FOR WACKER NEUSON

STATIONARY AND MOBILE

KDI MAKE LIGHT

The **LTV6** and **LTV8 light towers** combine the features and performance of traditional light towers in a smaller footprint. Flexibility is not a problem at all, the adjustable vertical mast extends 23 feet and can fully rotate at 360 degrees.
The other novelty is the new **G70**, equipped with a KDI 3404 engine. It is a **prime power generator** designed to withstand the rigors of repeated transport and continuous loads. It is compact and sound-proof, and it is able to provide single and three-phase power for construction, commercial, industrial and special event applications where the requirement is quiet power.

Wright said: «*There is no doubt that we need to continuously improve, also in terms of smaller engines and the hybrid could become a valuable solution for example under 19 kW engines*»

The agreement between Kohler and Waucker Neuson covers different kinds of applications and applies to both stationary and mobile units. Common denominator: overcome the obstacle of emissions, both in the case of Tier 4 Final and Stage V. The protagonists of this challenge are two members of the KDI family, both winners of the "industrial engines Oscar", the Diesel of the year: the KDI 2504TCR in 2012, KDI 3404TCR SCR in 2015. Whether it is the new prime powered generator G70, intended for rental services, or even in the case of the vertical lift track loader ST31, directives are not negligible.
To get a clearer picture of the situation we went straight to the source, chatting with Will **Wright**, Senior Director of Product Engineering & Purchasing at Wacker Neuson.

Mr. Wright, what's happening in the industry and why Wacker and Kohler chose to partner together?
There is an ongoing push to continually improve the emissions output of the engine and have a less environmental impact. As the engine is becoming more and more complicated, the interaction between the two companies becomes more and more critical for different reasons: systems become more and more complex, so durability and reliability need to be improved and we also have to cooperate a lot on the electronic side to make sure that we have a robust and reliable overall system, because there is very low tolerance towards machines in the field nowadays, expectations are very high and getting higher. We also have to deal with ever-changing regulations.

Kohler impressed Wacker Neuson. Track loader ST31, genset G70 and LTV6 tower lights chose KDI engines to accomplish the more stringent emissions regulations. Chatting with Will Wright about this agreement

Why Kohler engines? What's the impact on the application?
KDI product line was one of the main reasons why we chose Kohler. Kohler didn't take any existing technology to transform it into a Tier 4 Final, like many others did. They looked at the upcoming regulations and at the regulations already in place and they developed an engine specifically for Tier 4 Final. One of our needs was exactly an engine born for Tier 4 Final. Also, the two companies have a long history of cooperation between them. Close cooperation is needed to properly develop products as complicated as engines.

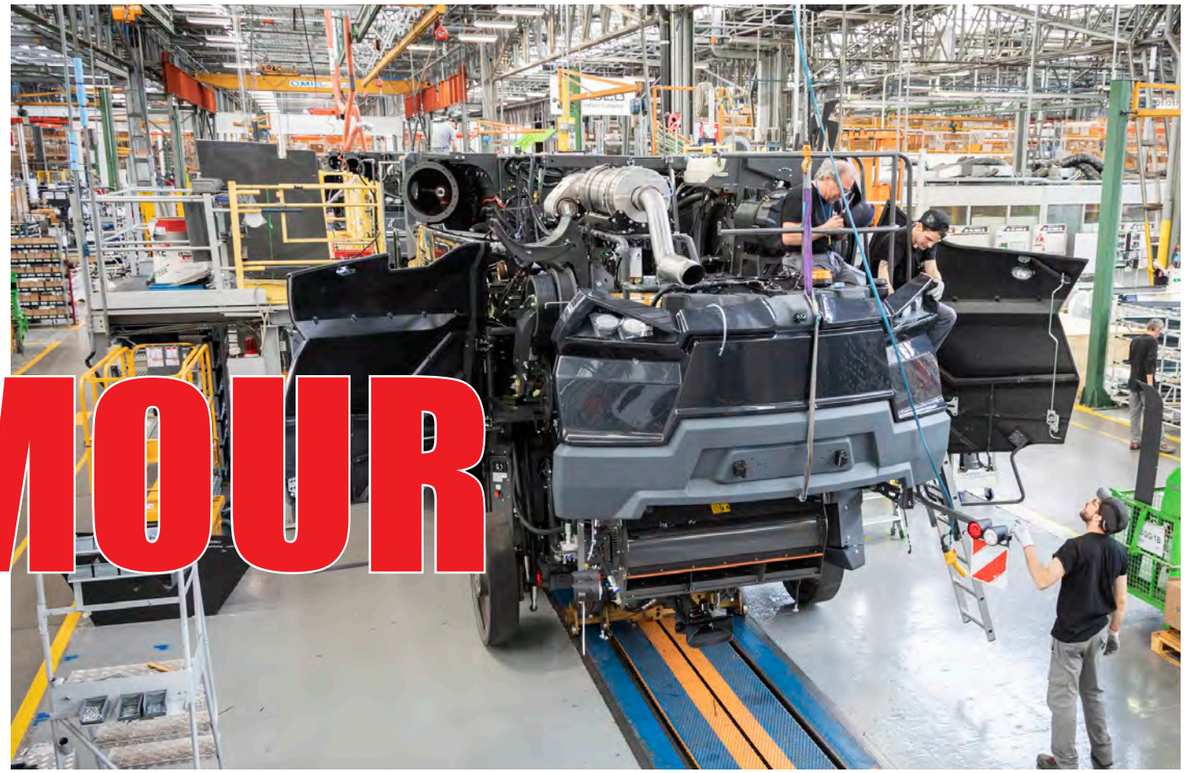
What applications are powered by Kohler?
Currently we have in production, or going into production, ten skid steer loaders from 1600 lb rated operating capacity up to a compact track loader of 4500 lb.

What's Kohler's trump card in Tier 4 F: a more compact installation?
The advantage of KDI engines for US market is also the DOC only, it was a huge driver. DPFs have their place and they do their work but US market prefers DOC only. Also, the compactness of the system and its simplicity truly makes the difference. Up to 55 kW the engine comes in a whole compact package which is very functional.

Is the hybrid module K-HEM a solution that might interest you on small excavators and wheel loaders?
We are in discussion with Kohler for that kind of system. One of the challenges that we have to face for our machinery is that in many cases we don't have all that variation in terms of maximum load. Usually there is a continuous load on the engine, but hybrid systems work better when there are gaps in the workload. The hybrid can help to fill in those gaps of pick power demands. We are trying to understand how to better utilize such kind of system on the machine side. **F.B.**

AGCO IDEAL & MAN D26 - D38

COUNTRY SIDE GLAMOUR



Why the black color? Brandon **Montgomery** got an answer: «*The "WOW!" effect struck the customers*». Under the Ideal bonnets Agco fit D26 and D38 engines. «*MAN engine is perfectly suited*» Montgomery said. «*I think we have achieved a very good engine installation*».

Agco has tailor-made on its combine platform an anthracite black dress that enhances its fashion appeal. Under this silhouette beats the heart of MAN. The duo from Augsburg also includes the D38, Diesel of the Year 2016.
To learn more about the Ideal series we met Daniele **Seganfreddo**, Agco's Product Marketing Combines, and Brandon **Montgomery**, Sr. Marketing Manager Global IDEAL & EME Gold Harvesting.

What are the aesthetic and commercial reasons of the Ideal range?

The keypoint is that in order to be competitive in the harvesting business we needed a premium machine. So our senior management decided to make a major investment, one of the largest that Agco has ever done.

Daniele Seganfreddo and Brandon Montgomery introduced us to the Ideal universe, one of the biggest investments in Agco Group's industrial history. The three versions of the stylish combine are equipped by Agco Power and by Man Engines D26 and D38, Diesel of the Year 2016

Why the black color?

Fields gave us the answer during the summer, with 40 demo units at work throughout Western Europe, when the "WOW!" effect struck the customers. Black color gave us what we wanted to achieve in terms of impact on insiders and onlookers. This is the main reason.

Did you start from customer needs? How did you give something more compared to your competitors?

We carried a global survey among our customers across the main regions were these machines were supposed to be sold, EMEA of course and Australia/ New Zealand, North and South America; 56% of Agco turnover is made in EMEA region, so we needed absolutely a machine that could be global but primarily suitable for European customers. We needed to have a machine with great harvesting and straw quality, and a narrow profile to be agile and versatile between the fields. This machine is able to easily work in hillside conditions, which is a typical situation in areas such as France, Germany and UK.

How did the cooperation with MAN start?

Ideal 7 features the 9.8-liters Agco Ecopower, while Ideal 8 and Ideal 9 are equipped with Man 12.4 and 15.2 liters. D26 and D38 are the natural complement to the Ecopower engines. They're also used on Fendt 1000, and feature an excellent power density/weight ratio. We wanted to offer customers a solution that is also suitable from a dimensional point of view, and Man engine is perfectly suited to this purpose.

Do you share MAN's strategy about EGR?

A combine operates at variable load and constant speed, unlike a tractor which continuously adjusts rotation speed according to the mounted equipment and always works at different speeds.

What are your first impressions about engine installation?

I think we have achieved a very good engine installation, clean, easy to service, including post treatment and cooling. One of the main features is the Air Sense cooling system includes a completely sealed radiator which is open on top to allow air intake through a fan, that can reverse the paddles to blow out dust and dirt, dramatically reducing the daily maintenance because it's self-cleaning.
The "blank sheet" approach to the design gave us the freedom to experiment; for example, having the radiator package on the right hand reduced maintenance, while the reversing fan is able to keep the machine cool and clean. Another peculiarity is the way the engine transfers power to the feeder house: we reduced by half the number of belts, power transfer is more efficient and maintenance is much easier.

Could LNG engines be an alternative in the next future?

This solution could be suitable for lower power ranges, where strong power absorption is needed. Removing the exhaust after treatment, which has high cost and does not have so much benefits, could open several opportunities: our goal is to reduce emissions at a cost that the customer is willing to pay for, and that's the most difficult task for any OEM.

What is the most important market for these machines, also in the long term, EME or North America?

Right now we have a global platform, all units are manufactured in Breganze, not only for Europe but also Australia/ Pacific, we have machines that just started demos last week there (ed. early November)*, and also in North America on corn and soy beans. Next year the production will start also in South America, in Santa Rosa factory, where we're now manufacturing second level prototypes, while production will start around May 2019.* **F.B.**

TECH DAY 2018. FPT INDUSTRIAL

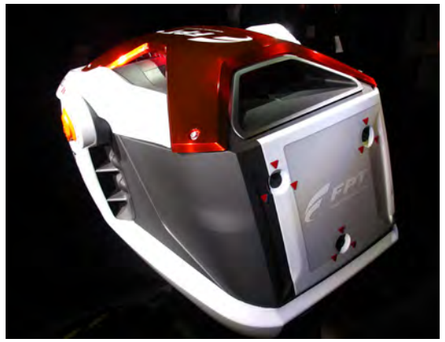
FOR A NON DYSTOPIAN 2030

At the Tech Day 2017 Cursor 13 NG was the star, 338 kW @1900 rpm and 2000 Nm @1100. The combustion system has been renewed, specifically designed for positive-ignition: its secret is the turbulence that ensures flame propagation to improve the combustion.
On the Cursor 13 NG Evo two new features have been introduced: active shaft management and a high pressure cooled EGR circuit, reintroduced in order to reduce the throttling losses at partial load, contributing to a reduction in consumption. The latter in fact can be quantified to 4% less on the C13 NG, in spite of the increase in consumption attributed to the EGR. This goal has been reached also thanks to the VET system, with its variable valve timing. Ultimately, data sheet shows gas and diesel come close to each other: 370 kW @900 rpm and 2200 Nm @1000.

Annalisa **Stupenengo**, Powertrain segment President: «*It won't be possible to have a leading form of energy in the future. We stand for freedom of choice. FPT will continue to have a pragmatic and multi-level approach*».

In the second Tech Day edition at the CNH Village however, FPT Industrial has paved the way to an engine evolution in all possible directions. The common feature is the 'multi' prefix. Multi- like the the power sources and the applications of reference, calibrated according to cycle and workload.
There are four main propulsion directions at the CNH Village: the Cursor X, the Electric powertrain division, the hydrogen fuel cell powertrain, the Cursor 13 NG Evo Prototype.
Let's start with the **Cursor X**, the capsule with futuristic features in a Star Trek style, that summarises FPT Industrial's vision: what will happen to propulsion in 2030? The answer lies within the module, which allows for the three different propulsion systems to be removed and interchanged (to be clear, the propulsion system can be extracted and substituted more or less like the battery of a cell phone): the natural gas internal combustion remains endothermic, an alternative to the fuel cell generation and to electric battery stored energy. The propulsion system can be converted from one mode to another, varying between a fully endothermic drive to electric drive, stand-alone, parallel or serial.
In the natural gas mode, with the option of electric mode, the engine can be used for passenger transport in urban areas and for regional transport. In the electric mode, the 200 km driving range ensures that the full load of deliveries can be completed in any city without having to 'plug in'. The hydrogen combustion cells are indicated for heavy-duty applications, with a working range that can reach 800 kilometres.
We have talked about electric mode. FPT did display the electrification banner at the IAA in Hannover. The designated department is called **e-Powertrain**, with its two products: the E-Axle, which supports up to 250 kilowatt with front-wheel, rear-wheel and all-wheel drive, ideal for bus&coach, and the Transfer Box, an additional unit to the original engine, be it thermic, hybrid or electric, with a torque at wheel of 8000 Nm.
FPT has not forgotten the mild-hybrid architecture, top-rated at least in the automotive sector. Two key components have emerged in this context: the E-Turbocharger and the E-Flywheel. The declared objective is an 8% reduction in fuel consumption during one pure diesel cycle and a transient response that yields an improvement in reactivity by 50%.

Cursor X: multi-power module, hydrogen platform, electrified branch and Cursor 13 NG Evo. These are the four cornerstones of Tech Day 2018. At the CNH Village Fpt goes a step forward



Hydrogen technology may well be futuristic, but it is 'already tangible' in the chassis, complete with tanks. The initial targets are long haul trucks, with an eye on large diggers, mine dumper trucks and combine harvesters with highly seasonal and massive workloads. Let's examine the case study of a truck between 26 and 44 tons. The first challenge is to maximise performances, relying on the fuel cell sequence - lith-ion batteries - and e-axle. The second challenge concerns efficiency, working on the integration of the components.
Next up, sustainability and autonomy (currently, 64 kilos of hydrogen are required to cover a distance of 800 kilometres), refilling time (20 minutes at a 350 bar pressure, compared to 120 minutes of the electric battery). Finally, reliability and durability, achieving 20 thousand hours.
The fuel cells supply energy to the e-axle, which in turn supplies energy to the wheels through the integrated electric motor. The 'big brother' hydrogen powertrain has everything under control: air circuits and fuel, peripheral devices, thermal management. The ultimate result of this mechanism of integration and supervision of the different components is the improved efficiency of the system: we are talking about around 50%. **D.F.**

MOTEURS BAUDOUIN

POWERGEN RISING STAR

One year after the Baudouin 100th birthday, DIESEL International asked the French company how it feels at the beginning of its second century of life.

One hundred years of life in 2018. What is the 'trait d'union' between a century-old company and its own projection in the near future?

Passion for what we do! From the onset, our founder, Charles Baudouin, always envisioned to grow beyond the shores of Marseille and diversify beyond fishing. Today our ambition to deliver the most robust engines to the world is stronger than ever. Our product range meets the most stringent emissions requirements. Our 130 sales and service points worldwide bring our passion wherever our customers operate.

January 2009. What you called 'the re-birth'. Weichai Power purchased Baudouin. How did this synergy move forward? What role does Baudouin China play in Weifang?

With a lot of positivity and energy from both parties. Weichai helped greatly through their financial support and huge engineering resources. Baudouin China, in particular, is a manufacturing facility based on the Weichai campus. We are the marine and power generation specialists in the group.

2014 is the year of the 12M26.3 première, in Hamburg and Cannes. How are the leisure markets feedbacks? Baudouin is well estimated as a reliable brand for fishing vessels. What other commercial applications lend themselves to the new diesel engine platform?

Baudouin enters the first year of its second century of life. The synergy with Weichai has brought the M26.3 engine platform and a growing market share in power generation applications. What's the secret? "*Passion*"

Fabrizio **Mozzi**, President and Managing Director of Baudouin, said: «*Until 2012, our market composition ws roughly 80% in fishing, 20% in other applications. Today, it is the opposite*».

ments. As we keep developing our presence in power generation, this concept has now been adopted on our PowerKit range of products.

Can you detail the most important technological features and upgrade (Bosch 1,800 bar common rail, double waste gate turbocharger, hydraulics, etc)?

As Baudouin remains the only engine company truly designed for marine applications (we do not marinize engines), we have worked with our partner, Bosch, to develop a new marine dedicated injection system and control system to be used on our M26.3 range. This makes our engine the most advanced marine power available today on the market.

This engine has been designed to answer the widest range of applications, from fishing to yachting. Until 2012, our market composition was roughly 80% in fishing, 20% in other applications. Today, it is the opposite. We have registered notable success in passenger and supply vessel applications globally.

In addition, we integrate premium marine components sourced from leading global manufacturers such as Honeywell, Mota, Danfoss, etc.

Where does the idea of a super-square engine (BxS 150 x 150 mm) come from?

At the time, in marine applications, it was the best compromise to respond to high torque and high speed require-

MEE Dubai 2018. In just one year, the conversion of the new platform for stationary applications proved to be a success. Are we going to see something new at MEE 2019?

Of course yes. We are committed to releasing new products at a fast pace and to becoming one of the top 5 power generation engine manufacturers in the next 5 years.

Any references in Europe and in the world of genset powered by Baudouin and some special requests and applications by OEMs?

2018 has been a very important year for our growth in power generation. We established relationships with companies that will guarantee our sustainable growth in the future. Among the largest companies we work with, are Electra Molins, Greenpower, GMI Algeria, Grupel, Emsa, New Way Power. More big names will be added in 2019.

Stage V, an appointment with history also for stationary applications. How is Baudouin moving? Is the SCR unavoidable both for the first power in Stage V and for the IMO Tier 3?

There are obvious similarities between IMO III, Tier 4 and Stage 5 for both marine and power generation applications. After-treatment is unavoidable on regular diesel engines to reach the new stringent emission standards. We are actively designing solutions to meet the new emission standards. We are already compliant with IMO III and are waiting for EPA 4 certification. We are currently actively evaluating Stage 5 for both industrial and inland waterways applications.

Can we expect a gas development of the engine block for cogeneration and biomasses applications, perhaps from a smart grid point of view?

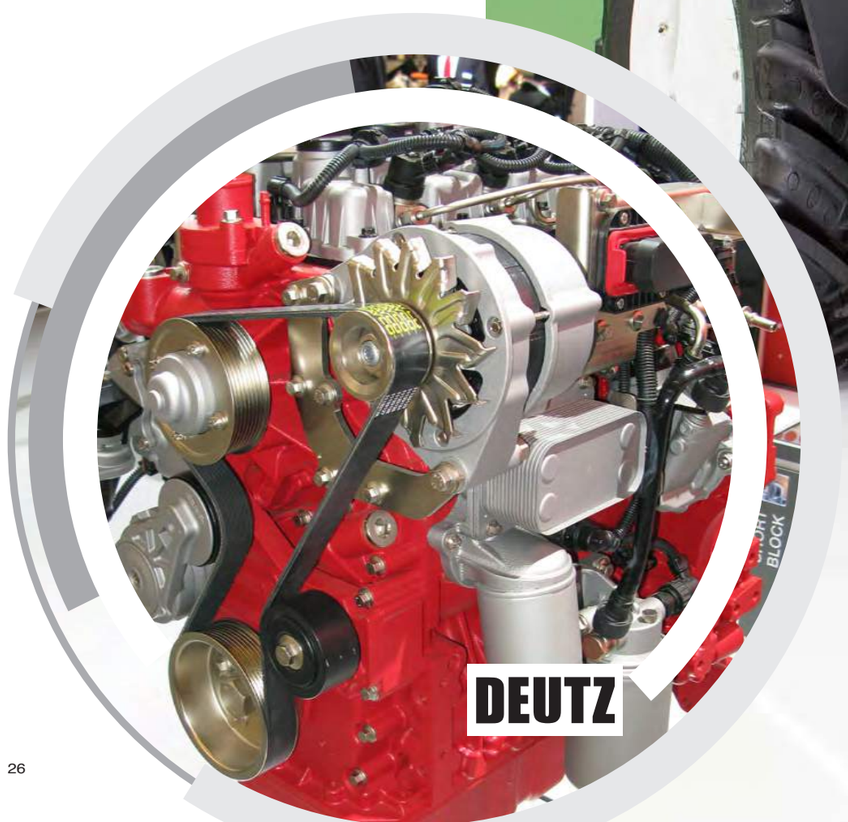
Today, the group owns PSI (USA), specialist of gas solutions, and has stakes of Ballard (Canada) and Ceres Power (UK), specialized in alternative energy and fuel cells. We are setting up an alternative energy campus where we aim to bring all these technologies together with electrical engines and batteries for complete hybrid packages, to be applied.

Guillame Le Doux

CARRARO AGRITALIA, DEUTZ, 4E

HYBRID BETWEEN FIELDS

“ It bears the signature of one historic Italian brand of agricultural machines. And there’s really so much know - how in the new Carraro Hybrid, featuring a solution that combines thermal and electrical power according to load curves in the name of downsizing ”



It was introduced on the eve of Eima with very good references such as the ‘Technical News’ and ‘Blue Prize’ prizes. Yet it was difficult to tell Ibrido, the concept created by Carraro in collaboration with 4e consulting – an engineering consultant based near Ferrara - from a conventional tractor: same layout as the Agricube, same dimensions, Carraro 24 + 24 synchronized mechanical transmission - also in this case with a struc-

DEUTZ TCD2.2

It was 2010 when Deutz TCD2.9 won the Diesel of the Year prize. From here arises the odd engine of the modular 725 cc cylinder that, in Deutz geometric taxonomy, whose name is TCD 2.2. In 2016 we also witnessed the conversion of the compact cylinder to LPG, following a Kion supply (speaking of front lifters). Carraro Agritalia has a privileged relationship with FPT Industrial, yet the choice on the endothermic engine of the hybrid package was not the 2.2 of VM Motori. The chosen one was the 55.4 kW Tcd 2.2 we admired at Electrip in Cologne. In that occasion the engine powered the thermal fraction of the propulsion package of two telehandlers, the Liebherr TL432-7 and the Manitou Mt 1135, taking the place of TCD3.6. If on those applications the whole propulsion system is made by Deutz, Carraro Ibrido is the result of a cooperation with 4e-consulting.

4E-CONSULTING

Thermodynamic studies, design of performance curves, software development, control and power electronics, wiring and batteries upgraded to the most rigorous safety standard. These – and more - are the contributions of 4e-consulting for the Carraro Hybrid. We spoke about it with Paolo **Patroncini**.

«The machine features state of the art technology: 400 V high voltage, integrated control system developed by us, permanent magnet motor. The electric motor delivers 50 kW and has been conceived to avoid performance degradation in electric-only mode. We privileged security also on hardware, for example using the 'interlock' system which automatically interrupts power in case of malfunctions in the electric circuit, safety devices in case of collisions or tampering. The flame-retardant battery technology comes from military submarines. The lithium iron phosphate battery pack doesn't catches fire even if pierced by a drill».

tural function, same controls and user interface. Then, opening the bonnets, here comes a surprise: a hybrid propulsion scoring 105 HP on the balance sheet, and a series of features making Ibrido the first real alternative to traditional internal combustion tractors. **Carraro** reached a real electrification analyzing working cycles and discretization of power absorption of various applications - traction, PTO, hydraulics - through field tests using a standard model in different work cycles.
Hence the choice of an architecture in which the hybrid propulsion is interposed between the internal combustion engine and the transmission, tests on single lithium battery cells to define the real electrical and thermal characteristics, and the development of a virtual model through software simulations in different scenarios. The analysis of traction and PTO power absorption led to suppose that the real utilization of specialized agricultural machines allows the downsizing of the internal combustion engine and the hybridization of the system, taking advantage of the typical features of electric machines (high torque from zero rpm, reactivity, efficiency and controllability); the analysis of power absorption discretized per cycle then allowed to classify which utilizations and to what extent it is possible to electrify.

> "Together with Carraro we have done a technological development that involves performance and, with even greater emphasis, safety. We have also interpreted the safety from a hardware point of view"

The outcome is a system featuring a diesel engine (the 55.4 kW Deutz **TCD2.2**, direct heir to the 4 cylinder TCD2.9, Diesel of the year 2010) and an electric motor as a 105 HP propulsion unit. One of the key elements to define the dimensioning of the hybrid propulsion system - see details in the box on this page - was the analysis of torque and fuel consumption maps of the diesel engine compared to the data acquired in the field tests. The outcome is three operating modes - Diesel, Hybrid and Pure Electric. In hybrid mode, the new VCU vehicle control unit strategy automatically manages the distribution of the total power load on the endothermic engine and the electric motor and the energy storage system. In electric mode the powertrain can be used as a three-range **CVT** (0 - 2 km/h, 2.5 - 9 km/h and 11 - 40 km/h); in this case a dedicated joystick controls the electric motor, managing progressive speed modulation, F/R function and Declutch function. In pure electric mode the F/R lever reverses the rotation direction of the electric motor without involving the gearbox.

CARRARO IBRIDO IN FIGURES

Manufacturer	Carraro Agritalia
Endothermic Engine	Deutz Tcd2.2
hybrid section	4e-consulting
transmission	Carraro 2 4F + 24R
Maximum speed	40 km/h
Hydraulics	Autonomous with independent electric motor
Power steering hydraulic pump	30 l/min
Auxiliary hydraulic pump	50 l/min
Pressure	190 bar
Rear lift capacity	2,600 kg cat. 2
Pitch	2.130 mm
Overall minimum width	1,600 mm
Maximum height	2,478 mm
Maximum length	3,950 mm
Maximum height	2,478 mm
Total weight (without ballast)	3.450 kg

The use of a 55 kW (75 HP) endothermic engine inside a powertrain delivering 77 kW (105 HP) allowed for an easier compliance with emissions regulations (being in the niche from 56 to 130 kW) and to take advantage of torque and consumption map, freeing up space and weight for the hybrid architecture. The management system keeps the engine working in the optimal consumption zone, set between 1,300 and 1,800 rpm, allowing for lower consumption, longer components life and maintenance intervals. In hybrid mode, the machine is only partially powered by the diesel engine, as the **VCU** strategy automatically switches it off and goes to Pure Electric mode whenever the total absorptions (traction and PTO) fall below a power threshold (and if the battery charge level is above the programmed level), lowering emissions to zero. This mode also allows for lower noise and vibrations. Once set in this mode, the hybrid propulsion group allows the speed to be varied continuously within a certain range (range A, B, C) without generating any torque voids or having to disengage the rear mechanical PTO, change the direction of travel without having to use the gear reverser, and accurately control space and time of maneuver.

Klaus Reichlin

1 LITER 3-CYLINDERS <19 KW

ULTRA COMPACT SHOCK

John Deere is a valued brand in this range of professional gardening machines. And the typical example of captive that sometimes looks at free market when a suitable displacement is not available.

There's life on one liter planet. We're not talking about the cylinder par excellence of the 4 cylinders in line architecture, which wrote the history of agricultural mechanization, we mean the displacement deriving from odd engines featuring the 300-400 cc cylinder. Fresh blood coming from the KDW 1003 (once Lombardini) introduced at Eima, promoted by Kohler as the endothermic partner of the hybrid kinematic chain **K-HEM** (Kohler Hybrid Energy Module). This engine size, which stays faithful to mechanical injection, naturally aspirated, is a candidate for hybrid driveline, just like the 4 cylinders up to 2 - 2.5 liters. Natural aspiration and exhaust, mechanical injection, costs containment that dissuades the use of common rail and recirculation find in this case an ally in

The narrow group of super-compact specialists enters the race of the 1 liter, three cylinders engines. Japanese school rules, but Kohler made its KDW 1003 the ideal partner for hybrid powertrains. Will this be the second life of these small hard-working mechanical engines? No turbo, mechanical injection, costs reduction, reliability.A formula that echoes from the past

the coupling to an electric motor. Featuring the same dimensions, compared to engines over 19 kilowatts which will have to be equipped with catalyser and particulate filter, the partial electrification of minitractors, skid steer loaders and front loaders would bring compliance with regulations and acceptable consumption rates. Across 1 liter displacement Oriental manufacturers are the winners, **mostly Japanese**. The range under 3 liters has always been a domain of Yanmar and Kubota, and also the new entry of the lot, the design of the 3C100, was born in Osaka, on the Kubota side. The manufacturer is Kioti. The Koreans also feature a 3-cylinder engine also available in power pack set-up both with water-oil mixed radiator and water-air STD radiator. On behalf of Europe we find Perkins and Kohler, who played as anticipated an old ace from its sleeve. In terms of power peaks we think of decimals, specific power rewards Kubota instead, while Kohler leads the group when it comes to specific torque, in line with maximum torque. KDW 1003 provides the hybrid package with the ease of mechanical and hydraulic connection and power delivery suitable for integration with the electric unit.

Yanmar wins the power density race, right ahead Perkins 400 (and here too we find a Japanese influence, that of Shibaura). The 400 series, in the three-cylinder version, showed an impressive upgrade at Agritechnica 2015, where the 1.7-liter 403F gained more power (30 kW and 130 Nm) also due to electronic management and the consequent implementation of common rail.

Lightness and compactness are in the DNA of the Japanese, as is also showed by the dimensions of the Yanmar itself and the mass/power ratio of Kubota. Speaking of Yanmar, the policy is clear: the implementation of common rail continues downwards involving the 19 - 56 kW range, then the 1.6 liters, with the consequent electronic control of the control unit and the support of the recirculation valve. From the Rising Sun comes an illustrious "desaparecido", Mitshubishi, last sighted in Europe at Bauma 2013, where the 4EG, 3.3 liters and 74 kW, was the representative of Tier

BRAND MODEL	KIOTI 3C 100LF	KOHLER KDW 1003	KUBOTA D902-E4B	MITSUBISHI L3E	PERKINS 403F-11	YANMAR 3TNM74F
I.D.						
B x S mm - S/B	75 x 76 - 1,01	75 x 77 - 1,03	72 x 73 - 1,02	76 x 70 - 0,92	77 x 81 - 1,05	74 x 77 - 1,04
Max power kW - rpm	3 - 1,00	3 - 1,02	3 - 0,89	3 - 0,95	3 - 1,13	3 - 0,99
Potenza intermittente kW - rpm	17,6 - 3.000	18 - 3.600	**18,5** - 3.600	17,7 - 3.600	18,4 - 2.800	17,8 - 3.600
Mep at max power bar	7,1	**6**	7	6,3	9	6,1
Piston speed m/s	7,6	9,3	8,8	8,4	**5,9**	9
Max Torque Nm - rpm	61 - 2.300	**67** - 2.000	57 - 2.300	52 - 2.000	64,7 - 1.800	55 - 2.600
Torque rise %	24,7	**27,2**	20,8	19,3	25,2	17,5
Torque at max power Nm	59	49	49	49	**78**	49
% Power at max torque (kW)	83,5 (**15**)	78 (14)	74,30 (14)	61,60 (11)	59 (10)	84,8 (15)
Specific power kW/ dm	17,4	17,5	**20,6**	18,6	16,2	17,9
Specific torque Nm/dm³	60,5	**65,1**	63,4	54,5	57,1	55,7
Areal specific power kW/dm²						
DETAILS						
Dry weight kg	100	87	72	75	87	88
LxWxH mm	502x481x562	510x438x515	467x420x544	526x418x500	491x400x576	450x416x506
Volume m³	0,14	0,12	0,11	0,11	0,11	**0,09**
Weight/power kg/kW	5,7	4,8	**3,9**	4,2	4,7	4,9
Weight/displacement kg/dm³	99,3	84,6	80,1	78,7	**76,9**	88,6
Power density kW/m³		150	168,2	160,9	167,3	**197,8**

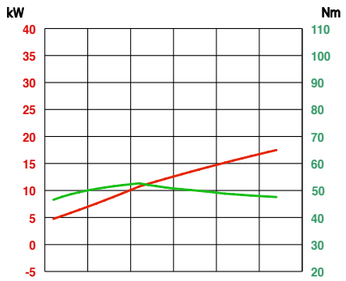
MASSEY FERGUSON & KUBOTA

Massey Ferguson equipped the MF GC1700 with Kubota and is available with SSM60 60 cm side discharge cutting plate. The versatility of this machine, which is proposed as a small multi-utility backhoe loader, is immediately evident from the standard front loader and rear excavator. Among other valuable elements, the cast-iron bucket link, the built-in greasers, a 12“ bucket and the floating arm derived from construction machines. The floating arm moves freely and facilitates the bucket positioning, allowing uniform cutting and regular leveling during filling. The same floating arm speeds up digging operations and cycle times reducing consumption.

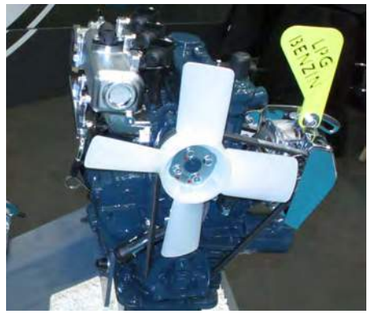
4 Final. No news about Stage V, but dwelling on super-compact we appreciate dimensional data. Stresses are contained, penalizing the performances (which are substantially aligned in this range) in favor of the so-called ‘durability’ of the engine block.
In conclusion, a suggestion: what if the hybrid word was associated with a gasified engine or a **LPG**? A kind of super-alternative? Kubota, for example, has the WG972 in its portfolio, a gasoline and LPG one liter engine. Specific curves? They’re in line with those of diesel, delivering 18.3 kW. A word to the wise… ■

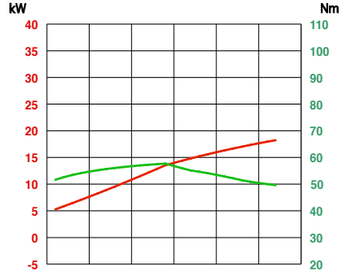
BRAND MODEL	KIOTI 3C 100LF	KOHLER KDW 1003	KUBOTA D902-E4B	MITSUBISHI L3E	PERKINS 403F-11	YANMAR 3TNM74F
INDEX						
TORQUE	8,4	**17,4**	14,4	7,3	7,2	17
PERFORMANCE	3	3,4	3,3	93,4	2,8	3
STRESS	5,1	5,9	5,6	24,1	**4,4**	5,2
LIGHTNESS	11,1	8,9	8,7	1,6	9	10,3
COMPACTNESS	23,7	29,7	**31,6**	2,6	28,8	30,7
DIESEL	5,5	6,1	6,3	**6,4**	5,7	5,7

1 MITSUBISHI

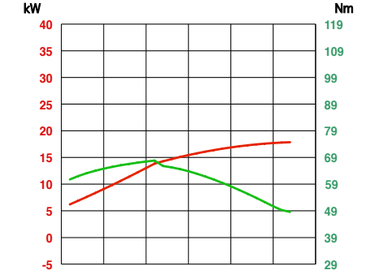


2 KUBOTA





3 KOHLER



2.2 LITERS. HYBRID FOUND HOME

DIRECTION DOWN SIZING

The unusual comparison is the one which identifies a specific displacement and arbitrarily takes it out of its reference range. Why 2.2 liters displacement? Eima showed a clear desire for hybrids, and the Carraro Ibrido is powered by Deutz TCD2.2. We saw this very same engine at work at Electrip in Cologne on Liebherr and Manitou TH demos. Among the strongholds in under three liters displacement range, Kohler is around 1.9 and 2.5 liters, Kubota adds to its 03 series 1.8 and 2.4 liters displacements. Curiously, two years ago Mahindra Power made its debut at Eima, but since then no nore sign has come from India. A 2.2-liter, 4 cylinders, 2.8 liters Euro (BxS 85x96 mm) was on display, delivering a power rate well suited for onroad applications, 88.2 kW @4,000 rpm. Torque stopped at 280 Nm @2,800 rpm. Deutz odd is the main inspiration of this trend standing right below the top, showing a lower Diesel index compared to Doosan - although by only 3 decimals, especially for torque reserve and stresses. TCD2.2 curves speak clearly in this regard: they're shaped for applications that require good transients response and responsive peaks. This attitude allowed the 2.2 liters to replace the popular 3.6 (which is going to reach 105 kW in Stage V) on the demo telehandlers seen in Cologne. But there's more, since Carraro Agritalia used this engine on the Carraro Hybrid.

We talked about **Diesel Index**. Perkins stands between Doosan and Deutz, almost on par with Germans. There's also a taste of the Rising Sun here due to the birthplace of 400 Series, Shibaura. The protagonist is the 404J evolution which reaches 55 kW, 51 of which are available at maximum torque (i.e. @2,800 rpm) where the four cylinders reaches 270 Nm. Doosan reached Stage V switching **from Delphi to Bosch**, thus winning the gold medal. Torque is one of the topics which brought success to Koreans. Speaking of Seoul and around, Kioti Daedong makes its debut, ending in the box below due to its under 40 kW power rate. Isuzu introduced the European fashioned 4LE2X, featuring common rail, waste gate valve, catalyst and a renewed confidence in exhaust gas recirculation.

Although we've lost track of VM for some time the brand came back to Eima International, announcing the promotion to Stage V. The odd from Ferrara proves himself 'tonic' and fearless, despite the investments made by competitors. 1,600 bar, integrated doc and dpf, starter on the injection side and side **PTO** to facilitate access and maintenance. The name of FPT Industrial three cylinders is R22, mainly used on New Holland machines; although not showing brilliant performances, as often happens to Nef and Cursor, it stands out for density figures. ■

> "The 2.2 liter again is the protagonist of this unusual comparison. Focus on a specific displacement - in this case we could say a rising one, looking to a future hybridization, after Deutz shows in Cologne on telehandlers, in Bologna on the Carraro"

CHRONICLE FROM FAR EAST: KIOTI & YANMAR

YANMAR. Among all the natural competitors in this range the most penalized is the **4TNV86CHT**, featuring 2.091 cc (BxS 86x90 mm). 48.5 kW @2,600 rpm and 216 Nm @1.690 rpm, improving by 10 and 20 percent the figures of the previous TNV86T.

KIOTI DAEDONG brings in a 2.177 cc 4 cylinders (BxS 87x92.4 mm), 33.6 kW @2,600 rpm and 140 Nm. The **4B243-LWS** is Stage 3A accompliant, mechanic injection, entrusted to an in line pump. In Korea Kioti engines are used on captive tractors and utility.

This natural power range is that of super-compact engines from 2 to 2.8 liters approx. Diesel International has in fact made that choice with 2.2 liters in November 2016 issue, and we propose it again now, adding a couple of units from Far East..

BRAND MODEL	DEUTZ TCD2.2	DOOSAN D24	FPT NEF45A	ISUZU 4LE2X	KIOTI DAEDONG 4A220TLW	PERKINS 404J-E22TA	VM R753
I.D.							
B x S mm - S/B	92 x 110 - 1,20	90 x 90 - 1,00	104 x 132 - 1,27	85 x 96 - 1,13	87 x 92 - 1,06	84 x 100 - 1,19	94 x 107 - 1,14
N, cylinder- dm^3	3 - 2,19	4 - 2,29	4 - 4,48	4 - 2,17	4 - 2,19	4 - 2,21	3 - 2,22
Max power kW - rpm	**55,4** - 2.600	55 - 2.600	45 - 1.500	43 - 2.200	40 - 2.600	55 - 2.800	52,2 - 2.600
Mep at max power bar	11,9	11,3	**8,2**	11	8,6	10,8	10,6
Piston speed m/s	9,5	7,8	**9,3**	7	8	9,3	9,3
Max Torque Nm - rpm	250 - 1.600	**280** - 1.600	250 - 1.800	215 - 1.600	175 - 1.700	270,1 - 1.800	250 - 1.800
Torque rise %	35,3	**40,8**	37,9	1,6	34,1	39	40
Torque at max power Nm	**206**	**206**	196	186	147	186	196
% Power at max torque (kW)	75,7 (42)	85,40 (47)	90,7 (47)	83,80 (36)	77,90 (31)	92,60 (**51**)	52,40 (26)
DETAILS							
Specific power kW/ dm	**25,1**	25,1	24	19,5	18	24,8	23,4
Specific torque Nm/dm^3	113,9	**122,2**	112,1	98,6	79,6	121,8	112,2
Volume m^3	0,31	0,26	0,64	0,28	2,35	0,33	**0,25**
Weight/power kg/kW	3,9	3,7	**4**	4,6	5,3	4,4	4,3
Weight/displacement kg/dm^3	98	89,1	**94,3**	91,3	95,6	109,2	101
Power density kW/m^3	178,7	211,5	**260**	153,6	17	166,7	208,8
INDEX							
Torque	12	12,2	10,1	7,9	10,6	12,2	**17,7**
Performance	4,8	4,7	4,7	49,7	3,6	4,9	4,7
Stress	8	7,8	**7,9**	43,6	6,1	8,3	7,9
Lightness	11	9,7	10,8	1,3	11,2	12,3	11,7
Density	21,4	**26,2**	32,4	25	19	20,6	25,8
DIESEL	6,8	**7,1**	6,6	6,1	6	6,9	6,7

DEUTZ ELECTRIP COLOGNE

CLEAN POWER OFF-ROAD

The first outcome of E-Deutz was displayed during Electrip in Cologne. DIESEL International was there to attend the Liebherr and Manitou telehandlers tests, both in hybrid and full electric version.
The TL 432-7 Liebherr telehandler is usually equipped with the 4 cylinder, 3, 6 liters, 74 kW engine, replaced by the 3-cylinders, 2.2 liter, 56 kW. The core of Liebherr telehandlers, 3.2 tons and 7 meters lifting capacity, combines the ICE and a 20 kW - 48 V electric motor. The **mechanical connection** is provided by the transmission system with integrated torque converter, which allows to disconnect the 2.2 liters and switch to full electric traction. Electricity is stored in 10 kWh batteries. The potential savings depend on workload and operating cycle of each specific application. Deutz, a must on telehandlers up to 100 kW, used these machines to pave the way for the E-Deutz project, reaching an average fuel saving around 15 percent.

Liebherr and Manitou provided the technological demonstrators of the first outcome of Torqeedo - Deutz synergy. The telescopic handlers used in the field tests in Cologne are available both in hybrid (featuring a TCD2.2 and a 20 kW electric engine) and full electric version. What about the next applications?

From yellow **Liebherr** to red **Manitou**. The MT 1135 too is usually powered by Deutz TCD3.6 (and Perkins 854E-34TA). The same Liebherr operation was replicated on the Manitou powertrain. The hybrid system includes a 55 kW **TCD2.2** and a 20 kW – 48V electric motor. At the same power rate, the torque required to support telescopic movements, handling activities and any slopes is provided by the integration of the asynchronous motor with the 2.2 liters, the odd version of TCD2.9 (Diesel of the Year 2010).
Voltage climbs to 360V to guarantee the operating autonomy of the 60 kW electric motor and the battery pack in this 30.5 kWh full electric version. The use of full electric machines is suitable for construction sites, especially when power sources and plug-in recharging are available, and in agricultural applications, especially indoor, such as harvesting greenhouse vegetables, silage handling for biogas fermenters, and in stables to feed the cattle.
Frank **Hiller,** Chairman of the Deutz Board of Directors, effectively sums up the spirit of Electrip: «*An interdisciplinary team of engineers from Torqeedo and Deutz* has effectively integrated our driving concept into two prototypes in just one semester. All this shows that we master the needed technology and our ability to provide the market electrified solutions». Electrification processes are developed by Deutz Innovation Center, which was inaugurated in January 2018, that gathers software, electronics, hardware, technical and market skills from both Deutz and Torqeedo. **K.R.**

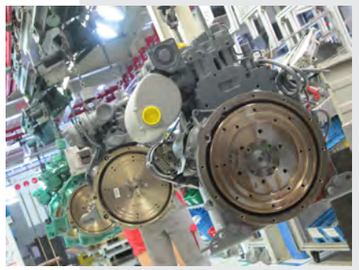
LIEBHERR. A 360° PARTNER

Four Liebherr four-cylinders and six-cylinders in the range from 200 to 620 kW are available in Stage V, Tier 4, China IV and Stage IIIA version. 9, 12, 13.5 and 18 liters engines will also enrich Liebherr portfolio.
Gebhard Schwarz, Managing Director of Liebherr-Component Technologies, commented: «*Thanks to its worldwide distribution network and its comprehensive support Deutz can reach new potential users for the engines resulting from this collaboration*».
This agreement comes from afar, thanks to a long-term collaboration that led Cologne engines to equip several Liebherr earthmoving applications such as crawler excavators, telehandlers and concrete pumps.

Michel **Denis**, Chairman and Managing Director of Manitou Group, commented: «This is the first prototype of electric telehandler we make thanks to Deutz. The integration of electric drive into our telehandlers is very encouraging for future developments».

DEUTZ BETWEEN PRESENT AND FUTURE

Where does Deutz want to go? The forecasts of Cologne management include 200 thousand units a year and a target of 15% in the long run. In a nutshell, this means a raise of Deutz turnover from 1.25 billion in 2015 to 2 billion in 2022. From 138 thousand to 200 thousand engines, in terms of production, a 31% leap ahead. To achieve this goal Deutz will have to reshape its historically Eurocentric range and set off to conquer Asia. Providing 'plug & play' technology for China IV is one of the available ways. The four commercial macro-areas will have to balance, therefore including United States, where gas and dual fuel applications may find space in addition to hybrids and electric.



LIEBHERR COMPONENTS COLMAR

EVERYTHING IS NOW READY

DIETHAR PLOHMBERGER. Colmar Managing Director

What is the production capacity of the Colmar plant?
Approximately 1,300 units per year over three shifts, although we are realistically able to manufacture 1,200 engines.

Are the main applications related maxi-excavators?
In terms of production volumes we have gensets (see agreement with Kohler SDMO). Engine design was originally conceived for mining machines. We have made some changes to adapt it to gensets. This factory only manufactures the D98 while the D96 is made in Bulle.

D98 will replace Mtu under the hoods of Liebherr dumpers?
The entire mechanical set-up is made in house, just like hydraulics. The engine represents the "key stone" to close the circle.

Diethar **Plohmberger**: «*We're looking for more applications that require slight engine adjustments, for example, railway and Oil&Gas*». And, about Bauma: «*Liebherr will set up a larger stand compared to 2016. D98 will therefore find its place*».

The ribbon of the D98 production plant was cut on Friday, October 5th 2018, in the presence of **Willi Liebherr**, President of Liebherr-International Board of Directors (and eponymous of the company established in 1949 by his father Hans). The ceremony seals a four years long path.
The stages that led us here begin in 2009 at the Bulle factory, the Liebherr Components headquarters in the Fribourg canton. After three years, in 2012, we witnessed the groundbreaking ceremony of the first factory in Alsace, France, close to the Swiss border. In May 2014 the factory has been completed, followed two years later by the assembly line which will be fully operational after two further years.
This rationalization of operations takes place in an area where Liebherr products are strongly rooted. 9400 Series hydraulic excavators are actually manufactured in the plant close to the engines factory (the "construction" factory is operational since 1961). The kinematic chain of the 9400 Series includes the Cummins QSK50, which will be available as an alternative to D9812 . The "autarchic" combination R 9400 - D9812 was tested at a cement plant in Héming, in the French region of the Grand Est, which has incorporated Alsace itself.
Another crucial step in the very short history of this factory is the agreement with **Kohler SDMO**, which was awarded the powergen versions of D96 and D98. This is the seal to Kohler line-up completion, which heavily draws from the portfolio of the sister company Kohler in Reggio Emilia and John Deere Power Systems.
We took advantage of this opportunity to visit the assembly, quality control and packaging lines. In the austere and dated world of industrial diesel it is rare to set foot in completely brand new warehouses. Colmar is a manufacturing center focused on pure assembly of components manufactured in other factories. Random samplings are carried out in the measurement area, without measurement exceptions, checking the performances (up to 4,000 kW) and the same measurement tools. Two machines are able to carry out checks up to 5 microns, while another one reaches 40 microns. Swiss precision is also showed by brightness standards, which follow specific reference points. Logistics is spread over an area of 2,000 sqm, where two trucks can move goods at the same time for a maximum of 350 trucks per month. The warehouse can store up to 3,300 pallets. Machine fleet includes a lifter that can handle goods up to one ton at seven meters.
DMU (Digital Mock-Up) analysis, a digital simulation procedure, is used in the three assembly lines. Operations take place in 12 assembly stations and 6 pre - assembly stations. A 3D view of the engine allows to identify the assembly stages. The ergonomic approach is also designed to ease assembly operations of the three monoblock variants, V12, V16 and V20. Every single operation is shared with other workstations. The engine block rotates 180° to cover all angles. Turbo is checked with a manual dynamometer before assembly. Finally, operators clean remaining impurities before packaging. Bench tests are fully automated. Two out of four test benches available are able to test up to 3 MW, while the other two reach 4.7 MW. **F.B.**

Colmar celebrates the opening of the D98 factory, Diesel of the year 2017. The ribbon cutting by Willi Liebherr took place in front of the factory management. Twelve assembly stations and six pre-assembly stations are able to produce up to 1,200/1,300 units per year. Over 300 people are expected to work there by the end of 2020

FENDT THINKS ‘ELECTRIC’

POWER OUTLETS AT WORK

Fendt calls it the farm of the future, structured around different solutions with one thing in common: an intensive use of electricity for power and electronics for control.
The most forward thinking project is definitely the Fendt e100 Vario, a full electric medium-size tractor. Futuristic not so much for its development (first class, as expected from the German manufacturer) but rather for the underlying philosophy.
It is a genuinely zero emission solution rather than hybrid, a concept that proves uninteresting in agricultural applications due to the continuous workload (the hybrid approach is appropriate when there is discontinuity). Although autonomy remains the main issue with this type of vehicle, the e100 Vario is still able to perform for a full working day, which corresponds to approximately 5 hours of continuous work, before it requires recharging.
The 50 kW electric engine is powered by a 100 kWh battery pack with a working voltage of 650 V.
The **battery** is charged either at standard alternating current charging stations (ideally the 22kW if possible), or with a direct current supercharger, through a CSS type 2 plug.
With the supercharger the battery is recharged up to 80% in 40 minutes: recharging during lunch break is sufficient to finish the workday.
All implements can be operated through standard hydraulic supply as well as through the **X Concept**, an electrical drive system developed by Fendt which can reach a peak power of 150 kW.
A simpler but equally interesting concept is the actual X Concept implemented onto a traditional tractor in order to complement or substitute the classic hydraulic system.

Fendt e100 Vario can be applied to medium duty applications, with its 50 kilowatt electric engine with a 100 kWh battery pack. It joins the X Concept. The Xaver swarm of tractors and autonomous driving also emerge

With a maximum power of 130 kW at 700 V, it dramatically amplifies the potential areas of application, and with the use of electricity, it completely overturns the operational mentality. It is now possible to operate not only the implements that are installed on the tractor, but also the ones that, for example, are located on towed machinery, without having to rely on the hydraulic system or on complex transmission shafts with universal joints. Other implements such as fans or cooling system pumps are also power-operated.
The first deployment of the X Concept is on the 700 Vario with a Agco Power-4 endothermic engine rated for 147 kW, and an alternator installed between the engine and the classic transmissions (in such a way that the alternator speed is linked to that of the engine).
Thanks to the **Powerbus** system which oversees their correct functioning, all consumers can be powered through the same plug. Special attention is given to safety. The electrical system has been built with meticulous attention to safety (a much needed precaution given the powers at stake and the operating voltage). For example, in the case of malfunction, the system intervenes instantaneously cutting the power supply.
This system is very interesting also from the environmental point of view, in that it eliminates any oil leakage into the environment.
Last of the new proposal catalogue is the most groundbreaking of projects, which substitutes the traditional tractor with a swarm of very small tractors, more or less the size of a kennel, which are delivered to the fields by a special trailer that then collects them at the end of the workday. Call sign: Xaver. In an autonomous yet coordinated manner, the mini tractors can perform all operations not like a single machine, but exactly like a swarm.
The whole operation is performed under remote control using a tablet, with the support of the data saved on the cloud.

Alberto Scalchi

Autonomous driving? **Honda** R&D Americas has developed a universal vehicle equipped with Gps and sensors, it can either be guided or it can operate independently even in adverse contexts. The chassis is equipped with rails to which any kind of load or specific gear can be fixed.

AUTONOMOUS ACROSS THE FIELDS

Volvo is trying out a second generation of the autonomous dumper HX02, which is able to reduce CO2 emissions and TCO by 25%.
Even more groundbreaking is the CE Zeux Concept, a project that has brought together Volvo and none other than Lego.
It is an excavator driven by four engines of 25 kW each and with two 30 kW engines to operate the arm. The overall operating mass is 13,000 kilos, of which as many as 1,500 are only for the 150 kWh battery, which ensures an autonomy of 4-5 hours of work. The real revolution, however, lies in the structure of the vehicle. Four isodiametric wheels with Ackerman steering geometry on each of them and the possibility to lift the vehicle’s centre of gravity (and therefore the bucket) during the unloading process but also to lower it during the work process while loading. A movement that is achieved thanks to a scissor hinge on the chassis.
Another special feature is the video camera used for remote driving which is located on top of a support and can move in the viewing direction to establish visual contact with the people who are operating in the proximity of the excavator. Furthermore, to provide a perfect picture of the operating context, a drone is constantly flying in the vicinity to control the area surrounding the excavator.

FPT INDUSTRIAL C16 1000

LIFE TO THE FULLEST

Fabio **Rigon**: «For the moment Hi-eSCR is not required. We will decide whether to implement it for inland water and comply with the venture regulations for commercial applications. At the moment it has no after treatment whatsoever»

Be it for the "Diesel of the year" writing on its coat of arms or because of Fabio Buzzi's record, the top of the range of the Cursor family has dived into the water with all it takes to emulate the success of Gregorio Paltrinieri, 1500m freestyle gold medalist at the Olympic Games in Rio de Janeiro in 2016. In Cannes, the 15.9 litre engine has capitalised the invested funding in a heavy duty engine block which has motorised New Holland combined harvesters and the Himoinsa 700 kVA generator sets. High pressure common rail, 2200 bar and Bosch's touch, double waste gate, 735 kilowatt (the famous 1000 horsepower threshold) at 2300 revs and 3500 Nm. The key word is compactness, as it is for the industrial sector, which brings it only one decimal away from the 8V of the 200 series by MTU at the highest comparison level of compactness. The same can be said for the encumbrance, as it is the only one to stand below the 2 cubic metre threshold (second only to Volvo Penta).

Following the water speed record in April 2018, the Cursor 16 in its marine version has met with the press at the Yachting Festival in Cannes. The C16 1000 is FPT Industrial's answer to the demands in the pleasure craft market

We interviewed Fabio **Rigon**, Vice President Emea of the FPT Industrial.

In three words: project, market demands and applications.

The applications are mainly planing boats, however we expect to target some semi planing boats as well. If we consider ten as the unit value, we can say that these applications have a ratio of nine to one.
The project emanated from a dual market expectation. The first expectation relates to raising the bar of power. The C13 can reach 825 hp but we have received requests for more aggressive performances, exactly the direction that we have taken, and we were able to stretch out to the technical and psychological threshold of 1000 horsepower. On the other hand the shipyards are hungry for higher specific torque, to improve planing at low speed. This is the reason why in order to ameliorate the planing and the time to torque compared to the C13, we opted for an increase in the cylinder capacity rather than optimising the thermodynamic performance of the 13 litre itself. It turned out to be a rewarding choice both in terms of development and of market demands.

Are there any similarities between the engine blocks?

The majority of the components have an off road origin. The most striking improvement concerns the extension to 600 hours in the oil change interval. In order to obtain this extension, we have improved the combustion chamber calibration and introduced a highly efficient blow by system. The engine block is the same, the cylinder head in CGI, compact graphite cast iron, the crankshaft and the pistons are entirely in C38 steel, the rods in C70 steel. The engine's propensity towards heavy duty can be appreciated also in the crankshaft and bearings, rods, steel pistons and rings as well as the oil capacity and hydraulic circuits with sea water pump, with a professional bronze body and impeller.

To conclude…

In order to increase durability, apart from using a sturdy combine harvester engine block and the crankshaft and steel pistons, we adjusted the water, air, oil and diesel circuits. We changed the heat exchanger, reviewing its size, to improve the heat exchange (in order to increase its duration, the engine must stay cooler), the material of the inlet pipes which are anodised, and we have substituted the air filter, now the external body is in epoxy material which renders it more resistant to salt and humidity. Another important modification concerned the introduction of twisted rods, resistant to dirt, water and mud.

Fabio Butturi

FABIO BUZZI AND THE C16

Since March 7th 2018, lake Como has no longer been associated only with gossip regarding George Clooney. Fabio Buzzi, on board a three-point hull by FB Design, was able to break his own previous speed record on water, established in 1992. Driven by a hyper-performing revision of the Cursor 16, he reached 277 km/h.

How have you optimised the Cursor 16?

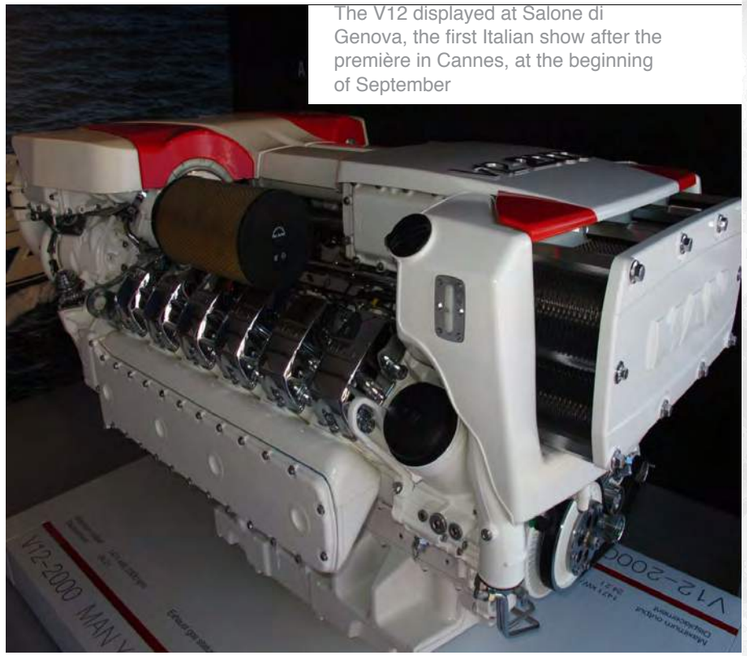
We installed two variable geometry turbines, one master and one slave, in order to obtain the maximum in terms of response and acceleration.

And besides the double Vgt?

The distribution is not on the front end, but on the flywheel side, therefore all rotational complications of the crankshaft do not fall on the distribution.
The engine block no longer has six or seven separate supports, but like modern racing engines it is divided into two horizontal planes, in order to lock the engine block and to make it considerably more rigid. When the combustion pressure is so high, the push on the rod can be problematic.

MAN ENGINES. V12 IN DETAIL

WELCOME TO 2000



The V12 displayed at Salone di Genova, the first Italian show after the première in Cannes, at the beginning of September

Man V12-2000 for marine applications. We met Matthias **Schreiber**, Head of Man Engines, in charge of engine and components division of Man Truck & Bus since January 2018.

What are the improvements to the injection system compared to the one previously used?

We have had very good experience with the 1,600 bar injection system we currently use in our latest V engine range. So, to achieve a higher power output of V12 (as well as the newly presented V8-1300, by the way), we changed the injection nozzles. Thanks to their new design we achieved higher injection rates. This in combination with further improvements in the ECU management helps to get fuel faster into the combustion chamber, which increases the performance of the engine.

Newly developed cylinder heads, what are the most significant changes?

We developed from scratch the cylinder heads for both engines but avoided changes of the geometry regarding air and exhaust gas routing parts of the engine. Our improvements primarily focus on thermal dissipation and better ways to cool the cylinder head.

New crankcase, can you specify which areas have been reinforced and which benefits have been obtained?

Man has raised the bar of its top of the range for pleasure craft. Reaching up to 2,000 HP (1,470 kW) needs more than a restyling. In Augsburg, R & D engineers achieved higher injection ratios, replaced nozzles, developed new cylinder heads, reinforced the crankcase

We did not change the external geometry, but strengthened the structure of the crankcase, which gives us more stiffness better suited for the high output of the engines. This general update of the cylinder block supports the high demand of great quality at MAN Engines.

Updated cooling system: What does that mean?

As you remember, we have talked about the modified turbo charger and injection nozzles, that help us to reduce the exhaust gas temperatures by approx. 20°K. In other words: if we had no improved exhaust gas temperatures, we could not have reached 2000 hp due to the high component load. The improved cooling capacity has no negative impact on fuel consumption. **L.H.**

WALVOIL. FPTS & SXP

BORN TO BE WISE

Davide **Mesturini***: «I talked about 'wise innovation', to highlight the need to understand what market is actually able to accept, how to measure the technical innovation and customize solutions tailored to specific needs»*

Based in the heart of Emilia motor valley, in Italy, Walvoil is a manufacturer of hydraulic valves and mechatronic systems. Knowledge is the core of the company's know-how, both in terms of disclosure and development of innovative products. Following its participation in Aachen, the Interpump Group company also play its part to the Fluid Power Society of India annual conference held in Bangalore, in India.

Following some excerpts from the conversation with Davide **Mesturini**, Research and Development Manager at Walvoil (on the left in the picture). «*We often think of 'disruptive' innovation, reason that led me to rock the boat of FPTS 2018 audience. In the last 20 years, especially in the academic field, oleo-dynamic components future challenges are listed but have still remained largely unchanged. More than 15 years ago oleo-dynamic distributors with high electronic integration and truly disruptive innovative contents were presented on the market. However, they have not achieved persuasive commercial successes because the market hardly incorporated these innovations*».

'Wise innovation' was the main theme of Davide Mesturini, from Walvoil, at the FTPS in Bangalore, India.
At Eima International in Bologna the company presented SXP, an innovative hydraulic directional valve

You mean wise instead disruptive?

«*I talked about 'wise innovation', to highlight the need to understand what market is actually able to accept, how to measure the technical innovation and customize solutions tailored to specific needs. I highlighted this danger in reference to the risk of technicians to pursue objectives of maximizing performance at the cost of excessive sophistication. Technologies and know-how availability makes possible large evolutionary steps, but the real challenge lies in knowing how to adapt innovation proposals to market contexts. To give you an example, rental market spread partly influences machines evolution, often putting the economic logic behind the performance. The 'wise innovation' meets the challenge of adding innovation, optimization from the point of view of efficiency and energy savings, respecting costs levels, simplicity and reliability sustainable by the market*»

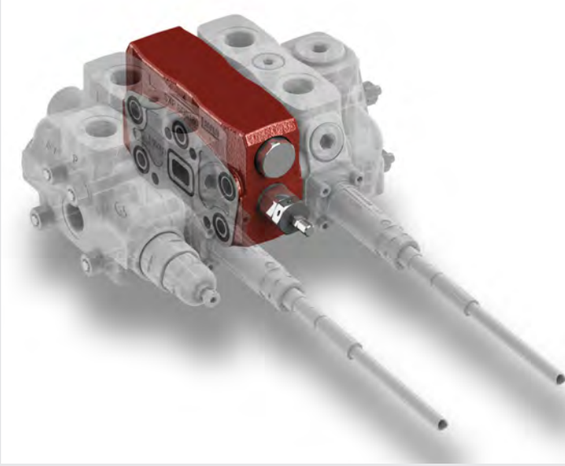
Latest trends in fluid power?

«*This congress is a Fluid Power Society of India at the Pes University organization, involving the Indian academic and industrial world. The issue, "Latest trends in Fluid Power Technology", was attended by about 150 companies. Talking about innovation as Walvoil we have brought to the table four main issues, on which we have been concentrating for years: energy efficiency, reliability, connectivity and customization. As for efficiency, intended as the possibility of energy recovery and storage, on an innovative system for the control of the pump and the dragging loads. A compensator control the descent through a compensation into the discharge orifice and sends the oil back into the circuit. Actuator movements take place through dragging load regeneration and recovery. Our test department has experimentally tested the circuit solution, previously optimized during simulation: a physical sample has been assembled on a Front Loader to highlight the system regeneration ability, thus recovering energy during movements with driving loads. Together with the University of Parma we have instead faced the optimization of the oleo-dynamic circuit of mini-excavators, concentrating on the recovery of energy from the rotation of the turret and the lowering of the excavator arm. The fuel savings recorded are in the order of 15%*».

Dante Ferrari

SXP: THE DIRECTIONAL VALVE

Walvoil SXP is the smart landmark in the hydraulic directional valves scenario which includes both circuits in one only solution: Parallel and Series. Stable operating conditions, universal application in the 'body' of any device patented by Walvoil or customizable on request, ease of use, are some of the levers with which the Walvoil SXP will try to make a breakthrough in the heart of worldwide construction, lifting, tele handling and agriculture OEMs. The 'fulcrum of the switch' is a logic element, included in the circuit and a series of connections. In addition to the logic element Walvoil inserts a sequence valve in the circuit. When the pressure value reaches the set value of the VM relief valve the logic element changes position and it remains in this position even if the pressure value falls below the calibration of VM. In traditional series circuits, during the simultaneous operation of two functions (typically lifting and bucket), if the cylinders of one function reach the limit switch, the cylinders of the other also stop. This is one of the main problems affecting these circuits, as well as adding up the pressures of the two functions, thus limiting the maximum load capacity. On the other hand, the parallel configuration, always for example with the same simultaneous movement, does not guarantee a correct distribution of the oil flows, and makes it difficult, if not impossible, for the movements to take place at the same time.



BONFIGLIOLI ELECTROMOBILITY

A NEW PROCESS HAS BEGUN

The implementation of Industry 4.0 technologies enables the optimisation of the entire production process

2018 December 12, Bonfiglioli inaugurated a brand new line of production entirely dedicated to electromobility, just next to their historic manufactur-ing centre in Villa Selva, Forlì.

The newborn hub, spread over an area of approximately 1**0,000 square metres**, has been designed for the production of innovative geared units, from gearmotors to electrical axles for powertrain of various sizes. An investment of over 10 million Euros, the new facility implements full led lighting, a rooftop photovoltaic plant in self-consumption mode and a system for heat recovery from industrial compressors.

The implementation of Industry 4.0 technologies (anthropomorphic robots, autonomous vehicles, interactive working instructions systems and full data connection systems) enables the optimisation of the entire production process without compromises in terms of industrial flexibility; innovative testing benches (such as those for double vibration tests) guarantee high quality standards.

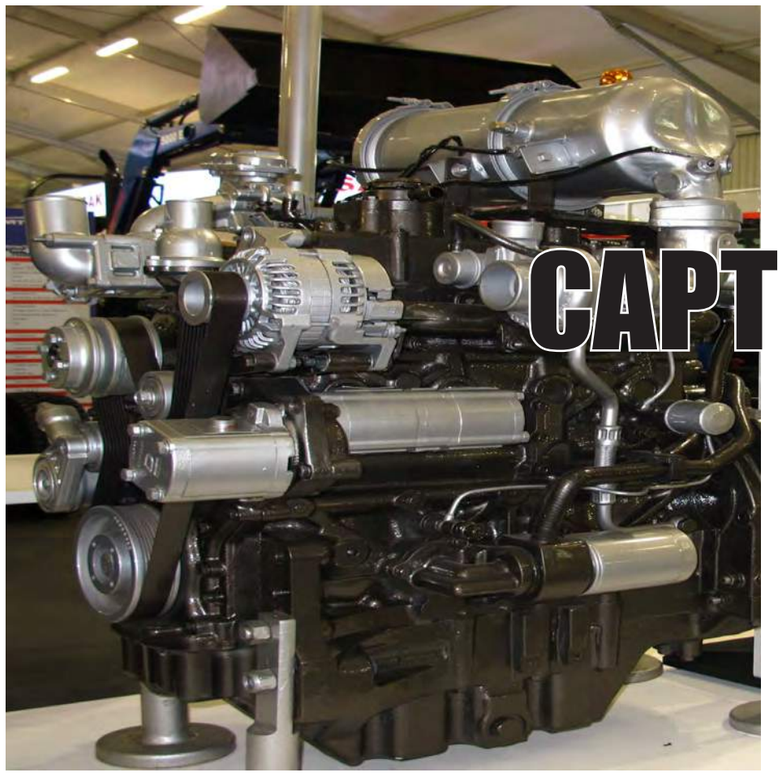
Next to the historic factory in Forlì, between Bologna with Lamborghini and Rimini with Fellini, the new Electromobility division was unveiled last December by Bonfiglioli Mobility and Wind Industries. 10,000 square metres for the production of electric geared units

The financial figures and growth forecast validate the festive atmosphere of the opening ceremony. The '**Mobility & Wind Industries**' business unit closes the year 2018 with a record turnover of approximately 550 million Euros (corresponding to 60% of the total turnover of the Bonfiglioli Group), with a 15% increase compared to the previous year. Of these 550 million, as much as 300 have come from the Forlì hub: an important indicator of the strategic relevance of the Villa Selva factory. These numbers are expected to grow exponentially in the next ten years, going from the current 5% of total vehicles sold to 48% by 2030. **D.V.**

ESCORTS TRACTORS AND KUBOTA have announced a jv for the production of utility tractors (initially 50,000 units per year). Will there be room for the Kubota engines?

ESCORTS TRACTORS - FARMTRAC

BETWEEN CAPTIVE AND FREE



At Eima International we asked Rajiv **Wahi**, head of International Business at Farmtrac Tractors Europe and Shakti **Kumar Singh**, DGM Engine Design & Testing, which engine strategies the Indian group is following.

How are Farmtrac and the Escorts group responding to the differentiation in the engine approach?

We are gradually shifting towards Perkins engines and our own manufactured engines, Stage V compliants and competitive both in terms of performance and cost. Currently, in the range between 14.7 and 25.7 kilowatt, we use Mitsubishi. We will continue to sell these engines until 2020. Perkins is our partner for the homologation to European standards.

We have the production capacity for approximately 150,000 engines per year. In India we manufacture tractors for 63 markets, in Poland we concentrate the production for the European market.

Farmtrac is the European outpost of New Delhi based company Escorts Tractors. Perkins for the highly regulated markets, Mitsubishi for compact engines. But captive engines are catching on, compliants with Stage V emission regulations

What about Stage V?

For some time now we have adopted water cooling systems, common rail and cooled EGR for the Tier 4 Final, and we have implemented on-board devices with temperature sensors, DOC and DPF, as well as SCR, when needed. The final goal is to limit the diesel consumption, in order to offer our clients a good TCO.

And regarding alternative fuels?

At Agritechnica we presented an electric tractor with built-in central mowing system. It should be on the market by the end of 2019. We are working on solar technology, also for agricultural applications, with 2027 as our focus, to provide new solutions for the future of agriculture. **Franck Billy**

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QUOTE

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