The Magazine for the materials handling professional







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# POUER PACK PROBE

Which is better: lead-acid or lithium-ion?



**5G or not 5G?** What does it mean – and why does it matter? Keeping your core asset in shape Tips for a fit, happy, healthy and efficient workforce Burning issues IC engine forklifts are here to stay

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The theme running through this issue of Eureka is 'power': the power sources used by forklift trucks; the power of advanced technology; and the human power that businesses depend upon. Knowledge is another essential source of power - and one which Eureka aims to generate with its information and advice.

In our opening and closing features, Mark Nicholson examines lift truck power issues. His first investigation compares advantages and disadvantages between lead-acid and lithium-ion batteries. There are many factors to consider, with each battery category offering a variety of innovations and product choices.

His other feature focuses on IC engine forklifts, whose continued technological improvement is driven largely by emission legislation. We find there is still a heavy demand for these trucks, which are ideal for many applications.

Assessing 5G and 'Edge' computing technologies, Ruari McCallion explains what they are, what they can contribute to materials handling and why you should consider them. The automated warehouse of the future may be closer than you think.

You may have the best-equipped operation in the world, but where would you be without good workers? Gian Schiava has gathered some ideas on keeping employees happy, healthy and productive - and not losing them to your competitors.

We hope the knowledge you gain from these articles will benefit you and your business. Please contact us with any feedback, questions or suggestions of further article topics. You can email comment@eurekapub. eu or message us via our website www.eurekapub.eu



Monica Escutia Commissioning Editor



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## LEAD-ACID AND LI-ION BATTERY BENEFITS COMPARED

Which is the better choice of battery for an electric forklift truck: lead-acid or lithium-ion? The answer depends on your application and your priorities. Mark Nicholson summarises the pros and cons, and finds out why lead-acid is still the most popular choice.

While lithium-ion (Li-ion) batteries promise exciting new possibilities, lead-acid technology has also continued to develop and has plenty of innovations to offer. Leading materials handling equipment manufacturers like Cat® Lift Trucks study the available technologies and choose optimum solutions for users today. Li-ion may be specified more frequently in future Cat® products, but at present lead-acid is considered the best option in most cases.

# THE CONTENDERS

The choice is not just between Li-ion and leadacid. Within each of those broad categories there are many different products to consider, with widely varying capabilities. A simplified summary follows.

### **FLOODED LEAD-ACID BATTERIES**

This is the traditional type which powers most electric lift trucks. Its lead plates, which act as electrodes, are suspended in a sulphuric acid electrolyte

### **SEALED LEAD-ACID BATTERIES** These are sometimes known as valve-regulated lead-acid (VRLA) batteries. To avoid the need for topping up with water, and the risk of acid leaks, the electrolyte is securely contained. There are two main types:

- Gel batteries with electrolyte forming a gel
- Absorbent glass mat (AGM) batteries with electrolyte held in a fibreglass mesh between the plates

The AGM category of sealed batteries has seen many recent advances. Developments have included using purer lead for the plates, making the plates thinner or enhancing them with carbon or other substances. To save time, we will simply refer to these as 'advanced AGM batteries'. Importantly, some of them can match or improve upon certain advantages previously considered unique to Li-ion.



Sealed lead-acid battery



### **LI-ION BATTERIES**

This battery type, benefiting from the high electrochemical potential of lithium, is also sealed. Its positive electrodes are made from lithium compounds such as lithium iron phosphate or lithium nickel manganese cobalt oxide. You will see these in the names and descriptions of Li-ion batteries. The specific compound chosen has a large influence on each battery's cost, performance and lifespan. A key feature of all Li-ion batteries is their electronic battery management system (BMS). This is essential to prevent overheating, overloading, excessive discharge and other potentially damaging or dangerous conditions. ►►





Li-ion battery

# HOW THEY COMPARE

### POWER AND ENERGY

Energy density, in watt-hours per kilogram or per litre, is a measure of how much energy a battery of a specific weight or size can hold. A battery with high energy density can hold a lot of energy and give a long runtime. Battery capacities can also be measured in amp-hours.

Power density, in watts per kilogram or per litre, is a measure of how rapidly the energy in a battery of a specific weight or size can be delivered. A battery with high power density can reliably drive and maintain the high currents needed for heavy duties.

Li-ion batteries have very high energy and power density, so they can store and deliver a lot of energy while taking up little space. Along with runtime and performance advantages, this may allow greater design freedom as the truck's shape need not be so heavily influenced by that of the battery. For counterweighting, heavy materials may need to be added to compensate for the lighter battery.

With their bulky construction traditional flooded lead-acid batteries have a relatively low energy density. However, they do have a high power density, enabling rapid supply of high current for heavy-duty applications. Gel and standard AGM batteries have less capacity, but there are advanced AGM products which are equal or superior to flooded lead-acid in storing and delivering energy.

### CHARGING

Flooded lead-acid batteries need to be charged for several hours at a time, while gel and standard AGM types may take a little longer. For forklifts in continuous operation, this means changing the battery after each shift. Timing of recharging is critical for most leadacid batteries. If they are recharged before discharging to about 20% of capacity, their lifespan will be shortened. Note that lead-acid battery performance can be improved by using intelligent chargers which avoid under- or overcharging, lower consumption, reduce gassing and prolong lifetime.

Li-ion batteries can be opportunity-charged at any time - during a lunch break, for instance - without losing performance or longevity. The

same is true for some advanced AGM products – but note that in their case it is a convenient. option rather than a necessity. With most Li-ion batteries, you absolutely must make sure those regular short recharges happen.

Opportunity charging can be delivered via strategically placed electric points, so no time is wasted driving to and from a charging room. If enough recharging time is allowed, there is no need for battery changes.

### MAINTENANCE

Maintenance of Li-ion and sealed lead-acid batteries is virtually zero, as they require no topping up with water. Flooded lead-acid batteries need to be checked and topped up regularly, although use of the right charger will lengthen the interval. Some battery products are specifically designed for longer intervals, while automatic top-up systems for use during charging are another option.

Maintaining back-up batteries is a key issue with flooded lead-acid cells, as they lose their charge quite quickly when not in use. They may need to be recharged every few months to avoid damagingly low charge levels and to ensure they are ready for action. A cool battery storage area is needed for this. The latest advanced AGM batteries can be stored for up to two years before recharging is needed. Charge storage life for Li-ion is even longer.

### SAFETY

Flooded lead-acid batteries are a potential source of acid spillage and of unhealthy acid aerosols in the air. They also produce explosive gases while charging, so a well-ventilated charging room and careful practices are vital. There are no such problems for Li-ion and sealed lead-acid batteries. Li-ion and advanced AGM technology also minimises the need for battery changes, with their associated risks, although investing in the latest rapid battery changing equipment can reduce those.

It is worth mentioning that Li-ion batteries can generate very high temperatures if their electronic controls fail. For safety, as well as damage avoidance, full discharge should be avoided, and no machine should be left unattended with a fully discharged Li-ion battery.

### LIFESPAN

Figures for battery longevity - measured as the number of discharge and recharge cycles they can provide within their service life - vary greatly between products. In general, flooded lead-acid batteries live a bit longer than sealed lead-acid but with advanced AGM products the difference is less. Li-ion batteries last a lot longer than others, although it seems like lifespan predictions for Li-ion are shortening. Difficult working conditions may also shorten their lives.

### RECYCLING

Almost all materials in a lead-acid battery can be recycled - and sometimes even sold at a profit. Li-ion batteries are currently much more difficult to recycle. One possibility being explored is to give them a second life, in a less demanding application, when they are no longer fit for their original forklift role. There may be major issues when everyone is struggling to recycle hundreds or thousands of Li-ion forklift batteries.

### ENERGY EFFICIENCY

Flooded lead-acid batteries need to be overcharged by 10 to 20 per cent to help maintain an even distribution of acid and reduce deposition of lead sulphate on their plates. Sealed lead-acid batteries require less overcharging, so their energy cost is lower. Li-ion batteries are even more efficient, as they have no such requirement.

### **TOTAL COST OF OWNERSHIP** (TCO)

Li-ion batteries have a much higher purchase price than others. You will also have to consider the cost of additional charging points, and you may need to invest in upgrading your electrical infrastructure to handle Li-ion chargers' higher

The latest Cat® electric hand pallet trucks feature a 48V Li-ion battery. A full charge takes just 3.5 hours and gives 6 hours of effective runtime. It can also be opportunity-charged, during breaks, without removal from the truck.

> "I don't favour one technology type over another, but rather feel that each has applications it is better suited to than the other. However, I am a little concerned that Li-ion has been somewhat oversold by some people recently. It's important to look beyond the hype and find the battery that's right for you."

Terry Kendrew, Managing Director of UK Cat lift truck distributor Impact Handling

At present, lead-acid batteries are considered the best answer to most forklift users' needs - but truck designers continue to monitor the potential of Li-ion technology.

"In a world where reducing carbon footprint has become a daily goal, recent developments in our electric forklift trucks offer a real alternative to customers. Nevertheless, good management of electrical energy is vital to the success of this energy transition. Opposing the use of either flooded lead-acid or lithium-ion batteries does not make sense. The key to success lies in the right combination of battery technologies. The right battery in the right application."

Jean-Jacques Boulet, Marketing Manager of French Cat lift truck distributor Aprolis

CAT

peak demands. Bear in mind, too, that a truck cannot simply be swapped from lead-acid to Liion: someone needs to pay for it to be adapted. The possible disposal cost for end-of-life Li-ion batteries is a further and as-yet unknown expense. Amongst lead-acid batteries, you will pay more for the most advanced products. Whether investing in these technologies makes economic sense depends on how much they will save you in the long term.

Li-ion offers a longer battery lifetime for your money, as well as energy efficiency savings. Li-ion batteries – and advanced AGM products which can be opportunity-charged - save on forklift downtime and the cost of buying and maintaining reserve battery supplies. Li-ion and sealed lead-acid batteries free up valuable space - as there is no need for a special ventilated charging room – while saving on maintenance time. At the moment, there are relatively few cases in which these savings justify the higher purchase cost of Li-ion batteries, but this could change as prices fall.

### Article feedback is welcome: editor@eurekapub.eu

# **SG OR NOT SG? THAT IS THE QUESTION!**

## ADVANCED TECHNOLOGY: 5G AND EDGE COMPUTING FOR WAREHOUSE MANAGEMENT

'5G' – Fifth Generation mobile communications technology – is coming down the road very rapidly. Among the claims made are that it offers some significant improvements for the advanced factory and the potential for an automated warehouse. It offers lower latency, faster reaction and the opportunity for Edge computing that can provide greater local control. **Ruari McCallion** cuts through the jargon to the heart of the matter.

It seems that hardly a year goes by without the emergence in business of a new acronym or buzz phrase. The two that are supposedly 'on everyone's lips' now are '5G' and 'Edge computing'. Naturally, we are assured that they will transform all aspects of business and usher in a new dawn of clean, fast, transparent, hands-free operations.

History and experience tell us that such claims are rarely matched by the reality.

The ongoing pressures to produce faster, with fewer errors, and to deliver on time, just in time, and definitely in full, with warehouses that are inevitably getting fuller and having to do more, probably with fewer people, make automation inevitable.

However, the other side of the coin is that IT systems are having to cope with levels of traffic beyond those they were designed for, over communications networks that slow down, the more they are used. Sometimes, you can be forgiven for thinking that a runner with a cleft stick would be faster at getting messages to the right destination and confirming receipt. If 5G and Edge computing can genuinely give systems a much-needed boost and make their lives easier, then materials handling professionals will want to hear about it.

### WHAT DOES IT MEAN?

First, let's cut through to what 5G is. It is the next generation of wireless mobile communications

technology, which will use both new radio wavelengths and next-generation software to boost capacity and speed. It will be using shorter wavelengths, which means shorter range, so the mast on the hill two or three kilometres away will not be the source of your 5G signal; it's more likely to be the pole on the street corner above you.

Edge computing is a lot less complicated than some may fear; in some ways, it's a step back into the past. Edge is a "mesh network of micro data centres that process or store critical data locally and push all received data to a central data centre or cloud storage repository, in a footprint of less than 100 square feet," according to research firm IDC.

### **CLOSE TO THE EDGE**

An 'Edge computer' is not a new piece of hardware: it's a description of a connected item. Cars and factory floor manufacturing machinery could all be considered as being 'Edge', as they are producing data. Their data will be transmitted elsewhere for analysis, operational management and to help with process improvement. Often, all the data will go off somewhere else – to a central server, for example. That unit may be in 'the Cloud': an off-site, secure location, operated and managed by IT specialists.

Using the Cloud is a great idea, in the same way that using the bank to hold and securely store your

money is a good idea. But the modern enterprise requires access to its data pretty much 24/7 and it is much more complex than simply paying a bill, receiving a payment or running the monthly payroll. As factories and warehouses become more complex, with more IT involvement, the communications routes become less Information Superhighway than Urban Freeway at rush-hour. Edge reverses the off-site trend, to an extent.

In doing so, it claims to boost communication speeds, shorten response times and make increasingly autonomous automation possible.

If you want to communicate faster, then you have two choices: you boost the capacity of the devices, or you bring the service centre closer. Edge computing employs a 'gateway' that (effectively) triages the information coming into it. Data from IIoT (Industrial Internet of Things) devices will be analysed 'at the edge of the network' (hence the name), before being sent to the appropriate place – the data centre or the Cloud. Or – crucially, for logistics and materials handling – it will be acted upon in the situation.

It is infrastructure that enables data to be processed as close to the source as  $\triangleright$ 



# EVENTS E

## SUPPLY CHAIN & LOGISTICS SUMMIT & EXPO

### **24 - 26 September 2019** The Hilton Antwerp, Belgium With a solid track record of delivering Directors and C-Suite Executives, the EMEA Supply Chain & Logistics Summit & Expo is one of the most established events of its kind in Europe.

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The exhibition is perfect for people responsible for planning, specifying, installing, maintaining and operating distribution centres, warehouses and storage facilities across the UK's supply chain.

www.imhx.net

## **INTERMODAL EUROPE 2019**

### **05 - 07 November 2019** Hamburg, Germany

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### www.intermodal-events.com

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possible. It facilitates faster processing and reduces latency – the time taken for a packet of information to make the trip to its destination and return. It's not that it breaks the laws of physics and transmits faster than the speed of light; it is that it will process data as close as possible to the point of origin, thus reducing the number of steps a packet has to take, and cutting down the distance it has to travel.

### **5G: BIG GENERATOR?**

According to Orange Business Systems, 5G communications are integral to Edge computing, effective digitisation in industry and the exploitation of the potential of IIoT and the Fourth Industrial Revolution. Its higher speeds, shorter latency and greater capacity facilitate IIoT.

A viral news story circulated in 2018, claiming that a mass die-off of birds in the Netherlands was caused by 5G testing. Fact-checking organisation Snopes.com examined the evidence and concluded that the report was false. Full information is available via the following link:

https://www.snopes.com/factcheck/5g-cellular-test-birds/

GSMA Intelligence predicts that the number of 5G connections around the world will have hit 1.3 billion by 2025, covering around 2.7 billion people, or roughly 40% of the global population. What does it mean for logistics and materials handling professionals?

The bandwidth and higher speeds of 5G will enable smart factories to utilise robots more effectively and more responsively; the on-site, smaller and more dedicated data centres of Edge computing can make decisions more quickly.

We are increasingly familiar with AGVs – automatic guided vehicles – but they are restricted to pre-determined routes and tasks; their ability to be genuinely autonomous and to employ AI (artificial intelligence) to learn about their environment and to make decisions is limited by latency. 4G's latency standard is 25 to 100 milliseconds – which is simply not fast enough for AI. Human beings process information when they see it and make decisions accordingly; autonomous machinery has to be able to perform at pretty much the same level. 5G latency is in the single-millisecond range.

It can operate very effectively over short distances, which makes it ideal for operations within factories and warehouses. Genuinely 'smart' materials handling vehicles, unmanned warehouse transportation and automated timeconsuming activities and processes become not just possible but realistic. It also improves the performance of augmented reality (AR) and virtual reality (VR).

### **BREAKING THROUGH** THE BLOCKAGE

We have learned from experience that every advance in telecommunications stimulates more usage – and concerns, both well-founded and unfounded. Allegations in the second category include 'damage to birds' and the old favourite: 'cancer-inducing microwaves'. Both have been thoroughly debunked.



In the former category is the downside about increased efficiency attracting more usage. Consumer traffic provides financial security to telecoms networks but it becomes a problem when it gets in the way of business. The only way of providing distinct segregation with previous systems would have been to physically separate networks.

"Network slicing is a new feature that has become available in 4G and will be available as standard in 5G," I was told by Jean-François Fava-Verde, Innovation Lead - Digital with Innovate UK, and previously head of telecoms at Orange. "It enables multiple virtual networks to run over shared physical networks." The principle of disaggregation can apply with wireless networks.

Orange is introducing a platform designed for demonstrations in the Opéra district of Paris and is conducting technical end-to-end 5G tests in Lille, Douai and Marseilles, running until mid-2019.

Autonomous, Al-operated lift trucks are not yet with us but the enabling technology is being developed, right now, and will be deployed within the next three to four years. It will be worth investigating to see if it meets your needs. •

Article feedback is welcome: editor@eurekapub.eu



## **AN EFFICIENT WAREHOUSE NEEDS FIT WAREHOUSE WORKERS**

Modern materials handling plays an ever-growing role within logistics operations, which in turn are essential for company profitability. Warehouses are being upgraded and modernised to meet delivery deadlines and keep the business competitive, but let's not overlook one particularly vital element. Gian Schiava finds out how some companies look beyond equipment, process and procedural efficiency to focus also on keeping their core asset in top shape: their employees.

To be frank, companies have ample opportunity to give their forklift users or warehouse employees equipment that offers great ergonomics. Drivers in the yard can be more productive thanks to fully enclosed cabins, protecting them from weather conditions, and effort-free controls like fingertip levers. But inside there are even more operatorfriendly developments available.

Order picker trucks minimise the necessity of bending, reaching or climbing with, for example, rising platforms. Highly automated facilities even bring goods to the picker and practically eliminate those endless walks through the warehouse. Futuristic aids like augmented reality glasses and exoskeletons (read Eureka 24) are set to help us even further.



Whilst equipment has made great progress in minimising effort, the market and consumer behaviour have done exactly the opposite. Pressure in the warehouse is higher than ever before, and smart managers are now having to make sure they do more than just create the right environment for their people. They are developing methods and incentive programmes to keep everybody fit, happy and healthy. We have found a few great examples from which to gain inspiration and we have even discovered a real warehouse workers' diet!

## THE CHOCOLATE CHALLENGE

Tony's Chocolonely has become, in just a few decades, one of the world's most renowned brands in chocolate. The company has a very explicit aim for its product (to be100 % slave free and support fair trade), along with a mission statement that sounds very promising: 'Crazy about chocolate, serious about people'. The business does more than most to offer its employees a stimulating and supporting environment.

However, the company also pays a lot of attention to the vitality of employees. Given that the company's chocolate product is not exactly the healthiest of foods, and that a lot of it is

eaten by staff, Tony's Chocolonely has come up with a Stay on Weight Bonus. If an employee's weight has not increased in a year, he or she will receive a small, symbolic bonus. The incentive is completely based on trust: people don't have to stand on scales as proof.

It is designed as a signal that it's important to pay attention to your health. In addition, employees can participate in weekly boot camps, as well as yoga classes, and they can even claim expenses for their sport sneakers once a year.

According to Kristel Moedt, Head of People and Culture. "We also think it is important that employees relax. We make sure that everyone takes at least 28 vacation days a year. And more is certainly allowed." (source: PW) ▶▶



Image credit: ©2019 Tony's Chocolonely Lt Crazy about chocolate - serious about people.

### PLANKING FOR BETTER CARE

If hospital employees are healthier, they are better able to offer optimal patient care. With this in mind, the Reinier de Graaf Hospital in Delft, the Netherlands, organised a Planking Challenge earlier this year. It challenged staff to do this fitness exercise every day for two weeks, preferably with as many colleagues as possible per team or department.

To keep the initiative in people's minds, workers could upload original planking photos digitally. They did this massively; they even shared pictures when they were on holidays. "The Planking Challenge not only ensures vitality among employees, but also builds team spirit," according the hospital. (source: Logistiek)

### **AN ARRAY OF HEALTH SERVICES** AT LOGISTICS PROVIDERS

It is quite common to find well-structured health programmes at companies where logistics are at the core: the 3PL logistics services providers. PKT Logistics Group, for example, offers yoga classes, gym programme discounts, Zumba lessons and weight loss programmes. Employees can declare their workout hours to enjoy benefits like dedicated parking spaces or monthly meal allowances!

Nike offers its workers at the European Logistics Campus a gym, an indoor court, an outdoor football pitch, tennis, volleyball and basketball courts, and an athletics track. Employees can also make use of an on-site personal trainer. These are just two examples, but many other 3PL companies understand that top performance in logistics requires healthy workers. So why not follow their example?

### THE WAREHOUSE WORKERS' DIET

Randstad, a global leader in the HR services industry, recognises that warehouse employees are now working in a fast-paced environment. This employer believes it's important for warehouse workers who do physical jobs to eat well. It lists four areas to focus on when developing a healthier diet:

- 1. Breakfast of champions. Randstad suggests starting with cereals for the fibre and eating a peanut butter and jelly sandwich or mixing yogurt with granola or fruit.
- 2. Think logistics. Here the magic words are mea prepping and bringing along ready-to-go items like bananas, salads in Tupperware boxes, hard-boiled eggs, yogurts or diced fruits.
- 3. Hydration. Hard work makes you sweat, so vou obviously need to stay hydrated. Consider sport drinks with minerals like sodium. calcium, chloride, magnesium, phosphorus and potassium, or just stick to... water.
- 4. Avoid added sugars. (Source: Randstad USA)







### **RETENTION BECOMES KEY**

The boom in e-commerce has led many companies to augment, optimise or strengthen their logistics activity. The other side of that coin is that in many European countries it is becoming increasingly difficult to find qualified employees. The increased digitalisation also means that existing workers have to upgrade their IT skills.

For quite a while now, there has been a battle for talent. Along with the usual compensations, like paid holidays, a decent wage and health insurance, companies must become creative in augmenting their attractiveness. For sure, training and talent development are important, but now those should be topped up with 'happinessenhancing' programmes. Besides, if you offer great fitness programmes, you also save on sickness expenses - which is a double gain.



# A healthy mind in a healthy body

Cat® Lift Trucks is part of a large global family whose me work in different countries with different cultures. Something they all have in common is that each person has just one body and one mind - and they need to take good care of it. The organisation is keen to help employees develop and maintain healthy lifestyles - and drop any unhealthy or risky habits. In the Netherlands, for instance, initiatives include health awareness training, weekly stretching and meditation sessions and coaching for keen runners. Workers at Rocla Solutions Finland's Cat lift truck dealer, are provided with a gym for use during breaks, after work and at weekends, with exercise advice from a professional trainer. Body composition analysis is available to encourage staff to monitor and reduce their fat levels. A wellbeing pilot programme is studying the effects of a tailored exercise and diet programme on three participants – with amazing results so far.

Article feedback is welcome: editor@eurekapub.eu





# THE FUTURE OF IC ENGINE FORKLIFTS

The latest round of new EU emission standards has again focused attention on the challenges facing IC engine lift truck manufacturers and users. With the help of specialists from Cat<sup>®</sup> Lift Trucks, Mark Nicholson looks at current trends and discusses the way forward for this important market segment.



### SALES TRENDS

Between 2001 and 2018, total counterbalance forklift sales in Europe have flipped from 60:40 in favour of IC engine to a 60:40 advantage for electric. However, variations in these percentages between countries suggest major cultural differences in preferred power sources.

At one extreme, electric makes up 82% of counterbalance sales in Italy - up from 73% in 2001. At the other, IC engine forklifts still dominate in the UK - where electric's share has only moved from 32% to 33% over the same period. Further comparisons are shown in Figure 1. Despite the overall trend toward electric, there is clearly a strong and continuing demand for IC engine products. ►



Figures comparing diesel and LPG forklift shares within the IC engine segment are not so easy to obtain. However, it is well known that European customers have always leaned more toward diesel, while Americans have preferred LPG. With its global development and manufacturing base, Cat Lift Trucks is equally well equipped to develop and improve technologies using both of those power sources, as well as electric.

"As the pressure to reduce emissions increases, and as electric trucks become more attractive for other reasons, both LPG and diesel customers are switching," says General Manager, Equipment, Willem de Jong. "Some diesel users may swap to LPG, but most are likely to change directly to electric. The effort of dealing with LPG bottle swapping, storage and refuelling, together with the health and safety regulations surrounding those activities, will be unappealing or impractical to many. It may also seem an unnecessary intermediate step to those who feel that a move to electric will ultimately be inevitable."

### CHALLENGES AND RESPONSES

"Electric trucks are gaining market share largely because of their advantage on emissions," IC Engine Product Manager Carmen van Boeckel comments. "In addition, today's electrics are becoming more powerful, durable and weatherresistant than their predecessors, so they can handle some outdoor roles which previously required IC trucks. They also offer sophisticated electronically controlled features which create an excellent user experience.

"But the IC engine lift truck is here to stay, and we can expect to see continuing technological development in this area. The new Stage V EU emission standards, along with increasing pressure to reduce carbon footprint, are driving further improvements in efficient, clean-burning engine technology. We also expect to see technologies from our electric trucks applied to IC products, including hybridised power systems and additional driver aids."

For LPG engines, the changes needed to comply with Stage V are relatively small and will result in little if any cost increase. For diesel engines it is much harder, and customers will eventually see

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realistic

hundreds or even thousands of Euros added to truck prices, depending on the model.

Willem de Jong adds: "In this new era, diesel forklifts will be more productive than ever, but customers will have to accept that the traditional simple diesel engine has become a thing of the past. Those older, mechanically controlled engines, built on many years of evolution, were well understood, very predictable in their applications and usually extremely reliable.

"The latest Stage V engines are much more sophisticated and fully electronically controlled. They have been subjected to rigorous testing programmes, of course, but they have yet to prove themselves to users in the marketplace. It will be an interesting time for forklift mechanics too, as they are used to maintaining engines without the use of a laptop."

There will probably be a greater demand than in the past for refurbishment of the existing population of older trucks to give them a second or third life. Although simple diesel engines will be phased out and will never come back, they may take many years to disappear.

# WHAT STAGE V MEANS

Stage V is the latest in a step-by-step EU programme to reduce harmful emissions from the engines of non-road mobile machinery. Beginning in the late 1990s, each stage has introduced increasingly stringent emission limits. These particularly target nitrogen oxides (NOx), hydrocarbons (HC), carbon monoxide (CO) and particulate matter (PM).

Stage V sees permitted levels of these substances in exhaust gases cut by about 96 to 97% compared to Stage I. For PM, which consists largely of soot, there are now limits on the number of particles emitted as well as the mass.

56 kW or from 130 kW upward, the new regulations have applied since January 2019. This typically covers forklifts with capacities up to about 5 tonnes or higher than about 16 tonnes. For those in between, Stage V will be implemented in January 2020. Transition arrangements will be in place up to 2022, so there will be no sudden shock to the market.

are amongst the non-EU countries which will probably apply the same standards.



## **CONTINUING IC ADVANTAGES**

Despite the additional cost of complying with Stage V, particularly for diesel forklifts, IC engine trucks will still be substantially cheaper to buy than electric. Rugged IC engine lift trucks will be difficult to replace with electric lift trucks in tough outdoor applications, especially where loads are heaviest.

Both LPG and diesel offer virtually non-stop productivity, as they can be refuelled quickly - in contrast to the time-consuming battery changes and recharging of electric trucks. There is also interest in the ability of LPG trucks to do occasional indoor as well as outdoor work, if local rules permit.

Diesel forklifts continue to score highest on torque - for more powerful performance - and on operating economy. They are also the easiest to supply with fuel in remote locations with no



For engines with a power rating below Norway, Switzerland and post-Brexit UK

To reduce emissions, engine designers will use a mixture of technologies including some or all of the following:

- Selective catalytic reduction (SCR) - uses catalysts like urea or diesel exhaust fluid (DEF) to reduce NOx
- Diesel oxidation catalyst (DOC) - converts HC, CO and some other emissions into less harmful substances
- Ammonia slip catalyst (ASC) - removes leftover ammonia from the SCR process
- Exhaust gas recirculation (EGR) - lowers peak temperature of combustion to reduce NOx and PM production
- Diesel particulate filter (DPF) - traps soot particles
- Exhaust after-treatment system (EATS) combines several of the elements above

Increasing engine efficiency will also help, as lower fuel consumption means lower emissions.

Rest assured, if you buy your forklifts from a reputable manufacturer with a European dealer network, like Cat Lift Trucks, they will comply with EU regulations. If, instead, you import them yourself from outside Europe, you will be responsible for ensuring they are compliant.

It is perfectly legal to continue using older trucks which pre-date the Stage V limits (although in some urban low-emission zones there are separate restrictions on the use of diesel machines). You can also confidently buy from existing stocks of new trucks which predate the new limits. These are only subject to the regulations which applied at the time they were placed on the European market.

mains electricity. They may even have a lower carbon footprint than an electric truck, if the energy used to charge the electric's battery has been generated by burning fossil fuels.

"For many applications, in many areas, switching from IC engine to electric simply isn't feasible - and isn't likely to be a realistic possibility any time soon." Carmen van Boeckel concludes. "Consider, for example, the huge practical difficulties involved in powering a large electric container handler. Or in running an electric fleet in a region which doesn't have the necessary electrical supply infrastructure. We can safely say that diesel and LPG still have much to contribute to the world's energy mix and to the materials handling industry." •

Article feedback is welcome: editor@eurekapub.eu

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