CONTAINER HANDLING & THE CO2 ROADMAP

Ports and terminals all over the world continue to seek ways to reduce their impact on the environment. Port equipment, Reachstackers and container handlers in particular have all been a major area of focus.

This focus on reducing the impact is also driven by an appetite to reduce operational costs. There are increasing demands from (local) governments who have offered incentives to support these new ideas and technologies

With all this investment and innovation, the question of this paper is what possibilities are there today (February 2021) and how should ports and terminals plan their operations to be ready for this future?

We are pushing the boundaries of how ‘clean’ an internal combustion engine can be.

// CONTAINER HANDLING AND THE INTERNAL COMBUSTION ENGINE (ICE) LOVE AFFAIR

Handling containers in the yard have been mainly done using internal combustion engines (ICE). Depending on the application, different machine types handle the containers, such as Reachstackers, laden container handlers, empty container handlers and lift trucks. Nevertheless, they are predominantly diesel, and therefore ICE driven.

But what makes the ICE so dominant as power source? The main benefit is the availability of diesel and the ability to refuel easily. For container terminal operations, constant machine availability is essential, which aligns perfect with the benefits of the diesel engine. When the machine runs out of fuel, it only takes a few minutes to get going again.

However, despite all the benefits of the ICE, there is one element that the industry cannot escape: the fact that ICE equipment uses fossil fuels and combustion to power the truck. This combustion emits exhaust gasses (e.g.NOx, CO2), along with many other industries, there has been a significant drive to reduce these exhaust emissions and therefore the CO2 emissions.

This is where the conversation about the opportunities with electric container handling trucks usually starts.

// CONTAINER HANDLING WITH ELECTRIC LIFT TRUCKS

It seems obvious that electric lift trucks are the answer to move to zero-emissions, as they have been available for decades, right?

Unfortunately, until recently, electric lift trucks have only been commercially viable for trucks handling loads up to about 5.5 tonnes. However, handling a 25-tonne laden container is quite a different challenge, and requires a lot more power and energy.

So where does that leave the industry today? And what is the possible pathway to electrification?

// LOWERING EMISSIONS FOR IC CONTAINER HANDLERS

Over the past two decades, the EU has adopted a series of directives to reduce emissions from (non-) road IC engines. Since 1997 there were various annexes.

The first Stage I and Stage II emission standards were established in the late 90s for diesel-powered engines with a power rating between 37 and 560 kW.

Then in 2004, 2014/26/EC incorporated Stage IIIA, IIIB, and IV emission standards and extended the scope of power ratings for regulated diesel engines.

The latest Stage V emissions standards replaced the previous multi-layered legal framework with one regulation for the whole of the EU, with emissions level targets now extremely “severe”. Stage V was phased in from January 2018 to January 2020 and is now law across the region.

Similar to the Stage I-V emission regulation, North America is following similar paths for emissions control with a Tier system. The latest regulation today in the US is the Tier 4 Final certification (the equivalent of Stage IV in Europe).

Hyster has always been at the forefront of environmental and fuel saving technologies.

STAGE V AT A GLANCE

For engines 130 kW to 751 kW (174 – 560 hp)

The regulations commenced on 1 January 2019 across the 174 to 751 hp (130-560 kW) power category (with an exemption rule that stock of pre-purchased engines for building trucks may be used up until June 30th 2021 and shipped until December 2021). This is typically large 18 tonne lift capacity lift trucks or Reachstackers.

Diesel engines should reduce Particulate Matter (PM) from the exhaust emissions by 90% and Oxides of Nitrogen (NOx) exhaust emissions by 45% compared to the current Tier 4F and Stage IV emissions standards.

The emissions standards for this power category are 0.4g/kW-hr for NOx and 0.015 g/kW-hr for PM. These extremely low levels can be described as 'near zero' emissions levels.

For engines from 56 to 130 kW (75 – 173hp)

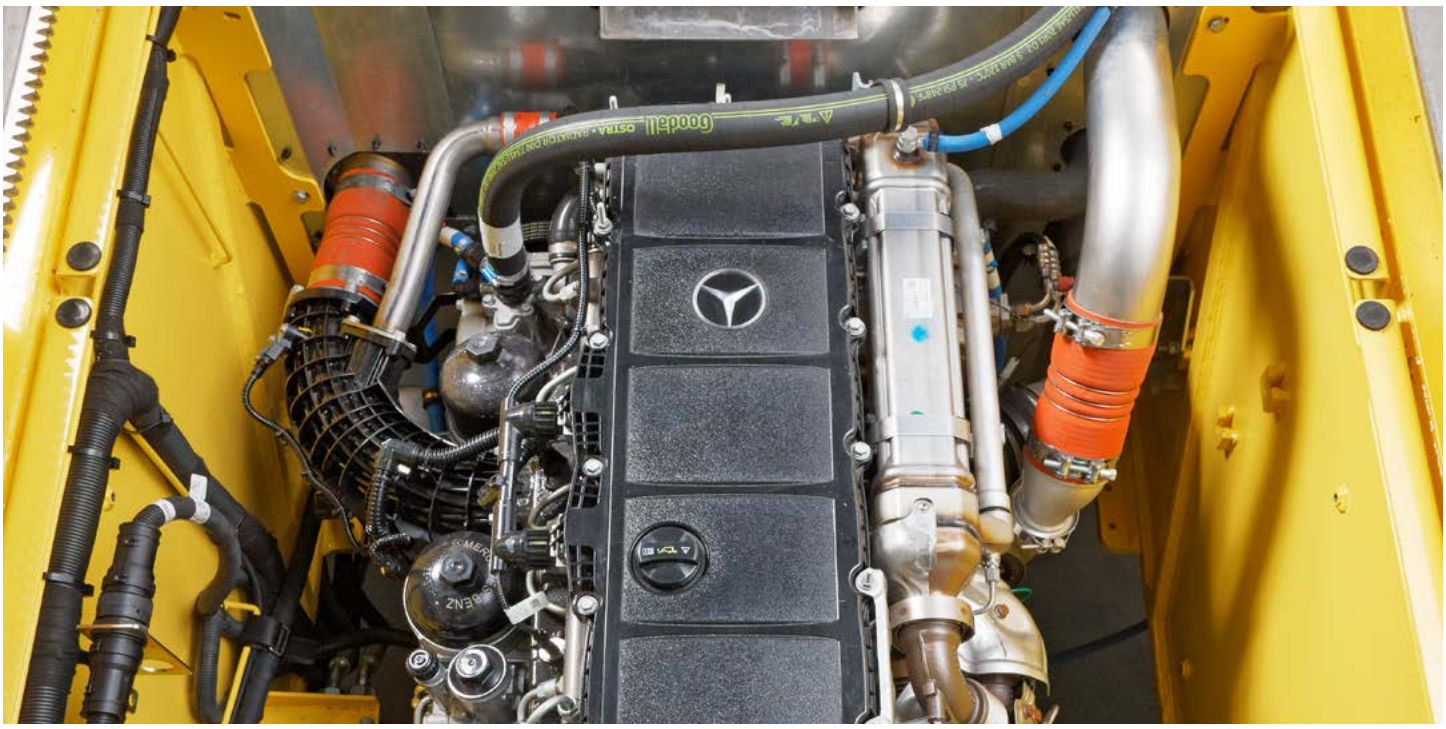
For engines within the 75 hp to 173 hp (56 – 130 kW) power category, the Stage V regulations commenced on 1 January 2020 with an exemption rule to use up stock of pre buy engines to build trucks until June 30th 2021 and ship until Dec 2021.

These are usually lift trucks with capacity of 10T to 18T and the emissions levels are the same as above.

For engines from up to 56 (75hp)

For engines up to 75 hp (56 kW) power category, the Stage V regulations commenced on 1 January 2019.

These are usually lift trucks with capacity of 1T to 9T and the emissions level requirements differ slightly to the above.



// WHAT OPTIONS DO PORTS & TERMINALS HAVE TODAY FOR LOWERING EMISSIONS AND CO2?

Many Stage V machines are available today from different manufacturers. All these engines will have extremely low exhaust emissions, but there are some differences - not on the emissions, but on the implementation of the engine and the vehicle performance.

Furthermore, CO2 emissions can only be reduced by lowering the fuel consumption. Although CO2 is not regulated in the Stage V regulations, Governments and national bodies can force end users to use products with lower CO2 emissions.

So, what questions should ports and terminals ask when selecting Stage V equipment?

1 // WHAT ARE THE PRODUCTIVITY LEVELS LIKE FOR THE STAGE V EQUIPMENT?

Stage V requirements should not hinder an operation. Existing productivity levels should be maintained or improved when machines are upgraded to these latest regulations.

Truck manufacturers that have only focused on reducing emissions and saving fuel, not on the productivity of the truck, can have slow and sluggish machines. This could lead to complaints, poor driver morale, and an inefficient operation, despite marginal savings at the fuel pump.

The approach Hyster has taken on Stage V is to remain the productivity of every Hyster® truck to be exceptional, while having a significant fuel savings too. This provides the best balance for operations, and for drivers.

After all, fast and responsive machines help keep drivers fresh and productive and can deliver up to 12% greater productivity (in the case of Hyster® lift trucks).

A good advice would be to research the performance statistics carefully, and make sure you try the equipment, before you decide to check whether it will suit your operation and drivers.

2 // WHAT ARE THE FUEL SAVINGS?

When comparing two different Stage V machines it is an easy start to compare the actual fuel consumption. However, when both are low and roughly the same, it is important to look further and include productivity in the comparison. Productivity has far greater impact on the overall cost of operation than a small percentage on fuel savings.

A third important factor to include in the comparison is the reliability. A proven reliability is essential in tough applications, as repair costs and replacement parts can soon mount up to a significant cost. This would add up to the costs and impact on the operation when a truck is down.

THE HYSTER JOURNEY

Hyster has met Stage V standards with Mercedes-Benz engines that feature:

- A cooled exhaust gas recirculation (EGR) system incorporated in the engine
- An integrated Mercedes-Benz Particulate Filter exhaust after treatment system

These features work together with a Selective Catalytic Reduction (SCR) and a Diesel Oxidation Catalyst (DOC). The DOC is a component of the after-treatment system that converts carbon monoxide (CO) and hydrocarbons into carbon dioxide (CO2) and water.

The integration of the new Stage V engine results in a new optimised powertrain with a new transmission and torque converter to reduce fuel consumption even further. Additionally, Hyster introduced new features to the truck to meet the latest customer requirements. Torque has been raised in the lower engine RPMs for smoother operation and faster engine response. Cooling on-demand has been developed by Hyster to limit the power consumption of the cooling system. The technology allows fuel savings and reduced cooling fan noise, with a larger overall cooling capacity.

Hyster has always been at the forefront of environmental and fuel saving technologies. Similar to the introduction of the Stage III and IV engines, this Stage V engine will comply to the latest standards and reduce fuel consumption. Additionally, and more importantly, the introduction will maintain the excellent performance and productivity of the Hyster® Big Truck Range.

"We were the first to bring huge fuel savings to the market with our Stage III and Stage IV products, but we did not compromise on productivity. Now with our Stage V range, the fuel savings are significant, and the productivity is exceptional, making this the best balance for operations who want to make real financial savings while improving their environmental performance."

Chris van de Werdt, Product Strategy Manager EMEA Big Trucks for Hyster Europe.

// ELECTRIFYING CONTAINER HANDLERS - PLANNING AHEAD

Many ports and terminals are keen to start their journey towards zero-emissions. There is a growing interest in electrified products and together with equipment manufacturers investigations are started on how to achieve this.

At the time of writing, many development programmes are underway to electrify port equipment, especially Reachstackers and container handlers.

Within Hyster, two main solutions are being developed for handling containers. Production models for these solutions are anticipated in the coming years.

These zero-emission container handling machines use electricity at a high voltage as the main source of energy. The electricity powers the truck using fully electric motors. The electricity is stored in lithium-ion batteries. To recharge the truck, several possibilities are common:

1 // RECHARGING AT CHARGING STATION

This solution is suitable for medium-duty cycles and smaller fleets. A lot of charging power is required for larger electric trucks. To optimise this solution at the location, the right energy infrastructure needs to be available and a strict charge management for opportunity charging needs to be implemented.

2 // RECHARGING USING A (FUEL CELL) RANGE EXTENDER

This solution is suitable for large fleets with 24/7 operations. The fuel cell “range extender” converts hydrogen to electricity to recharge the batteries of the electric truck. The hydrogen can be refuelled similarly to a natural gas fuel station.

Whether the ports have the infrastructure to implement the solutions for either of these options is to be investigated by the ports. Today, many ports and terminals are already starting to plan their future operational needs to accommodate this electrification. The changes require not an “overnight” fix; a proper investigation and investment is needed to be fully prepared. Challenges while facing these changes are different with every option, as elaborated below.

The first option would require the port to have significant power available from the electricity grid to charge large lithium-ion batteries quickly. This charging power must be considered for charging multiple trucks at the same time. Managing peak power demand will be a complex challenge for these operations.

The second option would require the port to have a robust infrastructure for Hydrogen. Sometimes this hydrogen is produced at a local industry, however, several (mobile) hydrogen fuel station solutions are already available on the market.

CASE STUDY 1: ELECTRIC CONTAINER HANDLERS - RECHARGING AT A CHARGING STATION

The first electric Hyster® H1150HD-CH is purely powered by a large lithium-ion battery. The battery can be charged using a high power wireless fast charger. It will be used at a customer in Port of Los Angeles.

The energy recovery achieved by the Container Handlers is achieved using the recovery of driving energy, as well as the full flow hydraulic energy recovery. Energy consumption reductions of up to 15% are expected compared to trucks without these systems.

Patented Hyster® energy recovery systems recover and store energy from lowering loads and braking. The innovative systems help to increase uptime through longer periods between charges, while also helping to reduce the overall energy costs.

CASE STUDY 2: ELECTRIC CONTAINER HANDLERS – WITH FUEL CELL RANGE EXTENDER

The second Hyster electric Container Handler also features a large lithium-ion battery. However, it is re-charged by two onboard fuel cells during operation. This approach better suits the challenges of the test site at another customer in the Port of Los Angeles and other heavy-duty terminal operations.

Continuous operation is possible as long as hydrogen is available from the on-board hydrogen tanks. Even when refilling is required, this is only expected to take around 15 minutes. Additionally, the battery can be charged separately with a charger during lunch and other breaks to minimise refuelling requirements even further.

CASE STUDY 3: ELECTRIC CONTAINER HANDLERS – WITH FUEL CELL RANGE EXTENDER

Hyster Europe is developing an electric ReachStacker featuring hydrogen fuel cells for the Port of Valencia. This truck is part of the European Horizon 2020 programme and H2Ports project. The MSC Terminal Valencia (MSCTV) will be the first in Europe to incorporate these types of hydrogen container handlers in its operations.

Several benefits can already be identified from the early tests with some of the trucks within the previous case studies. The accuracy and control of the lift and drive functions is even better than the IC models. This would improve the operator's handling precision. Furthermore, the noise levels are lower to improve the driver's comfort. Together, these improvements can increase productivity in the operation.

The noise level is also vastly reduced. This is especially important for inland terminals which are close to cities, and, in some cases, may make a big impact in reducing complaints from neighbourhoods, as well as preventing fines caused by breaching noise regulations.

Other early observations are that owners can expect a reduction in energy costs. Also, the company expects reduced vehicle maintenance costs thanks to the elimination of the engine, transmission, and other mechanical-driven components.

// CONCLUSION

A wide range of Stage V container handlers are available today for companies that need to upgrade their fleets to comply to the latest emissions regulations. It is important to take the fuel consumption into account, however, this fuel consumption can never be compared separate from the performance and expected productivity. Hence, a small difference in fuel consumption can mask a large difference in productivity and will only increase the total costs.

For ports wanting a zero-emission fleet in the future, it is important to plan ahead, and get the infrastructure ready for when the first electric container handling trucks arrive. Hyster is eager to discuss availability of these zero-emission trucks! Contact the specialist Hyster® ports and terminals team or contact your local Hyster® Dealer now.

The good news is that testing has so far shown that some of the machines in development offer comparable, or potentially even better, performance to the equivalent IC models and provide excellent energy efficiency and a low cost of ownership. For more information or to discuss plans for your terminal, get in touch with Hyster today.

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