



**More Profit**  
Greater reliability and longer lifetime maximizes your uptime and reduces Total Cost of Operation.

**Lower Operating Cost**  
With longer life and longer Time Between Overhauls, MaK engines cost less to operate with genuine MaK parts.

**Greater Safety**  
MaK engines operated with genuine MaK parts perform longer with fewer unplanned maintenance events or risk of failure.

**Availability**  
All parts can be dispatched within 24 hours through our strategically located distribution centre and delivered globally by our authorized distributors.

**The Power You Need.**

The Cat® and MaK™ brands of Caterpillar Marine offer premier high- and medium-speed propulsion, auxiliary, and generator set solutions, as well as optional dual fuel, diesel-electric, and hybrid system configurations. With the launch of Caterpillar Propulsion our comprehensive and evolving product line gives customers one source for the most extensive engine power range available, as well as for complete propulsion systems, controllable pitch propellers, transverse and azimuth thrusters, and controls. Cat and MaK products and technologies have proven reliability and are built to last in all marine applications, demonstrating superior productivity and the lowest lifecycle cost.

The Cat Global Dealer Network, more than 2,200 global service locations strong, ensures that you will have local expertise, highly-trained technicians, rapid parts delivery, and the proper equipment and services to keep you working – anytime, anywhere.

Construction, term, or repower financing through Cat Financial will help you make Cat and MaK power a reality. With our knowledge of customer needs, local markets, and legal and regulatory requirements, we have been providing tailored financing solutions and exceeding expectations since 1986.

For more information or to find your local dealer, visit our website: [www.cat.com/marine](http://www.cat.com/marine)  
Visit Cat Financial at: [www.CatPowerFinance.com](http://www.CatPowerFinance.com)

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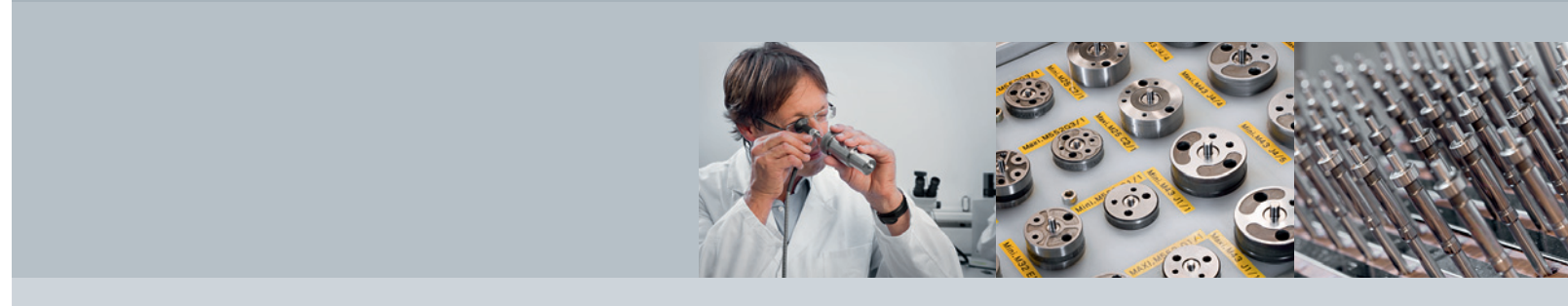
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# Injector Nozzle Elements

## Genuine MaK Parts





# Why Insist on Genuine MaK Parts?

## You Get what You Pay for

Quick access to quality parts is critical for your business – often making all the difference in uptime and staying profitable. Genuine MaK components are designed to function reliably as a complete system.

Our manufacturing techniques are improved continuously to ensure that using original MaK parts enhances engine performance and lowers emissions while increasing reliability.

Genuine MaK parts may often be rebuilt for a second life, adding value to your investment and reducing overall owning and operating costs – benefits you may not get from non-original competitive parts. As you would expect, all emission relevant genuine MaK parts conform to IMO requirements (as applicable), ensuring that your engine remains compliant with the relevant MARPOL Annex VI regulations and EIAPP certification (as applicable). Equally important, all of our MaK spare parts are backed by the Caterpillar Motoren parts warranty.

## Better Engineering, Materials, and Manufacturing. Better Product.

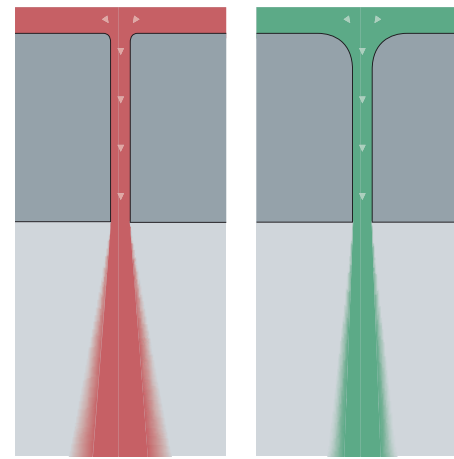
Our high quality materials and final machining processes produce injector nozzle elements that are guaranteed to offer long service life with minimal risk of failure.

Genuine MaK nozzle elements are designed to work with all other parts of the fuel system. The resulting fuel injector spray pattern is a major contribution to an optimal combustion process in the cylinder.

A proprietary MaK after treatment process, developed by Caterpillar fuel system engineers, ensures that the genuine MaK nozzle element produces an ideal spray pattern over its entire design lifetime.

Genuine MaK nozzle elements are designed specifically for reliable fuel injector operation with all recommended fuels and in all approved types and models of MaK engines.

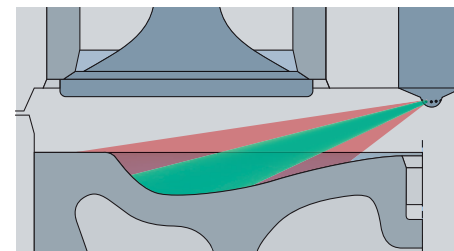
Effect of the rounding process to the spray distribution and droplet size



Non-original nozzle element without after treatment  
Spray angle = 15.3°  
Droplet size = 14.4 µm

Original MaK nozzle element with after treatment  
Spray angle = 12.2°  
Droplet size = 17.7 µm

Effect of the rounding process to the spray distribution in the combustion chamber



Non-original nozzle element without after treatment

Original MaK nozzle element with after treatment

## Where's the Difference?

An original MaK injection nozzle produces a fuel spray pattern that reduces emissions, lowers fuel consumption and also protects the piston from fuel impingement on the crown and liner surface. The optimized heat release reduces the temperature of components in the combustion chamber, thus providing longer life for valves, liners, piston rings and valve seats.

By means of intensive tests the designed manufacturing procedures/techniques were adjusted in a way to meet the best compromise of engine performance data (fuel consumption, smoke behavior) and the thermal load of parts in the combustion chamber (valve, piston and liner temperatures). By doing this the use of genuine MaK nozzle elements provide:

- A more constant pressure and consistent atomization of the fuel over longer time
- A smaller droplet size and optimized fuel spray penetration angle is produced
- A complete combustion process is maintained, with less smoke and lower emissions

The different nozzle parameters like the nominal nozzle hole diameter and length, nozzle hole inlet radii, longitudinal hole shape and others have a huge impact on the spray pattern which in turn influence engine performance data and the thermal stress level in the combustion chamber.

Engine measurements with nozzles whose parameters were modified due to a changed after treatment process revealed the following:

- A deviation in droplet size of 12% and 3° wider injection angle of the fuel, measured with non-original injector nozzles, will result in significant differences in heat release and thermal stress.
- Increased operating temperature of critical engine components means shorter life for injectors as well as potential damage to other components.

Especially the MaK after treatment process ensures an optimized nozzle geometry and therefore reliable and targeted engine performance data.

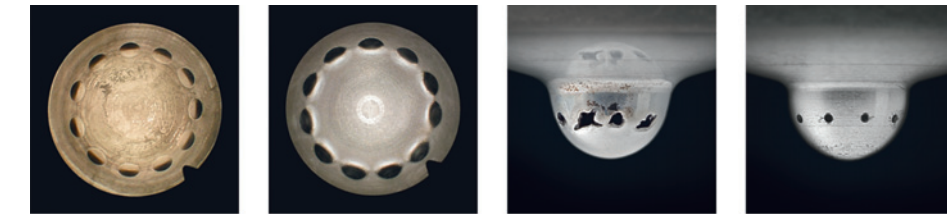
From our experience, using original and genuine MaK nozzle elements can lower cylinder liner temperatures up to 45°C, lower piston crown surface temperature by 30°C, and reduce exhaust valve temperatures by over 35°C.

## What's the Risk?

MaK original nozzles are fluid machined with a proprietary Caterpillar after treatment of the fuel delivery ports, where operating stress is reduced due to the smooth, rounded edges.

Inspection and testing of fuel injector nozzles from a non-original manufacturer revealed a lower level of quality, materials and manufacturing resulting in major deviations from the MaK specifications and original dimensions. There will be higher stresses in the area of the nozzle holes, which at the high operating temperatures can cause complete breakage of the nozzle tip, resulting in consequential damage to the cylinder head and exhaust valves.

Shape of spray hole inlet-ports. Comparison between MaK and non-original nozzle.



The non-original injector nozzle fuel delivery ports without after treatment could lead to fuel nozzle cracks, injector tip failure and consequential damages to the injector sleeve.

A proprietary after treatment process, developed by Caterpillar fuel system engineers, ensures that the final machining of a MaK nozzle element provides a smooth and consistent geometry.

Example of a non-original used injector nozzle from a non-original supplier with damage to the nozzle tip in the area of the atomizer holes and fuel delivery ports.

Compared to a genuine MaK nozzle element after several thousand hours in operation the difference is clear to see.

Using non-original injector nozzles can increase operating temperatures of critical engine components with shorter life for injectors as well as potential damage to exhaust valves, seats, piston rings and turbochargers.

Installing such non-original injector nozzles will lead to a shorter service life with risk of component failure and the potential of consequential damage to other engine components.

Often underestimated, these non-original injector nozzles also result in up to 25% lower fuel flow rates. As a consequence of this, the increased fuel pump delivery pressure will lead to higher mechanical loads on rollers and increased wear on camshafts.

Non-original nozzles do not conform to IMO MARPOL Annex VI, although the IMO marking may be printed on the nozzle.

By installing non-original parts, engine emissions, NO<sub>x</sub>, particulates, CO<sub>2</sub> and fuel consumption can all increase. The customer may lose their IMO certification when using non-original parts since their form, fit, and function will differ from the approved and tested genuine MaK components.



IMO identification MaK type number, e.g. MaK E 2/8



## Longer Life and Longer TBO. Lower Operating Cost.

MaK customers receive additional value for the price they pay. MaK aims to provide our customers with the best combination of reliability, emissions conformance, longest life, and lowest total owning and operating costs available in the industry. Customers will spend less on fewer replacement nozzles and labor and, equally important, will experience less downtime, lower fuel costs, and limited risk of engine failure.

## Faster. Less Expensive. Damage-Free Parts.

Any MaK part can be ordered easily through your MaK dealer.

All MaK spare parts originate from the Caterpillar factory in Kiel, Germany and are delivered through our distribution center located near the major international port of Hamburg. With its close proximity to both the international airport and the port infrastructure in Hamburg, the logistics center makes parts available quickly. In the event a part is not immediately available in dealer inventory, it will be dispatched from the Caterpillar Motoren distribution center within 24 hours.

Optimized packaging of parts ensures protection from damage. We maintain close contacts with logistic partners worldwide who specialize in ground, air, and sea transport, so that each shipment is collected and dispatched as efficiently as possible.

Genuine MaK Parts