profi
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The latest milking robot to be put through the DLG test is the Lely Astronaut A5 in its two-box configuration.

Lely Astronaut A5 double-box robot:

Top power consumption rates

The Astronaut, assessed in our 7/2019 issue, showed the single-box robot to be the most economical milking system we'd tested with the DLG. But there was one result that made us think ...

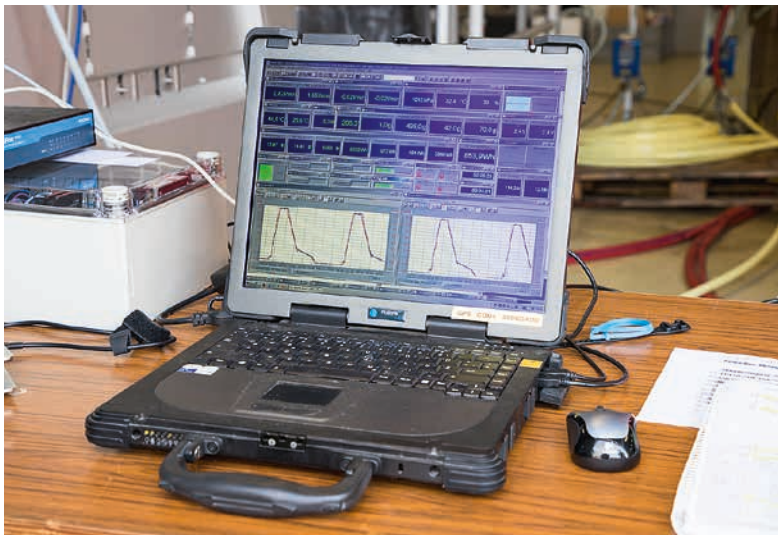
Higher energy prices have an instant impact on dairy farmers. But, as one, do you know how much electricity you're using for milking? To help all dairy farmers get a better grasp of how much water and electricity milking robots demand, the DLG, together with a number of automatic milking system firms, the Bavarian Institute for Agriculture as well as profi, devised a test to answer this question.

Back in 2014, three years after first discussing the idea, the first machine was tested. Lely was the first to take the plunge with its A4 Astronaut (profi 9/2015). Depending on the farm scenario (low-high milkers etc) electricity consumption ranged between 2.3 and 3.6kWh per 100l of milk, while water use was in the region of 26 to 46l.

In 2019, we did more testing with an A4, this time on a farm with 63 cows producing 1,990l per day over an average 2.8 milkings. Water consumption per 100 litres of milk was 38.4l, and the electricity consumption was 2.4kWh. After a service, consumption rates dropped to 33.5l and 2.3kWh.

With this initial on-farm comparison, we could confirm the simulated test was relevant, and that skimping on servicing could increase your running costs.

A Lely service technician was on hand to ensure proper operation during the test.



Different test scenarios were replicated for various milk flows.

Each milking with the artificial udder started with cleaning and stimulating the teats.

Big promises

So why are we talking about previous test results from a machine that was superseded in 2018 with the introduction of the A5? Well, the A4 is relatively similar to the new model, although, to be fair, a lot has happened behind the stainless-steel panelling. Some of these changes were specifically aimed at improving energy efficiency, Lely claiming the A5 would consume around 20% less electricity than its predecessor at the launch.

Reduced air requirement

This power saving is mainly due to a 70% reduction in air consumption, as the A5 isn't as reliant on pneumatic power for moving the arm, which is now done with electric motors. In fact, the A5 is not only noticeably quieter, but, thanks to the new TDS teat detection laser, attaching the cups is also visibly faster. Yet the key question remains: does the new design really provide the electricity savings promised by Lely?

Before we progress to the details, the overall consumption results achieved by the A5 in a double box set-up are the lowest the DLG has ever measured – despite the fact that its figures also include the power needed for the Pura intermediate cluster cleaning. But it is not all roses: its water consumption levels were higher than the previously tested A4.

Lower power consumption

Let's start with the promised 20% electricity saving. Based on 100l of milk in the bulk tank, which is what you'd expect from an average AMS farm (as per scenario 3 in the test), the A5 with two boxes consumed just 1.7kWh of electricity versus 2.6kWh/100l by the A4 – a reduction of 0.9kWh or 35%.

We know from previous DLG tests that auto milking systems in a two-box format require up to 30% less energy than the same make with a solo box. With two stalls and more milkings, the basic energy load is split over a larger daily output.

KEEPING IT BRIEF

This the third time that, together with the DLG, we've tested a Lely robot for electricity and water consumption rates.

The system tested was a double-box set-up with a central unit that supplied the cleaning water, vacuum and compressed air to both boxes.

The measurements took place at the German DLG lab in Groß-Umstadt, with a Lely technician on hand.

The test was split into four scenarios that show how the consumption levels can vary on different farms.

The load per litre decreases

One example of this is the compressor used to supply air to the A5. The DLG measured its basic load was 3.8kWh/min. Sounds low? In the 24 hours, this figure adds up to 5.5kWh; this equals half of the total daily consumption (nearly 11kWh) of the Atlas Copco SF4 running

After milking, the teat cups were disinfected with steam using Lely's Pura System.

The amount of peracetic acid used to clean the brushes was also measured.

HOW THE MEASUREMENTS WERE TAKEN

Lely delivered the two Astronaut A5 milking robots to the DLG test centre at Groß-Umstadt, Germany. The three-day test took place in mid-2021 with a Lely engineer on hand to ensure the units were operated properly.

The standard spec, double-box was using the software version 1.8, which features ISO recognition, meters two types of concentrate and liquid feed and has intermediate cluster cleaning with steam and the 'Hotfill' water mixing valve. The Atlas Copco SF4 FF compressor with diaphragm drier supplied the compressed air to both of the A5 robots.

Measuring scheme

The tests were carried out using UHT milk (3.5% fat), with the measurement standards developed for automatic milking systems following a precise time plan and procedure. Each milking session started with opening and closing the stall gate and simulating the feed being discharged. The robot then cleaned and stimulated the artificial udder, which is equipped with solenoid valves. After the teat cups were attached, the milk flow was not immediately consistent in all quarters – just as in real life. The technology also simulated three different milk flow curves to replicate slow, fast and very-fast milkers,

For fast milking cows, the measuring equipment simulated a maximum milk flow rate of up to 3.5l/min and an 11-litre milking. For slow milkers, the maximum flow was up to 2.0l/min (10 litres of milk in eight minutes). For very fast milkers with a maximum milk flow of up to 6l/min, the test rig simulated a yield of 12.5l.

After removing the cups and opening the exit gate, there was a minute's pause to make sure processes such as pumping were fully recorded. Each of the measurements, which need to be repeated at least five times, took up to 12 minutes.

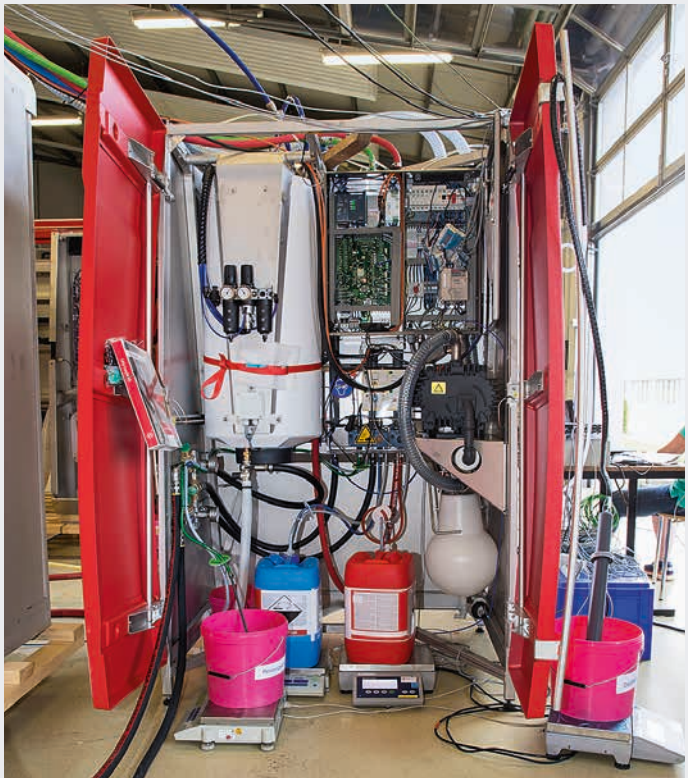
Cleaning influence

Most of the energy/water consumption was at the cleaning stage. There was a main clean, an intermediate clean, an intermediate rinse and a local rinse.

During the main cleaning, all elements that come into contact with milk were cleaned with hot water and a chemical. Since the temperature of the water in the feed line and during the cleaning has a big impact, the measurements were carried out with both 12°C cold and 45°C warm water in the supply line.

Local intermediate cleaning was done with warm water and chemicals, yet this programme only cleans the cups and pipes. The same applies to the intermediate rinse, but this doesn't use any detergent and only cold water.

In addition to measuring the amount of water and electricity used, the test also checked the amount of peracetic acid, acid and alkaline cleaning agents and dips used.



In addition to the consumption of electricity and water, the consumption of cleaning agents was also measured.

in standby. So, if at the end of the day, there is 4,000l of milk in the tank instead of 2,000l, the higher utilisation alone leads to a big reduction in the compressor power per litre of milk.

Speaking of basic load, even if a cow is not being milked, the pair of idle robots will get through 1kWh every hour; this alone adds up to 24kWh. There is also the base load of the internal boiler, which amounts to 2.2kWh.

You also clearly need to account for the power consumed for the machine to wash down. On the two-box A5, for example, the main wash cycle that is carried out with 90°C hot and cold water requires 5.8kWh of electricity. If the water is warmed to 45°C by a plate cooler, this is just 3.4kWh. This means heat recovery saves 7.2kWh/day.

Good management is key

Good herd management will also impact on your running costs. For instance, if a cow is undergoing treatment and all of the plant coming into contact with this milk needs to be cleaned with water and detergent, then simply rinsing the system with cold water is not sufficient because of the significant risk of cross contamination.

Manufacturers like Lely have updated their software to create a 'local cleaning cycle', which only washes the section between the teat cup and the three-way valves. This gives it an initial cold rinse, then uses hot water and cleaning product before finally rinsing with warm water.

The effects of this restricted cleaning cycle are very noticeable. We liked the fact that both robots are no longer occupied at the same time. And according to the test report, the local cleaning cycle only takes half the time – 5.5 minutes – of the main wash cycle. Another plus is that a local clean includes the vacuum pump, compressor and boiler, with the cold water line to the AMS boiler needing just 1.6kWh instead of the 6.4kWh required for the main clean – a handy saving of almost 5.0kWh.

Uses more water

The DLG test also revealed some interesting statistics on water use, the A5 consistently getting through more than the older A4. On the average AMS farm (Scenario 3) the A4 drank 450l per day, while the two-box A5 consumed 1,168l – an increase of 134 litres or 30% more per robot.

In our four different farm scenarios (see the following pages), water consumption was between 27.8 and 51.2l for every 100l of milk arriving at the tank. A poorly managed A5

The A5 uses much less compressed air compared to the older A4. Supplying air to both milking boxes, the Atlas Copco compressor still has plenty to do.

requires 0.5l of water to produce 1.0l of milk. This means vast amounts of waste water. In fact, for a 110-head herd producing 8,500l of milk you are looking at 450m³ of dirty water, which has to be stored and then spread. The additional consumption is partly due to the somewhat longer pipelines when using two milking boxes.

And it's not just the water use that increases; the amount of acidic and alkaline detergent also jumped by 20% compared to the figures from the one box A4 test in 2015. To put some more precise figures on the test, the main cleaning cycle required 410g of alkaline or 365g of acid. Requiring just 90g of an alkaline detergent, the local cleaning cycle also saves precious and expensive consumables.

We also measured the amount of teat dip. According to Lely, dip rate should be 5g per milking, but our test machine actually used 7.3g. However, since the testers used water instead of 'real' dip without calibrating the system to the lower viscosity, Lely suspects that the higher result is due to the thinner liquid.

Summary

Having already tested the Astronaut A4 twice, Lely once again stepped up to the mark and provided us with a double-box A5 to allow the DLG to measure water and electricity use. Both the manufacturer and end users can be satisfied with the final results. On electricity consumption, the A5 is not only lower than the single-box A4 we tested, but is the lowest energy result for any milking robot tested by the DLG to date on behalf of profi.

In Scenario 1, the test uses warm 45°C water from a plate cooler.

Water consumption is also pretty good and comparable with other machines, although it is higher than the aforementioned A4. The higher water consumption is probably the price that has to be paid for a more thorough hygiene regime.

So, the question is, which robot manufacturer will be next to step into the test ring and show what further savings are possible?

Martin Zäh

Dear reader

The milking robot test delivers a vast amount of data. To evaluate this in the light of real-life situations – as we do in the profi Powermix tractors tests – we have developed four scenarios under the leadership of Dr Jan Harms from the Bavarian State Institute for Agriculture and Industry.

These scenarios simulate the consumption rates of Automated Milking Systems (AMS) in four real-life farming situations. Scenario 1 shows the consumption rates in an AMS-optimised farm, while Scenario 2 is at the other end of the scale and poorly organised. Scenario 3 is an average farm, whereas Scenario 4 illustrates how low you can get the consumption figures if management and stock are at the top of their game.

SCENARIO 1
The optimised AMS farm

Scenario 1 is the farm geared up for robotic milking. Here slow-milking cows and those getting treatment are put through a parlour and not the robots. The two-box Automated Milking System in Scenario 1 completes 340 milkings per day – hence usage is excellent.

In all four of the scenarios, both milking boxes undergo the main cleaning process at the same time, three times per day as per the maker's recommendations using chemicals and 90°C hot water. To save on energy, the hot water boiler is coupled up to the milk plate cooler, which warms the water to 45°C.

In addition to the three main rinses., the farm in Scenario 1 needs just one local intermediate rinse with cold water every day. If hot water is available at a reasonable cost, it is also used for the 'hot-fill' rinsing programme, which proves to be more effective on rinsing out fat and protein. To be on the safe side, the cups are disinfected with steam (Lely Pura) after each milking.

RESULT

After 340 milkings, each yielding 11l, there are 3,670l of milk in the tank at the end of the day. For every 100l of milk, the A5 with two milking stalls requires 32l of water and 1.4kWh of electricity. Power consumption during one day by the optimised farm adds up to 50.6kWh. Water consumption amounts to 1,165l/day. The idle time for the two boxes comes in at 64 minutes.

SCENARIO 2
The non-optimised farm

This farm scenario is based on slow-milking and low-yielding cows, so the capacity of the robots is not being fully utilised with just 240 milkings per day. On top of this, no steps are being made to reduce the consumption rates: for instance, cows undergoing treatment are not milked in small groups but mixed with the rest of the herd, meaning that more regular cleaning is needed. A complete clean is done four times per day, and, by not utilising a plate cooler to pre-heat the water, the robot's boiler has to do all the work heating the water from cold.

A longer standstill of the system requires a system flush with water all the way to the bulk tank. This test scenario also includes three local intermediate rinses to flush the milk-carrying pipes up to the end unit after milking 'treated cows'. As with the first farm, the cups are disinfected with steam after each milking.

RESULT

Within 24 hours, the farm in this scenario consumes 57.8kWh more electricity than Scenario 1, but just 2,337l of milk is in the tank. Water consumption is almost on a par at 1,186l/day. Comparing the figures on a per 100l of milk, the farm uses 51.2l of water and 2.5kWh of electric. These are almost twice the figures of those achieved in Scenario 4.

SCENARIO 3
The average AMS farm

The herd is made up of a mix of easy- and fast-milking cows. All milking is done by the two robots. Those cows undergoing treatment are milked separately in a smaller group, which means the farm can get away with just the three main washdowns that are recommended by the manufacturer.

However, there is no heat recovery system so the boiler has to heat the 12°C cold water to 90°C. Each robot gets a local wash and a system rinse once a day. The clusters are disinfected with steam after each milking.

RESULT

Each day there are 3,210l of milk in the tank, which has a cost 55.3kWh of electricity and 1,104l of water. For every 100l of milk, the robot consumes 34.8l of water and 1.7kWh of electricity.

Compared with the A4 robot in its one-box configuration, the two A5s are 0.9kWh (35%) more economical. However, the water use has increased by 25% from 28.0l to 34.8l.

SCENARIO 4
Fast-milking cows

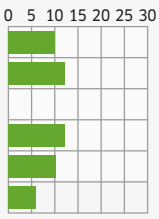
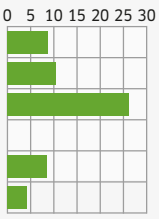
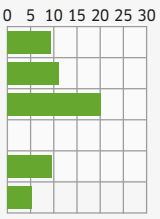
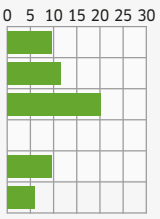
This is the farm where the focus is on high-performance milkers, and over the course of a day the two stalls have done 340 milkings with an average yield of 12.5l with a maximum milk flow of up to 6.0l.min.

Thanks to good management the farm only needs to do three main cleans per day as recommended by the maker. However, the water supply for the boiler is not linked to a plate cooler so it has to heat the water from 12°C. With an Idle time of 82 minutes per day there is enough time for one local intermediate wash. Steam is used to disinfect the teat cups.

RESULT

4,250l reach the tank, and, thanks to the high utilisation and excellent animal performance, consumption is very low. In fact, the results show that it takes just 1.3kWh of electricity and 27.8l of water per 100l of milk. Overall daily consumption is 56.8kWh of electricity and 1,168l of water.

LELY ASTRONAUT A5: CONSUMPTION WITH TWO MILKING BOXES

	SENARIO 1: OPTIMISED USE	SCENARIO 2: NON-OPTIMISED USE	SCENARIO 3: AVERAGE AMS FARM	SCENARIO 4: FAST-MILKING COWS
POWER CONSUMPTION PER DAY (KWH)				
Power consumption (kWh/day) Compressor Vacuum pump Water heater: Heating cold water Water heater: Heating warm water All other system elements Pura intermediate disinfection				
Total power consumption/day	50.56kWh	57.80kWh	55.25 kWh	56.76 kWh
CONSUMABLES USED PER DAY				
Water	1,165l	1,186l	1,104l	1,168l
Peracetic acid	850g	600g	750g	850g
Acidic detergent	548g	730g	548g	548g
Alkaline detergent	614g	818g	614g	614g
Teat dip	2,482g	1,752g	2,190g	2,482g
CONSUMPTION PER 100 LITRES OF MILK (AMS WITHOUT TANK)				
Water	**32.1litres**	**51.2litres**	**34.8litres**	**27.8litres**
Power consumption	**1.4kWh**	**2.5kWh**	**1.7kWh**	**1.3kWh**
Scenarios are based on the DLG measured values and following assumptions:	The calculation of the four 340 milkings/day (AMS-optimised operation, only fast milkers); 3 main cleanings (water heated to 45 °C in heat recovery); 1 local intermediate rinse; system idle time per day: 64min	240 milkings/day (35 fast and 85 slow milkers, poor management); 4 main cleanings (without heat recovery); 1 system rinse, 3 local intermediate rinses; system idle time per day: 228min	300 milkings/day (280 fast milkers and 20 slow milkers, average management); 3 main cleanings with water supplied at cold temperature (without heat recovery); 1 system flush, 1 intermediate flush locally, system idle per day: 193min	340 milkings/day; (top milkers and good management); 3 main cleanings using not pre-heated water (without heat recovery in operation); no system rinse; 1 local intermediate rinse; system idle time per day: 82min

In all four scenarios, the Lely Pura intermediate cluster disinfection with steam was considered.

DATA SHEET

System with two milking boxes	Item number 5.1005.0010-094; Machine software 1.8
Design	2 times right; with I-flow concept; central utility cabinet supplying power, compressed air, vacuum, water and detergent; frequency-controlled milk pump
Milking box power requirement	2.2kW/16A
Utility cabinet power requirement	8kW/32A, 120-litre water heater; 2,400W heating element
Teat cleaner	Two rotating brushes
Compressed air supply	Atlas Copco SF4 FF oil-free scroll compressor with integrated diaphragm refrigerant dryer, 400 l/min at 7.8 bar, 3.7kW connected load
System wash	Chemical, min. 90°C
Options	Lely Pura steam disinfection with 400W heating element, hotfill. Uses preheated water either by a heating system or a heat recovery system; 2 concentrate feed dispensers, 1 liquid feed dispenser
Price in test specification	Approx. €165,000 without VAT

The data sheet corresponds to the manufacturer's specifications.

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