FarmTest
Cattle

61 2009

Power and water-consumption

– with AMS

CATTLE

Dansk Landbrugsrådgivning

Power and waterconsumption with AMS

FarmTest # 61 – December 2009

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Web edition	Merete Charlotte Raft
Publisher	Dansk Landbrugsrådgivning, Dansk Kvæg
Edition	50 pcs. Web edition at www.FarmTest.dk
ISSN	16016785

Dansk Landbrugsrådgivning

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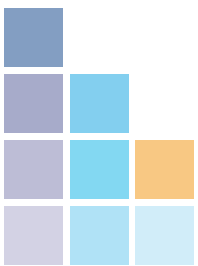
The European Community and the Ministry of Food by the Department of Food Trade Industry have participated in the financing of this FarmTest.

Content



Automatic milking systems (AMS) are found in approximately 880 Danish dairy herds today.

The purchase of an AMS is a considerable investment, and therefore it is important to know the variable costs when deciding which one to choose.

As a consequence of this, Dansk Kvæg ('Danish Cattle' – Danish Advisory Center) has worked out a FarmTest that exclusively focuses on the power and water consumption of the 5 most recent AMS's in the Danish market.

The FarmTest has been drawn up on the background of information from the companies that deal in AMS's. The companies have made references available to farmers with the most recently updated plants and have furthermore co-financed the measuring installations on the test plants.

Danish Agricultural Advisory Center would like to express its gratitude to the dealers for their contribution to the examination, both financially and for their references, and a warm thank you to all the farmers for the time and interest with which they have contributed. Without their help this FarmTest could not have taken place.

Dealers in this investigation:

- DeLaval A/S
- GEA WestfaliaSurge A/S
- S. A. Christensen A/S
- Agripartner ApS
- Lely Scandinavia A/S

This report can be seen at www.FarmTest.dk.

FarmTest

1. Résumé and conclusion

The optimal financial utilization of the AMS is high capacity utilization.

The target has to be good utilization of the AMS.

Power and water consumption for the main cleaning is constant, irrespective of the AMS capacity utilization, and a higher yield per cow will not cause any significant extra consumption per milking, so a couple of minutes' longer milking time has very little influence on the consumption of resources.

For the high capacity utilization to succeed, the following criteria must necessarily be fulfilled.

- High milk flow
- High yield
- A relatively low number of milkings
- Controlled cow traffic to avoid rejections
- Good visiting frequency to the AMS.

Significant factors for fulfilling these criteria are e.g. breeding, feeding and operational management. As some farmers express it: it is a matter of breeding "robot cows", but it is also important that heifers and new cows get an adequate adaptation period for the robot. Feeding is controlled so that there are activities in the barn 24/7, and cows that do not get used to visiting the robot have to be culled.

Only few dairy farmers focus on the utilization of the capacity, and the explanation for this is that the more cows that visit the robot of their own free will, the less the stress level of the herd will be.

Furthermore, for many farmers the investment in an AMS is not a question of eco-

nomy, but rather seen as an investment in improved life quality. Independence of fixed milking times and labour and the opportunity of being able to give priority to every day life are rated higher than the economy. But targeting good capacity utilization means optimising the economy of the AMS.

Even if it can be difficult to reach the maximum capacity utilization, it might be a good idea to listen to those who do reach it – HOW DO THEY DO IT? The more kg of milk that run through the robot every 24 hours, the better the economy of the power and water consumption.

1.1 Measurements

All measurements are made in close cooperation with the companies, and a standard of reference has been made in spite of the fact that no two plants operate in the same way.

Things that matter for the herds tested are that if pre-heated water is used, this consumption has to be measured separately, so that comparability becomes as real as possible.

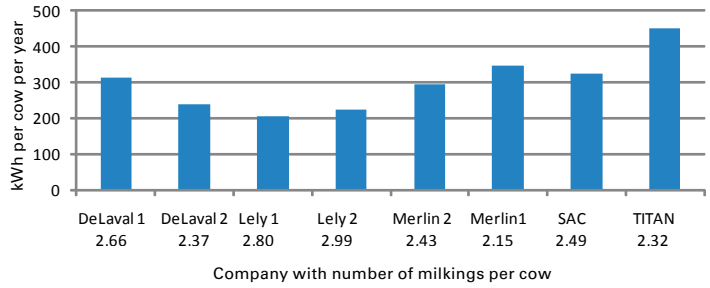


Figure 1: Power consumption measured per cow per year.

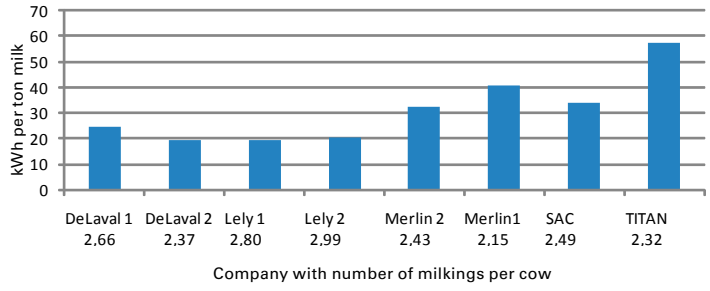


Figure 2: Power consumption measured per ton milk.

The very first measurements caused some obscurity as far as comparability was concerned, and were thus lacking a real expression of what representative installations are today. Consequently some plants had to find new test hosts, and therefore new measurements had to be made.

Measurements of TITAN (see section 3) were made in an ecological herd in the summer period where the cows were grazing, and consequently there has not been the same visiting frequency as can be expected in the winter period. Lely 1 is also from an ecological herd, but here the measurements were made in the winter period. All other herds are conventional.

Only SDM herds (black-and-white Danish dairy cows) were tested.

1.2 Power consumption

The difference in power consumption per cow per year (Figure 1) in the AMS's tested is about 250 kWh per year. With an electricity price of DKK 0.80 per kWh this means extra costs of about DKK 200 per cow. In the same plants differences of between 10 and 30 % have been measured, which speaks in favour of improved capacity utilization for plants with high power consumption per cow, or that the energy consuming installations need a service check.

Differences in power consumption can, besides poor capacity utilization, be due to a lack of adjustment of hot-water tanks, vacuum pumps or wrongly dimensioned and poorly maintained compressors. Be aware, when entering into any agreement, that the service checks will also include these installations.

In DeLaval 1 a defective check valve was the reason why the shunting of cold and hot water caused a too high consumption of hot water, which is clearly to be seen when the measured results are compared. This defect might not have been discovered if the FarmTest had not been carried out. Therefore attention on the power consuming installations is important to the AMS economy

Calcification of hot-water tanks, leaking hot-water taps, leaking compressors and adjacent piping, leakage of the vacuum system etc. are just a few of the parts requiring maintenance and full attention.

Power consumption per ton milk, c.f. Figure 2, is independent of the index for the milking time.

1.3 Water consumption

Wash water is discharged into the slurry tank. High water consumption causes large extra costs for storage and spreading.

Water consumption varies considerably from one AMS to another AMS. The main cleanings are clearly the largest consumers of water, but reducing the number of main cleanings brings the risk of reduced milk quality as poor cleaning causes scaling of the milk pipes and an increased somatic cell count.

High water consumption also brings about a need for increased storage capacity in the slurry tank and increased costs of spreading it onto the fields. The price of storage and spreading is about DKK 30 per cu m (source Mads Urup Gjødesen).

The difference between the lowest and the highest measured water consumption is about 4 cu m per year c.f. Figure 3, which in a herd with two AMS's, corresponding to about 130 dairy cows, requires capacity for, and the spreading of 520 cu m water per year. This is tantamount to increased costs of DKK 15,600 annually. Rather significant extra costs! On top of this comes the actual price of water, which may vary considerably depending on the water supply system that you have. The price in this test is fixed at DKK 5.00, and this will increase the annual costs by about DKK 2,600 to DKK 18,200.

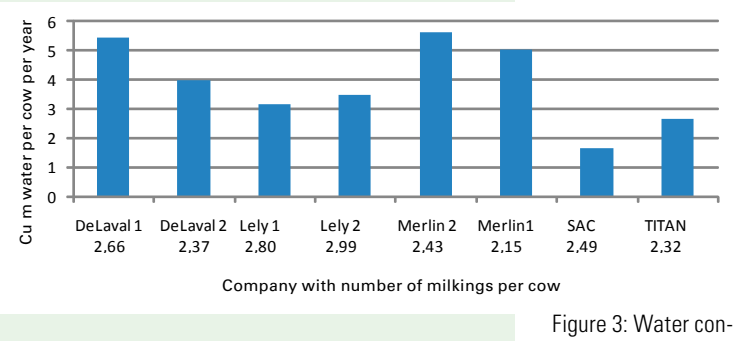


Figure 3: Water consumption per cow per year.

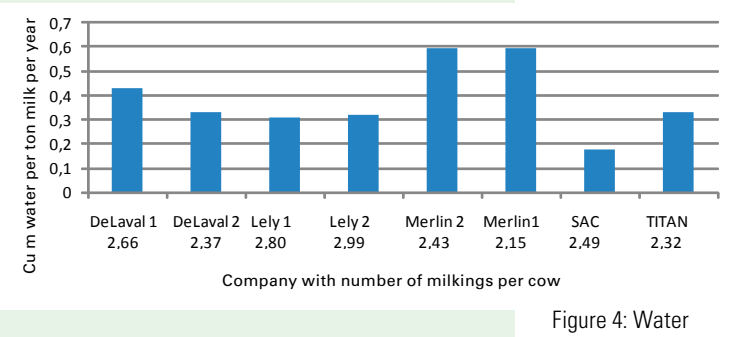


Figure 4: Water consumption per ton milk.

The companies have had an opportunity of improving the plants for the tests, which puts the companies under an obligation as far as a comparison with the results achieved are concerned.

You should install electricity and water meters on your robots so that you can make demands on the service checks – the electricity and water consumption measured in this test is achievable.

2. The implementation of the FarmTest

Examinations of electricity and water consumption for milking systems have been made before. The latest so far in 'FarmTest Kvæg' No 17 – 2004: "Electricity and water consumption of milking", where the consumption was measured for a number of AMS's and conventional milking systems.

Since 2004 all participating companies with AMS's have introduced new AMS models that apply new principles and components. Due to the new models that are available in the market today it was an expressed wish by not only the companies, but from farmers and consultants as well that all measurements were made for the most recent AMS models.

The examination includes tests of five different AMS's on seven different farms. A couple of companies mentioned that they would be interested in having extra measurements in order to have an improved basis of valuation.

Extra measurements were to be paid for by the companies themselves as far as installations were concerned, and extra measurements were made for DeLaval's VMS, Fullwood's Merlin and Lely's Astronaut A3.

There was no demand that new measurements were to be made on other plants than where the first measurements had been made, so this offered an opportunity for updating the plants where the measurements had been made.

FarmTest deals with tangible measurement data from the test farms.

Company	AMS model
DeLaval A/S	DeLaval VMS
Gea WestfaliaSurge Nordic	Titan
Lely Scandinavia A/S	Lely Astronaut A3
S. A. Christensen & Co.	RDS Futureline
Agripartner ApS	Merlin

The following electricity and water consumption has been calculated per AMS:

- Electricity consumption per milking
- Electricity consumption per ton milk
- Water consumption per AMS per 24 hours
- Water consumption per ton milk
- Water consumption per milking

The statements in the FarmTest have not been adjusted for the number of main cleanings, short cleanings, rinses etc, as it has not been possible to measure the individual washing processes. The number of main cleanings and short cleanings etc. appears from Table 2. The companies' expected water consumption per main cleaning, short cleaning etc. in their AMS's appears in Table 3 so that it is possible to calculate a theoretical water consumption per AMS.

No adjustments have been made for extra electricity consumption for the compressors working on separation boxes, but where it has been possible, separate compressors have been fitted to run these installations, which appears from the results in section 3.1.

The numbers that appear after the company names or in brackets after the product name in Figures and tables refer to the test c.f. section 3.1.

Correct setting of electric heaters, vacuum pumps and compressors are of vital importance to the electricity consumption.
The temperature of the supply water for the electric heaters in the seven different test farms was between 9.5 – 40 degrees C.

3. Results

The AMS electricity consumption is for the heating of water, the vacuum pumps, compressors, the control system and pumps for the AMS.

Table 1 below shows the concrete measurements for electricity per milking and ton of milk. For the sake of comparability, the measurements for SAC's Futureline and Fullwood's Merlin have been adjusted for the extra electricity consumption they have for heating as they had no pre-heated water in the electric heater. TITAN has not been adjusted…

Table 1: Measurements for electricity and registrations.

Electricity consumption measured per AMS per ton of milk and per milking				
Make of AMS – Breed of cattle	Number of milkings per 24 hrs. per AMS	Number of cows per AMS	Electricity consumption per ton of milk	Electricity consumption per milking
RDS Futureline – SDM	161	64.7	33.7 kWh	0.36 kWh
VMS (1) SDM	163	61.3	24.7 kWh	0.32 kWh
VMS (2) – SDM	159	67.0	19.4 kWh	0.27 kWh
Astronaut 3 (1) – SDM	186	66.5	19.4 kWh	0.20 kWh
Astronaut 3 (2) – SDM	172	57.5	20.5 kWh	0.21 kWh
Merlin (1) – SDM	134	62.6	41.0 kWh	0.44 kWh
Merlin (2) – SDM	141	58.0	31.4 kWh	0.33 kWh
TITAN – SDM	309	133.3	57.6 kWh	0.54 kWh

The water consumption is for the cleaning of the AMS with the adjacent piping for the milk tank, including the buffer tank, cleaning of teats and udder, rinsing after the milking, rinsing before and after main cleaning and the main cleaning itself. For DeLaval, which uses an integrated floor rinsing system, the water consumption for floor rinsing has not been included, but amounts to 80 - 90 l. per AMS per 24 hours.

Table 2 below shows the tangible water measurements per AMS per 24 hours. Per ton of milk and per milking.

Table 2: Water consumption results of the various tests.

Water consumption measured per AMS and per kg of milk and per milking					
Make of AMS – Breed of cattle	Number of main cleanings per 24 hrs.	Number of short cleanings per 24 hrs.	Water consumption per AMS per 24 hrs.	Water consumption per ton of milk	Water consumption per milking
RDS Futureline – SDM	3.0	0.2	295 litres	174 litres	1.83 litres
VMS (1) – SDM	3.0	4.3	915 litres	432 litres	5.62 litres
VMS(2) – SDM	3.0	3.5	735 litres	328 litres	4.64 litres
Astronaut 3 (1) – SDM	2.2	8.6	575 litres	301 litres	3.08 litres
Astronaut 3 (2) – SDM	3.0	0.6	550 litres	317 litres	3.20 litres
Merlin (1) – SDM	3.0	3.9	865 litres	598 litres	6.43 litres
Merlin (2) – SDM	3.0	2.7	895 litres	598 litres	6.36 litres
TITAN – SDM	2.1	1.4	965 litres	334 litres	3.12 litres

FarmTest presupposed that no pre-heated water was used. But for Lely Astronaut it was not possible to disconnect the pre-heated water, which gives lower energy consumption for the heating of water. In the following test round, all the companies had

the opportunity of choosing a plant with pre-heated water. The temperature of the pre-heated water is about 40°C measured at the nearest tapping location at the hot-water tank.

On the other test farms the cold-water temperature measured at the supply for the hot-water tank was about 9.5 and 12.5°C. In order to be able to compare the electricity consumption for the heating of water, the savings of using pre-heated water has been deducted for the plants where the water consumption and the washing temperature are known by the company. The saving has been deducted from each individual test in section 3.1

Table 3 below shows the temperature of the supply water for the AMS hot-water tank and the water consumption and water temperatures of the various cleaning processes in the individual AMS's.

Table 3: Cleaning data for the AMS's, provided by the companies.

Water temperature and consumption of the various cleaning processes per AMS. The data is provided by the companies

Company	Entrance temperature measured on the spot °C	Pre-rinsing litre / temp. l/°C	Main cleaning litre / temp. l/°C	Post-rinsing litre / temp. l/°C	Short cleaning litre / temp. l/°C	Rinsing between milkings litre / temp. l/°C
RDS Futureline	10.0	8 / 40	24 / 95	8.5 / 40 + 4.5 / 10	15 / 40	0.5 / 40 + 0.3 / 85
VMS	40	29 / 40	49 / 80	29 / 40	29 / 40	23 / 40
Astronaut 3	40	22.5 / 40	35 / 100	30 / 40	15 / 40	0.5 / 40
TITAN	12.5	?	?	?	?	?
Merlin	9.5		45 / 95 incl. pre- and post-rinsing		10 / 95	0.2 / 9.5

Table 4 below shows the annual consumption of water and electricity per cow for the five different brands of AMS. As a basis an average value was used for the herds tested. Furthermore the calculation was made on a relative consumption for an average of 2.5 milkings per cow per 24 hours.

Prices used in the calculations:

- The price of water from the public water supply: DKK 5.00 per cu m
- The price of storing and spreading water: DKK 30.00 per cu m
- The price of electricity including CO_2 tax: DKK 0.80 per kWh

Table 4: The annual costs of electricity and water per cow.

Annual costs of electricity and water per cow for 2.5 milkings per 24 hours.

	DeLaval	Merlin	SAC	Lely	TITAN
Daily milkings per cow	2.66/2.37 avr. 2.52	2.15/2.43 avr. 2.29	2.49	2.80/2.99 avr. 2.90	2.32
Water consumption per cow per year	4.72 cu m	5.33 cu m	1.66 cu m	3.31 cu m	2.64 cu m
Water consumption per cow per year with 2.5 milkings	4.68 cu m	5.82 cu m	1.67 cu m	2.85 cu m	2.84 cu m
Annual costs for water consumption	DKK 163.80	DKK 203.70	DKK 58.45	DKK 99.75	DKK 99.40
Electricity consumption per cow per year	274.6 kWh	321.0 kWh	323.9 kWh	214.6 kWh	456.3 kWh
Electricity consumption per cow per year with 2.5 milkings	272.4 kWh	350.4 kWh	325.2 kWh	185.0 kWh	491.7 kWh
Annual costs for electricity consumption	DKK 217.92	DKK 280.32	DKK 260.16	DKK 148.00	DKK 393.36
Annual costs per cow with 2.5 milkings	**DKK 381.72**	**DKK 484.02**	**DKK 318.61**	**DKK 247.75**	**DKK 492.76**

3.1 Measurements and statements of each individual test

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Figure 5: DeLaval VMS

DeLaval 1: Type VMS – measured in SDM herds with 2 AMS's		
Total electricity consumption per 24 hrs. (Average 122.5 cows milking per 24 hrs.)		
Electricity consump-tion:	Robots (incl. vacuum pumps)	55.4 kWh
	Compressor (incl. separation og cooling)	13.2 kWh
	Hot water tank	36.0 kWh
Total per 24 hrs.		104.6 kWh
Number of milkings per 24 hrs.		325.4
Number of milkings per cow per 24 hrs.		2.66
Kg milk per 24 hrs.		4,238.7
Electricity consumption per milking		0.32 kWh
Electricity consumption per cow per year		311.7 kWh
Electricity consumption per kg of milk		0.025 kWh
Total water consumption per 24 hrs.		
Water consump-tion:	Robots (avr. 3 main cleanings and 4.3 short cleanings per AMS)	1.83 cu m
	Water consumption per milking	5.62 litre
	Water consumption per kg of milk	0.43 litre

DeLaval 2: Type VMS – measured in an SDM herd with 2 robots		
Total electricity consumption per 24 hrs. (Average 134.0 cows milking per 24 hrs.)		
Electricity consumption:	Robots (incl. vacuum pumps)	53.0 kWh
	Compressor (incl. cooling and excl. selection)	14.5 kWh
	Hot water tank	19.7 kWh
Total		87.2 kWh
Number of milkings per 24 hrs.		317.1
Number of milkings per cow per 24 hrs.		2.37
Kg of milk per 24 hrs.		4486,0
Electricity consumption per milking		0.27 kWh
Electricity consumption per cow per year		237.5 kWh
Electricity consumption per kg of milk		0.019 kWh
Total water consumption per 24 hrs.		
Water consumption:	Robots (avr. 3 main cleanings and 3.45 short cleanings per AMS)	1.47 cu m
	Water consumption per milking	4.64 litres
	Water consumption per kg of milk	0.33 litres

GEA FarmTechnologies

Figure 6: Titan, 4 box

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Today TITAN has been taken over by GEA FarmTechnologies / WestfaliaSurge Nordic A/S. After the takeover GEA FarmTechnologies has developed a new AMS, MI one, which replaces TITAN.

The new development was required as the platform that TITAN used for communication and data had reached the limit for its potential. Furthermore GEA FarmTechnologies has a wish to make the milking robot an integrated part of the milking assortment, so that the milking equipment of the MI one – as far as it is possible – use the thoroughly tested components which the GEA has worked on the development of in recent years.

Gea FarmTechnologies: Type TITAN 4 box – measured in an SDM herd with two robots		
Total electricity consumption per 24 hrs. (Average 266.5 cows milking per 24 hrs.).		
Electricity consumption:	Vacuum pumps	166.70 kWh
	Compressor (Selection and cooling tank disconnected.)	55.30 kWh
	Robots	111.14 kWh
Total		333.14 kWh
Number of milkings per 24 hrs.		618.9
Number of milkings per cow per 24 hrs.		2.32
Kg milk per 24 hrs.		5780,0
Electricity consumption per milking		0.54 kWh
Electricity consumption per cow per year		456.3 kWh
Electricity consumption per kg of milk		0.058 kWh
Total water consumption per 24 hrs.		
Water consumption:	Total (avr. for 2,1 main cleanings and 1,4 short cleanings)	1.93 cu m
	Water consumption per milking	3.12 litres
	Water consumption per kg of milk	0.33 litres

Figure 7: MIone, 1-5 boxes

S. A. Christensen & Co.

Figure 8: SAC, RDS Futureline

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SAC: Type RDS Futureline – measured in an SDM herd with two robots		
Total electricity consumption per 24 hrs. (Average 129.4 cows milking per 24 hrs.)		
Electricity consumption:	Vacuum pump	30.5 kWh
	Boiler	23.6 kWh
	Compressor (incl. cooling tank, buffer and selection)	23.6 kWh
	Hot-water tank for main cleaning	25.7 kWh
	Robots	24.4 kWh
	Corrected electricity consumption	-13.2 kWh
Total		114.6 kWh
Number of milkings per 24 hrs.		321.6
Number of milkings per cow per 24 hrs.		2.49
Kg of milk per 24 hrs.		3,399
Electricity consumption per milking		0.36 kWh
Electricity consumption per cow per year		323.9 kWh
Electricity consumption per kg of milk		0.034 kWh
Total water consumption per 24 hrs.		
Water consumption:	Total (avr. 3.0 main cleanings og 0.2 short cleanings)	0.59 cu m
	Water consumption per milking	1.83 litres
	Water consumption per kg of milk	0.17 litres

Correction for electricity consumption:
The water is without pre-heating, so in comparison electricity is used for heating from 10 to 40°C, which is to be deducted from the total electricity consumption.
Reference is made to consumption per main cleaning, c.f. Table 3, and calculations c.f. Figure 11 enclosure 2.

Kwh per cleaning: $\frac{30°C \times 4.19\ J \times 378.8\ litres \times 0.001164\ kWh}{4.19\ J}$ = 13.2 kWh per 24 hrs.

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Figure 9: Lely A3

Lely 1: Type A3 – measured in an SDM herd with two robots		
Total electricity consumption per 24 hrs. (Average 133.0 cows milking per 24 hrs.)		
Electricity consump-tion:	Compressor (grazing selection disconnected, incl. cooling tank and pre-selection)	36.6 kWh
	Robots (incl. water pumps)	37.7 kWh
Total per 24 hrs.		74.3 kWh
Number of milkings per 24 hrs.		372.8
Number of milkings per cow per 24 hrs.		2.80
Kg of milk per 24 hrs.		3,825
Electricity consumption per milking		0.20 kWh
Electricity consumption per cow per year		203.9 kWh
Electricity consumption per kg of milk		0.019 kWh
Total water consumption per 24 hrs.		
Water con-sumption:	Total (avr. 2.2 main cleanings and 8.6 short cleanings)	1.15 cu m
	Water consumption per milking	3.08 litres
	Water consumption per kg of milk	0.30 litres

Lely 2: Type A3 – measured in an SDM herd with two robots		
Total electricity consumption per 24 hrs. (Average 115.0 cows milking per 24 hrs.)		
Electricity consumption:	Compressor (ecll. selection)	33.1 kWh
	Robots (incl. vacuum pumps)	37.9 kWh
Total per 24 hrs.		71.0 kWh
Number of milkings per 24 hrs.		343.7
Number of milkings per cow per 24 hrs.		2.99
Kg of milk per 24 hrs.		3,466.3
Electricity consumption per milking		0.21 kWh
Electricity consumption per cow per year		225.3 kWh
Electricity consumption per kg of milk		0.020 kWh
Total water consumption per 24 hrs.		
Water consumption:	Total (avr. 3.0 main cleanings and 0.6 short cleanings)	1.10 cu m
	Water consumption per milking	3.20 litres
	Water consumption per kg of milk	0.32 litres

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Figure 10: Merlin fra Fullwood

Fullwood 1: Merlin – measured in an SDM herd with two robots		
Total electricity consumption per 24 hrs. (Average 125.1 cows milking per 24 hrs.)		
Electricity consumption:	Compressor (cooling and pre-separation disconnected)	47.7 kWh
	Robots	7.2 kWh
	Vacuum pumps	24.9 kWh
	Hot-water tanks	51.2 kWh
	Adjustment for electricity consumption	-12.4 kWh
Total per 24 hrs.		118.6 kWh
Number of milkings per 24 hrs.		268.7
Number of milkings per cow per 24 hrs.		2.15
Kg of milk per 24 hrs.		2,890.8
Electricity consumption per milking		0.44 kWh
Electricity consumption per cow per year		346 kWh
Electricity consumption per kg of milk		0.041 kWh
Total water consumption per 24 hrs.		
Water consumption:	Total (avr. 3.0 main cleanings and 3.9 short cleanings per AMS)	1.73 cu m
	Water consumption per milking	6.44 litres
	Water consumption per kg of milk	0.60 litres
Adjustment for electricity consumption. The water is without pre-heating, so in comparison electricity is used for heating from 9,5 to 40°C, which is to be deducted from the total electricity consumption. Reference is made to consumption per main cleaning, c.f. Table 3, and calculations c.f. Enclosure 2. Kwh per cleaning: $\frac{30.5°C \times 4.19 \times 348 \text{ litres} \times 0.001164}{4.19}$ = 12.4 kWh per 24 hrs.		

Fullwood 2: Merlin – measured in the same SDM herd as the first measurement. The plant was standard updated after start-up.		
Total electricity consumption for 24 hrs. (Average 115.9 cows milking per 24 hrs.)		
Electricity consumption :	Compressor (cooling tank and pre-separation disconnected)	40.1 kWh
	Robots	6.9 kWh
	Vacuum pumps	22.2 kWh
	Hot-water tanks	36.3 kWh
	Adjustment for electricity consumption	-11.5 kWh
Total per 24 hrs.		94.0 kWh
Number of milkings per 24 hrs.		281.5
Number of milkings per cow per 24 hrs.		2.43
Kg of milk per 24 hrs.		2,995.6
Electricity consumption per milking		0.33 kWh
Electricity consumption per milking		296 kWh
Electricity consumption per kg of milk		0.031 kWh
Total water consumption per 24 hrs.		
Water consumption:	Total (avr. 3.0 main cleanings and 2.7 short cleanings per AMS)	1.79 cu m
	Water consumption per milking	6.36 litres
	Water consumption per kg of milk	0.62 litres

Adjustment for electricity consumption.
The water is without pre-heating, so in comparison electricity is used for heating from 9.5 to 40°C, which is to be deducted from the total electricity consumption.
Reference is made to consumption per main cleaning, c.f. Table 3, and calculations c.f. Enclosure 2.

Kwh per cleaning: $\frac{30.5°C \times 4.19 \times 324 \text{ litres} \times 0.001164}{4.19}$ = 11.5 kWh per 24 hrs.

4. Discussion

The differences in the energy consumption within the same type of AMS are worth noting.

The FarmTest demonstrated that plants of the same type can show a difference of electricity consumption per cow per year, converted to the same number of milkings, of more than 25 % compared with the lowest consumption.

For their participation in the FarmTest, the individual companies have selected the plants to be tested themselves and have thus had the opportunity of optimising the plants so that they operate appropriately.

The differences must among other things be due to lack of procedures for calibration of the AMS's, and be aware, where you as a farmer have the possibility of adjusting the plant, including the washing of teats, where this is possible, that it is checked individually so that no more hot water than what is necessary is used.

FarmTest wants vigorously to encourage farmers to discuss the electricity and water consumption with the companies.

The start-up of the AMS itself gives rise to a lot of activities, but first and foremost it is a matter of making the cows familiar with the use of the AMS and thus making the normal everday life work with regular routines and confident cows. When the plants have been commissioned, it would be appropriate to follow up on the electricity and water consumption. The FarmTest gives the companies basis for making assessments of the measurements made in comparison to sales materials and plants in the field and thus estimate the effectiveness of the largest consumers of electricity and water.

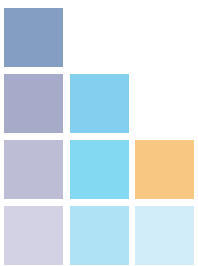
FarmTest recommends electricity and water meters to be installed.

A plant that has been commissioned must be updated according to the lowest consumption level, and if there are electricity and water meters installed, the farmer can make demands on the companies that the service checks document that the consumption has been checked, and that it lives up to the consumption rates measured in this FarmTest.

The costs of the installation of water and electricity meters did not vary much from one AMS to another and were about DKK 16,000 excl. VAT for two AMS's. An investment that will easily pay for itself if the electricity and water consumption is currently checked and optimum consumption ensured.

5. Litterature

FarmTest – Kvæg No. 17 - 2004: "Electricity and water consumption in milking"



Enclosures

Enclosure 1: Company comments on the FarmTest:

GEA FarmTechnologies / WestfaliaSurge Nordic A/S

Compared with the tested model, the newly developed model MI one has an electricity consumption that in internal tests seems to be considerably lower, in some cases down to half of the consumption of the TITAN. Focus has been on the development of a stable and service friendly machine with quick attachment of the teat cups and a gentle milking process.

The test is characterised by the special circumstances that the TITAN plants where the measurements were made, are with an ecological dairy farmer where the cows are grazing eight hours a day in the grazing season. Besides that, the examination was made less than a full year after commissioning.

SAC

SAC recommends an installation for the cooling of the milk by utilizing the surplus heat from the milk to preheat water for the AMS. This was disconnected in the test concerned as the demands for taking part in the FarmTest, described in a letter of 03 December 2007, stipulated that it was a pre-condition not to use preheated water in the measuring period.

RDS Futureline is delivered as a single box (this is the model that the test was made on) and a double box where two milking boxes are served by one robot arm.

In the double box there are electricity savings of about 1,900 kWh per year.

Merlin

In the course of the FarmTest, Merlin in Denmark was taken over by us, Agripartner, which unfortunately means that the FarmTest did not give Merlin the attention that we could have wished for. But we are ready now and look forward to good cooperation with Danish farmers so that the Merlin robot will get the presentation it deserves.

New Merlin robots are constantly being developed at the Fullwood's Factory in England, and for a long time the strategy has targeted efforts towards lower operational costs of both water and energy consumption. Measurements made by Fullwood also demonstrate that as far as electricity and water consumption is concerned these are on the same level with the other makes of robots. Consumption of 26 kWh per ton milk (with pre-heated water) and a water consumption of 230 litres per 24 hours is attainable.

Besides this, we would like to mention that in a few weeks Agripartner will launch a new generation of Merlin milking robots, and in a very short time some new exciting features will be released.

DeLaval

We should like to express our gratitude to Dansk Kvæg for carrying out this new test as a follow up on the first test back in 2004. In this period we have implemented many important, new energy savings measures that have helped to reduce the energy consumption of the VMS by more than 50 %. The hydraulically controlled arm saves a significant amount of energy in the system. The robot arm reduces the running time of the compressor by about 30 % and minimises not only the electricity consumption but also the maintenance costs of this component.

It has been found that the VMS uses more water than the other milking robots, but the reader must be aware that the VMS has more automatic cleaning processes designed to keep the system clean outside round the clock and with a minimum of work, at that. We estimate this amount of water to be between 100 and 150 litres, which are normally used for manual cleaning with a water hose (20 litres of water per minute). Besides that, with the teat preparation cup we have an especially powerful tool for the cleaning and preparation of the teats. This function uses more water than other solutions, but at the same time it makes an especially good preparation of the teats.

It is interesting to notice the significant difference in the VMS energy consumption of hot water. Not only does the heat retrieval system make significant cost savings, but besides that, the farmer must be aware of the effectiveness of his hot-water tank, as the test shows big differences for these. After the test was concluded we have for example learnt that in one of the test host's hot-water supply there was a defective check valve. This defect may be the explanation of a surplus consumption of 8 kWh per 24 hours per VMS for hot water seen in relation to the other test herd with a VMS.

Enclosure 2: Pre-heated water

To utilize the heat from the cooling of the milk for the pre-heating of the water is in itself a sensible and energy saving solution, but to compare the energy consumption of the AMS's requires, as far as it is possible, the same starting point unless the cooling of the milk is an integrated part of the AMS and is thus part of the entire purchase. If so, this investment is to be included in the calculation when comparing the AMS's.

If pre-heated water is used, the electricity consumption saved for heating is calculated as shown below:

Figure 11: Calculation - electricity consumption

Calculation of the saving per 24 hrs. for an AMS by using pre-heated water

Energy added in J = water exit temperature – supply temperature x 4.19 J (specific heat for water) x litres (kg)

4.19 J = 0.001164 kWh
1 kWh costs, electricity price approx. DKK 0.35 + network costs approx. DKK 0.35 + CO_2 tax DKK 0.10 in all DKK 0.80.

Example: with and without cooling of milk respectively

Water temperature for the AMS 10 and 35°C, respectively

- 3 main cleanings = 120 litres
- 3 pre- and post-rinses = 60 litres
- 6 short cleanings = 90 litres
- 180 rinses after milking = 180 litres

	Temperature	Amount of water
Main cleaning	95°C	40 litres
Pre- and post-rinses	40°C	20 litres
Short cleanings	40°C	15 litres
Rinsing after milking	40°C	1 litre

Without retrieval of heat from the cooling of milk (the water is heated from 10-95°C = 85°C):

- Main cleaning, energy added, 85°C x 4.19 J x 120 litres (kg) = 42,738 J
- Rinses and short cleanings: energy added 30°C x 4.19 J x 330 litres (kg) = 41,481 J

$$\text{Converted to kWh} - \frac{84{,}219 \text{ J} \times 0.001164 \text{ kWh}}{4.19 \text{ J}} = 23.40 \text{ kWh}$$

- **Price of heating DKK 18,72**

With retrieval of heat form the cooling of milk (the water is heated from 35-95°C = 60°C):

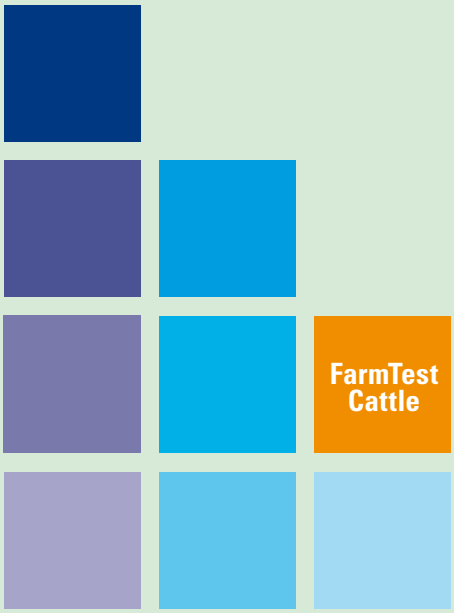
- Main cleaning, energy added, 60°C x 4.19 J x 120 litres (kg) = 30,168 J
- Rinses and short cleanings: energy added 5°C x 4.19 J x 330 litres (kg) = 6,914 J

$$\text{Converted to kWh} - \frac{37{,}082 \text{ J} \times 0.001164 \text{ kWh}}{4.19 \text{ J}} = 10.30 \text{ kWh}$$

- **Price of heating DKK 8,24**
- **Savings per 24 hrs. per AMS = DKK 10,48**

Per year the retrieval of heat from the cooling of milk means savings of approx. DKK 3.800 per AMS from electric heating of the cleaning water.

The savings from heating of the water have to be put in proportion to the investment in the cooling of the milk, but should not be considered alone, as the cooling of the milk is also used for warming up the house, warming up of the office and staff facilities, frost-proofing of drinking water etc.



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