FUNDAMENTALS OF NOZZLE TECHNOLOGY
PULSE WIDTH MODULATION

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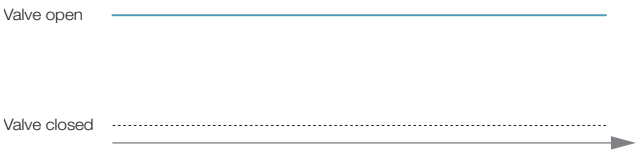
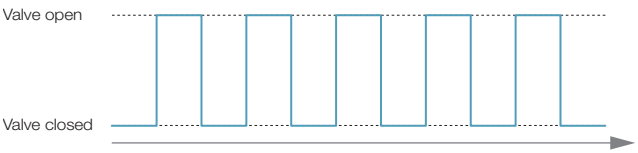
Pulse width modulation (PWM) is a current application trend for plant protection products. Whereas conventional nozzles are always open, a solenoid valve opens and closes the valve 10 to 30 times per second here. The frequency is either predefined or is defined in the basic settings. It is not decisive for the nozzle selection.

The duty cycle (DC) specifies the time ratio between open and closed valve as a percentage. It is an important variable for good lateral and longitudinal distribution of the sprayed liquid. The valve is open continuously with a duty cycle of 100 % – like with conventional nozzles. If the duty cycle is reduced to 50 %, the flow rate is also halved – with a constant pressure.



Duty cycle (DC) 100 %:
The valve is continuously open.



Duty cycle (DC) 50 %:
The nozzle is alternately closed and open for equal periods of time.

An example: With a duty cycle (DC) of 50 %, the applied quantity for nozzle size 06 (gray) corresponds to the quantity of a nozzle size 03 (blue) without PWM. Nozzles are ideally used with a duty cycle (DC) of 30 %–100 %.

PWM technology is particularly advantageous for the following applications:

- Individual nozzle switching and control with variable flow rate
- Constant droplet size and application quantity with variable working speed
- Drift reduction and uniform wetting quality with constant droplet size
- Curve compensation to avoid underdosing and overdosing at the outer and inner parts of the boom, e.g. when driving round obstacles
- Variation of application quantity for area-specific application
- Large flow rate control range of a nozzle without a significant change in the droplet size
- Spot spraying – for precise small-area application of plant protection products

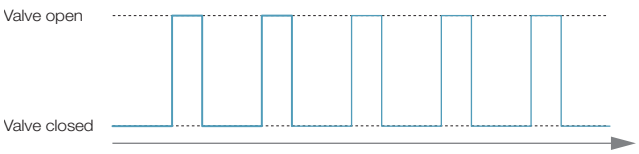
Tested and approved

Lechler agricultural nozzles were tested with PWM valves in an extensive test program. JKI approvals for PWM valves with different nozzle types are available. The drift reduction is based on the nozzle entries in the “Register of loss-reducing equipment”: same drift reduction class for duty cycle (DC) 100 % or one drift reduction class lower for “pulsing”.

Lechler flat fan, double flat fan and liquid fertilizer nozzles are generally suitable for PWM. This includes the series LU, AD and XDT without injector as well as ID, IDTA, IDK/IDKN and IDKT with injector and liquid fertilizer nozzles FD, FS.

The correct nozzle size ensures successful application

If the nozzle size is too small, there is an upper limit for the application quantity or possible speed. The PWM system can open by a maximum of 100 % and then possibly increase the pressure. There is a risk of drift if the pressure exceeds the recommended pressure for the nozzle.



Duty cycle (DC) 30 %:
The nozzle does not deliver any plant protection product for 70 % of the time.

The PWM system can compensate for an excessively large nozzle size by means of a lower duty cycle of 50 %–30 %, for example, and a reduction in the pressure range. The risk of more uneven distribution of the liquid in longitudinal and lateral direction as well as lower wetting due to the coarser droplet spectrum must be taken into account. The distribution may not be optimal particularly at higher speeds above 10 km/h and with a duty factor of less than 40 %.

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		DC PWM		[l/ha] 0,5m							
		%	[l/min]	6.0 km/h	8.0 km/h	10.0 km/h	12.0 km/h	14.0 km/h	16.0 km/h	18.0 km/h	20.0 km/h
06	1	100	1.36	272	204	163	136	117	102	91	82
		70	0.95	190	143	114	95	82	71	63	57
		50	0.68	136	102	82	68	58	51	45	41
		30	0.41	82	61	49	41	35	31	27	24
	2	100	1.93	386	290	232	183	165	145	129	***116***
		70	1.35	270	203	162	135	***116***	101	90	81
		50	0.97	193	145	***116***	97	83	72	64	58
		30	0.58	***116***	87	69	58	50	43	39	35
	3	100	2.36	472	354	283	236	202	177	157	***142***
		70	1.65	330	248	198	165	***142***	124	110	99
		50	1.18	236	177	***142***	118	101	89	79	71
		30	0.71	***142***	106	85	71	61	53	47	42
	4	100	2.73	546	410	328	273	234	205	182	164
		70	1.91	382	287	229	191	164	143	127	115
		50	1.37	273	205	164	137	117	102	91	82
		30	0.82	164	123	98	82	70	61	55	49
	5	100	3.05	610	458	366	305	261	229	203	***183***
		70	2.14	427	320	256	214	***183***	160	142	128
		50	1.53	305	229	***183***	153	131	114	102	92
		30	0.92	***183***	137	110	92	78	69	61	55
	6	100	3.34	668	501	401	334	286	251	223	***200***
		70	2.34	468	351	281	234	***200***	175	156	140
		50	1.67	334	251	***200***	167	143	125	111	100
		30	1	***200***	150	120	100	86	75	67	60
	8	100	3.86	772	579	463	386	331	290	257	232
		70	2.7	540	405	324	270	232	203	180	162
		50	1.93	386	290	232	193	165	145	129	116
		30	1.16	232	174	139	116	99	87	77	69

Based on the example of the above table for nozzle size 06 it is possible to clearly see the relationship between sprayer speed and duty cycle.

Determination of nozzle size

The flow rate control range of a nozzle is significantly increased with PWM. Selection of the correct nozzle size therefore requires a different approach. Ideally, the nozzle size is determined for a duty cycle of 70 % and average sprayer speed.

With a constant pressure in the boom, this allows the flow rate of a nozzle to be increased or reduced by 30 % respectively – in the range from 100 % to 40 %.

Rule of thumb:

Nozzle size x 1.5 = nozzle size for PWM

If a nozzle of size 04 is used without PWM technology, size 06 would be the recommended nozzle size with PWM technology with otherwise unchanged application conditions. The recommended pressure ranges of the nozzle series also apply for PWM.

Good to know

You can find lists of the PWM nozzles that have been included in the JKI “Directory of loss-reducing equipment” on our website.

Current list at:
www.lechler.com/de-en/service/loss-reducing