

THE COMPARISON OF THE NOZZLE INSPECTION METHODS: NOZZLE FLOW VS. SPRAY TRANSVERSE DISTRIBUTION - THE METHODOLOGY AND THE FIRST RESULTS

Artur Godyń

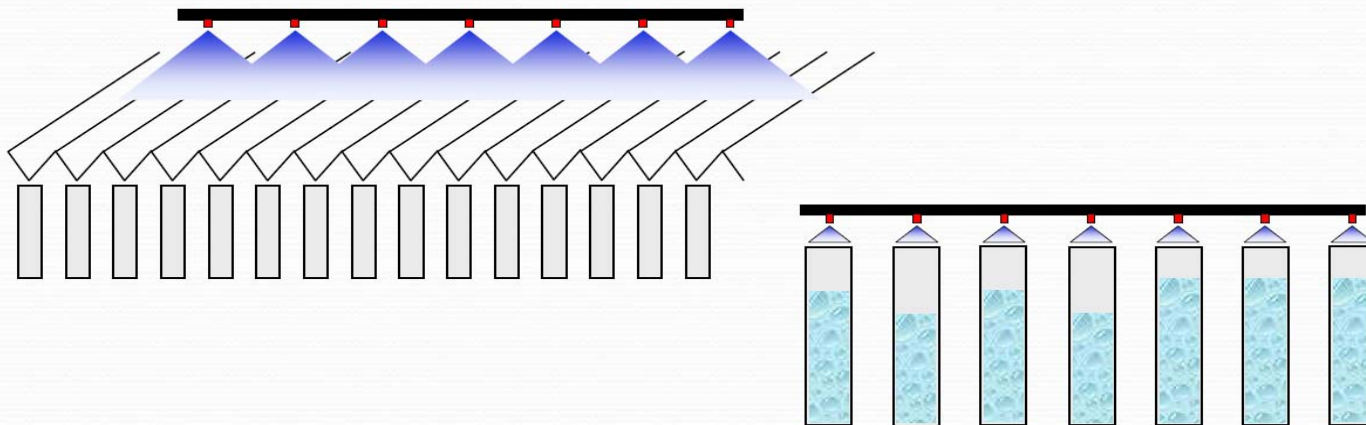
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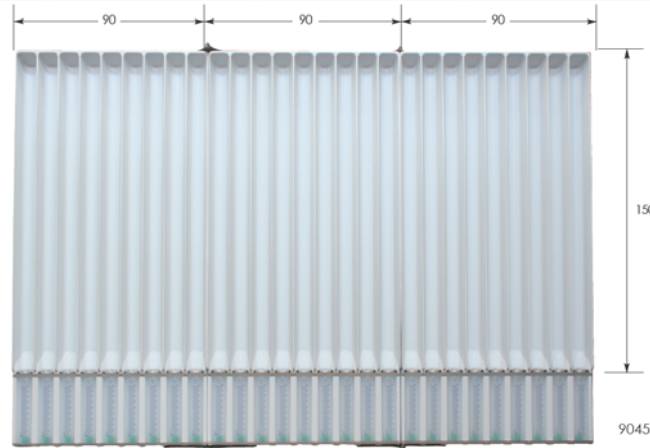
The methods of nozzle inspection

- **Measurement of transverse distribution:**
 - Coefficient of variation $CV\% < 10\%$
 - Number of grooves ($< 10\%$) with deviation $> 15\%$ from mean
- **Measurement of nozzle flow:**
 - Deviation from nominal flow $< 10\%$



Equipment transverse distribution

ISO 5682-2



Equipment

nozzle flow by volume



Materials and methods

Sprayer

- Field crop sprayer – tractor mounted „Krukowiak”
- Boom - 12 m
- Nozzle body - triple
- Pump - 105 l/min
- Tank - 500 l



Materials and methods

Equipment – transverse distribution msmnt

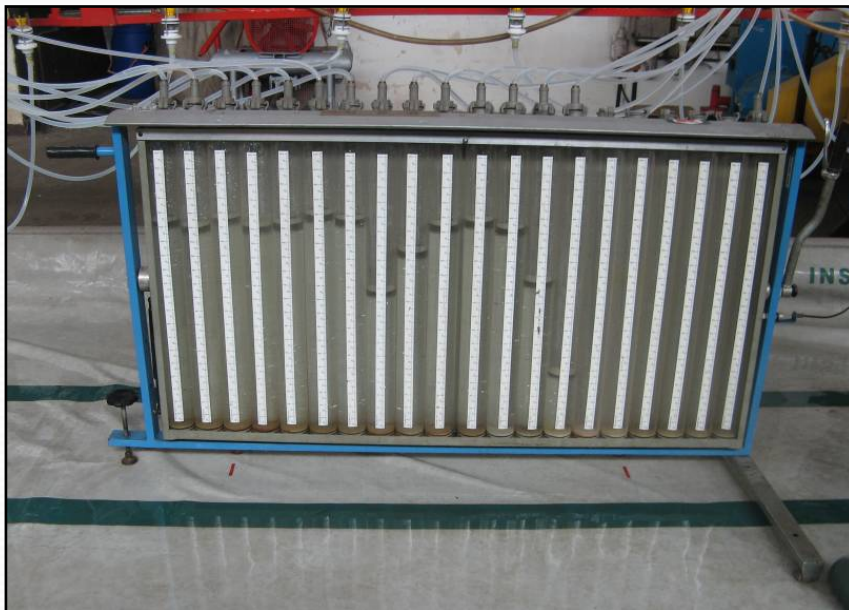
- **Patternators working in steps**
 - with electronic data sampling - PESSL Instruments (Austria)
 - with operator data readout - STABEN (Poland) – 3 m width



Materials and methods

Equipment – nozzle flow msmnt

- **Volume measuring devices**
 - Measuring cylinders (20 × 2000 ml) - SCHACHTNER
 - Ball flow-meter - LURMARK



Materials and methods

Nozzles

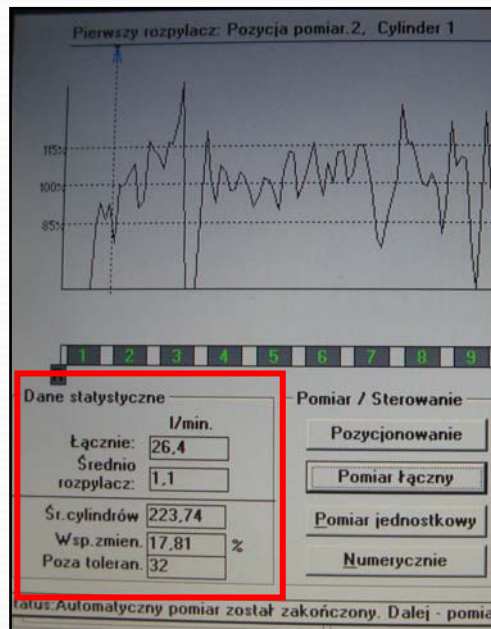
- Flat fan nozzles
 - Standard (LU 120-03) @ 3.0 bar
 - Air-injector (ID 120-03) @ 4.5 bar
 - Air-injector - Twin stream (IDKT 120-03) @ 4.5 bar



Materials and methods

Output data – patternator with electronic data sampling

- Coefficient of variation CV%
- Mean nozzle flow (l/min)
- Number of grooves outside the limits $\pm 10\%$ or $\pm 15\%$



Dane statystyczne	
	l/min.
Łącznie:	26,4
Średnio rozpylacz:	1,1
Śr. cylindrów	223,74
Wsp. zmien.	17,81 %
Poza toleran.	32

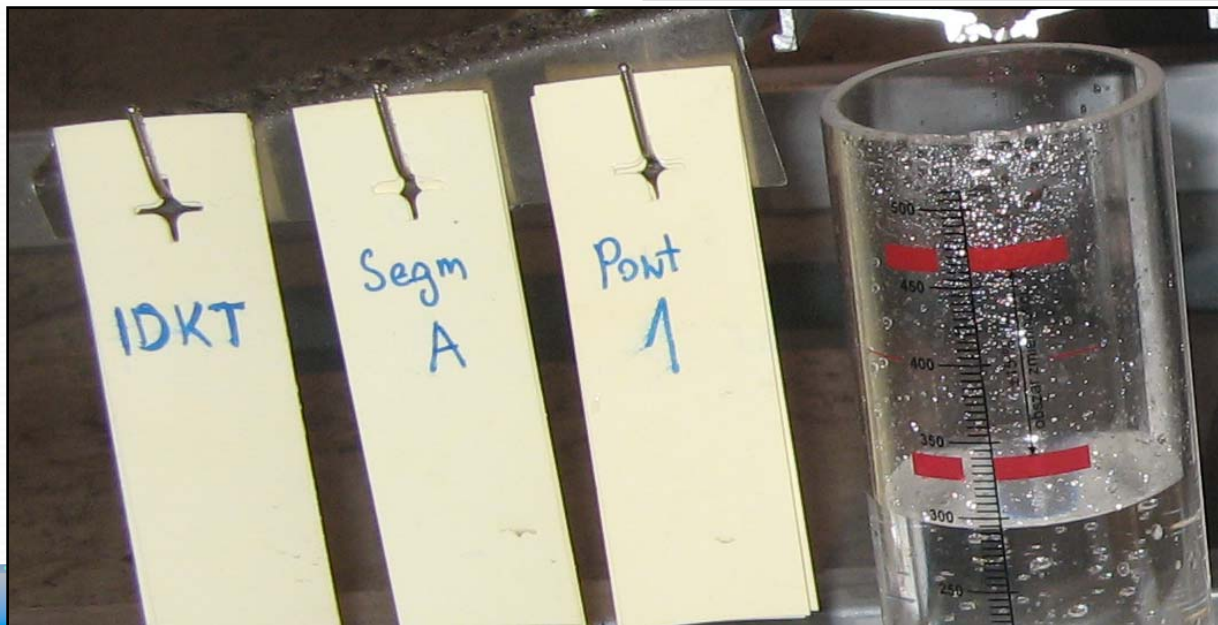
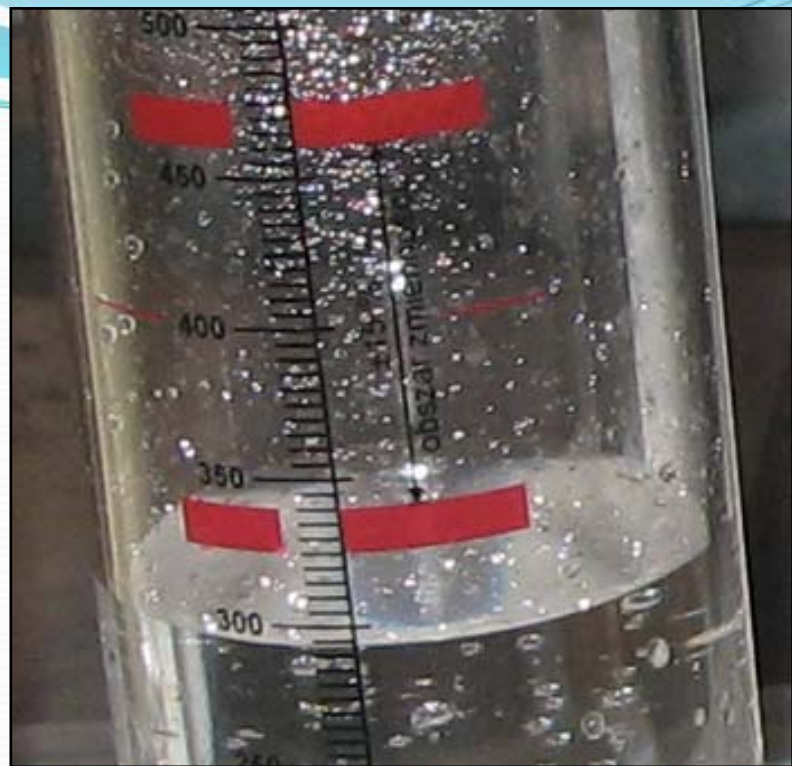


Materials and methods

Output data - patternator with operator data readout

- Number of grooves outside the limits $\pm 15\%$
- Liquid volume in each measuring cylinder (ml)





Materials and methods

Output data - nozzle flow measurements

- The flow of each nozzle (l/min)



Materials and methods

Calculations

- **Binary assessments of data** (inspection criteria: passed or not)
- **Linear assessments of data** (inspection criteria in the percent)
- **Repeatability of the data** (CV%)

Results (Experiment I)

Patternator with electronic data sampling

Nozzle type	Rep. 1	Rep. 2	Rep. 3	Rep. 4	CV%
Coefficient of Variation CV% (<10%)					
LU -120-03	10.89	10.11	10.25	10.57	2.6
IDKT -120-03		8.69	8.71	8.66	0.2
ID -120-03	7.08	6.33	6.06	6.16	5.3
Number of grooves outside limits $\pm 10\%$ (<12 pcs.)					
LU -120-03	32	31	34	35	4.6
IDKT -120-03		24	25	25	1.8
ID -120-03	10	9	9	6	14.7

Results (Experiment I)

Patternator with electronic data sampling: CV%

Nozzle	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Mean
Binary assessment					
LU -120-03	0	0	0	0	0
IDKT -120-03		1	1	1	1
ID -120-03	1	1	1	1	1
Linear assessment (%)					
LU -120-03	108.9	101.1	102.5	105.7	104.6
IDKT -120-03		86.9	87.1	86.6	86.9
ID -120-03	70.8	63.3	60.6	61.6	64.1

Results

Nozzle flow by SCHACHTNER



Nozzle type	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Mean
Number of nozzles outside limit ($\pm 10\%$)*					
LU-120-03	12+0	11+0	9+1	8+0	10.3
IDKT-120-03	11+0	7+0	2+1	8+0	7.3
ID-120-03	3+2	1+3	1+6	0+6	5.5
Mean nozzle flow deviation (%)					
LU-120-03	8.76	8.57	8.64	7.88	8.5
IDKT-120-03	9.87	7.71	6.07	7.89	7.9
ID-120-03	8.04	9.58	10.50	11.04	9.8

* „Over limit” + „Below limit”

Results



Nozzle flow by SCHACHTNER

Nozzle type	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Mean
Binary assessment					
LU -120-03	0	0	0	0	0.0
IDKT -120-03	0	0	0	0	0.0
ID -120-03	0	0	0	0	0.0
Mean nozzle flow deviation (%)					
LU -120-03	8.76	8.57	8.64	7.88	8.5
IDKT -120-03	9.87	7.71	6.07	7.89	7.9
ID -120-03	8.04	9.58	10.50	11.04	9.8

* „Over limit” + „Below limit”

Results

Nozzle flow by LURMARK



Nozzle type	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Mean
Number of nozzles outside limit ($\pm 10\%$)*					
LU-120-03	1+0	2+0	3+0	4+0	2.5
IDKT-120-03	9+0	3+1	6+0	2+0	5.3
ID-120-03	19+2	21+0	20+1	19+1	20.8
Mean nozzle flow deviation (%)					
LU-120-03	7.74	8.05	7.70	8.30	8.0
IDKT-120-03	11.02	9.08	9.87	7.88	9.5
ID-120-03	26.37	27.25	29.97	22.32	26.5

* „Over limit” + „Below limit”

Results

Nozzle flow by LURMARK



Nozzle type	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Mean
Binary assessment					
LU -120-03	0	0	0	0	0.0
IDKT -120-03	0	0	0	0	0.0
ID -120-03	0	0	0	0	0.0
Mean nozzle flow deviation (%)					
LU -120-03	7.74	8.05	7.70	8.30	8.0
IDKT -120-03	11.02	9.08	9.87	7.88	9.5
ID -120-03	26.37	27.25	29.97	22.32	26.5

* „Over limit” + „Below limit”

Results

Nozzle flow & mean flow repeatability

Nominal flow: LU – 1.19 l/min ; IDKT & ID: 1.46 l/min

Nozzle	Rep. 1	Rep. 2	Rep. 3	Rep. 4	CV%
Patternator with electronic data sampling					
LU-120-03	1.16	1.18	1.19	1.19	0.85
IDKT-120-03	1.38	1.39	1.40	1.39	0.36
ID-120-03	1.45	1.44	1.43	1.49	1.29
Set of 20 measuring cylinders (2000 ml) - SCHACHTNER					
LU-120-03	1.30	1.28	1.27	1.26	0.88
IDKT-120-03	1.61	1.59	1.56	1.57	1.17
ID-120-03	1.42	1.41	1.41	1.39	0.54
Ball flow-meter LURMARK					
LU-120-03	1.26	1.28	1.28	1.28	0.51
IDKT-120-03	1.62	1.58	1.60	1.58	1.11
ID-120-03	1.78	1.85	1.86	1.75	2.44

Summary

- **The analysis of the gathered data goes on**
- **The assessment and comparison of the inspection methods will be done based on:**
 - Repeatability of the gathered data
 - Binary assessment of the passing rate
 - Linear assessment of the passing rate
 - Time consuming of the measurements

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Thank You ...