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Short report

# **Transfer efficiency tests for new developped ANEST IWATA spray guns according to European Standard EN 13966-1 (VDMA german technical rule 24 366)**

**prepared for**

Anest Iwata Europe

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## 1 General aspects

The transfer efficiency (TE) is an important parameter of paint applicators. The procedure of TE testing that has been applied is orientated at the already finished German standard for spray guns without electrostatic, being defined in the EN 13 966-1. Some other countries require similar TE test procedures.

The results and parameters from the tests are listed in protocols. The protocols as well as the certificates have been handed out to Anest Iwata as PDF-Files.

## 2 Characteristics of the test procedure

The determination of the TE was performed according to prEN 13 966-1. The basic characteristics of the geometry used in the present investigations are given in Fig. 1 (s. page 4). The plate is orientated in vertical direction. The spray is applied horizontally with the spray gun moving from bottom to top.

The following equipment was tested:

<b>gun</b>	<b>Nozzle</b>	<b>dyn. inlet pressure</b>	<b>paint feed</b>	<b>spray distance</b>
New 71 – 0	0,8 mm	1,0 bar	gear pump	200 mm
-- " -----	-- " --	-- " --	-- " --	-- " --
-- " -----	-- " --	1,5 bar	-- " --	-- " --
-- " -----	-- " --	-- " --	-- " --	-- " --
New 71 – 21S	1,3 mm	2,0 bar	-- " --	-- " --
-- " -----	-- " --	-- " --	-- " --	-- " --
-- " -----	-- " --	2,5 bar	-- " --	-- " --
-- " -----	-- " --	-- " --	-- " --	-- " --
New 77 – 0	1,2 mm	2,0 bar	-- " --	250 mm
-- " -----	-- " --	-- " --	-- " --	-- " --
-- " -----	-- " --	2,5 bar	-- " --	-- " --
-- " -----	-- " --	-- " --	-- " --	-- " --



gun	nozzle	dyn. inlet pressure	paint feed	spray distance
New 77 – 1S	1,5 mm	2,0 bar	suction	250 mm
-- " -----	-- " --	-- " --	-- " --	-- " --
-- " -----	-- " --	2,5 bar	-- " --	-- " --
-- " -----	-- " --	-- " --	-- " --	-- " --
New 77 – 2S	2,0 mm	2,0 bar	-- " --	-- " --
-- " -----	-- " --	-- " --	-- " --	-- " --

The following paint materials were applied throughout the tests:

paint material		pot life	viscosity
water-based wood stain	ICA CAN 40 + H2O	-	17 s DIN4
solvent-based wood stain	Helios RAL 8017 + KAR	-	22 s DIN4
PU-2K finish for wood	Herberts Multimix RAL 8028 + Hardener + KAR	3 h	20 s DIN4
transparent opaque for wood	Herberts Multimix + Hardener	3 h	20 s DIN4
2K-Basecoat Metallic	Standohyd + Water	-	22-26 s DIN4
2K-Clearcoat	Mobihel 2K acrylic CC + 2K trdilec 1100	8 h	18 s DIN4
General metal paint	Herberts Multimix RAL 8011	-	18-23 s DIN4

Shaping air and paint flow regulation were fully open.

The tests were performed with an industrial 6-axis-paint robot FANUC P-200. The spray gun was mounted on an adaptor on which the trigger was pulled pneumatically to enable automatic mode.

In test series applying suction feed (s. above), the spray gun was weighed on a balance both before and after coating to an accuracy of 0,1 g. The total spray time then was 9,9 sec (given by robot control).

The test foils were weighed on a precision balance both before and after coating and drying to an accuracy of 0,1 mg. The robot speed was 150 resp. 300 mm/s, depending on paint material and paint flow rate. Thus, in combination with the height of the foil of 200 mm, it follows a coating time of 1,33 resp. 0,67 sec. The spray was applied horizontally with the spray gun moving from bottom to top. The schematical test setup is shown in fig. 1.

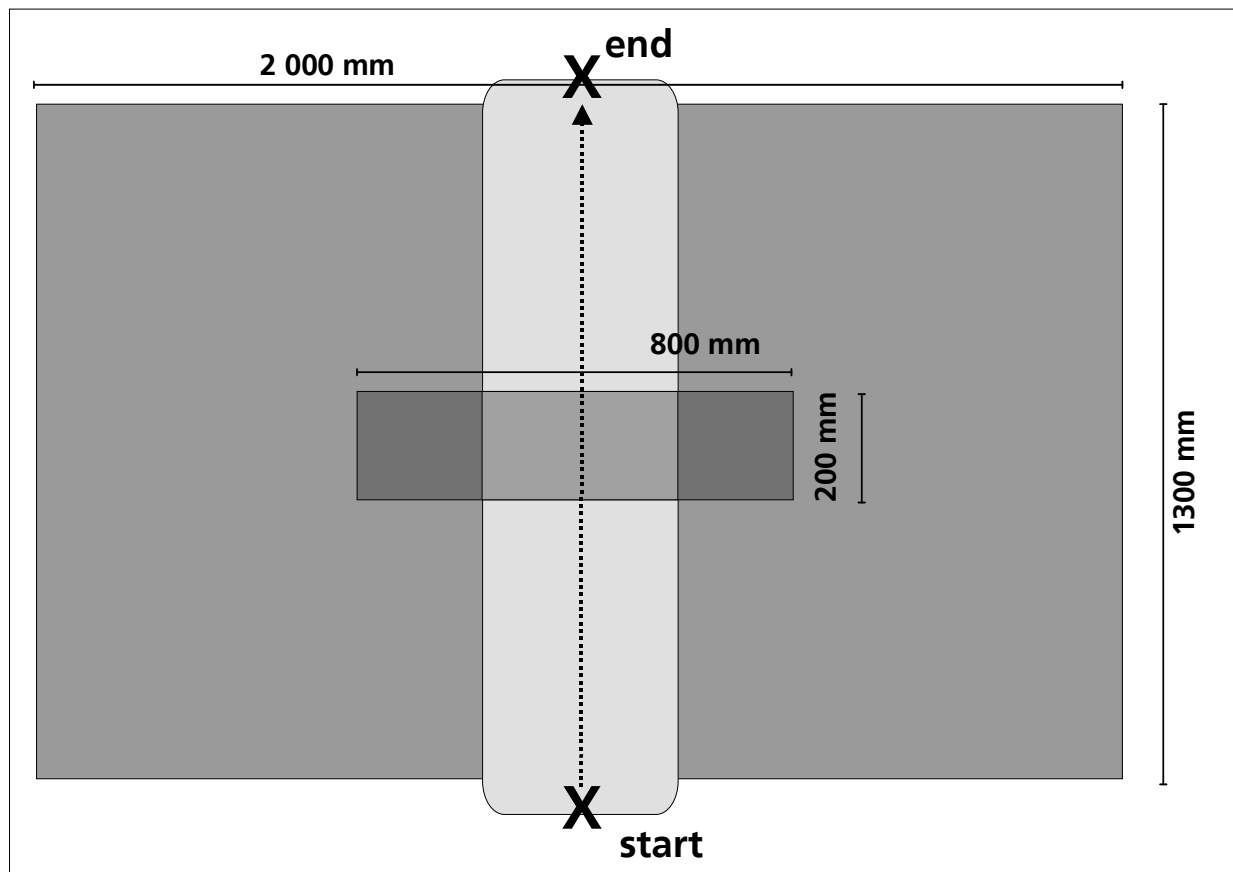


Fig. 1: test setup

### 3 Results

The following values for the TE were obtained:

<b>gun</b>	<b>paint</b>	<b>dyn. inlet air pressure [bar]</b>	<b>spray distance [mm]</b>	<b>Paint flow (g/min)</b>	<b>TE (mean) [%]</b>
<b>New 71-0</b>	water-based wood stain	1,0	200	220	<b>90</b>
-- " --	-- " --	1,5	-- " --	-- " --	<b>87</b>
-- " --	solvent-based wood stain	1,0	-- " --	300	<b>78</b>
-- " --	-- " --	1,5	-- " --	-- " --	<b>77</b>
<b>New 71-21S</b>	finish for wood	2,0	-- " --	280	<b>86</b>
-- " --	-- " --	2,5	-- " --	350	<b>87</b>
-- " --	opaque for wood	2,0	-- " --	300	<b>83</b>
-- " --	-- " --	2,5	-- " --	-- " --	<b>81</b>
<b>New 77-0</b>	finish for wood	2,0	250	480	<b>82</b>
-- " --	-- " --	2,5	-- " --	520	<b>80</b>
-- " --	opaque for wood	2,0	-- " --	400	<b>80</b>
-- " --	-- " --	2,5	-- " --	400	<b>77</b>



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<b>gun</b>	<b>paint</b>	<b>dyn. inlet air pressure [bar]</b>	<b>spray distance [mm]</b>	<b>Paint flow (g/min)</b>	<b>TE (mean) [%]</b>
<b>New 77-1S</b>	2K-Basecoat	2,0	250	approx. 115	<b>75</b>
-- " --	-- " --	2,5	-- " --	approx. 145	<b>74</b>
-- " --	2K-Clearcoat	2,0	-- " --	approx. 130	<b>71</b>
-- " --	-- " --	2,5	-- " --	approx. 170	<b>71</b>
<b>New 77-2S</b>	general metal paint	2,0	-- " --	approx. 230	<b>78</b>
-- " --	-- " --	2,5	-- " --	approx. 280	<b>80</b>

<b>solids determination #1</b>		<b>paint:</b> finish for wood	
<b>date:</b>	<b>18.01.06</b>	<b>71 - 21S</b>	
<b>density:</b> 1,0344			
#1 empty:	10,4167	#2 empty:	10,4276
#1 wet:	10,6934	#2 wet:	10,7299
#1 cured:	10,5530	#2 cured:	10,5709
#3 empty:	10,3901	#3 wet:	10,7174
#3 cured:	10,5560		
solids 1:	49,259	solids 2:	47,403
solids 3:	50,687		
<b>solids: 49,1</b>			

<b>solids determination #6</b>		<b>paint:</b> finish for wood	
<b>date:</b>	<b>19.01.06</b>		
<b>density:</b>			
#1 empty:	10,4482	#2 empty:	10,4205
#1 wet:	10,7118	#2 wet:	10,6587
#1 cured:	10,5809	#2 cured:	10,5424
#3 empty:	10,2554	#3 wet:	10,5610
#3 cured:	10,4150		
solids 1:	50,341	solids 2:	51,175
solids 3:	52,225		
<b>solids: 51,2</b>			

<b>solids determination #2</b>		<b>paint:</b> opaque for wood	
<b>date:</b>	<b>18.01.06</b>	<b>71 - 21S</b>	
<b>density:</b>			
#1 empty:	10,3333	#2 empty:	10,3148
#1 wet:	10,5782	#2 wet:	10,5258
#1 cured:	10,4465	#2 cured:	10,4118
#3 empty:	10,3122	#3 wet:	10,5463
#3 cured:	10,4221		
solids 1:	46,223	solids 2:	45,972
solids 3:	46,946		
<b>solids: 46,4</b>			

<b>solids determination #7</b>		<b>paint:</b> opaque for wood	
<b>date:</b>	<b>19.01.06</b>		
<b>density:</b>			
#1 empty:	10,4625	#2 empty:	10,3878
#1 wet:	10,7575	#2 wet:	10,6572
#1 cured:	10,5945	#2 cured:	10,5076
#3 empty:	10,4584	#3 wet:	10,7797
#3 cured:	10,6021		
solids 1:	44,746	solids 2:	44,469
solids 3:	44,725		
<b>solids: 44,6</b>			

<b>solids determination #3</b>		<b>paint:</b> water-base wood stain	
<b>date:</b>	<b>18.01.06</b>		
<b>density:</b>			
#1 empty:	10,3203	#2 empty:	10,2823
#1 wet:	10,6096	#2 wet:	10,4158
#1 cured:	10,3397	#2 cured:	10,2907
#3 empty:	10,2785	#3 wet:	10,4807
#3 cured:	10,2923		
solids 1:	6,706	solids 2:	6,292
solids 3:	6,825		
<b>solids: 6,6</b>			

<b>solids determination #8</b>		<b>paint:</b> 2K-BC metallic	
<b>date:</b>	<b>19.01.06</b>		
<b>density:</b>			
#1 empty:	10,4515	#2 empty:	10,4853
#1 wet:	10,7883	#2 wet:	10,7824
#1 cured:	10,5085	#2 cured:	10,5348
#3 empty:	10,3947	#3 wet:	10,7459
#3 cured:	10,4536		
solids 1:	16,924	solids 2:	16,661
solids 3:	16,771		
<b>solids: 16,8</b>			

<b>solids determination #4</b>		<b>paint:</b> solvent-base wood stain	
<b>date:</b>	<b>18.01.06</b>		
<b>density:</b>			
#1 empty:	10,3242	#2 empty:	10,3608
#1 wet:	10,5304	#2 wet:	10,6408
#1 cured:	10,3672	#2 cured:	10,4209
#3 empty:	10,4143	#3 wet:	10,5983
#3 cured:	10,4520		
solids 1:	20,854	solids 2:	21,464
solids 3:	20,489		
<b>solids: 20,9</b>			

<b>solids determination #9</b>		<b>paint:</b> 2K-CC	
<b>date:</b>	<b>20.01.06</b>		
<b>density:</b>			
#1 empty:	10,3515	#2 empty:	10,4309
#1 wet:	10,6085	#2 wet:	10,6585
#1 cured:	10,4775	#2 cured:	10,5441
#3 empty:	10,4004	#3 wet:	10,7738
#3 cured:	10,5897		
solids 1:	49,027	solids 2:	49,736
solids 3:	50,696		
<b>solids: 49,8</b>			

<b>solids determination #5</b>		<b>paint:</b> Wood filler	
<b>date:</b>	<b>19.01.06</b>		
<b>density:</b>			
#1 empty:		#2 empty:	
#1 wet:		#2 wet:	
#1 cured:		#2 cured:	
#3 empty:		#3 wet:	
#3 cured:		#3 cured:	
solids 1:	#DIV/0!	solids 2:	#DIV/0!
solids 3:	#DIV/0!	solids 3:	#DIV/0!
<b>solids: #####</b>			

<b>solids determination #10</b>		<b>paint:</b> metal paint	
<b>date:</b>	<b>20.01.06</b>		
<b>density:</b>			
#1 empty:	10,4463	#2 empty:	10,3294
#1 wet:	10,7875	#2 wet:	10,6344
#1 cured:	10,5975	#2 cured:	10,4664
#3 empty:	10,3531	#3 wet:	10,6955
#3 cured:	10,5052		
solids 1:	44,314	solids 2:	44,918
solids 3:	44,422		
<b>solids: 44,6</b>			

**New71 - 0**

**paint: water base wood-stain / 1,0 bar      Test-#: 05      solids [%]: 6,608**

foil	1	mean TE	paint flow	paint sprayed over foil				foil			TE	
			ml/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after		diff.
	1	TE	220	200	300	0,7	2,4	0,162	34,214	34,360	0,146	90,4
	2	90	220	200	300	0,7	2,4	0,162	36,963	37,108	0,145	90,0
	3		220	200	300	0,7	2,4	0,162	38,322	38,467	0,145	89,7

**paint: water base wood-stain / 1,5 bar      Test-#: 06      solids [%]: 6,608**

foil	1	mean TE	paint flow	paint sprayed over foil				foil			TE	
			ml/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after		diff.
	1	TE	220	200	300	0,7	2,4	0,162	37,893	38,034	0,141	87,5
	2	87	220	200	300	0,7	2,4	0,162	37,001	37,142	0,141	87,4
	3		220	200	300	0,7	2,4	0,162	37,390	37,530	0,141	87,0

**paint: solvent base wood-stain / 1,0 bar      Test-#: 07      solids [%]: 20,936**

foil	1	mean TE	paint flow	paint sprayed over foil				foil			TE	
			ml/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after		diff.
	1	TE	300	200	300	0,7	3,3	0,698	37,736	38,281	0,545	78,1
	2	78	300	200	300	0,7	3,3	0,698	33,991	34,538	0,547	78,4
	3		300	200	300	0,7	3,3	0,698	37,763	38,311	0,548	78,5

**paint: solvent base wood-stain / 1,5 bar      Test-#: 08      solids [%]: 20,936**

foil	1	mean TE	paint flow	paint sprayed over foil				foil			TE	
			ml/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after		diff.
	1	TE	300	200	300	0,7	3,3	0,698	38,751	39,277	0,527	75,5
	2	77	300	200	300	0,7	3,3	0,698	38,708	39,243	0,535	76,7
	3		300	200	300	0,7	3,3	0,698	35,464	36,006	0,542	77,7



**New71 - 21S**

**paint: finish for wood (komp. 3+4+5)      Test-#:    01      solids [%]:      49,117**

foil	1	mean TE	paint flow	paint sprayed over foil				foil			TE	
			ml/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after		diff.
	1	TE	280	200	150	1,3	6,2	3,056	36,086	38,706	2,621	85,7
	2	86	280	200	150	1,3	6,2	3,056	36,979	39,603	2,624	85,9
	3		280	200	150	1,3	6,2	3,056	38,242	40,882	2,640	86,4

**paint: finish for wood (komp. 3+4+5)      Test-#:    02      solids [%]:      49,117**

foil	1	mean TE	paint flow	paint sprayed over foil				foil			TE	
			ml/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after		diff.
	1	TE	350	200	150	1,3	7,8	3,820	35,075	38,371	3,296	86,3
	2	87	350	200	150	1,3	7,8	3,820	32,598	35,914	3,316	86,8
	3		350	200	150	1,3	7,8	3,820	34,425	37,790	3,365	88,1

**paint: opaque for wood / 2 bar      Test-#:    03      solids [%]:      46,380**

foil	1	mean TE	paint flow	paint sprayed over foil				foil			TE	
			ml/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after		diff.
	1	TE	300	200	150	1,3	6,7	3,092	31,241	33,787	2,546	82,3
	2	83	300	200	150	1,3	6,7	3,092	32,928	35,496	2,568	83,1
	3		300	200	150	1,3	6,7	3,092	35,314	37,872	2,558	82,7

**paint: opaque for wood / 2,5 bar      Test-#:    04      solids [%]:      46,380**

foil	1	mean TE	paint flow	paint sprayed over foil				foil			TE	
			ml/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after		diff.
	1	TE	300	200	150	1,3	6,7	3,092	33,188	35,700	2,512	81,2
	2	81	300	200	150	1,3	6,7	3,092	35,366	37,888	2,522	81,6
	3		300	200	150	1,3	6,7	3,092	31,454	33,957	2,503	81,0

**New77 - 0**

**paint: finish for wood (komp. 3+4+5)      Test-#:    09      solids [%]:      51,247**

foil	1	mean	paint flow		paint sprayed over foil				foil			TE
			ml/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after	diff.	
		TE	480	200	300	0,7	5,3	2,733	36,191	38,416	2,225	81,4
	2	82	480	200	300	0,7	5,3	2,733	38,218	40,453	2,235	81,8
	3		480	200	300	0,7	5,3	2,733	36,888	39,116	2,228	81,5

**paint: finish for wood (komp. 3+4+5)      Test-#:    10      solids [%]:      51,247**

foil	1	mean	paint flow		paint sprayed over foil				foil			TE
			ml/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after	diff.	
		TE	520	200	300	0,7	5,8	2,961	37,777	40,138	2,360	79,7
	2	80	520	200	300	0,7	5,8	2,961	34,291	36,658	2,367	79,9
	3		520	200	300	0,7	5,8	2,961	37,154	39,530	2,375	80,2

**paint: opaque for wood / 2 bar      Test-#:    11      solids [%]:      44,647**

foil	1	mean	paint flow		paint sprayed over foil				foil			TE
			ml/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after	diff.	
		TE	400	200	300	0,7	4,4	1,984	37,481	39,050	1,569	79,1
	2	80	400	200	300	0,7	4,4	1,984	37,866	39,451	1,585	79,9
	3		400	200	300	0,7	4,4	1,984	34,452	36,039	1,587	80,0

**paint: opaque for wood / 2,5 bar      Test-#:    12      solids [%]:      44,647**

foil	1	mean	paint flow		paint sprayed over foil				foil			TE
			ml/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after	diff.	
		TE	400	200	300	0,7	4,4	1,984	35,916	37,444	1,528	77,0
	2	77	400	200	300	0,7	4,4	1,984	37,284	38,819	1,535	77,3
	3		400	200	300	0,7	4,4	1,984	35,655	37,169	1,514	76,3

**New77 - 15**

**paint: 2K-Basecoat metallic / 2,0 bar** **Test-#: 13** **solids [%]: 16,785**

	mean	total paint flow					paint sprayed over foil					foil			TE
		before	after	Diff.	t (coat)	g/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after	diff.	
foil 1	TE	1570,9	1552,1	18,8	9,9	113,8	200	150	1,3	2,5	0,424	36,568	36,889	0,321	75,6
2	75	1552,1	1532,6	19,5	9,9	118,1	200	150	1,3	2,6	0,440	36,366	36,699	0,333	75,6
3		1532,6	1513,6	19,0	10,0	114,0	200	150	1,3	2,5	0,425	37,235	37,555	0,320	75,2

**paint: 2K-Basecoat metallic / 2,5 bar** **Test-#: 14** **solids [%]: 16,785**

	mean	total paint flow					paint sprayed over foil					foil			TE
		before	after	Diff.	t (coat)	g/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after	diff.	
foil 1	TE	1513,6	1489,7	23,9	9,9	144,8	200	150	1,3	3,2	0,540	36,434	36,835	0,401	74,3
2	74	1489,7	1466,0	23,8	9,9	143,9	200	150	1,3	3,2	0,537	36,167	36,570	0,403	75,1
3		1466,0	1442,4	23,6	9,9	142,9	200	150	1,3	3,2	0,533	36,348	36,743	0,394	74,0

**paint: 2K-Clearcoat / 2,0 bar** **Test-#: 15** **solids [%]: 49,820**

	mean	total paint flow					paint sprayed over foil					foil			TE
		before	after	Diff.	t (coat)	g/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after	diff.	
foil 1	TE	1587,1	1565,3	21,8	9,9	132,3	200	150	1,3	2,9	1,465	37,676	38,714	1,038	70,9
2	71	1565,3	1543,8	21,4	10,0	128,6	200	150	1,3	2,9	1,424	35,774	36,794	1,020	71,7
3		1543,8	1521,9	21,9	9,9	132,8	200	150	1,3	3,0	1,471	36,548	37,583	1,035	70,4

**paint: 2K-Clearcoat / 2,5 bar** **Test-#: 16** **solids [%]: 49,820**

	mean	total paint flow					paint sprayed over foil					foil			TE
		before	after	Diff.	t (coat)	g/min	width	v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after	diff.	
foil 1	TE	1521,9	1493,7	28,2	9,9	171,0	200	150	1,3	3,8	1,893	39,859	41,202	1,343	71,0
2	71	1493,7	1465,8	27,9	9,9	169,0	200	150	1,3	3,8	1,871	39,077	40,423	1,346	71,9
3		1465,8	1437,7	28,1	9,9	170,4	200	150	1,3	3,8	1,887	38,655	39,995	1,341	71,1

**New77 - 2S**

**paint: General metal paint / 2,0 bar** **Test-#:** 17 *solids [%]:* 44,551

foil	mean	total paint flow				paint sprayed over foil				foil			TE		
		before	after	Diff. t (coat)	g/min	width v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after	diff.			
1	TE	1721,6	1683,3	38,2	9,9	231,8	200	150	1,3	5,2	2,294	36,522	38,313	1,791	78,1
2	<b>78</b>	1683,3	1645,3	38,1	9,9	230,8	200	150	1,3	5,1	2,285	35,891	37,683	1,792	78,4
3		1645,3	1607,1	38,2	9,9	231,3	200	150	1,3	5,1	2,290	36,790	38,587	1,797	78,5

**paint: General metal paint / 2,5 bar** **Test-#:** 18 *solids [%]:* 44,551

foil	mean	total paint flow				paint sprayed over foil				foil			TE		
		before	after	Diff. t (coat)	g/min	width v (Rob.)	t (coat)	g (coat)	solids (coat)	before	after	diff.			
1	TE	1607,1	1561,0	46,1	9,9	279,3	200	150	1,3	6,2	2,765	36,710	38,936	2,226	80,5
2	<b>80</b>	1561,0	1515,1	45,9	9,9	277,9	200	150	1,3	6,2	2,752	33,931	36,125	2,194	79,7
3		1515,1	1469,3	45,8	9,9	277,8	200	150	1,3	6,2	2,750	34,503	36,710	2,207	80,2