Research Record No: 258

PRODUCTION, PROCESSING AND EVALUATION OF SCHIESSER 1 x 1 RIB FABRICS, AND THE CONSTRUCTION OF A STARFISH MODEL

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KEY WORDS: 1 x 1 RIB, STARFISH, SCHIESSER

C O N T E N T S

-ooOoo-

1. INTRODUCTION

An agreement with the Institut fuer Textil-und Verfahrenstechnik (ITV), Denkendorf, Germany, to set up a STARFISH user-centre there, was concluded in April 1986.

In order to demonstrate the principles involved in the operation of the STARFISH system, and to assist development within the industry in Germany, it was suggested that a project should be carried out together with a German knitgoods producer which would, at the same time, provide this demonstration and expand the STARFISH database.

Schiesser AG of Radolfzell agreed to act as the industrial partner in this study, and at a meeting in their factory in January 1987, the main outline of the project was agreed. It would be directed at 1 x 1 rib constructions in a range of yarn counts and stitch lengths produced on an 18 gauge machine, and these would be finished by three different routes, all of which were in standard use, at that time, within the Schiesser finishing unit.

It was agreed that IIC would evaluate the fabrics and derive a series of computer-based predictive models, which would be specific to the Schiesser operation.

2. FABRIC PRODUCTION

The knitting of the trial fabrics took place at Schiesser in November-December 1987. Three yarns were used; metric counts 50's, 55's and 70's, ring-spun, all from the same blend of American-type combed cotton, spun by Spinnerei am Uznaberg, Uznach, Switzerland.

Five cones of each yarn were tested at IIC. Test results were also reported by Schiesser; both sets of data are given in Table I. IIC obtained slightly higher values for both yarn count (tex) and twist, but the disagreement is not excessive. Both laboratories noted high coefficients of friction for all yarns.

Knitting was carried out on an Albi model ROF I, 18E gauge, 13 inch diameter with 2 x 744 needles.

Fourteen fabrics were knitted at a total of six stitch lengths, although it was not possible to produce fabric in every combination of yarn count and stitch length. The fabrics are indicated in the following chart by nominal tightness factors:-

NOMINAL TIGHTNESS FACTORS OF FABRICS PRODUCED

Stitch Length cm Nm	0.240	0.250	0.264	0.279	0.297	0.308
50	-	-	16.94	16.03	15.06	14.52
55	-	17.06	16.15	15.28	14.36	13.84
70	15.75	15.12	14.32	13.55	12.73	

Samples of the greige fabrics were submitted to IIC for testing. The test data are given in Table II. In addition measurements of average stitch height and width, before and after a five cycle wash/tumble relaxation treatment, were made at Schiesser using a Video Shrink Inspector (VSI) device. Further reference to this device, and the data obtained from it, will be made later in this report.

The wale density data obtained by IIC were used to arrange the fourteen fabrics in increasing order of width, to facilitate processing.

3. PROCESSING

Fabric processing took place at the finishing works of Schiesser AG in Radolfzell, during the period 25-28 April 1988.

Three processing routes were included in the study, these being:

1. continuous bleaching
2. winch bleaching
3. kier bleaching, followed by reactive dyeing in a Thies Roto-Stream jet machine

All fourteen fabric structures were processed through all three routes, to make a total of forty-two finished fabrics.

3.1. Continuous Bleaching

This was carried out in a Fleissner continuous range, using a peroxide pad-steam process. Details are shown in Table III. Fabric speed through the machine was about 20 metres per minute.

Following bleaching and washing-off the fabric was pre-dried using a suction drum dryer, and was then re-moistened using a Weko spray unit to give about 30% o.w.f. additional moisture and held in a scray for 3-5 minutes. It was then over-stretched and re-dried using a Fleissner "System Schiesser" relaxing dryer.

3.2. Winch Bleaching

The second fabric set was winch-bleached with peroxide, as described in Table IV. Following this process, the fabric was centrifuged, overstretched to (nominally) 168% of finished width and plaited into trucks. Drying took place in a Santex "Santashrink" relaxing dryer, the temperature settings in the four chambers being 140°, 120°, 120°, and 120°C respectively. A running speed of 22 metres per minute gave a dwell time of one minute in the machine.

After drying, the fabrics were finished on an Arbach model TAS steam calender. This was fitted with a "Video Shrink Inspector" device at the entry side, which was being used to monitor incoming courses, so that overfeed could be adjusted as deemed necessary.

3.3. Kier bleaching/Roto-Stream dyeing

Details of wet processing by this route are given in Table V. Drying and finishing was carried out similarly to that described for the winch bleached fabrics (para 3.2); the only difference being in the temperature settings for the Santashrink machine (130°, 130°, 120°. 120°C).

3.4. General Comments

Measurements of course density were made at various stages during processing to try to gain an understanding of fabric behaviour. The results are given in Table VI, and will be analysed at a later date.

Fluidity measurements (to B.S. 2610) carried out on the bleached fabrics gave the following results:-

- continuous bleached 4.8-5.9 (D.P. 1700-1900)
- winch bleached 3.9-5.5 (D.P. 1800-2100)

Whiteness was calculated by the equation given in ISO 105-J02 (1987).

- continuous bleached 79.5
- winch bleached 81.8

CIE 1976 X,Y,Z chromaticity co-ordinates for the Roto-Stream dyed fabric were 61.9, 67.0, 81.8 respectively. For the purposes of the current STARFISH nomenclature this would be regarded as a "pale" shade.

4. LABORATORY EVALUATION

Following completion of processing, samples of all forty-two finished fabrics were evaluated both at Schiesser and at IIC in Manchester.

IIC test results on the finished fabrics as received, and after washing and tumble drying are given in Tables VII to IX.

The primary purpose of this study was to evaluate the dimensional stability of the fabrics, and to determine the Reference State of each fabric construction in order to produce STARFISH predictive models relevant to Schiesser production conditions. Comparison of the data obtained in the two laboratories would, it was hoped, enable Schiesser to relate STARFISH predictions to specifications and requirements based on their own quality control reports.

Various other parameters (yarn and fabric strength, thickness, spirality) are measured as a matter of routine in knitgoods evaluations at IIC. These were not germane to this investigation, but are included in the tables as they may provide useful information in other studies.

A secondary investigation was carried out by IIC, comparing shrinkages obtained by tumble drying and line drying methods. A short report on this work is given in Section 7.

5. CONSTRUCTING THE MODEL

Construction of the current form of STARFISH predictive models is carried out in two steps.

Step 1 relates the greige-state yarn count and stitch length to the yarn count and stitch length in the finished fabric in the Reference State, that is, after five machine wash/tumble dry cycles.

Step 2 relates the Reference State yarn count and stitch length to course and wale densities and fabric weight in the same Reference State.

This section describes the construction of STARFISH models from IIC data on the Schiesser fabrics.

5.1. Greige Fabrics - Yarn Count and Stitch Length

Yarn count results were available from two sources, yarn package and knitted fabric testing. Simple mean values were therefore calculated, as indicated below:

Nominal count (Nm)	Yarn package (tex)	Knitted fabric (tex)	Mean (tex)	Deviation from nominal %
50	20.41	19.95	20.18	+0.9
55	18.07	17.87	17.97	-1.2
70	14.85	14.61	14.73	+3.1

The Nm 50 and Nm 70 yarns were found to be slightly heavier, and the Nm 55 slightly lighter, than nominal.

Stitch length results were averaged, where possible, across yarn counts, thus:-

Nominal stitch length (cm)	No. of fabric qualities	Test data on each quality	Mean stitch length cm	Diff from Nominal %
0.240	1	0.244	0.244	+1.7
0.250	2	0.253,0.253	0.253	+1.2
0.264	3	0.267,0.265,0.267	0.266	+0.8
0.279	3	0.280,0.280,0.282	0.281	+0.7
0.293	3	0.295,0.295,0.296	0.295	+0.7
0.308	2	0.310,0.311	0.310	+0.6

The measured stitch lengths were slightly longer than nominal by an average of 0.9%.

These values were then used in the construction of the computer model.

5.2. Step One - Prediction of yarn count and stitch length in the Reference State.

Three finishing routes were examined in this study. For convenience, in the computer programme these have been labelled:

- continuous bleach
- winch bleach
- Roto-Stream dye (pale shades)

It should be remarked at the outset that these labels may not indicate the main factor controlling the fabric behaviour. For example, the Roto-Stream dyed fabric was pre-bleached in a kier. With a different preparation, fabric dyed in a Roto-Stream machine might well behave differently. At a later date, a more extensive study may well reveal that this route would have been more suitably labelled "kier bleach". For the moment however,, the labels given above will be used.

In Step One of the STARFISH model, the final yarn count and stitch length, after processing, and after relaxing to the Reference State, are compared to the yarn count and stitch length in the greige fabric. It has been found that these can be related using the general equation

$$Y = aX \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The calculated values for the coefficient a for each finishing route, and for the greige Reference State, are given in Table X together with coefficients of correlation (r^2) with the measured data.

5.3. Step Two - Course and wale densities, stitch density and weight

In the second step of the mathematical treatment of the test data, regression equations are constructed linking finished fabric dimensions, in the Reference State, to yarn count and stitch length.

For course and wale density prediction, the equations are of the form:

$$Y = a + bX_1 + cX_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where, X_1 is the reciprocal of stitch length and X_2 is the square root of the yarn count in tex, both in the finished Reference State.

Equations for the prediction of stitch density and fabric weight have also been calculated, although these are not used in the current model. The stitch density equation is of form (2) X_1 being the reciprocal of (stitch length) squared and X_2 is the yarn count in tex.

The fabric weight equation is of form ($Y = a + bX$) where X is the yarn count divided by the stitch length.

The equation coefficients, and coefficients of correlation (r^2) with the observed data are given in Table XI.

Some of these equations are plotted in Figures 1-12, which show the goodness of fit with the observed data.

Figures 1-4 refer to the course density, in courses per cm, for greige, continuous bleached, winch bleached and Roto-Stream dyed fabrics respectively. The observed data fit the prediction quite well, with the fabrics knitted from the Nm70 yarn showing the greatest deviations.

Figures 5-8 showing corresponding wale density data, exhibit rather greater overall variations.

Figures 9-12, referring to the weight data indicate a possible slight imperfection in the STARFISH model, in that low tightness factors have appeared to result in a lower weight than that predicted, with the converse for tighter fabrics.

The equations have been incorporated into a development STARFISH computer programme, provisionally labelled STARDEV4.

Note regarding fabric weight.

It is of interest to note that weight could be modelled by the equation:

$$Y = aX$$

where X is the yarn count divided by the stitch length, without impairment to the correlation. In this case:

	a	r^2
Greige	3.38431	0.968
Continuous bleach	2.87221	0.970
Winch bleach	3.14410	0.969
Roto-Stream dye	3.12932	0.988

6. INTERLABORATORY COMPARISON

The data submitted by Schiesser comprised:

a) measurements of shrinkage in a five cycle machine wash/tumble dry test,

b) measurements of stitch height and stitch width, carried out before and after the five cycle wash/tumble treatment, using the Sick VSI Video Shrink Inspector.(See Appendix).

6.1. Shrinkage data

The comparison of shrinkage data on knitted cotton fabrics may be complicated by the possibility that some relaxation may have occurred during the time taken for transportation of samples from one laboratory to another prior to testing. For this reason the main weight of this part of the study should be placed on the comparison of the Reference State data, described in subsection 6.2.

Essential differences in the conditions of measurement in the two laboratories must also be taken into account. Specimens in the IIC method are single layer, and measurements are made under tension-free conditions. Schiesser employed a test method developed at ITV Denkendorf using tubular specimens, with measurements made under a small but definite widthway tension.

The two sets of shrinkage results are shown in Table XII. The correlation between the length shrinkages is quite good; overall the mean Schiesser result is 8.2%, and for IIC 8.1%.

For width shrinkage, however, IIC have obtained consistently lower values for all the fabrics, average values being Schiesser 5.0%, IIC 1.7%.

Schiesser also reported shrinkage values using the VSI to measure stitch dimensions before and after the relaxation treatment. Here, the mean values were - length 7.8%, width 3.2%. It is not known if the fabric was under tension during these measurements.

6.2. Course and wale densities

The measurements obtained by Schiesser for stitch height and stitch width, after relaxation, were converted to course and wale densities, using the equations:

$$\text{courses per 3cm} = \frac{30000}{\text{stitch height (mm)}}$$

$$\text{visible wales per 3cm} = \frac{30000}{2 \times \text{stitch width (mm)}}$$

The results are shown in Table XIII.

In figures 13 and 14, these results are compared with the corresponding IIC measurements. From these figures, it would appear that Schiesser have obtained a greater degree of relaxation, with reasonable agreement between the laboratories achieved only with greige fabric wales and Roto-Stream dyed courses.

These discrepancies do not mean that a STARFISH predictive system, built up from the IIC data, would not be of value to Schiesser. A simple series of correction factors may be sufficient to bring the two testing regimes into line. For example, equations of the type Y = a + bX have been calculated linking the two data sets, with reasonable levels of correlation, as shown in the following table:

	a	b	r^2
Courses per 3cm			
Greige	1.527	1.033	0.988
Continuous bleach	-2.496	1.070	0.994
Winch bleach	-3.593	1.097	0.989
Roto-Stream dye	-2.892	1.064	0.992
Overall	**-3.262**	**1.092**	**0.953**
Wales per 3cm			
Greige	-3.287	1.087	0.938
Continuous bleach	0.552	1.055	0.857
Winch bleach	9.266	0.797	0.827
Roto-Stream dye	-0.005	1.043	0.953
Overall	**9.039**	**0.786**	**0.755**

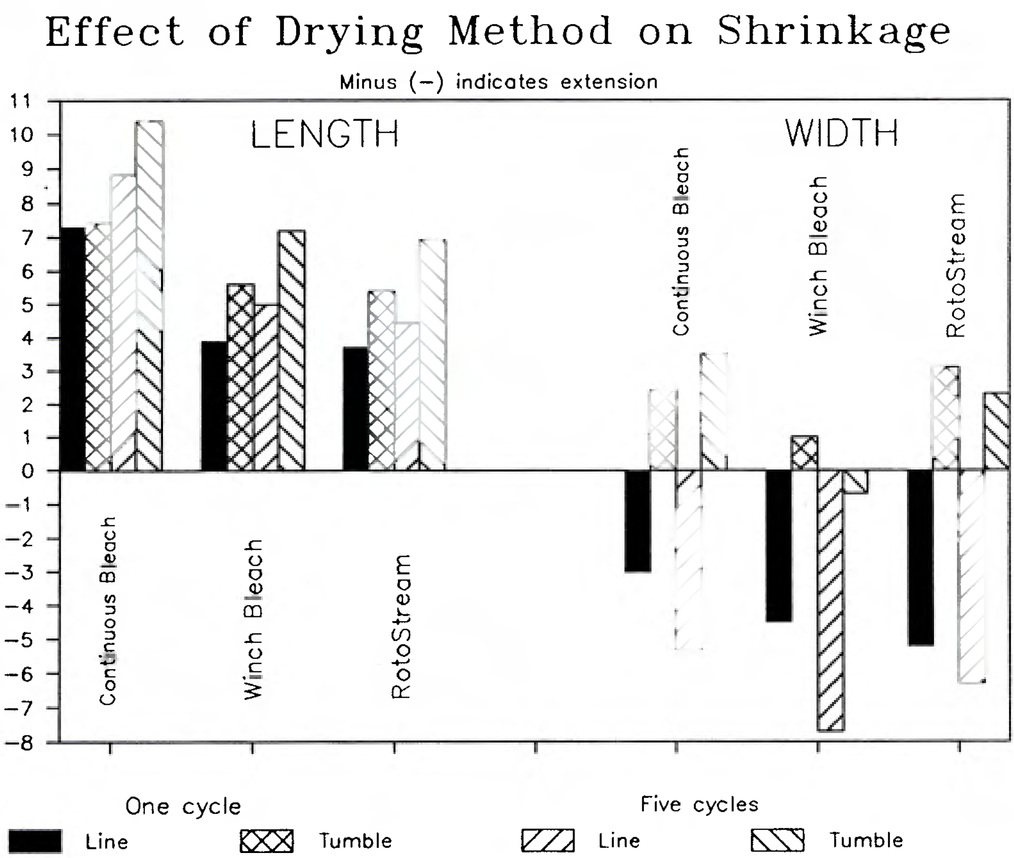
An overall corrective equation might be considered for course density, but on the basis of this analysis, separate equations would be necessary for wale density conversions.

7. TUMBLE/LINE DRYING STUDY

Following the main IIC evaluation, sufficient remained from all but four of the forty-two finished fabric samples for a second series of laundering trials.

In this study, line drying was used in place of tumble drying. The specimens were hung on a line with the wales vertical. Measurements were made after one and five wash cycles. In addition to shrinkage, measurements were made of course and wale densities. The test results are shown in Tables XIV to XVI.

The mean shrinkage results are shown in the chart below, which gives an indication of the dependence of fabric behaviour on the drying method employed. In particular, a width shrinkage of 2-3 per cent in tumble drying can become an extension of 6-7 per cent in line drying!



8. CONCLUSIONS

A series of equations, based on the STARFISH predictive system, has been obtained to model the behaviour of cotton 1 x 1 rib fabrics, knitted and finished at Schiesser AG. Three finishing routes have been studied; continuous bleaching, winch bleaching and kier bleaching followed by reactive dyeing in a Thies Roto-stream jet machine.

These equations have been incorporated into a STARFISH computer programme, provisionally codenamed STARDEV4. Correlation of the predicted with the observed fabric behaviour, using IIC data, is excellent (as might be expected); however, the relaxation procedure carried out at Schiesser has been found to give significantly different results, and any attempt at adaptation of the STARFISH predictive system to Schiesser test data would probably require the use of correction factors.

The study has demonstrated that the equipment and operating methods at this factory are capable of delivering fabric with good dimensional stability. Shrinkages from the Santashrink machine were rather better than those obtained on the fabric which passed through the Fleissner relaxing range, though this may not necessarily be a typical result.

In a subsidiary study, considerable differences in the behaviour of rib fabrics have been demonstrated in a comparison of line and tumble drying.

Table I

Schiesser Rib - Yarns

	Nm50	Nm55	Nm70
Yarn count (Tex)	20.41	18.07	14.85
Twist (turns per metre)	855	866	937
Single end strength (g)	307.23	249.75	204.68
Extension at break (%)	6.77	6.41	6.33
Coefficient of friction (mu)	0.18	0.21	0.16
Yarn count (Ne)	28.93	32.69	39.76
Turns per inch	21.72	22.00	23.79
Twist Factor - alpha Tex	38.63	36.81	36.09
Twist Factor - English	4.04	3.85	3.77
Tenacity (g./Tex)	15.05	13.82	13.78
Nm	49.0	55.3	67.3
α_m	122	116	114

15.5.83

	Nm	tex	T/m	α_{metr}	α_{engl}
50/1	49,18	20,33	816,8	116,47	3,85
55/1	56,8	17,61	853,0	113,1	3,73
70/1	68,3	14,64	916,1	110,91	3,66

Results of Schiesser Yarn - Testing

for our Starfish - qualities

Table II

Schiesser Rib - Grey Fabrics

	50/264	50/279	50/293	50/308	55/250	55/264	55/279	55/293	55/308	70/240
Weight (gsm), BW	183.34	176.40	166.35	165.00	163.05	156.57	152.07	154.88	144.93	134.08
Weight (gsm), AW	254.26	247.98	230.27	221.93	231.53	222.82	210.32	205.99	195.93	194.77
Courses per 3cm, BW	49.70	46.20	42.20	38.95	51.50	47.80	43.80	41.85	38.15	52.40
Courses per 3cm, AW	59.23	56.38	52.63	49.33	61.33	57.73	53.90	51.00	48.28	62.50
Wales per 3cm, BW	30.90	30.90	30.50	30.55	30.70	30.90	31.65	31.60	29.95	30.75
Wales per 3cm, AW	37.48	36.40	34.65	33.83	39.05	37.68	36.43	35.43	33.60	40.63
Stitch length (mm) BW	2.67	2.80	2.95	3.10	2.53	2.65	2.80	2.95	3.11	2.44
Stitch length (mm) AW	2.64	2.77	2.92	3.05	2.50	2.62	2.79	2.91	3.06	2.41
Burst strength (kPa), BW	673.80	643.40	579.70	606.40	629.30	626.90	582.00	552.20	546.40	542.50
Burst strength (kPa), AW	714.00	692.20	661.10	620.60	666.00	636.20	547.20	580.00	545.90	554.30
Distension at burst (mm), BW	18.31	18.43	19.67	18.87	17.86	17.91	18.53	18.63	18.88	17.65
Distension at burst (mm), AW	23.24	22.90	23.24	23.26	21.78	21.86	21.81	22.44	22.22	22.49
Angle of spirality, BW	-2.22	-2.07	-3.53	-3.72	-1.53	-1.30	-1.66	-3.80	-2.93	-2.80
Angle of spirality, AW	1.88	4.14	3.82	4.00	3.48	0.88	2.66	3.70	4.44	3.72
Width (cm), BW	36.23	35.63	35.73	35.87	34.97	35.63	35.70	36.00	36.53	34.07
Yarn strength (g), BW	272.71	276.27	279.16	273.11	219.28	214.39	207.35	226.99	221.41	179.57
Yarn strength (g), AW	246.76	267.13	248.99	260.35	214.75	209.39	212.63	205.04	204.61	173.45
Yarn ext. at break (%), BW	8.89	9.70	8.68	9.34	7.78	8.34	7.83	8.66	8.28	7.81
Yarn ext. at break (%), AW	9.50	10.22	9.95	10.51	8.70	9.41	9.50	9.68	9.29	8.96
Yarn count (tex), BW	20.17	20.12	19.77	19.75	17.73	17.95	17.70	17.97	18.00	14.54
Yarn count (tex), AW	19.59	19.76	19.62	19.45	17.72	17.50	17.27	17.71	17.83	14.33
Thickness (mm x 1000), BW	827	836	883	901	785	772	818	856	881	725
Thickness (mm x 1000), AW	1121	1149	1142	1189	1074	1123	1128	1148	1185	1006

NOTES

5x after 5 machine wash (60 deg.C.)/tumble dry cycles
BW as received (before wash)
AW after 5 wash/tumble dry cycles (after wash)

Table II (cont.)

Schiesser Rib - Grey Fabrics

	70/250	70/264	70/279	70/293
Weight (gsm), BW	129.95	128.22	127.72	124.64
Weight (gsm), AW	191.34	181.88	177.53	170.88
Courses per 3cm, BW	49.45	46.10	41.55	39.10
Courses per 3cm, AW	59.55	55.93	53.38	50.15
Wales per 3cm, BW	32.00	32.95	32.80	32.75
Wales per 3cm, AW	40.05	38.62	36.82	36.66
Stitch length (mm) BW	2.53	2.67	2.82	2.96
Stitch length (mm) AW	2.51	2.64	2.79	2.91
Burst strength (kPa), BW	519.30	498.70	452.30	489.30
Burst strength (kPa), AW	512.50	493.40	484.70	472.80
Distension at burst (mm), BW	17.88	17.36	17.03	18.24
Distension at burst (mm), AW	22.46	22.46	22.49	22.59
Angle of spirality, BW	-2.16	-0.95	-2.36	-2.90
Angle of spirality, AW	1.62	0.26	0.50	0.76
Width (cm), BW	34.27	33.40	33.90	34.07
Yarn strength (g), BW	188.19	189.12	180.37	169.17
Yarn strength (g), AW	171.85	161.98	169.83	170.67
Yarn ext. at break (%), BW	8.49	8.31	8.39	8.13
Yarn ext. at break (%), AW	8.99	8.82	9.32	9.19
Yarn count (tex), BW	14.52	14.69	14.80	14.53
Yarn count (tex), AW	14.28	14.43	14.56	14.37

NOTES

5x after 5 machine wash (60 deg.C.)/tumble dry cycles
BW as received (before wash)
AW after 5 wash/tumble dry cycles (after wash)

TABLE III

Continuous Bleaching

A Continuous bleaching (Fleissner)

1) First bath (impregnating)
   - wetting
   - sodium hydroxide
   - hydrogen peroxide
   - stabilizer
   - antifoam
   - fluorescent whitener
   - organic complexing agent

2) Foulard (residual moisture 140 %)

3) perforated belt steamer
   30 min, 96° C

4) suction washing machines (2 times)
   70° C
   and foulards

5) Second impregnating bath (blank vat)
   - emulsifying agent
   - complexing agent
   - hydrosul phite
   and foulard

6) perforated belt steamer
   3 min, 92° C

7) suction washing machines (3 times)
   70° C and foulards

8) softening bath and foulard

9) suction drum drier, 1 min
   8 drums: 130° C, 100° C, 100° C, 100° C

B Relax Drier

1) Weko-humidifier
   (30° residual moisture)

2) overstretching to 190 %

3) drying at 100° C,
   agitated carrying strap
   2 min

C Steam calender

3.3.1988
828 GK/NR

TABLE IV

PARTIE-NR.: 85586 MEHRFACHFAERBER/BLEICHER: N

26. 4. 88

FARBNAME	FARB-NR.	QUAL.	A	D	MASCH-BEZ.	SPINNER	FLOTTE
WEISS	0001	4467	2	N	GR. KUFE A 7	00	1:18,00

MENGE: 241,84 KG

NETZEN			
0,2500 % INVADIN AF	650066	0,605	....
BLEICHEN OHNE			
2,0000 % LASTABIL GS	650115	4,837	....
2,0000 % AETZNATRON	650036	4,837	....
10,0000 % WASSERSTOFFPEROXID 50 %	650012	24,184	....
0,4400 % LEUKOPHOR BCD FLUESSIG	650056	1,064	....
2. BLEICHBAD			
,5000 % LASTABIL GS	650115	1,209	....
3,0000 % WASSERSTOFFPEROXID 50 %	650012	7,255	....
WEICHMACHEN			
~~3,0000~~ 2,5 % POLYAVIN VK	650085	~~7,255~~	7,– ....
0,5000 % POLYAVIN VS	650086	1,209	....
0,5000 % ESSIGSAEURE 60 %	650039	1,209	....

FAERBEVORSCHRIFT: 39

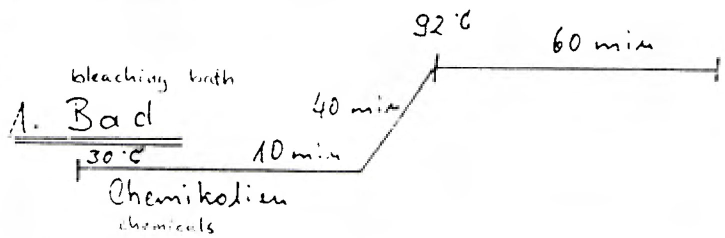
TEXT:
TEXT: Versuch H. Gönner

DATUM: 26.4. ....

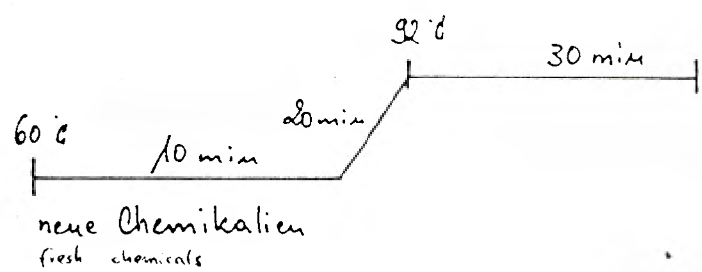
winch bleaching (all qualities)

Weiß auf Kufe für alle Qualitäten: 39

1. netzen wetting



Muster sampling
1/2 Bad ablassen drainage of half the liquor
frisches Wasser zulaufen lassen refill with fresh water
bis 60 °C neue Chemik. zugeben
before 60 °C are reached, addition of new chemicals



mustern sampling

4 x heiß spülen 4 times hot rinsing bath

+ aviviert (softening bath

PARTIE-NR.: 85587   MEHRFACHFAERBER/BLEICHER: N   TABLE V

26.4.88

FARBNAME	FARB-NR.	QUAL.	A	D	MASCH-BEZ.	SPINNER	FLOTTE
OZON	0721	4467	0	N	ROTO 2	00	1:08,20

MENGE: 257,84 KG   9.9   3 ropes

Netzen Bleiche

FAERBEN

1,0000 G HEPTOL WZB	650068	~~2,114~~	2,500
0,8100 G LYOPRINT RG 0,5	650069	~~1,713~~	1,500
0,0380 % CIBACRON BLAU TR-E	670080	~~0,098~~	98,0
0,0019 % CIBACRONVIOLETT TRE	670082	~~0,005~~	5,0
6,2000 G SODA CALC.98	650098	~~13,109~~	15,500

liquor at start   FLOTTENANFANG: ~~1314~~ LITER 1500,0

end   FLOTTENENDSTAND: ~~2114~~ LITER 2500,0

WEICHMACHEN softening

2,5000 % SANDOLUB NVJ FLUESSIG   650043   ~~6,446~~ 7,-

FAERBEVORSCHRIFT: 21

TEXT: Versuch H. Gönner
TEXT:

DATUM: 26.4.88

UNTERSCHRIFT: ......

netzen: 0,25% Sandozin = 0,600 kg
bleichen: 0,5% Ätznatron = 1,500 kg
5,0% Wasserstoffperoxid = 15,000 kg

sample after 3 ...
Nach 25 Min Mustern

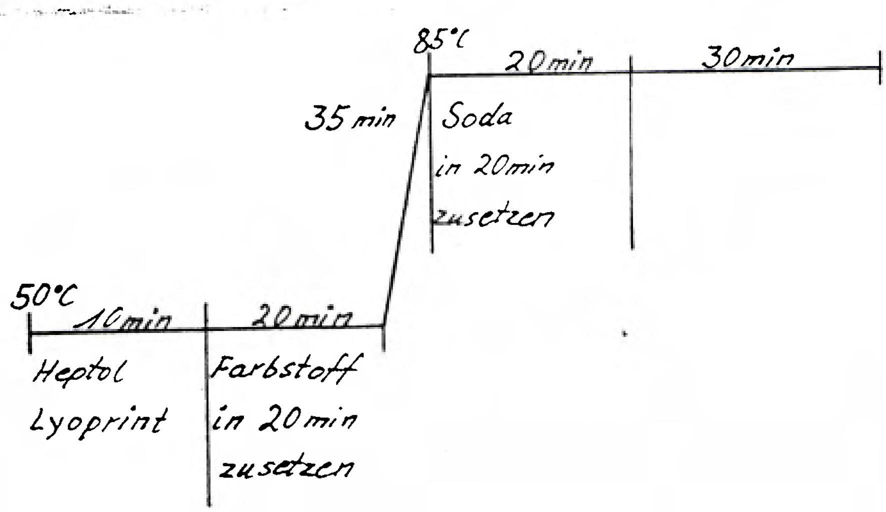


Table VI. Course density measurements during processing.

	Winch bleached				Roto-Stream dyed			
	1	2	3	4	1	2	3	4
50/264				54			54½	54
50/279						51	53	52
50/293				46½		47	48½	48½
50/308				45		43	46½	45½
55/250				56½		57	56½	58
55/264	49	51	54			52½	54½	54½
55/279				49		47	49½	
55/293	42	44	48½		44½	43	48	47½
55/308	41½	41	46			41	44	
70/240							58½	59½
70/250	48		54½	55			56	
70/264	44	48	51½			45	56	
70/279		45	50		44	45	48½	
70/293				46½		41	45	

1 After centrifuging
2 After wet-stretching
3 After Santex dryer
4 After calendering

Table VII

Schiesser Rib – Finished Fabrics

Series C – continuous bleached

	50/264	50/279	50/293	50/308	55/250	55/264	55/279	55/293	55/308
Length shrinkage (%), TD	6.22	6.46	7.30	9.57	5.03	6.72	6.95	5.49	10.66
Width shrinkage (%), TD	3.92	3.97	1.24	1.73	4.21	3.41	2.18	1.04	1.51
Length shrinkage (%), 5x	8.96	9.11	9.64	12.09	8.30	9.79	10.00	9.57	13.23
Width shrinkage (%), 5x	5.55	5.36	2.36	-0.19	6.27	5.16	4.74	2.05	0.46
Weight (gsm), BW	195.08	181.33	174.69	167.78	174.14	166.00	157.00	153.82	145.57
Weight (gsm), AW	215.71	205.89	197.98	188.69	194.94	186.30	175.47	171.63	163.64
Courses per 3cm, BW	51.95	48.95	45.65	41.50	54.45	50.35	47.50	43.45	40.25
Courses per 3cm, TD	55.20	52.40	48.40	45.75	58.00	54.00	50.73	47.00	44.90
Courses per 3cm, AW	56.90	53.00	49.50	46.95	58.90	55.50	51.65	48.50	45.95
Wales per 3cm, BW	32.40	32.10	31.00	31.05	32.95	32.70	32.25	31.25	30.75
Wales per 3cm, TD	33.55	32.95	32.25	31.25	34.45	33.60	33.40	32.45	31.05
Wales per 3cm, AW	33.85	32.95	31.80	30.60	35.00	34.00	32.55	31.80	30.20
Stitch length (mm) BW	2.63	2.75	2.91	3.06	2.49	2.61	2.77	2.91	3.07
Stitch length (mm) AW	2.63	2.74	2.89	3.03	2.48	2.61	2.76	2.89	3.04
Burst strength (kPa), BW	671.40	599.90	573.50	590.80	635.70	604.90	517.10	416.30	515.80
Burst strength (kPa), AW	677.20	456.00	492.70	590.50	638.20	598.40	454.80	396.80	533.60
Distension at burst (mm), BW	18.04	17.62	18.34	17.21	17.22	17.34	15.71	19.00	16.93
Distension at burst (mm), AW	19.15	20.47	20.66	20.78	18.36	19.36	19.89	19.61	20.59
Angle of spirality, BW	-0.29	0.32	-0.06	0.17	-0.33	0.03	-0.01	0.11	-0.69
Angle of spirality, AW	0.42	0.76	1.49	0.97	-0.07	0.19	0.96	1.60	0.97
Width (cm), BW	34.33	34.77	34.93	36.30	34.27	34.07	34.53	35.33	36.67
Yarn strength (g), BW	295.91	320.12	309.04	313.20	258.81	259.97	251.59	260.24	260.60
Yarn strength (g), AW	341.27	316.39	317.23	316.43	279.49	277.59	276.49	276.95	256.77
Yarn ext. at break (%), BW	8.27	7.80	7.82	8.24	7.64	8.17	6.91	7.20	7.95
Yarn ext. at break (%), AW	8.47	7.36	6.66	8.03	7.77	7.91	6.84	6.84	7.66
Yarn count (tex), BW	19.62	19.82	19.47	19.66	17.52	17.48	17.23	17.38	17.29
Yarn count (tex), AW	19.42	19.66	19.63	19.22	17.26	17.24	17.05	16.89	17.37
Thickness (mm x 1000), BW	750	769	753	792	708	729	733	739	757
Thickness (mm x 1000), AW	965	883	899	982	898	919	862	866	949

NOTES

5x after 5 machine wash (60 deg.C.)/tumble dry cycles

BW as received (before wash)

AW after 5 wash/tumble dry cycles (after wash)

Table VII (cont.)

Schiesser Rib - Finished Fabrics

Series C - continuous bleached

	70/240	70/250	70/264	70/279	70/293
Length shrinkage (%), TD	6.76	7.72	9.13	8.35	7.08
Width shrinkage (%), TD	3.69	2.40	0.66	2.40	1.46
Length shrinkage (%), 5x	9.72	11.08	12.56	10.87	10.20
Width shrinkage (%), 5x	5.66	3.79	1.90	4.26	1.91
Weight (gsm), BW	143.26	141.25	136.46	128.72	125.10
Weight (gsm), AW	160.68	159.49	153.87	143.40	145.51
Courses per 3cm, BW	55.00	51.30	47.75	43.80	41.83
Courses per 3cm, TD	58.80	55.70	52.25	48.25	47.37
Courses per 3cm, AW	60.30	57.40	53.85	49.80	47.85
Wales per 3cm, BW	34.30	34.90	34.65	33.65	33.40
Wales per 3cm, TD	35.40	35.60	34.70	34.60	32.20
Wales per 3cm, AW	35.65	35.80	34.85	33.50	33.05
Stitch length (mm) BW	2.41	2.50	2.63	2.70	2.91
Stitch length (mm) AW	2.39	2.49	2.62	2.77	2.90
Burst strength (kPa), BW	490.70	486.40	470.80	406.10	424.50
Burst strength (kPa), AW	529.30	502.60	489.20	364.40	385.90
Distension at burst (mm), BW	16.80	16.87	17.11	19.05	18.60
Distension at burst (mm), AW	18.66	18.66	19.86	20.97	20.90
Angle of spirality, BW	-0.12	1.09	0.45	0.26	-0.14
Angle of spirality, AW	0.89	-0.13	0.88	0.58	1.35
Width (cm), BW	32.30	32.57	32.53	32.77	32.93
Yarn strength (g), BW	206.97	204.04	205.60	194.51	203.40
Yarn strength (g), AW	206.96	224.35	215.37	225.64	224.63
Yarn ext. at break (%), BW	7.67	7.59	7.75	6.43	6.85
Yarn ext. at break (%), AW	7.09	7.81	7.82	6.57	7.77
Yarn count (tex), BW	14.24	14.33	14.19	13.88	14.61
Yarn count (tex), AW	14.10	14.01	14.02	13.84	14.45
Thickness (mm x 1000), BW	655	662	679	676	702
Thickness (mm x 1000), AW	838	848	852	794	800

NOTES

5x after 5 machine wash (60 deg.C.)/tumble dry cycles
BW as received (before wash)
AW after 5 wash/tumble dry cycles (after wash)

Table VIII

Schiesser Rib - Finished Fabrics

Series K - winch bleached

	50/264	50/279	50/293	50/308	55/250	55/264	55/279	55/293	55/308
Length shrinkage (%), TD	5.12	4.96	5.42	7.21	3.90	5.18	5.96	5.60	7.33
Width shrinkage (%), TD	0.81	1.45	1.19	-0.89	2.36	1.34	0.34	0.90	-0.60
Length shrinkage (%), 5x	6.13	5.92	7.53	9.21	5.53	6.04	7.29	7.57	9.60
Width shrinkage (%), 5x	-0.88	-0.78	-0.08	-2.58	2.08	-0.37	-2.68	-1.91	-2.77
Weight (gsm), BW	226.56	214.84	207.90	200.42	205.67	196.80	188.75	182.55	169.82
Weight (gsm), AW	238.72	224.50	219.95	208.77	216.40	202.69	195.70	192.93	179.37
Courses per 3cm, BW	54.30	51.95	48.75	44.80	58.00	52.80	49.55	46.75	43.50
Courses per 3cm, TD	57.75	54.45	50.90	47.50	60.25	56.85	52.40	49.35	45.95
Courses per 3cm, AW	57.90	54.75	52.15	48.85	61.00	56.30	53.35	50.10	47.25
Wales per 3cm, BW	35.55	34.30	33.50	32.80	36.65	35.30	35.40	34.70	32.85
Wales per 3cm, TD	36.05	34.30	33.55	32.45	37.45	35.75	34.40	34.00	32.65
Wales per 3cm, AW	35.63	34.10	33.33	32.10	37.58	35.13	33.88	33.73	32.08
Stitch length (mm) BW	2.64	2.78	2.91	3.06	2.50	2.63	2.77	2.91	3.06
Stitch length (mm) AW	2.62	2.76	2.89	3.03	2.49	2.60	2.75	2.88	3.04
Burst strength (kPa), BW	700.70	654.20	670.20	621.80	659.40	617.50	572.60	560.70	532.60
Burst strength (kPa), AW	671.10	644.30	614.60	567.50	660.70	585.40	543.60	544.60	485.90
Distension at burst (mm), BW	21.73	22.24	21.99	21.59	20.88	20.92	21.71	20.22	19.30
Distension at burst (mm), AW	21.39	22.42	21.47	22.07	21.58	21.09	22.23	21.10	22.03
Angle of spirality, BW	-1.21	0.71	-0.38	-2.05	0.54	1.30	-0.95	-0.98	-4.90
Angle of spirality, AW	-0.51	0.68	-0.59	-0.88	0.46	-0.08	0.28	-1.71	-1.95
Width (cm), BW	31.57	32.53	33.05	33.40	31.07	31.70	31.87	31.88	32.62
Yarn strength (g), BW	264.88	259.81	269.05	261.17	219.11	216.44	211.23	205.40	213.57
Yarn strength (g), AW	297.60	289.92	288.12	277.25	241.88	230.40	242.56	236.43	236.45
Yarn ext. at break (%), BW	7.66	7.86	8.57	8.49	7.95	7.04	6.94	7.34	7.42
Yarn ext. at break (%), AW	7.73	7.76	8.23	8.26	7.68	6.73	7.14	7.64	7.51
Yarn count (tex), BW	19.70	19.53	19.81	19.85	17.44	17.38	17.43	17.30	17.41
Yarn count (tex), AW	19.55	19.37	19.67	19.63	17.31	17.44	17.38	17.59	17.51
Thickness (mm x 1000), BW	898	917	945	945	862	868	894	919	929
Thickness (mm x 1000), AW	985	1009	1091	1090	975	950	984	1063	1066

NOTES

5x after 5 machine wash (60 deg.C.)/tumble dry cycles
BW as received (before wash)
AW after 5 wash/tumble dry cycles (after wash)

Table VIII (cont.)

Schiesser Rib - Finished Fabrics

Series K - winch bleached

	70/240	70/250	70/264	70/279	70/293
Length shrinkage (%), TD	4.26	4.64	5.74	5.95	6.71
Width shrinkage (%), TD	3.12	1.37	0.96	0.60	1.20
Length shrinkage (%), 5x	5.72	6.33	7.60	7.64	8.08
Width shrinkage (%), 5x	3.24	0.92	0.13	-2.17	-1.99
Weight (gsm), BW	173.62	163.70	157.43	154.41	146.40
Weight (gsm), AW	189.13	171.04	167.15	159.77	154.36
Courses per 3cm, BW	59.05	55.45	51.60	48.75	46.15
Courses per 3cm, TD	62.40	58.15	54.80	51.30	48.35
Courses per 3cm, AW	62.60	58.85	55.35	51.90	49.40
Wales per 3cm, BW	38.30	37.60	36.65	35.55	33.05
Wales per 3cm, TD	39.30	37.05	36.75	35.20	33.80
Wales per 3cm, AW	39.40	37.03	36.20	34.44	32.90
Stitch length (mm) BW`	2.40	2.51	2.64	2.78	2.92
Stitch length (mm) AW	2.38	2.49	2.62	2.77	2.90
Burst strength (kPa), BW	526.00	469.30	475.10	451.40	438.60
Burst strength (kPa), AW	535.20	508.10	473.00	437.50	428.00
Distension at burst (mm), BW	20.12	20.19	20.06	23.22	22.82
Distension at burst (mm), AW	21.68	22.53	22.38	23.86	23.59
Angle of spirality, BW	0.56	1.06	1.30	-2.66	-2.32
Angle of spirality, AW	-0.24	0.56	0.74	-1.92	-0.91
Width (cm), BW	29.67	29.60	31.03	31.47	32.00
Yarn strength (g), BW	182.93	169.58	166.21	168.24	177.45
Yarn strength (g), AW	207.84	194.15	194.91	192.93	199.56
Yarn ext. at break (%), BW	7.85	7.84	7.89	6.81	7.13
Yarn ext. at break (%), AW	7.99	7.64	7.79	6.83	7.21
Yarn count (tex), BW	14.30	14.04	14.25	14.08	14.44
Yarn count (tex), AW	14.14	13.90	13.90	14.36	14.38
Thickness (mm x 1000), BW	816	816	835	830	849
Thickness (mm x 1000), AW	909	902	919	905	929

NOTES

- 5x after 5 machine wash (60 deg.C.)/tumble dry cycles
- BW as received (before wash)
- AW after 5 wash/tumble dry cycles (after wash)

Table IX

Schiesser Rib - Finished Fabrics

Series R - Rotostream dyed

	50/264	50/279	50/293	50/308	55/250	55/264	55/279	55/293	55/308
Length shrinkage (%), TD	4.35	4.07	4.63	6.20	3.91	3.95	5.14	6.01	7.19
Width shrinkage (%), TD	3.00	3.27	2.96	2.47	2.05	3.23	3.33	2.62	3.04
Length shrinkage (%), 5x	5.59	6.32	6.17	7.89	5.15	5.36	6.57	8.59	8.56
Width shrinkage (%), 5x	3.00	2.05	2.26	1.99	1.70	3.15	2.69	1.52	2.32
Weight (gsm), BW	220.31	208.95	203.06	190.38	203.15	191.79	177.23	174.23	163.63
Weight (gsm), AW	236.63	226.54	216.36	204.33	218.33	206.61	194.32	186.25	178.16
Courses per 3cm, BW	54.50	51.60	48.65	44.85	57.25	53.95	49.40	45.75	43.20
Courses per 3cm, TD	57.20	53.75	50.50	47.70	59.45	56.05	51.90	49.30	46.10
Courses per 3cm, AW	57.50	55.05	51.75	48.55	60.95	57.25	53.30	50.10	47.15
Wales per 3cm, BW	35.40	34.30	33.05	32.10	37.10	35.50	34.35	33.45	31.85
Wales per 3cm, TD	36.20	35.10	34.20	32.75	37.70	36.35	35.20	34.30	33.10
Wales per 3cm, AW	35.73	35.20	33.95	32.70	37.13	35.93	34.58	34.15	32.50
Stitch length (mm) BW	2.63	2.76	2.91	3.05	2.49	2.62	2.76	2.90	3.06
Stitch length (mm) AW	2.61	2.75	2.89	3.03	2.47	2.59	2.75	2.87	3.04
Burst strength (kPa), BW	706.00	624.70	561.20	488.90	636.50	596.60	586.20	422.20	426.70
Burst strength (kPa), AW	684.00	669.40	650.80	600.50	626.80	621.00	546.70	576.30	530.90
Distension at burst (mm), BW	21.13	21.16	23.45	21.76	21.24	20.74	21.53	19.85	20.27
Distension at burst (mm), AW	21.62	22.45	21.86	22.16	21.76	20.95	22.13	21.71	22.36
Angle of spirality, BW	-0.73	-0.42	-0.53	0.60	-2.81	1.21	-0.85	-0.61	-0.29
Angle of spirality, AW	0.02	0.89	0.81	1.32	-1.46	0.12	0.28	1.20	0.48
Width (cm), BW	31.57	32.70	33.60	34.43	30.47	31.60	32.87	33.10	34.67
Yarn strength (g), BW	245.95	242.59	263.48	257.75	195.51	218.76	203.64	188.48	194.60
Yarn strength (g), AW	303.19	276.40	286.80	289.05	246.97	250.72	233.16	233.57	236.67
Yarn ext. at break (%), BW	8.69	9.11	9.50	9.30	8.19	8.62	8.63	8.39	8.71
Yarn ext. at break (%), AW	8.94	8.69	8.75	8.67	8.22	9.05	8.45	8.23	8.14
Yarn count (tex), BW	19.69	19.39	19.33	19.40	17.38	17.31	17.19	17.22	17.49
Yarn count (tex), AW	19.76	19.54	19.86	19.28	17.46	17.57	17.54	17.39	17.34
Thickness (mm x 1000), BW	873	901	903	912	844	855	858	870	881
Thickness (mm x 1000), AW	1008	1037	1039	1057	978	990	997	1004	1044

NOTES

- 5x after 5 machine wash (60 deg.C.)/tumble dry cycles
- BW as received (before wash)
- AW after 5 wash/tumble dry cycles (after wash)

Table IX (cont.)

Schiesser Rib - Finished Fabrics

Series R - Rotostream dyed

	70/240	70/250	70/264	70/279	70/293
Length shrinkage (%), TD	4.55	5.80	5.51	5.10	7.15
Width shrinkage (%), TD	3.64	3.50	3.07	4.16	3.04
Length shrinkage (%), 5x	5.80	6.97	7.30	7.22	8.98
Width shrinkage (%), 5x	3.19	0.67	1.98	2.57	1.74
Weight (gsm), BW	167.98	160.30	153.50	143.89	140.60
Weight (gsm), AW	187.71	174.83	170.89	161.52	156.29
Courses per 3cm, BW	58.60	54.40	51.50	47.60	44.95
Courses per 3cm, TD	61.20	57.90	54.70	50.45	48.30
Courses per 3cm, AW	62.15	58.00	55.55	52.00	49.15
Wales per 3cm, BW	38.60	38.07	36.00	34.55	34.40
Wales per 3cm, TD	40.35	39.40	37.40	36.05	35.30
Wales per 3cm, AW	39.95	38.40	36.30	35.25	34.60
Stitch length (mm) BW	2.39	2.50	2.63	2.78	2.92
Stitch length (mm) AW	2.38	2.50	2.62	2.76	2.91
Burst strength (kPa), BW	521.90	469.10	471.00	477.10	421.90
Burst strength (kPa), AW	517.70	483.90	472.50	455.50	464.00
Distension at burst (mm), BW	21.03	21.50	22.47	22.92	20.60
Distension at burst (mm), AW	22.33	21.96	22.98	22.05	22.79
Angle of spirality, BW	-1.25	-2.86	-3.01	0.42	-0.95
Angle of spirality, AW	-2.37	-3.06	0.16	0.50	0.53
Width (cm), BW	28.37	29.55	30.93	32.60	32.30
Yarn strength (g), BW	183.39	163.39	159.61	158.11	168.61
Yarn strength (g), AW	187.73	178.79	192.65	185.58	188.68
Yarn ext. at break (%), BW	7.78	7.01	7.95	8.58	8.54
Yarn ext. at break (%), AW	7.70	7.27	8.40	8.32	8.36
Yarn count (tex), BW	14.02	14.01	14.21	14.11	14.47
Yarn count (tex), AW	14.14	13.93	14.30	14.28	14.37
Thickness (mm x 1000), BW	775	792	790	796	808
Thickness (mm x 1000), AW	900	924	935	927	940

NOTES

- 5x after 5 machine wash (60 deg.C.)/tumble dry cycles
- BW as received (before wash)
- AW after 5 wash/tumble dry cycles (after wash)

TABLE X

	Yarn Count (tex)		Stitch Length (cm)	
	a	r^2	a	r^2
Greige	0.97552	0.9990	0.98751	0.9992
Continuous bleach	0.95976	0.9985	0.98103	0.9993
Winch bleach	0.96719	0.9988	0.97984	0.9983
Roto-Stream dye	0.96994	0.9993	0.97869	0.9993

TABLE XI

Equations for prediction of courses per cm, wales per cm, stitch density and fabric weight.

Courses per cm

	a	b	c	r^2
Greige	-9.25320	5.92622	1.44801	0.9904
Continuous bleach	-10.20793	6.04935	1.34340	0.9953
Winch bleach	-9.47433	6.02633	1.31229	0.9923
Roto-Stream dye	-9.34046	5.92525	1.35284	0.9918

Wales per cm

	a	b	c	r^2
Greige	6.61069	2.26374	-0.62284	0.9795
Continuous bleach	6.13958	1.82957	-0.43697	0.9417
Winch bleach	2.88808	2.54798	-0.15604	0.9676
Roto-Stream	5.48709	2.17883	-0.41520	0.9567

Stitches per square cm

	a	b	c	r^2
Greige	6.27805	15.22276	0.79106	0.9924
Continuous bleach	0.94283	13.15329	0.88041	0.9898
Winch bleach	-26.22481	15.57304	1.46714	0.9856
Roto-Stream dye	-5.80398	14.71999	1.04563	0.9861

Weight g. per square cm

	a	b	r^2
Greige	-3.83862	3.44541	0.9689
Continuous bleach	-4.72287	2.94819	0.9702
Winch bleach	-8.34541	3.27710	0.9703
Roto-Stream dye	-3.49884	3.18489	0.9884

Table XII: Comparison of Shrinkage Data (5 wash/tumble cycles).

	Series C Continuous bleach				Series K Winch bleach				Series R Roto-Stream			
	Schiesser		IIC		Schiesser		IIC		Schiesser		IIC	
	Len	Wid	Len	Wid	Len	Wid	Len	Wid	Len	Wid	Len	Wid
50/264	8.4	7.9	9	5.6	7.3	3.2	6.1	-0.9	6.4	3.5	5.6	3
50/279	9.4	7.6	9.1	5.4	7.7	2.4	5.9	-0.8	6.2	4.8	6.3	2.9
50/293	11	5	9.6	2.4	7	2.9	7.5	-0.1	6.3	3.8	6.2	2.3
50/308	11.5	5.1	12.1	-0.2	9.7	0.3	9.2	-2.6	7	2.8	7.9	2
55/250	8.2	9.9	8.3	6.3	7	5.6	5.5	2.1	6.5	4.6	5.2	1.7
55/264	9.2	7.8	9.8	5.2	7.1	4.1	6	-0.4	6.1	4.5	5.4	3.2
55/279	9.8	7.6	10.1	4.7	7.9	1.3	7.3	-2.7	7	5.2	6.6	2.7
55/293	10.9	5.7	9.6	2.1	7.3	1.9	7.6	-1.9	6.9	4.2	8.6	1.5
55/308	11.9	5.1	13.2	0.5	8.8	1.2	9.6	-2.8	7.7	3.9	8.6	2.3
70/240	8.9	10.7	9.7	5.7	5.9	6.6	5.7	3.2	5.8	6.1	5.8	3.2
70/250	10.3	8.9	11.1	3.8	7.8	4.5	6.3	0.9	6.2	6	7	0.7
70/264	10.9	6.9	12.6	1.9	7.7	3.9	7.6	0.1	7	4.8	7.3	2
70/279	11.6	5.8	10.9	4.3	8.2	4.5	7.6	-2.2	6.7	7.3	7.2	2.6
70/293	11.5	3.6	10.3	1.9	7.4	4.2	8.1	-2	8.2	4.5	9	1.7

Table XIII: VSI data converted to stitch densities - relaxed fabrics.

	Courses per 3cm				Wales per 3cm			
	Grey	Cont.B	Winch B	Roto D	Grey	Cont.B	Winch B	Roto D
50/264	62.8	58.3	60.4	59.4	37.5	35.7	36.9	37.1
50/279	59.1	54.6	57.3	56.1	35.9	33.9	36	36.1
50/293	56.1	50.9	53.3	52.2	34.7	33.6	35.1	35.3
50/308	52.6	48	50.1	48.8	34.1	33.2	35	33.9
55/250	65.2	61	63.3	61.2	38.6	36.6	38	39.3
55/264	61	56.4	59.5	58	38.1	36.2	38.4	36.9
55/279	57	52.8	54.4	53.7	35.6	34.4	37.2	36.2
55/293	55.4	49.6	51.6	50.4	34.4	34	35.3	35.2
55/308	51.5	46.7	47.8	47.2	32.8	33.2	34.3	34.1
70/240	66.5	62.4	64.5	62.9	41.4	39.7	41.1	41.4
70/250	62.8	58.4	60.4	59.3	40	38.3	39.7	39.7
70/264	59.8	54.9	57.1	56	38.3	37.4	38	38.8
70/279	55.8	50.8	53.4	51.9	37.8	36.4	38.2	37.6
70/293	52.9	48	50.4	49.3	37.3	36.1	35.9	36

Table XIV

Schiesser Rib - Line Dried

SERIES C

	50/264	50/279	50/293	50/308	55/250	55/264	55/279	55/293	55/308
Length shrinkage (%), LD	5.69	5.07	7.73	8.27	5.39	6.46	6.94		8.75
Width shrinkage (%), LD	0.70	-0.27	-2.18	-6.70	1.64	-1.05	-3.70		-8.24
Length shrinkage (%), 5x	6.56	6.55	9.36	10.67	6.34	7.60	8.04		10.43
Width shrinkage (%), 5x	-0.78	-1.02	-3.44	-11.09	0.49	-3.50	-6.23		-11.50
Courses per 3cm, BW	51.95	48.95	45.65	41.50	54.45	50.35	47.50	43.45	40.25
Courses per 3cm, LD	55.05	51.70	48.15	45.10	57.60	54.05	49.85		43.85
Courses per 3cm, AW	55.70	51.80	48.65	45.85	58.05	54.25	50.45		44.65
Wales per 3cm, BW	32.40	32.10	31.00	31.05	32.95	32.70	32.25	31.25	30.75
Wales per 3cm, LD	32.50	30.85	30.03	28.65	33.75	32.20	30.80		27.90
Wales per 3cm, AW	32.55	31.15	30.10	28.10	33.35	31.55	30.20		27.83

NOTES

- LD after one machine wash (60 deg.C.)/line dry cycle
- 5x after 5 machine wash (60 deg.C.)/line dry cycles
- BW as received (before wash)
- AW after 5 wash/line dry cycles (after wash)

Table XIV (cont.)

Schiesser Rib - Line Dried

SERIES C

	70/240	70/250	70/264	70/279	70/293
Length shrinkage (%), LD	5.84	7.38	8.92	10.28	
Width shrinkage (%), LD	0.51	-3.06	-4.52	-7.89	
Length shrinkage (%), 5x	7.62	8.64	10.90	12.89	
Width shrinkage (%), 5x	-1.35	-3.57	-8.47	-13.40	
Courses per 3cm, BW	55.00	51.30	47.75	43.80	41.83
Courses per 3cm, LD	58.55	55.85	51.75	48.50	
Courses per 3cm, AW	59.35	56.40	53.35	50.65	
Wales per 3cm, BW	34.30	34.90	34.65	33.65	33.40
Wales per 3cm, LD	34.50	33.80	33.05	31.40	
Wales per 3cm, AW	33.40	33.65	31.15	29.30	

NOTES

- LD after one machine wash (60 deg.C.)/line dry cycle
- 5x after 5 machine wash (60 deg.C.)/line dry cycles
- BW as received (before wash)
- AW after 5 wash/line dry cycles (after wash)

Table XV

Schiesser Rib – Line Dried

SERIES K

	50/264	50/279	50/293	50/308	55/250	55/264	55/279	55/293	55/308
Length shrinkage (%), LD	3.19	2.93	3.71	4.63	2.75	3.75	3.55	4.07	5.95
Width shrinkage (%), LD	-2.18	-1.70	-5.15	-6.31	-1.22	-2.90	-4.58	-6.34	-7.69
Length shrinkage (%), 5x	3.64	3.81	5.48	5.78	3.31	3.99	4.56	4.97	7.91
Width shrinkage (%), 5x	-2.98	-4.33	-9.14	-9.88	-3.61	-4.98	-7.97	-10.69	-12.70
Courses per 3cm, BW	54.30	51.95	48.75	44.00	58.00	52.80	49.55	46.75	43.50
Courses per 3cm, LD	57.05	53.50	50.45	47.45	59.60	55.55	51.65	48.35	46.00
Courses per 3cm, AW	57.20	54.20	51.35	47.75	60.20	55.95	51.65	49.55	46.45
Wales per 3cm, BW	35.55	34.30	33.50	32.80	36.65	35.30	35.40	34.70	32.85
Wales per 3cm, LD	34.90	33.65	32.45	31.40	36.00	35.00	34.20	31.77	29.85
Wales per 3cm, AW	34.60	33.10	31.37	29.80	34.90	34.15	33.45	31.40	29.30

NOTES

- LD after one machine wash (60 deg.C.)/line dry cycle
- 5x after 5 machine wash (60 deg.C.)/line dry cycles
- BW as received (before wash)
- AW after 5 wash/line dry cycles (after wash)

Table XV (cont.)

Schiesser Rib - Line Dried

SERIES K

	70/240	70/250	70/264	70/279	70/293
Length shrinkage (%), LD	2.06	3.47	4.54	4.30	5.21
Width shrinkage (%), LD	-0.08	-3.24	-6.40	-5.52	-9.25
Length shrinkage (%), 5x	3.65	4.62	5.62	5.20	6.95
Width shrinkage (%), 5x	-2.65	-6.25	-8.48	-9.21	-15.08
Courses per 3cm, BW	59.85	55.45	51.60	48.75	46.15
Courses per 3cm, LD	62.15	57.10	54.55	50.55	49.10
Courses per 3cm, AW	62.55	57.95	55.00	51.20	49.10
Wales per 3cm, BW	38.30	37.60	36.65	35.55	33.05
Wales per 3cm, LD	37.45	36.70	34.90	34.25	31.00
Wales per 3cm, AW	36.50	35.63	33.47	32.45	30.40

NOTES

- LD after one machine wash (60 deg.C.)/line dry cycle
- 5x after 5 machine wash (60 deg.C.)/line dry cycles
- BW as received (before wash)
- AW after 5 wash/line dry cycles (after wash)

Table XVI

Schiesser Rib - Line Dried

SERIES R

	50/264	50/279	50/293	50/308	55/250	55/264	55/279	55/293	55/308
Length shrinkage (%), LD	2.33		3.49	4.75	2.14	2.64	3.52		4.40
Width shrinkage (%), LD	-2.26		-4.14	-10.33	-1.64	-3.55	-5.37		-10.20
Length shrinkage (%), 5x	2.73		4.04	4.93	3.26	3.67	3.27		4.04
Width shrinkage (%), 5x	-2.73		-5.05	-10.62	-3.71	-4.98	-4.11		-10.46
Courses per 3cm, BW	54.50	51.60	48.65	44.05	57.25	53.95	49.40	45.75	43.20
Courses per 3cm, LD	56.20		49.65	46.05	58.75	55.00	51.95		45.65
Courses per 3cm, AW	56.45		49.95	47.15	59.45	55.40	51.45		45.65
Wales per 3cm, BW	35.40	34.30	33.05	32.10	37.10	35.50	34.35	33.45	31.85
Wales per 3cm, LD	34.55		31.00	29.55	35.95	34.05	32.25		29.40
Wales per 3cm, AW	34.45		31.40	29.20	35.50	34.00	32.55		29.55

NOTES

LD after one machine wash (60 deg.C.)/line dry cycle
5x after 5 machine wash (60 deg.C.)/line dry cycles
BW as received (before wash)
AW after 5 wash/line dry cycles (after wash)

Table XVI (cont.)

Schiesser Rib - Line Dried

SERIES R

	70/240	70/250	70/264	70/279	70/293
Length shrinkage (%), LD	3.31	3.19	3.86	5.29	5.28
Width shrinkage (%), LD	-1.82	-4.28	-4.65	-7.53	-6.28
Length shrinkage (%), 5x	4.59	4.71	4.83	6.62	5.22
Width shrinkage (%), 5x	-3.09	-7.12	-6.22	-11.44	-5.38
Courses per 3cm, BW	58.60	54.40	51.50	47.60	44.95
Courses per 3cm, LD	59.85	56.20	54.35	49.80	47.30
Courses per 3cm, AW	60.45	57.10	53.65	50.00	47.25
Wales per 3cm, BW	38.60	38.07	36.00	34.55	34.40
Wales per 3cm, LD	38.90	35.75	34.10	32.93	31.30
Wales per 3cm, AW	38.30	35.65	34.20	32.00	31.43

NOTES

- LD after one machine wash (60 deg.C.)/line dry cycle
- 5x after 5 machine wash (60 deg.C.)/line dry cycles
- BW as received (before wash)
- AW after 5 wash/line dry cycles (after wash)

Fig.1. Ref. State Courses per cm. - GREIGE.

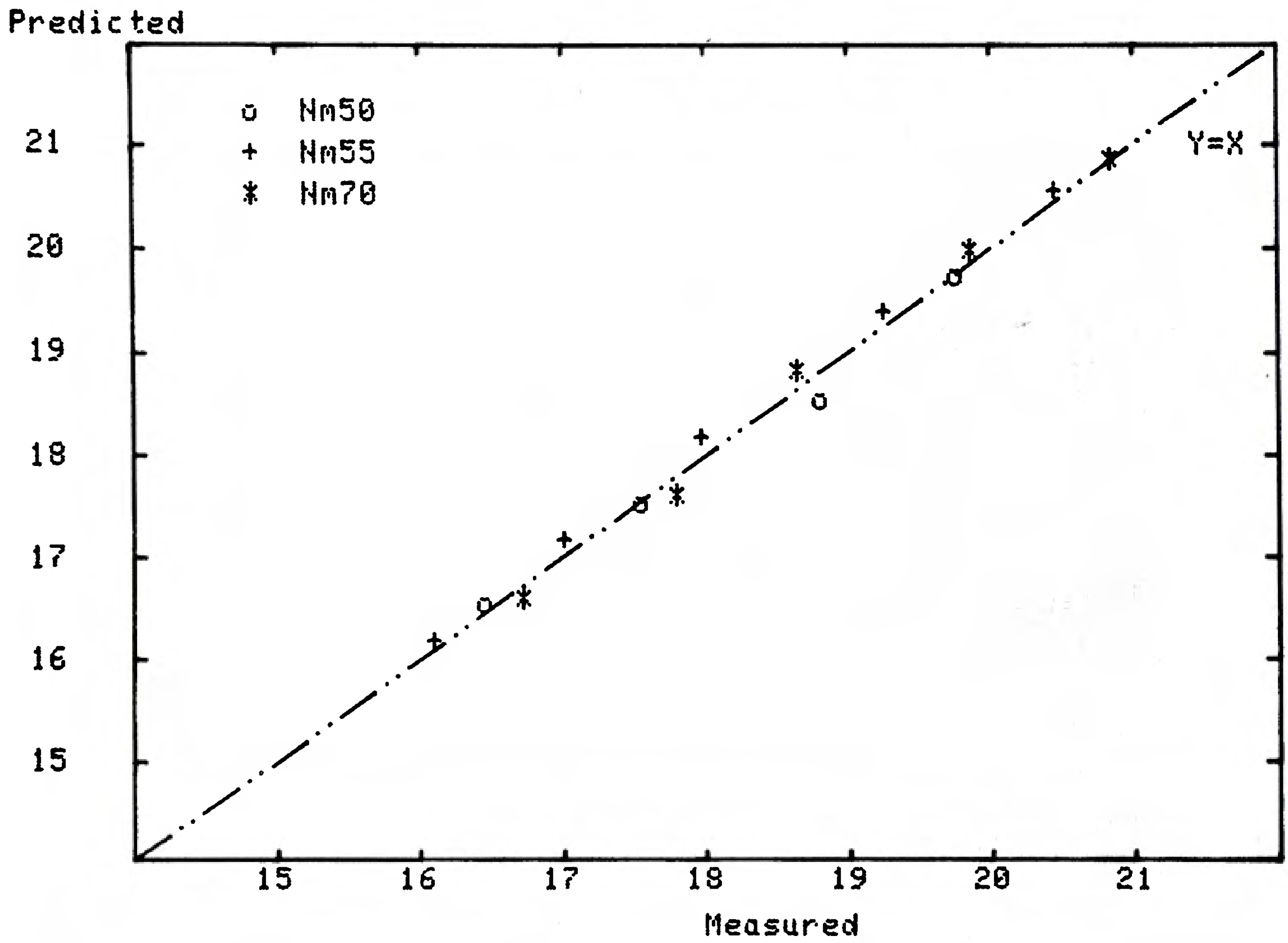


Fig.2. Ref. State Courses per cm. - CONTINUOUS BLEACH.

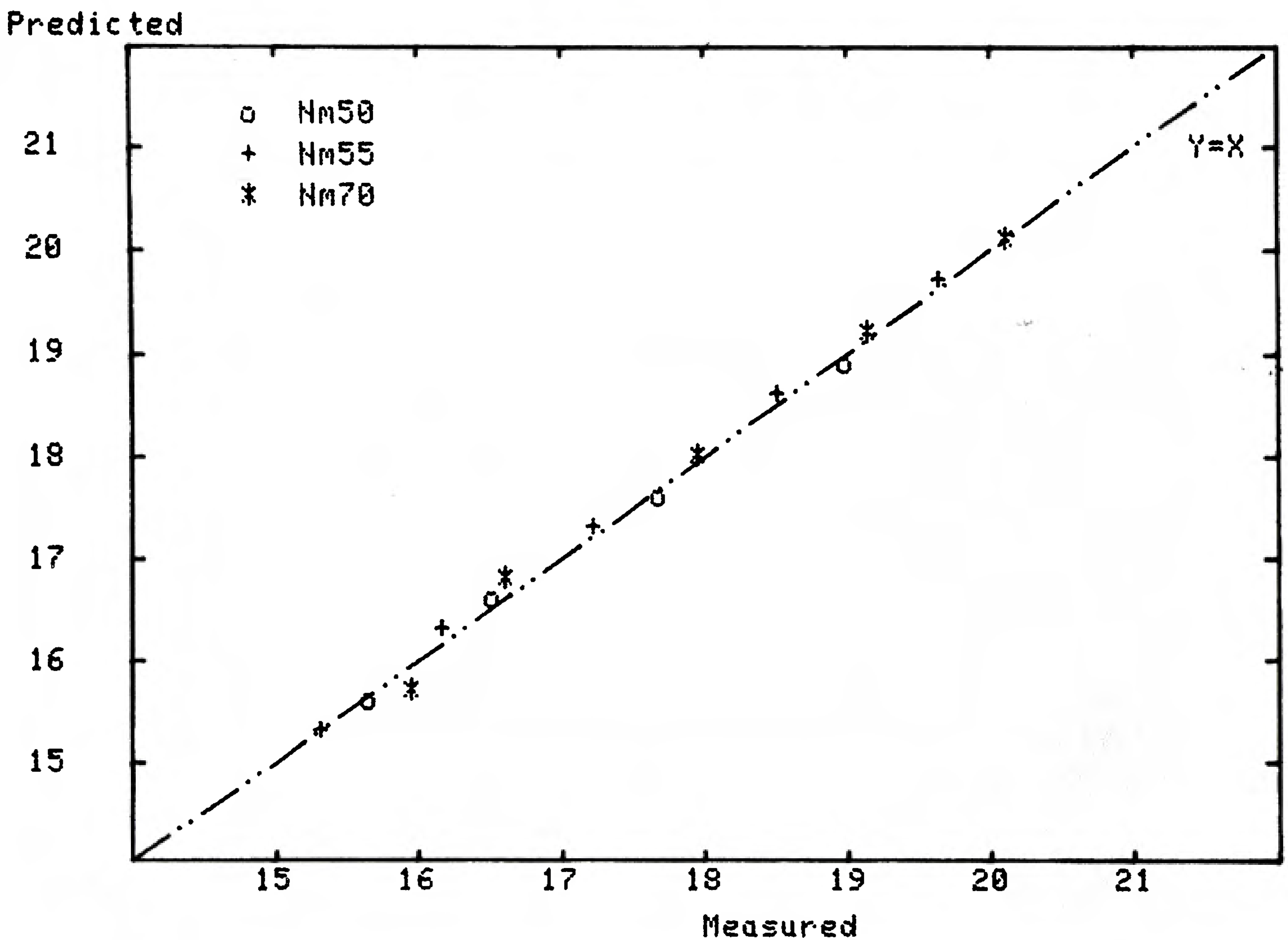


Fig.3. Ref. State Courses per cm. - WINCH BLEACH.

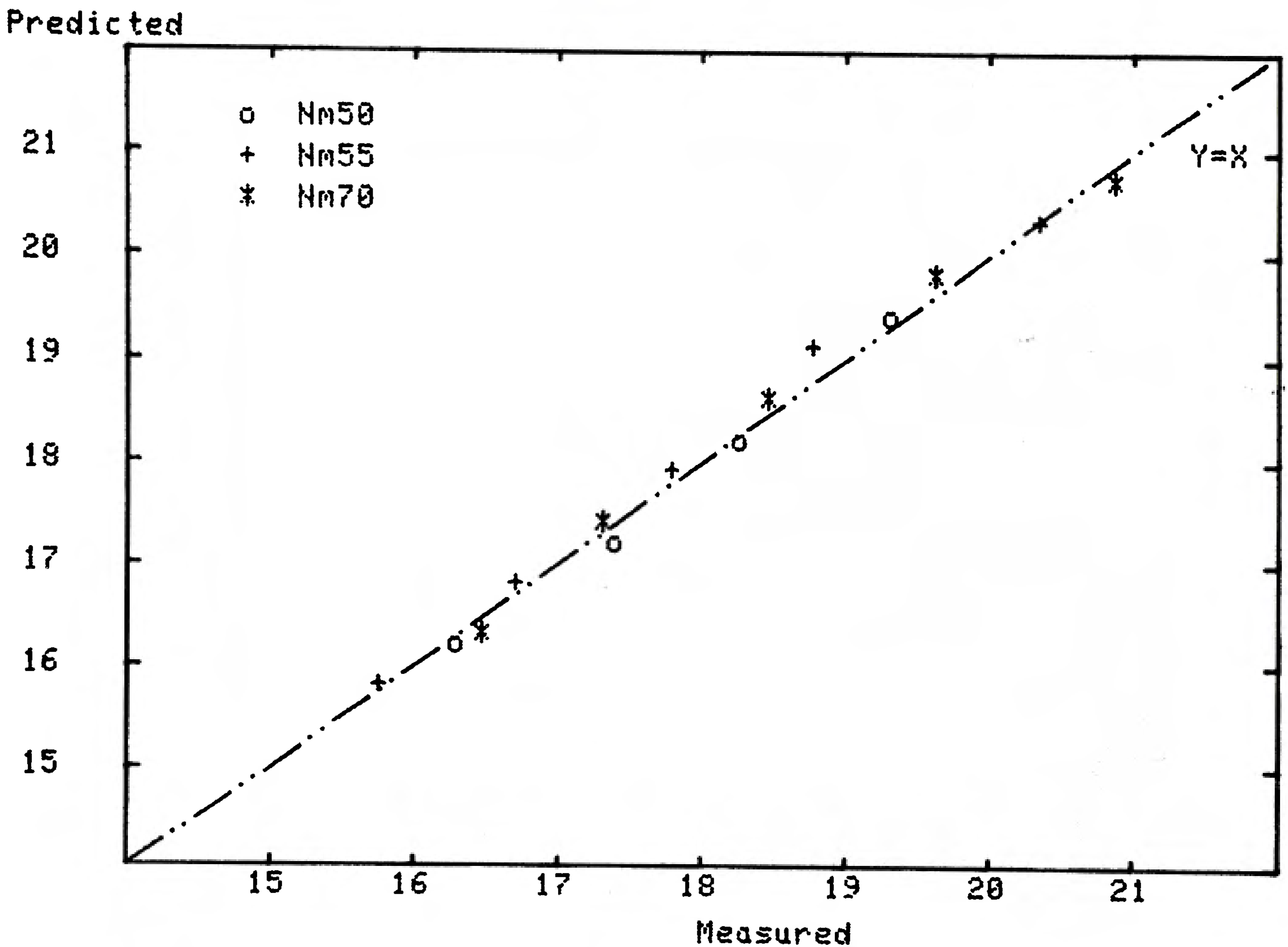


Fig.4. Ref. State Courses per cm. - ROTO-STREAM DYED.

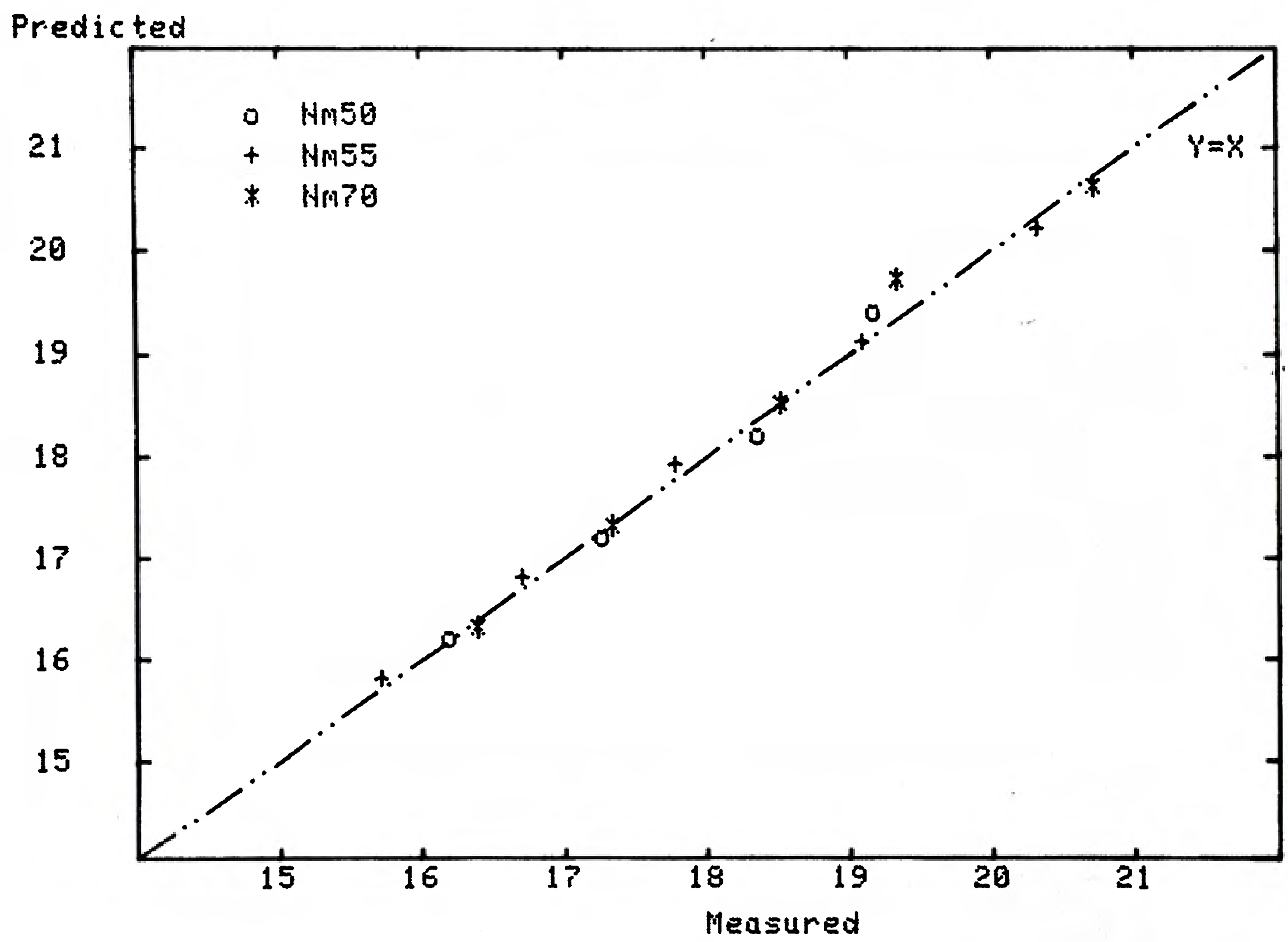


Fig.5. Ref. State Wales per cm. - GREIGE.

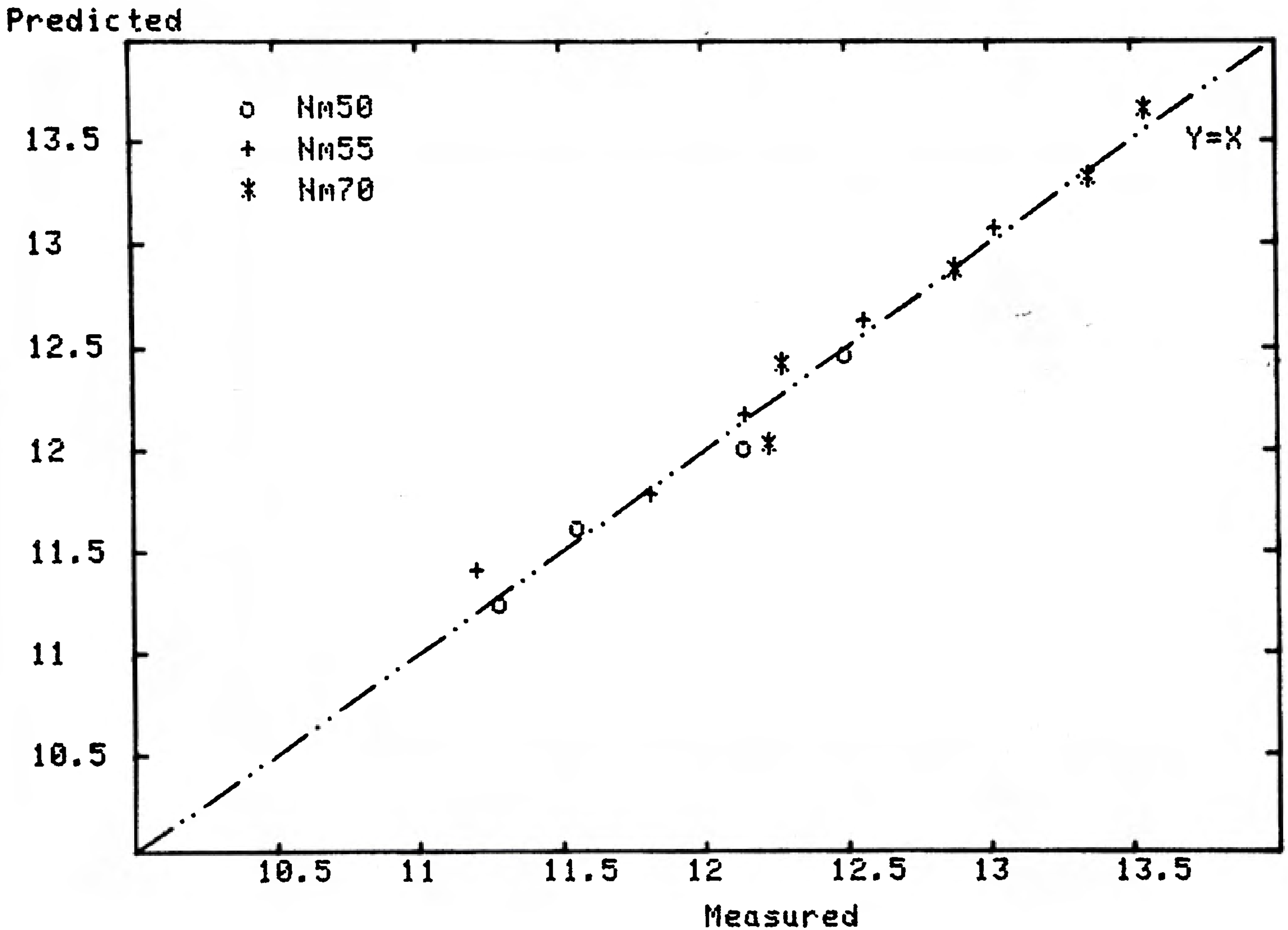


Fig.6. Ref. State Wales per cm. - CONTINUOUS BLEACH.

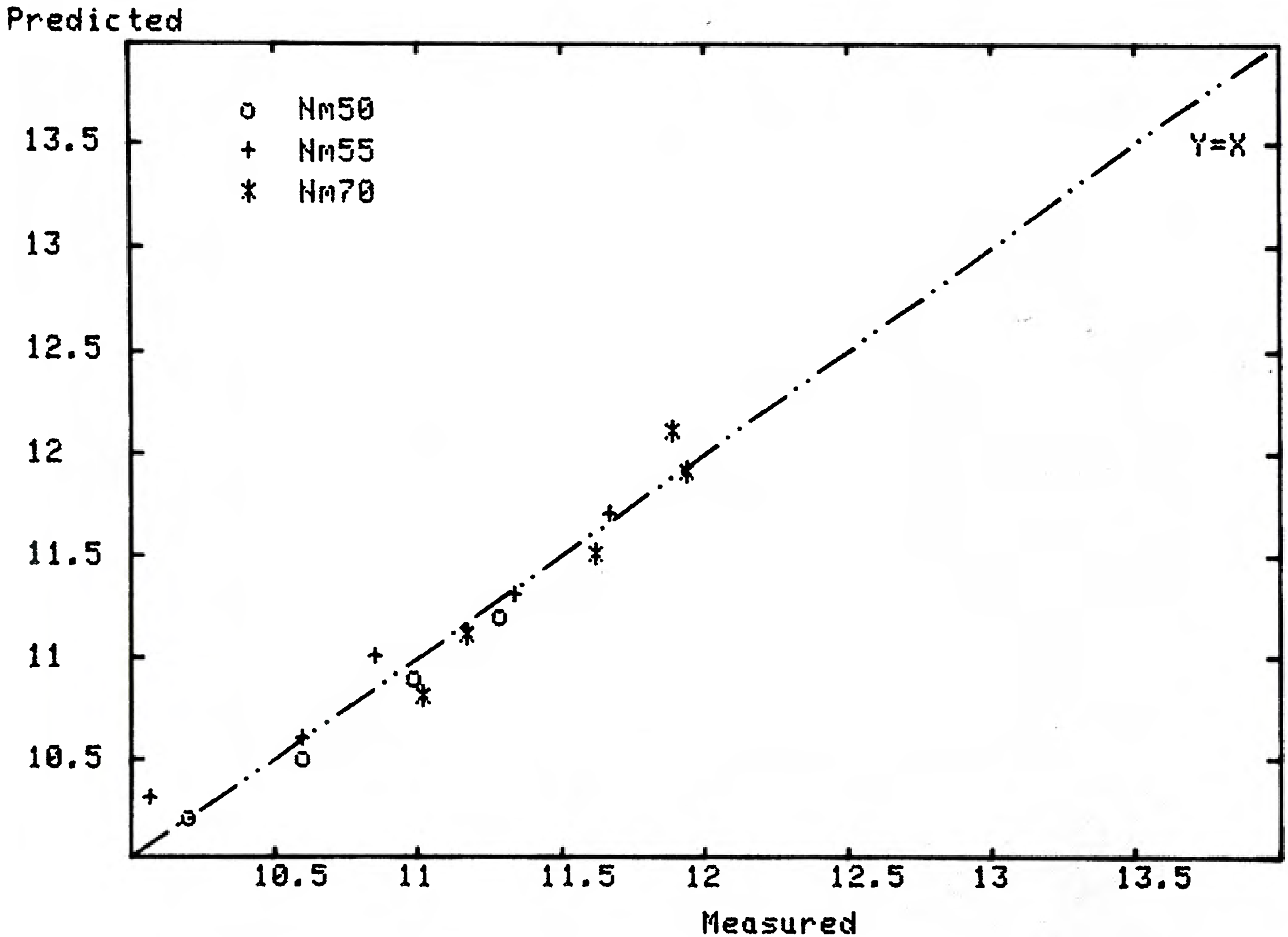


Fig.7. Ref. State Wales per cm. - WINCH BLEACH.

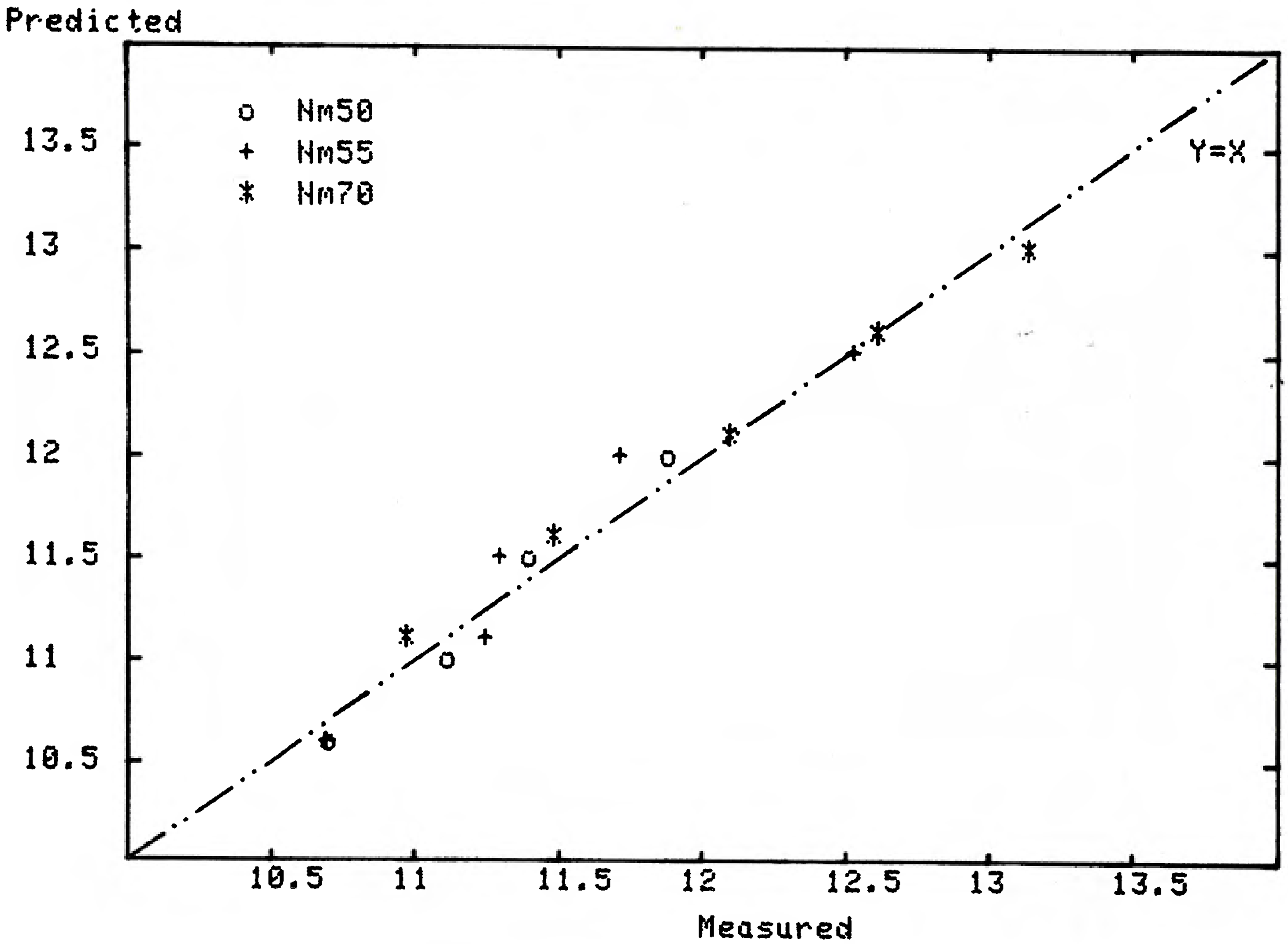


Fig.8. Ref. State Wales per cm. - ROTOSTREAM DYED.

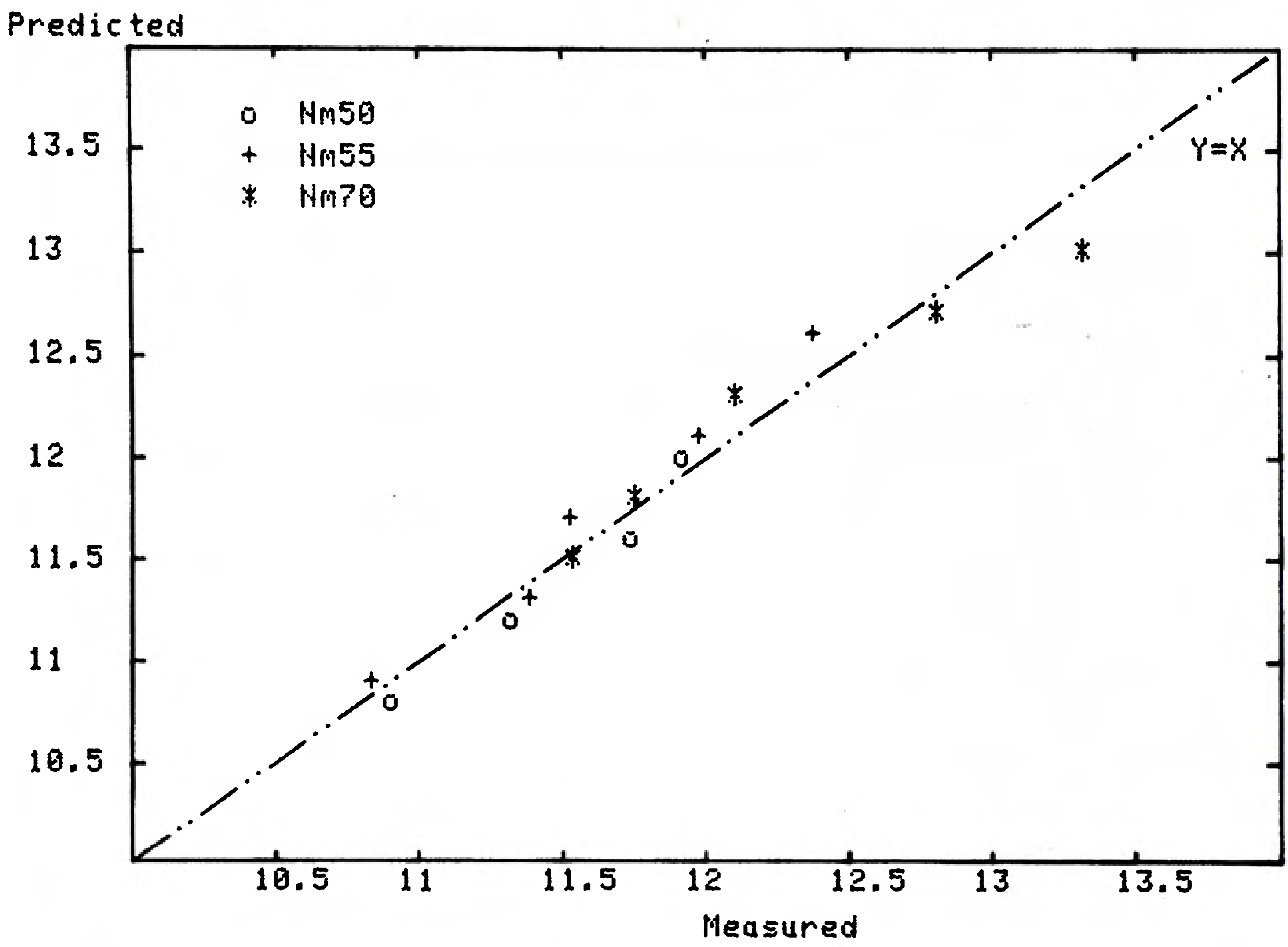


Fig.9. Ref. State Fabric Weight (g/sq m) - GREIGE.

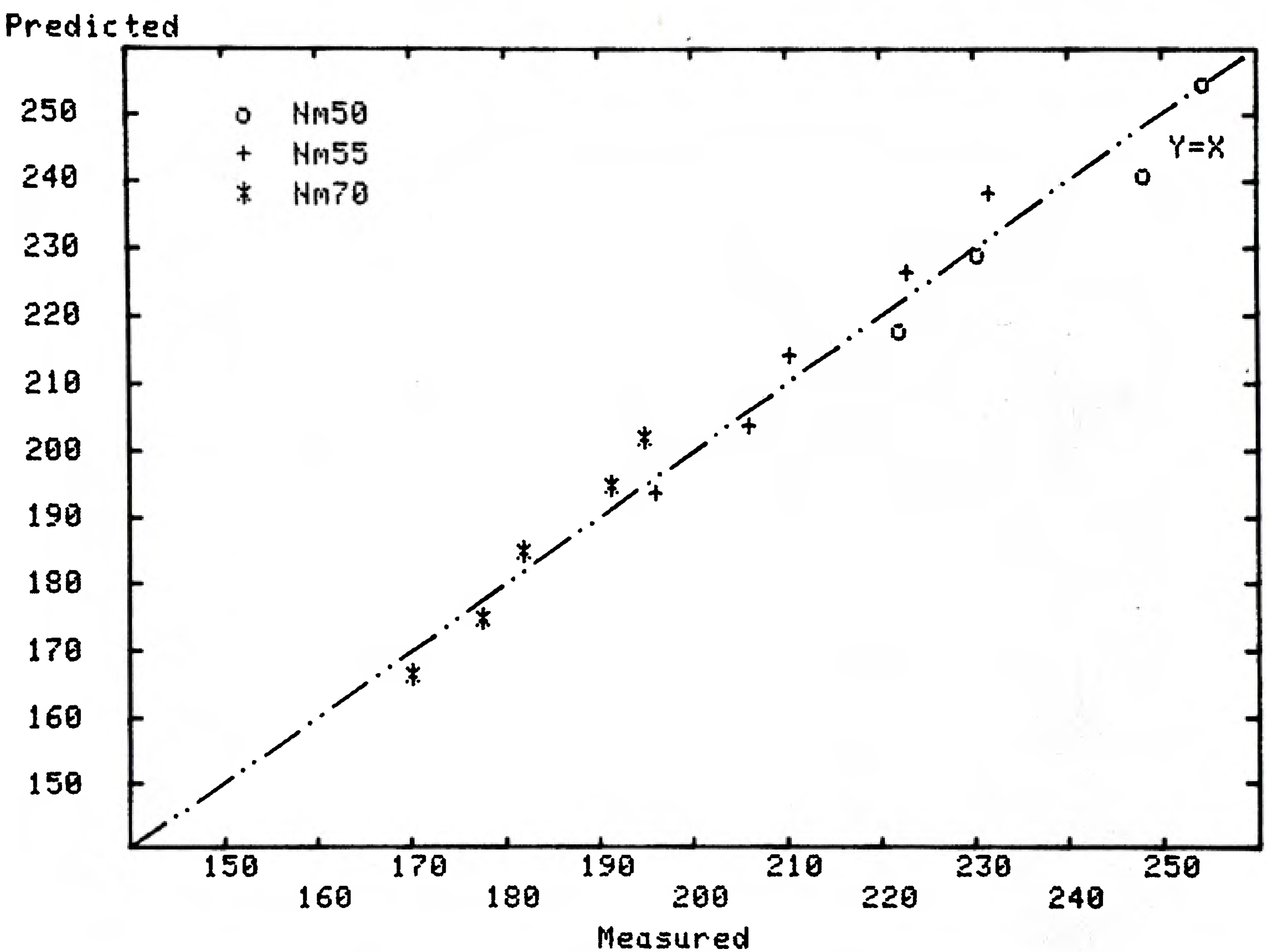


Fig.10. Ref. State Fabric Weight (g/sq m) - CONTINUOUS BLEACH.

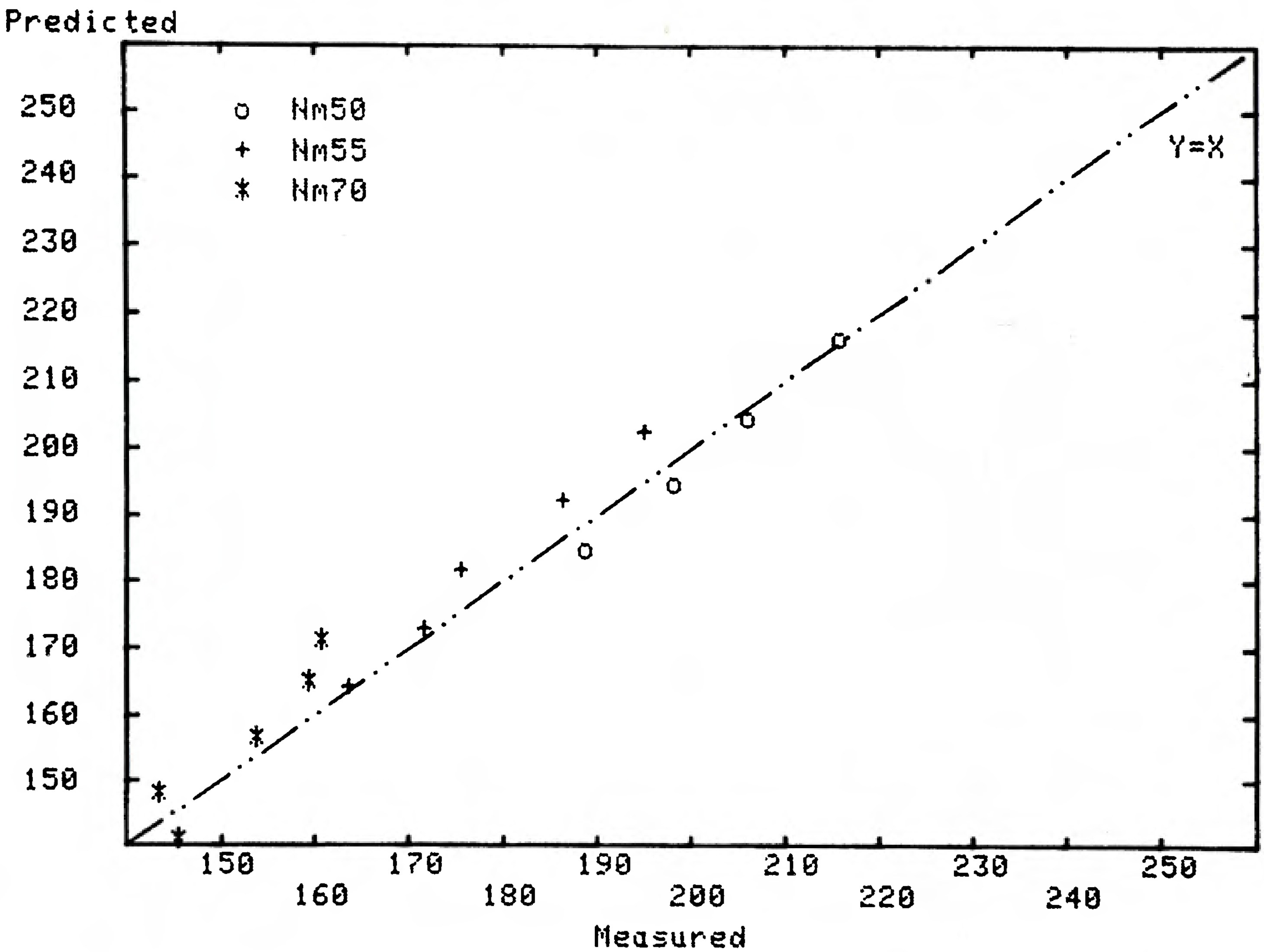


Fig.11. Ref. State Fabric Weight (g/sq m) - WINCH BLEACH.

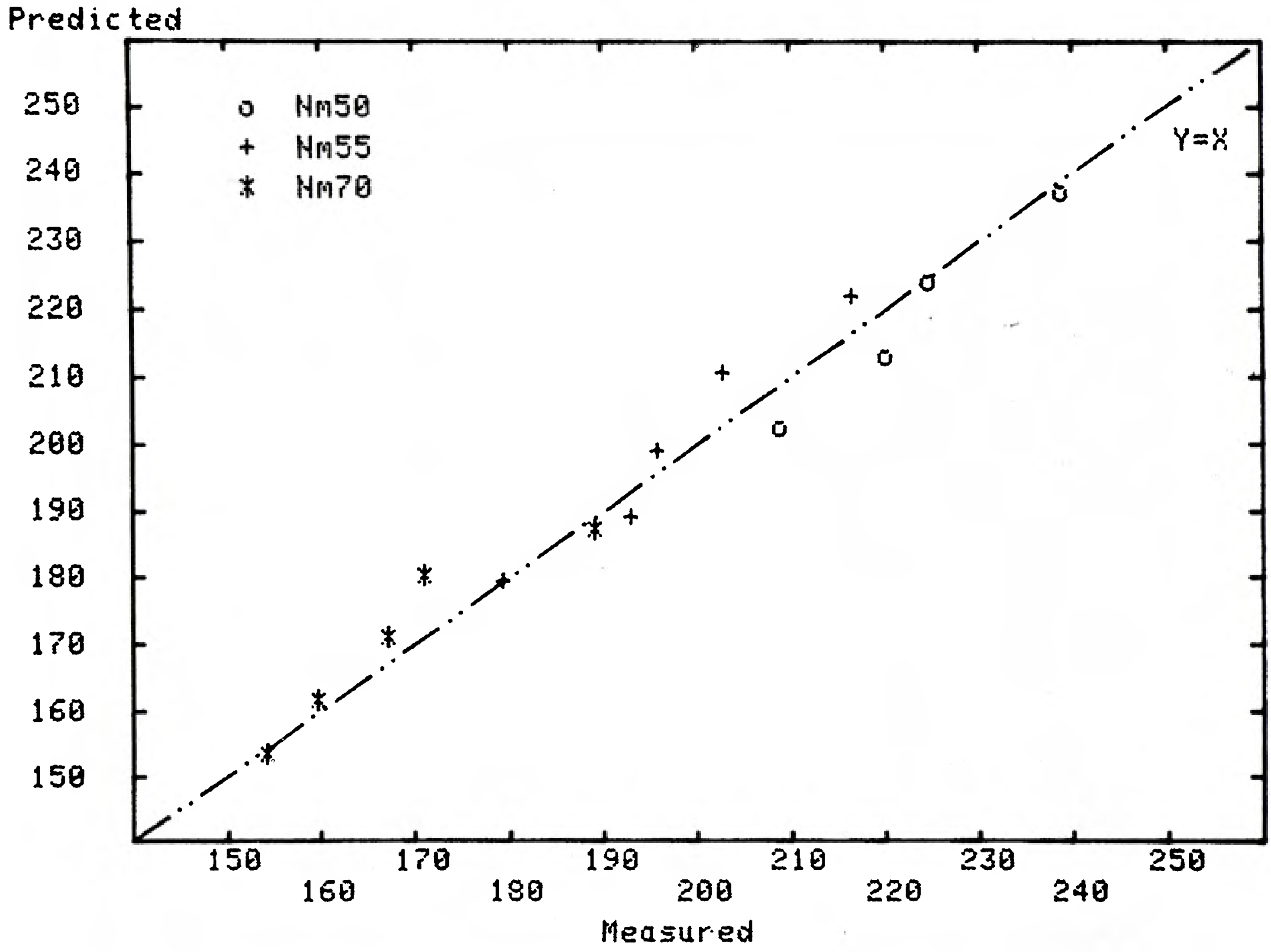


Fig.12. Ref. State Fabric Weight (g/sq m) - ROTO-STREAM DYED.

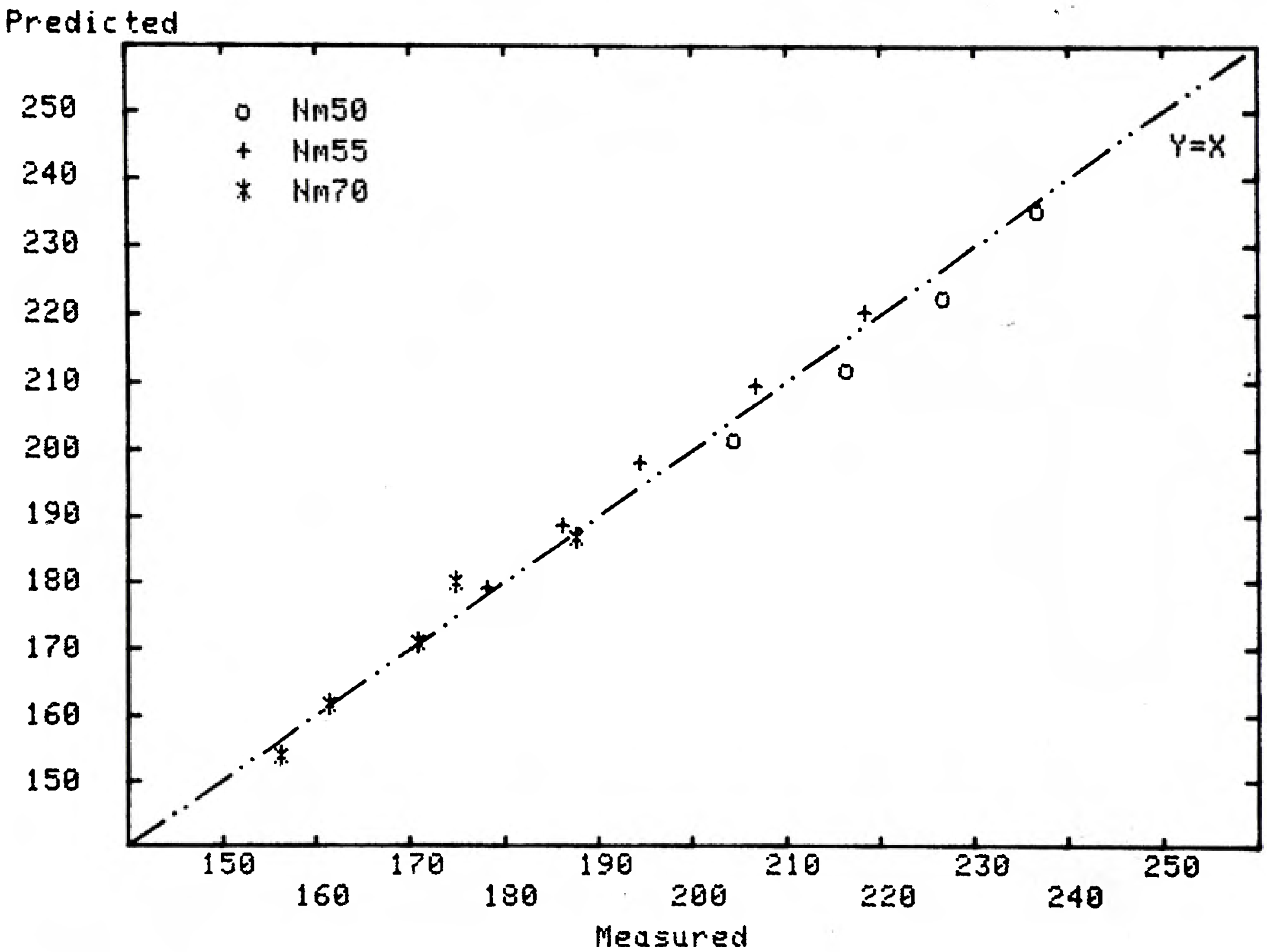


Fig.13. Course Density - Stitches per 3 cm.

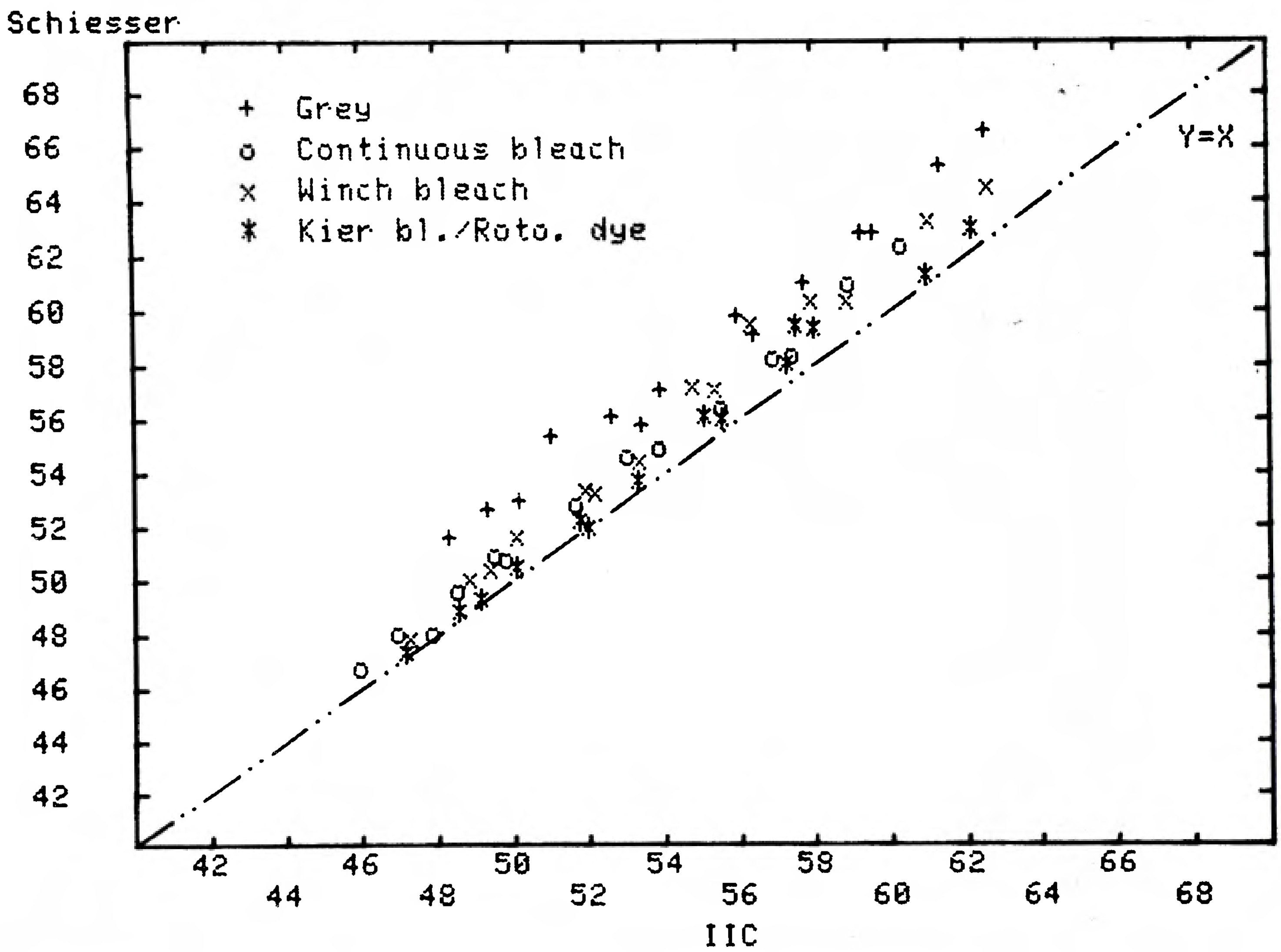
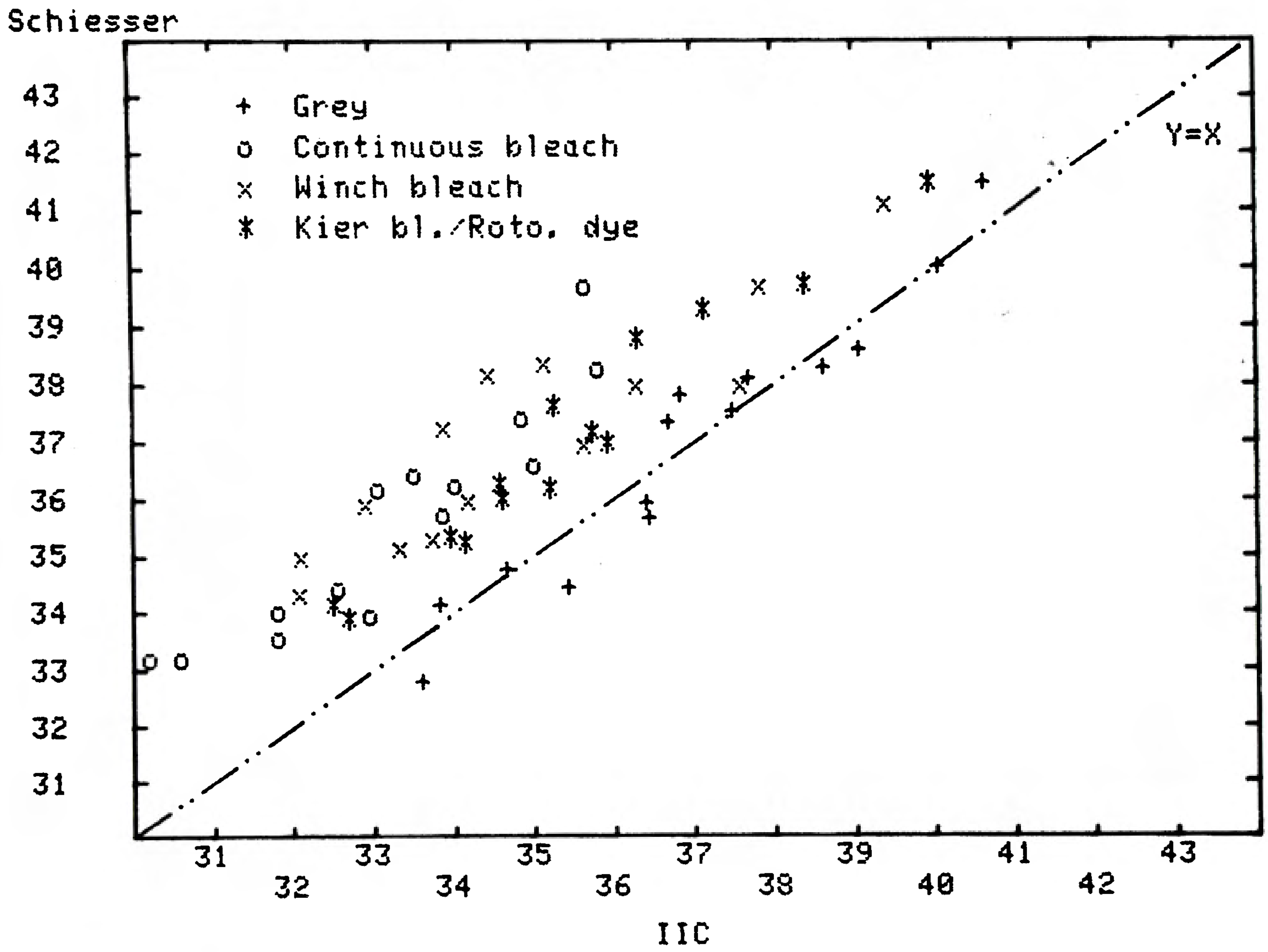


Fig.14. Wale Density - Stitches per 3 cm.

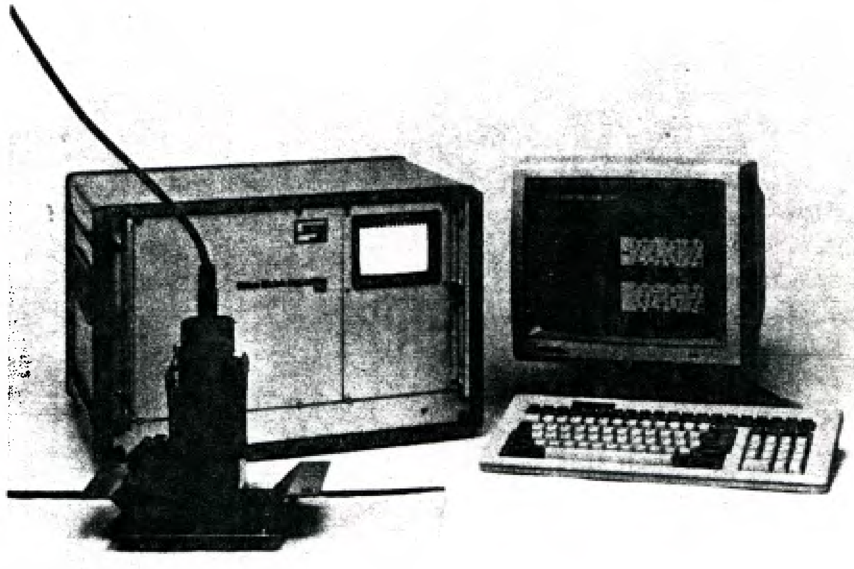


Product Information No. PB 04/1

VSI Video Shrink Inspector

General

The VSI Video Shrink Inspector processes close-ups of textile surfaces, according to a non-contact operating measuring principle.
Using an optical pattern-recognition method, it continuously measures any change in the fabric's geometry, regardless of its construction or wetness.



Application

When knitted or woven goods are manufactured, finished or processed, shrinkage or distortion always occur. Until now, it has been necessary to cut out and measure samples after each process in order to determine these changes.
The VSI Video Shrink Inspector, however, provides **immediate and non-contact** measurement of changes in the fabric's shape after each process such as bleaching, dyeing, sanforizing, or steaming.

Design

The measuring head contains a **lighting equipment with two infrared stroboscopes** and an **image sensor** consisting of a **CCD matrix camera** with a resolution of 500.580 picture elements.
The **evaluator** contains the image computer with a storage capacity of 256 kbyte.
A 5½" monitor is provided to visualize the inspected textile surface.
A menu-controlled programme is available to enter different measuring parameters via a terminal and to call the edited measuring results via a monitor or printer.

Description of Operation

Knitted or woven goods of any color pass the measuring head of the VSI inspector. The image computer digitalizes and stores a picture detail of 2 x 2 cm with a resolution of about 250.000 picture elements and 256 gray values per element. A correlation-pattern-recognition method is then used to determine the statistically determined stitch width and length of the irregular textile construction.
These values are then compared to stored reference values or to the measuring results of another measuring head to determine the longitudinal and transverse shrinkage or distortion.
The measured values are then indicated at 1-second intervals with a 0.5%-accuracy.

The VSI Video Shrink Inspector is suited for the following measurements:

1. VSI with one measuring head:
(comparison to reference values)

- Stitch width and length of single-ply or double-ply knitted goods;
- Longitudinal and transverse geometry of woven goods;
- Residual shrinkage potential whereas the measured values are compared to reference values;
- Residual shrinkage potential of fashioned goods.

2. VSI with two measuring heads:

- Shrinkage caused by processes such as tentering, sanforizing, steaming, or bleaching;
- Correcting variable for direct process control.

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„Intelligenter" Sensor zur berührungslosen und zerstörungsfreien Schrumpfmessung von Maschen- und Webware

"Intelligent" Sensor for Non-Contact and Non-Destructive Measurement of Shrinkage of Knitted and Woven Fabrics

Es wird ein neuentwickeltes System zur berührungslosen und zerstörungsfreien Messung der Geometrie-Änderungen von Maschen- und Webwaren beschrieben (eine Kurznotiz hierüber brachten wir bereits in Heft 3/85, S. 158). Eine Infrarot-Halbleiter-Kamera nimmt Nahaufnahmen der bewegten Textiloberfläche auf; die digitalisierten Bilder werden mit Hilfe einer mikroprozessorgesteuerten Mustererkennung automatisch ausgewertet. Das Verfahren arbeitet unabhängig von der Farbe bei ein- und doppellagiger Ware; Schräglauf wird selbständig kompensiert. Die Meßgenauigkeit beträgt 0,1% bei Meßzeiten von 1 Sekunde. Geometrische Veränderungen, wie Längsschrumpf und Querverzug, können damit während des Produktionsprozesses kontinuierlich erfaßt und ggf. ausgeregelt werden. Durch Vergleich mit einer Referenz läßt sich sogar bei bereits konfektionierter und verpackter Ware individuell die maximale Restschrumpfung angeben.

A newly developed system for the non-contact and non-destructive measurement of geometrical changes in knitted and woven textiles is presented (a short note was already published in 3/85, page 158). An infra-red semi-conductor camera scans macropictures of the moving textile surface. The digitized image sequence is analyzed with a computer-based pattern recognition program. The system works independent of colour for single and double-laid materials; oblique motion is automatically corrected. The measurement accuracy is 0.1% with an analysis time of 1 second. The system permits continuous monitoring of geometrical changes occurring during all stages of the production and finishing process. It is also possible to indicate the maximum residual shrinkage of already made-up materials by comparing the actual measurement with a stored reference.

1. Künstliche Intelligenz in der Industrie

Die jüngsten Fortschritte in der Mikroelektronik und Sensortechnik ermöglichen die Automatisierung von Aufgaben, die bisher der menschlichen Intelligenz vorbehalten waren. Die wohl am weitesten vorgedrungenen Arbeiten aus dem Forschungsgebiet der sog. „Künstlichen Intelligenz" stammen aus dem Bereich des automatischen Verstehens und Auswertens von Bildern, vorwiegend zur Prozeßdatenerfassung, zur Qualitätskontrolle und zur Fertigungssteuerung. Computergesteuerte Bilddatenverarbeitungssysteme (abgek. BDV-Systeme) bestehen aus einem optischen Sensor (meistens einer Halbleiter-Videokamera), einer Rechnerschnittstelle mit schnellem Analog/Digital-Umsetzer und Bildspeicher sowie einem mehr oder weniger spezialisierten Rechner zur Berechnung der im allgemeinen sehr komplexen Mustererkennungs-Aufgaben.

Die ungeheuren Datenmengen und die geforderten kurzen Auswertezeiten stellen große Anforderungen sowohl an die Hardware als auch an die Software. Allerdings werden jüngste Entwicklungen von speziellen BDV-Chips hier erhebliche Vereinfachungen bewirken. Es muß aber zugestanden werden, daß heute noch eine erhebliche Lücke klafft zwischen den industriellen Aufgaben, die *prinzipiell* mit der BDV zu lösen sind, und den wenigen, die *tatsächlich* zufriedenstellend in der Praxis arbeiten. Es gibt hierfür mehrere Gründe:

1. Die Erwartungen der Industriepraktiker waren und sind oft überzogen und unrealistisch. Man erhofft sich von der noch sehr jungen „Künstlichen Intelligenz" Dinge, die oft schon an die Grenzen der menschlichen Intelligenz stoßen. Diese hat aber bekanntlich einige Millionen Jahre Entwicklungsvorsprung!

Ein Beispiel hierzu aus der Textilindustrie ist der Wunsch nach einer kompletten Automatisierung der Schauplätze für die Qualitätskontrolle, wobei selbstverständlich alle nur denkbaren Fehler erkannt werden sollen bei großen Materialbreiten, hohen Durchlaufgeschwindigkeiten, der kompletten Produktpalette und minimalen Kosten.

2. Die Forschungsinstitute haben diesem Erwartungsdruck nachgegeben und oft mit den kompliziertesten Aufgaben angefangen. Gleichzeitig hat man die Hardware vernachlässigt und sich vor allem auf die Entwicklung geeigneter Algorithmen und Programme für kommerziell verfügbare BDV-Systeme konzentriert. Das Ergebnis war zwangsläufig sowohl teuer als auch enttäuschend.

3. Man hat die BDV viel zu sehr als reinen Ersatz für die menschliche Sichtkontrolle verstanden und dabei eine ganze Reihe einfacherer Aufgaben am Rande übersehen.

Wir berichten im folgenden über eine Neuentwicklung für die Textilindustrie, die wir am Transferzentrum Konstanz für Bilddatenverarbeitung, einer Einrichtung der *Steinbeis*-Stiftung für Wirtschaftsförderung, durchführen. Diese Entwicklung ist ein typisches Beispiel für unsere Philosophie der „eng zugeschnittenen BDV". Wir fordern vom Anwender eine vernünftige Beschränkung seiner Wünsche und gehen selbst von vollständig modularen kommerziellen Systemen weg. Wir sind dadurch in der Lage, Low-cost-BDV-Systeme anzubieten, die zwar nur *eine* spezielle Aufgabe lösen können, dies aber mit niedrigem Aufwand und sehr kurzer Entwicklungszeit.

2. Unterentwickelte Schrumpfungs-Meßtechnik

Bei der Herstellung und Verarbeitung von Maschen- und Webwaren spielen Schrumpf- und Verzugsprozesse eine große Rolle. Bei Längsschrumpfungen von 10 bis 20% für Maschenwaren auf dem Wege von der Produktionsmaschine bis zum letzten Waschgang beim Kunden sollte man eigentlich erwarten, daß diese Prozeßgröße meßtechnisch entsprechend erfaßt und kontrolliert wird. Um so erstaunlicher ist es zumindest für einen in der Textiltechnologie eher unbedarften Informatiker, mit welch vergleichsweise primitiven Methoden die geometrischen Veränderungen von Maschen- und Webwaren gemessen werden.

Man bringt linien- oder kreisförmige Markierungen auf das Material auf und mißt deren Veränderungen von Hand nach. Dieses Verfahren ist zerstörend, es unterbricht den laufenden Produktionsprozeß und ist mit vielen subjektiven Fehlerquellen behaftet. Auch die von einem bekannten Textilforschungsinstitut angebotene Variante, die Veränderungen an den aufgebrachten Markierungen per Koordinaten-Digitizer und Arbeitsplatzcomputer auszuwerten, ist hierbei nur eine sehr relative Verbesserung. Am schwerstwiegenden ist aber die Tatsache, daß diese manuellen Messungen nur stichprobenartig durchgeführt werden können. Damit stehen aber für die wichtige Prozeßgröße „Schrumpfung" keine fortlaufenden Meßdaten zur Verfügung. Alle die Prozesse, welche die Geometrie verändern, wie Tumbeln, Sanforisieren, Bleichen, Färben, Dämpfen usw., lassen sich nicht im Sinne einer vorgegebenen Soll-Schrumpfung regeln, weil ein entsprechender Sensor fehlt.

Wir haben uns auf Anregung eines bedeutenden regionalen Herstellers von Strickwaren die Aufgabe gestellt, mit Hilfe der BDV ein berührungsloses, zerstörungsfreies und kontinuierlich messendes Verfahren zur Bestimmung der Schrumpfung und des Querverzugs bei Maschenwaren zu entwickeln. Dieser „intelligente" Sensor soll eine kontinuierliche Überwachung der geometrischen Veränderungen während des gesamten Produktionsablaufs ermöglichen, die Führungsgröße zur automatischen Regelung liefern und eine Aussage über das verbleibende Restschrumpf-Potential liefern.

3. Computergesteuerte Auswertung lokaler Maschenbilder

Die manuelle Auswertung von aufgebrachten Markierungen ist eine *globale* Methode. Sie bestimmt einen Mittelwert für die Anzahl von Maschen je Längeneinheit. Die Schrumpfung muß aber auch *lokal*, d.h. in der einzelnen Masche, wiederzufinden sein, allerdings

→

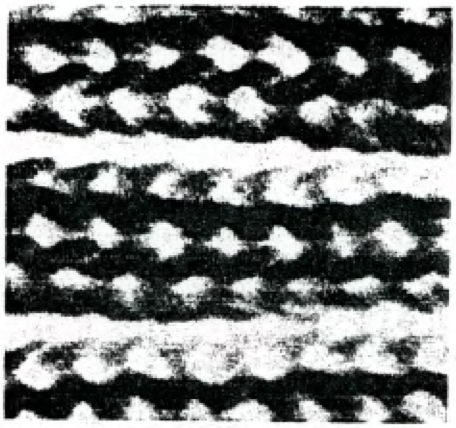

Bild 1 Nahaufnahme eines Maschenbildes; Größe und Abstand der einzelnen Maschen schwanken beträchtlich

mit einer viel größeren statistischen Unsicherheit. Der Grundgedanke unseres Verfahrens ist, auf globale Markierungen zu verzichten und das Helligkeitsbild der einzelnen Masche selbst geometrisch auszuwerten.

Wie Bild 1 zeigt, schwanken Größe und Form der einzelnen Masche beträchtlich. Wir beschreiben daher die optisch erfaßbare Textiloberfläche als einen periodischen Prozeß mit starken überlagerten, zufälligen Schwankungen. Wenn es gelingt, die Grundperiode, d.h. die mittlere Maschenweite, von diesen Schwankungen zu befreien, dann wäre die Meßaufgabe prinzipiell gelöst.

Mit Hilfe einer miniaturisierten und infrarot-empfindlichen Halbleiter-Matrix-Kamera (Bild 2) erfassen wir ein Grauwertbild in einem relativ kleinen Ausschnitt von typ. 30 Maschen (Bild 3). Diese Aufnahmen erfolgen kontinuierlich an der bewegten ein- oder doppellagigen Ware. Durch eine sehr kurze Beleuchtung mit einem ebenfalls neuentwickelten Infrarot-Halbleiter-Stroboskop werden scharfe Bilder auch bei sehr unterschiedlichen Färbungen und Stricktypen erreicht. An die Materialführung werden keine besonderen Anforderungen gestellt.

Bild 2 Zur Aufnahme lokaler Maschenbilder wird eine miniaturisierte und infrarot-empfindliche Halbleiter-Matrix-Kamera mit einer Auflösung von 512 × 380 Bildpunkten eingesetzt (zum Größenvergleich ein Feuerzeug)

Das auf einem 32-bit-Mikroprozessor ablaufende Mustererkennungsprogramm vermag automatisch Schräglauf zu erkennen und legt eine Meßlinie durch die Maschenmitten (Bild 4). Falten, Flusen oder sonstige Störungen werden erkannt, und die Meßlinie wird automatisch in ungestörte Bildbereiche verlegt. Entlang und quer zur Maschenmitte erfolgt die Bestimmung der geometrischen Daten. Die Auflösung des Systems beträgt 0,1% und liegt damit weit über den manuell erreichbaren Genauigkeiten. Das System läßt sich mit zwei Kameras ausrüsten, so daß die Schrumpfung zwischen Ein- und Ausgang einer Verarbeitungsstufe gemessen werden kann. Selbstverständlich lassen sich Schrumpf und Querverzug auch durch Vergleich mit einer gespeicherten Referenz ermitteln. Bei Meßzeiten von typ. 1 Sekunde ist eine praktisch lückenlose Überwachung möglich. Diese Meßzeiten sind ausreichend klein, um als Regelgröße zu dienen.

Eine umfangreiche Betriebs-Software erlaubt die Erstellung einer kompletten Produktionsstatistik, die Meßwertausgabe in digitaler und analoger Form, den kompletten System-Selbsttest sowie die Verbindung zu externen Prozeßrechnern. Die Bedienung ist äußerst einfach und verlangt weder Kenntnisse der Informatik noch der Bilddatenverarbeitung. Das gesamte System hat in einem 19"-Gehäuse Platz.

4. Weiterentwicklung zu einem Industriegerät

Unser System wird z.Z. mit Unterstützung eines regionalen Herstellers von Strickwaren als funktionsfähiger Prototyp entwickelt.

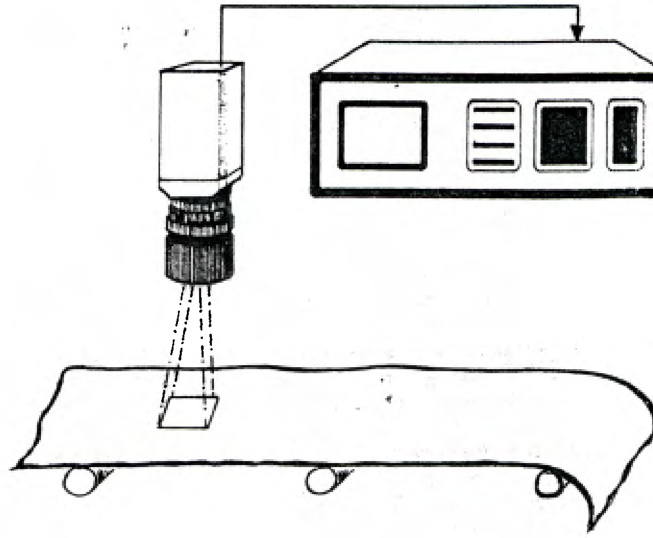

Bild 3 Die Bildaufnahme erfolgt an der bewegten ein- oder doppellagigen Ware; diese braucht nicht besonders geführt zu werden

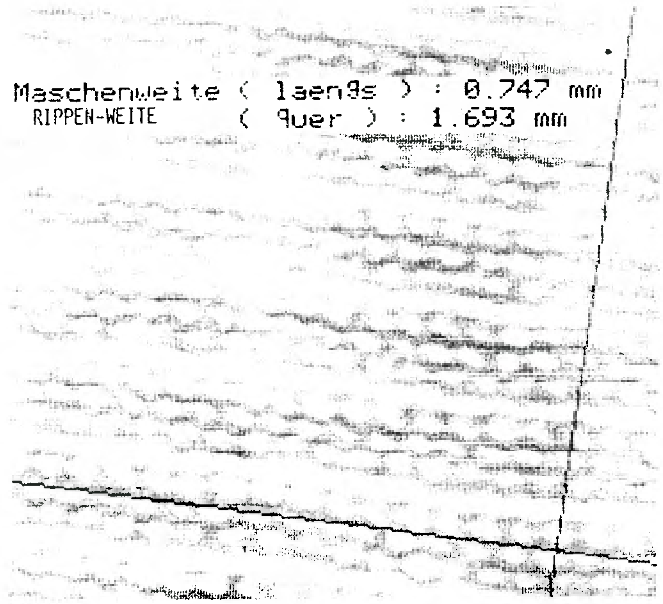

Bild 4 Das Mustererkennungsprogramm findet auch bei Schräglauf automatisch die Maschenmitte und wertet in Längs- und Querrichtung aus

Die Anwendungsmöglichkeiten gehen über eine reine Schrumpfkontrolle weit hinaus. Als kontinuierliche Quelle für Schrumpfungs-Meßdaten stellt dieser „intelligente" Sensor die Führungsgröße für eine direkte digitale Regelung bereit. Da das System leicht uminstalliert werden kann, lassen sich die Verursacher geometrischer Veränderungen gezielt einkreisen. Durch die fortlaufende Messung läßt sich auch die Schwankung der lokalen Schrumpfung und damit eine genaue Statistik dieser Prozeßgröße erstellen. Schließlich ist es sogar möglich, bereits konfektionierte und sogar (durchsichtig) verpackte Ware in einer Endkontrolle einzeln auszumessen und durch Vergleich mit einer Referenz individuell eine maximale Restschrumpfung anzugeben. Die insgesamt erzielbaren Qualitätsverbesserungen sind offensichtlich und in einer sich in starkem Konkurrenzdruck befindlichen Industrie wohl auch erforderlich.

Das Verfahren ist patentrechtlich geschützt; die Verwertungsrechte liegen beim Erfinder *Prof. Massen.* Für die Weiterentwicklung des Prototyps zu einem industriereifen Seriengerät wird ein Zeitraum von ca. 12 Monaten angesetzt. Prof. Massen sucht hierfür interessierte Unternehmer und bittet um Kontaktaufnahme über das Transferzentrum Konstanz für Bilddatenverarbeitung, Reichenaustr. 81c, D-7750 Konstanz, Tel. 0 75 31/5 75 02.

The machine types, gauges, and yarns used will depend on the density of the fabric and the resistance required against filtering liquids. The advantage of warp knitted filter fabrics is their perfectly uniform openings which are guaranteed by the slip-resistant nature of the fabric. An example is a lint filter for washing machines produced on the KS 2 tricot machine in a gauge of E 28 and widths of 213-533 cm (84-210"). The production rate is 60 m/h, and the fabric weight is approximately 35 g/m². Nylon yarns of 22 dtex f 1 are used.

Figure 17 Mosaic carrier net

Figure 18 Coated warp knit for bags, suitcases, garments, etc.

Figure 19 Raschel knitted snow chain (Courtesy Sintac-Technik, Am Lunedeich, D-2850 Bremerhaven)

Figure 20 Sandwich fabric for house slippers: outside printed short pile velour, inside solid colored high pile velour

Figure 21 Warp knitted dish cloths with crochet-like, open terry structure

Figure 22 Measuring a warp knitted reflectar for a transmission antenna (Courtesy MBB, D-8012 Ottobrunn)

Figure 23 Lint filter for washing machines

Prof. Dr.-Ing. Robert Massen, Dipl.-Ing. (FH) Uwe Winkler

Transfer Center Constance for Videotext Processing at the Steinbeis Foundation for Economic Development

"Intelligent" Sensor for Non-contact and Non-destructive Measurement of Shrinkage in Knitted and Woven Fabrics

A newly developed system for non-cantact and non-destructive measurement of geometric changes in knitted and woven textiles is presented (a short note was already published in 3/85, p. 158). An infrared semiconductor camera scans macro-images of the moving textile surface. The digitized image sequence is analyzed with a computer based pattern recognition program. The system works independently of color for single and double-laid materials; oblique motion is automatically corrected. The measurement accuracy is 0.1% with an analysis time of 1 second. The system permits continuous monitoring of geometric changes occurring during all stages of the production and finishing process. It is also possible to indicate the maximum residual shrinkage of made-up materials by comparing the actual measurement with a stored reference.

1. Artificial Intelligence in the Industry

Most recent progress in microelectronics and sensor technology makes it possible to automate functions previously reserved to human intelligence. The most progressive research, perhaps, from the area of "artificial intelligence" comes from the area of automatic image interpretation and processing, primarily for process data control, quality control, and fabrication control. Computerized video data processing (VDP) systems consist of an optical sensor (generally a semiconductor video camera), a computer interface with a fast analog/digital converter and video memory and a more or less specialized computer to calculate the generally very complex pattern recognition problems.

The enormous volumes of data and short evaluation time frames made great demands on both hardware and software. But most recent developments of special VDP chips will bring about some simplification here. It must be admitted that quite a gap still persists between the industrial functions which can *principally* be solved by VDP and the few that *actually* run satisfactorily in practice. There are several reasons for this:

1. The expectations of industry people were and are often exaggerated and unrealistic. The still very young field of artificial intelligence is expected to perform feats that often approach the limits of human intelligence. Which, we know, has several million years of a head start developing!

One example from the textile industry is the wish for complete automation of inspection tables for quality control, naturally with recognition of all conceivable defects over wide sheets, at high transit rates, covering the entire product line, and at minimal cost.

2. Research institutes have caved in to that pressure of expectations and have often begun with the most complicated of functions. At the same time, hardware was neglected, while emphasis was placed on the development of suitable algorithms and programs for commercially available VDP systems. The results were necessarily both costly and disappointing.

3. VDP was viewed too much as a substitute for visual (human) inspection, while a number of simpler functions were overlooked along the way.

We here report on a new development for the textile industry by the Transferzentrum Konstanz fuer Bilddatenverarbeitung, an agency of the *Steinbeis* Foundation for Economic Development. This development is a typical example of our philosophy of "closely tailored" VDP. We ask users to reasonably curtail their wishes and even depart from completely modular commercial systems. This enables us to offer low cost VDP systems which may only handle *one* particular function, but which do this at low cost and upon a very short development period.

2. Underdeveloped Shrinkage Measureme[ ] Technology

In knitgoods and wovens manufactu[ ] shrinkage and distortion play a lar[ ] role. Given 10-20% lengthwise knitgoo[ ] shrinkage on the way from the productio[ ] machine to the last wash at the cu[ ] tomer's, one might expect this pro[ ] variable to be suitably measured an[ ] controlled. It is all the more astonish[ ] ing, at least for an information man wh[ ] is rather more at sea in textile techn[ ] logy, by what relatively primiti[ ] methods geometric changes in knitgoo[ ] and wovens are indeed measured.

Linear or circular markings ar[ ] made on the fabric, and dimension[ ] changes are measured by hand. This is [ ] destructive method, it interrup[ ] production, and is open to subjecti[ ] error. The variant of processing th[ ] changes between markings with coordina[ ] digitizers and a desktop computer, [ ] offered by a well known textile researc[ ] institute, is no more than a relati[ ] improvement. The most serious objectio[ ] is the fact that these manual measur[ ] ments are only spot checks and d[ ] not provide any continuous measuremen[ ] data on the important variable "shrink[ ] age." All processes that alter th[ ] geometry, like tumbling, Sanforizing[ ] bleaching, dyeing, ageing, etc., cann[ ] be handled in terms of specified shrink[ ] age for lack of a suitable sensor.

At the instigation of a majo[ ] regional manufacturer of knitgoods w[ ] set ourselves the task of developing [ ] contactless, nondestructive, continuou[ ] measurement system to determine shrinkag[ ] and crosswise distortion in knitgood[ ] This "intelligent" sensor should provid[ ] continuous monitoring of geometri[ ] change during the entire productio[ ] process, supply the signal for automati[ ] control, and provide information o[ ] the residual shrinkage potential.

3. Computer Processing of Local Loo[ ] Patterns

Manual evaluation of applied markings [ ] a *global* method. It derives an averag[ ] for the number of loops per unit lengt[ ] But shrinkage must also be reflecte[ ] *locally*, i.e. on the individual loo[ ] level, albeit at much lower statistica[ ] certainty. The basic idea of our method is to dispense with global markings and to process the brightness pattern of each individual loop geometrically.

As Fig.1 shows, the size and shape of the individual loops differ considerably. We therefore describe the optically detectable textile surface as a periodic process with strong random fluctuations superimposed. If it is possible to rid the basic period or mean loop width of these fluctuations, the measurement function is principally solved.

Using a miniature, infrared sensitive semiconductor camera (Fig.2), we capture a grey scale image of a relatively small detail of typically 30 loops (Fig.3). These images are captured continuously while the single or double fabric sheet is moving along. The very brief exposure to an equally new infrared semiconductor strobe produces sharp images, even of different dyeings and knit types. There are no special material guidance requirements.

The pattern recognition program running on a 32-bit microprocessor automatically recognizes skewing and places a measurement line through the centers of the loops (Fig.4). Creases, lint, and other interferences are recognized, and the measurement line is automatically placed into problemfree areas. The geometric data are determined along and at right angles to the loop center. System resolution is 0.1%, which makes it far more accurate than manual methods can achieve. The system may be equipped with two cameras for measuring shrinkage between the input and output of a process stage. Shrinkage and lateral distortion can naturally also be determined by comparison with a stored reference. At measurement times of typically 1 second, monitoring is virtually contiguous. These measurement times are sufficiently short to serve as control signals.

Extensive operating software makes it possible to establish complete production statistics, to output measurement data in digital and analog form, to perform a complete system self-test, and to connect external process control computers. Operation is extremely simple and requires neither informatics nor video data processing skills. The entire system is housed in a 19" unit.

4. Development to the Level of Industrial Application

Our system is presently under development as functional prototype, with the support of a regional knitgoods manufacturer. The applications range far beyond simple shrinkage control. As a continuous source of shrinkage measurement data, this "intelligent" sensor provides the control signal for direct digital regulation. Since the system is easily reinstalled, the causes of geometrical changes can be specifically localized. Through continuous measurement, fluctuation in local shrinkage and exact statistics of this process variable can be determined. Finally, it is also possible to measure made-up products and even packaged goods (transparent packaging) for a final check and to state the maximum residual shrinkage by comparison with a reference value. The total quality improvements possible are obviously needed in an industry that feels severe competitive pressure.

The process is patented; the exploitation rights are vested in the inventor, *Prof. Massen.* A period of about 12 months is posited for the development of the prototype to an instrument ready for serial industry use. Prof. Massen is seeking interested entrepreneurs and requests they contact him via Transferzentrum Konstanz fuer Bilddatenverarbeitung, Reichenauerstr. 81c, D-7750 Konstanz, Tel. 0 75 31/5 75 02.

Figure 1 Close-up of a loop pattern; size and interval between loops vary considerably

Figure 2 A miniature infrared semiconductor matrix camera with 512x380 pixel resolution is used to record local loop patterns (a lighter shown for scale)

Figure 3 The image is recorded from a moving single or double sheet; there are no special guidance requirements for the goods

Figure 4 The pattern recognition program automatically determines the centers of the loops, even when the fabric is skewed; evaluation both crosswise and lengthwise

Dipl.-Ing. Claus Tischbein, Seevetal 3-Maschen

What Influence Have Squeezing Systems on Washing Processes?

The direct and indirect influence of squeezing systems on the effects obtained in continuous washing-out of water-soluble and water-insoluble or sparingly soluble substances from normal textiles in the web form are discussed. Calculations and test results are presented to substantiate individual effects.

There are different views, even among specialists, about the effect of squeezers in washing processes. We will here attempt to contribute to clarifying this question.

First, it is important to differentiate between pure washing processes, i.e. the removal of a certain or of several substances from the fabric, and a combined chemical and wash treatment, as in pad-steam processes. Because of the intended liquor separation effect, squeezers are absolutely required in the latter case. Their effect in wash processes should be viewed with some differentiation.

When highly water-soluble substances are washed out, e.g. alkali, acids, salts, or hydrolyzates, the direct washing effect of squeezers enhances the washing efficiency by only about 0.5%, as an example will illustrate below. The relatively high price of squeezers were better invested in an extended washing sequence in this case.

In such "solution wash" washing machines, as used after mercerizing and boiling-off, for example, squeezers offer hardly any advantage. When washers are universally employed, however, sensibly installed squeezers are practical and economical, however. This applies particularly to washers used to wash off gel-like or water-insoluble substances such as print thickeners, synthetic size, or dispersions.

Squeezers for Washing-off Water-Soluble Products

The washing-off properties of water-soluble electrolytes, especially of NaOH, have frequently been investigated. The washing-off of NaOH can now be precalculated with good precision for a variety of washing machines and washing-off conditions. The substance transfer index gamma required for calculation is easily determined by experiment. One major reason for this finding is the relatively simple and accurate measurement of initial and final add-on levels on the fabric.

If determining the substances quantitatively is involved or imprecise, however, one must yet dispense with using mathematical formulas to aid in the design of washing machines. Unfortunately the latter is the case with most of the substances used in the textile industry, so that one is generally dependent on practical experience, partial insights, and analogies.

In all washing processes, especially the washing-off of easily soluble substances, it is important to achieve the most exact bath separation possible, i.e. to avoid entraining liquor with the fabric.

According to [1], the following equation applies to counterflow:

$$C_n = \frac{C_0}{1 + F + F^2 + \ldots F^n} \quad (1)$$

where

C_n = concentration of the substance to