



International Institute For Cotton
Technical Research Division
Manchester

Research Record No: 158

Central Project 1978 Phase 2 (Supplementary)
Further Dyeing And Finishing Operations

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June 1982

Key Words: Interlock, 1x1 Rib, Dyeing, Finishing

Classification: Fabrics/Knitted/Processing

Digital Version: April 2012

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1. Introduction

During 1978 a project was started on 20 gauge interlock and 14 gauge 1x1 rib fabrics with the aim of determining the precise effect of knitting variations on the final properties of these knitted structures. In particular, the interaction of various yarn count/stitch length combinations was of interest and a range of fabrics with the following constructions was produced.

	Interlock	1x1 Rib
Yarns, Ne	34, 38, 42	26, 30, 34
Stitch Lengths, mm	3.07, 3.24, 3.40, 3.59, 3.77	2.67, 2.85, 3.06, 3.26, 3.50

For the 1x1 rib fabrics, the 34Ne yarn was also knitted at a stitch length of 2.48 mm

A number of pieces of each quality were produced to enable several finishing routes including piece mercerising to be carried out. Sufficient fabric was knitted to enable a complete set of interlock and 1x1 rib fabrics to be held in reserve in case of accidents or for further trials.

Research Record No. 83 describes the knitting of these fabrics and *Research Record No. 94* describes the dyeing and finishing operations which were carried out at Meridian Dyers during 1978.

All fabrics were fully tested at various stages of finishing, both in the unwashed and the “fully relaxed” (IIC Reference) state and the test results were used as a data base for computer programmes for analysing the many interactions of yarn count, stitch length and finishing route on fabric properties. Using the equations found from the analysis, a computer model was built which allows for rapid prediction of the approximate weight and dimensions of finished fabric using a number of finishing routes.

One of the main discoveries of this work was that there appears to be differences in the “fully relaxed” structures (the base from which predictions are made) of fabrics dyed by winch and by jet machines. The implication of this is that finished fabric specifications may have to take into consideration the dyeing route, or that only certain finishers may be able to meet certain specifications due to limitations in the machinery available to them.

If this is the case, then there are some far reaching implications, the main one being that fabric may have to be specifically knitted for a particular finishing route.

Unfortunately, the winch dyed route was carried out on only 6 of the 15 or so qualities knitted, since at the time it was only considered to be a minor route. With hindsight, it would have been preferable to have included the full range of yarn count/stitch length combinations in this route.

For this reason, it was felt that these observations should be confirmed in light of the considerations just mentioned. The spare sets of interlock and rib fabrics were therefore dyed and finished at Meridian by both the winch route and the jet route. This report describes these operations and records the observations and measurements taken during the processing.

2. Fabric Coding

The coding system used was as described in *Research Records 83 and 94*. For example,

The lot numbers used for these processing batches were as follows.

	Interlock	Rib
Winch	Lot 4	Lot 21
Jet	Lot 3	Lot 22

Each piece was approximately 50 metres in length giving dye batch sizes of approximately 130kg for rib and 150kg for interlock.

3. Processing Routes

There have been a number of changes in equipment and processing routes at Meridian during the past four years which can be briefly summarised as follows.

1. The Thies *R-Jet 95* machines are losing favour due to their rough action and are being modified by the addition of fabric transport (winch) wheels to make them similar to the Thies *Eco-Soft* machines and allows a reduction in the pressure at the venturi.
2. Mechanical compaction is completely out of favour (in the UK) except for whites or where specifically requested by a customer.
3. The preferred route, at present, following dyeing consists of wet stretching on the Calator *Airtex* followed by drying on two Tubetex dryers linked together. Final calendaring being carried out on the Heliot *Plimatic* calendars.

In deciding the precise routes to adopt for the current lots, consideration was given to the fact that the main purpose was to compare the winch and the jet machines. Whether wet stretching has an influence on the fully relaxed structure has not been investigated in any detail and therefore it was felt that to incorporate wet stretching in the finishing operation was likely to cloud the issue. It was decided therefore to stay with the old processing route and to omit mechanical compaction.

Additionally, since crosslinking is not to be carried out on these particular fabrics, softening agent was applied in the dyeing vessel as is customary.

The only other difference was the use of the Thies *Eco-Soft* jet dyeing machine as opposed to the *R-Jet 95* used previously. As well as its loss of favour the size of the present dye lots (average 140kg) necessitates a two-tube machine thus ruling out the remaining *R-Jet 95*'s which are three-tube versions.

The decision was taken to use the *Eco-Soft* machine (*Figure 11*) which represents the current fashion of jets with softer action and incorporating a winch wheel to assist fabric transportation.

The complete processing route was therefore as follows.

- Dye* (winch or jet), post soften
- Hydroextract
- Pegg dry

- Calender - Heliot *Plimatic*
- Sample

* Shade in each case 2% Procion Blue HEG

4. Finishing Targets

Use was made of the STARFISH model to give targets for width and number of courses. Target shrinkage figures of 15% and 12% for length and width respectively were chosen, and only predictions for the jet dyed route were selected. These targets were used for both jet and winch dye lots.

The computer print-outs are given as *Figures 1 and 2*.

The dye lots were assembled in order of increasing target width to facilitate easy processing at the drying and calendaring stages.

5. Processing Details

5.1. Interlock - Jet dyed, Lot 3

Dyeing details are given in *Figure 3*.

In-process measurements are given in *Figure 4*.

Observations:

Poor fabric appearance.

Difficulty in obtaining target course levels, particularly with the slacker fabrics.

5.2. Interlock - Winch dyed, Lot 4

Due to a weighing error, hydros instead of bicarbonate was added to the dyebath by mistake. This was immediately spotted by the dyer who dropped the bath and rinsed the fabric. The shade obtained was therefore on the pale side but the time in the dye vessel was representative.

Dyeing details are given in *Figure 5*.

In-process measurements are given in *Figure 6*.

Observations:

Fabric appearance considerably better than the jet dyed set.

Difficulty in obtaining target course levels, particularly with the slacker fabrics.

5.3. 1x1 Rib - Jet dyed, Lot 22

Dyeing details are given in *Figure 7*.

In-process measurements are given in *Figure 8*.

Observations:

As with the interlock set, the fabric appearance was rather poor due to surface fibre.

Target course levels were attainable with the tighter fabrics but unattainable at the slacker end.

5.4. 1x1 Rib - Winch dyed, Lot 21

Dyeing details are given in *Figure 9*.

In-process measurements are given in *Figure 10*.

Observations:

Considerably better appearance than the jet dyed set in terms of lack of hairiness.

Courses attainable with the tighter fabrics but not with the slacker fabrics.

6. Sampling

Five-metre samples were removed from the middle of each piece prior to parcelling. At the same time, width and courses per 3cm were measured to enable the degree of creep on storage to be evaluated.

7. Conclusions

1. Apart from the problem of a wrong chemical addition during one dyeing cycle, no other undue difficulties were experienced.
2. The difference between the hydroextracted width and the target width from the Pegg dryer is not sufficient to enable much overfeed to be applied on the dryer. This reinforces the view that the only mechanical way of increasing the number of courses, other than compacting or tumbling, is to wet stretch.
3. The first impression is that the Thies *Eco-Soft* jet dyeing machine is equally as rough on cotton fabrics as the *R-Jet-95*, although particular comparisons will have to be carried out in due course.

Figure 1

**** IIC -STARFISH- MODEL PREDICTIONS ****

INTERLOCK: 20g 24 in. 1500 needles 13-MAY-82 10:37
 Jet dyed page 1

As knitted			Fin. relaxed			As delivered		weight g/sn	width cm(T)	Process in order
Yarn No	StLen cm	TF	Yarn No	StLen cm	TF	courses 3cm	wales 3cm			
..... @ LxW Shrinkage = 15 x 12										
34.0	0.307	13.6	34.2	0.303	13.7	43.9	38.4	199.6	58.6	4
34.0	0.324	12.9	34.2	0.319	13.0	41.4	37.2	190.7	60.5	7
34.0	0.340	12.3	34.2	0.334	12.4	39.4	36.2	183.1	62.2	10
34.0	0.359	11.6	34.2	0.353	11.8	37.2	35.1	174.9	64.2	13
34.0	0.377	11.1	34.2	0.370	11.2	35.2	34.1	167.8	66.0	15
38.0	0.307	12.0	38.3	0.303	13.0	43.6	39.3	180.6	57.3	2
38.0	0.324	12.2	38.3	0.319	12.3	41.1	38.1	172.6	59.1	5
38.0	0.340	11.6	38.3	0.334	11.7	39.1	37.1	165.8	60.7	8
38.0	0.359	11.0	38.3	0.353	11.1	36.8	36.0	158.5	62.6	11
38.0	0.377	10.5	38.3	0.370	10.6	34.9	35.0	152.3	64.3	14
42.0	0.307	12.2	42.5	0.303	12.3	43.3	40.1	165.2	56.2	1
42.0	0.324	11.6	42.5	0.319	11.7	40.9	38.9	158.0	57.9	3
42.0	0.340	11.0	42.5	0.334	11.1	38.8	37.8	151.9	59.5	6
42.0	0.359	10.4	42.5	0.353	10.6	36.6	36.7	145.3	61.3	9
42.0	0.377	9.9	42.5	0.370	10.1	34.7	35.8	139.6	62.9	12

Figure 2

**** IIC -STARFISH- MODEL PREDICTIONS ****

RIB1x1: 14g 24 in. 1056 needles 13-MAY-82 10:40
 Jet dyed page 1

As knitted			Fin. relaxed			As delivered		weight g/sn	width cm(T)	Process in order
Yarn No	StLen cm	TF	Yarn No	StLen cm	TF	courses 3cm	wales 3cm			
..... @ LxW Shrinkage = 15 x 12										
26.0	0.267	17.8	26.0	0.266	17.9	49.0	29.8	198.4	53.1	4
26.0	0.285	16.7	26.0	0.283	16.8	45.8	28.3	185.5	55.9	7
26.0	0.306	15.6	26.0	0.303	15.7	42.6	26.8	172.2	59.0	10
26.0	0.326	14.6	26.0	0.322	14.8	39.9	25.6	161.1	62.0	13
26.0	0.350	13.6	26.0	0.345	13.8	37.1	24.2	149.4	65.4	16
30.0	0.267	16.6	30.1	0.266	16.7	48.1	29.9	169.7	53.0	3
30.0	0.285	15.6	30.1	0.283	15.6	45.0	28.4	158.5	55.7	6
30.0	0.306	14.5	30.1	0.303	14.6	41.7	26.9	147.0	58.9	9
30.0	0.326	13.6	30.1	0.322	13.7	39.0	25.6	137.4	61.8	12
30.0	0.350	12.7	30.1	0.345	12.8	36.2	24.3	127.3	65.2	15
34.0	0.248	16.8	34.1	0.248	16.8	51.2	31.7	159.6	49.9	1
34.0	0.267	15.6	34.1	0.266	15.6	47.4	30.0	147.7	52.9	3
34.0	0.285	14.6	34.1	0.283	14.7	44.2	28.5	137.9	55.6	5
34.0	0.306	13.6	34.1	0.303	13.7	41.0	27.0	127.8	58.7	8
34.0	0.326	12.8	34.1	0.322	12.9	38.3	25.7	119.3	61.6	11
34.0	0.350	11.9	34.1	0.345	12.0	35.5	24.4	110.4	65.0	14

Figure 3

SHADE: 110 / 1170
 CUSTOMER/LOT NO: BLUE *Interlock*
 THIS MACHINE NO: ECO
 WEIGHT: 154 K NO. OF PIECES: METRES: MACHINE CAPACITY: LITRES
 22 1600

1. SCOUR
 K. LYOCOL HEB
 K. SODA ASH
 K.
 START AT °C. RAISE TO THE BOIL.
 BOIL FOR MINS.
 WASH OFF WELL.

2. BLEACH
 J K. VISCAMIN CA
 K. STABILISER
 J K. CAUSTIC LIQ.
 K. TETRAON B.
 8 K. HYDROGEN PEROXIDE
 START AT 50 °C. RAISE TO 95 °C.
 RUN FOR 20 MINS. WASH OFF WELL.
 3K HYDRO 20 - 70 °C

START AT 50°C ADD DYE OVER 10 MIN. RUN FOR 20 MIN
 RAISE TO 85°C RUN 15 MIN ADD 1/3 OF SALT OVER 20
 RUN 15 MIN ADD 1/3 OF SALT OVER 20 MIN RUN 10 MIN. ADD
 REMAINING 1/3 OF SALT OVER 20 MIN RUN FOR 30 MIN. ADD
 BICARBONATE OVER 10 MIN. RUN 15 MIN ADD SODA ASH IN
 TWO PARTS OVER 20 MIN. RUN FOR 40 MIN & SHOW.

CHEMICALS.	G/L	SHADE PASSED.
1/2 K. RESIST SALT. <i>Pal</i>		* NO ADDS *
96 K. SALT.		
24 K. SODA ASH		
8 K. GLAUBERS. Bicarbonate		
K. CAUSTIC LIQ.		

DYESTUFF	ADDITIONS					TOTAL	TOTAL
	1	2	3	4	5	DYE	%
3080 Procion Blue HEG (not HEGN)							

4. BACK SCOUR.
 K. SCOUDEX R
 K.
 RAISE TO THE BOIL, BOIL FOR 70 MINS.
 WASH OFF WELL.

5. SOFTEN. *ACOLUBE BSL 2000*
 K. ~~SCOUDEX R~~
 3 K. ~~SCOUDEX R~~ *BSL*
 K. ~~SCOUDEX R~~ TX
 20 MINS. AT 40 °C PH 6.

Machine Speed. Approx. 180 yds/min

Figure 4

INTERLOCK ECOSOFT LOT 3	TARGETS		PEGG DRYER		CALENDER		SAMPLING	
	WIDTH	C/3	WIDTH	C/3	WIDTH	C/3	WIDTH	C/3
1 42/307 ✓	56	43½	56	41	56	41½	56	43
2 38/307 ✓	57½	43½	57½	43	57.5	43	57½	43/43
3 42/324 ✓	58	41	58	39	58	40	58	39
4 34/307 ✓	58½	44	58½	44	58½	44½	58½	44½
5 38/324 ✓	59	41	59	39	59.5	40½	58½	40½
6 42/340 ✓	59½	39	59½	36	59.5	36	59½	36
7 34/324 ✓	60½	41½	60½	40	61	40½	60¾	40
8 38/340 ✓	60½	39	60½	37	61	37	60½	37½
9 42/359 ✓	61½	36½	61½	32	61.5	33	61½	33½
10 34/340 ✓	62	39½	62	37	62	38	61½	37½
11 38/359 ✓	62½	37	62½	33½	62½	34	62¾	34
12 42/377 ✓	63	35	63	31	64	31	64	30½
13 34/359 ✓	64	37	64	35 35	64.5	35	64	34½
14 38/377 ✓	64½	35	64½	32	65	32	64½	31
15 34/377 ✓	66	35	66	32	66	33	65¾	33½

Figure 5

CUSTOMER/LOT NO: **11C TRIAL** FABRIC: **Interlock** M/C. NO:
4
 WEIGHT: **155** KILOS. NO. PIECES: **WINCH** M/C. CAPACITY LITRES
3000

1. SCOUR:
 K. DYSOX
 K. SANDOPAN DTCL
 K. SOVATEX PN/O
 K. SODA ASH
 K. VISCAMINGA
 RAISE TO THE BOIL, BOIL FOR
 MINS. WASH OFF WELL. NEUTRALIZE
 WITH ACETIC ACID.

1 1/2 K. CONTAVAN HW.
7 K. CAUSTIC LIQ.
6 K. HYDROGEN PEROXIDE.
 RAISE TO THE BOIL IN 30MINS.
 BOIL FOR 30MINS. SHOW.
 NEUTRALIZE WITH **3** K. ACETIC ACID.
20 MINS. AT 60 C. WASH OFF WELL.
 2 hot washed

START AT 50°C ADD DYE OVER 10MIN. RUN FOR 20MIN.
 RAISE TO 85°C RUN 15 MIN. ADD 1/3 OF SALT OVER 20MIN
 10 MIN. ADD 1/3 OF SALT OVER 20MIN RUN 10 MIN. ADD
 REMAINING 1/3 OF SALT OVER 20 MIN RUN FOR 30 MIN. ADD
 SODIUM CARBONATE OVER 10 MIN. RUN 15 MIN. ADD SODA ASH IN
 PARTS OVER 20MIN. RUN FOR 40 MIN & SHOW.

CHEMICALS. 4 K. RESIST SALT Material PAL G/L 15 K. SALT. 30 K. SODA ASH. K. CAUSTIC. K. GLAUBERS. 13 K. SANDOPAN DTCL. Bicarb. K. LYCOGEN MS. K. SPA.	SHADE PASSED NO ADDS
--	---------------------------------------

DYESTUFF.	ADDITIONS					TOTAL	TOTAL
	1	2	3	4	5	DYE	%
3,000g Procion Blue HEG							

4. BACKSCOUR.
2 K. SCOUREX.
 K. TRIMINE PR.
 K.
 RAISE TO THE BOIL, BOIL FOR **20** MINS
 WASH OFF WELL.

5. SOFTEN.
~~10~~ K. ALKALINE BLS
~~3~~ K. BIODSYN PCT2
~~3~~ K. HYDROLYSE TX.
 20 MINS. AT **40°C** PH.
3 Kg. ALKALINE BSL 20.

Figure 6

INTERLOCK WINCH NOT H.	TARGETS		PREG DRIER		CAMDOR		AT	
	WIDTH	C/3	WIDTH	C/3	WIDTH	C/3	SAMPLING WIDTH	C/3
1 42/307	56	43½	56	42½	56	40½	56	42½
2 38/307	57½	43½	57½	43½	57½	43	57	42
3 42/324	58	41	58	39	58	40	58	39½
4 34/307	58½	44	58½	45	58½	46	58½	43½
5 38/324	59	41	59	39	59	41	59	39½
6 42/340	59½	39	59½	37	59½	36½	59½	36½
7 34/324	60½	41½	60½	41½	61	42	60½	40½
8 38/340	60½	39	60½	38	61	38½	60½	38
9 42/359	61½	36½	61½	35	61½	35	62	34
10 34/340	62	39½	62	37	62½	38½	62	37½
11 38/359	62½	37	62½	34½	62½	35	63	34
12 42/377	63	35	63	32½	63½	31½	63½	31½
13 34/359	64	37	64	35	64	35½	64	34½
14 38/377	64½	35	64½	33	64½	33	65½	31½
15 34/377	66	35	66	33½	66½	33½	66½	33½

Figure 7

CUSTOMER/LOT NO: 370 22 FABRIC: 1x1 13 W/O. 10:
 WEIGHT: 134 KILOG. NO. PIECES: 181 W/O. CAPACITY LITRES
181 181 ECOSOFT 22 1000

1. SCOUR:
 K. DYSOL
 K. SANGOLAN D/CM
 K. SOVATEX PR/O
 K. SODA LSH
 K. VISCAMINGA
 RAISE TO THE BOIL, BOIL FOR
 15 MINS. WASH OFF WELL. NEUTRALIZE
 WITH ACETIC ACID.

2 K. COMTEVAN HW. Viscavin CA
6 K. C. DUSTIC LIQ.
10 % HYDROGEN PEROXIDE.
 RAISE TO THE BOIL IN 30 MINS.
 BOIL FOR 30 MINS. SHOW
 NEUTRALIZE WITH 4 K. ACETIC ACID. HYDEOS
 20 MINS. AT 70 C. WASH OFF WELL.

Check absorbency

— START AT 50°C ADD DYE OVER 10 MIN. RUN FOR 20 MIN
 3. RAISE TO 80°C RUN 15 MIN ADD 1/3 OF SALT OVER 20 MIN
 RUN 10 MIN ADD 1/3 OF SALT OVER 20 MIN RUN 10 MIN ADD
 REMAINING 1/3 OF SALT OVER 20 MIN RUN FOR 30 MIN ADD
BICARBONATE OVER 10 MIN RUN 15 MIN ADD SODA ASH IN
 TWO PARTS OVER 20 MIN RUN FOR 40 MIN & SHOW.

CHEMICALS: 2 K. RESIST SALT MATEXIL PAL G/L
128 K. SALT
24 K. SODA LSH
3 K. BAKING BICARBONATE
 K. SANGOLAN D/CM
 K. LYOGEL
 K. SPZ

SHIRTS PASSED

DESCRIPTION	QTY	TOTAL	TOTAL
		QTY	QTY
2680gms Procion Blue HEG			
(NOT HEGIN)			

4. BACKWASH:
3/4 K. SCORBER.
 K. TRIAMINE LSH
 K.
 RAISE TO THE BOIL, BOIL FOR 15 MINS.
 WASH OFF WELL.

2 Ks Alcolube BSL200
 K. SANGOLAN D/CM
 K. PRODYNE P/O
 K. MYSOLURE TX.
 30 MINS. AT 70 C. PH. 10.5

Machine speed approx. 180 yards/minute

Figure 8

141 R13 ECOSOFT LOT 22 VARIANT	TARGETS		PREGG D _{PREL}		PLIMATIC CAMENDOL		SAMPAIN G.	
	WIDTH	C/3	WIDTH	C/3	WIDTH	C/3	WIDTH	C/3
1 34/248	50	51	49	52½	52	54	51	53
2 34/267	53	47½	51½	47	53	47½	53	47
3 30/267	53	48	51½	48½	53	48	53½	50
4 26/267	53	49	51½	49	53.5 50	50	53	49½
5 34/285	55½	44	54½	41	55.5	48	55½	43
6 30/285	55½	45	54½	44	56	44½	55½	45
7 26/285	56	46	55	44½	56.5	47	56	46½
8 34/306	58½	41	57½	37½	58.5	39	58	39
9 30/306	59	42	57½	39	59	41	59½	40
10 26/306	59	43	57½	40	59½	41	59	41½
11 34/326	61½	38½	60	34	62	35	60½	33½
12 30/326	62	39	60½	33½	62½	36	62	36
13 26/326	62	40	60½	34	62	36½	62	36½
14 34/350	65	35½	63½	32	64.5	31	65	32
15 30/350	65	36	63½	33	65	33	65	33
16 26/350	65½	37	64½	33	66	35	65½	35

Figure 9

CUSTOMER/LOT NO: **VAC 21** FABRIC: **KA RIB** P/O. NO: **1**
 WEIGHT: **13A** KILOG. NO. TUBS: **LOT 21** M/C. CAPACITY LITRE: **2500.**
 WASH

1. SCOUR:
 K. DYSOL
 K. SODIUM HYDROXIDE
 K. SODIUM PERBORATE
 K. SODA ASH
 K. VISCOSENE
 RAISE TO THE BOIL, BOIL FOR
 15 MIN. WASH OFF WELL. REPEAT WITH
 WITH ACETIC ACID.

1 1/2 L. GENTLE BLUE
7 L. ACETIC ACID
 K. P. BLENDED PEROXIDE
 RAISE TO THE BOIL IN 10 MIN.
 BOIL FOR 15 MIN. ADD **Hydras**
 BLENDED WITH 1/2 L. ACETIC ACID.
 20 MIN. AT 70 C. WASH OFF WELL.

Check absorbency

START AT 50°C ADD DYE OVER 10 MIN RUN FOR 20 MIN.
 RAISE TO 85°C RUN 15 MIN ADD 1/3 OF SALT OVER 20 MIN
 RUN 10 MIN ADD 1/3 OF SALT OVER 20 MIN RUN 10 MIN ADD
 REMAINING 1/3 OF SALT OVER 20 MIN RUN FOR 30 MIN ADD
BICARBONATE OVER 10 MIN RUN 15 MIN AND SOON ASH IN
 TWO PARTS OVER 20 MIN RUN FOR 40 MIN & SHOW.

CHEMICALS: **1 1/2** L. GENTLE BLUE **Matex (PA)**
150 g. SALT
38 g. SALT
13 g. BICARBONATE
 K. SODIUM HYDROXIDE
 K. SODIUM PERBORATE
 K. SODA ASH
 K. VISCOSENE

BYSTUFF

2680gms Procion Blue HEG
(NOT HEGN)

ITEM NO	QTY	UNIT	TOTAL

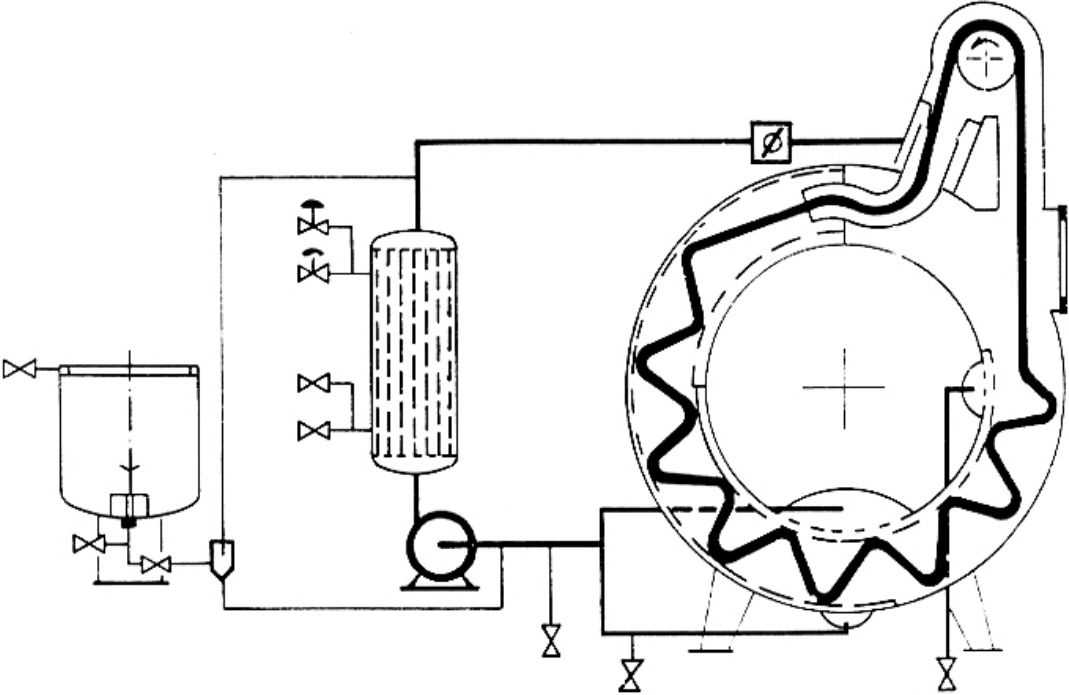
4. BACKSCOUR:
1 1/2 K. SCODREX
 K. TRIAMINE PG
 K.
 RAISE TO THE BOIL, BOIL FOR 20 MIN
 WASH OFF WELL.

5. FINISH: **Alcolube BSH 200**
 K. ALUMINUM SUL
 K. BRASSYN 8012
 K. MYSTOLUBE TX.
30 MIN. AT **40°C** PH. 6 SHC

Figure 10

1x1 RIB WINCH LOT 21	TARGETS		PECC		CARONDEL		SAMPLING	
	WIDTH	C/3	WIDTH	C/3	WIDTH	C/3	WIDTH	C/3
1 34/248	50	51	49½	52	50½	55	52	55
2 34/267	53	47½	51½	47	53	48	52.5	48
3 30/267	53	48	51½	47	53	50	53	50
4 26/267	53	49	51½	49	54	52	53	52
5 34/285	55½	44	54	44	55.5	44	56	44
6 30/285	55½	45	54½	45½	55	48	56½	46.5
7 26/285	56	46	54½	46	56	47½	56	47.5
8 34/306	58½	41	57	39	58½	39	58.5	40
9 30/306	59	42	58	40	59	41	58.5	40.5
10 26/306	59	43	58	41	59½	42	59	42
11 34/326	61½	38½	60	34½	62	35	61.5	35
12 30/326	62	39	60½	36	62.5	35½	61.5	36
13 26/326	62	40	60½	36½	62.5	38	62.5	37
14 34/350	65	35½	64	32½	65	32	64.5	32
15 30/350	65	36	64	33½	65	33	65.0	33
16 26/350	65½	37	64½	34	65½	34	65.5	34

Figure 11



The Thies 'Eco-Soft'