OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

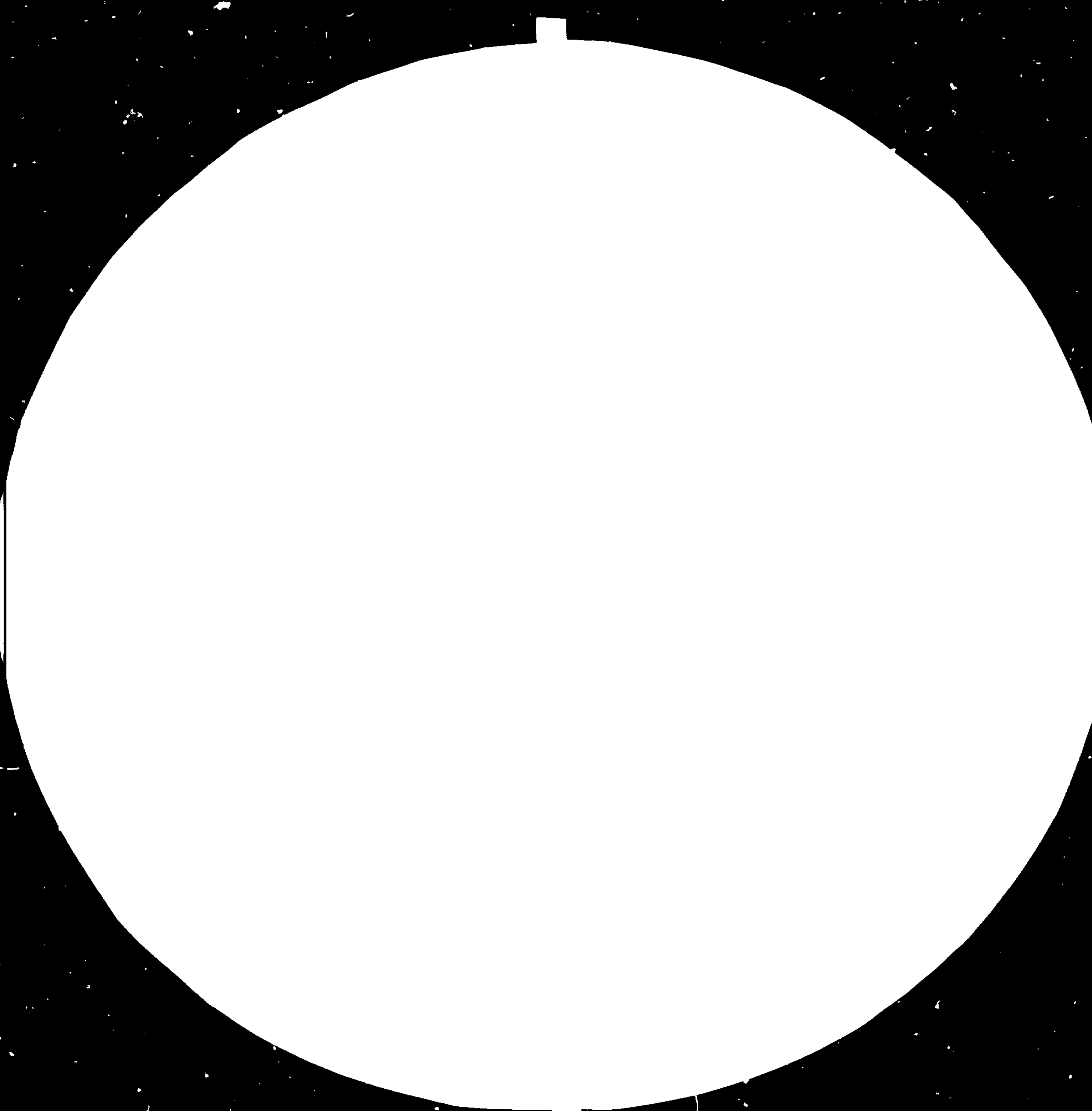
FAIR USE POLICY

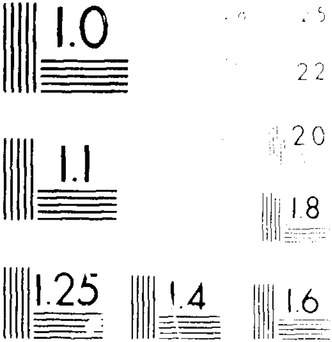
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org




1.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

August 1984

14124

Turkey.

FINAL REPORT
ON
BIOLOGICAL INVESTIGATIONS
FOR
SEKA PULP AND PAPER MILLS

DP/TUR/81/018

PART I - IZMIT MILL

DP/

This report is based on work done under the UNDP Project TUR/81/018 carried out and reported by Dieter J.H. WENZL during June/July 1984

C O N T E N T

LIST OF TABLES AND APPENDICES

FINAL REPORT ON BIOLOGICAL INVESTIGATIONS FOR SEKA-PULP AND PAPER MILLS
Part I: IZMIT FACTORY

(UNDP Project TUR/81/ 018) by Dieter JH.Wenzl

SUMMARY: Extensive microbiological investigations have been carried out at the SEKA-Izmit factory which covered 9 out of the lo paper machines in operation.The investigations included the determination of the bio-activity in the production systems of these paper machines with regard to possible slime formation, that would lead to disturbances in the production of paper or board.Five out of the nine machines investigated showed severe to very heavy biological activity and substantial to very severe slime formation, at least in the primary circuits.
A number of biocides was tested against the microflora existing in the individual PM-systems.Primarily four of these biocides were found to be particularly effective.
After thorough investigation and measurements of the PM-circuits concerning their capacity (K) and overflow rates (V),the optimum treatment levels,duration and frequency of treatment periods as well as points of addition for biocides were established.
Besides the practical investigatory work, the writer also trained his co-worker, Miss M. Öztirpan in the various steps ofthe investigations such as:

- -PM-circuit identification and measuring
- -Determination of the bio-activity in the circuit
- -Application of the Biocide Selection Test (BST)
- -Evaluation of test results
- -Implementation of a biocide treatment programme based on the test results and systems factors
- -Investigation of slime samples under the microscope.

I. METHODS:

I.1BIO_ACTIVITY AND BIOCIDE SELECTION TEST:

For the determination of the BA and the BST, the reductase method has been applied.The mechanisms involved in this method have been described elswhere(1).The cited article has been translated into turkish some time ago.The exact working method for the reductase test has been written up by the writer and was also translated into turkish. Both translations have been given to Miss Öztirpan in order to help her better understand our mode of working.
Let us repeat in brief:
For the determination of the BA,a sample of substrate is subjected to the reductase test(R-test).The time for color change (TCC) indicates the BA, i.e.the faster the individual color steps are reached,the higher is the BA.
In the BST-method,samples of the individual substrates are treated with determined amounts of the biocidesto be tested.The stronger the inhibition of the BA in comparison the theblank sample, i.e.the greater the extension of the time for color change(TCC),the better is the biocide.(see also APP. 1,evaluation of R-test results).

1.2 PLATE COUNTS:

Dip slides were used for the counting of bacteria and fungi as well as yeasts.We used this method to parallel the R-tests in all measurements of the BA.
(Orion "Easicult" from Finland as well as UROTUBE and MYCOSLIDES from Roche were applied.We would givepreference to the Easicult slides).

I.3 MICROSCOPY:

For the investigation of slime samples taken from the paper machines, a Hertel & Reuss bin-ocular microscope with a phase contrast condensor was used.Magnifications between 150 and 600 times were usually applied. The PHAKO-condensor allows a substantially better dissolution of the preparations especially when much fibre or- even worse-much filler- is present.With PHAKO available,staining of the preparation, which usually kills the microorganisms,is mostly unnecessary.However, IF desired, lacto-fuchsin or alternatively crystal violet or eventually safranin/malachite-green for differentrtial spore staining, are valuable stains.

I.4 BIOCIDES:

Seven different biocides of the mostwidely used types have been employed in our investigations.These biocideshave the following code-designation and corresponding chemical composition:

CODE	Chemical Character
25	2-component organo-sulfur product
90	Organo-bromine compound
93	Organo-bromine, organo-sulfur combination
110	Methylene-bis-thiocyanate
1002	Organo-sulfur with MTC
52	Modified, substituted Thiocarbamate
881	Thiocarbamate/Thiocarbamate combination product.

[illegible] concentrations, expressed in ppm applied in the [illegible]'s are generally based on equal cost levels.

II.RESULTS OF THE INVESTIGATIONS:

II.1 [illegible] No.1

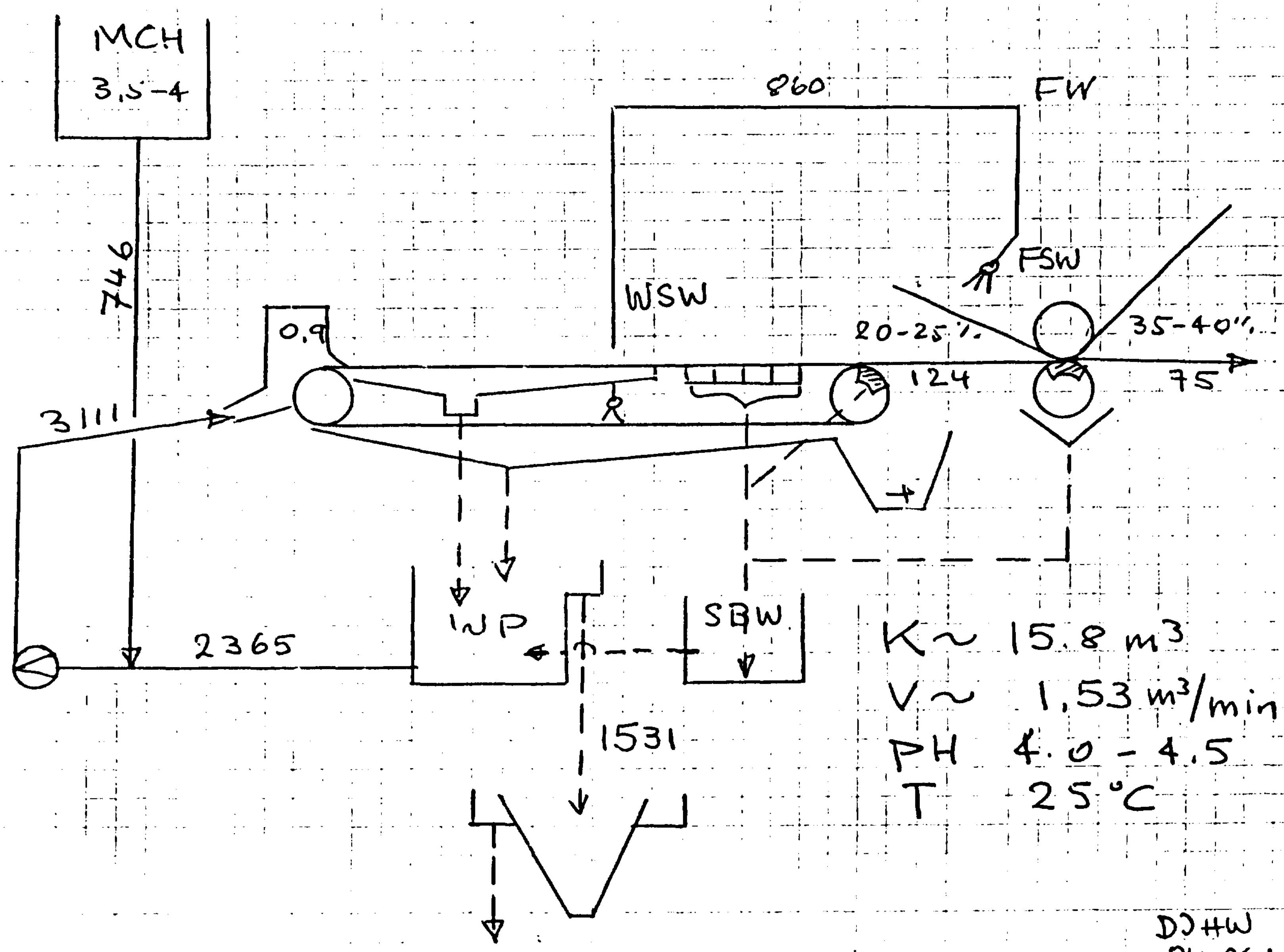
PM No.1:

[illegible] produces about 60 tpd fine paper with [illegible] between 60 and 160 g[illegible] material comprises of bleached sulfite pulp [illegible] lay-out [illegible] 1.54 m [illegible]

Fig. 1

PM-. ~40 t/d Fine Paper 60-120 gsm (28 kg/min)

WATER BALANCE



DJHW
840615

fig 1a

PM-1 Calculations

40 tpd = 28 kg/min. 60-120 gsm fine paper

width 2.55, pH 4.5-5.0 Temp. 25-30C.

C_{MCH}3.5-4.0%, C_{couch}20-25, C_{HB}0.9, C_{press}35-40

Q-Freshwater (all into prim.circuit 0.86m3/min

All waters combined in circuit from where the overflow goes to settler funnels.

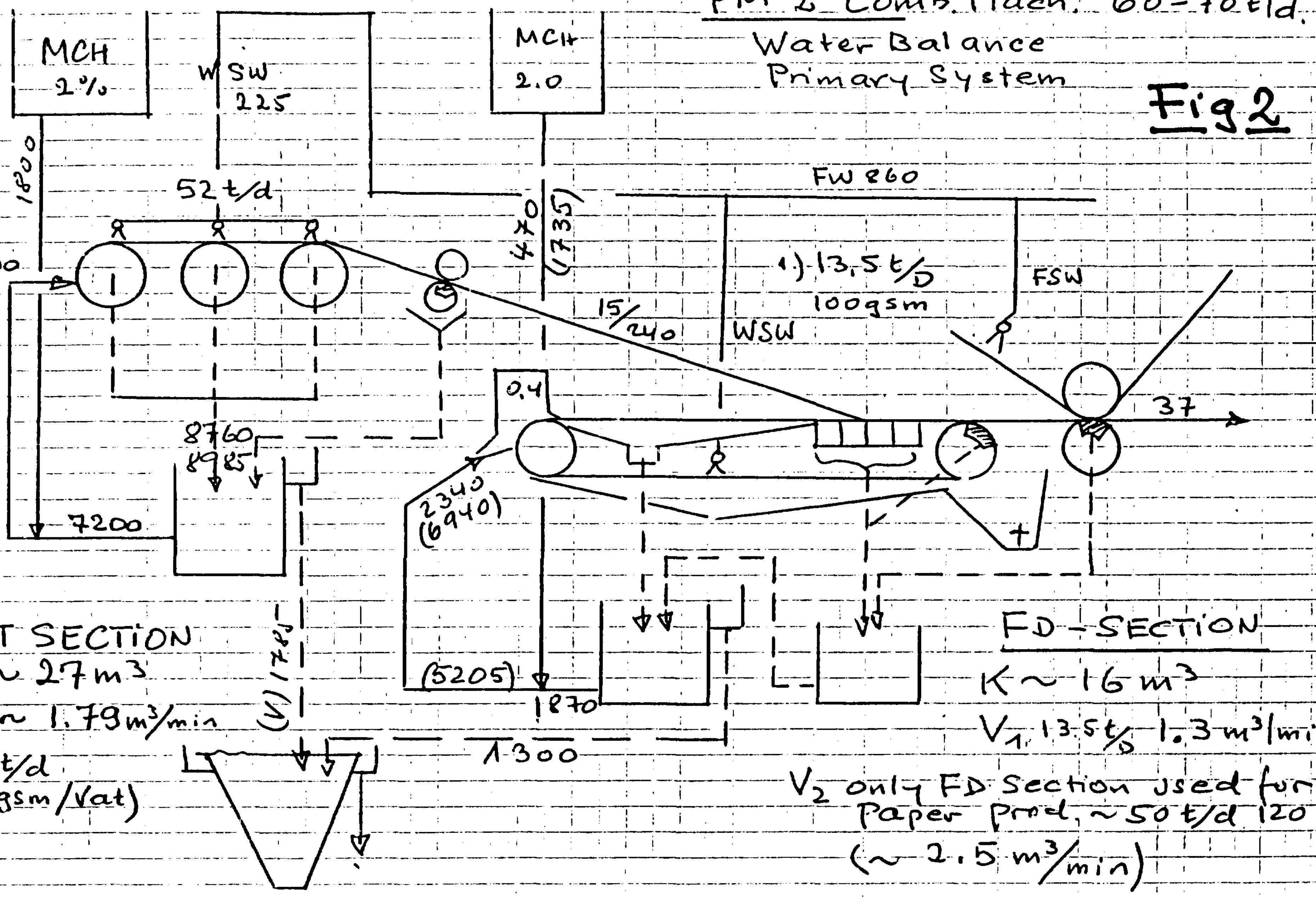
K estimated after measuring with 15.8 m3

V: Basis 28 kg/min production

Max. dilution Headbox	3100 l/min
Final consistency (press) 37%	75.7 l/min
Difference	3025 l/min
Fresh water added	860 l/min
Total water amount	3885 l/min
Water needed for HB-dilution	
(3.75/0.9% = 746/3100	2354 l/min
Excess water	1531 l/min = V

PM 2 Comb. Mach. 60-70 t/d.
Water Balance
Primary System

Fig 2



DJHW
84-06-15

Fig. 2a

PM 2 CALCULATIONS

60-70 tpd board or heavier paper 70-700 gsm.

5 Vats , minimum uptake 70 gsm/vat,FD-Section uptake 70-150 gsm

Width 2.55, pH 5.0 Temp 30C.

C_{MCH} 2.0%, C_{couch} 20%, C_{press} 35-40%

Water consumption Vat-section 0.045m3/min/Vat

Fourdrinier section 0.86 m3/min.(same as PM 1)

VAT SECTION:all waters combined incl. press water.At full production maximum water loss.At lower prod. rates, the three sections of the Vat-part can be used like:

1Vat,1 plus 2 Vats,2 Vats, 2 plus 2 Vats and (fully) 1 plus 2 plus 2 Vats.Each sub-section has its own diölution and centricleaner system.

K:tubing and centricleaners	11.0 m3
Chests	15.8 m3
Total	26.8 m3

(for lower production calculate with fifth of the total K.

V:Basis 500 gsm(100 gsm top at FD-section) 80 gsm/Vat.

Production rate total 65 tpd, thereof 52 tpd for the Vats = 36 kg/min.

Max. Dilution (C_{HB} 0.4% at Vats)	9000 l/min
Final consistency at transfer(15%)	240 l/min
Difference	8760 l/min
Max FW added	225 l/min
Total water flow	8985 l/min
Dilution water needed Vats	7200 l/min
Excess water	1785 l/min = V

2.b Fourdrinier Section(is always used):

All waters, WW-I, WSW.SBW and FWW are mixed and then the overflow takes place.

K:wire pit, WW-chests and tubing 15.8 m3

V:Basis 65 tpd total, 500 gsm of which 100 gsm = 20% on the FD-wire = 13.5 tpd = 9.4 kg/min.

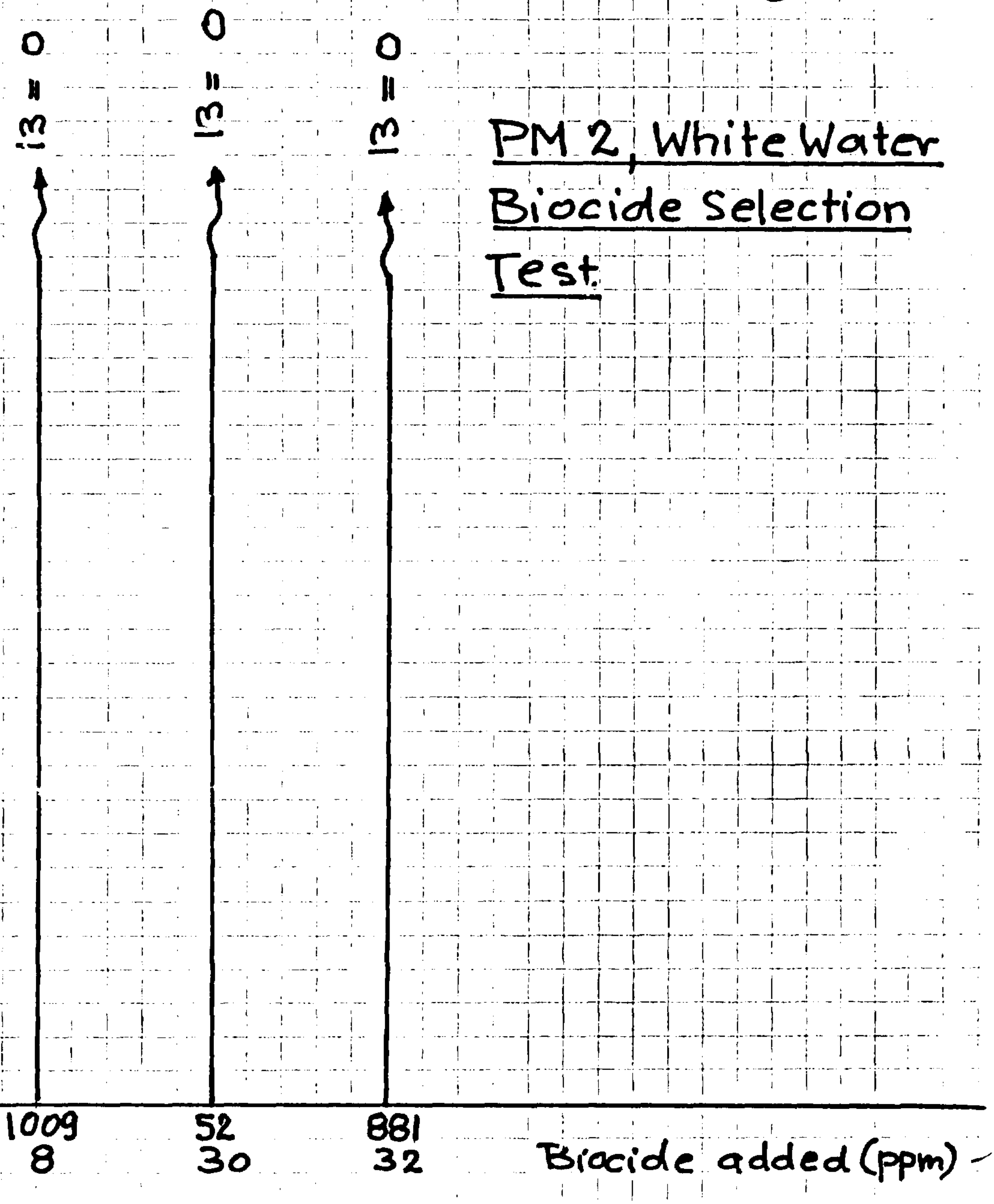
Max. dilution HB 0.4 %	2340 l/min
Max conc. presses 37%	25 l/min
Difference	2315 l/min
Fresh water added	860 l/min
Total water flow	3175 l/min
Dil Water needed	1870 l/min

2c, contin. Calculations PM 2

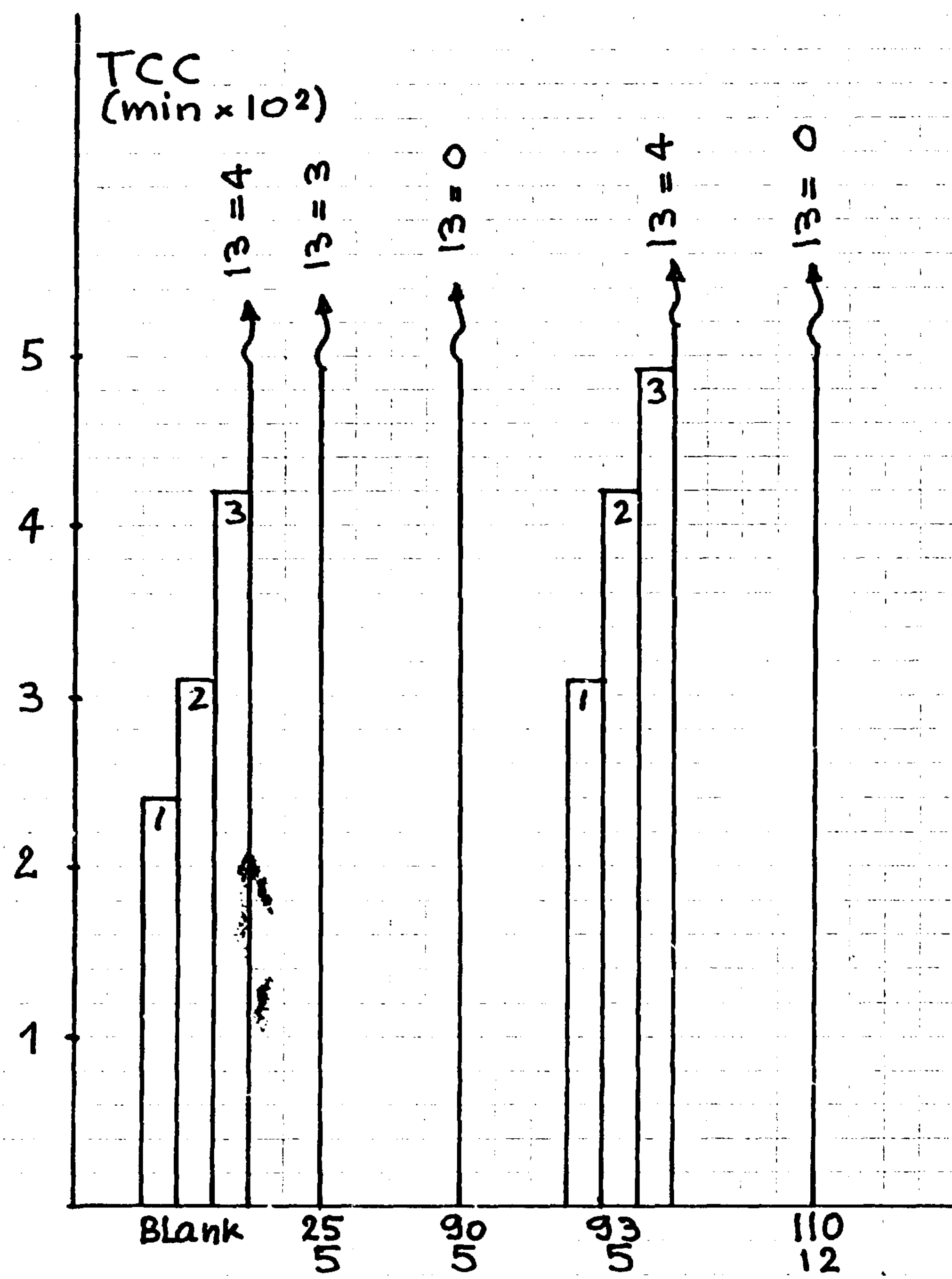
In case of paper production only on the FD-wire

Basis 50tpd, 120 gsm = 34,7 kg/min	
Max. Dilution Headbox (0.5%)	6940 l/min
Max Consistency Press /37%)	94 l/min
Difference	6840 l/min
Fresh water added	860 l/min
Total water flow	7706 l/min
Excess water	
Dil.water needed 2.0%/0.5%	
=1735/6940 l/min	5200 l/min
Remains excess	2500 l/min = V

Fig. 3.



DJHW - 840621


TCC
(min x 10²)
5
4
3
2
1
13 = 4
13 = 3
13 = 0
13 = 4
13 = 0
1
2
3
1
2
3
Blank
25
5
90
5
93
5
110
12

however, indicated, that the deposits must havebeen quite old(presence of anaerobes).

RECOMMENDATION:Under the present conditions, with the high amount of fresh water used,a slime control programme does not seem to be necessary. Systems cleaning, especially that of the back water system must be improved.We also suggest to use dekanter water at least for the wire showers. This would reduce the overflow volume by about one half and would make an eventual slime control programme more effective and cheaper.

PM No. 2:

This is a combined Vat-former/Fourdrinier machine with varying capacity between 50 and 70 tpd.Raw materials are groundwood, unbleached sulfite cellulose and waste paper up to 30% ofthe total furnish.

The complicated primary system, which must be divided into the VAT- and the FOURDRINIER-section is shown in Fig.2.The calculations concerning the factors K and V are listed for the VAT-section under 2a and 2b and for the FOURDRINIER section under 2c.

The BA in the primary systems of both sections must be considered as high which is confirmed by the magnitude of the plate counts with 10^8 col/ml.

Visual inspection of PM 2, which was reportedly cleaned the day before showed a rather clean upper wire part and lower wire part at the fourdrinier section while the Vat-section was at thattime not working. The dekanter-settler functioned well at this time and showed a clear overflow.On the other hand, slime accretions were found in the dekanter overflow gutters as well as in the wire- and suction box pit. Microscopical inspection of the slime samples indicated FUNGUS-slime as the dominating binding material in the deposit with, however, large amounts of free floating bacteria also present.

RECOMMENDATIONS:

Based on our findings, PM 2 is not really in danger for a true slime problem and can probably be kept free of trouble causing slime formation if the wash-ups and cleanings of thePM-circuit can be improved drastically and quickly.IF,however-what should be done in any event-the fresh water consumption will be reduced substantially.this situation can change very quickly.For this case, we have drafted a slime control programme which can be found in the table (APP.2).

The BST carried out indicates 1009 as the best biocide which is followed by product 52.The suggestions for slime control treatment are provided for two different operating conditions for PM 2: (fig 3.)

1.VAT-section at FULL capacity,FOURDRINIER-section producing the top layer with a capacity of 13.5 tpd.

2.FOURDRINIER-section used alone for the production of heavier grades with an assumed capacity of 50 tpd.

The addition of thebiocides should be made to the primary system of the FOIURDRINIER, but to the machine chest of the VAT-section.The latter because not all the vats are operating always.In case the FD-section is working alone,theoverflow from the primary circuit is very high. Therefore, also in this case,the biocide is better added to the machine chest in order to achieve a somewhat longer contact time for the biocide in the furnish.

II.2 Mill Dept. No. 2

PM No.4:This small fourdrinier machine produces about 7 tpd of low grammage fine papers.The pH in the system is between 4-5, the operating temperature around 25 C.The lay-out of the system is shown in fig 4 and 4a Our calculations are based on the assumption,that white waterI is mixed completely with wire shower water (WSW) and suction box water(SBW). Consequently, the overflow (V) is based on the consistency-difference between machine chest and suction couch.
The BA in the system is very low(APP.1) which is confirmed by the low counts in the order to 10^5 col/ml.Visual inspection showed a very clean primary system and also rather clean white water collecting chests.

RECOMMENDATION:
No slime control programme is required for the time being.One should instead continue and further improve housekeeping, that is machine cleaning and boil-outs.If the water consumption on PM 4 will be reduced,frequent follow up and controls according to the principles outlined in this report are necessary.Once the BA should increase drastically, a suitable slime control programme has to be installed.

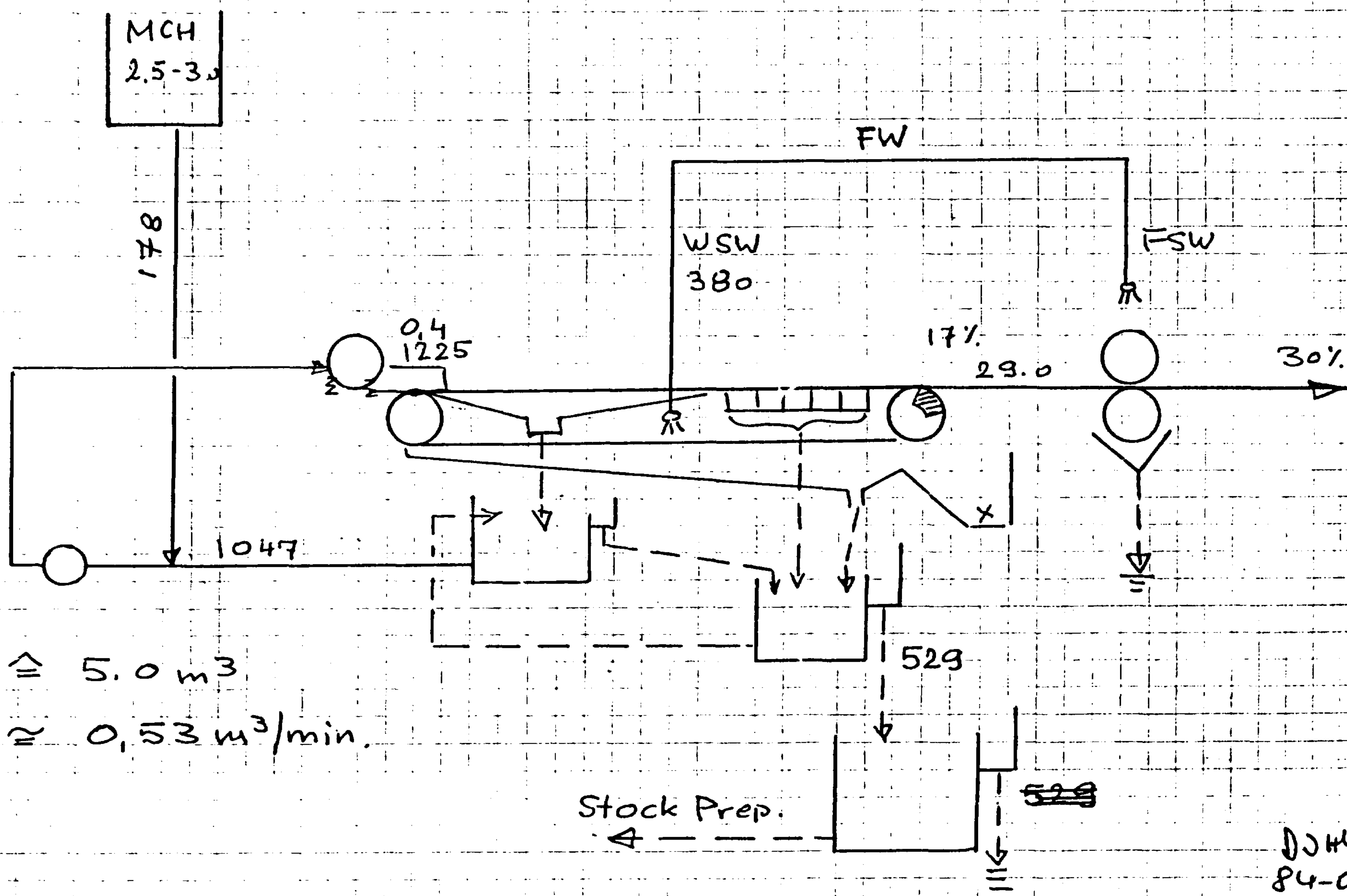
PM No.9:
This is another small, open draw fourdrinier with a capacity of 7 tpd mainly cigarette paper.Hemp pulp, produced in an integrated pulp mill is the main fibre source.The lay-out of the primary system is shown in fig.5and the respective calculations in fig 5a.The volume of the primary system was measured with about 8 m3.The overflow(V) from the wire pit,which is collecting only WW-I is determined by the consistencydifference between the MCH and the first suction box PLUS the water leaving with the paper sheet.Assuming, the consistency in both places is the same,the minimum water loss from the primary circuit amounts to 0.14 m3/min.There IS , however, an unknown amount of fresh water added to the wire pit in order to keep the level constant,which may increase this figure.
The BA of PM 9 (see APP.1) is unproportionally high if one considers that the finest of all grades are produced on this machine.No error is possible as we checked this several times with the same result. The BST(see fig6) indicates biocide 90 as the most effectiveone already at low concentrations.The visual inspection of PM 9 revealed, quite in line with the high BA substantial deposits in the upper wire part(deflectors) less in the lower wire part and much in the wire- and suction box pit.
Microscopical inspection of slime samples showed bacterial microflora providing the binding power for the deposits.This is conform with the alkaline pH in this system which depresses fungal growth.The deposits contained-logically based on the type of paper produced-very high amounts of fi ller and fibre fines.The furnish composition is prone for deposit formation in any case and severe opera ting problems can occur when such deposits are intensified through biological activities. This unexpected situation on PM 9 required a number of additional investigations:

II.21 Separate Investigation of the Raw Materials

II.211, Hemp Cellulose:
Due to a two-shift operation of the cellulose plant, hemp pulp in moist rolls with a dry content of 30% may be stored for more than one week.Bales so raw, one week old, showed heavy disfigurement

PM4, 7 t/d - 4.9 kg/min. low gsm. fine papers

Water Balance Primary System. Fig. 4



K ≙ 5.0 m3

V ≃ 0,53 m³/min.

DJHW
84-06-16

fig 4 a

PM-4 Calculations:

Basis 7 tpd fourdrinier, fine papers, width 2.20 meters pH 5.3

Temp. 25 C.

C_{MCH} 2.75%, C_{couch} 17%, C_{press} 30%

Fresh water added:a) directly to circuit at the knotters 0.108 m3/min, indirectly through shower collecting tray 0.27 m3/min. Totally 0.38 m3/min.

All waters are combined and mixed in the primary circuit from there an overflow goes to stock prepn. to the hollanders some goes to the canal.

K:wire pit and collecting chest incl tubing 5.0 m3

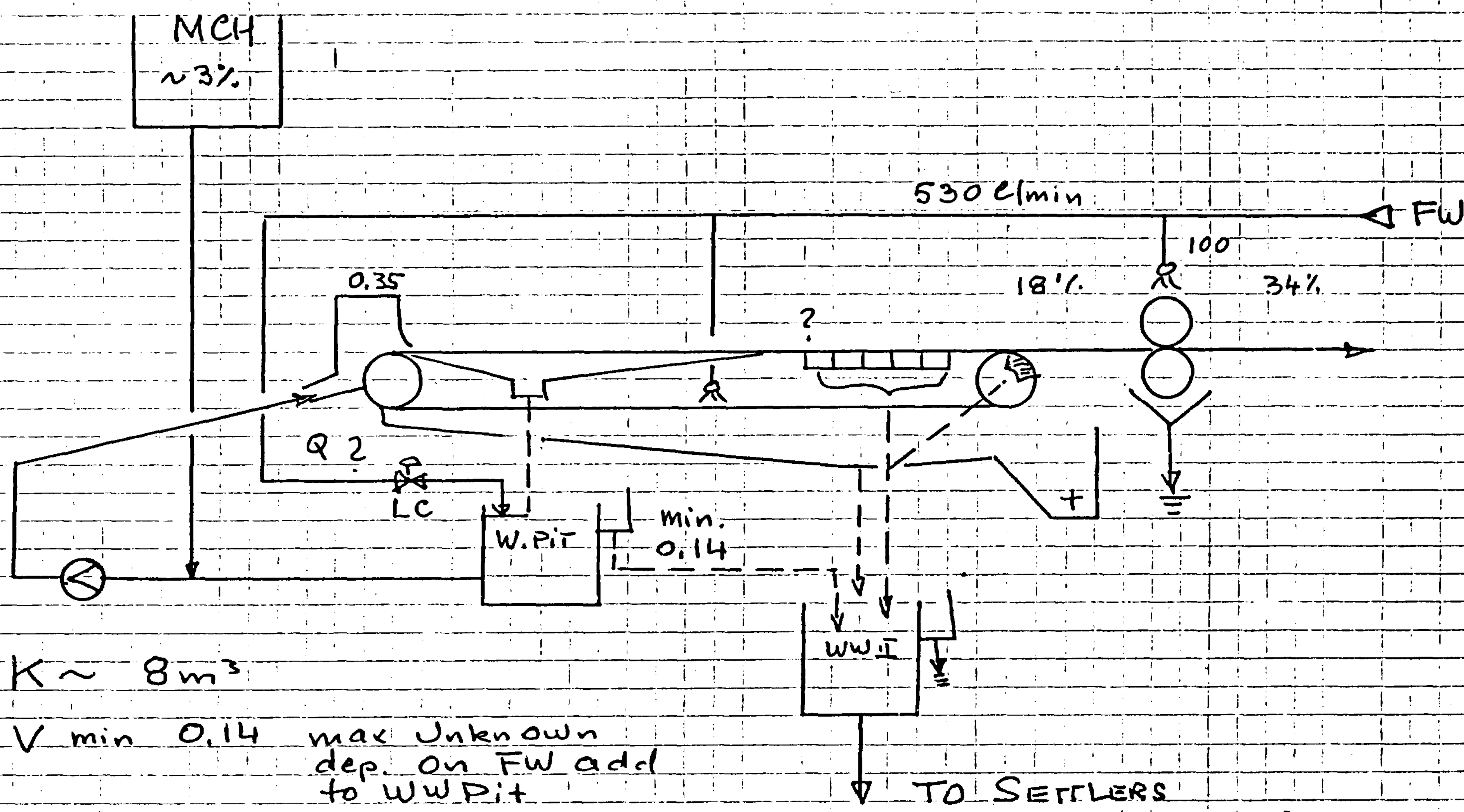
V: Basis 4.9 kg/min

Max dilution at headbox (0.4 %)	1215 l/min
Max consistency couch(17%)	29 l/min
Difference	1186 l/min
Fresh water added	380 l/min
Dilution water needed	
2.75%/0.4% =178/1215 l/min	1047 l/min
Difference = excess water	519 l/min = V

PM 9, 7 t/D = 4.9 kg/min mainly Cigarette Paper

Water Balance Primary Circuit

Fig. 5



K ~ 8 m³

V min 0.14 max Unknown dep. on FW add to WW Pit

DJHW
840616

fig 5 a

PM 9 Calculations

Basis 7tpd = 4.9 kg/min mainly cigarette paper.Width 2.70 meter

pH 7-8, temp. 25 C.

C_{MCH} 3.0% , C_{HBox} 0.35% , C_{couch} 18% , C_{press} 34 %
This machine has a non working wire pit.

Fresh water:WSW leaves primary circuit meets with SBW and goes to the settlers,Q = 0.53 m3/min.

Felt showers(two needle showers) estimated with 0.1 m3/min goes to the canal

Dandy roll shower 0.1 m3/min to WW-II

Total FW used(leaving the system) 0.73 m3/min = 148 l/kg

K:wire pit tubing etc. 8.0 m3

V:Basis 4.9 kg/min, max dil.0.35%   1400 l/min

Max Conc. at first suction box unknown but can hardly be estimated higher that 3.0% (C_{MCH}).There is, however no SBW-water added to primary system but Fresh water to pro wide an overflow from the Wire pit to the SBW-pit.This is manually controlled and cannot be measured.
IF we assume, the system would be kept exactly in balance, that is overflow = ZERO:

The V-rate is determined by the difference in consistency between the first suction box and the couch

3.0%/18.5% =163/26 l/min = 137 l/min = V.

Considering thefact, that fresh water is added manually suggests, that probably at least wtice the amouint of dilution water is used so that V would increase to 0.27 m3/min.

If one, on the other hand considers the figuresgiven in the Svitelski Report(viz page 9 of that report) the calculated amount of water going to the settlers is given with 92 m3/hr corresponds to 1.53 m3/min which would be the factor for V.This would mean, that at least 1.3 m3/min of FW are added to the primary system.

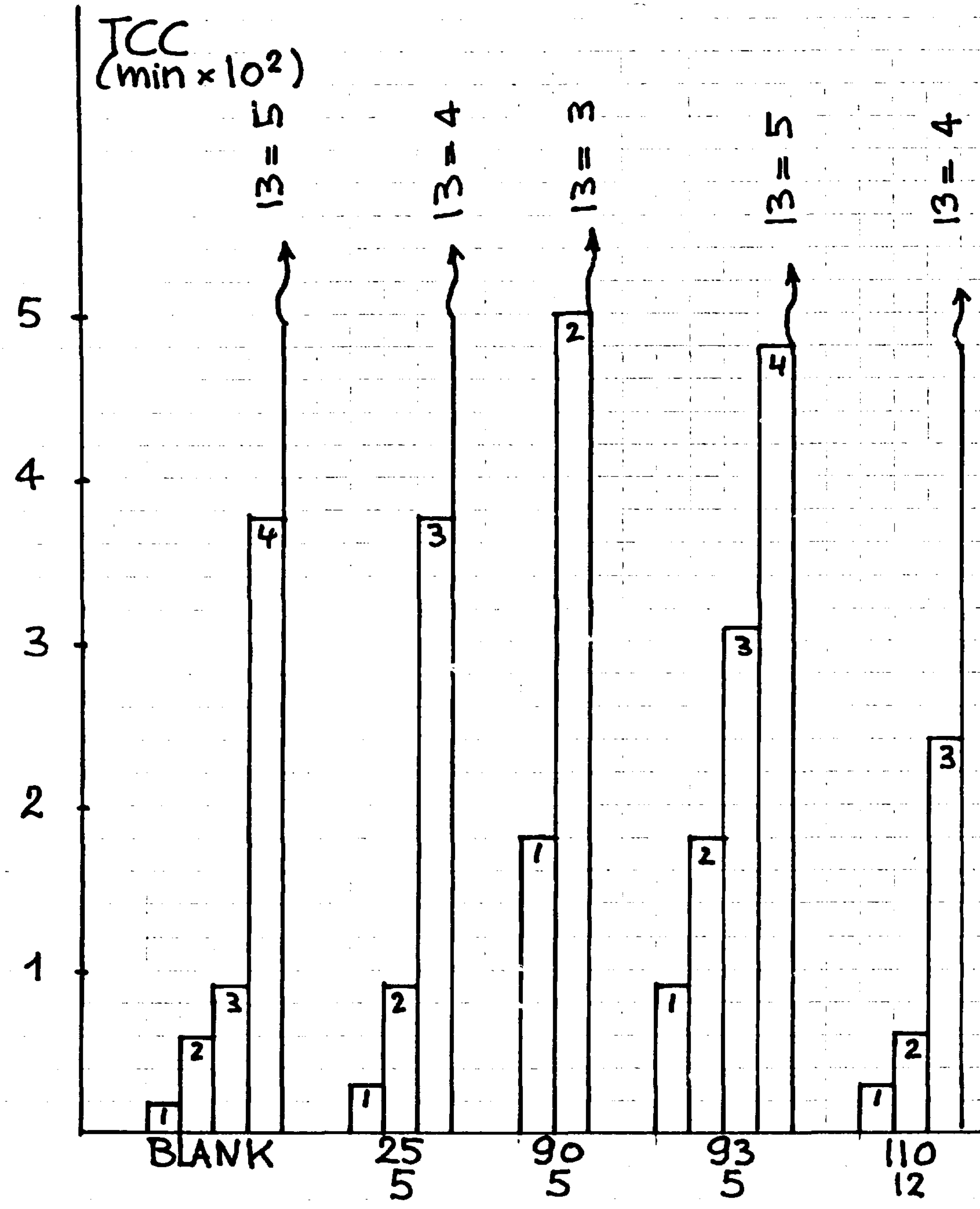
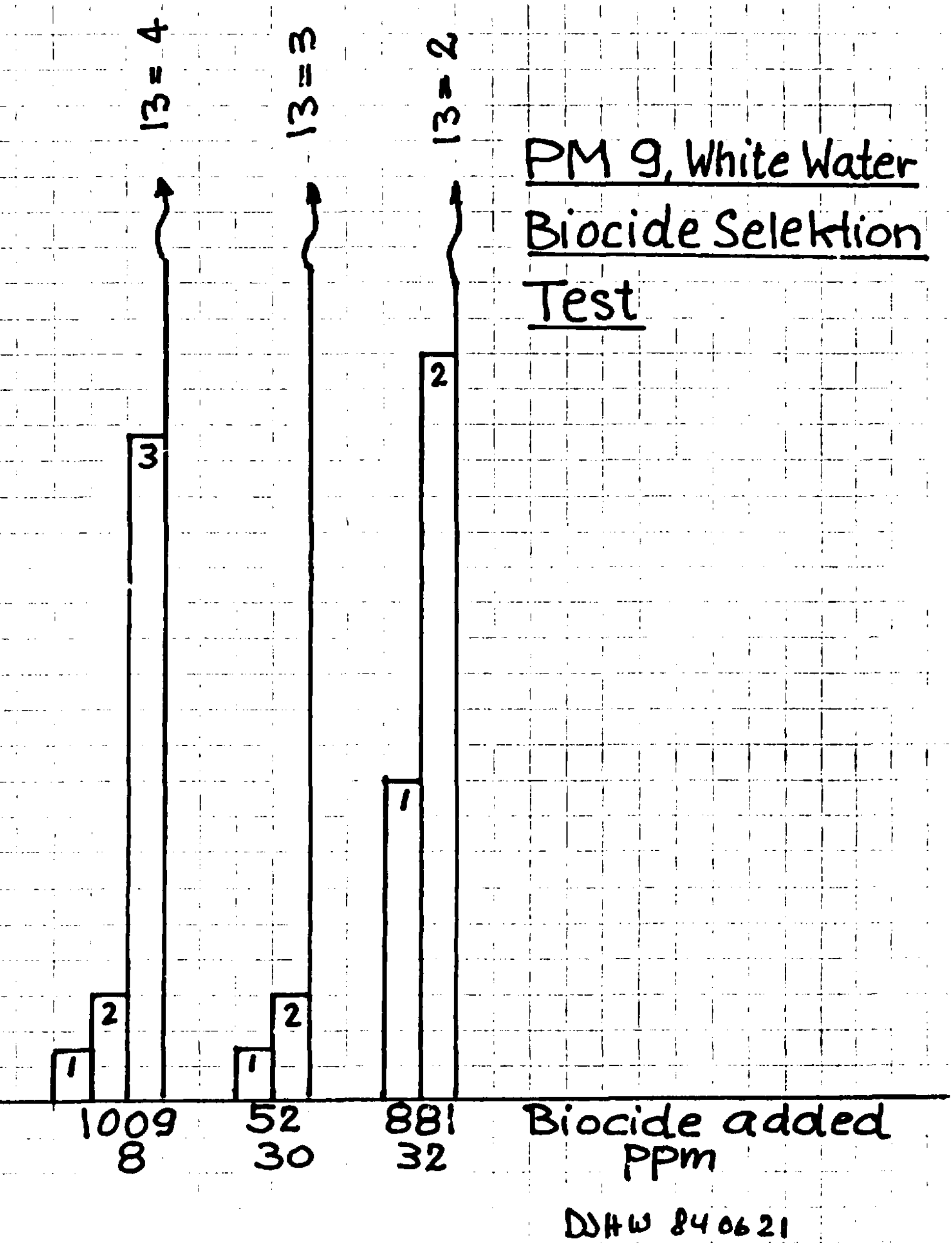

TCC (min × 10²)
BLANK
25 5
90 5
93 5
110 12

Fig. 6



PM 9, White Water
Biocide Selektion
Test
13 = 4
13 = 3
13 = 2
3
2
1
2
1
2
1
1009
8
52
30
881
32
Biocide added
ppm
DJHW 840621

from fungus growth.Samples from such bales were taken purposely from the INSIDE of the bales and werecompared with samples taken from the OUTSIDE of freshly produced hemp pulp bales.
Slurries of 10g/Liter o.d. pulp were prepared and were subjected to the R-test.Total counts were also done.The results are shown in fig7 .
The high BA concurrent with the high counts obtained from the fresh pulp are very surprising.We therefore endeavoured to find the source for the contamination.Fig 8 shows a simplified sketch of the hemp celiulose preparation system.Places from where samples for further investigations were taken are marked with (S).The results from the total count determination are as follows:

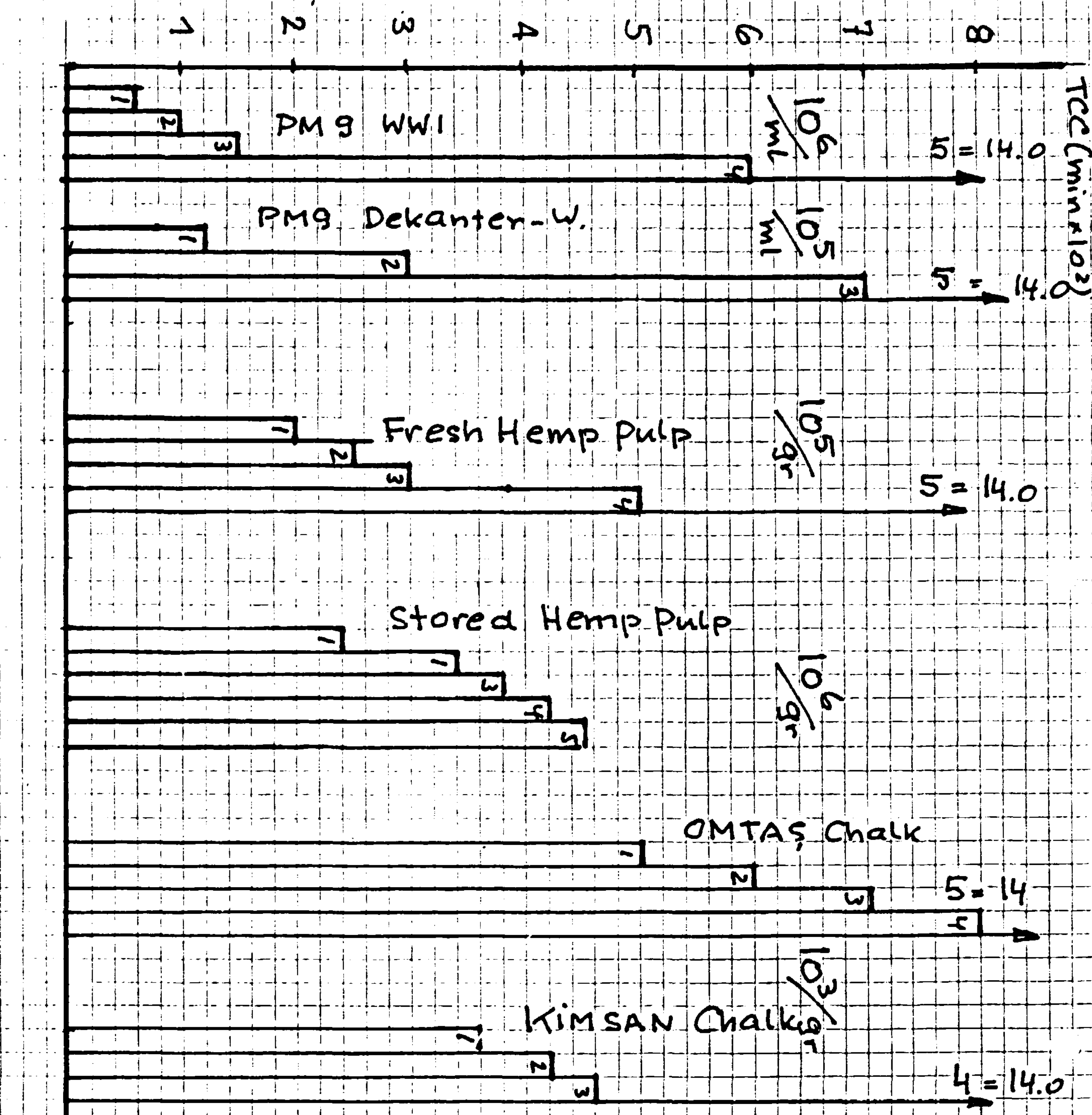
SAMPLE	TOTAL COUNTS/ml or grs.
Wash water to Hollanders for unbl. pulp	10^6/ml
Backwater from unbl. Decker	5×10^2/ml
Raw water for washing of b leached pulp	6×10^3/ml
Bleached Pulp from storage chest	5×10^4/ gr.
Bleached pulp from fresh rolls	10^5/ml

Considering the quantity proportions, the raw water used for washing and diluting the bleached pulp must be considered as the main source of infection.

II.212, Chalk Fillers:
Ca.Carbonate from two different sources is used in large amounts as filler in the production of cigarette paper.The chalk is precipitated Ca-Carbonate.For o ur investigat ions, powdered chalk was sampled from previously un-opened plastic bags and was suspended in sterile water at a consistencyof 50 grs/Liter.This suspension was then subjected to R-tests and to total count measurement.The results of these tests are included in fig.7 and indicate,that also the filler contributes to the heavy bacterial infection in the system of PM 9.

II.22 ANALYSIS:
The high biological activity in the system of PM 9, which is very unusual for a machine producing such fine grades as cigarette paper, must be attributed to the raw materials used and/or the way these raw materials are treated or produced.The chalk, which is supplied in sealed bags, obviously becomes infected already during its production. Chemical cellulose fibre aFTER A THREE STAGE BLEACHING PROCEDURE MUST BE STERILE, at least on the last washer.The contaminating sourcein this case is definitely the process water.The bacterial microflora must be a rather resistant one, as normally, there are easily detectable quantities of hypochlorite left in the pulp slurry (odor).This observation could indicate organisms such as B-subtilis or B-Cereus which are well known for their chlorine resistance.The heavy fungus growth and the disfigurement on the storedpulp bales is of no importance for the situation at PM 9.This is confirmed by the following facts.

- 6 -

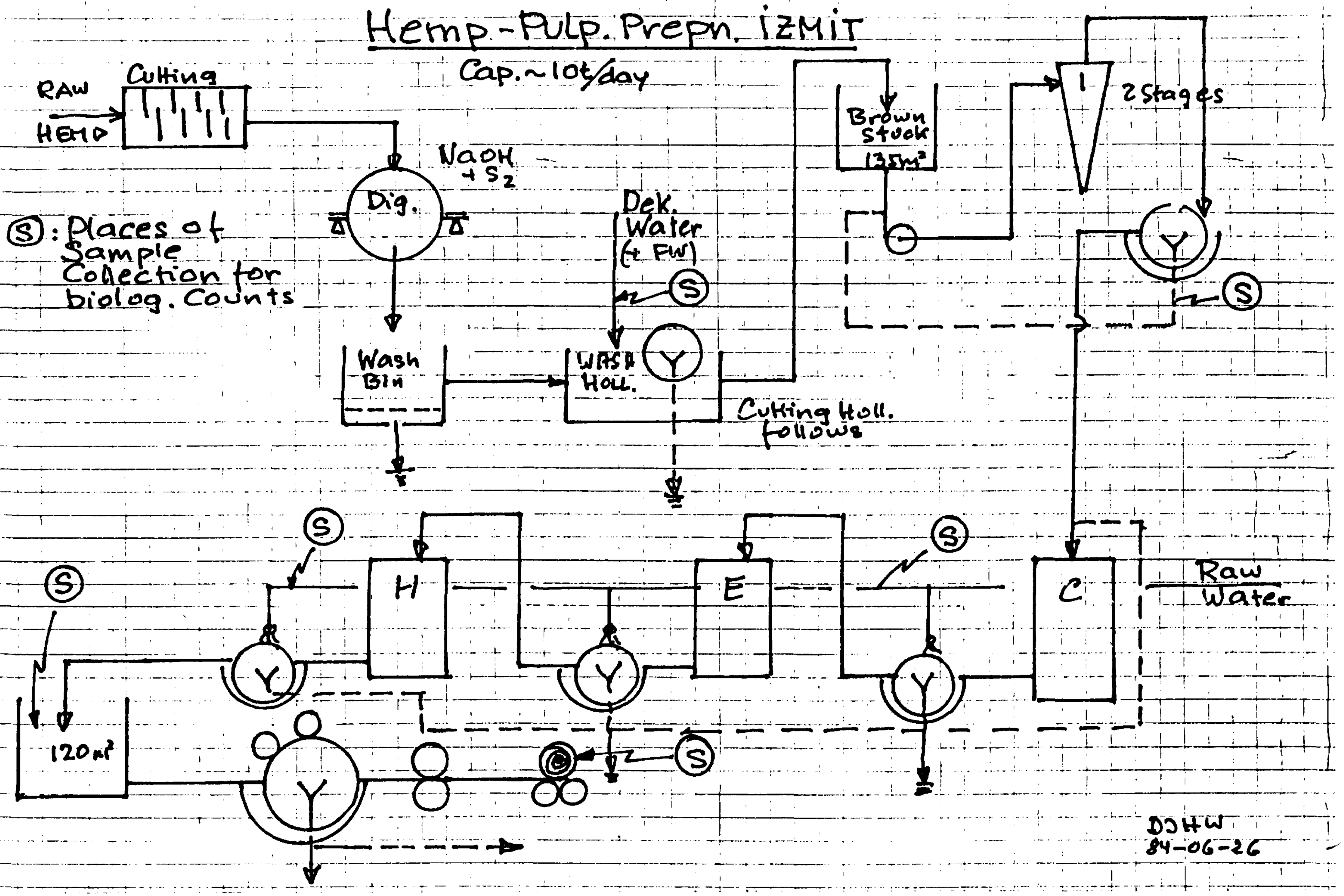


10⁵/gr (Total Counts)

Bioactivity in Raw Materials of PM-9

Fig. 7

Fig. 8


Hemp-Pulp. Prepn. İZMIT
Cap. ~ 10t/day
RAW HEMP
Cutting
NaOH + S2
Dig.
S: Places of Sample Collection for biolog. Counts
Wash Bin
Dek. Water (+ FW)
S
WASH Holl.
Cutting Holl. follows
Brown Stock 135m³
2 Stages
S
H
E
C
S
S
S
Raw Water
120m³
S
DJHW
84-06-26

-we did notfind any traces of fungus growth in the machine system of PM 9

-fungus is unlikely to grow and sporilate at the high pH-level maintained at PM 9

-there was no fungus growth found even in old bales, when sampling was done in the inside of the bales.

-fungus growth was found after incubation even on fresh samples taken from the outside of the bales,which showed no disfigurement

Consequently,the fungus attack, as poor as it looks on the longer stored bales comes from the environment in the store room, whereas the disturbing bacterial microflora grows IN the hemp pulp and elsewhere.
Another observation during our work is worth mentioning:
Wh en we did microskopy on hemp pulp samples, both from new and old bales,we found two different kinds of fibre.The typical slim, narrow-lumen hemp fibres and thick, stiff bundle-like aggregations of which no inner structure could be identified.Through differential staining procedures, we could clearly observe,that only the fibre bundle aggregates showed heavy biological attack.While we-admittedly-are not very familiar with hemp and while we tried in vain to find some information on hemp fibre morphology in Izmit, we suggest, that these fibre aggregates resemble shives in wood pulp.With otherwords driving the chemical process used for the hemp pulp a bit further (through higher chemical input and/or extending the cooking time) one might be able to produce hemp cellulose with a better quality and less sensitive towards biological attack.

II.3 COUNTERMEASURES:

Housekeeping and cleaning of the PM-9 system need to be enforced, particularly also in the cellar areas.For slime control in the primary system we beg to refer to APP.2.The use of biocide90 offers the best guarantee for a troublefree operation.Most important, however, is to combat the infection of the raw material through a treatment of the bleached hemp pulp.In order to find the most suitable biocide for this purpose,as seperate series of BST's was done(fig.9).
From these tests, we can see, that all biocides provide a good protection.While biocide 90, which performed best also in the PM-9 system would be the logical one to use,we would rather recommend for this application biocide 1009 or 110 because they are much easier dispersed in water.
The biocide should be added to the absolute LAST wash water or transporting water which conveys the cellulose pulp from the washer to the storage chest(s).It must be ascertained, that none of the water which is used for pre-dilution of the biocide,is lost in the washer itself.Our investigation shows, that by using the right biocide at the right concentration,a sterile hemp pulp will be made available for PM 9.Practical application of such a treatment will show, whether a separate slime control treatment in the PM-9 system will still be required.
NOTE:The biocide concentration is calculated in ppm, that is g/m3 of pulp suspension.Consequently, the pulp CONSISTENCY of the p ulp suspension determines, how much biocide needs to be used per TON of o.d. pulp.At the present consistency in the storage tank of around 3.5 %, 30 grs/to are required for eaeb ppm.IF we considera daily use of 5.5 tons of pulp equivalent to 172 m3/day for 30 ppm biocide, 5.25 kg/day are required.IF the consistency at the washer could be increased to 6-7 %, this quantity could be reduced by one half.

- 7 -

fig. 9

PRESERVATION TESTS FOR BLEACHED HEMP PULP

Samples of hemp pulp were taken from the drainage machine with a solids content of 30%.A suspension in sterile water was prepared with a consistency of 10 grs/Liter and stored for 20 hours at 37 C.

This in order to activate the microflora.The suspension was then filtered and the filtrate was used as substrate for the BST-test with the aid of the Reductase method.

The following biocides and biocide concentrations were applied:

BIOCIDE	BIOCIDE CONCENTRATION (ppm)		
90	25	50	100
110	50	100	200
1009	30	60	120
52	200	300	500
881	100	300	500

The BLANK sample showed the following bio-activity:

Color step	I	II	III	IV	V
Time for color change (minutes)	155	185	275	455	575

ALL samples treated with biocides showed NO color change after 1400 minutes which was the end of the observation time.

Thereafter, we re-infected each biocide treated sample with 1 ml each of the heavily infected BLANK sample.There was still no color change after another 1400 minutes.

This means, even the lowest concentration of either biocide will provide a sterile pulp and- what is most important for practical application- will take care of re-infection.

NOTE:Microorganisms tend to adhere to solid matter, i.e. fibre in this case.The BA in the pulp suspension filtrate is therefore much lower than it would have been in the pulp suspension,hwich for experimental reasons could not be applied.This is to be considered when judging the necessary biocide concentration for preservation.

II.3 Mill Dept.No. 3

PM No. 6:
This is a combined machine with a Vat-section and a Fourdrinier-section for a production of around 80 tpd of multilayer board.Raw materials are up to 80% waste paper and 10-12 % each of GWD and ubl. Kraft for quality improvement.The pH is around 7.5 and the temperature around 30C. The primary system of PM 6 is shown in fig.10 with the volume and overflow calculations in fig 10a.The capacity was measured and is estimated with 28 m3 (K).The overflow rate (V) in the vat -section is determined by the Δ Machine chest and transfer of the wet sheet to the fourdrinier wire.To this, the cleaning water at the vats, which was fresh water when we made our investigations, must be added.The value for (V) is, thus, estimated with 2.6 m3/min.
In the fourdrinier-section, again, all waters are commingled in the wire pit from where the overflow goes to the polydisk.The latter applies also for the vat-section.The capacity (K) in the FD-section is estimated with 25 m3 and (V), based on the Δ_c between machine chest and and couch with 0.83 m3/min.
The BA in both sections of PM 6 is extraordinary high with a four step color change within about 100 min.The plate counts with 10^{6-7} confirm this.
Visual inspection of the machine system revealed enormous accretions of biological slime all over the upper and lower wire part.Most desastrous is the situation in the machine cellar,where the backwater collecting chests are covered with huge amounts of solid foam,that leave no room for aeration.Anaerobic growth in these areas, which manifests itself by the putrefactive odor is one of the consequences.
Microscopical inspection of slime samples showed a heavy and virulent bacterial infection which provides the binding power for the heavy deposits.In the lower part of the wet-end, we also found a heavy contamination from filamentous iron bacteria (Spherotilus Nathans) which organisms form extremely stringy deposits.Fungus was completely absent in the deposits, which is in line with the slightly alkaline pH.

COUNTERMEASURES:
Based on the writers experience, the situation on PM 6 is such, that only a coordinated approach will be able to improve the situation.
This approach includes:

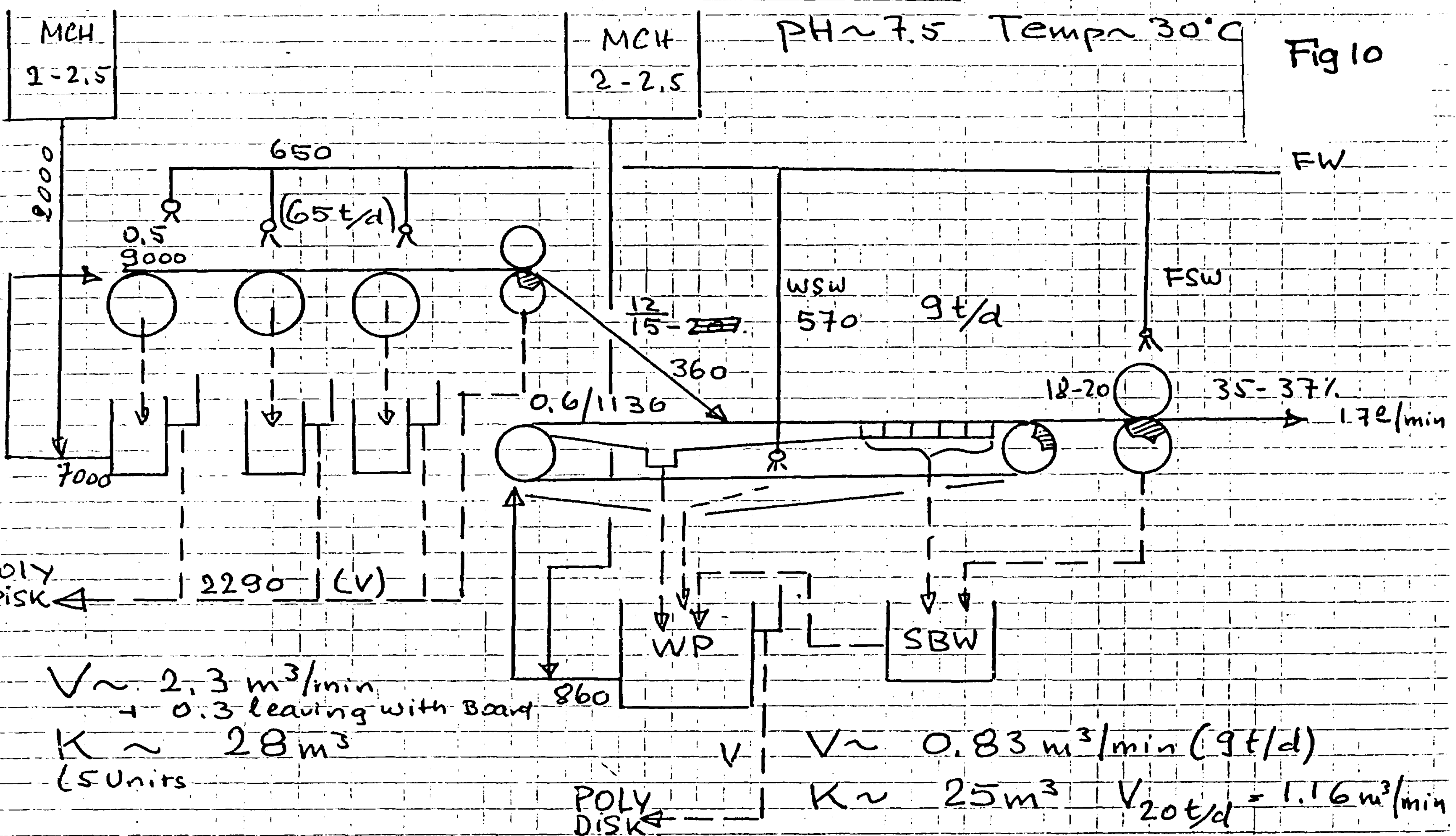
-closing up the circuit by drastically reducing the amount of fresh water.

-Changing the water flow in the fourdrinier section, so that only WWI is collected in the wire pit and neither shower- or SB-water are mixed with the WW-I.The excess waters should instead be sent directly to the Polydisk.This measure will greatly improve the chances for effective slime control.

-Before ANY biocide is applied, PM 6 needs to recieve a very thorough boil out.The secondary systems tanks and chests also require separate effective cleaning.(see further for boil out procedures).

-A slime control should be initiated after the boil out has been done for which we recommend biocide90 which has performed best in the BST (see fig.11)As an alternative, biocide 110 could be used.

PM 6 80 t/d Board + Paper WATER BALANCE



DJHW
84-06-15

fig 10a

PM 6 Calculations

Board machine with 5 Vats and fourdrinier wire.Width 3.20 meters

pH 7.5, temp. 30C.C_{MCH}2-2,5 %, $C_{transfer\ vats}$15-20%, $C_{couch(FD)}$18-20%

C_{press}35 %.

Fresh water: Vat section 0.1 m3/min, FD-Section 0.1 m3/min.

Max. Production rate 80 tpd.All excess water from vats collected and sent to the polydisk.

K, Vat section:tubing 8.0 collecting chests, vats and tanks,20.0 m3 Total 28 m3

V, Vat section:Basis 5 Vats with minimum 70 gsm/Vat FD-section min. 50 gsm.At full production of 80 tpd about 65 tpd vat section. = 45 kg/min.

Maximum dilution (0.5%)	9000 1/min
Final consistency transfer(12.5%)	360 1/min
Difference	8640 1/min
Fresh water added incl. Polydisk clarified water	650 1/min
total water	9290
dilution water needed	7000 1/min
Excess water	2290 1/min = V

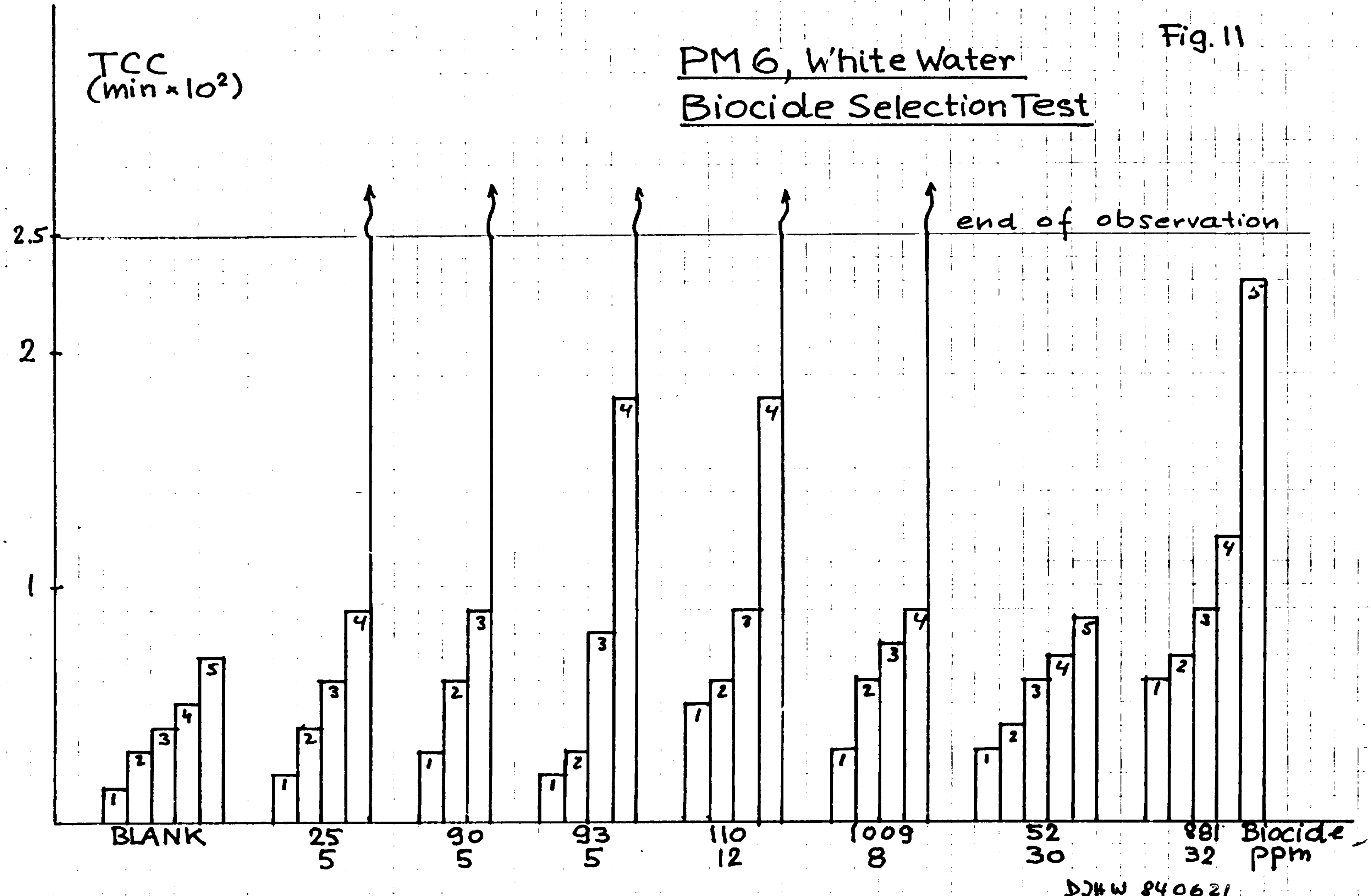
Fourdrinier Section:

K: estimated after measuring with 25 m3

V: Basis 50 gsm on FD-wire of total 450 gsm =9 tpd =6.25 kg/min.

Max dilution Headbox (0.55 %)	1136 1/min
Final consistencypresses(37%)	17 1/min
Difference	1119 1/min
Dilution through WSW etc	570 1/min
total water	1689 1/min
Dilution water needed Headbox	859 1/min
Excess water	830 1/min = V

Fig. 11



PM 6, White Water
Biocide Selection Test
TCC
(min × 10²)
2.5
2
1
end of observation
BLANK
25
5
90
5
93
5
110
12
1009
8
52
30
881
32
Biocide
ppm
DJHW 840621

Our recommendations (APP.2) are based on full production of PM 6 with an output of 80 tpd.The addition of the biocide should be done to the machine chest in the Vat-section and to the primary circuit for the fourdrinier section.Treatment levels and -periods indicated are the absolute minimum for the beginningAFTER a good boil-out.Once the system is in balance microbiologically, a reduction of the treatment may be considered.

PM No. 7:
This is a fourdrinier machine with an output of 55 tpd mainly improved bogus fl oting paper using about 60% waste paper and 40% "yellow" straw pulp as fibre furnish.The pH in the system varies much, probably due to poor washing of the straw pulp and has been measured as high as 8.5 The temperature ranges around 30C.
The basic lay-out of the system is shown in fig. 12.Again we have the unfortunate situation that all waters are commingled in the wire pit which causes a high overflow to the polydisk and, thus, a high (V)-figure.(12a).
The BA shows the same extraordinary high figures as for PM 6.A complete color changes takes place within 100 min which is also confirmed again by plate counts in the order of 10^{7-8}/ml.Biocides 90 and 100, especially at the hiugher dosage rates show a very good efficiency against this extremely virulent microflora.
Visual inspection of PM 7 revealed the same as on PM 6.Heavy slime accretions in the entire wet-end as well as in the WW collecting tanks. Again,m the chests in the cellarwere not accessible because of layers of solid dry foam everywhere.Most discouraging was the fact, that we found this kind of situation ONE day after a so called cleaning of the machine.
Microscopical investigation of slime samples again showed a very heavy and virulent, in this case more mixed, microflora.The binding power was provided by rod-shaped bacteria(B. aerogenes).The presence of much spirillae,anaerobes, indicates, that the slime depositionmust have stayed in the system for longer times.We even did find some fungus growth, despite the high systems-pH, although its contribution to the deposit formation is rather unimportant.All in all, the situation on PM 7 is even worse than on PM 6, if that is possible.

COUNTERMEASURES:
The statements for PM 6 apply as well for PM 7

-the water flows should be changed as indicated earlier and this should be fairly easy to accomplish on a FD-machine.

-before anything is started with biocides, a boil out MUST be made.

-for slime control, we recommend biocide 90 and alternatively bioci de 110.The amounts suggested are the absolute minimum for the beginning(fig. 13 and 13a).

In addition to the aforementioned countermeasures, we feel, that the situation on PM 7(and also on PM 6) cou ld be much improved if the retention of fines could be increased. this would also improve the efficiency of the polydisk and with this the quality of the clarified water which is used as WSW. A good retention aid, applied properly could produce miracles what concerns paper machine cleanness and, in conjunction with this, slime control efficiency.

PM 7 Prod 55 t/d, 38 kg/min

Fig. 12

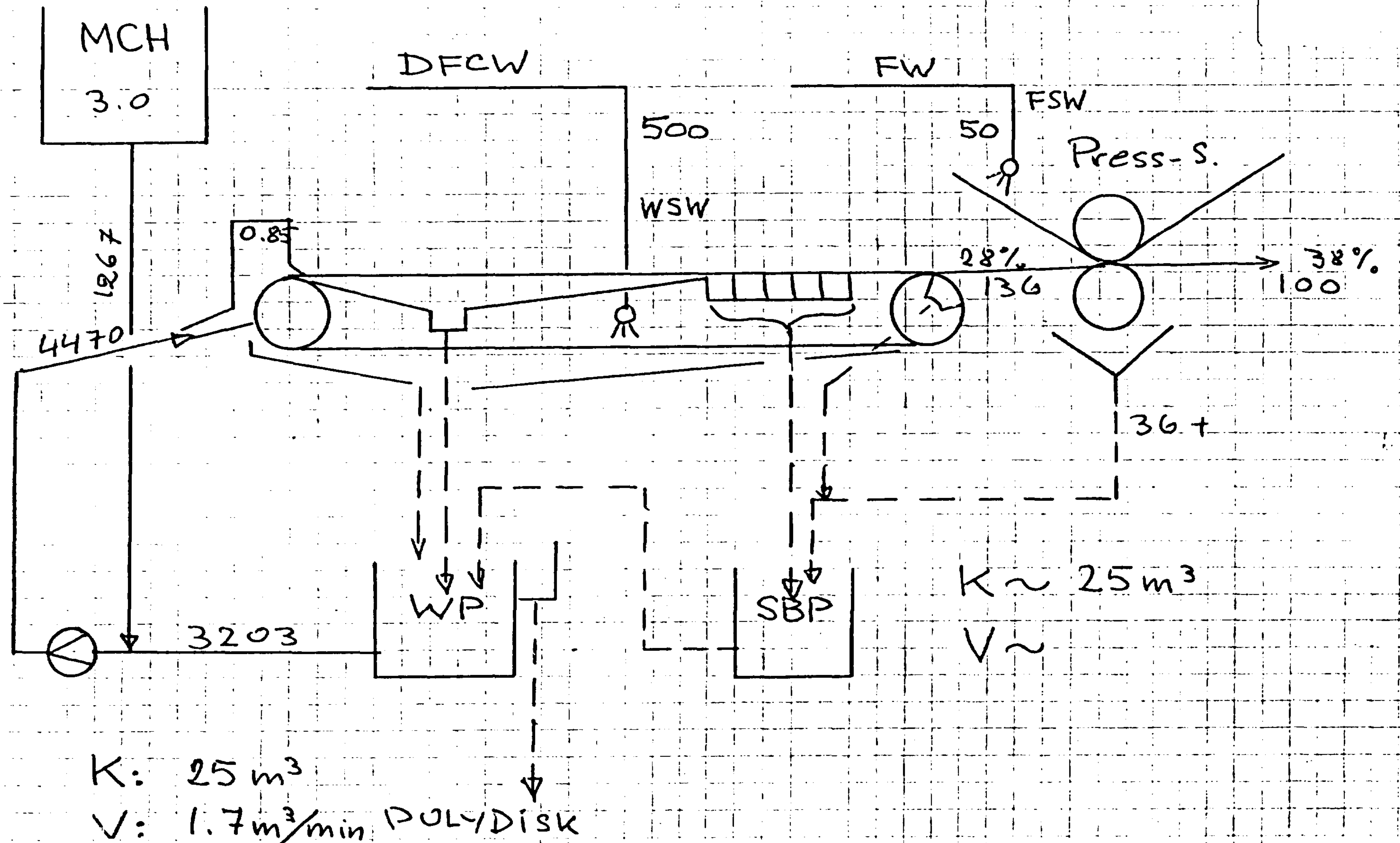


fig 12.a

PM 7 Calculations:

Fourdrinier paper machine production rate 55 tpd fluting with 160-180 gsm.(38 kg/min.)

C_{MCH}3.0% ,C_{couch}28 %, C_{press}38%, C_{HB}0.85 %

K: identical to PM 6 25 m3

V: Basis 38 kg/min.All water incl. press water collected in wire pit,excess water incl. shower waters going to the polydisk.

Max dilution for 0.85% HB	4470 l/min
Max consistency presses (38)	100 l/min
Difference	4370 l/min
Shower waters added	550 l/min
Total water flow	4920 l/min
Dilution needed at headbox	3203 l/min
Excess water	1717 l/min = V

PM 7, White Water

Biocide Selection Test with

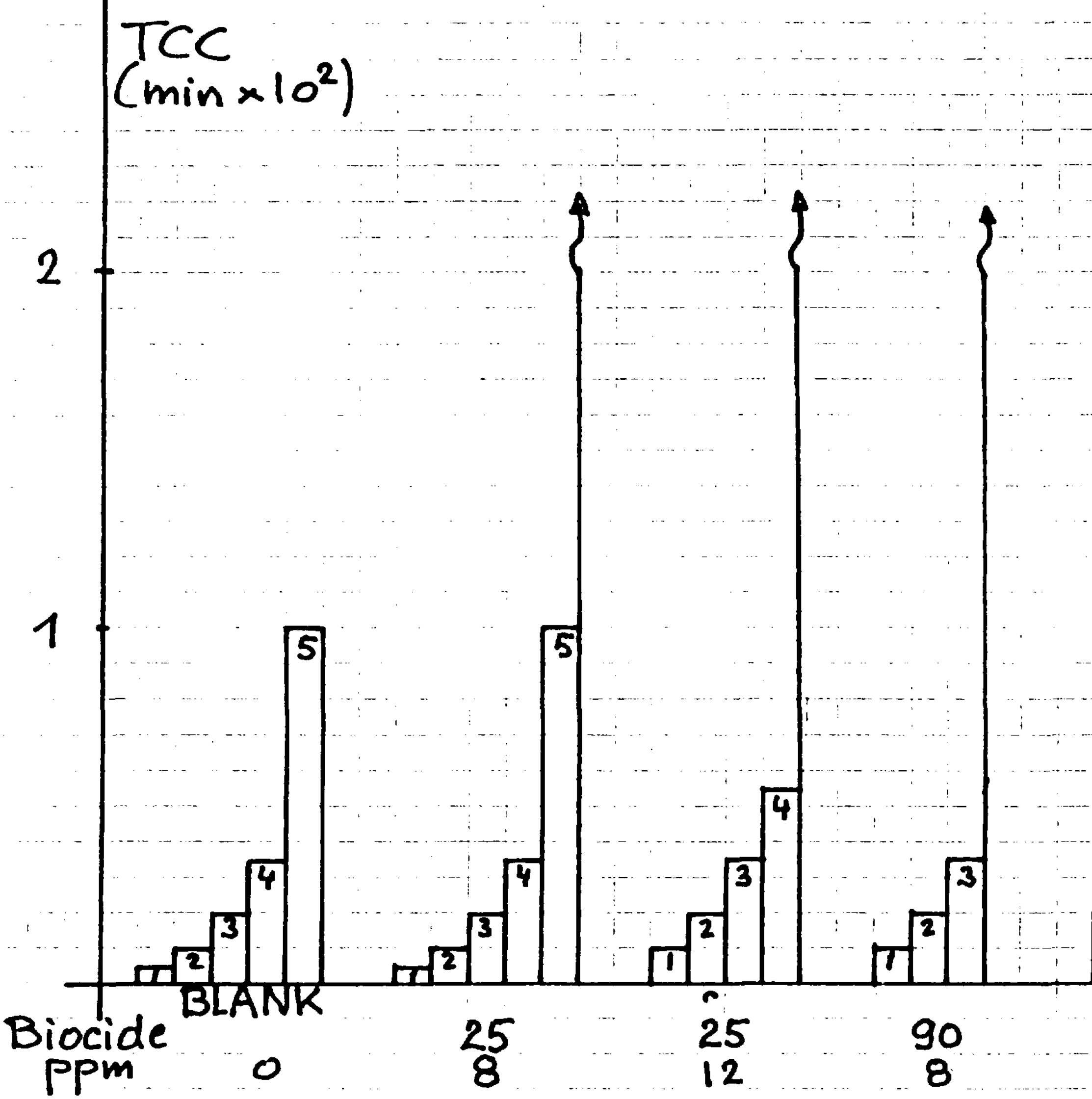
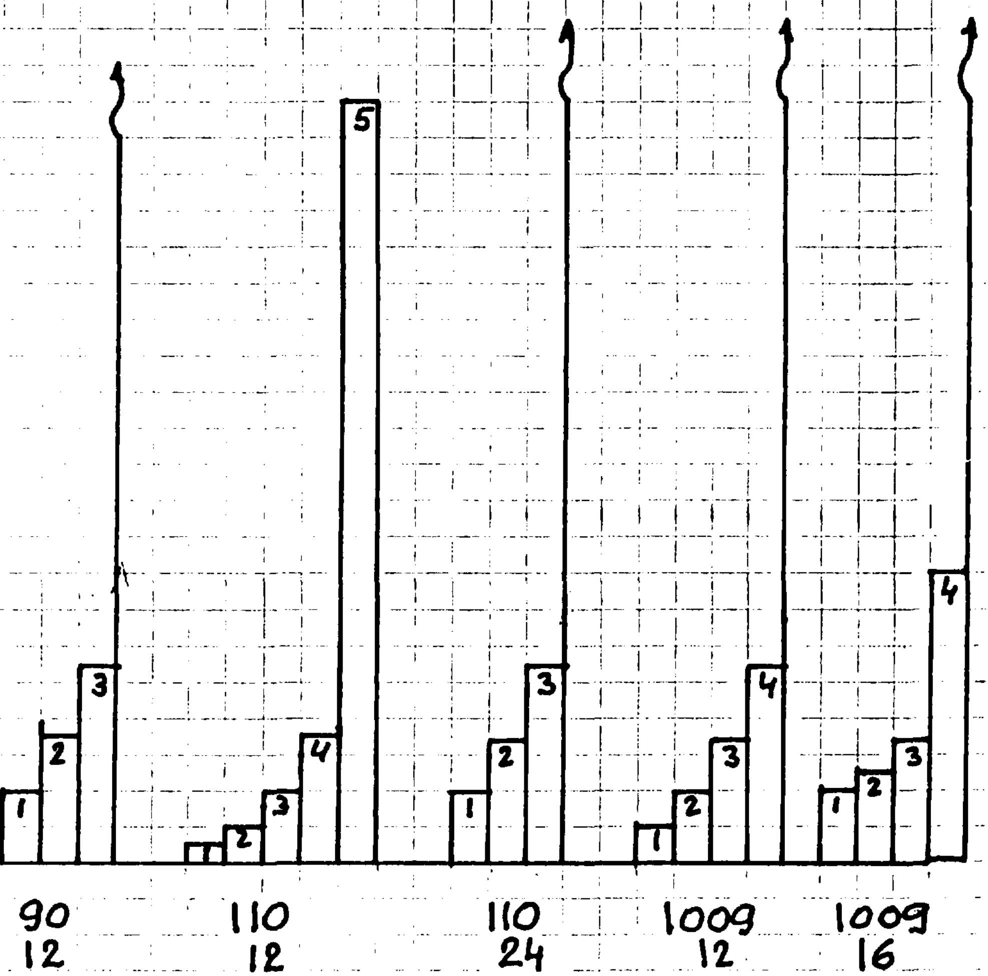


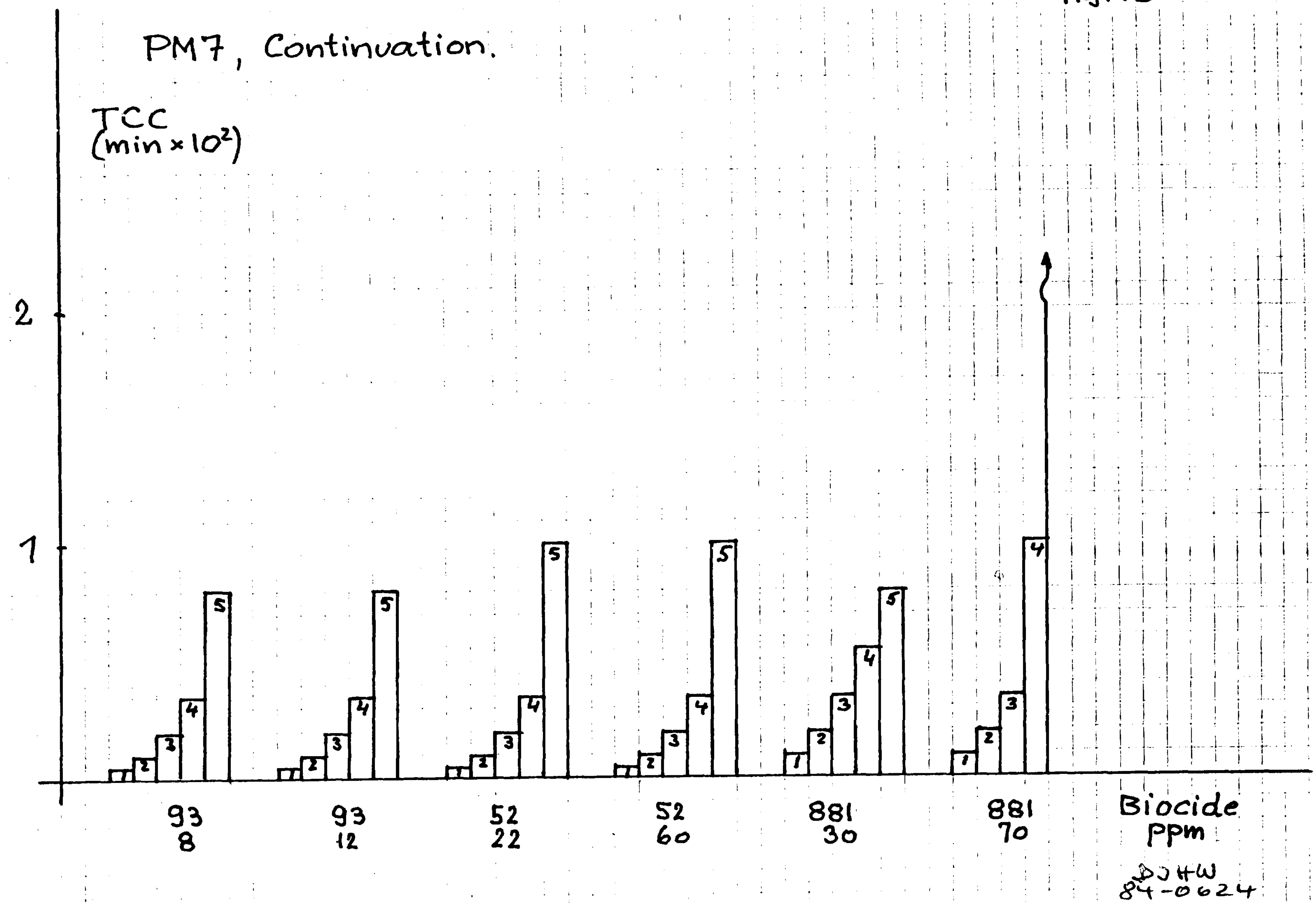
Fig. 13

2 different Biocide Concentrations



DJHW
840624

Fig. 13 A


PM7, Continuation.
TCC
(min × 10²)
2
1
1
2
3
4
5
4
93
8
93
12
52
22
52
60
881
30
881
70
Biocide
ppm
DJHW
84-0624

II.4 Mill Dept. No.4

PM No.3

A fourdrinier machine with a capacity of about 55 tpd of GWD-containing writing and printing papers in the grammage range between 50 and 100 gsm, pH of the system about 5.5 and temperature around 30 C.
Lay-out ofthe primary system is shown in fig 14 .Again, this PM has a so called "working wire pit"with the WSW going into the primary circuitand also SBW-water and press water are mixed with WW-I.Changing this would reduce the factor (V) from 1.75 to 1.1 m3/min and would make slime control easier and more economic.The capacity of the system (K) was measured with about 60 m3.(fig.14a).
The BA in the system of PM 3 is comparatively low with no or change after 400 min (App. 1).This corresponds well with the total counts of about 10^4/ml.In this mill depot. we also checked the GWD-production line which showed a considerably higher BA.
Visual inspection of PM 3 indicated- incontrast to the BA and the low overall counts-rather heavy slime depositions in the wet end.The only explanation for this contradiction is- again-very poor efficiency of down time cleaning which- in this case- was reportedly done 3days before our inspection.
Microscopical investigation of slime samples revealed a straight bacterial microflora as binding source of the deposits.

RECOMMENDATIONS:
Besides our earlier suggestions for changing the water flows and reduce fresh water consumption, we feel, there is no need for an immediate implementation of aslime control programme.Most important, however,is a dramatic improvement of down time cleaning procedures.Once this is established,carefull visual inspection of the critical areas in the system on a frequent schedule will indicate the speed of new slime accretions.If it shall become necessary, a slime control programme can easily be designed and implemented following the basic principles outlined in this report elswhere.

PM No.8:

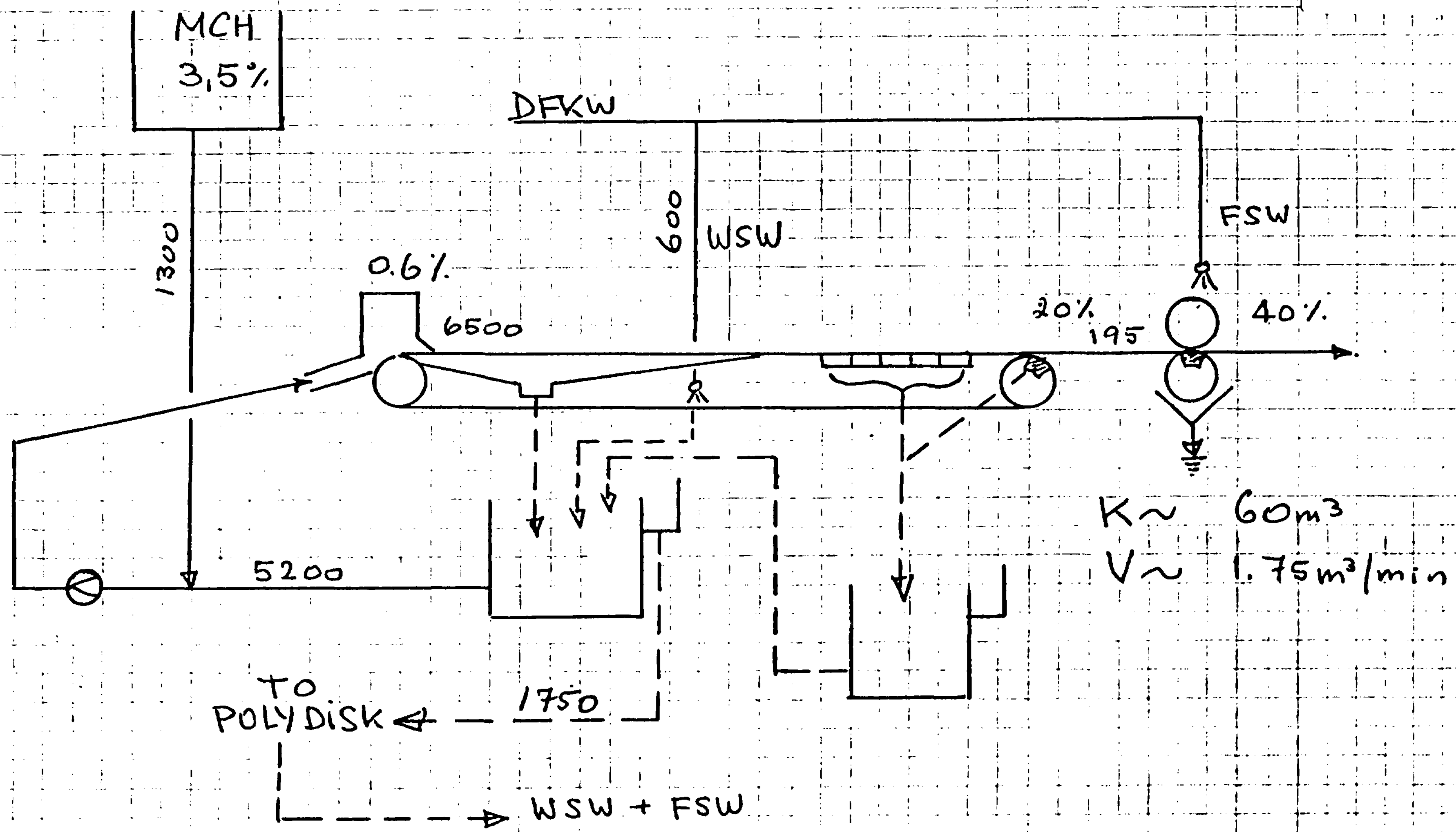
This is another fourdrinier machine with a capacity of up to 100 tpd primarily newsprint besides also heavier printing grades.pH in the system lais around 5.5 and the temperature around 30 C.Raw materials are stone GWD and unbleached sulfite from own production.
Lay-out of PM 8 is shown in fig.15 and the systems factor calculation in fig 15a.In principle, these are the same as for PM 3 with higher figures for (K) and (V) due to the higher production.
The BA in the primary system(App.2) is moderate to high which is in line with total counts between 10^5 and 10^6.The bioactivity can, however, be easily controlled with five out of the seven biocides tested. (fig 16)
Visual inspection of thePM-system showed heavy slime accretions in the upper and lower wire part.Wire- and SBW-pit were not accessible because they were covered with foam.Cleaning was reportedly doen ONE day before our inspection.
Microscopical investigation of slime samples indicated again a bacterial microflora as the chief binding source for the deposit formation. Anaerobes were also present.

COUNTERMEASURES:
The slime accumulations found in the wire section as well as the rather high BA indicate the need for at least a prophylactic slime control treatment.In addition, the downtime cleaning operations must be drastically improved.For slime control biocides 90 and 52 seem to be the best candidates as is demonstrated in the BST-results(fig 16)

PM.3 55 t/d = 38 kg/min. Printing grades GWD cont.

Water Balance, Primary System

Fig. 14.



DJHW
84-06-16

fig 14a

PM 3 Calculations:

Fourdrinier paper machine width 2.90 meters, production 45-60 tpd wood free and wood containing printing grades.pH 5.0 Temp. 28C

C_{MCH}3.5%,C_{Hbox}0.6 % ,C_{couch}20%, $C_{presses}$40%-

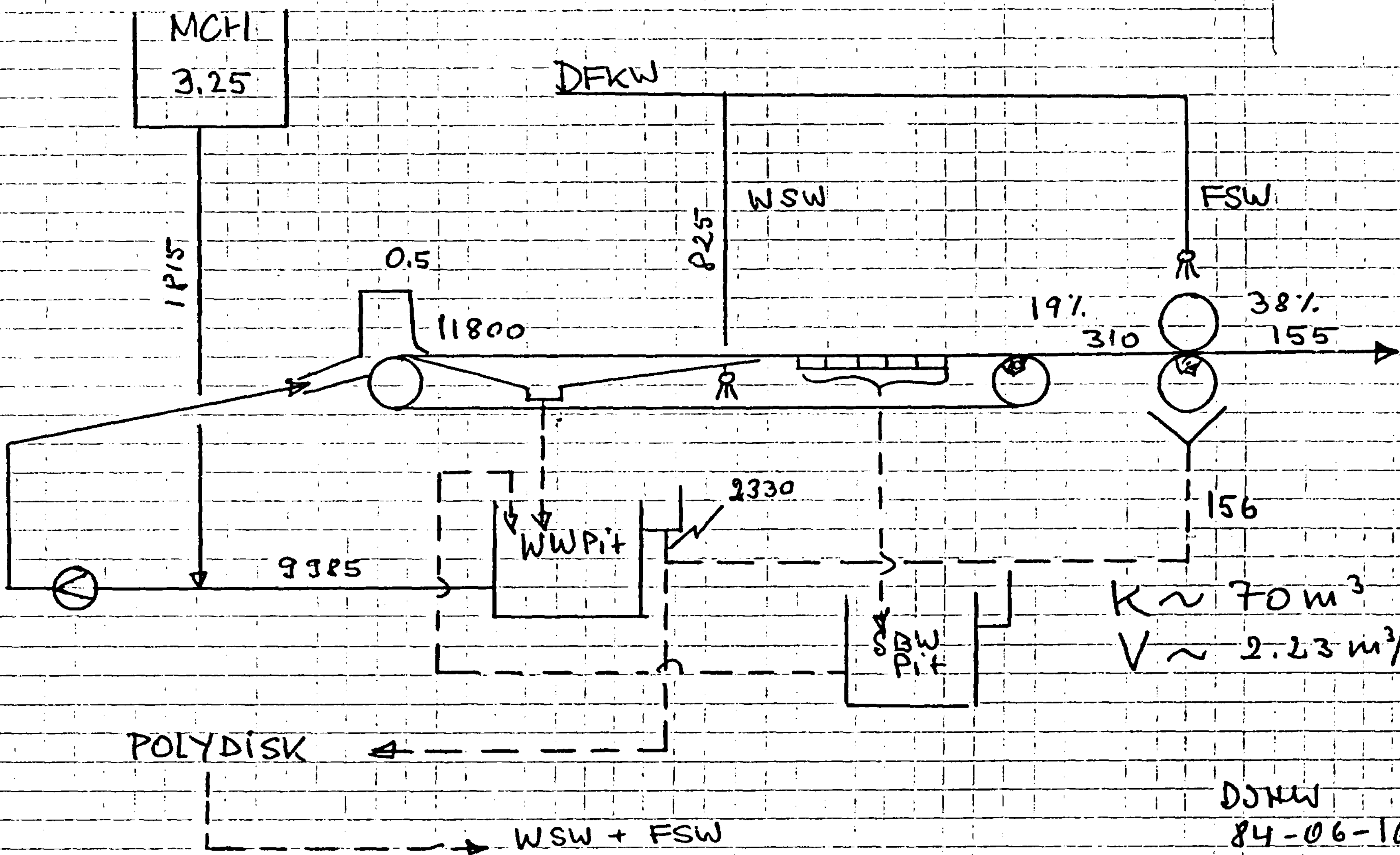
K: headbox, screening, tubino, WW-chest and SBW-pit,tanks totally 60 m3

V: basis 39 kg/min production

max. dilution headbox (0.6%)	6500 l/min
Final consistency couch(20%)	195 l/min
Difference	6304 l/min
Dilution through showers etc.	600 l/min
Total water flow	6905 l/min
Water needed for HB dilutoion	5200 l/min
Excess water	1750 l/min = V

PM8 70(NP) – 100 t/D (heavier grades) average used
85 t/d = 59 kg/min. Water Balance
Primary Circuit

Fig.15



DJHW
84-06-16

fig. 15 a

PM 8 Calculations

Fourdrinier width 3.50 meters, production 70-100 tpd wood cont. printing grades.pH 5.5 Temp 30 C.

C_{MCH} 3.5 % , C_{Hbox} 0.5 % , C_{couch} 18-20%, $C_{presses}$ 35-40%

K: about 70 m3

V:Basis 85 tpd = 59 kg/min.All water up to suction couch collected and mixed in primary circuit. Press water directly to Polydisk.

Max. dilution at Head box(0.5%)	11800 l/min
Final consistency couch (18%)	310 l/min
Difference	11490 l/min
dilution through shower water	825 l/min
Total water flow	12315 l/min
Dilution water needed headbox	9985 l/min
Excess water	2330 l/min = V

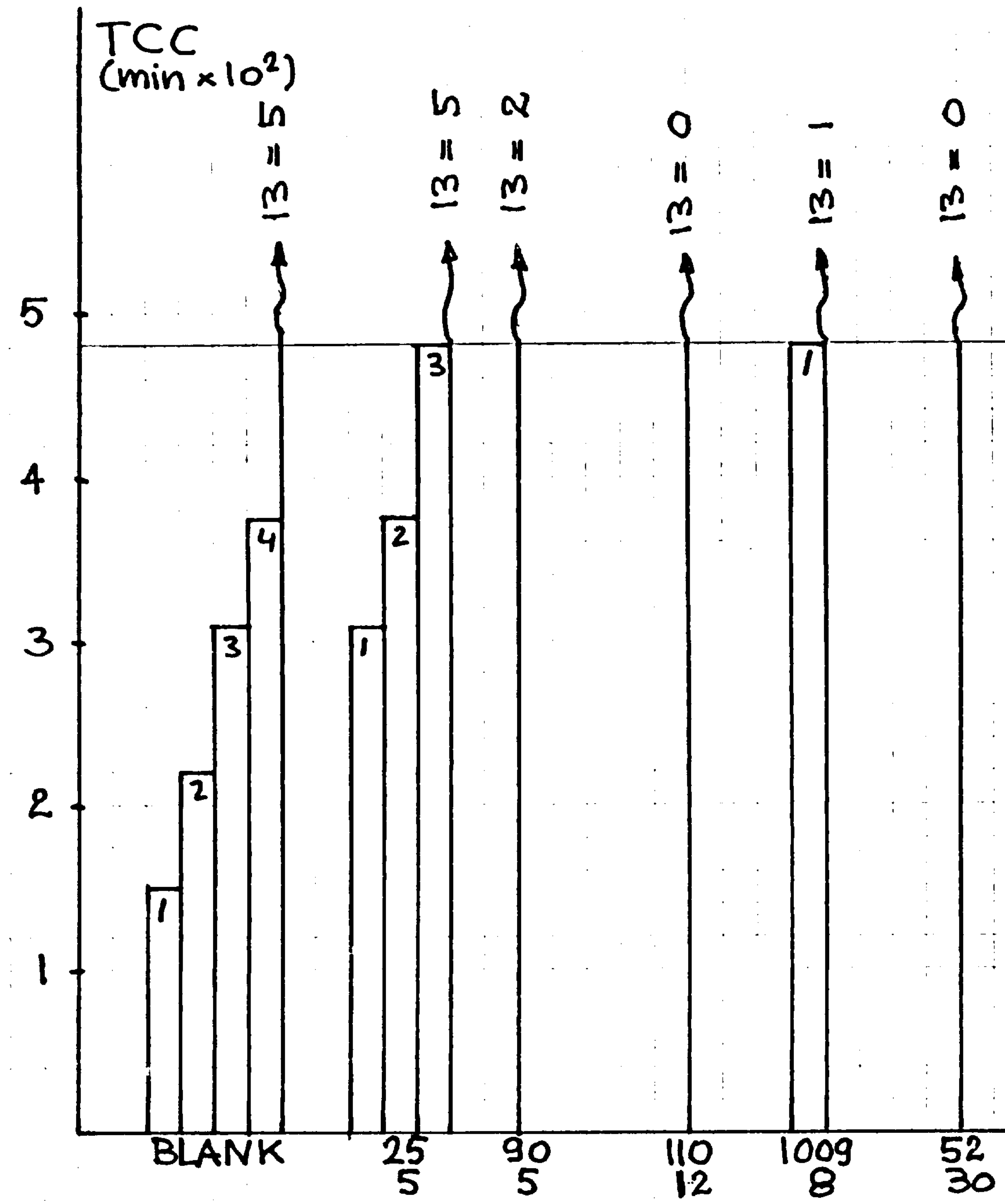
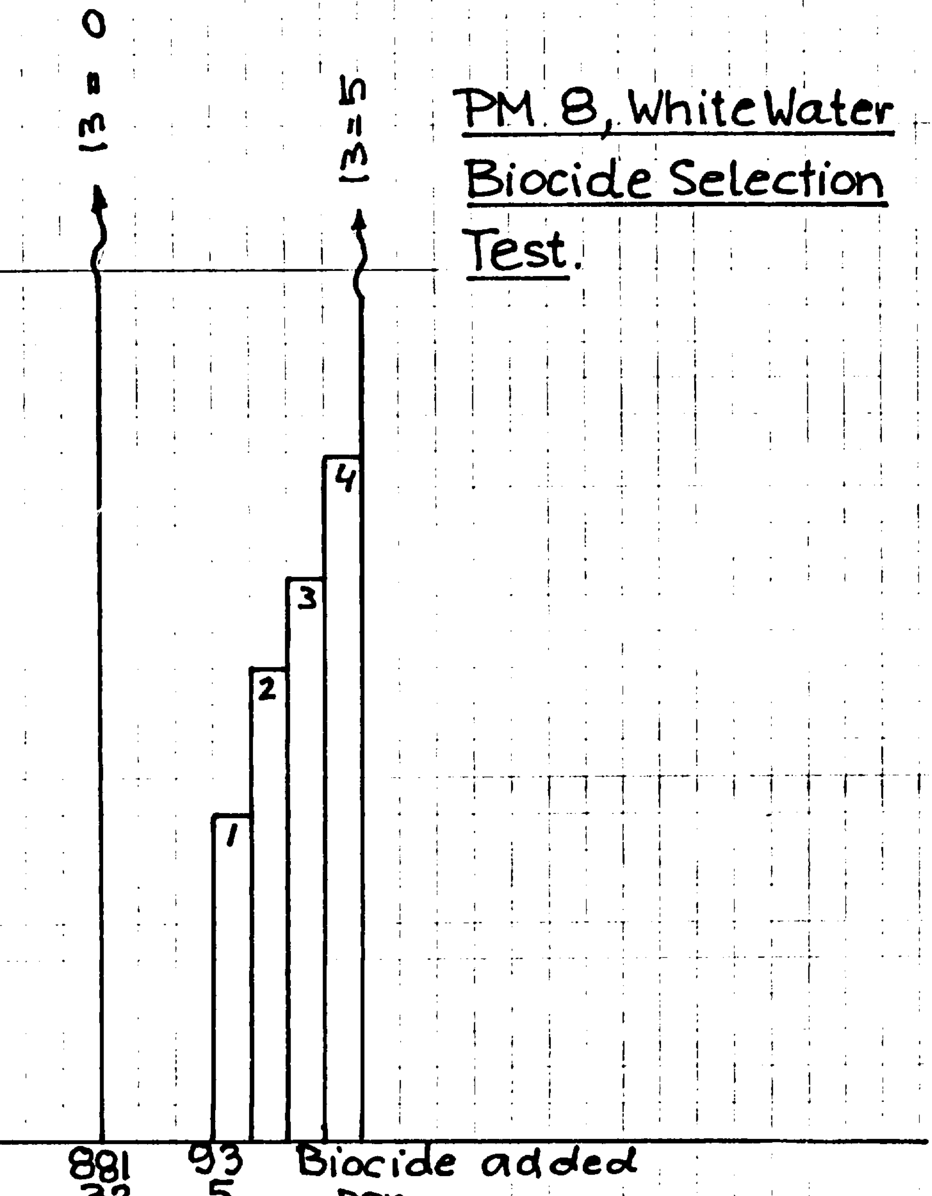

TCC (min × 10²)
5
4
3
2
1
13 = 5
13 = 5
13 = 2
13 = 0
13 = 1
13 = 0
1
2
3
4
1
2
3
1
BLANK
25 5
90 5
110 12
1009 8
52 30

Fig. 16

PM. 8, White Water Biocide Selection Test.



DJHW
840621

With regard to the feeding programme for the biocides (App.2) we believe biocide 52 could be used at the lower concentratiomn of lets say 20 ppm and treatment periods could be reduced to only twiceper day, PROVIDED, downtime cleaning IS REALLY improved.

II.5 Mill Dept. No. 5

PM No.5:
This is a Yankee machine with a single transfer press felt having apro- duction capacity of about 30 tpd of one side glazed light weight papers.Furnish compositioncan vary greatly and includes unbleached sulfite,bleached sul fite,GWD as well as selected waste paper.The lay-out of the pr imary system is shown in fig 17.The capacity (K) was measured and estimated with 30 m3 due to the voluminous screenin g system. During the time of our investigations, PM 5 was mostly standing.Hence, we could not include this machine into our investigation programme.

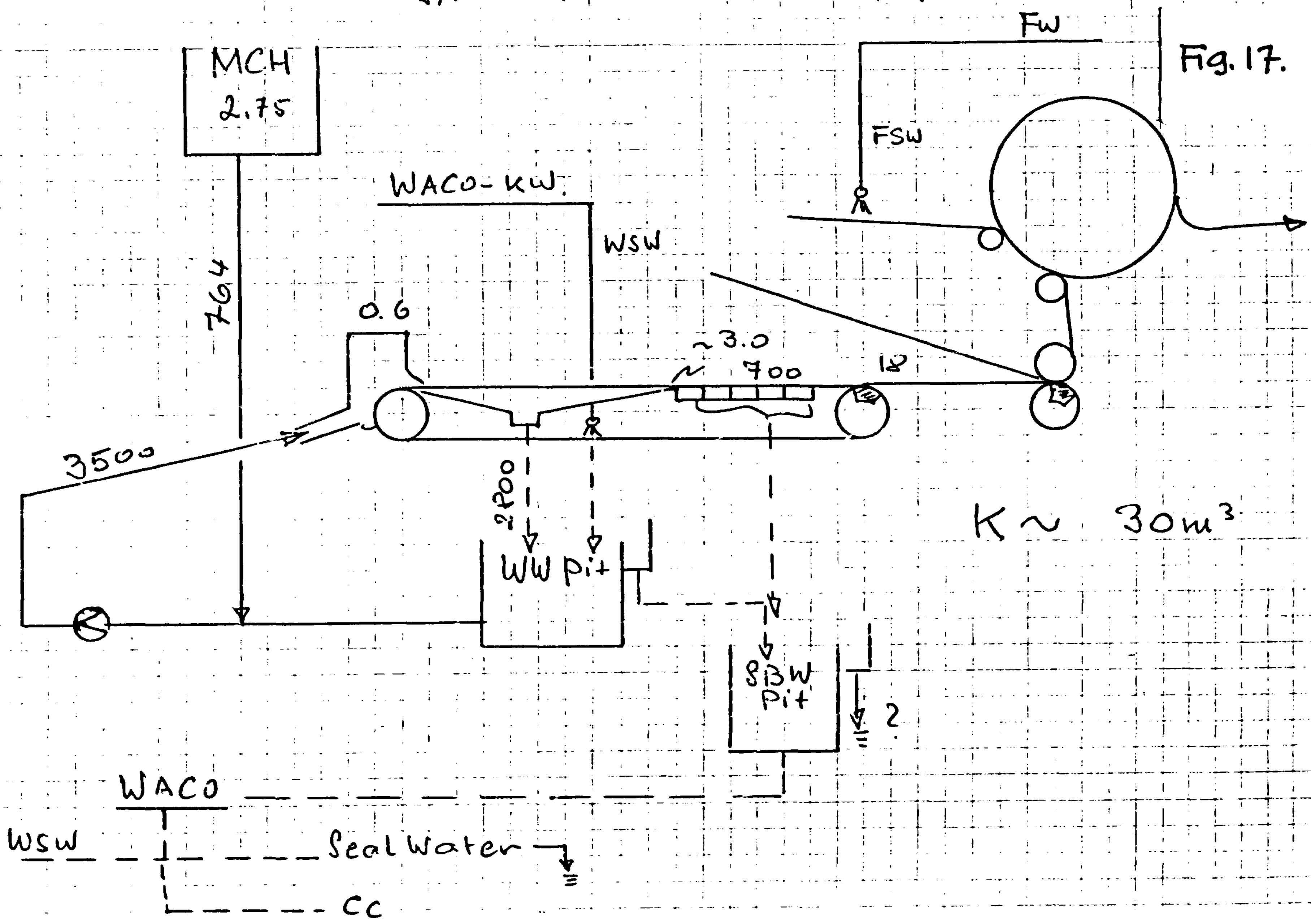
PM No. 10:
A Yankee machine with one transfer and one bottom felt,equipped with two felted post driers after the Yankee cylinder.Production capacity 40 tpd of one side glazed low grammage papers.Raw materials only bleached cellulose straw and coniferous basis.Systems pH ranges between 4-4,5 and the temperature around 30 C.The lay out of this machine is shown in fig.18 and the sys tems calculations in fig. 18a.Capacity (K) was measured with about 19 m3.Overflow(V) is determined by the Δ_c Machine chest /first suction box plus the water leaving with the sheet towards the suction couch.In addition, also the WSWmust be added, as this goes to the wire pit.Th is leads to an estimated overflow (V) of 1.92 m3/min.
Inspection of the machine was done 12 (!) days after the last cleaning and revealed a rather clean wire part.Slime accumulations where, however, found in the wire and suction box pit.Microscopical inspec- tion of these depos its indicated a beginning contamination by fungi. The BA in the system was low with no color change after 400 min.

RECOMMENDATIONS:
For the time being, there seems no need for a continuous slime control programme.Good housekeeping and thorough cleaning of the accessible partts of the primary system as well as frequent cleaning of the tanks in the cellar should be enough to prevent a serious slime flare up. If the water consumption shall be reduced,however, an increase in the BA must be envisaged.The development in this case should be followed closely by the methods explained in this report.

III.GENERAL CONSIDERATIONS AND SUGGESTIONS:

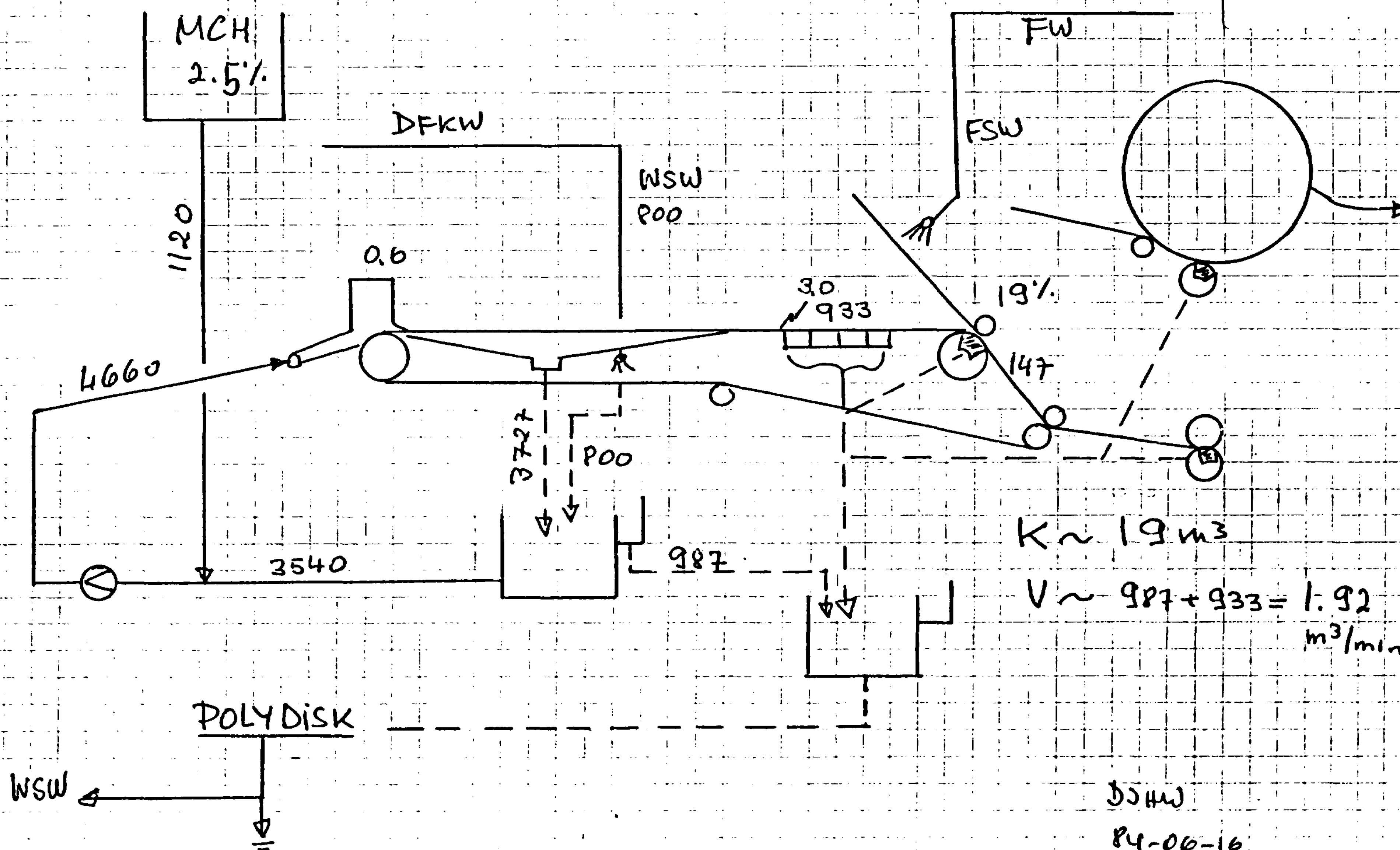
III.1:DOWN TIME CLEANING AND BOIL OUTS:
Good housekeeping is an essential step forward to deposit free pro- duction systems and tro ublefree operation of a paper or board machine. Good houskeeping also allows to reduce the need and costs for chemical addtives such as biocides.From our inspections and other observations in IZMIT, we can only conclude,that downtime cleaning is entirely unsatis- factory while boil outs apperently are not practiced at all.
We strongly suggest to equip at least each mill dept. with one high pressure cleaning apparatus (water pressure booster eqt.)There are several suppliers of such equipment available.Until this equipment can be madeavailable,the hoses used for cleaning the machines should at least be equipped with pistol type jet attachments to which a steel tube one half meter long with 1/2 " Dia should be fitted and to which a needle type nozzle should be attached.This will not only greatly im- prove the cleaning effectiveness,as one can reach into more hidden places,as well, it will also greatly reduce the water consumption for cleaning.

P' 5, Yankee 30 t/d c e side glazed light weight
= 21 kg/min Water Balance, Primary Circuit



PM10 Yanky PM 40t/d light weight, 1 side glazed
= 28 kg/min
Water Balance, Primary System

Fig. 18



K ~ 19 m3
V ~ 987 + 933 = 1.92 m³/min.

DJHW
84-06-16

fig 18 a

PM 10 Calculations:

Yankee-machine with a production rate of 40 tpd machine glazed papers.

C_{MCH} 2.5 %, C_{Hbox} 0.6 %, $C_{1st.\ suctionbox(est)}$ 3.0 % C_{couch} 19%

K:Wire pit SBW-Pit, tubing etc. 18 m3

V: Basis 28 kg/min,WW-I and shower water collected in the wire pit,SB-water in SBW and from there to polydisk.Unknown overflow from SBW-pit to canal.

V based on an estimated consistency of 3 % at the first suction box.The Δ_cHeadbox/1st suction box determines the amoiunt of wh ite water with 3727 l/min.To this the amount of WSW must be added with 800 l/min and the water going with the sheet to the suction couch = Δ_c1st SB/couch with 933 l/min.

V =(3727 + 800 + 933)-3540 = 1920 l/min = V
===

For larger surfaces to be cleaned, the availability of fan type nozzles is very helpfull.Once the HP-equipment is availabl..e, the cleaning efficiency, of course, will again be multiplied.

III.2Boil Outs:

Not all parts of the system can be cleaned mechanically. This applies especially forthe tubings.For this reason, chemical boil outs should be done at least once permonth or, whenever a longer stop is scheduled. Generall..y, the boil out solution is prepoared with white water still remaining in the circuit.If necessary, itcan be extended with clarified white water from the save all.Usually one half of the systems volume (see K-figure) is sufficient as volume for the boil out solution. To the water, a good dispersant should be added first, while the solution is already pumped through the system.Then, the addition of alkali (NaOH or $Na2CO3$) follows,in order to obtain a final pH in the solution of AT LEAST 10.The solution should be heated to at least 50 C.It should then be pumped through the p rimary system via the headbox and (in case the wire is not changed) over the slowly moving wire to the wire pit and back to the machine or whatever buffer chest is available.The circulation time should be at least 1_2 hours.Aft er use, the boil out solution must be drained from the system and may eventually have to be neutralized, depending on the effluent system situation. Thereafter the system must be flushed with fresh water and drained again.Finally the primary system will be filled with fresh water to which a sanitizing aid (biocide) may be added at a suitable concentration. If a chlorine compound is used, one should provide at least 5 ppm active chlorine in the solution.

III.3,Water Conservation:

The water consumption at IZMIT is extraordinary high as we found ourselves and havealso read from previous reports.By experience and comparison we would say, it is between 5-10 times higher compared to nowadays standards in continental european mills.the reasons for the drastically reduced water consumption in Europe are NOT in the first place the costs of water but the costs for EFFLUENT treatment in order to meet the very stringent requirements of the water authorities.

We understand from our discussions at Izmit, that plans are set up to install an effluent treatment plant.As such investment will be made for the future, it MUST consist of TWO steps, chemo-mechanical treatment followed by biological treatment.This will cost large investments whereby the costs will largely depend on the AMOUNT of effluent to be treated. Consequently,plans to improve the situation in Izmit for the benefit of the environment MUST begin with plans and implementations to REDUCE WATER CONSUMPTION.

Closing up production circuitsin paper and board machine systems has advantages and disadvantages.the problems arising from systems closure have been summarized in an article published by the writer (2).

Systems closure in general can be greatly facilitated by changing and adjusting the water streams in the production circuit optimal.In essence, each individual production departement should operate as closed as possible in order to keep the individual circuits separate.This applies for integrated pulp mills, groundwood or mechanical pulp mills as wellas for waste paper treatment plants.These raw material producing u nits must be layed out in such a way, that their stoc k is sent to the paper mill at the highest feasible consistency whereby the paper mill should use its back water for diluting this furnish to pumpable consistency.Alsoat the PM itself,water flows can be optimized.The primary system should be kept completely seperate and must not be diluted with e.g. shower water, SB-water or press water.Wire and felt shower waters should be kept in a separate circuit with a buffer chest.Suitable filters can be used to remove excessive amounts of fines or felt hairs from the water.(see also Part II of this report, where such a system is outlined in detail.).

Proper water flow management of a paper machine has a strong meaning when it comes to the designation of a slime control programme as is shown in the following:

Present status:Capacityofthe system (K) 16 m3, Production 40 tpd =28 kg/min.All waters commingled in the wire pit.Total water collected including the WSW 3885 l/min.Maximum dilution water needed to reach head box consistency of 0.9% = 2355 l/min.Water surplus = 1530 l/min =(V).If biocide 90 as an example should be added to have an effective concentration of 5 ppm+ over a certain period of time,lets say 3 tim.:es per day for at least 30 min.,20 grs/min must be dosed which give a max. conc. of 11.2 ppm after 30 min.The daily consumption of biocide 9o will then amount to 0.54 kg

ALTERNATIVE:The water flows are changed.WSW and FWW are collected seperately, cleaned over filter and recycled.the reduction of the water consumption will be about 80%.The suction box wateris sentdirectly to the save all.Assuming HB-consistency equals the consistency at the 1st suction box(3.5 %) and assuming, the consistency at the suction couch is 22 %,the overflow-through the water leaving with the sheet)- is reduced to 0.62 m3/min.Consequences?

-we can now reduce the biocidelevel to one half and still reach amaxcimum concentration of 11 ppm after 30 min.An effectiveconcentration (5 ppm +) is kept in turn over 40 min.

-IF we use the SAME amoun t of biocide as indicated under "present status"feeding 20 grs/min, we reach a maximum concentration of almost 22 ppm and keep an effective concentration (5ppm +)over about 60 min.This would mean, with the same treatment costs, far better efficiency.

IV.CONCLUSIONS:

The biological investigati.ons carried out at the Izmit mill of SEKA have shown,that several of the paper machines in this mill suffer from substantial to very heavy slime problems.These were found at least in the accessible areas of the most critical primary system.Unfortunately, there was neither possibility nor time available to thoroughly inspect also the normally not accessible parts of the primary system such as headbox, manifolds and screening areas.By experience,we can, however, state, thatwhen the accessible parts are full of deposits, there is at least a great likelihood, that deposits are formed in those hidden areas which- upon breaking loose- will inevitably c ause breaks and downtime on the production machine.

This then leads to the conclusions mill management will have to draw from the results of this trial and investigation report, namely:

HOW MUCH DO THE OBSERVATIONS WE HAVEMADE CONTRIBUTE TO THE OPERATING EFFICIENCY OF THE IZMIT PAPER MILLS ?

We have endeavoured to obtain some insight into this matter and have evaluated production data.We have listed these data together with downtime,number of breaks etc. in one table (App. VII).These are figures plainly stated as recieved and we do not feel competent to draw any final conclusions from these, however, we like to offer the following comments:

- 13 -

-the number of scheduled stops on all paper machines is excessively high.

-the number of UN-scheduled stops is equally high and in many cases even exceeds thatof the scheduled stops.

-the numberoif breaks is extremely high o n the light weight papers produced inb dept. no. 2.

-couch and press breaks count in all cases for the majority ofthe total breaks number.These breaks, however, arethe ones whichare most likely caused by broken loose deposits(e.g. slime).

We have no possibility to decide to what extend biological deposits have contributed to breaks and, with this, to productionlosses.Our fair estimate would be at least 25%.
Let us recall then:The costs for papermachine downtime based on world marketpaperand board prices aND average workingcosts must be calculated after:

$$TL\ 70.- \text{ to } 200.- \times min^{-1} \times \text{tpd production}$$

This means, ONE minute downtime on a machine producing 100 tpd of paper or board costs between TL 7000.- and 20.000.

IF we put against this the costs for slime control treatment with between TL 150.- to 250.-/to of prod:⁻ᵗion, we see, that these treatment costs would be compensated by the saving of between 2-5 minutes.

We trust, the results of our investigations have indicated ways to control the undesired activities of microorganisms in paper machine circuits.We have also tried to demonstrate,how suitable biocides should be appliedaND HOW THEIR EFFICIENCY can be easily controlled. We must now leave the final decision to production management.

AKNOWLEDGEMENT:
the writer gratefully aknowledges the excellent cooperation and assistance he got from all parts of the production and R&D departeme. Izmit.We were particularly enthused by the never ceasing readiness to help by Messrs Yelen and Mengi.
Miss Öztirpan tried her very best to follow the writers investigatory programme despite all languge problems.We trust, that she soon will be in a position to effectively continue our work and get optimum results from the application of biocides.
Finally, we like to thank Mr. A. Doğukan who helped very much to overcome the ever existing language problems.

References:

WENZL, D.J.H: Möglichkeiten zur Optimierung des Einsatzes von Bioziden in Industriellen Wasserkreisläufen. Wochenblatt, 1983.

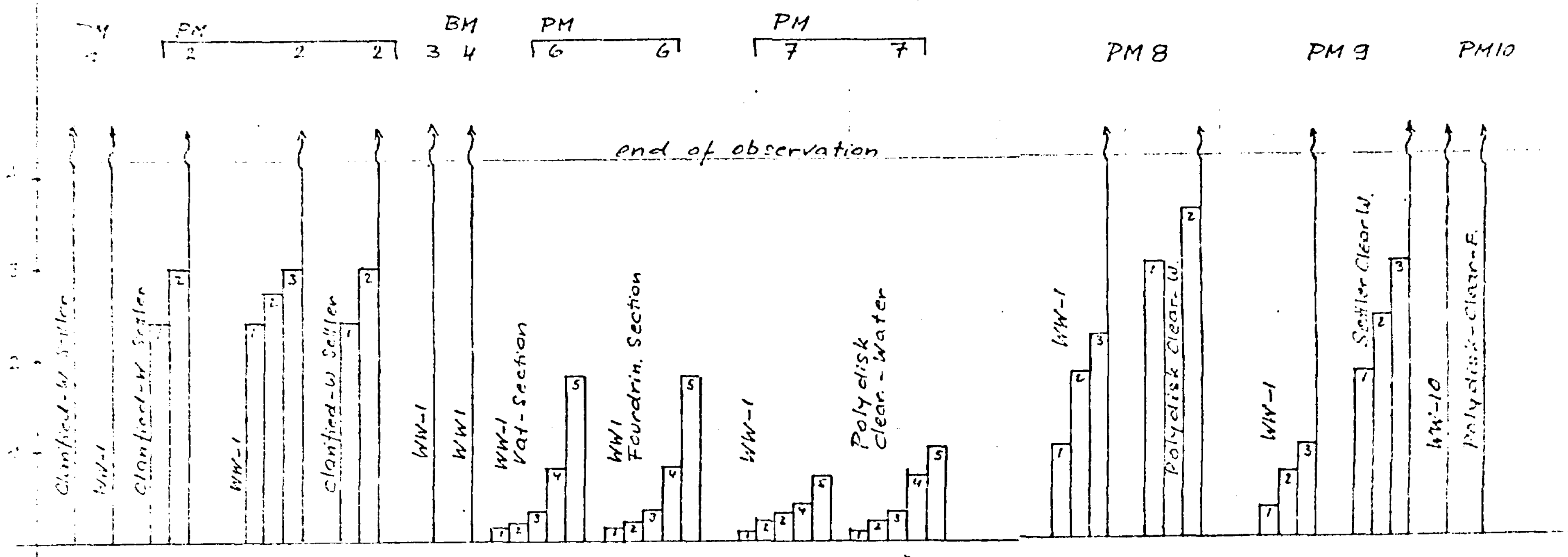
WENZL,D,J.H.:Effect of Systems Closure on the Operating Conditions of Paper and Board Machines. TAPPI, Annual Meeting 1981, pre-print.

84-07-16, DJHW.

Determination of Bio-Activity (Reductase-Test)

SEKA - İZMIT

App. 1.



DJHW
84-06-20

App. II

TENTATIVE SLIME CONTROL PROGRAMS FOR SEKA IZMIT PAPER MACHINES

Paper machine No	2 FD-Sect	2 Vat Sect.	2 FD-Only	6 FD-Sect	6 Vat Sect.	9	7	8	Remarks:
Prod. (t/day)	65		50	80		7	55	85	
BIOCIDE(s) A	1009	1009	1009	90		90	90	90	
B	52	52	52	110		52	110	52	
Effective Conc. (ppm) A	8	8	8	8		5	12	5	According to BST
B	20	20	20	16		25	25	30	
Dosing Rate A (grs/min)	25	40	65	25	50	5	40	30	
B	60	100	138	50	100	15	80	180	
Dosing period (minutes)	30	30	15	30	30	30 (60)	30	30	
Periods/day	3	as needed	6	3	3	3	3	3	
Max. Conc. reachead (ppm) A	16	19	21	18	18	14	19	8	
B	39	47	42	36	36	67	39	47	
Effective Conc. over Minutes:	30	30	20	40	30	80 (120)	30	30	
Amount Biocide (kg/day) A	6.75	as needed	6.0	2.25	4.5	0.45	3.6	2.7	
B	16.2		12.5	4.5	9.0	2.7	7.2	16.2	
Dosing Place	P.C.	MCH	MCH	P.C.	MCH	P.C.	P.C.	MCH	P.C.= Primary Circuit MCH= Machine Chest
Remarks:	basis 13.5 tpd FD Sect 50 t/d Vat sect.		50tpd	basis 80tpd					

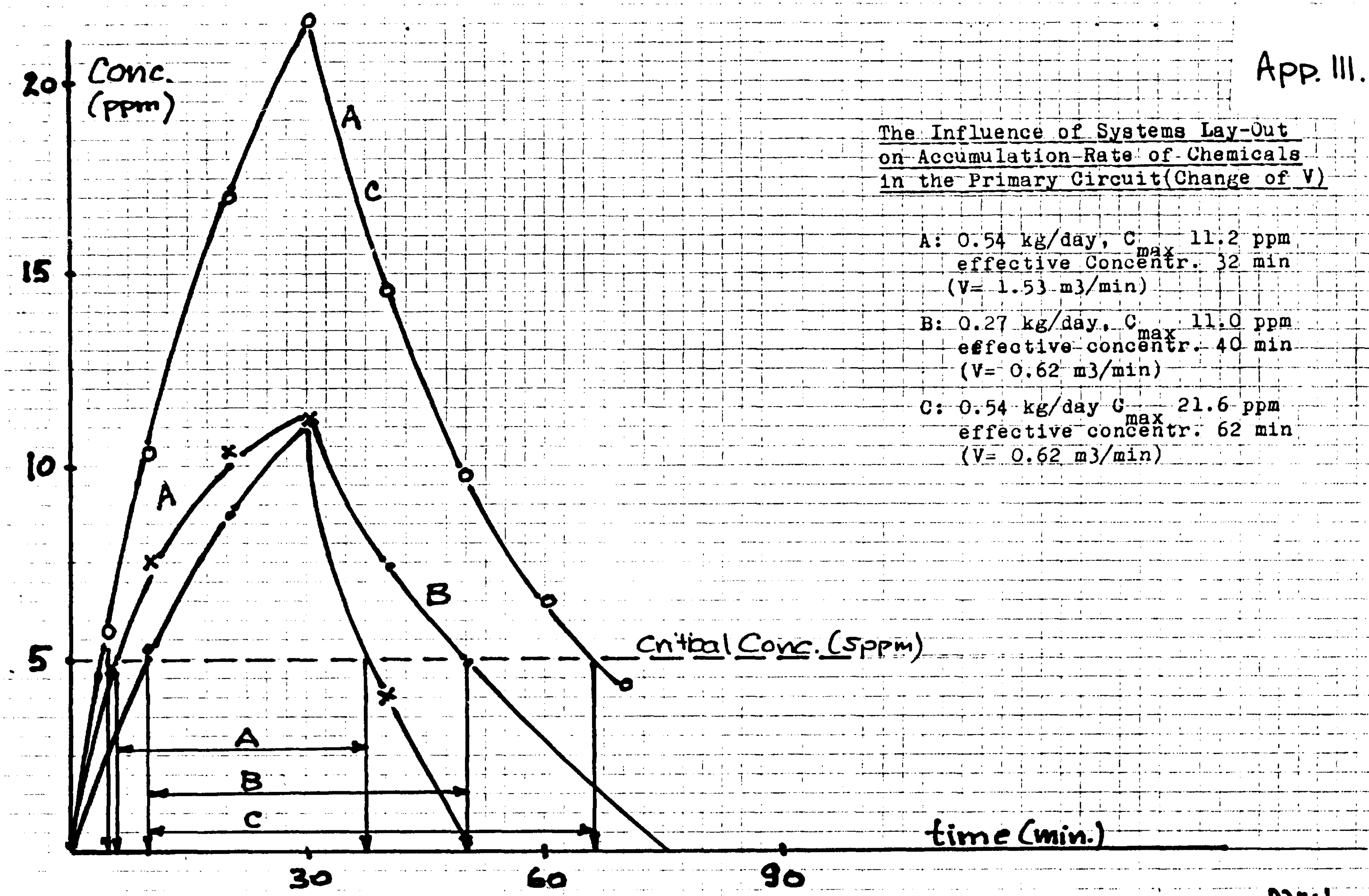
App. III.

The Influence of Systems Lay-Out on Accumulation-Rate of Chemicals in the Primary Circuit (Change of V)

A: 0.54 kg/day, C_{max} 11.2 ppm
effective Concentr. 32 min
(V= 1.53 m3/min)

B: 0.27 kg/day, C_{max} 11.0 ppm
effective concentr. 40 min
(V= 0.62 m3/min)

C: 0.54 kg/day C_{max} 21.6 ppm
effective concentr. 62 min
(V= 0.62 m3/min)



App IV

SLIME CONTROL INSPECTION REPORT;Paper Machines

PM Number:______,Production (t/d)______, Qualities________________

Date of Inspection:____________ Last Cleaning:_________ Boil Out_________

Slime Control Programme in use:

	Dosing Point:	grs/min:	Duration:	Periods/day	Biocide:
A					
B					
C					
D					

Inspection of the Machine System: (indicate VISUAL Observations)

Wire Part:

WW-Chests:

Other Places:

(Mark with S and number where samples of slime accretions were taken)

Microscopical Investigation of slime Samples:
(Follow number of samples indicated before)

Recommendations: (Indicate what changes , if any, should be done).

DJHW|PUP|D-3

BUCKMAN LABORATORIES, INC.

App. V.

Questionnaire for Biological Investigations of Industrial Water Circuits or Paper Machines

Name of Mill: Location:

Production: t/d, Type of Production:

Paper Machine No:

Information on Circuit: pH: Temperature:

Volume of Primary Circuit:

Type of Primary WW-Treatment:

Volume of Water leaving Circuit:

Volume of Fresh Water Consumption (m^3/to

Information on MBC-Treatment: (indicate all places where fed)

Type of Product:			
Dosing (grs/min)			
Dosing Intervals and length:			

Factors for Accumulation and Deconcentration:

$$\frac{d}{V}, \quad \frac{V}{K}, \quad 1 - \frac{V}{K}$$

$$= \qquad = \qquad =$$

Indicate calculated Accumulation and deconcentration Rates after:

Accumulation: $C_t = \frac{d}{V} \cdot \left(1 - \frac{V}{K}\right) \cdot \left[1 - \left(1 - \frac{V}{K}\right)^t\right]$

Deconcentration: $C_\theta = C_{max} \cdot \left(1 - \frac{V}{K}\right)^\theta$ in ppm.

Use same approach for secondary WFW and other circuits IF the necessary basic factors are available and IF MBC feeding is intended in these places.

Use backside of this sheet for additional space.

22. 02. 83

App. VI

BASIC DATA FOR ACCUMULATION_ AND DECONCENTRATION RATES SEKA-IZMIT

PM No:	Prod. (t/d)	Capacity K=m3	Overflow V= m3/min	$1-\frac{V}{K}$	Remarks
1	40	15.8	1.531	0.903	
2	65	Vat27	1.7	0.936	
		FD 16	1.3 (2.5)*	0.919	* FD alone
3	55	60	1.75	0.971	
4	7	5	0.52	0.896	
5	30	25			
6	80	Vat 28	2.60	0.907	
		FD 25	0.83*	0.967	* 1.116 at 20t/d.
7	55	25			
8	85	70	2.53	0.964	
9	7	8	0.137*	0.983	*minimum.
10	40	19	1.90	0.900	

App.VII

Production Efficiency Records, May-June, Izmit

Explanations

Row-#

1. Total days of month
2. Total hours = days/month x 24
3. Effective hours:Working hours of paper machine as reported by production management.
4. Total tons produced
5. Production in tons per effective hours (4 : 3)
6. Machine downtime excluding breaks (6 through 9)
10. Breaks statistics (10 a-c)
11. Number of breaks per tons of effective production (10a : 4)
12. Number of tons produced until 1 break occurred ((4 : 10a)
13. Effective production time (min) until one break occurred (Pos 3 x 60 divided by pos 10a x 5)
14. Lost production hours
15. Lost production (hours) due to downtime, scheduled and unscheduled.
16. Lost production time due to breaks(10a x 5 divided by 60)
18. Duration of average downtime (15 : 9)
19. Corrected production efficiency(2 minus 17 divided by pos. 2)
20. Lost production in tons(Pos 17 times pos 5)
21. Value loss:The sales value of the paper qualities producedon the individual machines has been used here as factor.The digures are divided into losses by planned and un-planned downtime and breaks.The effective production rate (pos. 5) was multiplied with thehours of lost production time for each item and multiplied with the sales value for the paper quality in question. The figures are given in TL x 10^6.

Productio Efficiency Records JUNE/MAY, SEKA - 12 MIT App.VII

Criteria item.	Dept I				Dept II				Dept. III				Dept IV				Dep. V				Σ
	PM 1		2		4		9		6		7		13		8		5		10		
	June	May	June	May	June	May	June	May	June	May	June	May	June	May	June	May	June	May	June	May	
1 Total Days	26	31	26	31	26	31	26	31	26	31	26	31	26	31	26	31	26	31	26	31	[illegible]
2 hours	624	744	624	744	624	744	624	744	624	744	624	744	624	744	624	744	624	744	624	744	13080
3 Effect. hrs	561	709	542	639	555	707	582	707	561	657	549	666	535	682	564	696	407	719	531	631	12282
4. Prod. (to)	917	1124	995	880	168	210	174	213	1575	2014	969	1512	1083	1778	1850	2430	507	695	854	1029	21783
5 to/effect hrs	1.63	1.51	1.82	1.38	0.30	0.30	0,3	0.31	2.81	3.07	1.55	2.27	2.02	2.61	3.28	3.50	1.24	1.25	1.61	1.56	1.78
6 STOPS																					
7 Planned	19	15	37	15	35	16	7	20	7	17	12	5	40	37	23	25	27	7	29	57	450
8 unplanned	15	20	16	90	10	21	11	17	32	70	39	71	25	25	13	123	164	18	40	26	746
9 Total	34	35	53	105	45	37	18	37	39	87	51	76	65	62	36	48	191	25	69	83	[illegible]
10 BREAKS:																					
A Total	180	160	90	85	1580	1700	687	662	120	120	220	180	140	150	230	180	100	150	170	180	7084
B Couch-Press	110	100	70	60	960	1065	531	516	60	60	130	130	81	69	193	130	70	100	60	70	
C Other	70	60	20	25	620	635	158	146	60	60	90	50	59	81	37	50	30	50	110	110	
11 [illegible] Prod	0.196	0.142	0.09	0.097	9.4	8.10	3.95	3.11	0.08	0.06	0.23	0.12	0.129	0.08	0.12	0.074	0.197	0.162	0.2	0.175	
12 Break/kto	5.1	7.04	11.1	10.3	0.11	0.12	0.25	0.32	13.2	16.7	4.35	8.33	7.75	11.90	8.33	13.51	5.08	5.95	5.0	5.7	
13 Breaks/[illegible]	182	266	364	451	21	25	50.8	64.1	280	329	149	222	229	273	147	232	245	285	187	220	
14 LOST PROD (hrs)																					
15 Downtime	63	35	69.5	97.9	69	37	37	37	63	87	75	78	89	62	60	48	215	25	93	63	1138
16 Breaks	15	13.3	7.5	7.1	131.7	141.7	57	55	10	1.0	18.3	15	11.7	12.5	19.2	15	8.3	12.5	14.2	15	[illegible]
17 Total (hrs)	78	48.3	77	105	200.7	178.7	94.3	91.1	73	97	93.3	93	100.7	74.5	79.2	63	223.3	37.5	107.2	78	[illegible]
18 hrs/stop	1.4	0.62	1.3	0.93	1.53	1.0	2.05	1.0	1.62	11.0	1.47	1.03	1.37	1.00	1.67	0.96	1.13	1.00	1.35	1.00	
19. Prod. Effc %	87.5	93.5	87.7	86.6	67.8	76.0	84.9	87.8	88.3	67	85	87.5	83.9	90.0	87.3	91.5	64.2	95	82.8	86.2	85.2
20 Lost tons	127.1	72.9	140.1	144.9	60.2	53.6	28.3	27.3	205.1	297.8	144.6	211.1	203.4	194.4	259.8	220.5	276.9	46.9	172.6	152.9	[illegible]
21 VALUE LOST																					
22 Prod. price TL×10⁶	0.19	0.18	0.15	0.15	0.35	0.35	0.35	0.35	0.175	0.125	0.11	0.11	0.16	0.16	0.16	0.16	0.18	0.18	0.3	0.3	
23 By Downt.	18.4	9.51	19.0	20.3	7.25	3.9	3.9	3.9	3.5	3.8	12.8	19.5	28.8	25.9	31.5	26.9	48.0	5.60	44.9	38.8	
24 By Breaks	4.4	3.62	2.05	1.5	13.8	14.9	5.9	5.8	22.1	33.4	3.1	3.8	3.8	5.2	10.1	8.4	1.85	2.80	6.9	7.0	
25 Total: (TL×10⁶)	22.8	13.13	21.05	21.8	21.1	18.8	9.8	9.7	25.6	37.2	15.9	23.3	32.6	31.1	41.6	35.3	49.85	8.40	51.7	45.8	478.[illegible]

August 1984

FINAL REPORT

ON

BIOLOGICAL INVESTIGATIONS

FOR

SEKA PULP AND PAPER MILLS

PART II - AKZU MILL

This report is based on work done under the UNDP Project TUR/81/018 carried out and reported by Dieter J.H. Wenzl during June/July 1984

REPORT ON MICROBIOLOGICAL INVESTIGATIONS

PART II

SEKA- AKZU MILL

Giresun

UNDP Project TUR/81/ 018, by Dieter J.H. WENZL

SUMMARY:Only one week was spent at Akzu, inspecting the paper machine, doing investigations of the biological activity in the system and carrying out biocide selection tests.The paper machine suffers from a rather heavy slime accumulation mainly of bacterial origin.The presently applied slime control programme is insufficient and ineffective primarily because of the lack of proper do sing equipment.The biocide used showed a rather good efficiency in the BST,however,its effectiveness is superceeded by at least two other biocides.The water consumption at the paper machine isfar too high which has several negative effects last, no t least,it makes slime control difficult and expensive. Ways to rectify this are given also in this report.

I. Basis Information:

I.1The paper machine:
This is a BELOIT fourdrinier with HP-headbox,automatic pick-up followed by a twinver press and a third press.The designed capacity is 300 tpd salable paper. The production rate presently for 52-55 gsm Newsprint is around 200 tpd.The furnish consists of 80 % stone GWD and 20% semibleched coniferous kraft, which is supplied in dry bales.The pH in the system ranges between 6.5 to 7.0.Alum is added at a rate of 0.6 % on furnish.The temperatur is around 35 C.

I.2 Flow calculations:
The principle lay-out of the primary system is shownin fig. 1.While the machine has a non working wire pit in which only the WW-I is collected and while the wire shower water (WSW)is collected seperately and lead to the suction box pit(SBP) and the knock-off shower water to the couch pit,SB-water is mostly returned to the primary system as dilution water in the centricleaner DECULATOR system.The capacity (K) of the primary system, thus, includes also the SBW-pit and the corresponding tubings.It was measured as exactly as possible with 140 m3.We measured an overflow from the wire pit with 5 m3 /min, whereas production mgmt. informed us of an overflow from the SBW-pit of only 4 m3/min.This figure was tentatively used as (V).

I.3 Slime control treatment:
BUSAN 881 (Burkman Laboratories, S.A., Gent, Belgium)has been and still is being used as biocide since some years.Wewere informed, that the product is doesed at a rate of about 90 li ters (108 kg) per day continuously.This would be equivalent to a feeding rate of 75 ml/min. The product is, however, not regularly applied but only when it is found necessary.Inspecting the dosing system,which is supposed to deliver the product into the level box of the paper machine,we are at a loss to understand, how 75 ml/min could possibly have been dosed with the pump available which is a centrifugal type constant feed pump with a capacity of 20 liters per MINUTE against 2.5 bar. Nevertheless,based on our calculations, using $K = 140$, $V = 4.0$ and $d = 75$ grs/min,the continuous addition of B 881 should result in a maximum concentration of 18 ppm (see fig. 2)

II. Work Done:

II.1 Paper machine inspection:
The machine was stopped due to a power plant failure all July 3rd and resumed product. ion only at 8.30 on July 4th.No cleaning had been performed of the wet end and we found ample accumulations of biological slime in the upper and lower wire part,between the deflectors and foils and heavy slime accretions also in the press part, especially in the shower water splashing areas.
Microscopical investigation of the slime samples revealed a bacterial microflora as binding source in the deposits at the paper machine, whereas filamentous slime (Spherotilus N.) was found primarily as binder in the deposits from the press part.

II.2: Determination of the Bio-Activity:
The BA-tests were done on July 6,when the machine had been in continuous operation again for 48 hours.Samples of WW-I, clarified water from the polydisk and wire shower water (fresh water) were used as substrates and were subjected to the Reductase-Test.Color changes to color step III (pink) occurred within 4 hours which indicates a high bio-activity. The BA in the fresh water (WSW) was low, however still significant for such a substrate.(see fig.3)

II.3 Biocide Selection Tests:
The BST was set up the same day as the BA-Test using WW-I as substrate. Five different biocides were applied in two different concentrations. As a basis for an equivalent cost treatment, we used 15 ppm B 881 which is close to the level achieved with the present treatment IF applied as it should.

II.4 Biocide Treatment under Controlled Conditions:
In lack of a suitable dosing pump and in order to make at least ONE test under controlled conditions, we managed to set up a simple drip feedingdevice for a one hour feeding period according to example C shown in fig. 2.This should yield a concentration of 48 ppm B 881 and maintain the effective concentration of 30 ppm for about 60 minutes.Samples for the R-Test were taken before (BLANK) immediately after dosing stop, as well as 30 and 60 minutes later.

III. Results:

III.1, Bioactivity:
The BA-measurements are shown in Fig.3a.The high BA of the WW-I is obvious.Also the polidisk water(DFCW) has a high BA if one considers the much lower solids content of this substrate.Also for the fresh water used as WSW, which has practically no SS, the BA must be considered as substantial.

III.2 Biocide Selection Tests:
The results from the BSTs are shown in fig.4.The result indicate the following:

- -all biocides tested, even at the lower concentrations give a good inhibition of the bio-activity if compared with the BLANK sample.

- -B 881, presently used, gives satisfactory results, however it is by far outperformed by the biocides 110, 1009 and also by biocide 90 at the higher concentration.

The composition and chemical character of the biocides used can be found in part I of this report on Izmit.

III.3 Practical Slime Control Test on the Paper Machine:
(see also II.4)
The results of the provisional application of B 881 to the primary system of the paper machine can been seen from fig.3b.The diagrammatic display of these results allows the following conclusions:

-dosing 240 ml/min opf B881 gives apronounced inhibition effect (compare column 1 and 5).

-The inhibition is highest immediately after dosing(5) and fades out very quickly after 30 and 60 min (6 and 7).

-The same applies also for the polydisk system(8 and 9).

-The practical application of B 881 does by far not reach the inhibiting effect obtained with the addition of 30 ppm of the product in the BST (compare 4 and 5).

-consequently, the factors used in the calculation of accumulation and deconcentration cannot be correct.

-the mistake in the calculation lais with all likelihood in the factor (V).Both, our estimation and even more the information obtained from prod. mgmt.are apparently much too low and uncontrolled dilution of the primary systems water with hughe amounts of fresh water must lead to a substantially higher ovberflow(V).

IV. Recommendations:

IV.1 Dosing of Biocides:
The pre-requisite for an effective slime control or preservation programme for paper andboard machines is the exact dosing of such a product per unittime.This determines the factor (d) in the calculation of the accumulation rate.How this can be achieved is shown in fig. 5.The key is a reliable and adjustable chemical dosing pump which should (for this case) allow a maximum capacity of 30 liters per hour (500 ml/min).The supply tank- ifdosing is not done directly from the drum,-must be equipped with a drain valve and a water connection for rinsing must be available nearby.In order to be able to exactly measure the dosing rate against whatever heading exists in the system, thesimple installation of alevel control and feedrate-check tube is highly advisable.
As dosing will havetobe done intermittendly,the pump must be attached to a timer.In order to ascertain the same feeding intervals,the timer should be interlocked with a main switch at the paper machine which will stop timer and dosing pump whenever the machine stops and will re-activate the dosing system when production is started again.

IV.2 Choice of Biocide:
While B 881 is a creditable biocide, we would recommend to switch to B 1009 or B 110 which both showed excellent inhibition of the BA. B 1009 has thebroader spectrum of activity as it is a two component product and should be given preference.Based on equal costs, the dosing rate for B 1 009 should be reduced to 60 ml/min which leads to a daily consumption of about 25 kg.

IV.3 Choice of Dosing Point:
While there is nothing wrong with dosing of the biocide to the level box,we feel, it is an unconvenient place.As indicated in fig.5 we wou ld suggest to dose into the first stage centricleaner reject chest.The product will then be almost 100 % distributed into the

primary system via the second cleaner stage.This installation allows much shorter feeding lines,gives less heading for the pump and also facilitates storage and handling of the biocide drums, which would be on the same floor.

IV.4 Effect of Systems Closure on the Efficiency of Biocide Treatment:

The basic principles appliccable for the optimization of biocide treatments have been explained elswhere (ref 1).The results oibtained at AKZU-mill demonstrate clearly, that a too high water consumption makes slime control difficult and costly.As we mentioned before, we are quite certain about the factor (K),that is the capacity of the primary circuit.Factor (V), that is overflow, however, is way out(fig 6).
In the diagram fig 6 we have demonstrated, what this means in practice. The same figure for (d) that is 240 ml/min has been used.V, however, has been changed from 4.0 m3/min to 1.5 m3/min by eliminating fresh water from the showers getting into the primary circuit.This leads to the following advantages:

- -FW-consumption is reduced by at least 2.5 m3/min
- -almost twive the maximum concentration of biocide is reached when dosing stops.
- -The effective concentration is maintained in the circuit tw ice as long.
- -the possibility exists to reduce treatment level and with that costs by half through feeding only 3 times /day over 1 hours with same duration of effective concentration.

IV.5 How to Close a Paper Machine System.

T his try to show in fig.7.The headbox consistency determines the maximum flow rate in the circuit.The consistency difference between machine chest (MCH) and the consistencyin the web BEFORE the first suction box determines the overflow from the wire- to the suction box pit.IFΔA/B = 1, there would be no overflow and- for level control- an excessive amo unt of SB-water would have to be recycled to the wire pit.Therefore, the volume as well as tubings of the SBW-pit must be included in (K).The overflow (V) then leaves from the SBW-pit and it determined by theΔA/H.
Wire shower water (WSW)is co llected separately(as pra cticed at AKZU BUT, it will not be sent to the SBW-circuit but to a buffer che st instead from where it will have its own circuit.(SWP)
Polydisk clarified water ought to be used as shower water for the PM-wire.Heated fresh water is to be used for felt washing.The shower waters after use will be treated with a suitable filtering equipment (E).This can be either a CELLECO STRAIN-EL or a Bauer HYDRASIEVE or similar equipment.The SWP has a level control and heated FW is used as make-up water if any is needed.This offers the following advantages:

- -Fresh water consumption is drastically reduced.
- -Circuit temperature will increase by several degrees C.
- -Steam heating of primary circuit becomes unnecessary.
- -Higher circuit temperature will improve drainage
- -Slime control costs will become lower and efficiency will improve greatly.

IV.6 Housekeeping:
Good houskeeping has a tremendous effect on machine runnability and makes deposit control (/slime or other deposits) much easier.
A high pressure equipment IS available at AKZU.We strongly recommend to make full use of this equipment whenever the machine has a stop. This applies particularly for the upper and lower wire part of the machine.If not available, suitable needle type and fan-type nozzles should be purchased which would make the efficiency of HP-cleaning even more interesting.HP cleaning requires much less water than normal hosing.In addition, whenever a longer stop is planned,such as needed for wire or felt changes,a good boil out should be made in the primary system.(we refer to part I of this report .)

CONCLUSIONS:

AKZU, in comparison to the IZMIT mill is an easy case.MUCH improvement could be achieved with a minimum of investment but requiring a fair amount of good will.Based on its wire width and general lay-out, this paper machine should produceat least 250 tpd salable paper.

Aknowledgement:
In summary, we wish to thank mill management for the great hospitality we recieved at AKZU.
Our particular thanks are directed to Mr. Necdet Oktay, the never tired interpreter with great technical understanding as well, Mr. S. Özdem who offerd us all the help in his laboratory as well as Mr.S.Seyhan, who assisted him.Finally, we thank Mr. A.K. Millioglu for his help and valuable advice.

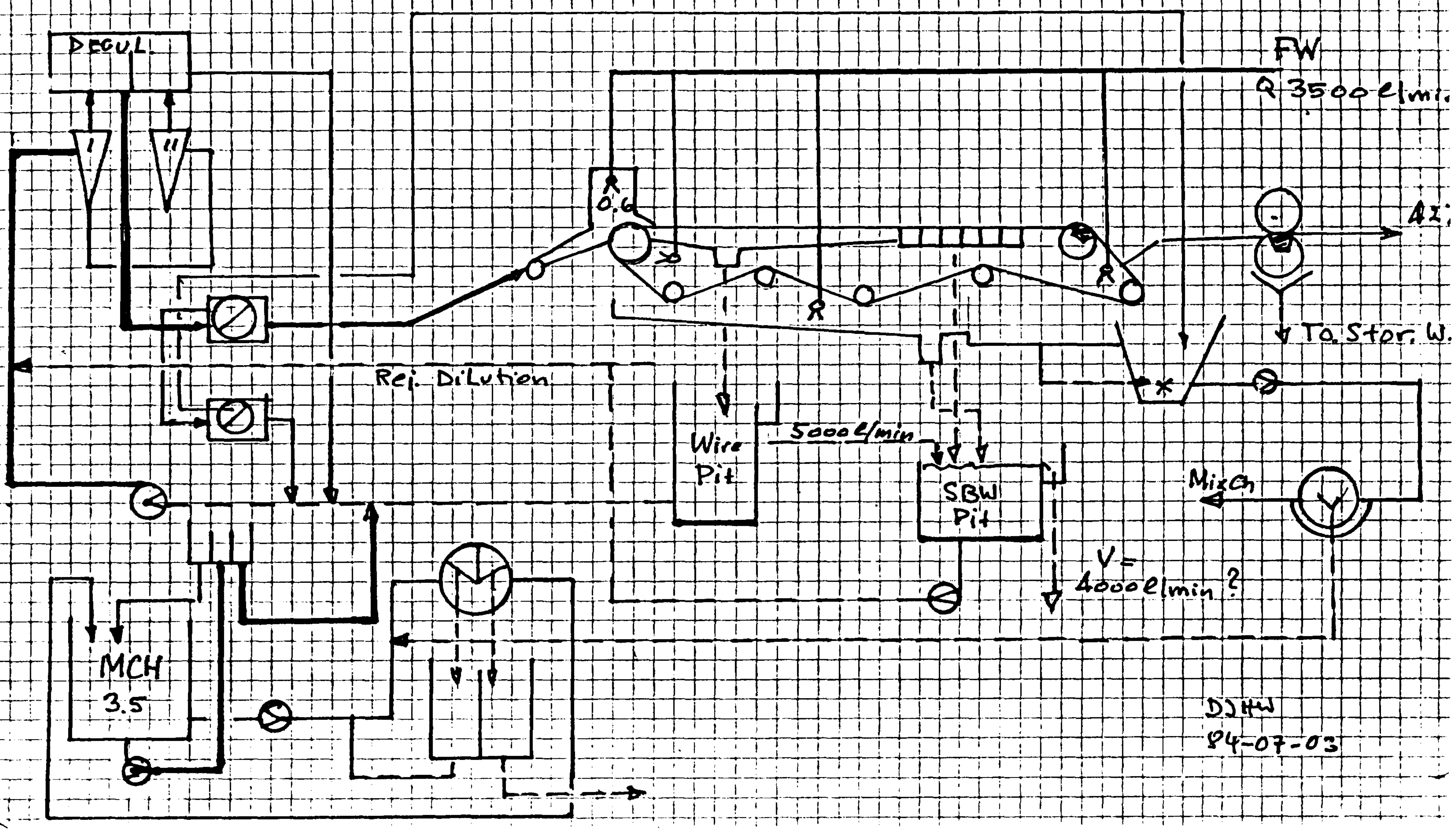
84-07-18 DJHW.

SEKA AKZU-Newsprint-PM: Prod 250 t/d Brt 535 m/min
80% GWD 20% SBSA

Basic Data

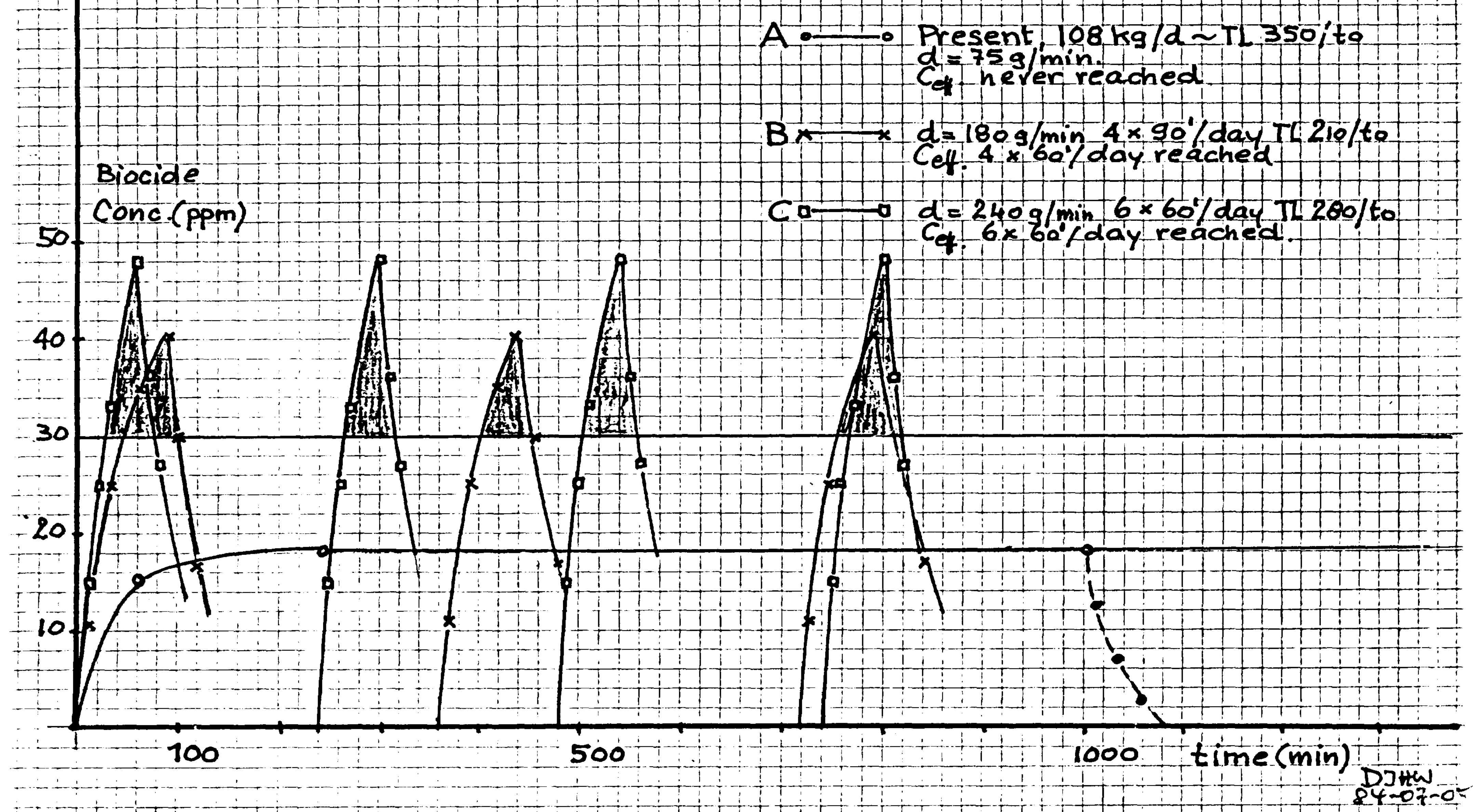
Primary System. K~150 m³ V≈4.0 m³/min

Fig 1



Effect of Dosing Mode on Biocide Concentration in Primary Circuit
(Model B881, effective Conc. 30 ppm)
BASIS: K ~ 140 m³ V ~ 4 m³/min.

Fig. 2



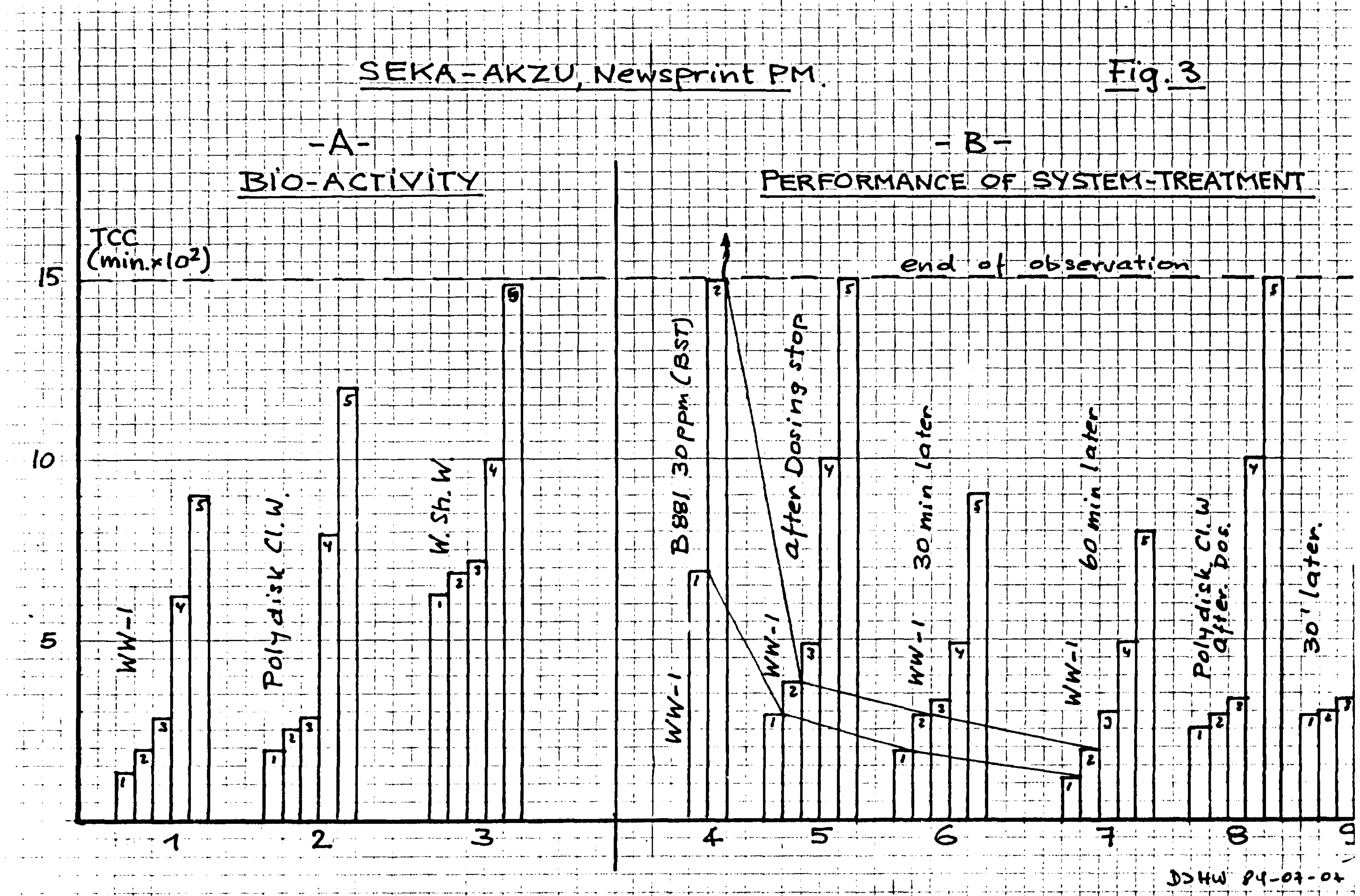
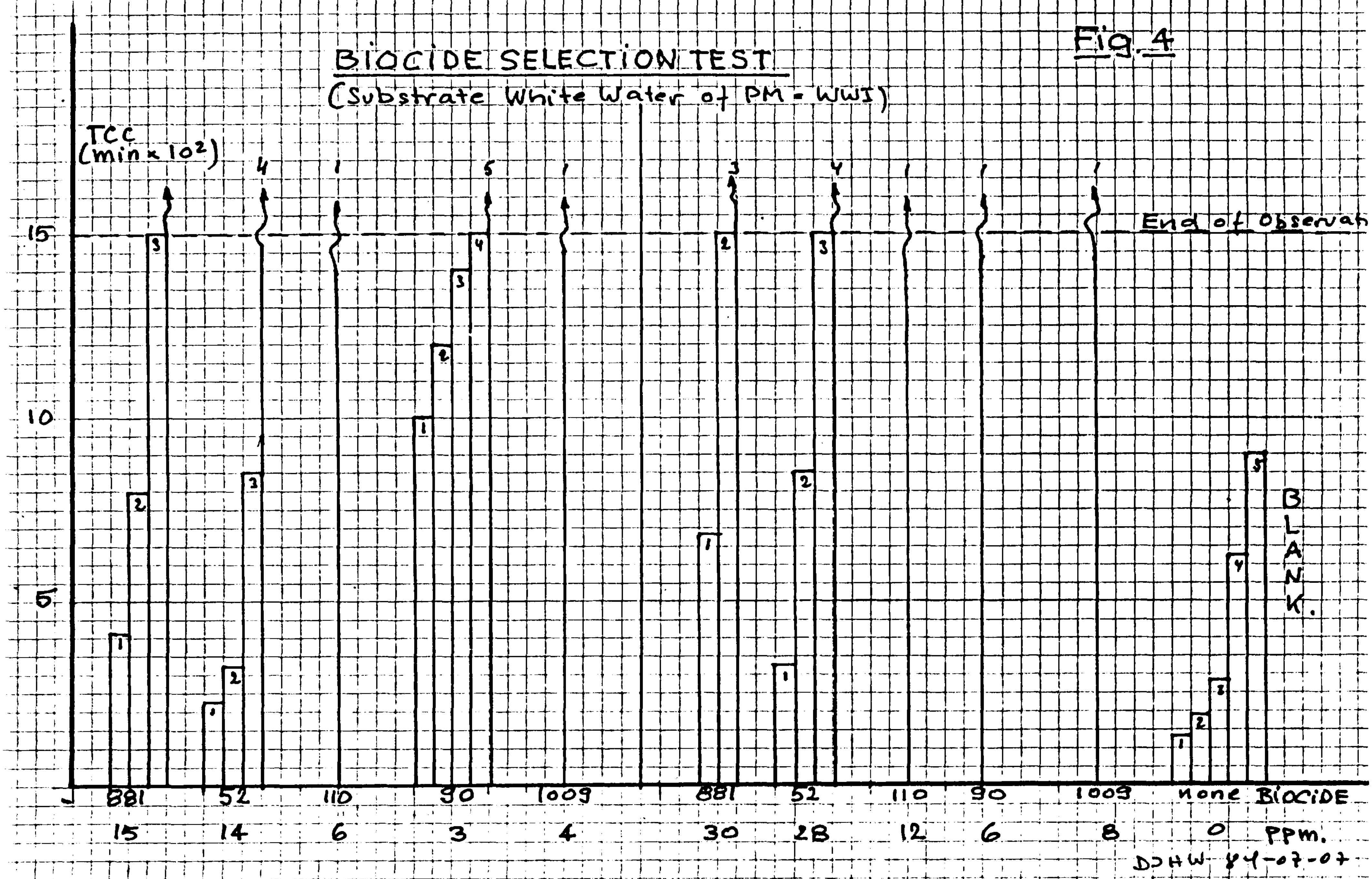

SEKA-AKZU, Newsprint PM.
Fig. 3
-A-
BIO-ACTIVITY
-B-
PERFORMANCE OF SYSTEM-TREATMENT
TCC (min.x10²)
15
10
5
end of observation
WW-1
Polydisk Cl.W.
W. Sh. W.
WW-1
B 881 30 ppm (BST)
WW-1
after Dosing stop
WW-1
30 min later
WW-1
60 min later
Polydisk Cl.W after Dos.
30' later.
1
2
3
4
5
6
7
8
9
DSHW 84-07-04

Fig. 4

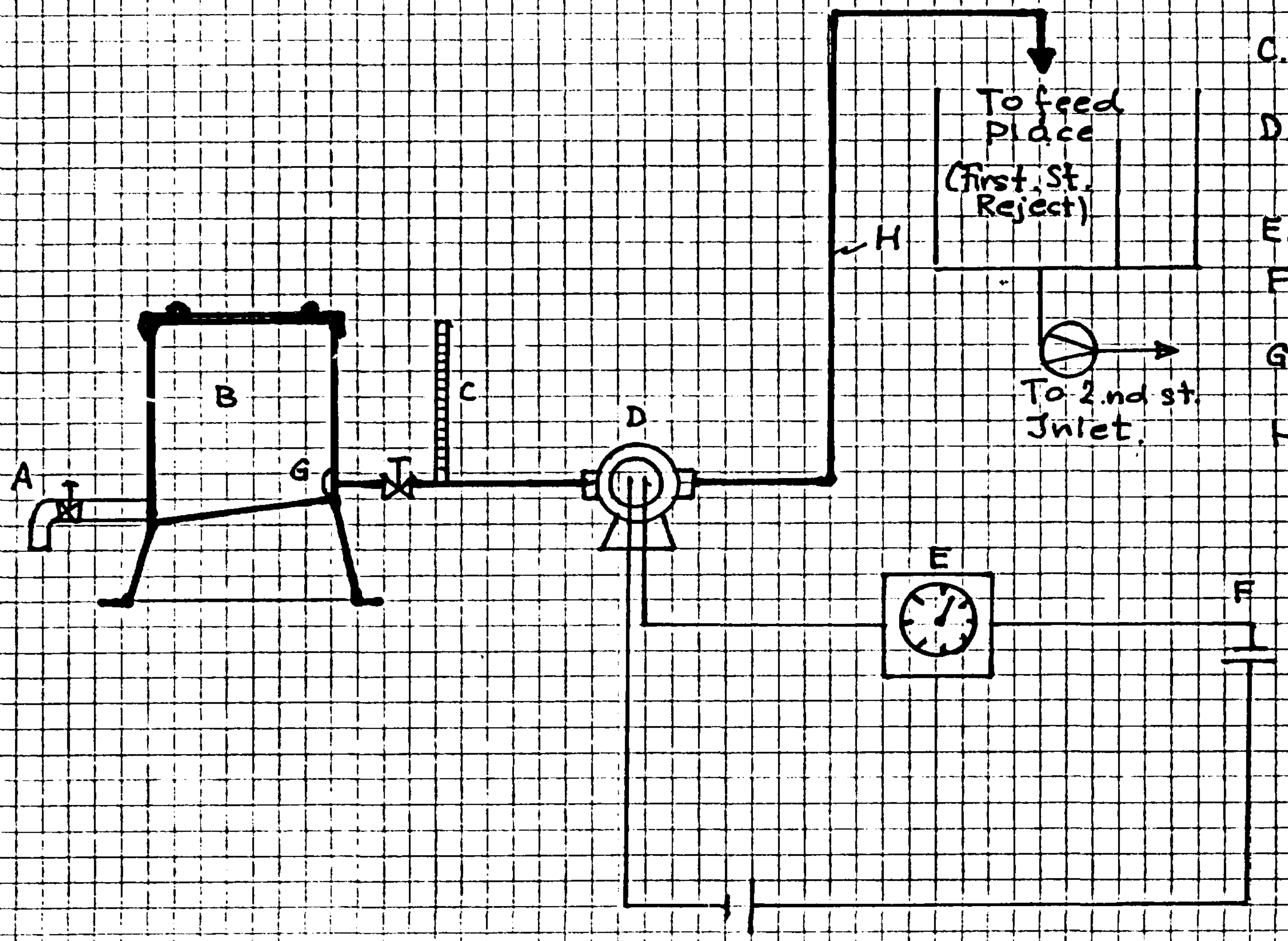
BIOCIDE SELECTION TEST

(Substrate White Water of PM - WWI)



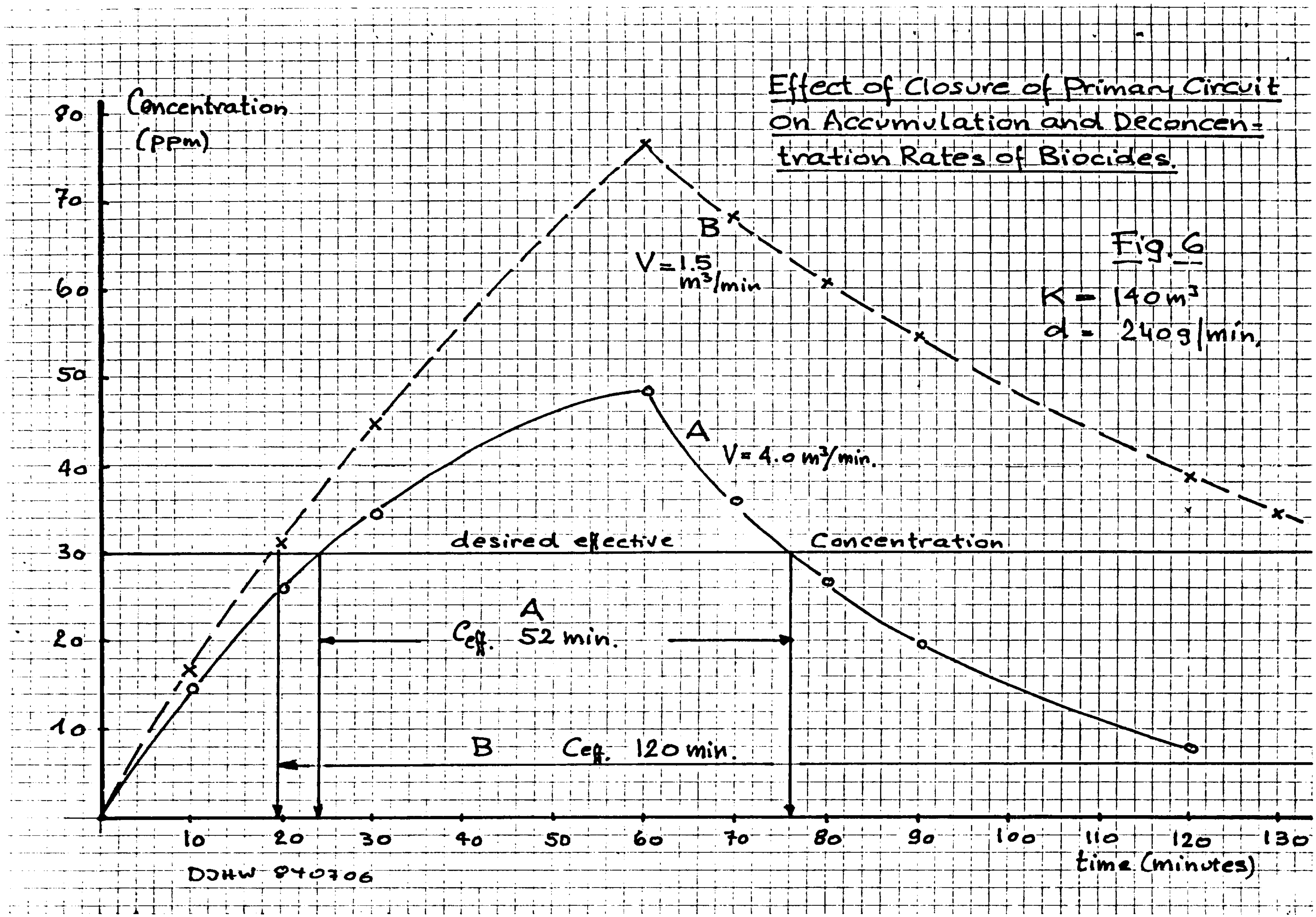
Biocide Dosing Lay-Out

Fig. 5



A. Drain
B. Supply Tank stainle[ss] (max 1000 l.) or PE.
C. Level Control + Flow Rate Check
D. Chemical Dosing Pum[p] Cap. max 30 l/hour against 5 bar
E. Timer
F. A main switch at the Paper Machine
G. 80-100 mesh stainless Screen
H. Tubing 10 mm. i.d. Stainless or PE

DJHW
04-07-05.


Effect of Closure of Primary Circuit on Accumulation and Deconcentration Rates of Biocides.
Fig. 6
K = 140 m³
d = 240 g/min.
Concentration (ppm)
80
70
60
50
40
30
20
10
10
20
30
40
50
60
70
80
90
100
110
120
130
time (minutes)
B
V = 1.5 m³/min
A
V = 4.0 m³/min.
desired effective
Concentration
A
Ceff. 52 min.
B
Ceff. 120 min.
DJHW 840706

How to Close the Primary System

Fig. 7