CHAPTER 6

CONCLUSION

It has been found that the freeness has little influence upon the ratio of the tensile strengths. The operating condition for freeness should be determined for each type of furnish and it must be proper to the operating freeness. Too high freeness will produce low tensile breaking lengths, but too low freeness will increase manufacturing cost and the consistency can not be reduced as required due to slow drainage rate at the fourdrinier wire and the wire of this paper machine is short. The relative velocity between jet and wire also has a little influence upon the ratio. But higher jet velocity than wire velocity will reduces tensile strengths of the tissue paper. It is suggested that operating condition for jet velocity should be equal or lower than the wire velocity.

Consistency of stock in the head box and quality of furnish are factors which have influence upon the ratio. The ratio decreases rapidly as the consistency in the head box decreases. To the quality of furnish the ratio decreases as higher tensile strength fibres are used, but it has a limitation on production cost.

APPENDIX A

Result 1

Head box level ,IN.	100	108	115
MD. Breaking length,M.	620	625	545
CD. Breaking length,M.	207	204	168
Ratio	3.0	3.1	3.3

Effect of head box level on breaking length and the ratio of tensile strength. Machine speed 1450 feet per minute.

Result 2

Freeness ,CSF.	423	363	273
MD. Breaking length,M.	493	580	625
CD. Breaking length,M.	136	176	203
Ratio	3.8	3.3	3.1

Effect of freeness on breaking length and the ratio of tensile strength. Machine speed 1450 feet per minute.

Result 3

Head box consistency,%	0.303	0.243	0.217
MD. Breaking length ,M.	715	660	625
CD. Breaking length ,M.	147	162	215
Ratio	4.9	4.1	2.9

Effect of head box consistency on breaking length and the ratio of tensile strength. Machine speed 1440 feet per minute.

Result 4(a)

Furnish Type	1	2
MD. Breaking length,M.	615	725
CD. Breaking length,M.	94	157
Ratio	6.6	4.7

Effect of quality of furnish on breaking length and the ratio of tensile strength. Machine speed 1420 feet per minute.

Furnish

Type 1 : 83% Export sulphite (soft wood bleached sulphite pulp)
17% Sekunda (hard wood bleached kraft pulp)

Type 2 : 80% Export sulphite (soft wood bleached sulphite pulp)
20% Coho-k (soft wood bleached kraft pulp)

Result 4(b)

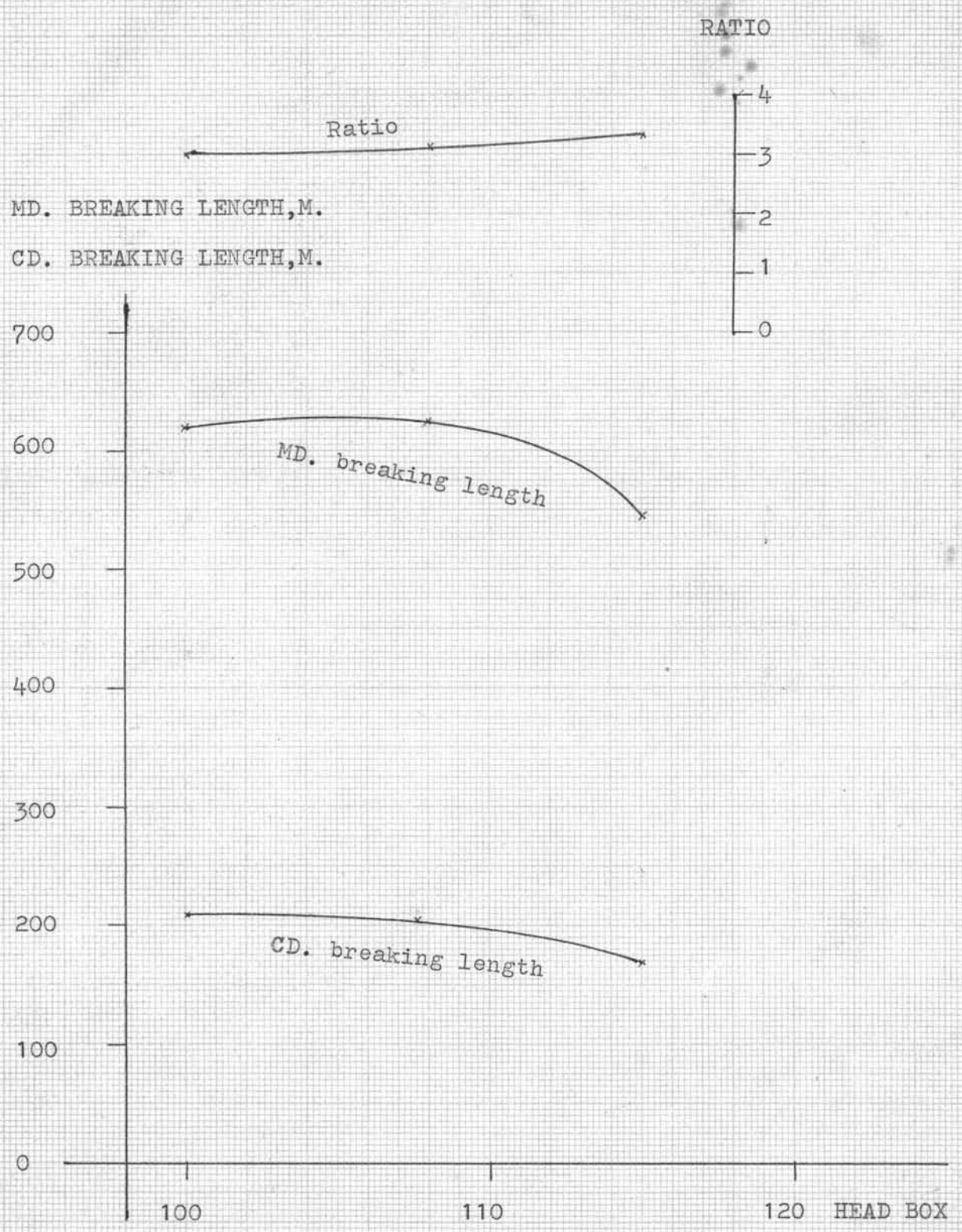
Furnish Type	1	2
MD. Breaking length,M.	625	705
CD. Breaking length,M.	140	219
Ratio	4.5	3.6

Effect of quality of furnish on breaking length and the ratio of tensile strength. Machine speed 1440 feet per minute.

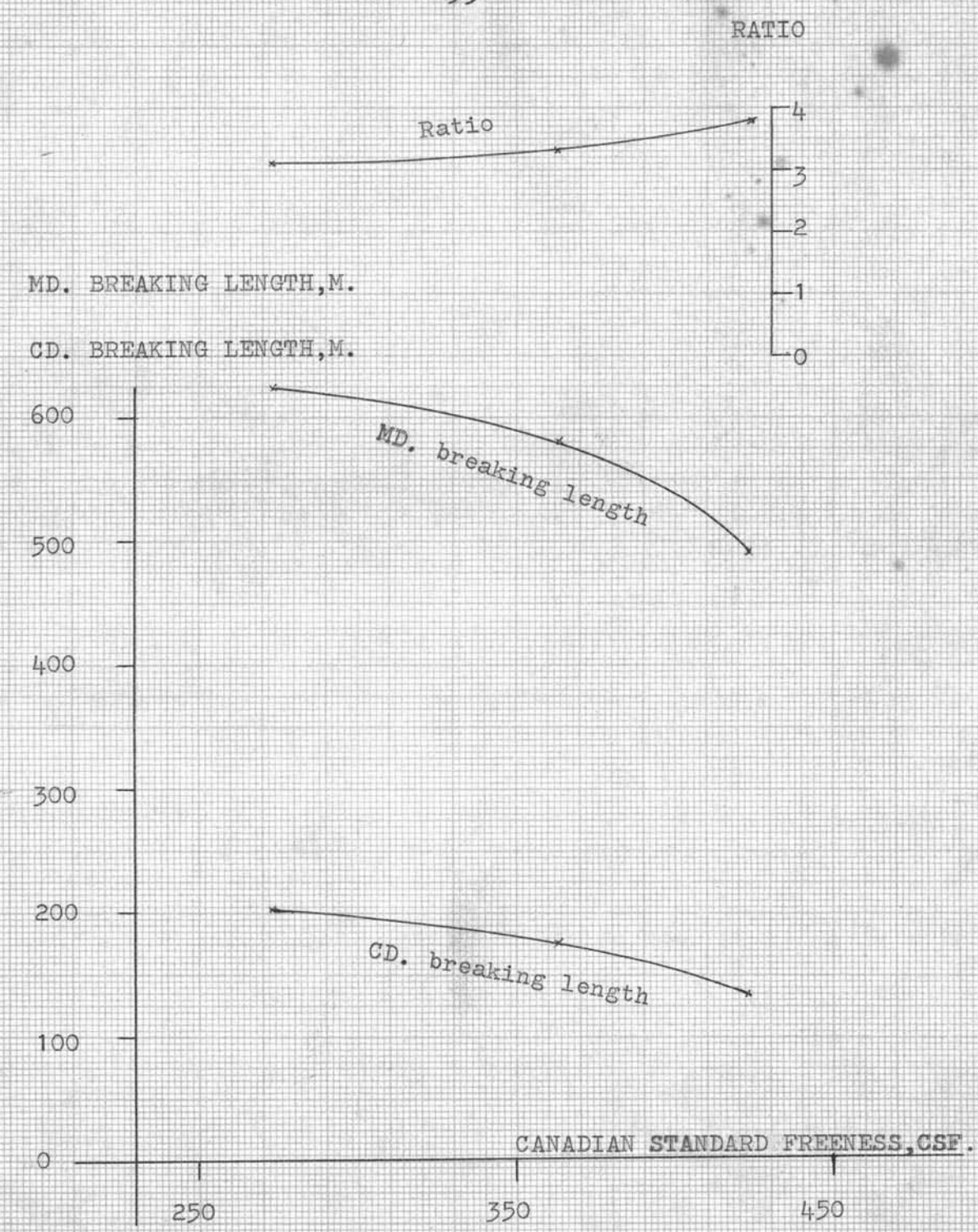
Furnish

Type 1 : 50% Coho-k (soft wood bleached kraft pulp)
50% Rottneros (ground wood)

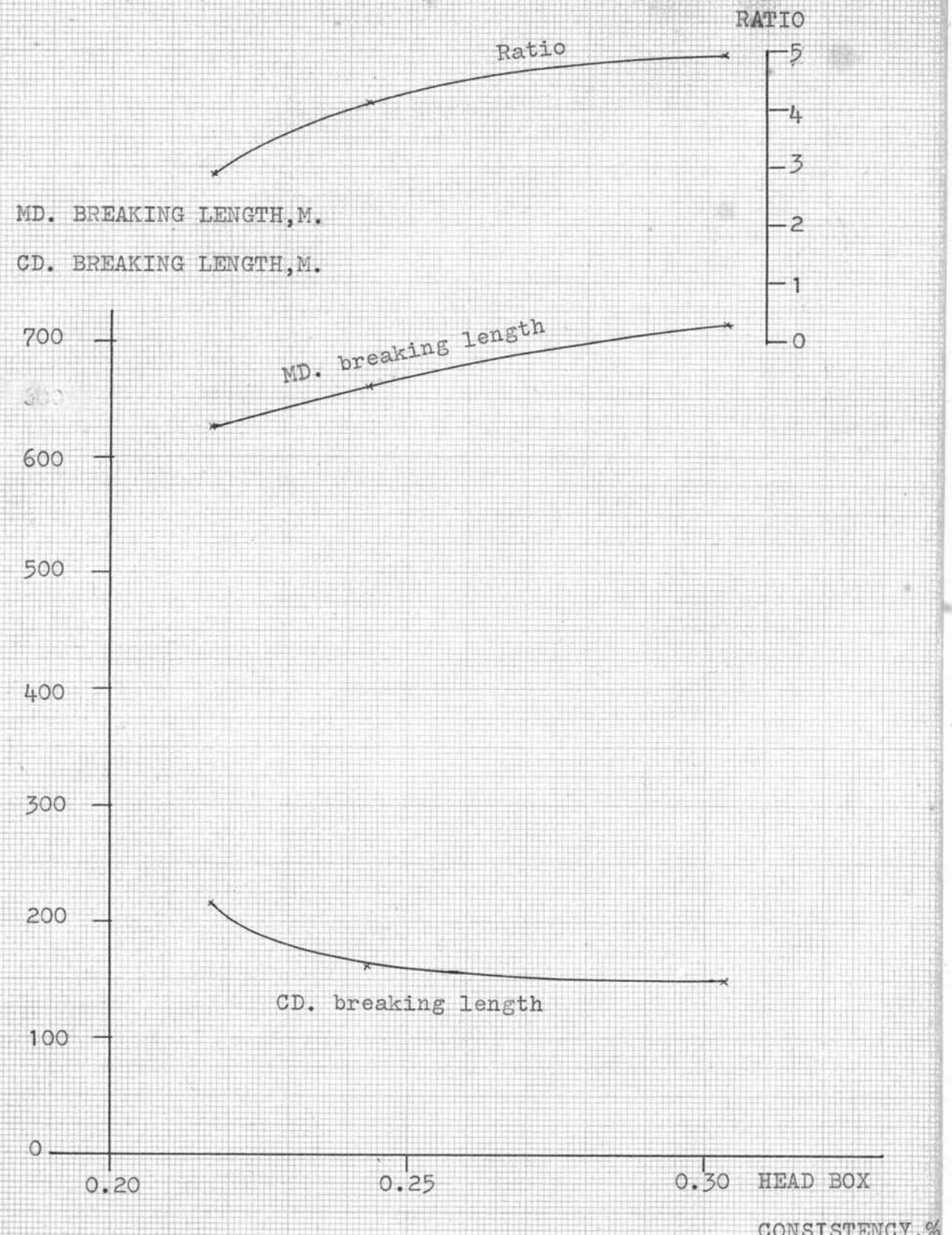
Type 2 : 36% Coho-k (soft wood bleached kraft pulp)
28% Rottneros (ground wood)
36% Tyee-k (hard wood bleached kraft pulp)



GRAPH 1 Head Box Level v.s. Ratio,
MD. and CD. Breaking Lengths.



GRAPH 2 Canadian Standard Freeness v.s. Ratio, MD. and CD. Breaking Lengths.



GRAPH 3 Head Box Consistency v.s. Ratio,

MD. and CD. Breaking Lengths.

APPENDIX B

TABLE 1 Yankee speed versus 100% theoretical head.

YANKEE SPEED FEET/MIN.	HEAD IN.	YANKEE SPEED FEET/MIN.	HEAD IN.	YANKEE SPEED FEET/MIN.	HEAD IN.
1000	52	1200	74	1400	101
1010	53	1210	76	1410	104
1020	54	1220	77	1420	106
1030	55	1230	78	1430	107
1040	56	1240	79	1440	108
1050	57	1250	81	1450	109
1060	58	1260	82	1460	110
1070	59	1270	83	1470	112
1080	60	1280	85	1480	113
1090	62	1290	86	1490	115
1100	63	1300	87	1500	116
1110	64	1310	89	1510	118
1120	65	1320	90	1520	119
1130	66	1330	91	1530	121
1140	67	1340	93	1540	122
1150	68	1350	94	1550	124
1160	69	1360	96	1560	126
1170	71	1370	97	1570	127
1180	72	1380	98	1580	129
1190	73	1390	100	1590	130

TABLE 2 Freeness correction to 0.30% consistency.

Free-ness read	Consistency of stock at test, %															
	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30
	Points freeness to be substracted															
260	100	93	86	79	72	65	58	51	44	37	30	24	18	12	6	0
270	107	99	91	83	75	67	59	52	45	38	31	25	19	12	6	0
280	108	100	92	84	76	68	60	53	46	39	32	25	19	12	6	0
290	110	102	94	86	78	70	62	54	47	40	33	26	19	13	6	0
300	112	104	96	88	80	72	64	56	48	41	34	27	20	13	7	0
310	113	105	97	89	81	73	65	57	49	41	34	27	20	13	7	0
320	120	111	102	93	84	75	66	58	50	42	35	27	20	13	7	0
330	122	113	104	95	86	77	68	59	51	43	35	27	20	13	7	0
340	123	114	105	96	87	78	69	60	52	43	35	27	20	13	7	0
350	124	115	106	97	88	79	70	61	52	43	35	27	20	13	7	0
360	130	120	110	100	90	80	70	61	52	43	35	28	21	14	7	0
370	131	121	111	101	91	81	71	61	52	44	36	28	21	14	7	0
380	131	121	111	101	91	81	71	61	52	44	36	29	21	14	7	0
390	132	122	113	102	92	82	72	62	53	45	37	29	21	14	7	0
400	132	122	113	102	92	82	72	62	53	45	37	29	21	14	7	0
420	133	122	113	102	92	82	72	62	53	45	37	29	21	14	7	0
440	133	122	113	102	92	82	72	62	53	45	37	29	21	14	7	0
460	133	122	113	102	92	82	72	62	53	45	37	29	21	14	7	0
480	133	122	113	102	92	82	72	62	53	45	37	29	21	14	7	0
500	133	122	113	102	92	82	72	62	53	45	37	29	21	14	7	0

TABLE 2 (continue)

Free-ness read	Consistency of stock at test, %												
	0.30	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.40	0.41	0.42
	Points freeness to be added												
260	0	7	13	19	24	30	35	40	45	50	55	60	65
270	0	7	13	19	25	31	36	41	46	51	56	61	66
280	0	7	13	19	25	31	36	41	47	52	57	62	67
290	0	7	13	19	25	31	36	42	47	52	57	62	67
300	0	7	13	19	25	31	36	42	48	53	58	63	68
310	0	7	13	19	25	31	37	43	48	53	58	63	68
320	0	7	13	19	25	31	37	43	48	53	58	63	68
330	0	7	13	19	25	32	38	43	48	53	58	63	68
340	0	7	14	20	26	32	38	44	49	54	59	64	69
350	0	7	14	20	26	32	38	44	49	54	59	64	69
360	0	7	14	20	26	32	38	44	49	54	59	64	69
370	0	7	14	20	26	32	38	44	49	54	59	64	69
380	0	7	14	20	26	32	38	44	49	54	59	64	69
390	0	7	14	20	26	32	38	44	49	54	59	64	69
400	0	7	14	20	26	32	38	44	49	54	59	64	69
420	0	7	14	20	26	32	38	44	49	54	59	64	69
440	0	7	14	20	26	32	38	44	49	54	59	64	69
460	0	7	14	20	26	32	38	44	49	53	58	63	68
480	0	7	14	20	26	32	38	42	47	52	57	62	67
500	0	7	14	20	26	32	36	41	46	51	56	61	66

TABLE 3 Freeness correction to 20°C.

Free-ness read	Temperature of stock at test, °C															
	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	Points freeness to be substracted															
260	20	24	28	32	36	40	45	49	54	58	62	66	69	73	78	82
270	20	24	29	33	37	41	46	50	54	59	63	67	72	76	80	84
280	21	25	29	34	38	42	48	52	56	61	65	69	74	78	82	87
290	21	25	29	34	38	42	48	52	56	61	65	69	74	78	82	87
300	21	25	30	34	39	43	48	53	57	62	66	71	76	80	84	89
310	21	25	30	34	39	43	48	53	57	62	66	71	76	80	84	89
320	21	25	30	34	39	43	48	53	57	62	66	71	76	80	84	89
330	22	26	31	35	40	44	49	54	59	64	68	73	78	82	86	91
340	22	26	31	35	40	44	49	54	59	64	68	73	78	82	86	91
350	22	26	31	35	40	44	49	54	59	64	68	73	78	82	86	91
360	22	26	31	35	40	44	49	54	59	64	68	73	78	82	86	91
370	22	26	31	36	41	45	50	55	60	65	70	75	80	84	88	93
380	22	27	31	36	41	45	50	55	60	65	70	75	80	84	88	93
390	22	27	31	36	41	45	50	55	60	65	70	75	80	84	88	93
400	23	28	32	37	41	46	51	55	61	66	71	77	81	86	91	96
420	23	27	31	36	41	45	50	55	60	65	70	75	79	84	89	93
440	22	27	31	36	41	45	50	55	60	65	70	75	79	84	89	93
460	22	27	31	35	40	44	49	54	59	64	69	73	78	82	87	91
480	21	25	30	34	39	43	48	53	57	62	68	71	76	80	84	89
500	21	25	29	34	38	42	46	51	55	61	66	69	74	78	82	87

DEFINITION

Furnish : The fiberous and non fiberous constituents comprising paper.

Stock : A term loosely applied to papermaking fibrous material in all stages before formation on the machine wire.

Broke : Paper thrown out in sorting, reeling, and other finishing processes which is usually returned to the stock preparation plant for processing.

Stuff : Stuff is pulp which is ready for forming into paper by two chief processes, commonly referred to as beating and refining.

White water : All water of a paper mill which have been separated from stock or pulp suspension either on the machine or accessory equipment, such as washers, save-alls, and also from pulp grinders.

Pulper : Pulper is used as a stock preparation batch. The majority of applications cover

1) The blending of slush pulps with chemical additives and fillers.
2) Disintegration of wet-lap or dry balded pulp, blending, and mixing with non fibrous additives; and
3) Disintegration of wet and dry paper machine broke.

High density cleaner : It is used to remove the impurities from stock.

Deflaker : Deflaker is used for separating fibre bundles.

Save all : Save-all is used to save both fibre and filler and return them to the machine chest in suitable condition for inclusion in the sheet being made. A proper designed save-all system should recover at least 95% of all suspended solids for most grades of paper.

Refiner : The purposes of refining are beating and cutting fibres.

Consistency controller : In any form of paper making, the control of the consistency of stuff going to machines is of the utmost importance. Without uniform consistency, papermaking is impossible. Basically, three important factors enter into the present methods of consistency controll:

1) Preparation and sampling of the stock going to the controllers.
2) Measurement of the apparent viscosity.
3) Transfer of the measurement to a dilution valve.

Selectifier screen : Selectifier screens immediately ahead of the machine headbox serve several purposes. They are a final means of removing as much as possible of the dirt, lumps, slivers, pipe scale, and other foreign matter that might otherwise get into the sheet or damage the wire. Passage of the fibres through the fine screen also serves to straighten them, comb them out, and

separate the individual fibres. Another function of the screen is to take out strings, lumps and slime, passing only stock that is uniform in character. Delivery of a homogeneous mixture of stock and water assists in maintaining a constant output of the paper machine.

Headbox : The headbox proper lies between the distributor and slice and performs several functions. The primary function is to provide a volume where excessive turbulences and cross flows created in the distributor are equalized, inequalities in velocity of flow are corrected, and the stock is delivered to the slice. It also must provide sufficient pond depth to allow operating at the proper head to give the required stock velocity through the slice opening. If the head box is an air-cushioned one, construction must allow for regulation of pond level and air pressure.

Slice : That part of fourdrinier machine which regulates the flow of stock from the headbox onto the fourdrinier wire in a sheet of liquid of even thickness or volume. The slice extends across the wire and forms that part of the headbox adjacent to the wire. It is usually adjustable in width within limits to the width of the sheet being made.

Breast roll : The first large roll over which the fourdrinier wire

passes before the stock is run into the paper machine.

Deflector : Deflector is essentially prevents any water from being thrown from one roll to the next, and will also scrape off any water adhering to the bottom of the wire.

Foil : Foil is used to remove water from the wire.

Suction box : A device used to remove water from the paper stock on the fourdrinier wire of the paper machine, or on the wet felt of the cylinder machine prior to pressing. It consists of a box having a perforated top over which the wire or felt passes. Water is removed from the stock or web by suction caused by suitable evacuation of the box.

Yankee dryer: The term "Yankee" dryer is used for the type of paper machine used for making light papers, such as tissue, creped wadding, cigarette paper,etc. It has one large dryer roll, covered by a hood. In drying a sheet of paper two basic physical processes are involved, heat transfer and mass transfer. Heat is transferred from some source such as steam to the wet sheet in order to provide the energy required to drive the moisture from the sheet. The moisture evaporates and is then transferred from the sheet to the surrounding atmosphere by the mass transfer process.

Tissue : Generally term for paper, substance less than 25 G./M^2 made from chemical or semichemical or both, depending on

the use.

Tissue paper : Generally term for lightly creped, unsized papers including handkerchiefs, facial tissues, table napkins and toilet paper, made mostly from bleached sulphite pulp derived from soft wood and hard wood which are only lightly beaten.

Theoretical head : Theoretical head may be defined as the headbox level or pressure required to give the stock and water coming out of the slice a velocity equal to that of the wire.

Consistency : Consistency is a means of expressing the weight of pulp in 100 parts of pulp and water. For example, a stock consistency of 3.0% would contain 3 parts of pulp and 97 parts of water.

Freeness : Freeness is the drainage characteristics of stocks. The more a given type of fibres has been beaten or refined, the less freely will water drain through a mat of those fibres. Stock which permits water to drain through it freely is called free stock. If it offers more resistance to flow and the drainage therefore is less, it is called slow stock. Various freeness tests are in use to measure this characteristic of the stock and to predict how it will drain on the cylinder molds. It will be clear from the above that the amout of drain-

age water through the cylinder mold will be greater for free stock than for slow stock and the consistency will therefore be lower.

Breaking length : The breaking length of paper is the length of a uniform strip just sufficient to cause the strip to break under its own weight when suspended by one end.ie. It is the length of a strip of any width whose weight equals the breaking load for that width. The significance of breaking length lies in the fact that it is roughly proportional to the conventional tensile strength referred to a unit cross section.

Basis weight : Basis weight is defined as weight of paper per unit area.

Tear strength: Tear strength is defined as the force which is required to maintain an initiated tear in the paper.

Folding endu endurance : The paper is folded backwards and forwards, while under aconstant tensile load. The folding endurance is the number of foldings, backwards and forwards, which the paper can withstand before breaking.

Bursting strength : The paper is held fast by a ring against a table fitted with a central, collapsed, diaphragm. The diaphragm is forced upward by an increasing oil pressure and finally bursts the paper. The oil pressure at that

exact moment, the bursting pressure, is read off on a pressure gauge and is stated in kp./cm.^{2}. By dividing by the basis weight, expressed as kg./m.^{2}, the burst factor is obtained. The burst factor is important for packaging papers.

Opacity : Opacity is defined as the ratio of the brightness of the illuminated paper when backed by a standard black background to its brightness when backed by a standard white surface and identically illuminated. Opacity in paper is chiefly important in preventing ink on the opposite side.

SAMPLE OF CALCULATION

Consistency determination

The sample has been diluted and 1000 c.c. of diluted stock was measured out. Test has been done in a Buchner funnel on weighed filter under vacuum.

Weight of oven dry pulp pad and filter paper = 4.40 G.

Weight of filter paper = 1.50 G.

∴ Consistency of stock = 4.40 - 1.50

= 2.90 %

Freeness determination

The diluted stock has been also taken out for 1000 c.c. and temperature was measured, the measured temperature was 38°C.

From consistency determination we knew that there were 2.9 G. of fibres in 1000 c.c. of diluted stock.

∴ Consistency of the diluted stock = $\frac{2.9}{1000} * 100$

= 0.29 %

The 1000 c.c. of diluted stock was measured for freeness in Canadian Standard Freeness tester, the measured freeness was 620 CSF.. This freeness must be corrected for temperature and consistency.

The measured freeness was 620 CSF., and diluted stock's consistency was 0.29%. From table 2 (appendix B), points freeness to be substracted was 6.

Then the freeness must be corrected to 20°C. The measured freeness was 620 CSF., and the temperature was 38°C. From table 3 (appen-

dix B), points freeness to be substracted was 75.

∴ The corrected freeness was = 620 - 6 - 75

= 539 CSF.

Breaking length determination

Two strips of tissue paper has been tested for tensile strength and the tensile strength was 309 G./15MM., the basis weigth was 16.5 G./M.^{2}.

∴ The tensile strength of one strip = $\frac{309}{2}$ G./15MM.

= $\frac{309}{2} * \frac{1000}{15}$ G./M.

∴ = 10300 G./M.

∴ The tensile breaking length = $\frac{10300}{16.5}$ M.

= 625 M.