Study on quality control of Pulp and its Paper Making Potentials

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A study on the laboratory refined and tested pulp regarding its paper making potential is undertaken with a view to explore its practical utility and limitations It is observed that judged purely on its routine application for predicting the strength of paper produced in the mill from the routine laboratory testing procedures for pulp, it has rather limited merit. In case, however, pulp refined in the factory refineries is analysed, one can predict reasonably confidently, the properties of paper expected on a mill production scale. This predictability ratio keeps on improving from factory refined to headbox pulp. The most appropriate place for pulp analysis appears to be machine chest. It is also observed that the properties of paper produced go on deteriorating gradually as are proceeds from refiners to headbox.

Bleached and Uubleached pulps from various sources and produced by different procedures is subject to a series of tests under standard conditions to maintain a check on quality and also to determine the predictability of its paper making potentials. Since practically all pulp is later converted to different qualities of paper or fibres, one endeavours to develop testing procedures suitable for working out usable correlations between different characteristics of pulp and paper produced therefrom. Although this is considered to be the basic philosophy of pulp and paper testing, experience shows that in many miils one seldom attempts to investigate quantitative or even qualitative relationship between the strength characteristics of pulp and those of paper produced from it, **in actual mass scale fabrication.** If at any time, some relationship between the two relevant aspects — especially in actual factory production — are attempted, one may be astonished that very often expected trends do not show to the desired degree.

Some sample relationships between pulp tested as per lab standards and paper produced from it on factory scale for several months from reputed paper manufacturing mill is illustrated in Figs. 1-3. The relationships exhibit a wide departure from the expected trend viz. a "good" pulp always yields a "good" paper and vice versa. It indicates that inspite of pulp quality being important, other factors are equally significant and cannot be ignored. There may be several plausible explanations for the lack of correlation between the characteristics of pulp as tested by lab. methods and those of paper. The subsequent steps of manufacture such as refining, chemical additions etc. may be more decisive, the testing procedures adopted may not be capable of yielding full information, the employed tests may not be very "reciprocative" of the actual state of affairs in full production, such as refining in the factory may not impart the same characteristics to the pulp as those by the laboratory refiner and a quantitative correlation may or may not exist between the two machines.

It is also a common experience that the same raw material when refined to the same degree, but by different machines communicate different strength properties to it. Following figures collected from a Paper Mill reinforce the above.

	Velley Beaten Pulp				Factory Refined Pulp			
	SR	Substance g/m²	Burst factor	Breaking length	SR	Substance g/m²	Burst factor	Breaking length
1.	27	58	27.9	3781 m	27	60	25.7	3311 m
2.	32	60	25.7	3422 m	32	58	20.6	2701 m

Apart from pulp refining conditions, the type of tests adopted both for pulp and paper also yield different information. Recent computorised relationships have shown that the correlation coefficients and the reliability of prediction between ground wood pulp and paper produced from it, is strongly dependent on a particular test; thus one of the most dependable criterion of pulp for paper evaluation is wet web strength — a test seldom employed by India mills for routine evaluation of pulp — next in order comes drainage time, fibre length and fibre length distribution. Unexpectedly tear factor did not exhibit dependence to any property (1).

Further subsequent steps of manufacture such as addition of chemicals, dilution of pulp etc. may bring about such profound changes in the fundamentals of the pulp that its inherent characteristics could become less important for getting a suitable predictability ratio between pulp and paper. In board manufacture from semi-chemical pulp, investigations reveal a gradual deterioration of board making potentials from factory beaten to wet lap pulp (2). In such cases for predictability studies, one may have to test the "treated pulp". In fact TAPPI also suggests testing the beaten pulp with the addition of appropriate chemicals if necessary. However, unless the influence of refining, additives etc. is precisely investigated, such procedure may also not yield value of desired practical and quantitative importance. Pulp testing procedures and their infuence and especially their interpretation on paper manufacture, are responsible for many day to day inter

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and intra mill disputes. The investigations reported in this paper were consequently undertaken to study various factors of pulps and additives on their paper making qualities to enable one to make a certain calculations of paper quality from that of pulp.

The normal method adopted for testing pulp in most of the Indian pulp and Paper Mills is as follows :

Small quantity of pulp from storage chest or hydrapulper is withdrawn and beaten in a velley beater to an appropriate degree or degrees of freeness by a standardized procedure (Tappi 200 ts-66). From the beaten pulp, hand sheets are prepared by a recommended method (Tappi 205m — 58). The same are dried, conditioned and subjected to certain quality determining specified tests (Tappi 220m-60).

Judged on their own, these testing procedures have their merit especially when different qualities and consignments of pulp are to be tested or compared before acceptance by the mill. They are also adoptable strictly to judge the pulp quality in a routine way. In case, however, these results are directly to be used for predicting the character of paper produced from it, the procedure appears to be of limited promise. The same becomes evident on examining Figures 1 to 3. Thus whereas the

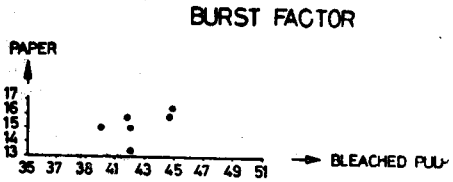


Fig. 1

pulp may exhibit a five fold increase in certain characteristics, the paper produced from it in the factory may hardly show any change of practical importance.

If, however, while adopting the same procedure of testing, certain "standard chemicals" such as alum and rosin are incorporated in a fixed manner. the predictability between pulp characteristics and paper produced in the factory shows a noticeable improvement over that of plain pulp — as reflected by the correlation coefficient (0.88) in Figs.

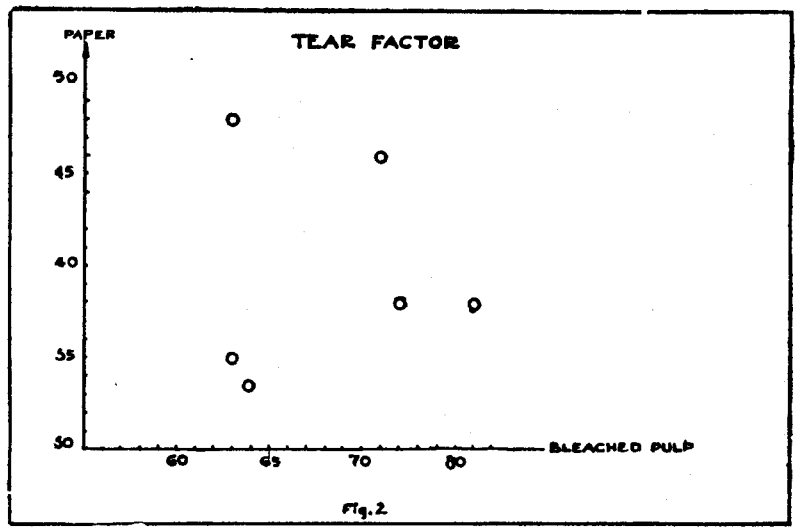


Fig. 2

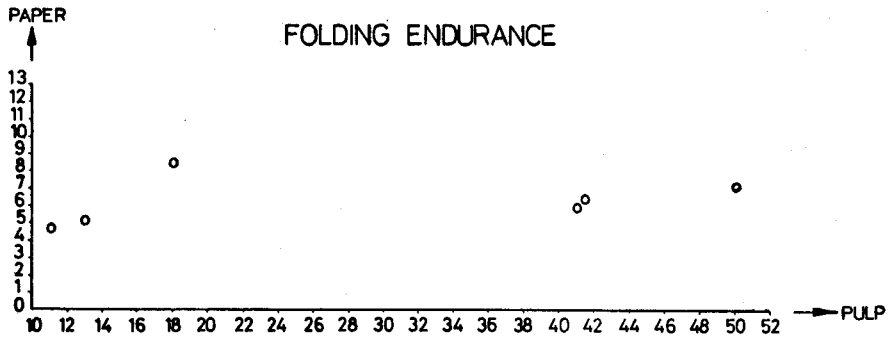
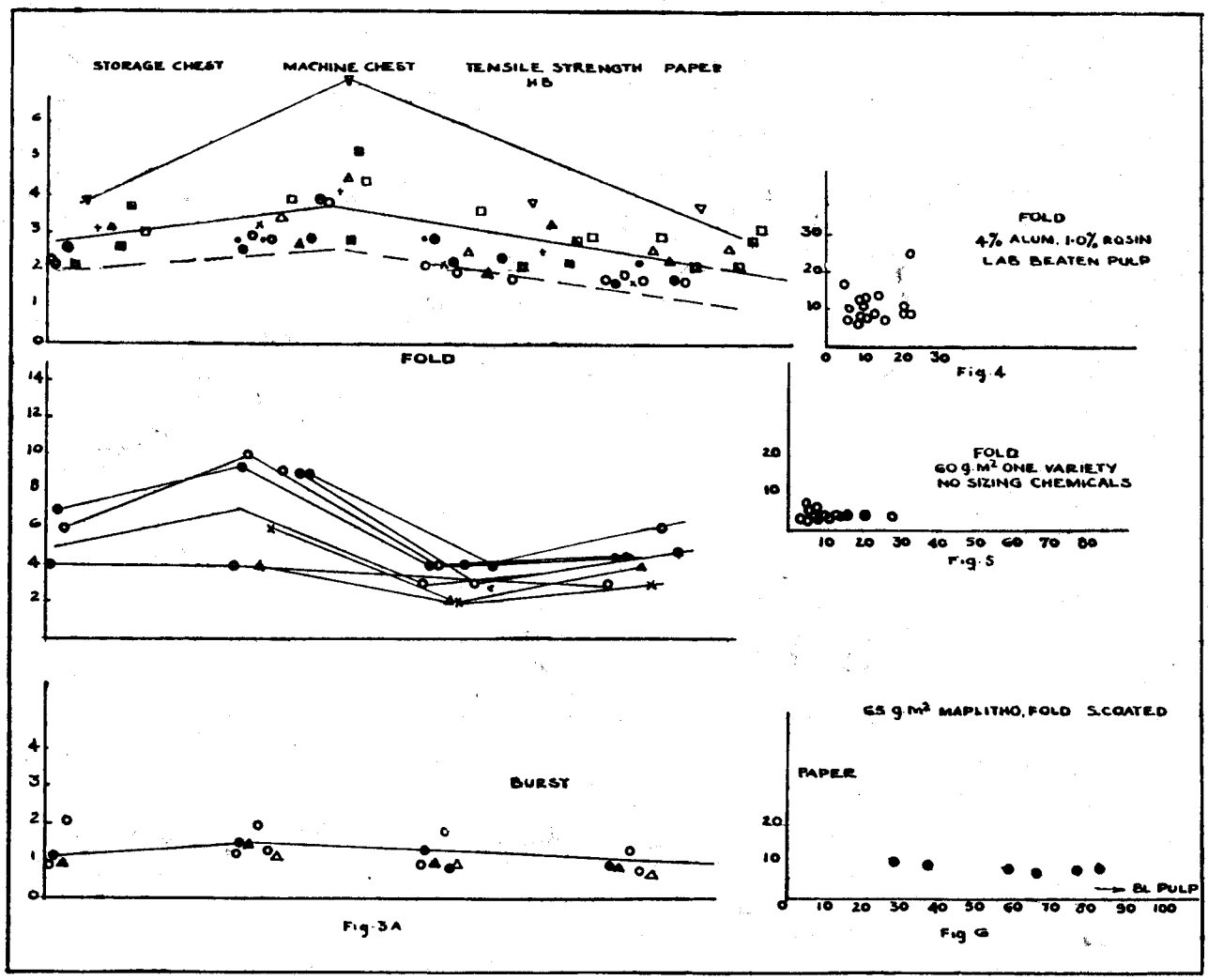


Fig. 3

4 and 5. This considerable improvement in predictability naturally suggests looking for other possible factors capable of further refining the predictability ratio between pulp and paper.

Another reason for the poor fore-telling of lab-refined and tested pulp versus paper produced was suspected to be due to different characteristics bestowed to the same pulp by Velley beater and factory refiner. This was confirmed by taking a large number of samples of unrefined pulp from storage chest and testing the same by making the hand sheets in a prescribed way. In order to make the results realistic, the hand sheets prepared was of the same gram weight, as that running in the machine at the time of sampling the pulp. Although unbeaten pulp produces slightly "irregular" sheets, due to unavoidable lumps in it — even still taking this limitation into account — a significant improvement between the pulp and paper characteristics is obvious, as reflected by a typical correlation between the two in Figure 6. An added confirmation to the same is provided by trying a relationship between **factory refined** pulp at 40° SR and paper produced in the factory. The relevant plot given in Figure 6 showed a high correlation coefficient (0.90) between the two characteristics. This sample analysis indicates that the physico-chemical characteristics of pulp, even when beaten to the same degree, are different from the two machines and qualitative or quantitative explanation might be possible by subjecting the two pulps to exhaustive physico-chemical techniques. Taking all the above uncertainties into account, it is still logical to assume that the basic characteristics of pulp ought to be a decisive criteria for the manufacture of paper and as such the incorporation of chemicals, loading materials, furnish, sizing agents etc. should exert

a proportionate influence on its characteristics especially with regard to paper making potentials. This is clearly indicated in the plot of hand sheets from machine chest pulp and factory refined pulp and also from head box pulp and their respective paper making qualities (Fig. 6-11).



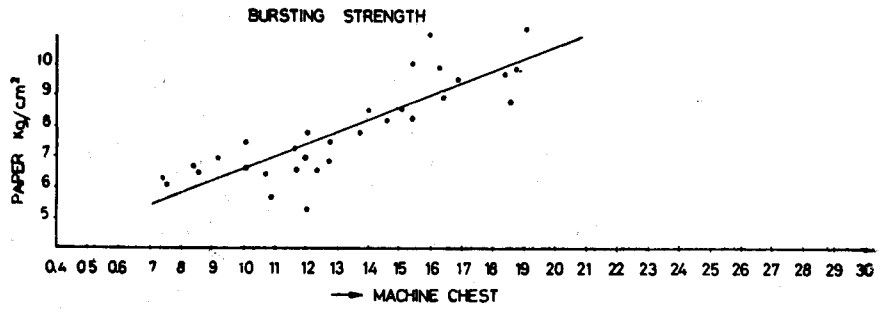


Fig. 7

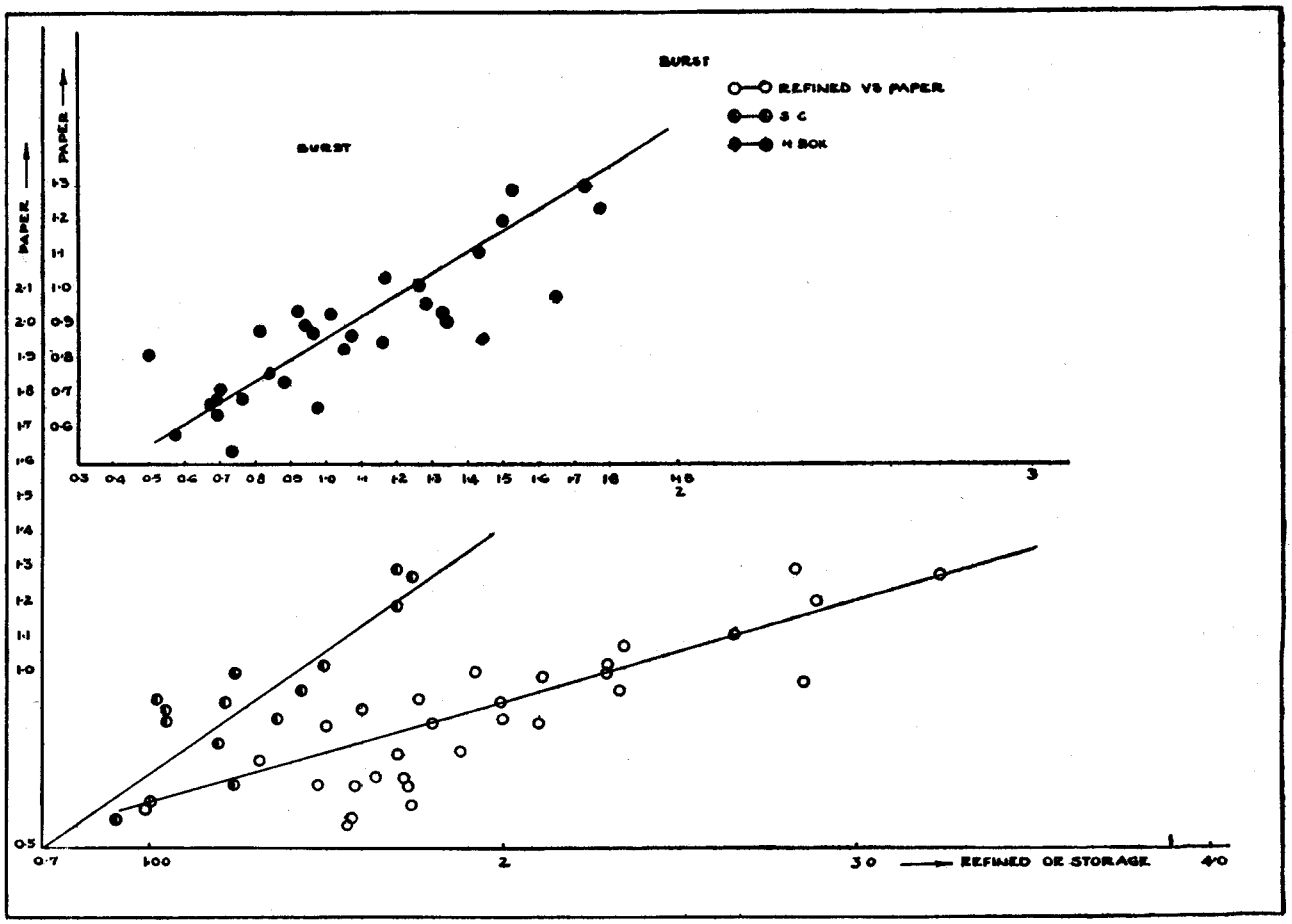

BURST
REFINED VS PAPER
S C
M SOK
BURST
PAPER
REFINED OR STORAGE

Fig. 6 A

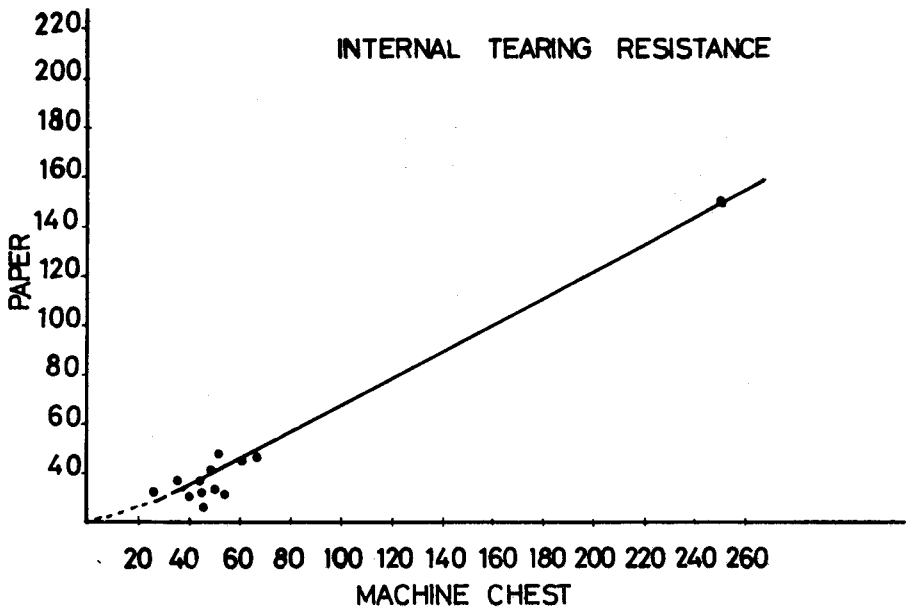

INTERNAL TEARING RESISTANCE
PAPER
220
200
180
160
140
120
100
80
60
40
20 40 60 80 100 120 140 160 180 200 220 240 260
MACHINE CHEST

Fig. 8

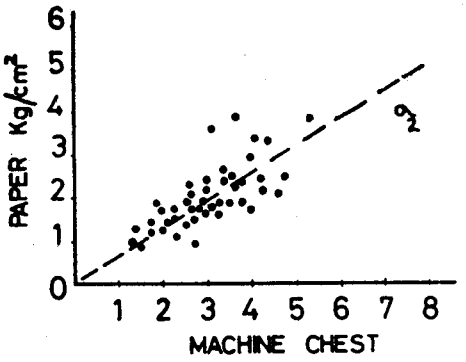


Fig. 9

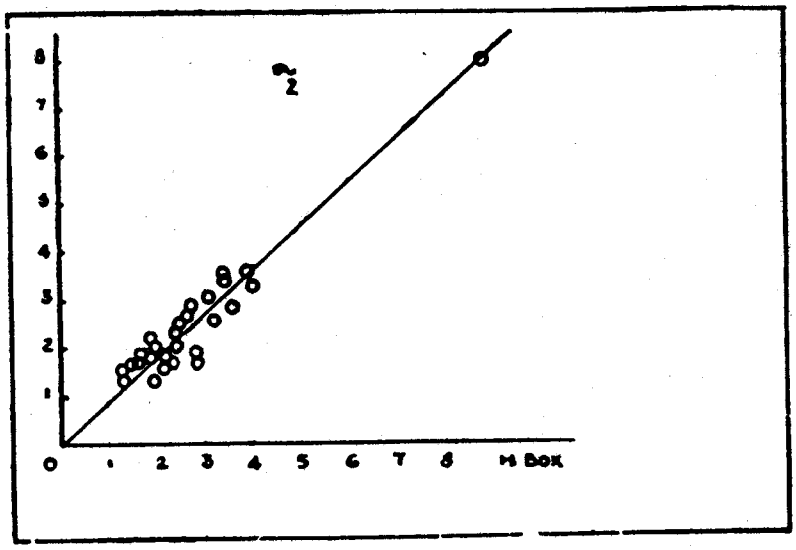


Fig. 10

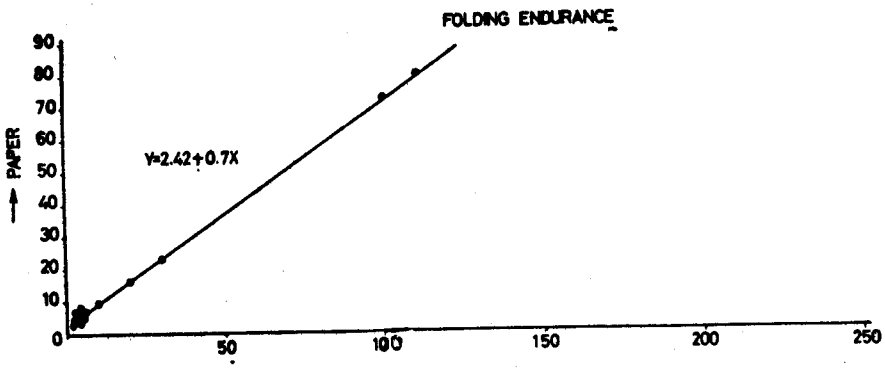


Fig. 11

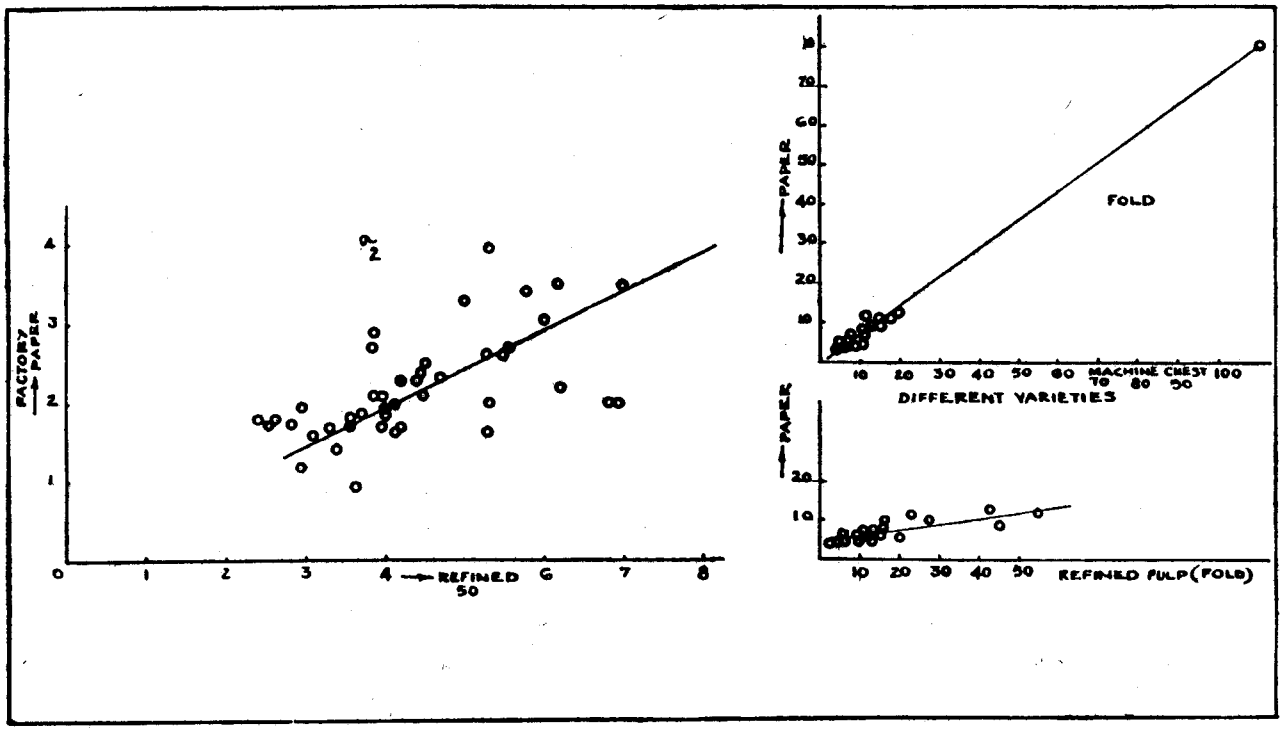


Fig. 12 and 14

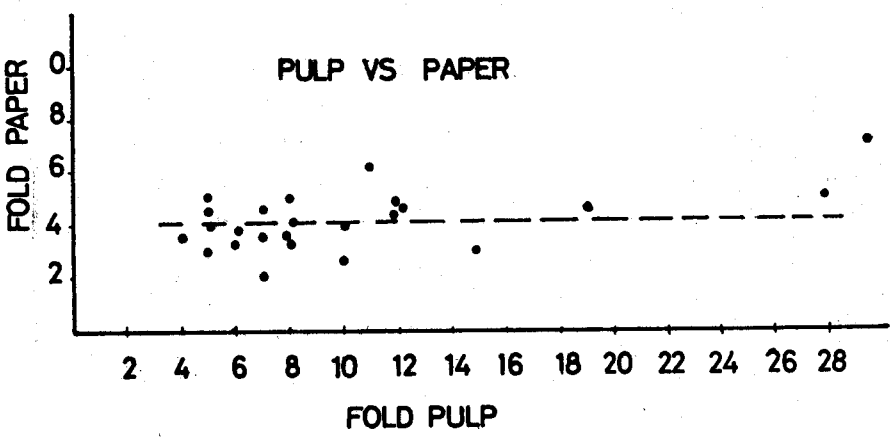


Fig. 13

There is a noticeable improvement of predictability potential as the plup withdrawl for testing is done in the flow line towards Fourdinier Machine. This is evident from the following table, where correlation coefficients for folding endurance — one of the most "evasive" property of paper — are given :—

Correlation for fold

1. Lab beaten pulp with alum and rosin	0.88
2. Factory refined pulp and paper	0.896
3. Machine chest pulp and paper	0.950
4. Head box pulp and paper	0.970

A significant comparison is offered in Fig. 13 by the relationship of laboratory refined and paper produced. A striking improvement in the relationship is observed from beaten pulp to head box pulp suggesting the most suitable place, at least from practical point of view, for routine testing of pulp in a factory appear to be immediately after refiners or at machine chest, where values of practical application can be obtained and also timely corrective actions adopted. At the head box, althou gh the predictability is highest, timely action for improvements may be possible to a limited extent only.

Another corollary of the above statistical analysis was the determination of relationship of storage, refined, machine chest and head box pulp. The same was accomplished by testing the pulp from various places in the flow line to Fourdinier Machine and paper manufactured from it. The appropriate results are gathered in Figure 12 for various strength characteristics.

The representation shows that there is a gradual and predictable down grading of pulp from refined pulp to head box. (In most of the cases except folding endurance a significant improvement in most of the properties was observable from storage chest to refining — before the addition of any chemical. The same was evidently due to the well-known refining and defibrilling action on pulp). Folding endurance between unrefined and refined pulps did not show any significant change. which was confirmed by determining the ratio of the error in mean value of the two pulp and the standard error of the mean, as per the following computation.

X_1 = 6.7 (Storage chest), n_1 = 18, where n_1 = No. of observation for storage chest

X_2 = 7.7 (refined pulp), n_2 = 18
n_2 = No. of observations for refined pulp

X_1 = Mean value for storage chest

X_2 = Mean value for refined pulp

$$t = \frac{(X_1 - X_2)}{\sqrt{\frac{\sigma}{n}}} = 0.8 \text{ (non significant)}$$

σ = Standard deviation

This result is of both academic and practical importance as it shows, firstly the factory and the laboratory beaten produce pulp varying in fundamental paper making characteristics — as experience confirms folding endurance increases by beating in the lab-beater — and secondly, at least for the pulp and the machines under question, beating may not help in producing paper of high fold value. Actual practical acquaintance in some of the mills indicate that where high folding endurance is the desired characteristics in paper, a certain proportion of unbeaten pulp in the normal pulp furnish enhances this characteristics considerably. In proceeding from head box to paper making, a slight increase in folding endurance was noticeable.

The general decrease of paper making capabilities of pulp from refining to head box could be brought about by various chemicals and loading agents. It could possibly be agreed that loading agents were chiefly responsible for this deterioration in the quality of the pulp. However, this deterioration has been observed from refining to head box even in the case of pulp without any loading whatsoever (3) also; suggesting other factors, besides loading could also deteriorate the pulp.

As an adjunct to the above investigations, the influence of some of the important chemicals on the pulp quality was determined, which will be the subject matter of a separate publication.

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(1) Ullman, Uddo, Tappi May 1969, p. 834

(2) Kumar, V. B. Norsk Skogindustri 5, 1961 p. 243.

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