Some Aspects of Improvements in Fourdrinier Paper Machine Wet Section Design

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I. Developments for utilisation of short-fibred raw material in Paper Making :

Utilisation of short-fibred pulp in paper making, particularly as in the present context of raw material shortage in India, has always been a problem of the day. As machinery designers, AB Karlstads Mekaniska Werkstad (popularly known as KMW), the century old pulp and paper machinery manufacturers in Sweden, have brought about some latest developments in paper machine wet section designs, which are worthy of mentioning here and therefore form the subject matter of the present article.

II. KMW Paper Laboratory :

The developments are originated in the Paper Laboratory of KMW in Karlstad, which is a highly advanced test-house with all modern facilities like pertaining test rooms, photographic laboratory, instrument laboratory and a laboratory for radio-active isotope work. The laboratory hall comprises principally a Paper Machine in small scale, consisting of a Pulping System and the Wet part of a paper machine. The dimensions of this paper machine is similar to a substantially big paper machine except that the width is decreased. Hence the results obtained on this machine are directly reproducible to production machines. Measuring and registering instruments are provided in great extent on to this machine for the purpose of measuring all the characteristics of the pulp and the machine reactions, as for example, the De-watering or Drainage can be measured on the wire, wherever necessary. (Fig. 1)

The major work undertaken in KMW laboratory is the improvement of existing paper machines and development of new methods and designs in paper machines for producing superior grades of paper. The activities have been concentrated from the very inception of the laboratory, on the difficult problems of sheet formation, functions of inlet box and forming part. It is today universally admitted that above all those are the parts that determine the machine speed and the quality of the paper. Advanced inlet box studies also form a basic part in the functions of the laboratory and intensive research work in close conjuction with the KMW workshops, situated at a proximity to the laboratory, has produced specific results in the forms of KMW Inlet Boxes, Drainage Tester, Uniformer, Unipress and Fabricpress.

III. KMW Drainage Tester :

With KMW Drainage Tester type PL, it is possible to study the drainage characteristics of pulps under similar drainage conditions as obtained on paper and cellulose machines, filters, thickeners, etc. The drainage process is a process based on constant pressure and therefore directly simulates the water removal at Wet Suction Boxes, Filters and Breast Roll Formers. Complementary equipment used in conjunction with the drainage tester also measures air permeability of the sheet in direct sequence with formation.

The drainage properties measured with this drainage tester makes it possible :

1. To determine the influence of direct operating conditions (pulp, consistency, speed, pressure, basis weight, etc.) for a machine with given equipment.

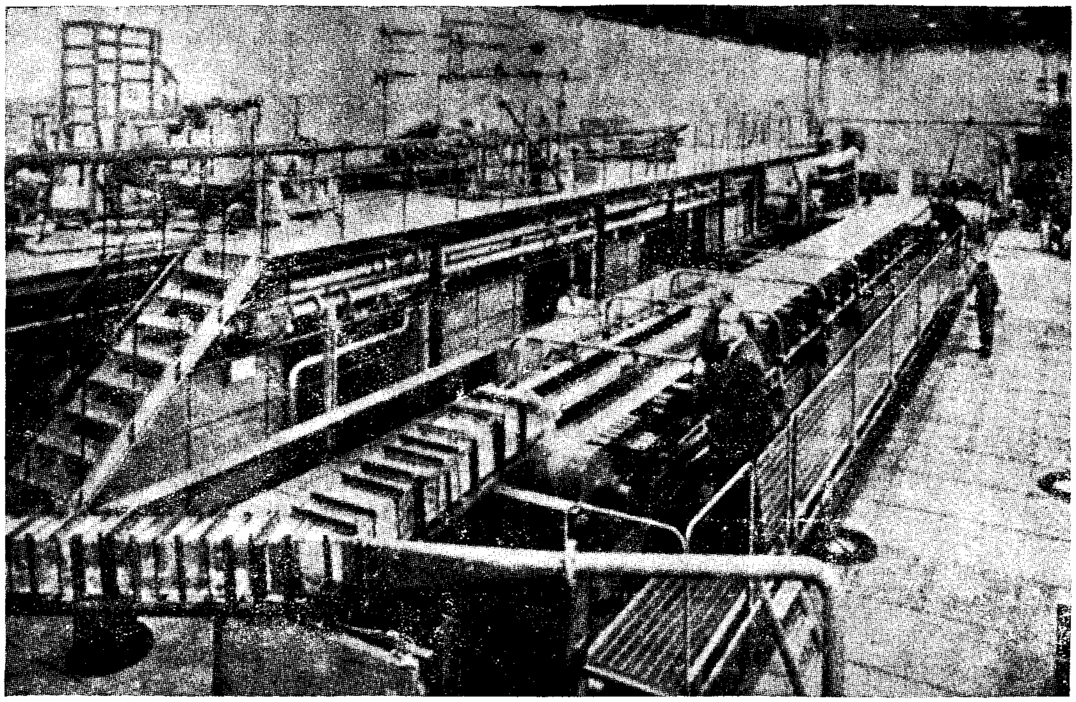


Fig. 1 Paper Machine-wet Section KMW Laboratory in Karlstad

2. To design the web forming machine for desired drainage capacities.

3. To choose suitable drainage elements and determine the optimum ranges of operation.

4. To design dry suction boxes and couch concerning suction area and vacuum supply.

The KMW Drainage Tester consists of the following parts :

Support Parts :

1 Vacuum chamber.
1 Tank - abt. 90 litres.
1 Connection between vacuum chamber and tank.
1 Bottom plate.
1 Water-ejector pump.

Testing Parts :

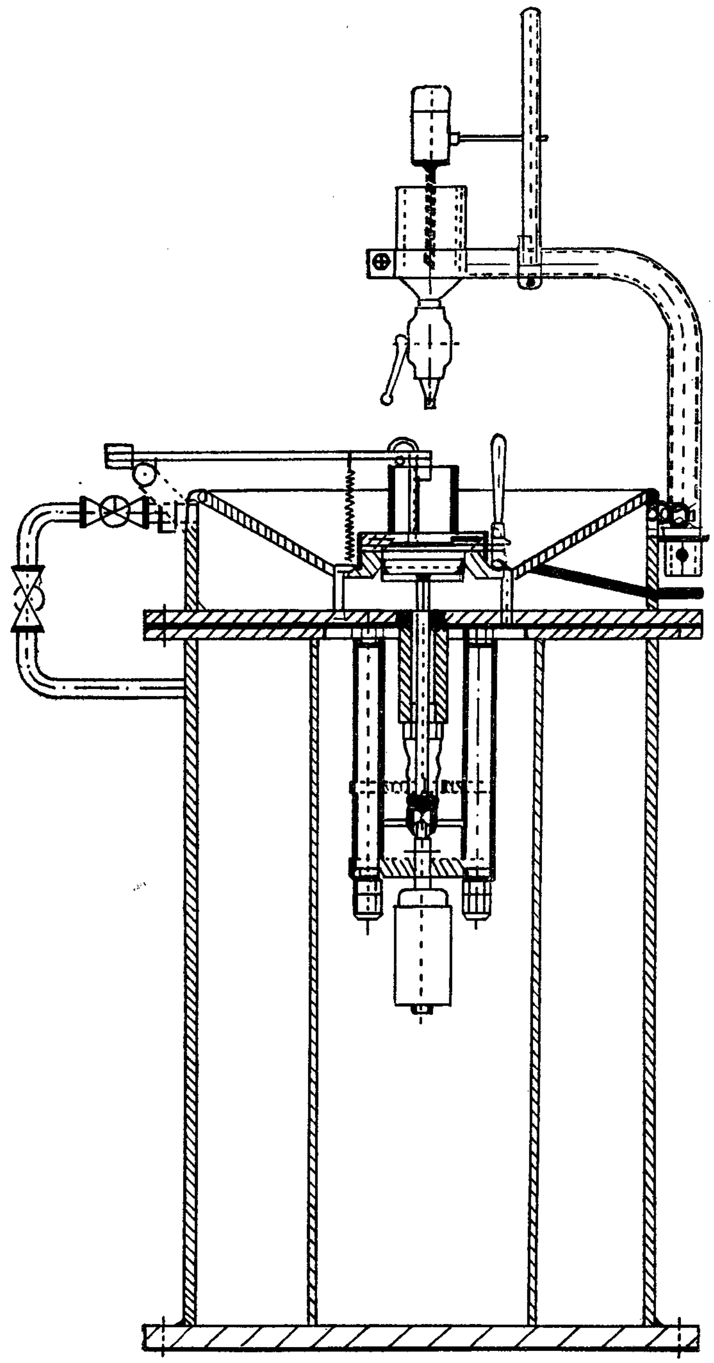
1 Cylinder with wire.
1 Saw toothed circular knife.
1 Pneumatic piston.
1 Foot-plate with valve.
1 Micro switch.
1 Arm with platinum probe.
1 Vacuum meter, U-type.

Deflocculator Parts on Swing-Arm :

1 Rotor
1 Container with floc breakers
1 Ball valve

The drainage process in the KMW drainage tester is that of constant pressure. This is maintained during a test by providing an air-tight chamber combined with a tank of suitable volume. The application of the constant pressure differential across the wire in this tester is instantaneous. This is obtained in the following manner. (Fig. 2)

Fig. 2



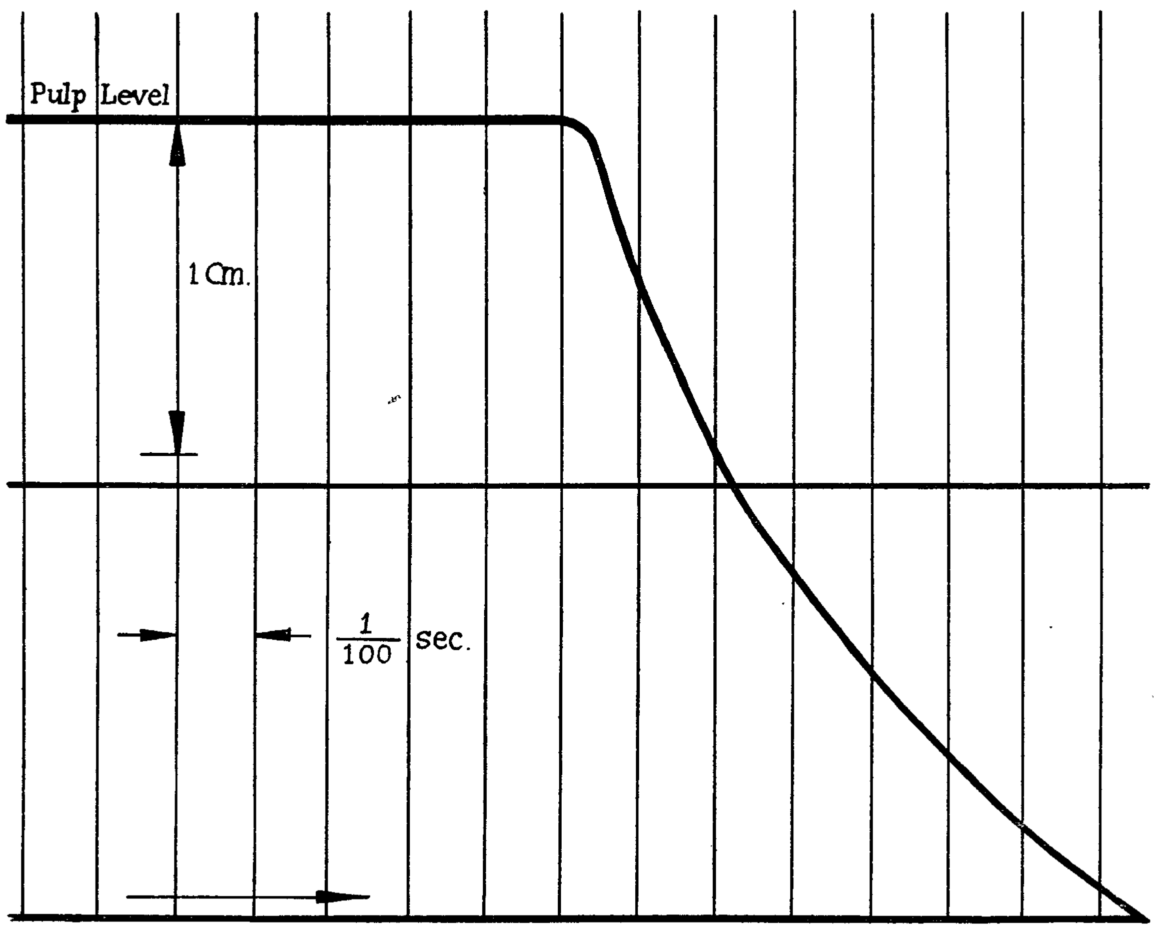
KMW Drainage Tester

A plastic foil is sealed between cylinder and chamber and the chamber and tank are evacuated to the required vacuum level. The foil is sliced by a circular knife and drainage begins at the same time. The chamber is designed for the use of water as the transport medium though air may also be used with slight differences in the results.

When the vacuum is applied to the wire, the pulp accelerates in the cylinder as drainage begins. Acceleration requires a driving force so that the constant pressure differential is obtained after the acceleration period is ended. This period is a small part of the whole drainage period less than 0.01 sec. — and therefore can be neglected.

The drainage tester can be operated at any vacuum. (The plastic foil withstands pressures up to 0.6 kp/cm^2.)

The drainage process is recorded by the probe immersed in the pulp above the wire. On the recorder a curve is obtained of position of pulp level versus time. (Fig. 3)



Drainage Curve for Unbleached Sulphate Pulp

Fig. 3

With the complementary equipment the trace of pulp level versus time is indicated by following the travel of the light metal cup. From this curve the mat weight build up can be determined as a function of the time.

With KMW's drainage tester it is possible to study the influence of pulp type, quality, formation, mat weight, flocculation, consistency and temperature under a controlled constant pressure differential.

IV. KMW Inlet Box :

The function of an inlet system is to deliver the stock to the wire, evenly distributed across the machine, well-dispersed and at a steady velocity. Problems that are faced in achieving goods results are summed up in (a) Flocculation, (b) Cross-Currents, (c) Turbulence, (d) Slime deposits, etc.

While adopting remedial measures the flow spreading has always been treated rather as a specific paper making problem than as a hydrodynamic one and this has produced diversification in the development of inlet boxes of all types and designs by different manufactures, even sometimes by the same manufacturer. To achieve a smooth deceleration of stock velocity, problems appear in maintaining a homogemous fibre suspension. KMW Air cushion Headboxes with slice and manifold inlet, particularly the Pressurised Head boxes, have been successful in more or less eliminating the above mentioned hazards. (Fig. 4)

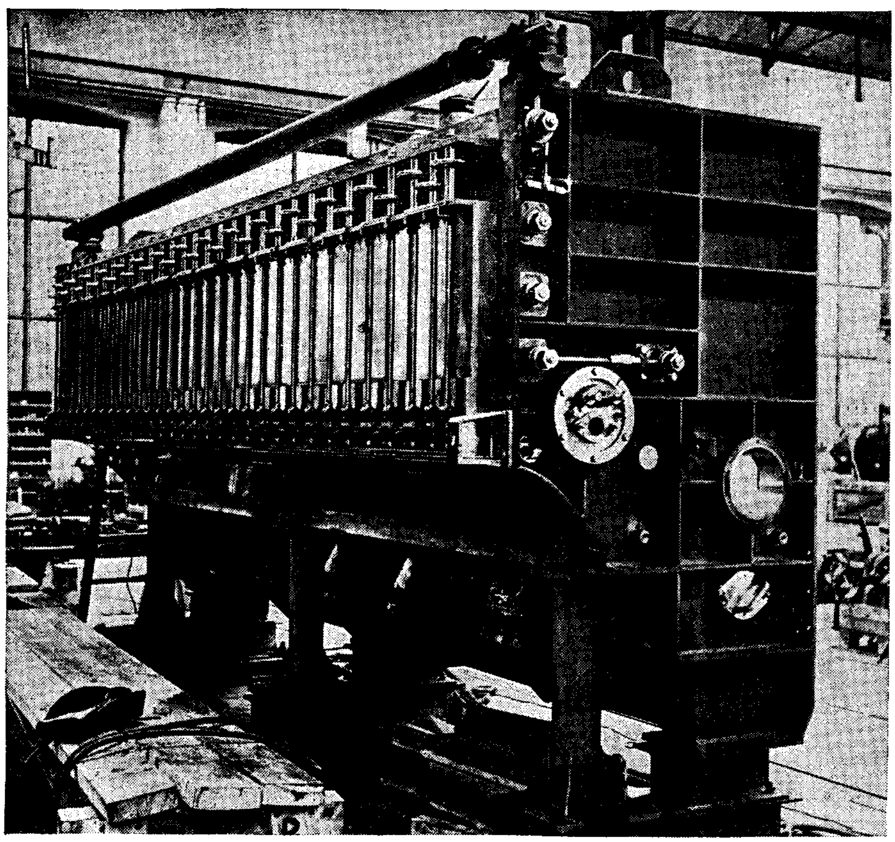


Fig. 4 KMW Pressurised Headbox with Slice & Manifold Inlet.

The merging of the manifold jets and deceleration is achieved through the so-called Explosion Chamber where the incoming stock deflected before leaving the chamber by the throttling slot and the deflection of the incoming jets so achieved, set up a stable eddy, which dissipiates part of the kinetic energy, spreads stock uniformly to the spaces between the jets and evens out pressure and velocity across the machine.

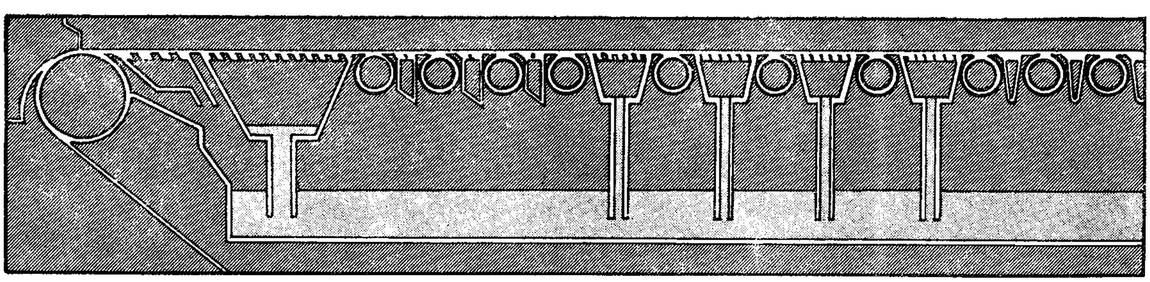
The KMW pressurised inlet box is particularly suited for high speed newsprint even from short fibred raw material like bagasse, and kraft machines. Due to absence of surfaces facing downwards, foam collection and lump formation are minimised, fibres cannot build up and the major obstacle of the tricky slime formation problem has been eliminated.

V. KMW Uniformer

It has been established beyond doubt that table rolls most commonly used for wire drainage are not suitable for modern paper making and for continuous sheet formation action particularly in high speed paper machines. For proper sheet forming conditions it is desirable to obtain uniform fibre and filter distribution, a specific fibre orientation and smooth surfaces on both sides for the resulting paper web. This obviously had brought out a multitude of problems which have, in the history of paper machine design, been treated by running the fourdrinier wire on Forming Boards, Table Rolls, Foils, Suction Boxes, Forming Boxes etc.

The suction effect at the nip of the Table Rolls with its strikingly inflexible drainage factor led to single and multifoil units with adjustable camber and suction boxes. Satisfactory methods of eliminating surface instability could never be developed in high speed machines without resorting to the combination of Table Rolls with other devises of dewatering.

A very detailed research study in KMW of the conditions influencing dewatering has given valuable hints to design and develop the wet end particularly by a drainage device known as the KMW Uniformer. The KMW Uniformer in principle consists in distributing the fourdrinier with wet suction boxes, which work through water seals from a trough placed between the supporting beams of the wire part. The water seal inside the machine permits a smooth suction-off along the entire machine width. The suction box location can be varied depending upon the optimum drainage requirements according to the grade of paper. The suction profile can be controlled almost at will. (Fig. 5)



KMW UNIFORMER SCHEMATIC ARRANGEMENT

Fig. 5

Among the benefits derived from using the KMW Uniformer a few are listed below :

1. Permits an unlimited flexibility in the use of wet suction boxes. It gives to the machine a high and controlled drainage capacity.

2. The paper maker can operate with lower headbox consistency and can form the sheet in a position where the sheet properties will be optimum.

3. The design of the Uniformer makes its application universal in paper making due to its wide quality range.

4. A simple and controllable white water system can be worked efficiently with the Uniformer.

5. Wire length is appreciably reduced.

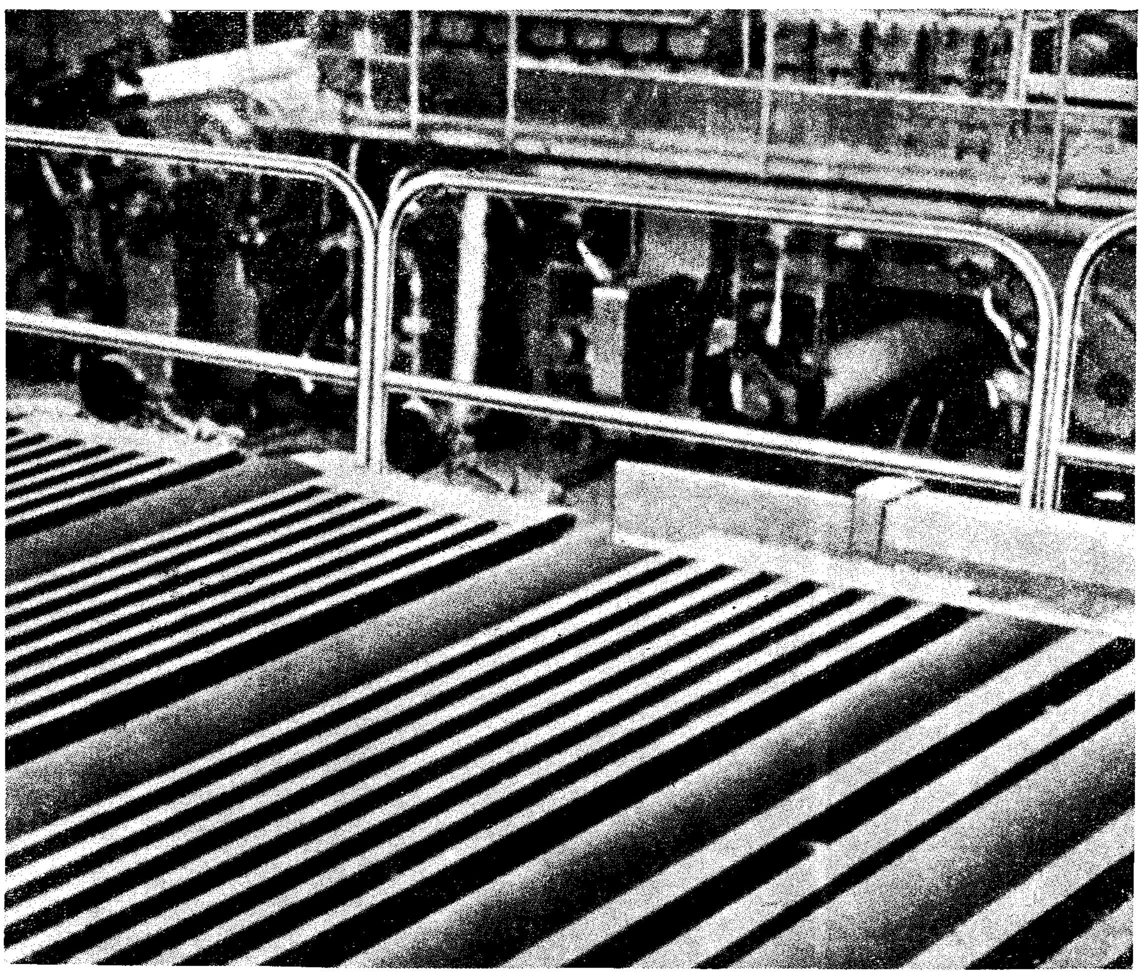
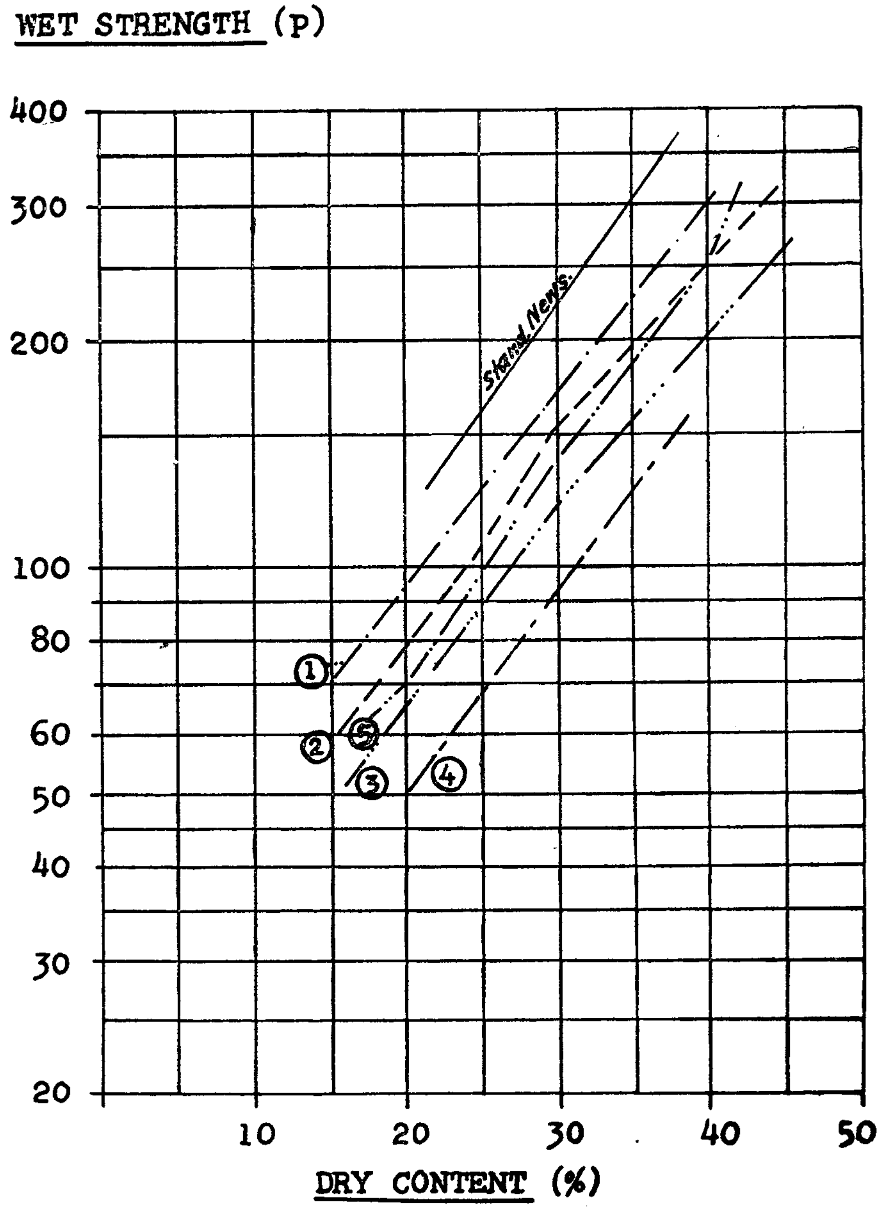


Fig. 6 General view of Paper Machine equipped with KMW Uniformer

Fig. 7 Relation between Dry Content of Furnish after first draw and wet strength of Web.

Basic weight: 100 g/m^2



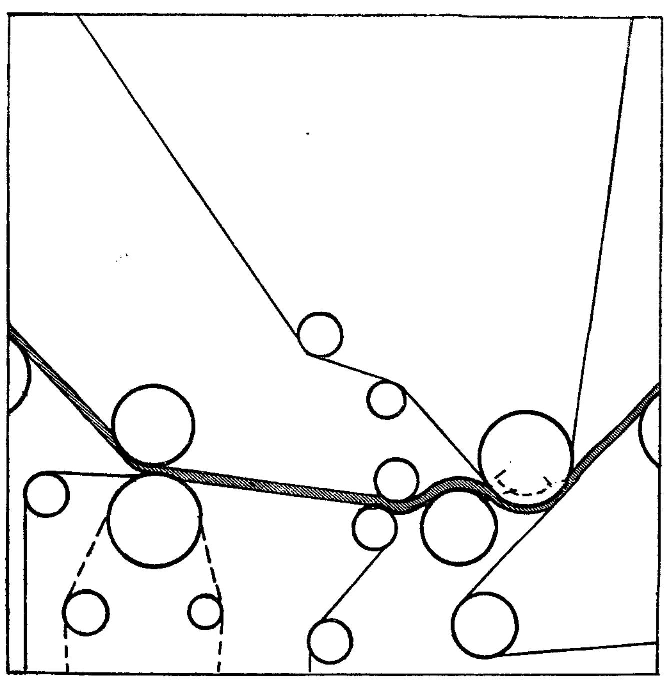
Furnish :

1. 50% Mechanical Bagasse Pulp
   50% Imported Sulphate Pulp
2. 60% Mechanical Bagasse Pulp
   40% Imported Sulphate Pulp
3. 70% Mechanical Bagasse Pulp (Whole Bagasse)
   30% Imported Sulphate Pulp
4. 65% Mechanical Bagasse Pulp
   25% Chemical Bagasse Pulp
   10% Imported Sulphate Pulp
5. 70% Mechanical Bagasse Pulp (Accept)
   30% Imported Sulphate Pulp

VI. KMW Unipress :

The wet strength of the paper web is mainly dependent on the fibre length distribution in the furnish and the moisture content in the paper. Hence one of the main points for breakage of paper web is in the open draw between the wire pick-up and the first press felt. The effect of moisture can be studied from the attached graph (Fig. 7) prepared by compiling data from different compositions of short and long fibred furnishes, which clearly indicates that the higher the dryness the higher the wet strength.

Therefore to improve the runability of the paper web and make it possible to operate even short fibred pulp of low wet strength on high speed machine, suction pick-up before the press had been developed. KMW have further progressed by moving the first press nearer to the suction pick-up thereby eliminating the draw. This arrangement of combining the pick-up with the first press forms the fundamentals of KMW Unipress. With this arrangement, the paper web is transferred to the felt from the wire without an open draw and then pressed while on the pick-up felt (Fig. 8)



Fundamentals of KMW Uni Press

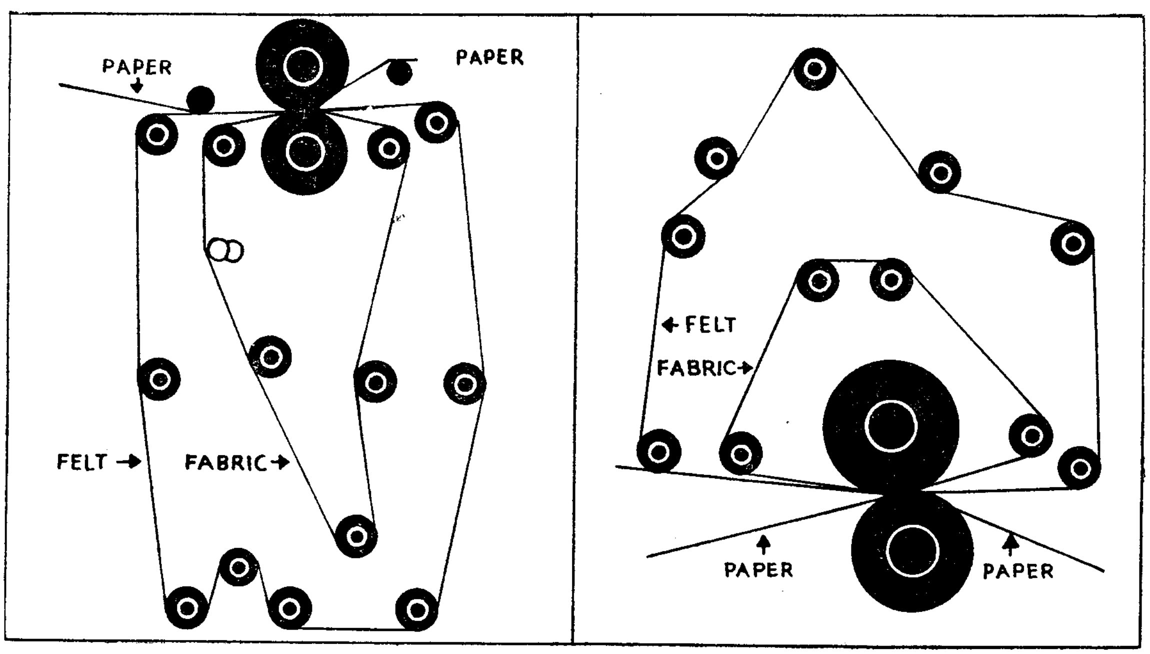
Fig. 8

VII. KMW Fabric Press :

The dryness of the paper web is further increased in the presses by having the system of Fabric Press at the second press. The Fabric Press is a Swedish American invention developed by the Central Laboratory of Swedish Paper Mills. Stockholm, and the Mead Corporation of USA and improved upon by KMW particularly for Fabric & Felt replacement.

KMW Fabric Press is a conventional press with solid rolls provided with a synthetic fabric running in the nip between felt and roll. By utilizing the voids in the materials as storage spaces, the fabric facilitates drainage of water squeezed out from the web at the nip. The water removal capacity of the Fabric Press is in most cases higher than that of plain or suction presses.

The running costs of a Fabric Press being proved to be quite comparable with a conventional Suction Press, the felt life has not changed and the cost of the Fabric can be for practical purposes compared with the general costs of the Suction Press. It is also in actual installations been proved that a Fabric Press installed instead of a common suction press, contributes to considerable increase in the dryness of the web entering the dry section of the paper machine.



ARRANGEMENT OF KMW FABRIC PRESS
Fig. 9

Since the pressability of the furnish determines the moisture content after a given operation, it has been found that to achieve the same dryness a conventional press together with suction pick-up would be considerably more expensive and would necessitate longer down time for felt change. The combination of KMW Unipress and Fabric Press also require less vacuum, less power and cause less marking. This enables the machine to have the widest variation in the basis weight of paper i. e. from as low as 16 GSM to as high as 200 GSM.

By installing the KM Uniformer, KMW Uni. Press and KMW Fabric Press on the machine, the following immediate benefits can be derived :

(i) Versatility in the machine as regards adaptability to all speeds, basis weights and qualities.

(ii) Permit higher nip pressure and give higher dryness than any known alternative.

(iii) Give superior paper machine runability and improve paper properties.

(iv) Are of simple design, low maintenance costs.

(v) Require minimum of space, can be installed on most existing machines.

(vi) Are adaptable for computer control.

(vii) Give longer life for the felts, therefore, shorter machine down time for felt changes etc.

The system is also of interest for rebuilding machines in order to increase speed and capacity especially thinking of frequently existing shortage of space which prevents addition of any conventional press.

VIII. **Newsprint from Bagasse :**

With the introduction of the above mentioned designs and techniques in the form of machine equipment, KMW had undertaken large scale production investigations on manufacture of newsprint from short fibred cellulose raw material and obviously the growing world interest in bagasse directed their research studies towards this raw material which is abundantly available at home and abroad. The fact remained that a few years ago, all attempts made to produce newsprint and magazine grade papers from bagasse proved technically and commercially unsuccessful. However, in the last few years, the technical research and large scale mill trials have demonstrated the feasibility of producing also these grades of paper from fibre furnishes with a high content of bagasse as chemical and/or mechanical pulp. The large scale mill runs of bagasse newsprint have been carried out in Sweden by KMW in collaboration with AB Defibrator.

In the manufacture of conventional newsprint the necessary strength characteristics of the finished sheet (i. e. breaking strength, burst, tearing strength and double fold) are obtained by adding to the groundwood some 20% of long fibred chemical pulp. It is however important to note that the strength properties of the finished paper alone do not determine what amount of chemical pulp must be added to the furnish. Equally, or perhaps even more important are the wet strength properties of the paper web when run on high-speed modern machines.

In the course of investigation a great number of different furnishes and qualities of mechanical bagasse pulp were tested in the laboratory and some typical results are recorded in the table below :

Sulphate bagasse pulp (35° SR)	(A)
Groundwood (Scandinavian spruce)	(B)
Mechanical bagasse pulp	(C)

Furnish.	40	50	60	50	50	50
A%	40	50	60	50	50	50
B%	60	50	40	40	30	20
C%	—	—	—	10	20	30
Basis weight. g/m^2	77.0	76.5	81.8	71.3	71.2	71.5
Thickness in/u	171	152	157	142	141	138
Bulk. cc/g	2.22	1.99	1.92	1.92	1.99	1.93
Porosity, sec/100 cc	28.5	36.2	44.3	69.4	78.7	97.8
Breaking length. m	3040	3400	3500	4000	4000	4100
Elongation. %	2.2	2.5	2.7	2.1	2.2	2.1
Burst factor	14.3	17.3	18.2	19.4	19.4	18.9
Tear factor	47.8	47.1	47.9	42.6	42.7	41.4
Opacity % (50 g/m^2)	—	92.9	—	—	95.2	95.4

The above results show that on the whole a good quality finished newsprint sheet may be produced from 40-50% of conventional groundwood and the balance of chemical bagasse pulp. They also show that, when half the furnish consists of chemical bagasse pulp, a large share of 60% or more of the conventional groundwood can easily be replaced by mechanical bagasse pulp without adversely affecting the characteristics of the paper.

The trials have also established that the pith, which hitherto had to be discarded for its lowering the drainage rate and strength of pulp. can economically be included in bagasse pulp for newsprint manufacture. This has been made possible by treating the pulp in disc refiners. which improves the drainage properties, high opacity and strength of the pith fraction.

The most critical papermaking factor of making newsprint from short fibred raw material like bagasse is the wet strength., which together with pressability of the furnish and the magnitude of the adhesive forces between the furnish and the press surface contribute to the runability limitations. In practice the runability limitations of bagasse pulp with high pith content have been overcome by machine runs on high speed paper machines equipped with the KMW Uniformer, Unipress & Fabric Press.

The aforementioned facts and the very successful achievement of KMW. in the wet section design of the fourdrinier paper machine, in the long run, will open up new vistas in the field of paper making in this country. where long fibred raw material is gradually becoming a far cry.

Literature :

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