Wet End Engineering—An Utmost Necessity to Increase Productivity

KAPOOR J.*, JAUHARI M.B * VARDHAN R.*
KUMAR PAWAN*

Sophisticated Fourdrinier machine of 20th Century was first conceived by Mr. Louis Robert. It was he who first thought of using fine wire cloth in continuous form for the production of paper, sponsored by Henry and Sca y Fourdrinier. The first Fourdrinier Machine was started in England at Fronmoxe in the year 1803 due to enthusiam of Bryan Donking, an Engineer. Since its structure has remained same but engineers and technologists have made it a perfect science from simple art.

The technologists and paper makers are exposed to new challenges to maintain and to increase the productivity with much improved quality. To cope up the challenges with uniform and reproducible quality the various aspects of engineering and science are incorporated to get the desired results.

The study anlysis the different engineering and technology aspects of wet end of fourdrinier paper machines.

FIRST

In some old machines, no attention is paid to flow velocities or to bends or elbows or proper slopes. All these are designed in the way that pipe be large enough to get stock to the machine. Now, of course, piping design in fact the design of the whole wet end thick and thin stock systems—is an exact science. Pipe slopes, air venting. stock velocities are all parts of the design of wet end piping system.

The stock piping system is like a gear in a gear train. In a gear train, no tooth is more important and yet to equal importance to all other teeth Thus the stock piping system is just as important as every mechanical component and auxiliary system down the paper machine. This is required to be designed to provide

— Stability and controllability for the desired uniform flow conditions.
— Good mixing and fiber dispersion
— Cleanliness

It is challenging before Industry to get best of the existing to get more and more productivity. For the most part we have advanced beyond the simple system of open head boxes. Although the stability of many of these systems was beyond reprcach, higher speeds, air cushioned, and hydraulic head boxes, cleaning screening and deaerating equipment and secondary flow circuits have introduced problems and have challenged the industry to meet the increased production and quality standards.

Some of the recommendations are made to increase the productivity i.e by overcoming the short term or long term problems.

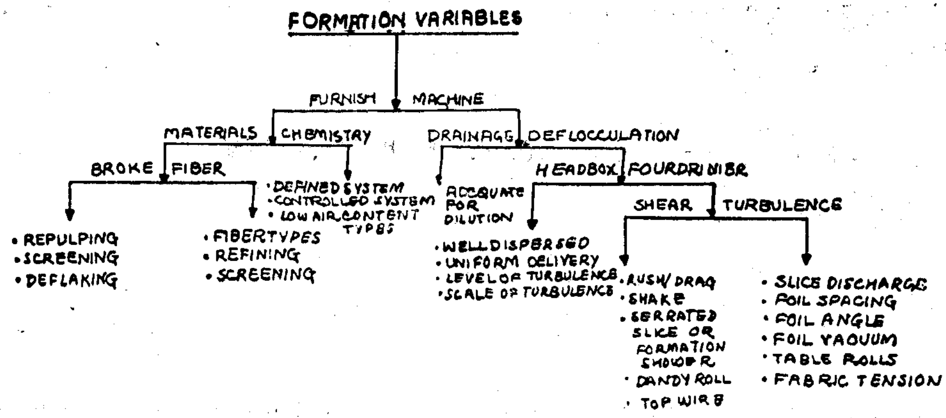
The piping for the stuff box is of very much importance. By feeding the bottom of one end discharging to the machine through a vertical dropleg from the centre compartment and overflowing the far end, the box as opposed to a closed system accomplishes three things—

— eliminates much of the free air in the stock
— minimum the effect of pulsations or variations in the preceeding system.
— Provide a constant head reference for the basis weight valve.

SECOND

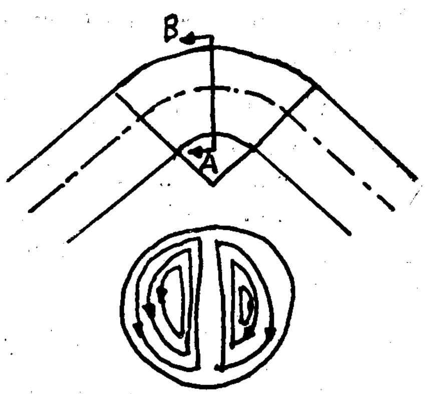
Basis weight valve in the machine supply dropleg must be located in lower reach to ensure submergence

*Ballarpur Industries Limited (Unit : Shree Gopal)
Yamuna Nagar

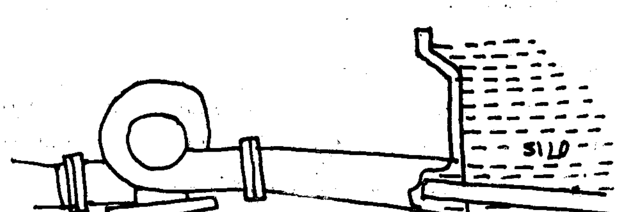


THE 20-POINT programme to improve productivity

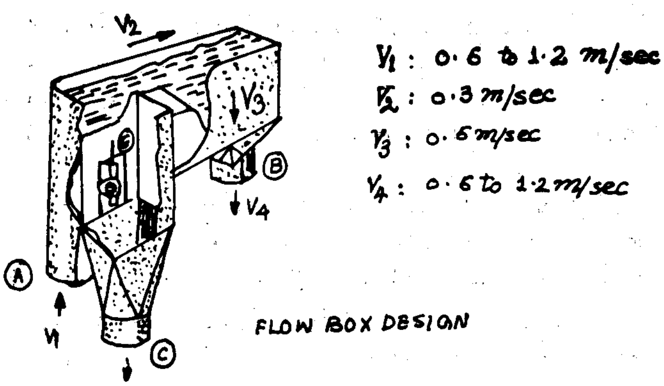
- WET END PIPING
- BASIS WEIGHT VALVE LOCATION
- FAN PUMP SELECTION & PIPING
- ENTRAINMENT OF AIR
- WIRE PIT DESIGNING
- SCREENING & CLEANING EQPT. SELECTION
- PULSE GENERATION
- JET BEHAVIOUR
- SHEAR & TURBULENCE
- WIRE LIFE
- DRAINAGE TABLE
- MACHINE SHOWERS & DOCTORS
- VACUUM APPLICATION
- MACHINE CLOTHING
- CHEMICAL AIDS



Section A-B



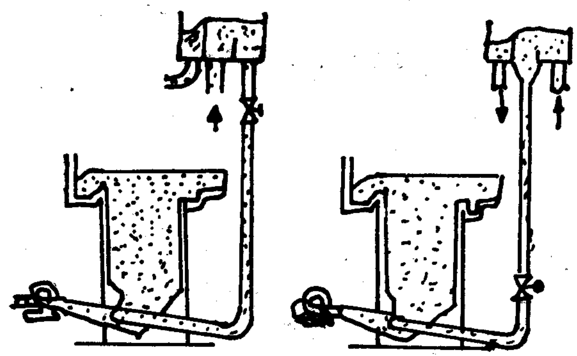
with respect to the down stream level and reduces the possibility of cavitation from low pressure and high pressure drop. This prevents erratic pressure pulsations which accompany cascading as well as promoting line cleanliness.



FLOW BOX DESIGN

THIRD

The introduction of heavy stock before the fan pump suction should be located such that it is not competitive with other secondary flow lines entering the vicinity should two lines enter the pump suction line diametrically opposed to each other, a change in one would change the back pressure of and consequently the flow from the other. The normal recommended entry for heavy stock is either axially into the pump suction line or if from the side, into the lower quadrant and at angle of almost 45° in the direction of flow—



HEAVY STOCK METERING FOR STABILITY
FIG. 2

FOURTH

Fan pump should be preceded by a constant head source generally it is wire pit. Fan pump variations and pulsations cause basis weight variations and "barring" so it is better to put improved, variable speed DC drive, which not only assures better speed control but contributes flexibility to the system. This also minimizes longer term random variation due to electrical characteristics. Similarly vanes of the fan pump must be chosen with accuracy and giving due to considerations all the variables. By employing the "Staggered" or "Split" vane impeller the pulsations, though doubled infrequence are diminished to half their amplitude. Maximum pulsation amplitude of (0 01 kg /cm^2) at the pump discharge is generally specified. There are other sources of noise (both random and periodic) in the piping system such at the resonant frequency of the piping itself, valve cavitation and structural or equipment vibration but time would not permit detailed discourse in these areas. Let it suffice to say that it is not always possible to eliminate a source nor may it be economically feasible to do so. In these cases it is now possible to alternate the majority of these pulsations through the application of a pulse attenuator in the approach piping immediately preceding the head box which is being utilized by atleast one mill in India. The effective frequency coverage by this attenuator is over the broad band of 1–40 hz.

FIFTH

Entry into headbox is very critical factor. The transition into the headbox header should be gentle and at least 2.9–3.2 meters of straight section should preceed the head box. This is to allow the flow to settle down after the elbow created turbulence.

SIXTH

Unstable system is caused by the entrainment of air in the stock, which manifests itself as head variations, machined direction basis weight variations, slime or dirt spots, foaming and pinholes. It is necessary :

— to find the sources of air entrainment and to eliminate them whenever possible

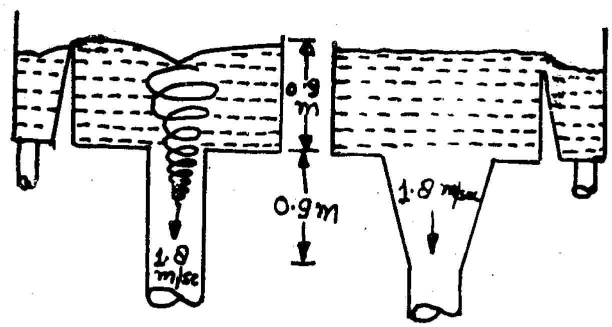
— to convey the balance of air in a manner which be least detrimental to the flow.

— to expel the balance of air at convenient points.

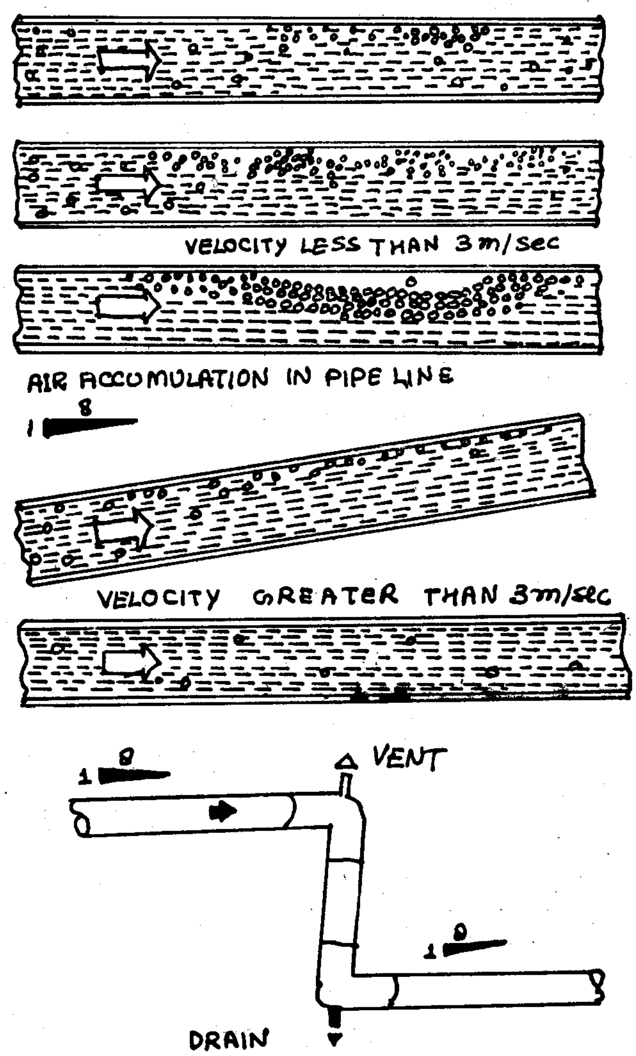
If we see these sources may be three mainly in the stock preparation section e.g. fill lines to chests, the discharges of which are not submerged with respect to the liq. Level in the respective chests, weir overflow baffles or metering gates wherein the level drop down stream of the devices is excessive or no control on the down stream level whatsoever is effected, control valves physically located too high to provide a full line on the down stream side, and fourdrinier drainage devices such as table rolls, the latter group is an example where entrainment is difficult to eliminate.

So the optimum solution has to be found. Vortices are commonly found over the discharge outlets of chests, stuff boxes and wire pits are the result of insufficient submergence over the discharge in meters numerically equal to or greater than the discharge velocity in meters per second.

It is required to see the miscellaneous sources of air entrainment as violent agitation or low levels in an agitated chest Recognizing, however, that the stock will contain some residual free air, the piping system should be designed accordingly. At the flow rate of approximately 2.4 m/sec air is released from the stock. With a horizontal run air would have a tendency to adhere to the pipe, developing air pockets and forming breeding spots for dirt and slime. As the pocket size develops, the air would break loose causing a flow interruption and carrying with it the accumulated dirt and slime. So a slope of about 1.8 must be given (Figure). To terminate a line at some elevation lower than its origin necessitates a slope upwards while traversing the horizontal distance followed by a vertical drop to terminal. This problem may be removed by providing a continuous vent line back to chest pit.

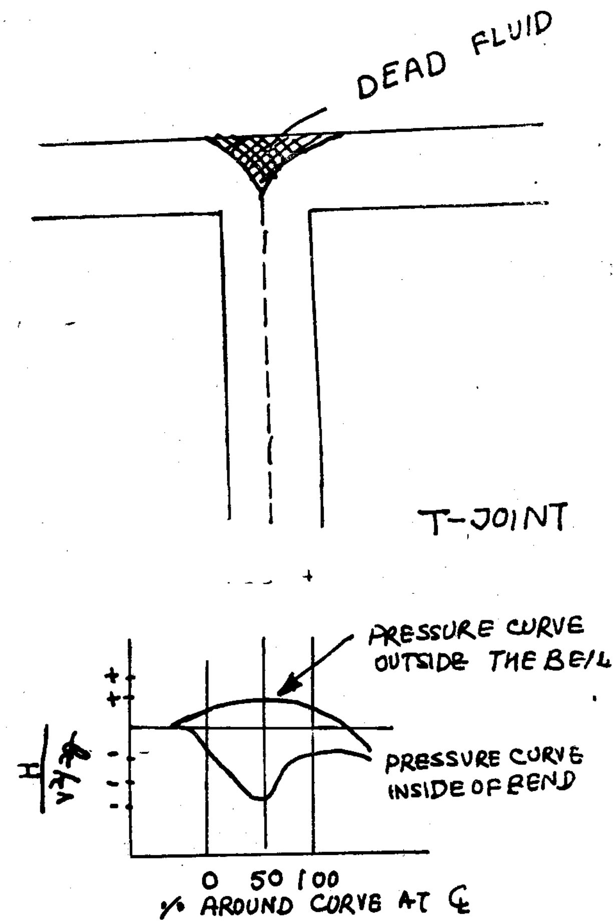


STOCK PIPING



PIPING ARRANGEMENT

FIG. 3



FLOW CONDITIONS AT A BEND

FIG. 5

SEVENTH

Wire pit selection is also an important feature.

The Fourdrinier type pit should be employed on free sheets and high volumetric flows. Saveall down spouts usually front and back side discharge the fourdrinier drainage into the outer channels near the breast roll end of the pit. The flow is directed toward the couch end at slow mean velocities (0.3 – 0.4 m/sec) where the flow is reversed, the outer channels are merged and the total flow returned toward the breast roll end in the centre channel. Thus approximately one minute of open channel flow time (depending upon fourdrinier length) allows release of the free air as well as dissipating turbulance thereby allowing a uniform overflow at the terminal end of the center channel. Immediately before the overflow weir a low velocity silo feeds the white water vertically from the centre channel to the fan pump. The low velocity gives the final assurance of deareation and elimination of turbulance while with the constant level maintained by the overflow providing a constant suction head for the fan pump,

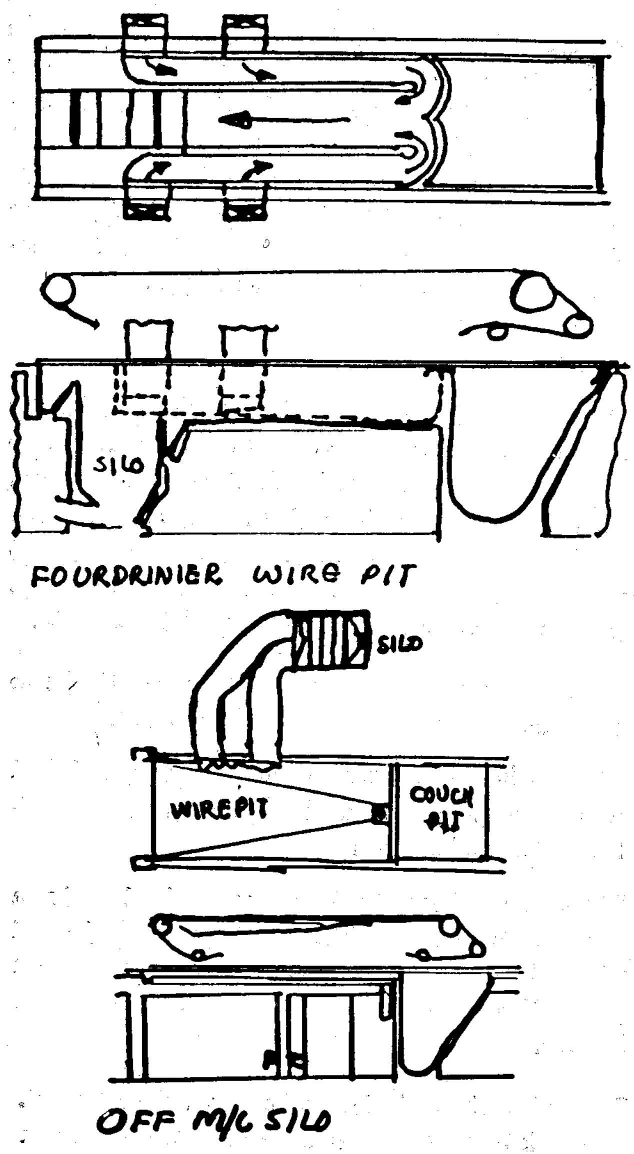


FIG. 6

Off machine silo is generally used when clays and other fillers are used when total volumetric flows are low, and with most twin wire attachments. To prevent settlement of these fillers in the deaeration channels which results in a maintenace problem the channels are shortened and a little dearation sacrificed. The channel lengths from the backside save all through outlets to the silo are generally made just long enough to dissipate turbulance to achieve su face stability over the silo and overflow weir. 30 secds. "dwell" time is still desirable in this silo design. Thus a properly designed silo will remove much of the free air, provide a constant head for the fan pump (without vortexing, provide a constant back pressure for the basis weight va ve and provide an area for the introduction and deaeration of seal pit make up water. Inherent with this design is the automatic separation of fourdrinier drainage and shower water, often desirable where tray water consistencies are relatively high.

EIGHT

It is necessary to design the efficient cleaning system. The basis problems which might be encountered with cleaning and screening are as follows :

For cleaners :

a) **Excessive wear**

1. Insufficient rejects flow
2. Orbiting of contaminants witin a plugged cleaner
3. Excessive debris or glass debris in coming to system

b) **Plugging of the Unit**

1. High consistency
2. Insufficent reject rate
3. Low pressure drop
4. Excessive or gross contaminents entering the system

c) **Cleaner inefficiency**

1. High consistency
2. Low pressure drop
3. Poor maintenance
4. Improper cleaner size selection

For Pressure Screens :

a) Plugging and/or stringing causes :

1. Too low cleaning pulse generated by the rotating assembly.
2. Too low reject flow rate.
3. Excessive flow through the scrreen.
4. Operating inlet consistency too high.
5. Incorrect choice of screen plates, opcn area, or perforation size.
6. Loose belts.

Excessive power consumption causes

1. Low flow through the screen.
2. Air in the furnish.
3. Incorrect clearance of pulsating assembly.
4. Excessive foreign material entering the system.
5. High consistency in the rejects gutter.

Noise or Vibration causes

1. Excessive entrained air in the stock.
2. Foreign material caught in the rotating assembly.
3. Rotating assembly set too close to the screen plates.
4. Worn bearings.

If due consideration is not given to the screening operation the problem of pulsing and barring may appear. Screens could be run at frequency of 15 hz or less with no problem.

NINTH

Requirement of a good screen are good cleaning, good combing thorough mixing capacity, mechanical reliability and freedom from gathering hydraulic disturbances fiber flocs approaching and traversing through the holes of screen plate break up. Seven basic characteristics of pressure pulses have to be kept in mind to see the paper machine stability.

1. A pulse will travel in the pulp slurry at the speed of sound.
2. The pulse will travel in all the directions even against the pulp flow.
3. A pulse can be generated by rotating machines, valves, tight elbows, pipe flanges, by pass arrangements and various vibrating sources.
4. A pulse can be dampened by the same hydraulic equipment that can generate pulses.
5. Pulses have an amplitude (Size), a frequency (number per time interval) and phase (starting time reference)
6. Pulses can interact and take a combined form.
7. Machinery has a natural frequency where it will vibrate if excited by a vibration having th: same or nearly the same frequency.

Pulscs in a pressure screen can be generated by the interactirn of the rotor foils and the geometry of the screen. The special y curved foil blade travelling near the sc een plate generates a continuous prcssure surge and suction wave. The pressure is continuous when measured on the foil. Changing the configuration of the screen body or change in the speed can reduce or eliminate this pulse. Paper M/cs head boxes are especially concerned with 10 to 40 hz range. A screen natural frequency falls in this range. Another important aspect of the screen is their finish. The accept side should be polished to avoid slime build up and stringing. Connecting flanges should be of metal to metal type.

TENTH

Jet behaviour is the point which needs critical study from productivity point of view. This parameter is also important for substance variability, sheet formation, first pass retention, opacity and other quality defects. For all these variables the culprit is jet. Figure ( ) gives the jet trajectory parameters. The optimal settings of a given head box should meet the following criteria.

— There snould be a short distance for the jet to travel before landing on the forming board.

— The jet should land properly on the forming board with a sealing effect at its leading edge and uniformly across its width

— The net static head should be maintained. As a result, the velocity difference between the jet and wire will be negative or close to zero at the contact point. This will prevent return flows or fluctuations in mass.

Table gives the variables to be given close control. A close check up must be done to get the maximum productivity from machine.

TABLE : Input and output values for the head box

Inputs	Outputs
Slice angle :	Vertical component of the jet impingement velocity Vx
Slice opening : b	jet impingement point relative to lower lip edge X
Lower lip extension beyond Upper lip edge : L	Jet to wire intercept length in the absence of stock above the wire.
Height of the lower lip edge above the wire H	
Stock thickness at slice:B	Total head inside the headbox
Slice width	Net static head inside the headbox.
Angle of lower slice plate relative to the horizontal "VI."	Stock flow rate
Wire speed	Jet angle α
Jet/wire speed ratio	Jet contraction coefficient
stock depth/thickness at perforated roll	Mean stock flow velocity inside the headbox.
Perforated roll diameter	Flow velocity through perforated roll holes
Diameter of roll perfection	Optimal speed of perforated roll
Perforated roll percent open area.	Wake ecoefficient Estimated wake length.

By calculating and controlling the above variables wet consolidation past can very well be engineered for best possible productivity.

ELEVENTH

Shear is beneficial when the induced force is of sufficient magnitude to pull flocs apart but not large enough to disrupt sheet structure. Shear generating devices include :

- Rush/drag ratio
- Mechanical shake
- Formation showers and phase changing devices
- Dandy rolls
- Top wire units

a) Shear is created when the speed differential exists in discharge velocity and the wire speed.

b) Formation depends a bit on shake number S Shake number must be maintained over 50.

$$\text{Shake number} = \frac{\text{Frequency}^2 \times \text{amplitude}}{\text{speed}}$$

It is best to shake the breast roll to start deflocula-tion immediately. This factor counts for the major reason why the best formed sheets are made at low speeds

c) Dandy rolls create shear and improve formation and many grades cannot be made without them. Following must be followed when using Dandy.

1. The open area under the dany roll should equivalent to diameter of the dandy. This condition provides a neutral cushion for the roll and permits running the sheet wetter without crushing.
2. The dandy should be placed so that one third of the open area is upstream of the dandy centerline. This location minimises water throwing.
3. The dandy roll should depress the plane of the fabric $\frac{1}{4}$ to $\frac{3}{4}$". It is typically necessary to raise the dandy on heavy weight grades and lower it on light weight grades.
4. Fiber consistency should be 2.5 to 3.5% entering the dandy. Many dandy rolls are now located, between vacuum augmented foils
5. Dandy rpm should be in the range of 150 to 200 rpm.

TURBULENCE

Turbulence on the forming table is a well known mechanism for improving formation and hence productivity. The intensity of turbulence is based on height of peaks on table using 0 to 10 ranky method.

Turbulence generating in techniques include :

- Bonding slice discharge jets (not normally recommended)
- Spacing of hydrofoil blades
- High hydrofoil angles
- Table rolls
- Spacing of table rolls and deflectors
- Fabric tension
- Blunt nosed or re-entry nosed hydrofoil blades
- Vacuum augmented hydrofoils/wet boxes.

TWELFTH

One of the important parameter to productivity is to improve the wire life. It is necessary to analyse the reasons of warning of wire. In bronze wires when the strand is warned by 58% it is removed i e. defining it as 100%.

$$\% \text{ worn} = \frac{C-A}{0\text{-}58C} \times 100\%$$

C = Initial strand thickness
A = Worn ,, ,,

This must be correlated with fabric revolutions.

$$\text{Fabric revolution} = \frac{\text{Machine speed} \times 1440 \text{ per day}}{\text{Fabric length}}$$

The main types of wear are drag wear, filler or gritwear, Creep wear, edge wear etc.

The fabric must be chosen accordingly, Creep wear can be contro led by controlling the creep angle at turning rolls.

This can be measured by creep/revolution.

$$\text{Creep/revolution} = \frac{\gamma}{\mu E}(T_1 \log \frac{T_1}{T_4} - (T_1\text{-}T_4)) \text{ inches}$$

T_1 = High tension
T_4 = low tension
μ = friction col/t
E = Elastic module

Edge wear is more due to suction devices. Deflection of the fabric in to a hole or slot is affected by.

- The size of hole or slot
- The stiffness of fabri
- The machine direction fabric tension
- The cross direction fabric tension

To get rid of above effects and to get optimum productivity from machine the correct choice of weave and material of construction is must.

THIRTEENTH

One of the best way to get the maximum productivity is to modify the existing drainage table. Vacuum augmented foil unit is one of the most modern way to improve machine productivity. Typical applications require 1-25" H_2O vacuum with an air flow of up to 25 CFM/Sq. ft. of open top surface area. A simple separator must be put in line to separate air from water. These must be

- free of horizontal and vertical vibrations
- it must have facility of mounting the blades of any angle
- must be adjustable horizontally and vertically to allow for unit levelling.
- Must be equipped with clean out plugs.
- On seal leg units, avortex breaker must be provided or vacuum fluctuations will occur.
- The vacuum inlet line should have a see through section for observation and assurance that air only exists in the line.

The accurate application of a vacuum unit in the easily part of the forming table provides an excellent paper making tool to control energy input in the form of turbulence to sustain sheet deformation through modification. At the same time the unit eliminates drainage pulses that would diminish the fines retentivity of the fibre mat., particularly in the early stage of mat build up. The unit protects the deposited mat against disruption by higher shear rates in the free suspension above it. The results are increased fines retention and more uniform distribution of fines through the sheet, reduction in pin holing and decreased porosity e. g. in glassine, OTC, CTA and other finer grades to news and brown papers.

Another advantage of a unit in the early part of the forming zone, particularly on a paper machine using free stock, having high basis weight, sheets is its efficiency of water removal at low energy consumption. It speeds up the progressive bridging and bonding of fibers. This results in a stronger, dryer and smoother sheet. A stronger sheet produces improved machine efficiency, a dryer sheet off the couch improves press performance, a smoother sheet conforms better to the surface of the dryer can increasing the heat transfer rates and producing savings in steam consumption. Fourdrinier energy is saved because the unit reduces the height of the undrained suspension in a short distance this reducing the liquid sheer occuring in remai-

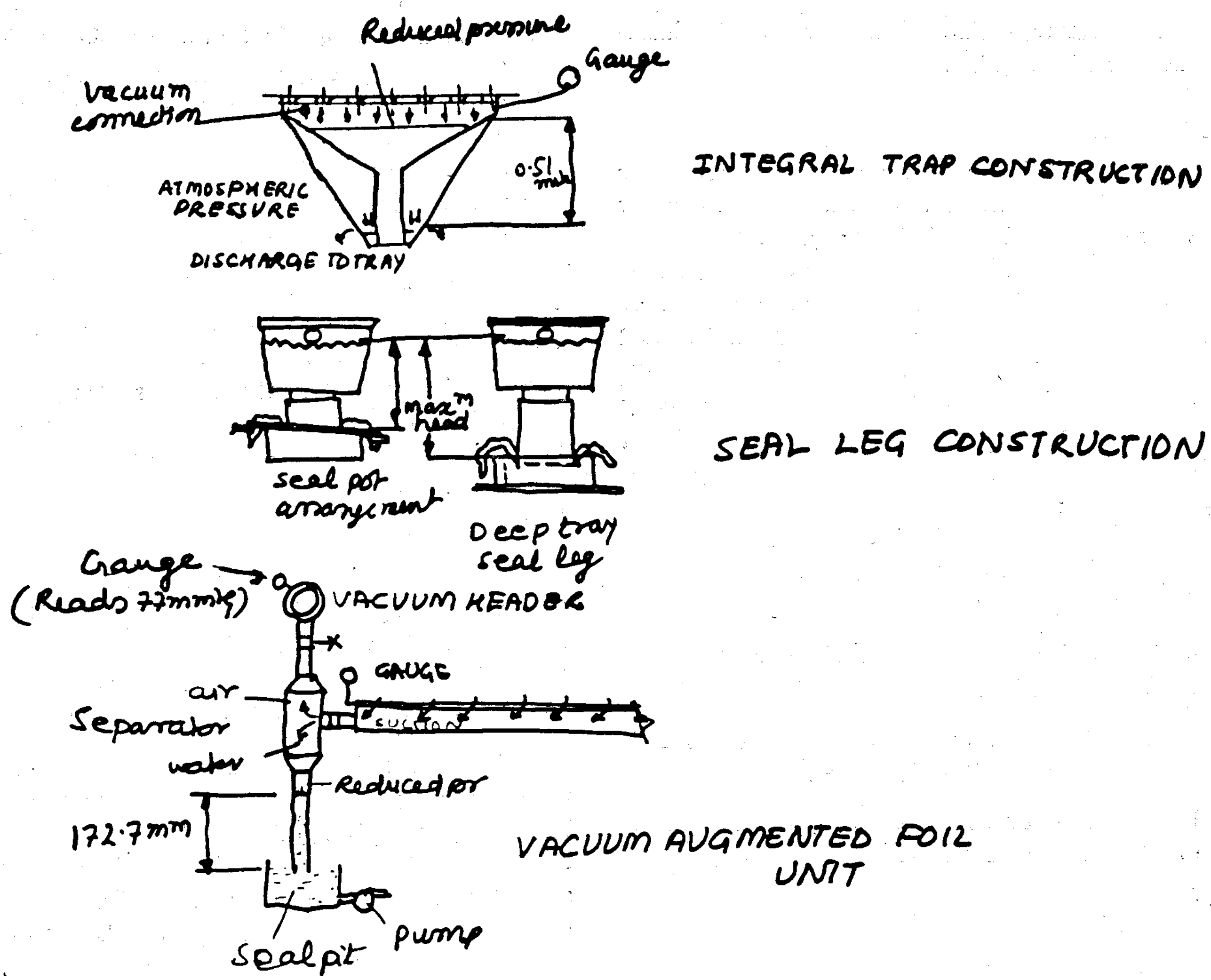


FIG. 7

ned of table. Additionally a dryer sheet enters the flat box section making it possible to reduce flat box vacuum horse power.

All above factors lead to higher productivity.

FOURTEENTH :

There are number of showers types available for specific use. This must be chosen accurately to get the better productivity from machine. Following must be kept in mind.

— For open head box swing shower must be used, in which nozzle pipe rotates by an arc of 180°.

— For closed head box a shower rotating full 360° must be used.

— Formation showers ae 20-30 cm from head box may be installed having sufficient volume and velocity to impart shear force to the stock surface to lessen streaks which may be caused by a particular slice.

— Solid breast roll should be serviced by three stationary, fan nozzle showers, first one inside the wire to keep the roll clean, second one outside the wire an centre line of roll to extend wire life, by increasing temperature of wire and third outside the wire above the roll with the nozzle directed to the underside of slice.

— In dandy roll needle jet, oscillating low volume, jet nozle shower must be installed inside the dandy whenever possible with nozzles spraying upward and toward the head box.

— The knock off shower must be of high volume fan type.

— Wire life extender (anti corrosive and anti galvanic chemicals) showers may be used on synthetic formy fabrics.

— High pressure, osciallating shower must be installed for wire cleaning.

FIFTEENTH

Good doctor designing is very much important for roll cleaning, removal of stock accumulations, water rings, fuzz, pitch and filler build ups and may serve as deflectors controlling the flow of water on the forming section of machine. Because of above, doctors must be adequately engineered for the intended services and must be properly installed and aligned. These precautions may reduce the production losses, as well as early ridging and pimpling of wires. Doctor levelness, blade angle, blade pressure must be chosen in optimum way. Generally :

— Doctor levelness must be ± 1/64 of an inch (measured by level gauge)

— Doctor blade angle should be 25°±2.5° (measured by circular gauge).

— pressure should not exceed on average of 0.7 PLI (measured by 0.006" feeler gauge).

— i.e. one must never under estimate the importance or values of a good doctor.

SIXTEENTH

Accurate application of vacuum is very much important to the productivity. On modern high speed machine the power consumption for producing vacuum approaches that required for driving the machine e, g. 120 KWH/ton of paper. It is very much important to choose right type of pump to have more efficient operation. The down time created by the pump is very dangerous to productivity. Water ring vacuum pump is operating most efficiently because of its ability to with stand water and fiber carryover without interruption in operation. If large capacities of the vacuum are required then the common header system is more useful as it gives several advantages.

1. It provides for only as much vacuum capacity as needed at an absolute minimum of horse power required.
2. The ability to utilise ½ or 1½ vacuum pumps per services when needed Typically a water ring vacuum pump can be operated with each half at different vacuum levels when needed.
3. Vacuum capacity back up. Should one Vacuum pump outage occur, blanks in the header may be removed to redistribute vacuum capacity. This enables the paper machine to operate at only a slight loss in production while pump repairs are made. The use of throttling valve is limited to the wire box application only.

Lighter grades have less resistance to air flow and hence a lower vacuum will result with a constant volume pump. The medium weight grade offers a higher resistance to air flow. Here the water ring vacuum pump senses this restriction and by the nature of its characteristics tracks the restriction to deliver constant volume at a higher vacuum. Similarly for heavy weight grade The power at all times has remained cconstant.

Unnecessary air flow and power has not been wasted on the light grade which is easier to dry in the press section and dryers. On the heavier grades when the water ring vacm pump pulls a higher than design one can expect water removal at constant horse power.

This characteristic optimises paper dewatering and sheet hardening at the couch, enabling the paper machine to run as fast as possible on all grades. This variable vacuum characteristics also is of benefit when applied to the felt section. The type of vacuum pump compensates for decreasing felt permeability to provide

1. Maximum sheet water removal
2. Increased felt life
3. Reduced down time for felt changes and hence improved productivity.

The seal water reuse system must be used for substantial energy savings. Special consideration must be given for vacuum piping to prevent any unreasonable loss. Pipe line air velocities between 900–1200 meters per minute must be used, determining at 'rare' condition of cross connections are there to use in emergency conditions the losses must be taken care of.

SEVENTEENTH

The efficient drive system is must for the paper machine productivity. The basic requirements of the drive sytem are:—

1. Precise speed regulation for optimal sheet formation and maintaining the accurate draw relationship to the press.

2. Controlled distribution of power input to prevent slip and to obtain optimum wire life.
3. Operator adjustment and indication of speed (draw) and load distribution.
4. Independent operation of the total fourdrinier and specific drive points for maintenance, inspection and w sh-up.
5. Drive equipment sizing to provide proper fourdrinier operation.

The wire turning roll and the couch roll are the major drive points of the fourdrinier, these rolls are always driven. Maximum forming wire life can be obtained by evenly distributing the power input to fourdrinier. A couch roll drive load limiting system may be installed based on couch vacuum. Since sliding friction is less than static friction, shut down of drive may be required to re-establish drivability under slippage condition. The drive regulation system should be designed to prevent slip age from occuring rather than limiting overspeed after slippage has occured. Drive should never be undersized. Oversizing can promote improper operating by masking increased loading and in correct power distribution This may also cause couch and wire turning roll slippage, reduced forming wire life and increased roll surface wear due to creepage

The above consideration is important not only from productivity but also from energy conservation point of view.

EIGHTEENTH

Today's instrumentation requirements are dictated by the need for gaining maximum profit through improved production, more uniform quality and better use of available man power. Some of the automation achievements for today's paper machines are as follows :

— Solid state electronic instrumentation for analog control and for inter facing with computers through computer/manual (C/M) and/or computor/manual/analog (C/M/A) control stations.

— Digital measurement and control of paper machine speeds and draws using solid state silicon controlled rectifier (SCR) motor control.

— Automation systems for the control of basis weight and moisture.

— CRT and logging displays of paper machine operation. Group displays are available to the operator on stock blending and additives, refining, speeds and draws. wet end flow balance dryer drainage, moisture and basis weight profile, and paper machine production.

— Computer control of selected control room design. The newer paper m/c installations have centralised control operation of the paper machine and stock preparation area.

— Improved on line paper machine sensors.

This is of course a separate detailed topic in itself. Control systems and instrumentation should be carefully analysed from the needs of the process and their economic justification. It is important to know how the process operates and what the key relationships are between variables. Then to achieve the best process performance, the correct level of automatic control must be applied, keeping in mind simplicity of the design for operator understanding and dependable equipment operation.

NINETEENTH

In optimizing the wet end for maximum productivity or during design the wet end of the new paper machine this is very much necessary to correlate the engineering aspects with the chemical aids. There are number of chemicals, available which not only increase the productivity but also the wet web strength. A study may be very well formulated on the dynamic drainage jar, vacuum water release analyser and wet web strength tester to get the best results The chemicals are named as retention aids, deflocculants, drainage aids etc. The requirement is to choose the chemical which may simulate all effects.

Following may be kept in mind while designing the system—

1. To achieve efficient use of polymer and pigment the retention aid must be added at a point of good agitation. This might be the outlet of fan pump or perhaps even into the fan pump.
2. A certain amount of time (10–30 secds) is required to build up retention to the plateau level. On a particular machine this time will depend on the

polymer used and on the degree of agitation subsequent to the addition. The paper maker must beware of adding the polymer too close to the head box.

3. Retention aids of high molecular weight and high charge density provide good retention by the electrostatic patch mechanism. Disrupted flocks reform relatively quickely and completely. Such polymers should be most effective when time for recovery is available after points of strong agitation.
4. Polymers of high molecular weight and low charge density form a more shear resistant floc (that the high charge density type) via the bridging mechanism. Filler and fines retention is high. Flocs disrupted by very strong agitation will not reform completely even with longer recovcry times. The polymer to be used on a particular paper machine must be tailored to the characteristics of the stock handling system and the machine.
5. Poor retention caused by sta ch in the wet end can be overcome by larger dosage of retention aid or by enzyme treatment to degrade the starch.
6. Carryover of pulping and bleaching liquors can reduce filler and fines retention. For some liquors a combination of polymer and alum can improve retention economically.

TWENTEETH

Correct choice of the clothing is one of the most important field to get the maximum productivity There has been tremendous invariations in clothing designing. The rightful application of these new techniques could yield advantages in the form of improved production. cost reduction and energy conservation. The most important characteristics of the wire affecting the sheet forming are—

— Open area.
— Permeability and flow resistance.
— Wet penetration into wire surface voids.

For metal wires, a few characteristics like wear and corrosion resistance, open area and permeability are almost sufficient but for synthetic wires, wear, corrosion resistance, mechanical stability and runnability of wire are also important. For stability of wire following may be taken into consideration :

— Wire must be prestretched by a heat getting treatment.
— Design may be chosen which involve a larger extent of MD orientation of the strands.
— double layered wires have more stability.

Vertical mass distribution is very much important. This may vary from one wire design to another, open area remaining the constant.

The chosen wire must give optimum retention and drainage. In this context permeability of wire is important. Permeability may very well be judged by the pyhsical characteristics of wire e.g. the normally used formula for vertical pressure drop, dp/dz suggested by Irmay for through isotropic porono media may be used.

where

U	= flow speed	μ	= fluid viscosity
Su	= spec. surface (Vol. basis)	α	= Kozeny's factor
		ϱ	= Density of liquid
E	= Pore fraction	β	= Constant

From above equation it is clear that pressure drop caused by the void volume t and the specific surface Sv of the material is quite important. The turbulent flow component is of significance only during the very initial stage of sheet forming As it is at this stage that the wire really influences drainage, this component should not be ignored.

Second aspect is the wet penetration into wire surface voids, causing drainage wire mark. This wire mark depends very strongly on mesh counts, increasing with decreasing mesh numbers. The relative dimensions of the stock fibers is very much important in this respect. With the same mesh number, one may have a series of different designs, varying in the surface appearance. If the fiber be treated as straight beam this deflection ($\triangle\gamma$) may be given as :

$\triangle\gamma$ = deflection
L = Distance between supports (strands)
E = model of elasticity of fiber
L = Moment of inertia of fiber
K = constant
L = distance between two wires
P = flow pressure

Fiber support index (FSI) is a important parameter to characterize a wire. FSI is critical for every machine and raw materials used.

So we may say that one general characteristic of the new generation wire designs is a lower number of sheet supporting wire knuckles. The average knuckle length has increased. To increase the number of supports and for other reasons it seems reasonable to assume that in years to come there will be trend towards wires with higher mesh numbers.

CONCLUDING REMARKS

By following the above said '20 POINT PROGRAMME' the productivity of a mill may be enhanced very well.

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