Suction Couch Wasted Volume (Couch Vacuum can be eliminated on Modern Machines)

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ABSTRACT

Couch vacuum application on modern paper machines with suction pick ups is less critical. The couch roll vacuum is very inefficient at and above the particular machine speed range due to rewetting leaving the couch than entering, in which case the entire power of the vacuum has been wasted and the vacuum pump can be stopped.

INTRODUCTION

Suction couch roll was invented and employed in the year 1908. It became possible to increase machine speed considerably with the use of suction couch. It is the next element of the paper machine after the flat boxes. The suction couch helps drainage and improves the strength of paper web in such a way that it can be carried away through the presses. Suction couch removes free water from the paper web.

Suction couch is generally installed on modern machine (close draw with suction pick up) and has perforated shell. Inside the shell there is suction box connected with vacuum pump.

Vacuum in the box evacuates capillary spaces and removes free water along with the air stream following through the fibrous material. Part of the free water removed from the web gets through suction box and rest stays in the holes of the shell from which it is later removed by centrifugal force. Amount of water which stays in the holes and does not pass through the suction box increases with the increase of the machine speed.

On high speed machines during drainage of the web on suction couch at about 90% of water (expelled from web) stays in the shell perforations. This water is thrown out by centrifugal force on run. Remaining water at about 10% falls in the centre of suction box and is removed by vacuum pump[1].

Sheet rewet may be a significant problem with suction couch rolls. In severe cases, the sheet remains more wet while exiting the couch than entering. Rewetting might have occurred before and after the suction box. Rewet ahead of the box occurs when the water film on the roll surface transfers to the bottom of the sheet. This rewet causes the couch roll to run dirty. The high pressure cleaning and corrosion inhibitor showers compound the problem.

Many observations will be written about the couch roll elimination in future trends. Likely it will

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disappear from all paper machines over 450 m/min with suction pick-ups. As speeds have increased, the efficiency of the drilled couch has decreased.

WHY IS THIS SO?

There is number called the "WASTED VOLUME OF THE COUCH"

The vacuum pump continually pumps out of the couch shell, as a result of the differential pressure (ΔP) going to zero when the outgoing seal strip passes. Then when this same area rotates to the ingoing seal strip, the vacuum pump has to pump this same volume again. When some numbers are considered it is seen for the wasted power as machines get wider and faster.

The wasted volume, $W_v = (D.A.).(W).(U).(t).(\Delta P)$

W_v = Wasted volume (m^3/min)

D.A. = Drilled Area of suction couch roll (%)

W = Drilled Width (meter)

U = Machine Speed (meter/sec)

t = Couch Shell thickness of suction couch roll (meter)

ΔP = Vacuum Level at suction couch box (mm of Hg.)

For example,

If consider a machine 9.15 meter wide running at 731 m/min (12.2m/sec) with a couch shell thickness of 0.0635 meter and a drilled area of 28% operating at 500mm of Hg, the wasted volume is :-

$W_v = 9.15\ (12.2)0.0635(0.28)500/760 = 1.3\ m^3/sec = 78 m^3/min$

With Machines getting wider and faster, it can calculate for 1341m/min (22.35m/sec), 10.98 meter wide, and other dimensions as above, the Wv is 2.87 m^3/sec or 172.23m^3/min.

If energy costs Rs. 32,867 per horse power per year and about 0.71m^3/min per horse power, the yearly cost to pump out the couch is (172.23/0.71)* (32867) = 79,72,790.

To justify this cost, the paper maker must get maximum operating efficiency by drying the sheet to minimum 20% o.d. before entering the couch.

EXPERIMENTAL

For some other reason it was noted that even at low vacuum level on couch no changes in dryness after first press with suction pick up occurred because of the required dryness availability before first press nip.

The experimental studies were carried out for the rewetting phenomena at couch vacuum in a high speed machine to know whether it has either speed limit or not.

The sheet dryness at various places with couch vacuum were tested cited in Table-I.

Couch suction vacuum pump motor of 250 kw kept shut i.e. zero mm of Hg at couch and again dryness at various places were exhibited and tabulated as cited in Table-I.

The paper runnability and quality noted for lowering down machine speed upto 450 m/min without couch vacuum and no other changes at backhand were found. The dryness before the suction pick up however if requires still more can be increased by developing flat boxes vacuum level.

Table-1 Average paper dryness at various places with and without suction couch

	With couch vacuum	Without couch vacuum
Dryness after couch	16.0% to 18.0%	13.0% to 15.0%
Dryness after first press	37.0% to 39.0%	40.0% to 41.0%
Dryness after second press	41.0% to 42.5%	41.5% to 43.0%

Table-2

	M/c speed (m/min)	M/c width (meter)	Grades (gsm)	Furnish	Trimmed sheet width (meter)	Suction pick up Vac level (mm of Hg.)	Forming fabric
With couch	270 to 470	4.1	120 to 54	Bamboo-30 to 40% Acacia/ Eucalyptis 10 to 5% Casurina -60 to 55%	3.50 to 3.62	250 to 300 (uni-press-60)	Double layer
Without couch vac.	----do----	--do--	----do----	----do----	----do----	----do----	---do---

	Pick up roll vac. doctor vac. level (mm of Hg.)	Pick up felt uhle boxes (mm of Hg.)
With couch vac.	200 to 250	250 to 300
Without couch vac.	----do----	----do----

°SR After Stock Refiner	°SR At Head Box
25 to 32	29 to 36

RESULTS AND DISCUSSION

It was noted that when sheet was running without couch vacuum the dryness after first press had no significant effect compared with the dryness with couch vacuum and the runnability and quality remained as usual. In view of an ineffectual reason the author realised that vacuum on couch had no significance for the dryness after first press with suction pick up and the machine and to run continuously by stopping the couch vacuum pump motor further.

During no use of couch roll vacuum the following parameters must be maintained :-

i) Flat boxes vacuum level from 200 to 305 mm of Hg, for double layer and above forming fabrics.

ii) Pick-up suction box vacuum level from 405 to 500 mm of Hg.

The above phenomena is also supported by V.E. Hansan and John C.W. Evans.

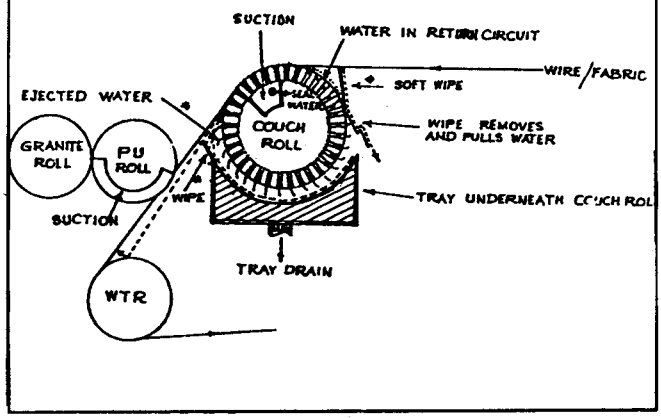
Hansan[2] points out that "Vacuum applications to couch rolls is very inefficient" and suggests that "suction couch rolls could be eliminated" on many modern machines with substantial reduction in capital and operating costs.

Evans[3] also reported on two newsprint machines in Finland operating at 610 m/min speed with suction pick ups and "No vacuum on couch rolls."

As per their critical investigations the unsatisfactory factor is the amount of water the couch carries. As soon as it passes the outgoing seal it starts to "throw" the water . Beyond 610 m/min it becomes impossible to clear the suction holes. The water film rides the couch surface re-wets the sheet at ingoing nip before the suction comes on the couch. This condition is gradually started on every drilled couch running over 488 m/min which represents the water returning to the sheet, lowering the consistency, and then suddenly being "jerked" out by the high differential pressure (ΔP) at which the couch is operating.

If the water film is 1 mm thick on a high speed machine running at 610 m/min on a 49 gsm and if the sheet leaves the hivacs (flat boxes) at 15% b.d., then at the moment of rewetting, the consistency has dropped to 3.5%. When this happens the couch runs

FIGURE-1
COUCH ~ PU ~ WTR AREA



very dirty, and has to be cleaned regularly. If the seal water is also turned on high it gets the situation where the sheet is wetter leaving the couch than entering, in which case the entire power of the vacuum pump has been wasted.

On the outgoing side of the couch, the water being "thrown" out is often picked up by the pick-up. When the pick-up is close to the couch, some of this effluent is sucked up into the felt, resulting in dirty felts. When pick-up is half way between the couch and the wire turning roll, this stream of water is very close to the fabric. Some operators "bleed" a hole in order to get the effluent directed downwards away from the fabric. The final situation is where a tremendous mist develops under the pick-up. This is continually drawn into the pick-up. It is possible to install a soft wipe bearing against the fabric and solve this problem. There is no danger to the fabric with a soft wipe as illustrated in figure-1.

CONCLUSION

Couch vacuum is applicable significantly on high speed open draw machines for operating efficiency to get the required dryness of the sheet off the couch on the other hand.

Considering with close draw high speed machines with suction pick up a suction couch is always loaded with fibres, and is the reason that couches are so costly to maintain apart from the seal strips and to get rid of these costs the opportunity of the recent theory and formula must be taken for consideration to stop the wasted volume at couch and save further energy and huge wasted cost.

The author's estimation for the annual savings for his present 100 tpd machine is Rs. 60,00,000 (Rupees Sixty Lakhs) approximately in 300 days run.

SAVING POINTS :

1. Couch vacuum pump motor (250 kw)
2. Couch vacuum pump sealing water
3. Couch drive motor dragload reduction
4. Couch vacuum pump driving flat belt
5. Couch suction box maintenance
6. Couch vacuum pump and motor maintenance
7. Couch roll shower water
8. Increased wire life to some extent

Special requirements may be included :-

i) Rubber covered couch rolls with doctors to remove dirt.

ii) Reduced load on the couch roll by transferring some of the load to the "Wire Turning Roll"

iii) Running high head box temperature to increase dewatering on "Foils" and "Flat Boxes" ahead of the couch.

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