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It is often overlooked that a properly designed and operated vacuum system is absolutely essential for the operation of a paper machine in order to obtain the most economical and profitable paper production.

When major design changes are made on an existing paper machine, new demands are also imposed on the vacuum pump installation in order to adjust the vacuum system to the new requirements. The capability of the existing vacuum system must be evaluated and the totally revised requirments must be established. If the machine under reconstruction is equipped with Nash vacuum pumps, expert technical evaluation could reveal that new requirements can be sometimes achieved without installation of additional vacuum pumps because often, the capacity of Nash pumps can be expanded by an increase in the speed of the pump, or a rearrangement of the existing units, taking the best advantage of the flexibility of these pumps. However, more often, additional vacuum capacity will be required which, again, due to the flexibility of Nash pumps, can be expanded without major changes in the overall pump and piping layout. There are at least three problems encountered with paper machines

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# Vacuum Pump Requirements on Paper Machines

which can be traced back to an inadequate vacuum system :

- 1. A high wet end break frequency
- 2. A low sheet dryness after presses
- 3. Felt plugging and/or felt wetness

While in the process of modernizing an existing system, improvements on the above can and must be made, but to achieve the objectives, first of all, it must be established which suction points require upgrading. A survey of the vacuum conditions must be conducted on the basis of of worldwide accepted TAPPI vacuum selection factors from which the displacement and degree of vacuum has to be calculated and determined with respect to the vacuum suction point open area. Briefly some of the changes on suction point requirements can be outlined as follows:

# 1. Wire Boxes

Vacuum is used to compress the wet sheet on the wire and to remove water from the capillaries by passing air through. The effect of vaccum on sheet dryness shows that a higher dryness is obtained if the vacuum is increased step-wise from flat box to flat box. There is an interesting trend in the U.S. to increase the vacuum in the wire suction box area. Due to lower wire abrasion by the use of high quality suction box covers. some mills increase the vacuum up

to the level at which the wire marking becomes intolerable.

#### **Practical Suggestions :**

- a. Install means for reading and controlling the vacuum on each box.
- b. Check that the pipe lines between the boxes and vacuum pumps are as short and straight as possible without sacks where water can accumulate.
- c. Check that water separators and drop legs function properly.
- d. Check that the vacuum readings are steady. Fluctuations often indicate malfunctions or deficiencies within the machine and piping.
- e. Check on the rate of drainage from each flat box and adjust the vacuum to assure that drainage is sutiably divided between the boxes.

# 2. Couch Roll

Frequent wet breaks are quite often a sign of insufficient vacuum and dryness produced by the couch roll. The sheet, depending on the grade of paper, reaches the couch at 10-15% dryness and leaves it at 20-30% dryness respectively (bone dry). The dewatering on the couch increases linearly with the vacuum, but only up to a certain level-presumably, where all the capillaries have been emptied. It is our opinion

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that an additional investment for vacuum for capacity will be justified in all cases where dryness remains considerably under 20%. Practical Suggestions :

- a. Check sheet dryness after the couch with respect to paper weight, machine speed and vacuum.
- b. Estimate the possible effects of increased couch vacuum on the sheet dryness and break frequency.
- c. Measure the take-off angle from the couch. The higher the angle, the lower the tension during transfer.

# 3. Presses

It is important to recognize that the suction press roll does not suck water out of the sheet or felt. In the press nip, water is pressed out of the sheet in the felt and from the felt into the holes of the suction roll. The vacuum sucks the water-or rather, the mist from the press holes into the suction box and further to the Nash pump.

We are in a position to state that the press section is quite often the limiting factor in the rate of production. Disregarding new design developments for the press section, it is always a question how to achieve maximum dewatering within minimum time without loss of production and quality. Partially, this is being achieved by th usee of improved felts and often by the change of press designs and configurations. In considering improvements on the press section, paper makers are faced with either to change the press design, or to rebuild and modernize the entire press section. A

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trend exists to use grooved press rolls which, however, should be recommended for use only at the second and third press positions as wringers.

It is not the purpose of this presentation to list and discuss the various press designs which we leave up to the experts in this field-the paper machine builders. But we can add to their experience that the full dewatering capacity effect by the use of the improved press roll designs can be achieved only with a correct layout and/or adaptation of a proper vacuum system to suit and serve these new press rolls. Only a sufficiently dewatered and cleaned felt will be helpful.

#### **Practical Suggestions :**

- a. Check the sheet dryness before and after each press.
- b. Provide for efficient continuous felt cleaning to assure that the felts are not plugged.
- c. Assure that the felt dryness when entering the press nip is sufficient to absorb the water from the sheet without restriction by hydraulic pressure in the felt at the nip.

#### 4. Felt Cleaning and Dewatering

One of the best ways of improving the performance of old press sections is to provide means for better felt cleaning and dewatering A properly dewatered felt will receive more water from the sheet in the press nip. Often, considerable improvement can be obtained by more efficient felt cleaning and drying.

In view of the change in the more

open and/or synthetic felt, a considerable increase in vacuum displacement is required. For some felt products, the vacuum displacement capacity has to be doubled in accordance to obtain proper cleaning and drying of the felts. The exchange of felts of different type and quality will change demands on the vacuum installation. The air volume passing through the felt can vary up to 70% for new felts and an additional change of suction volume can occur during the time the felt is in operation. We are therefore, of the opinion that for. operating the various types of felts, or for a general changeover of the paper machine to other types of felts, a Nash multi-vacuum pump system will be of considerable assistance for the adjustment of the displacement requirements than a socalled central single blower system.

Felts with a strong tendency of blinding require a high volume of cleaning water. Due to insufficient dewatering, the press section can be flooded by the residual water. A decrease in paper dryness and in the worst case, a break of the web will follow. Furthermore, insufficient felt dewatering can result in a shorter felt life.

The effect of the felt suction tubes to clean and dewater at the same time can vary considerably between conventional woolen and synthetic felts. It has been reported that the results of several tests which were made, show that the cleaning intensity of the suction tube under constant vacuum will increase with the decrease in slot width. However an undersized slot will have less water

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removal capacity; therefore, some recent installations are equipped with two parallel individual slots. It is being reported that a 10-12 mm slot provides with optimum results in cleaning and dewatering. The use of a second tube or slot after the first one may increase the water removal as much as 50%.

#### **Practical Suggestions :**

- a. Check that the in-going press nips are not flooded. This indicates that the felts hold too much water when entering the nip.
- b. Check the felt moisture before and after the nip. A good clean felt should carry water out of the nip to be removed by the felt suction boxes.
- c. Assure that the box sealing surface is smooth and in good condition.
- d. Check that the vacuum in the tubes is correct in accordance

with the requirements for the felt used.

A few words should be said regarding the application of a multiple pump Nash installation which permits considerable flexibility to meet changes in operating conditions and mechanical improvements in the suction boxes. The above suction points require low, medium and high vacua areas which can be readily achieved by the use of a Nash pump which, depending on the selection of the proper cones, will provide different compression ratios. Furthermore, this flexibility can be utilized on an application for which a pump previously used on a low suction point can be changed later on to produce a higher vacuum by the simple change of the cones. A further advantage of this pump design is that the two inlets permit to handle two suction points at different vaccum levels separately, providing that the vaccum diffe-

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rential does not exceed 8" Hg.

I wish to take this opportunity to point out that we consider it of the utmost importance to cooperate with design engineers responsible for new paper mach ne design and improvements and with project engineers responsible for the changes in operating conditions. We are ready to assist our clients and to share our experience with them and we wish to emphasize again not to overlook the very important fact that the undersizing of a vaccum installation will cause a considerably higher input energy requirement at the dryers to compensate for insufficient drying of the web at the wet end and press sections.

I have purposely omitted discussing a number of specific cases during this brief lecture which I trust I can answer on an individual basis at your convenience.

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