Energy Saving Potential in Dryer Section

Panigrahi C.S., Goyal Sunil and Khamroi Anirban

INTRODUCTION

With the cost of energy increasing every day, the need for adopting measures to save energy has become very important. Various reports and surveys indicate that steam energy used in any Paper Mill is substantially (4 to 6 times) Higher than the total electrical energy used. Since the Dryer Section consumes the major part of the steam, the performance and efficiency of Dryer Drainage and Steam Control System merit a critical analysis.

To achieve reduction in steam consumption in Dryer Section following need to be done:-

> Increase in off-press dryness with Shoe Press

> Efficient Steam & Condensate System

> Prevention of non-condensible in Steam

> Use of Thermorims to enhance heat transfer

> proper Hood and Pocket Ventilation System

This Paper seeks to highlight the possible short comings in a Dryer Section and aims to suggest ways and means in achieving steam economy.

SHOE-PRESS-Key to higher dryness after Press Section

Over the past decade the shoe press has established itself in machines for board and packaging papers. However, the first application worldwide of a shoe press in a machine for Newsprint

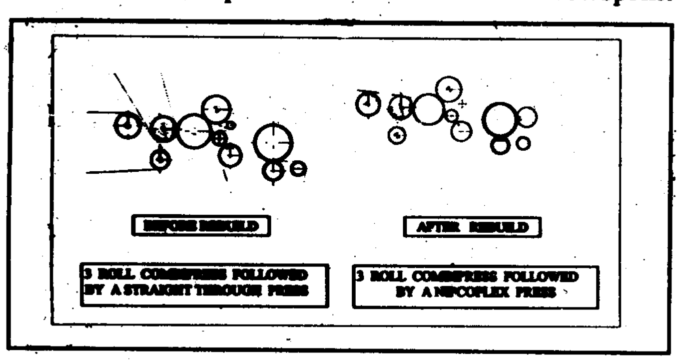

Fig. 1

and the excellent results obtained thereof have opened up a very broad area of investigation. This Shoe Press, put during a machine rebuild in Switzerland, has helped to achieve high dry content of 49-50% even with the basis weight range of 35-50 g/m² and at operating speed upto 1160 m/min. The results achieved are shown below which proves that with a Shoe Press higher dryness is achievable without compromising of Bulk:-

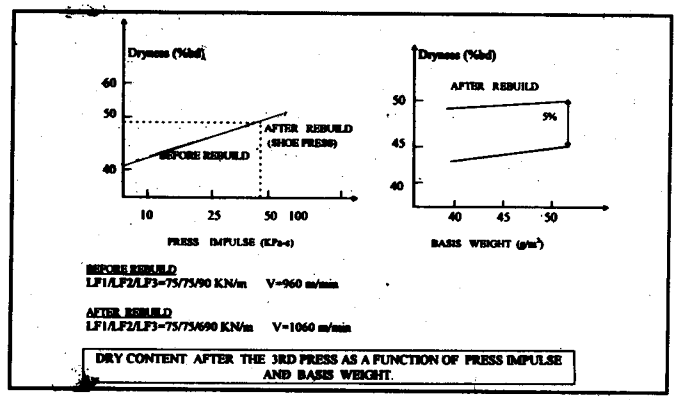

Fig.2

Another Shoe Press for writing and printing paper went on stream in a paper machine for wood free copy papers in September 1995. A 3-nip Press

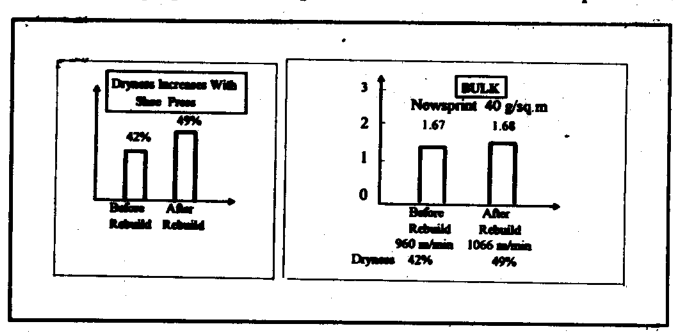

Fig.3

Larsen & Toubro Ltd.,

Paper Division,

1B. Park Plaza, 71 Park Street, Calcutta- 700016

with integrated shoe press in the third nip position has become operational in 1996 in a Newsprint machine operating at 1700 m/min. The results obtained are equally encouraging.

The success of the shoe pressing concept in all grades of paper has given the Paper Industry a tool to increase the off press dryness by atleast 5% compared to the conventional press section. The use of a steam blow box on the suction roll increases the dry content after the press by an additional 1%.

Since every 1% increase in off-press dryness reduces the drying capacity requirement in Dryer Section by 4-5%, the size of Dryer Section and steam energy consumption can be radically reduced with the Shoe Press Concept. It is thus expected that using Shoe Press, the steam consumption can be brought down by 28-30% which definitely gives excellent production economics. The higher initial investment can be made up with drastic cut on dryer section investment and operating cost.

Steam Consumption in Dryer Section

A Dryer Section in a Paper Machine uses steam for:

SHEET HEATING	Heat required to heat the sheet to evaporation temperature is determined by entering sheet temperature.
EvAPORATION	Heat required for ecaporation is essentially fixed and depends on moisture content at dryer Section inlet.
AIR HEATING	Depends on Hood System and air supply temperature.
NON CONDENSIBLE BLEED	Bleed steam is used for removing non-condensible.
VENTING	A good dryer drainage system never vents steam to maintain differential pressure in the dryers. Unfortunately some machines use as much steam for venting as for drying the paper.

IMPORTANCE OF STEAM & CONDENSATE SYSTEM

The steam consumption related to the above areas depends mainly on Steam and Condensate System. Infact, the design and fuctioning of the steam and condensate system have the most significant impact on steam use and drying rate. The basic requirements for an efficient Steam & Condensate System are:

- \> Properly sized and located close clearance siphons.
- \> Ability to develop adequate and controllable differential pressure across the steam joints.
- \> properly designed equipment and piping.
- \> prevention of non-condensibles in steam.
- \> Simple system design and operator friendly controls.

Each of the above factors have a major contribution in steam consumption and only an optimum design can ensure economic steam usage. The importance of the above factors are highlighted below.

Proper Sizing Of Siphons

The heat conductivity of cast iron is 85 times that of water and it is, therefore, of paramount importance that for maximum efficiency in heat transfer and energy usage, the condensed water must be removed rapidly, continuously and uniformly.

Efficient dryer drainage requires siphon of appropriate size, which, in turn, depends on two critical factors:-

- \> The mass flow of blow-through steam must be sufficient to entrain the condensate and carry it away.
- \> The velocity in the siphon pipe also must be sufficient to ensure that the condensate is carried out of the dryer.

Undersized Siphons

If the siphons are undersized, it requires high differential pressure to generate a flow of blow-through steam capable of efficiently removing the condensate. Since operation at such pressure is difficult, such system operate with marginal blow-through flows causing

> Dryer flooding
> Inconsistent dryer operation
> Non-uniform CD temperature profiles

Oversized Siphons

If the siphons are oversized, it requires very high blow-through steam flows to create enough velocity in the siphon pipe to guarantee efficient condensate removal. The high flow of blow- through steam will create problems outside the dryers.

Steam & Condensate lines are usually too small to handle such high flows. If it is a cascade system, the dryer groups receiving the blow through steam may not have enough condensing capacity to handle the excessive load of steam. Any small change in differential pressure will cause large changes in the blow through steam. Hence the system will not be able to operate at the full efficiency.

Design of Condensate Lines

The condensate lines handle a mixture of blow-through steam and condensate.The pressure-loss characteristics of a two phase mixture of steam and condensate results in high pressure losses. Pressure loss in the lines should be minimised.

Velocities must be kept low in the lines outside the dryers. The number of elbows and fittings in the condensate lines should be kept to an absolute minimum. Elbows should be of long radius designs.

An undersized condensate or steam line can cause dryer drainage problem. Hence the calculation of the pipe line diameter for the condensate mixture should be based on the blow-through steam rate and not on the condensate rate. It is important that the pipes for the blow-through steam are large enough and that no additional resistance has a negative effect on the differential pressure.

Steam and condensate piping should be designed for:

> Minimum available steam pressure
> Maximum anticipated pressure drop

This is because that with decrease in steam pressure, the specific volume increases causing high line velocities and pressure loss.

Presence of Non-Condensibles

The presence of non-condensibles like air in steam should be prevented because:

> It reduces drying capacity
> It gives a false impression of steam pressure as is evident from Dalton's law of partial pressure.
> Dryer steam temperature is lowered proportionately to the amount of air in the steam mixture. As a result dryer surface temperature will drop a great deal due to loss in heat transfer.

APPLICATION OF THERMO RIMS

At speeds in excess of 400 m/min a condensate rim forms in the dryer, which is kept in considerable turbulence by the influence of gravity, with a relatively favourable transport of heat through the condensate. This turbulence dies out with growing speed and a largely stable condensate layer is formed which reaches a thermal resistance (as early as at 2 mm thickness and speed around 800 m/min) which is twice that at the dryer wall itself. Thus the layer of water between the steam and the cylinder shell causes a severe restriction to the heat transfer.

The condensate in the condensate rim is retarded as a result of gravity at the upward rotating dryer side relative to the dryer wall and accelerated at the downward rotating dryer side. Hence, described relative motion of the condensate may be disturbed by means of axis-parallel bars of thermo rim at the interior wall of the dryer. This imparts increased turbulence to the condensate, creating improved heat transfer through the condensate layer.

Depending on the operating conditions, the improvement can be clearly ascertained at speeds beyond approx. 600 m/min.

If the thermo rims are installed, increases in the drying capacity of 5 to 15% can be achieved. While for new machines of higher speed, thermorims are now routinely recommended, the existing mills operating with old dryers can obtain increased drying capacity and production by installing thermorims inside the dryers. Thus effective steam consumption can be brought down. A number of machine rebuilds and new machines put up by Voith Sulzer and L & T have proved this point beyond doubt.

DRYER AIR SYSTEMS

Proper operation of the dryer air systems has a significant impact on energy use. Enclosed dryer hoods have lower energy consumption than open hoods because of reduced dryer radiation loss. Closed hoods also improves heat recovery potential, because of higher temperature exhaust air. They also require much less amount of heated make-up air compared to open hoods.

The rate of evaporation from the surface of an exposed sheet is increased by lowering the vapour pressure of the air in the immediate vicinity of the sheet. This is most easily accomplished by increasing the flow of air across the surface.

The basic requirements of a Pocket Ventilation System are:

> To provide maximum drying capacity through full width high-volume ventilation so that the atmosphere around the sheet in the pockets is at a low humidity condusive to optimum mass transfer.

> To provide uniform CD drying profile by inserting sufficient volume of air in the pocket.

> To provide proper hood air balance (supply vs exhaust) to prevent hood sweating.

The PV air distribution down the length of the machine must be properly fine tuned based on the actual evaporation curve of the machine. This will optimise energy usage and help to achieve hood air balance.

CASE STUDY- recent experience

We were approached by one of the major paper producing house in India to eliminate their dryer problems leading to production bottleneck in two of their machines. The major problems faced by them were:

> Poor condensate removal and dryer flooding.

> Inconsistent drying and uneven moisture profile.

> High dryer drive load and tripping.

> High steam consumption

The problems were identified and complete solution provided in form of a properly designed steam & Condensate System with latest design of steam joints and stationary siphons. The results obtaines were spectacular as the problems were eliminated and dryer performance optimised leading to increase in production. The steam consumption also came down significantly.

The high speed Newsprint machine supplied recently by Voith Sulzer- L &T has achieved steam consumption of upto 1.4 ton/ton of paper.

The above cases prove that steam economy is very much achievable and needs special attention and expertise.

CONCLUSION

Since average steam consumption on Paper Machines in India is about 3 ton/ton of paper, steam energy usage can be drastically cut down with the means described above. The proper solution can be obtained only when all the factors are taken care of. This, however, enjoins upon the machine builder and paper maker to work together and make all efforts in this direction. The proposals given above seek to provide a few tools towards achieving this end and when implemented, the result will speak for itself.