The Removal of Condensate & Air From Paper Machine Drying Cylinders

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The out put and quality of paper made on a continuous machine is so much a function of the control of heat transfer in the drying cylinder that any factor influencing this are bound to affect the productive capacity of the machine. Heat transfer is greatly affected by efficient cylinder drainage and by the non-presence of air in the drying cylinders. The subject of condensate and air removal is, therefore of supreme importance to the paper maker so far as output and quality are concerned and to the Engineer from the economy view point.

The efficiency of each cylinder as a unit depends on it having an efficient and controlled steam supply and efficient means of carrying the condensate from the bottom of the cylinder, where it naturally collects to the exhaust nozzle and thence to the condensate collecting main.

Most machines are fitted with a valve for controlling the steam supply to the cylinder and the pressure drop between the steam supply main and the cylinder face is simply a matter of pipe sizing. The design of water lifters still causes considerable controversy and the relative merits of bucket and siphon type water lifters is still being discussed at length. There seems to be agreement that above certain speeds the centrifugal action of the water in the revolving cylinder makes the use of siphon pipes necessary, but here are a few further comments which are worthy of consideration.

When cylinder steam pressure is lower than that needed to overcome the hydraulic head of condensate in the siphon pipes, then bucket water lifters are the only practical means of keeping the cylinders free from condensate, other than running the exhaust main under vacuum and from a practical point of view. But the bucket must be of such capacity that their displacement multiplied by the cylinder evolution per hour is greater than the rate of condensation in the cylinder otherwise water logging is inevitable. This is most important on machines run on low speed and a heavy rate of condensation because unlike the siphon pipe, the capacity of a bucket water lifter varies directly with the machine speed.

When syphon pipes are used it is an advantage as will be seen later, to keep the pipe bore as small as possible. This has the double advantage of allowing a greater cross sectional area amount for steam flow through combined nozzle and reducing the unsupported weight of the siphon.

As a matter of interest the frictional loss in a $\frac{3}{4}''$ in bore siphon pipe 5′ long when carrying 800 lb of condensate per hour is only $\frac{1}{2}''$ water. Larger siphon pipes have therefore no practical advantage in reducing frictional loss.

It is when we come to consider the discharge of condensate into the common condensate main that we must decide whether we are draining the cylinders as units or the machine as a whole.

It is still common practice to collect the cylinder exhaust in to a common main and to drain this main either by a large trap or by a drop log system. Both these arrangements amount to the same thing in that the pressure in the condensate main is the same for all cylinders and it follows that, as each cylinder is connected to this main, the cylinder, too must run at a constant pressure. So on a system of this kind control of temperature radiant through the machine can only be achieved by reducing the heat output of some of the cylinders by partial water logging. The obvious result is a reduction of output and difficulty in keeping sufficient control of temperature radiant.

From a fuel efficiency point of view the system is undesirable as it means an increase in steam consumption per lb of paper; the reason being, of course that whilst radiation losses from the machine remain reasonably constant for different outputs, their ratio to total heat consumption increases with reduced output.

If it is agreed that from the steam point of view, each cylinder of the machine is a unit then surely the rational way of ensuring correct drainage is by treating each cylinder separately, that is by fitting a steam trap on each cylinder separately, which is correctly designed for the job it has to do and is of sufficient capacity to deal with all variations of condensate load and steam pressure.

As condensate is formed in each cylinder continuously, it is reasonable to use a steam trap which will give a continuous discharge and a simple float type trap most nearly meets this condition in the design of trap. However certain peculiarities of cylinder drainage should be noted. When a float trap is fitted to an individual cylinder with a siphon pipe water lifter the condition will often occur when the trap has for the moment, discharged all the water and the siphon pipe, nozzles and trap are fitted with steam. The trap will then be closed and will not open again until more water reaches it. But the water is collecting at the bottom of the cylinder and cannot reach the trap until the steam in the siphon pipe surrounded by the steam can condense and until the heat lost from the nozzle and the trap causes condensation of the entrapped steam, the trap will not open. This may take quite a time during which condensate will be building up in the cylinder and reducing the surface temperature.

During the time the trap is discharging the condensate is being forced by steam pressure up the siphon pipe and the pressure on the condensate is being reduced. The reduction in pressure causes flash steam to be generated and flash steam may collect in the trap and cause it to close before it has, infact released all the condensate.

To overcome these difficulties, it is necessary to use traps on cylinders which are capable of releasing the entrapped steam. It is usually done by fitting a small adjustable valve which bypasses the main valve.

Where bucket type water lifters are used steam locking may occur when steam passes into the nozzle and trap during time the bucket is filling. When the bucket reaches its discharge position, the steam in the trap has not time to condensate and so allow the bucket full of condensate to be released by the trap. Again a trap fitted with a steam lock release is essential.

The presence of air and other incondensable gases in any steam heated plant tends to reduce heat transfer and output. It is particularly the case in Paper Machine drying eylinders because of the large volume of air which collects in them when the machine is not under steam and because of the comparatively low steam pressures at which they work.

The air which is initially present in cylinders must be released as completely as possible otherwise it reduces the temperature of the steam/Air mixture which is formed when steam is turned on. Air removal from cylinders when machines are starting up can, as you are aware, reduec output for many hours after starting.

The most serious effect of air however is that it is carried to the cylinder wall by the condensing steam, where it is deposited in a layer of varying thickness. The conductivity of air being extremely low, even the thinnest deposit of air easily interferes with heat transfer. The fact that air does not deposit evenly over the cylinder face leads to differences in surface temperature across the cylinder face. It is for this reason that the presence of air in the cylinder is perhaps even more serious than that of condensate because of its effect on quality as well as output.

Individual trapping cylinders will not cure air trouble but it can be overcome by fitting automatic airvents of sufficient capacity at each condensate nozzle.

Quick release of air when starting up a machine, not only decreases the time taken to bring the machine up to normal temperature. But also reduces the amount of air which can mix with the steam and deposit on the inside of the cylinder face.

Wet-end cylinders can be run under vacuum by maintaining a still higher vacuum in the condensate main and provided the traps and airvents are correctly chosen and installed, the condensate main vacuum will in no way interfere with the control of other parts of the machine.