Thermal insulation of drying cylinder ends

CROASDALE MARK.

SUMMARY

A large number of surveys of machine dryer sections has confirmed that large savings can be made by the thermal insulation of Drying cylinder ends. The THERMOLATOR(R) has been developed to achieve this aim with none of the shortcomings and practical disadvantages of previous attempts.

The use of advanced fibres in the from of a one piece needled wadding covered with aluminised woven glass fibre has ensured effective insulation with the advantages of light weight, flexibility and non-flammability. Special methods of fastening ensure easy installation and maintenance. Steam consumption reductions of the order of 5% c an be achieved.

Because of the large amounts of energy used in the Paper Industry, costs have always received a great deal of attention, but never more so than at present with the prospect of ever increasing fuel bills. With energy costs now representing a large percentage of production costs, a small saving can mean a significant improvement in productivity and make the difference between profit and loss.

By far the greatest consumption of steam in the paper making process takes places in the drying section and it has long been known that due to the design of a typical drying cylinder, heat is lost unproductively from the cylinder ends. Consequently, attempts have been made in the past to apply thermal insulation. However, what seems at first a simple idea, when looked at in detail becomes problematic and many previous attempts have either failed in service or been abandoned in the face of practical problems such as the lack of suitable materials and difficulties of access for maintenance.

Thomas Hardman & Sons have therefore embarked on a cylinder end insulation project with two main object in view :

a) To establish exactly what savings can be achived.

b) To find a practical and cost effective way of achieving these savings.

CYLINDER END HEAT LOSSES

A theoretical appreciation of heat transfer from drying cylinder ends was a first requirement. Heat is lost by three processes :

1. Radiation.
2. Conduction from cylinder end to atmosphere and from journal to bearings.
3. Convection, both induced and forced by the rotation of the cylinder.

Since most cylinder ends are cast iron and of a similar thickness, there are five remaining variables which effect the rate of heat transfer. They are :

1. The cylinder diameter—heat transfer is directly proportional to surface area.
2. The pressure of steam fed to the cylinder (and the degree of superheat). The greater the temperature difference between steam and surrounding air, the greater the flow of heat.
3. The temperature of the cylinder end surface.
4. The ambient temperature adjacent to the drying section.
5. Tne speed of rotation.

A calculation has been developed, based on these variables which utilises estimated heat transfer coefficients and average thermodynamic properties for air which gives valid estimates of actual heat loss. Field trials of cyclinder end insulation in North America have shown that the calculation can be verified empirically and that real savings actually tend to be greater.

A computer programme has been devised to make this calculation rapidly and allow one variable at a time to be changed, so that the effect on heat loss can be determined immediately. Experimentation with the programme shows that the two variables which have the most pronounced effect are the cylinder end diameter and speed of rotation.

MACHINE SURVEYS

To gather quantitative information on the wastage of heat from cylinder ends, many surveys have been carried out on a variety of machines in the U.K. As might be expected, the results vary greatly over a wide range, losses being far less serious in, for example, slow low pressure machines producing board than high speed tissue machines with MG cylinders.

In conducting the surveys, no problems were encountered with the variables listed above, which are all easily ascertained with the exception of the cylinder end surface temperatures. These are measured with an infra-red thermometer whilst the machine is running.

A typical set of results for a machine producing fluting is shown below :

Cylinder diameter (ft)	5
Steam pressure (psi)	40
Cylinder end surface temperature (°C)	125°
Ambient temperature (°C)	28°
Machine speed (m/min)	150

The heat lost from a single cylinder over a period of one year (8760 hours) is found to be 190×10^6 But equivalent to 86 tonnes of steam. With a typical cost of raising steam of £ 9 per tonne and for example 40 cylinders in the drying section this represents a loss of £ 31,000 per annum (£ 770 per cylinder).

On a larger, faster machine the figure may exceed £ 1000 per cylinder whilst the value of steam wasted in a single MG cylinder can be great as £ 20,000.

ACHIEVEMENT OF SAVINGS

Further calculation shows that an insulator applied to the cylinder ends with an overall heat transfer coefficient (h) of of 0.7 W m^{-2} K^{-1} will save approximately 90% of the heat lost. To be a practical solution to the problem, however, an insulator must also fulfill the following requirements :

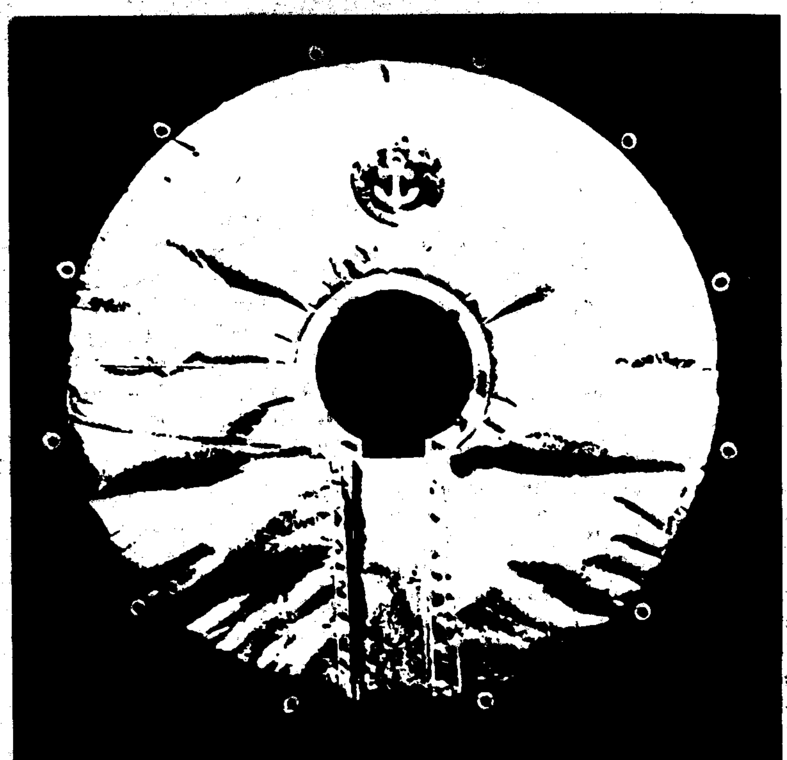
- Safety and fire resistance
- Cost effectiveness
- Ease of installation
- Provision of access to manholes
- Oil, water and chemical resistance
- Long service life

Thomas Hardman's new product, the THERMOLATOR(R) is designed to meet these requirements and is specially intended for use in the paper industry.

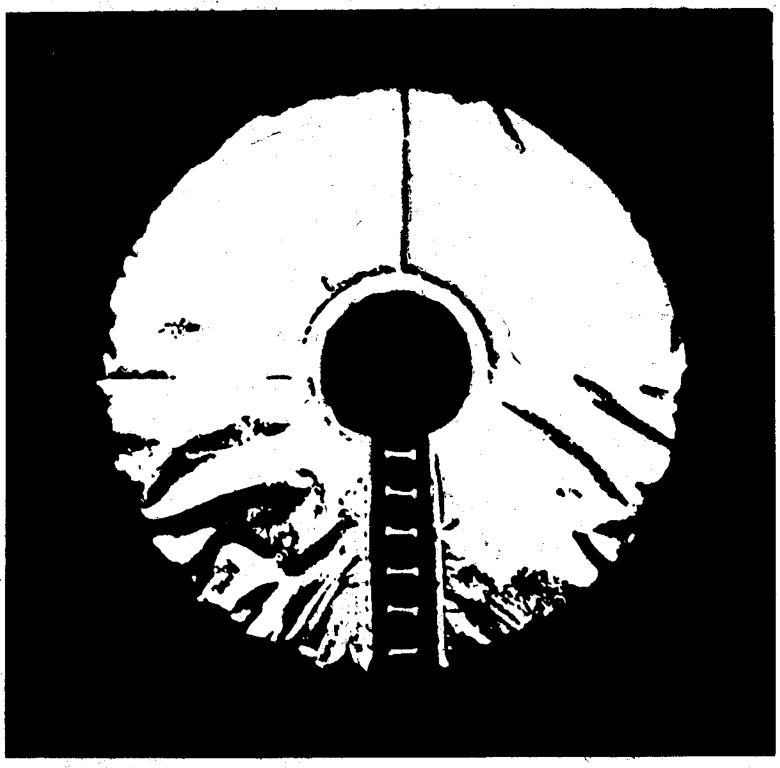
The THERMOLATOR(R) is a flexible, one piece, composite insulator tailored to fit the individual cylinder end and mounted with specially designed fasteners.

a) Construction

The main insulating material is a 20 mm thick needled wedding of Nomex Aramid fibre. This is a high temperature fibre of long staple length which outlasts conventional insulating material such as glass fibre. Being non-brittle and needled into a single piece, the wadding



THROMLATOR(R)
front



THERMOLATOR$^{(R)}$
Rear

will not compact or shift under the influence of machine vibration and rotation, as is the case with less suitable materials. In addition, Nomex resists hydrolysis and is resistant to acids and solvents.

The THERMOLATOR$^{(R)}$ has an outer cover of film-aluminised woven glass fibre, a space age material with all the advantages of a metal surface combined with the flexibility of textiles. The remaining parts are trimmed with woven Nomex cloth of the kind used for flameproof overalls. Rope and cord components are also in Nomex.

b) Principles of Operation

Radiated and conducted heat loss is contained by the insulating wadding as well as being reduced by the reflectivity and low emissivity of the aluminised outer surfaces. The overall heat transfer coefficient is less than 0.7 W m^{-} K^{-1}. Hot air is trapped behind the THERMOLATOR$^{(R)}$ which is prevented from escaping by a compressible seal which is held against the circumference of the cylinder end. The seal is filled with a resilient Nomex fibre wadding. Where the cylinder configuration allows, the THERMOLATOR$^{(R)}$ is attached to existing bolt heads by special hooks and clamps which can be quickly secured.

Where no bolt heads are available, studs are screwed to the edge of the cylinder end casting after drilling a series of small holes in an area of low stress. Additional support at the journal, when required takes the form of a loop of Nomex rope or steel clamp ring and bolts. To allow fitting without removing the cylinder from its bearings, a gap is incorporated which is laced up when in position and covered by an insulated flap.

c) Pay-back on Investment

Due to harsh nature of the paper making environment, no short cuts can be taken with grade of materials and product quality.

Clothing 40 cylinders in the example quoted will cost £28,000. In the first year savings will be approximately £ 28,000, based on today's energy costs, i.e. a pay-back of one year.

The service life of THERMOLATORS$^{(R)}$ which experience no direct wear and tear should be at least five years without repair or replacement.

Pay-back periods for MG cylinders have been calculated to be as short as six months in faster machines.

CONCLUSION :

Field trials in the U.K. are already proving the success of THERMOLATORS$^{(R)}$ with initial indications confirming the calculated savings. Figures from the Department of Energy estimate a target saving for the U.K. of 20,000 t.c.e. achieveable by insulation of drying cylinder ends. This represents an energy saving opportunity that the industry can ill afford to miss.

References

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