MARINE STEAM TURBINES

(*FORMING THE SUPPLEMENTARY VOLUME TO "MARINE ENGINES AND BOILERS"*)

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§ 44. **Other Losses.**—The losses to be accounted for in a turbine are the following:—

1. Steam friction losses including eddies and impact losses.
2. Clearance losses.
3. Ventilation losses.
4. Mechanical friction losses.

1. The losses resulting from the friction of the drums or discs rotating in steam are so small in marine steam turbines that it is hardly possible to calculate them. The losses due to the fluid friction of the steam in the nozzles, guide, and moving blades is, however, considerable. These losses are allowed for in the calculation by multiplying the steam velocities with coefficients which are less than unity (see Sections III. and IV. on the Calculation of the A.E.G. and Parsons Turbine).

2. The clearance losses include the blade clearance losses, losses in the dummies and glands (see Sections III. and IV. below).

3. In marine steam turbines the ventilation losses are of considerable importance, as nearly all these turbines contain rotating parts which are running light when steaming both ahead and astern. If a row of blades rotates in air at atmospheric pressure, especially in a contrary direction to that for which it is bladed, a considerable resistance has to be overcome, and this happens to be the case with a reversing turbine direct coupled to the ahead turbine, so that the design is always arranged for that section of the turbine which is for the time running light to rotate in vacuum. The absence of a medium tending to act as a break will then considerably reduce the ventilation losses.

These are, however, not the only ventilation losses which occur, as the wheels or drum, especially when partial steam admission is employed, rotate in a space surrounded by steam, and cause ventilation losses which have to be overcome.

It is clear that these losses cannot be calculated with any degree of accuracy, and that the allowance to be made for these must be ascertained experimentally for each type of turbine. Generally, however, the following holds good:—

to overcome ventilation losses is = to
the third power of the r.p.m.

The work required to overcome the ventilation losses is proportional to the specific weight of the steam as well as to the third power of the number of revolutions (approximately).*

In a complete marine turbine installation the ventilation losses amount to about 2 to 4 per cent. of the total output when steaming ahead, but when steaming astern these losses will be at least doubled, depending on how many wheels or rows of blades there are in the ahead turbine.

4. The bearing friction can be calculated on the usual lines.

If, w is the weight of the rotating parts in kg. (or lbs.),
d ,, diameter of the shaft in mm. (ins.),
n ,, number of revolutions,
ρ ,, friction coefficient,

then the total bearing friction R in horse-power will be:

$$R = \frac{w \cdot \rho \cdot d\pi n}{60 \cdot 75} = \frac{w \cdot \rho \cdot d \cdot n}{1{,}430} \text{ metric units.}$$

$$R = \frac{w \cdot \rho \cdot d\pi n}{33{,}000} = \frac{w \cdot \rho \cdot d \cdot n}{10{,}500} \text{ English units.}$$

The friction in the thrust-block also requires to be taken into consideration, but if the friction coefficient for the main bearings is taken on the high side, then the allowance made for these will be sufficient to cover the thrustblock friction.

As forced lubrication is always used for the bearings of steam turbines, the co-efficient of friction will be small and will not exceed ·01 to ·005.

By working out a concrete example it will be seen that the bearing friction is of much smaller importance than the ventilation losses.

* See Stodola, "Steam Turbine," English Ed., p. 129, 4th German Ed., p. 120.