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# NASA TECH BRIEF

Lewis Research Center



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# **Prediction of Windage Power Loss in Alternators**

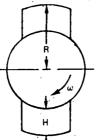
#### The problem:

To calculate windage losses in rotating machinery. Past practice has been to estimate the windage loss by comparing a proposed machine to a similar existing machine with known windage loss. For conventional machinery, a considerable body of data exists, and this technique is adequate. However, present day requirements for higher speed rotating electrical machinery have created a need for analytical techniques capable of predicting windage losses.

## The solution:

Simplified equations and constants have been developed based on laminar and turbulent flow theory

between parallel plates. These equations were checked by comparing calculated results with experimental data for a smoothcylindrical rotor and a slotted alternator. Agreement was generally good, with a maximum variation of 7% between experimental and calculated losses.



Modifications of these equations were applied to a salient-pole homopolar inductor alternator, with and without shrouds. The results were compared to experimental losses in an equivalent machine run in two different gases over a range of pressures. The curves for both gases show  $\pm 10\%$  agreement between the test data and the calculated losses over a pressure range from below standard atmospheric pressure to 275 kN/m<sup>2</sup> (40 psia).

#### How it's done:

The windage loss for a solid rotor was found to be  $W = R^4 LC_d \pi \rho \omega^3$  where

$$\rho = \text{gas density}$$

 $\mathbf{R} = \mathbf{rotor} \ \mathbf{radius}$ 

 $\omega$  = angular velocity

L = length of the rotor

 $C_{di}$  = a turbulent theory drag coefficient functionally dependent on Reynolds number

For a salient-pole machine, the loss equation must be multiplied by:

$$K = 8.5 \left(\frac{n}{R}\right) + 2.2$$

This equation, based on empirical results, is limited to  $\frac{H}{R}$  values >0.06.

The addition of a shroud to this design resulted in  $K = \frac{3}{2}$ .

Using the techniques described in the report, it appears that the basic equation can be modified to accommodate other rotating electrical machinery designs.

## Notes:

1. Documentation is available from:

National Technical Information Service Springfield, Virginia 22151 Single document price \$3.00 (or microfiche \$0.95)

#### Reference:

NASA-TN-D-4849 (N68-37162), Prediction of Windage Power Loss in Alternators

## Technical questions may be directed to: Technology Utilization Officer Lewis Research Center 21000 Brookpark Road Cleveland, Ohio 44135 Reference: B71-10074

(continued overleaf)

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# Patent status:

No patent action is contemplated by NASA.

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Category 06