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Design and Manufacturing of Propeller Shaft Brake

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***Abstract*: This project deals with problems faced in propeller shaft braking. We are going to design and manufacture a cost effective mechanism. A marine propulsion system for a water craft comprises a relatively large engine and a power transmission including an output shaft for driving the propeller. The power transmission includes forward and reverse shafts, gear trains between these shafts and the output shaft, and clutches for the forward and reverse shafts. In most of shipping vessels and small boats, idealling of propeller causes more wear to the shaft than rotation due to the motor this is also walled wind milling. The market demanded a radical improvement of the traditional block brake. After all, an expensive disk brake system cannot always be an option. The question was how to do it properly at low cost. Thus, we chose a double-caliper brake with an ingenious hinged movement that guarantees a slip-free hold on the propeller shaft. The design of the braking system avoids any radial or axial loading of the shaft.**

***Keywords*: Brake, propeller, shaft, wind milling**

1. Introduction

A marine propulsion system for a water craft comprises a relatively large engine or power plant and a power transmission including an output shaft for driving the propeller. The power transmission includes forward and reverse shafts, gear trains between these shafts and the output shaft, and clutches for the forward and reverse shafts. A cruiser circumnavigating the world will experience more prop shaft rotations due to sailing than due to motoring. The bearings and gearbox will wear due to sailing, not due to motoring. The rotating drive train will produce vibrations and noise. Some brands of gearboxes have lubrication which is engine driven, a freewheeling prop will wear down the gearbox fast. Many gearbox manufacturers recommend to lock the prop by putting the gearbox in reverse. So we had to incorporate something to stop the prop from rotating: a prop shaft brake. A shaft brake is provided to stop rotation of the output shaft for the propeller which minimizes damaging shocks to the propulsion system which sometimes occur during maneuvering operations. The brake is located concentrically with the forward shaft of the power transmission and is effective to the propeller shaft through interconnecting gears when both clutches are disengaged.

2. Operating principle

The brake is installed around the coupling flange by means of a hinged assembly, one side of which is attached to the engine bed. A screw is then adjusted to accurately set the brake’s free position. A mechanical screw acts on one of the brake calipers, pushing it out of position so the propeller shaft is constricted on opposite sides by the hinged movement. The strong brake calipers are fitted with a thick brake liner to ensure an absolutely slip-free hold on the propeller shaft.

A. Problem statement

Many fishing trollers faced the problem of their fishing net being stuck in the boat’s propeller while being reeled in by the winch, damaging the net. This problem was caused due to ideal propellers being moved due to ocean currents this is known as wind milling effect. To overcome this, we have to design a brake system to stop a propeller shaft made of stainless steel of mass 120 kg and diameter 70mm, rotating at a speed of 600 rpm to avoid wind milling effect.

B. Calculations

We consider a power screw of square threads with 4 TPI and a nominal diameter of 20 mm and length 70mm. Operator applies force of 150N on the handle to apply the brakes. Brake pads used are made of non-asbestos, non-corrosive ceramic polymer with coefficient of friction of 0.45

Solution: shaft is mounted on a lathe machine and rotated till it reaches 600 rpm (maximum limit of freewheeling), then time required for it to reach 300 rpm is measured to calculate value for angular acceleration.

Torque of Shaft:

$T_s = I * \alpha$

$I = ½*m*r^2$

$I = ½*120*0.035*0.035$

$= 0.0735 \text{ kg/mm}^4$

$\alpha = \Delta\omega/t$

$\alpha = [\frac{62.8-31.4}{4}]$

$= 7.85 \text{ rad/sec}^2$

$T_s = 0.735*7.85$

$= 0.5769 \text{ Nm}$

where; I = mass moment of Inertia of shaft
m = mass of shaft

r = radius of shaft
α = angular acceleration
ω = angular acceleration
t = time required for shaft to decelerate
n = rotational speed of shaft

Torque applied by screw:
Given: d_n = 20mm; z =4
Referrring B.V. Bhandari to Design manual we get following values for d_n = 20mm
d_m = 26mm; d_c = 21mm ; p = 5mm ; μ = 0.15
(neglecting collar friction)

$\alpha_s = \tan^{-1}(\frac{l}{\pi dm})$
$= 13.5^o$
$\Phi = \tan^{-1}(\mu)$
$= 8.53^o$

Where; α_s = helix angle
Φ = friction angle
μ = coefficient of friction between screw and nut

Torque applied by screw on clamp

$T_l = \frac{F*dm}{2} tan(\alpha s + \phi)$
$= \frac{150*0.026}{2}$ (13.5 + 8.53)

= 0.7986 N.m

Torque applied by brake pad on shaft is given by:
$T_b = \frac{Tl}{\mu b*2}$

$= \frac{0.7986}{0.45*2}$

T_b = 0.887 N.m

Where; T_b = torque applied by brake
μ_b = coefficient of friction of brake pads

As the brake force is more than torque of shaft 0.887 > 0.5769 thus the design is safe.

Value for T_l was calculated without consideration of a handle for operation, as we know addition of a handle increases the applied torque hence a handle of any length could be considered for this operation.

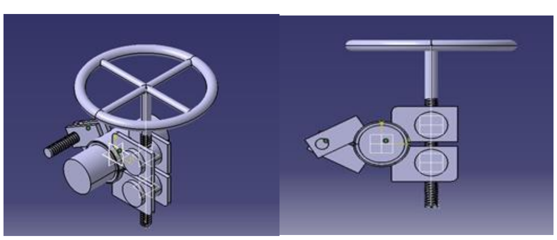

Fig. 1. 3-D Model of brake

3. Future scope of the project work

The work carried out in this research can be further used for further studies in propeller shaft braking system. In future with addition/alteration in the braking system will help manufacturers to hold on estimated cost of project i.e. reduction of additional work of the project. This research discovers economical way to reduce loss caused and find a way of easier propeller braking with an aid of this project, as compare to cost involved in software and its training. More could be added to the system to make it user friendly as a mechanical mechanism is though cost effective but harder to handle, thus the mechanism can be made hydraulic or pneumatic operated.

4. Conclusion

This paper presented design and manufacturing of propeller shaft brake.

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