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DESIGN AND PERFORMANCE ANALYSIS OF HYDRO-KINETIC FLUID COUPLING

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ABSTRACT

A fluid coupling is a hydrodynamic device used to transmit rotating mechanical power. It has been used in automobile transmissions as an alternative to a mechanical clutch. It also has widespread application in marine and industrial machine drives, where variable speed operation and/or controlled start-up without shock loading of the power transmission system are essential. In this review paper, a mathematical model is made and developed a practical working model. For Checking the parts of fluid coupling, assembly made in Pro-E software and analysed for static structural in Approach called "ANSYS". Finally the practical model check with various fluid which has different properties used in fluid coupling and made different speed and power output for various situation.

KEYWORDS: *Fluid Coupling, Tachometer, Fluid Substance, Fluid coupling test rig.*

1. Introduction

Fluid coupling is the device which is operated without mechanical joint between two shafts. The coupling is occurring only with fluid; here the power is transmitted by means of a fluid.

Fluid coupling operates on the hydrokinetic principle; it permits the use of an I. C. engine or electric motor with the attendant advantages of simplicity, ruggedness and low operating costs. Torque transmitted is directly proportional to the amount of fluid in the unit and hence it is very simple, by varying the oil fill, to match the coupling to the exact requirements of the drive machine.

Fig.1. Hydrokinetic fluid Coupling

In a typical automobile, the fluid coupling is most commonly called a torque converter. The torque converter bolts onto the engine via the flywheel or starter ring and attaches to the transmission's input shaft. From there, it directly powers and moves the vehicle. Many variables are factored into the design of this fluid coupling, including the vehicle's weight, engine torque, horsepower, optimal operating speed and usage. All factors are carefully considered when choosing the fluid coupling's proper stall speed and lock-up speed.

2. Fluid coupling Design

The calculation of the geometrical parameters of a hydrodynamic coupling is based on one dimensional model of fluid flow, and on the theory of conformity. The main purpose of this calculation method is to provide the means for designing a hydrodynamic coupling corresponding to the predefined working characteristics. The starting inputs that will be used for determining the geometrical parameters of the hydrodynamic coupling are defined by design requirements. These requirements necessarily.

Include:

P – Power transmitted to the pump shaft by the driving machine,

np – Pump shaft speed,

η – Clutch efficiency,

ρ – Fluid density,

ρs –Coupling working fluid density,

p –Working pressure.

The calculation of the hydrodynamic coupling geometrical parameters can be represented. Specific charge of the working space is $q = 0,72$.

Specific Shaft speed { *np* } =1500 rpm.

The basic dimension for best performance in the variable power and speed we are used the following flow chart and find out dimension.

Speed of input shaft = *np =1500 rpm*

Pump Head = [Hp] = $\left[\frac{\rho' (P.\eta)^{1/2}}{np} \right]^{4/5}$ Mtr.

where

ρ' is Specific gravity of fluid

Discharge Flow = [m^3/s] = $\frac{P.10^3.\eta}{\rho.g.Hp} = Q$

Pump Shaft speed = [rad/sec] = $w_p = \frac{\pi.np}{30}$

Meridian Component of fluid velocity [m/s] = $cm = 0.06 \sqrt{2.g.Hp}$

Inlet Area (Ai) and Outlet Area (Ao) of impeller = [m^2] = *Q/cm*

Pump and Turbine diameter = [m] = $re = \sqrt{\frac{g.Hp}{W_p^2.(1-i.m^2)}}$,

$ri = m . re$

$m = ri / re$

$= \frac{1 + 3V^2}{3 + V^2}$

$V = 0.4$

Impeller inlet (b1) and outlet (b2) Width = [m]

$= b2 , \frac{Q}{2.\pi.re.cm}$

$= b1, \frac{Q}{2.\pi.ri.}$

Numbers of Pump impeller blades = $Z1 = 8.65 (D . 1000)^{0.279}$

Numbers of turbine impeller blades = $Z2 = (Z1 \pm 2)$

3. Pro-E model and actual model

As per photo shown the input shaft is fixed with pump impeller that is opposite side of turbine runner and at the end of input shaft at pump impeller side there is one Metric single row taper roller bearing is placed where at input side single raw ball bearing is place with seal and also oil seal is there.

The oil seal is placed on input shaft with casing contact; the casing has turbine impeller vanes. Here same no. of vanes is placed on the turbine impeller. The casing has two parts one is input side which has vanes where another part has only hollow place in which the pump impeller placed, and at the output side the casing having output shaft with various application. (Pulley, shaft, hollow shaft etc.)

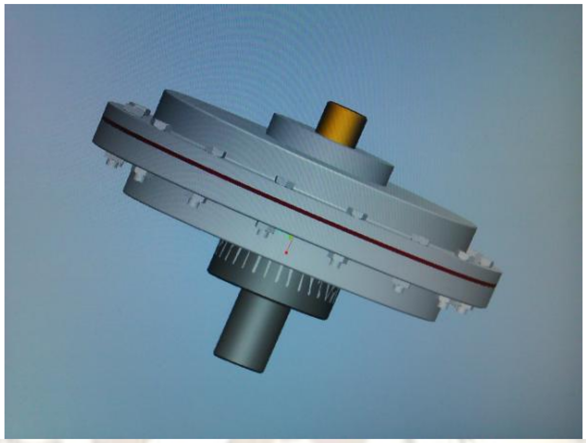


Fig.2. Hydrokinetic fluid Coupling Pro-E model

Fig. 3. Hydrokinetic fluid Coupling actual model

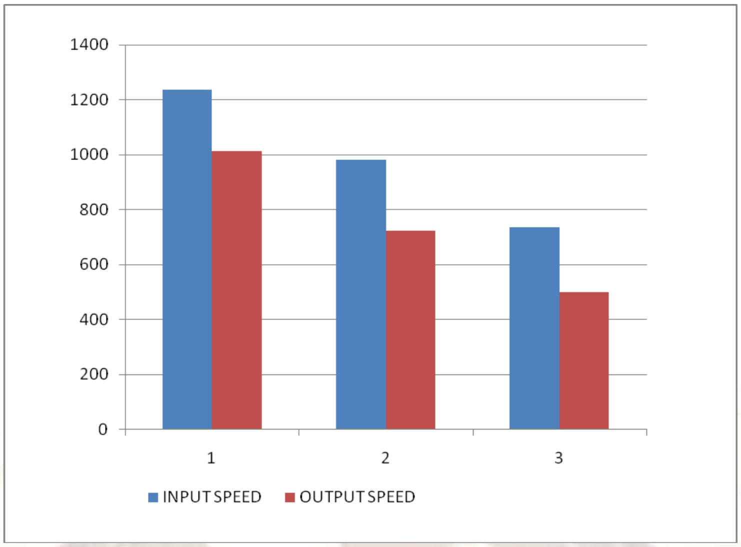
4. Fluid coupling analysis & results

4.1 Output speed at various input speed with same quality fluid.

Here the reading takes as following specification
Oil type: ISO VG 68
Oil quantity: 580 ml
Input power: 3 HP
Input speed varying and measuring out put speed.

Table 1.Output speed of fluid coupling at different input speed

SR NO	INPUT SPEED	OUTPUT SPEED
1	1235	1011
2	980	723
3	735	498



Graph 1. Output speed of fluid coupling at different input speed

As we know above readings the ratio of input speed to output is decrease as the increase of input speed so as per that we are conclude for our application the at higher speed coupling output sped higher but that is certain limit that is for general application 4 pole motor drive the coupling output speed is limited up to 1420 rpm.

4.2 Various quantity of fluid with same speed.

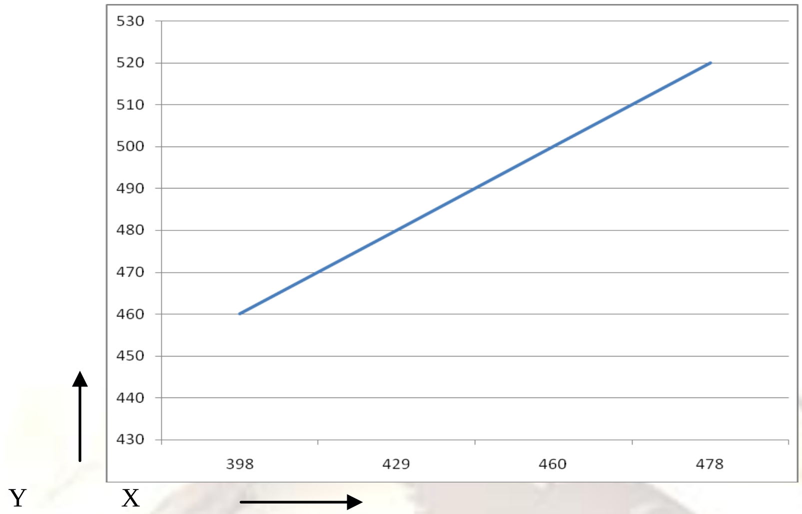
The quantity required to full the fluid coupling is 0.615 liter. But for best operation the maximum quantity required is 0.522 liter and should be not less than 0.465 liter for this fluid coupling. Less fluid inside the fluid coupling creates more slip while higher quantity makes it rigid.

Here the reading takes as following specification

Oil type: ISO VG 68
Input speed: 735 rpm
Input power: 3 HP
Varying quantity of oil inside the fluid coupling and measuring out put speed with fixed input speed

Table 2 .Output speed of fluid coupling at different quantity of fluid

SR NO	**QUANTITY OF OIL (ml)**	**OUTPUT SPEED**
INPUT SPEED 735 RPM		
1	460	398
2	480	429
3	500	460
4	520	478



Graph 2. Output speed of fluid coupling at different quantity of fluid and same input speed
The Y- axis shown quantity of oil in ml where X-axis shown speed of output shaft.

The fluid inside the coupling plays role, the quantity is defined as per total volume inside the coupling and working condition and type of fluid. For SAE 60 oil the highest quantity of oil is limited up to 520 ml for our application.
We shown as the quantity increase the increase in output speed the highest speed is limited up to 500rpm for our application that is deigned for high speed less no of vanes with higher pith angle decide the high peed coupling.

4.3 Different fluid with rated speed.

SR NO	TYPE OF OIL (ml)	KINETIC VISCOSITY 40º IN MM²/S	OUTPUT SPEED rpm
Input speed : 980 rpm			
1	ISO VG 32	35.2	629
2	ISO VG 46	50.6	723
3	ISO VG 68	74.8	742

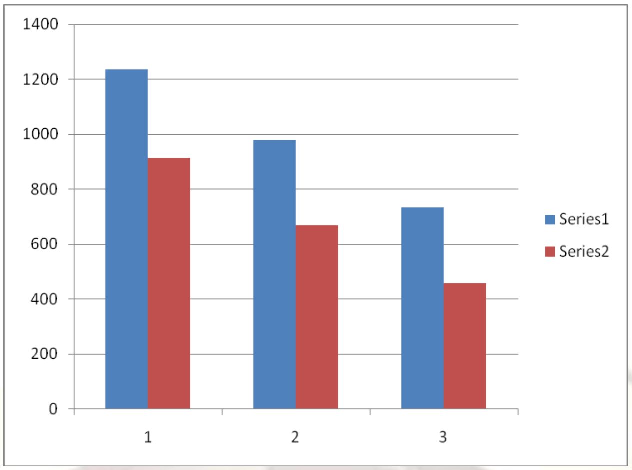
Table 3 .Output speed of fluid coupling at different quality of fluid

As we know higher the viscosity the high friction occurs so more thrust is there but pure lubrication factor produce heat. Here the pressure of input impeller convert or transmitted the power in form of velocity. Shorty the input torque creates pressure at pump impeller the pressure convert into velocity at output impeller and that velocity finally create torque at output side.

4.4 Various input speed with same depth of cut and feed rate.
Here the reading takes as following specification
Oil type: ISO VG 68
Oil quantity: 580 ml
Input power: 3 HP
Input speed varying and measuring out put speed with same feed and depth of cut on lathe machine.

SR NO	INPUT SPEED rpm	OUTPUT SPEED rpm	RATIO- SPEED Input/Outputs
1	1235	915	1.349727
2	980	669	1.464873
3	735	458	1.604803

Table 4 .Output speed of fluid coupling at various input speed at same loading



Graph 3. Output speed of fluid coupling at different input speed at same loading

Blue colour column shown the input speed where red colour column shown the output speed with respect to input speed.

6. Conclusion

After Design and analysis following conclusions have been made:

1. As per graph 1 shows for same quantity of oil and same type of oil increasing the input speed the output speed increase, but the ratio of input and output speed is increase 8 to 12% with the increase of input speed.

2. As per shown in graph 2 the output speed of fluid coupling is increase with increase of quantity of fluid, the limit of fluid quantity is 91% of total volume of fluid coupling.

3. Higher the viscosity cause better thrust but not easy flow in vanes where viscosity causes easy flow with medium thrust. For higher number of vanes low viscosity oil like ISO VG 32, ISO VG 46 USED called high speed coupling. Generally ISO VG 46 is used in most of application.

4. For same size with same oil quantity and type the output power is depended on input speed as the input speed increase more power is transmitted. Shorty the fluid coupling transmitted higher value power at higher speed.

7. Future Scope

[1]. The future work may possible for different additive used in fluid for different application.
[2]. The vanes angle also affect the power and speed so due to change of position may possible to get analysis.

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