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Experimental Study on Fluid Coupling by using Various Working Fluids

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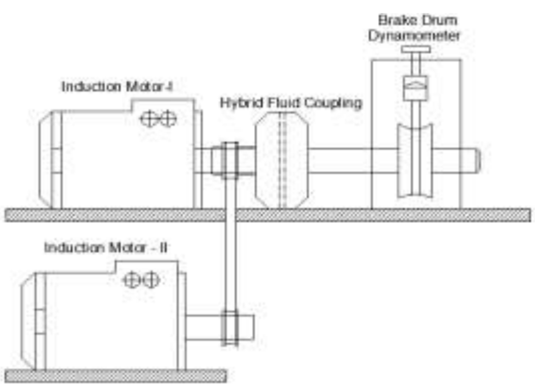
Abstract: *Fluid coupling, this is useful to transfer Mechanical Power or Torque from one shaft to another shaft without using any mechanical devices like gears or belt drives etc. It works on hydrodynamic principle,it has been used in automobile transmission alternative to clutch. It is very important to transfer power very efficiently to avoid power losses. Efficiency of power transfer mostly depends on properties of the working fluid. In this paper,i would like to discuss a fluid coupling model with two pumps and one turbine (i.e hydraulic coupling) and tested with different working fluids (Multi Grade Oils).*

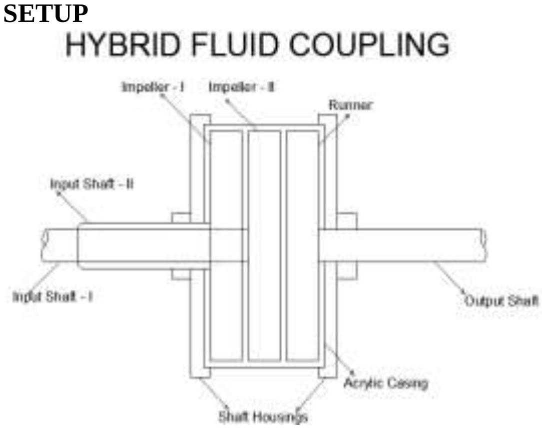
Keywords: *Fluid Coupling, Multi Grade Oils, Hydraulic Coupling.*

I.INTRODUCTION

Fluid coupling works on the hydrodynamic principle. It consists of a pump known as impeller and a turbine known as runner. A large number of radial vanes are mounted on periphery of the impeller and runner, both impeller and runner are mounted on different shafts which are aligned axially, enclosed suitably in a casing. They face each other with an air gap. There is no mechanical connection between the impeller and the runner (i.e. driving and driven units). The impeller is suitably connected to the prime mover like electric motor or an internal combustion engine, while the runner is connected to the output shaft, this shaft is further connected to the driven machine through the suitable arrangement. Fluid is filled in the fluid coupling from the filling plug provided on its body. The power is transmitted by virtue of the fluid filled in the fluid coupling. The rotating impeller causes the fluid within its vanes to move radially out under the action of centrifugal force, and then the fluid is discharged into the runner at the outer radius. In the runner, fluid flows radially inwards, the fluid gets adhered to the runner vanes causing it to rotate in the same direction. For the flow to occur without any disorder the speed of the impeller must be greater than the runner.

II. TEST SETUP





Hybrid Power Transmission System Coupling fastening details

III. GENERAL PROPERTIES OF THE WORKING FLUIDS

3.1. Viscosity:

It is defined as the internal resistance offered by one layer of Fluid to adjacent layer of the fluid. If viscosity of the fluid is more than it opposes the motion of fluid, it reduces the kinetic energy of the fluid. For fluid coupling, the fluid with less viscosity is preferred.

3.2 Specific Heat:

It is defined as the amount of heat required to rise the Temperature of unit mass of substance through unit degree temperature difference. Specific Heat actually represents heat absorbing capacity of the medium, grater the specific heat greater is the heat absorbing capacity. For Fluid Coupling, fluid with more Specific Heat is preferred.

3.3 Thermal Expansion:

It is defined as the expansion character of fluid by increasing the temperature. While working heat generation takes place in fluid coupling and temperature increases. For Fluid Coupling, fluid with less thermal expansion is preferred.

3.4 Density:

The power transmission from impellor to rotor takes place through fluid's kinetic energy, the kinetic energy is dependent on the density of the fluid. For fluid coupling, fluid with more Density is preferred.

3.5 Lubrication:

The impellor and rotor of the fluid coupling system are mechanical parts and they required regular lubrication for better functioning so it is important that the fluid must have good lubrication properties.

Properties of working fluids used in this paper:

Name of the Oil	**Kinematic Viscosity (Centi Stokes)**		**Density (kg/m^3)**
	@ 40^0C	**@ 100^0C**	
SAE 0 W – 40	75.00	13.50	$0.8500 * 10^3$
SAE 5 W – 40	83.60	13.40	$0.8530 * 10^3$
SAE 10 W – 40	93.27	14.60	$0.8505 * 10^3$

Table.1

Specifications of Hybrid Power Transmission System Components

Motors

Input Power of the Motor-1 : 0.5 HP
Input Power of the Motor-2 : 0.25 HP
Number of poles : 4
Speed : 1500 RPM
Power Factor : 0.85
Frequency : 50 Hz
No of phase : Single Phase
Rated voltage : 240 V
Rated current : 3.0 A

Brake Drum Dynamometer

Design specifications of the Dynamometer are as follows:
Type:Brake Dynamometer-Belt
Cooling: Air cooled
Brake Drum Diameter:120 mm
Belt thickness:6mm
Output Power (Watts)= 2PN(W*R)/60
Where W in Newtons, R in Meters, N Speed in RPM.

Impellers/Runner

Outer Diameter : 127mm
Dia of Impeller Eye : 65mm
No. of Vanes : 24
Length of Vane : 31mm
Width of Vane : 10mm
Thickness of Vane : 1.5mm
Face Angle of the Vane: 15^0

Shaft (Impeller and Runner)
Length : 140mm
Outer Diameter : 17mm

Impeller/ Runner Housing
Outer Diameter : 170mm
Inner Diameter : 130mm
Groove depth : 5mm

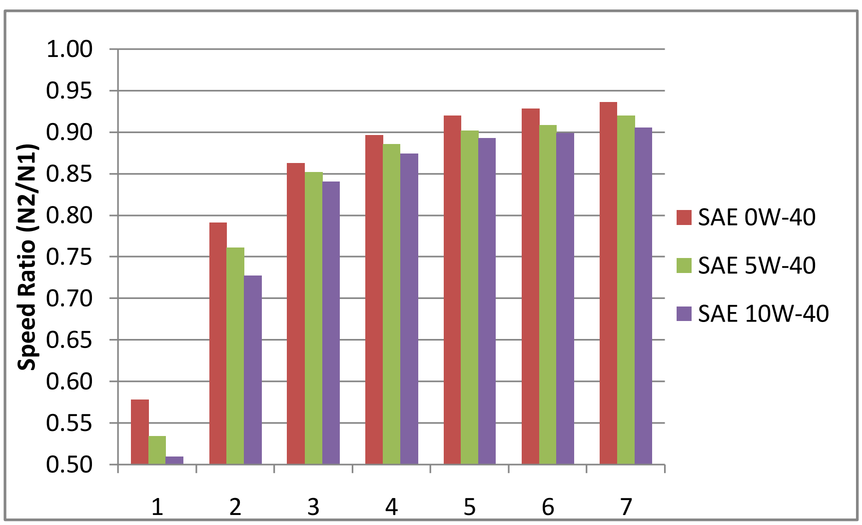
Useful Formula:

1. Power, $P_1 = (2\Pi N_1 T_1)/60$
2. Power, $P_2 = (2\Pi N_2 T_2)/60$
3. Torque, $T_1 = (P1*60)/(2\Pi N_1)$
4. Torque, $T_2 = W*R$

Test Results and Analysis

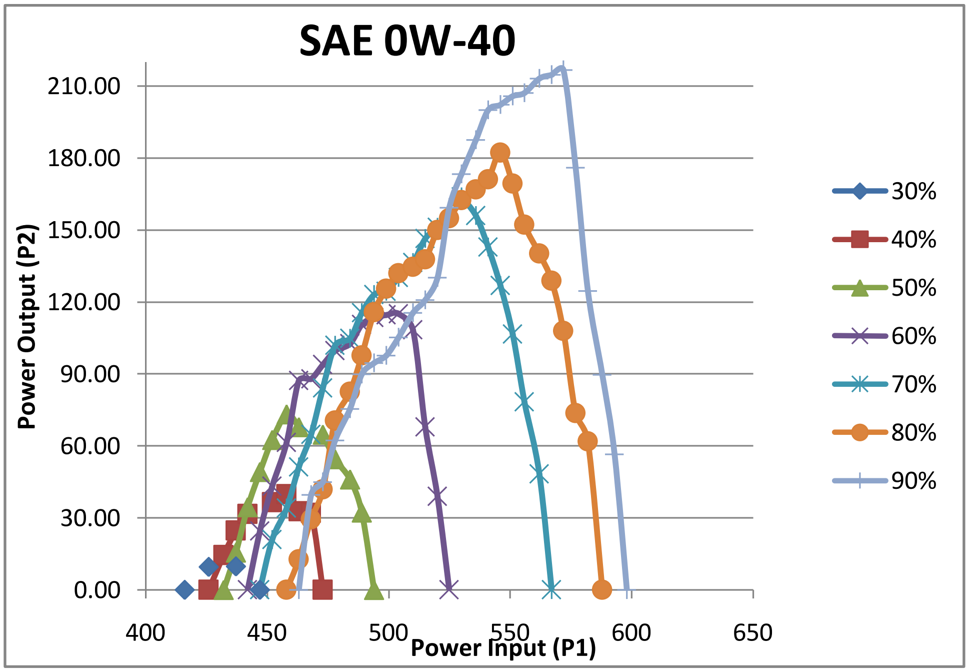
Filling %	Speed Ratio (N_2/N_1)		
	SAE 0 W 40	**SAE 5 W 40**	**SAE 10 W 40**
30%	0.58	0.53	0.51
40%	0.79	0.76	0.73
50%	0.86	0.85	0.84
60%	0.90	0.89	0.87
70%	0.92	0.90	0.89
80%	0.93	0.91	0.90
90%	0.94	0.92	0.91

Graphs:
Comparison of speed ratios of various fluids



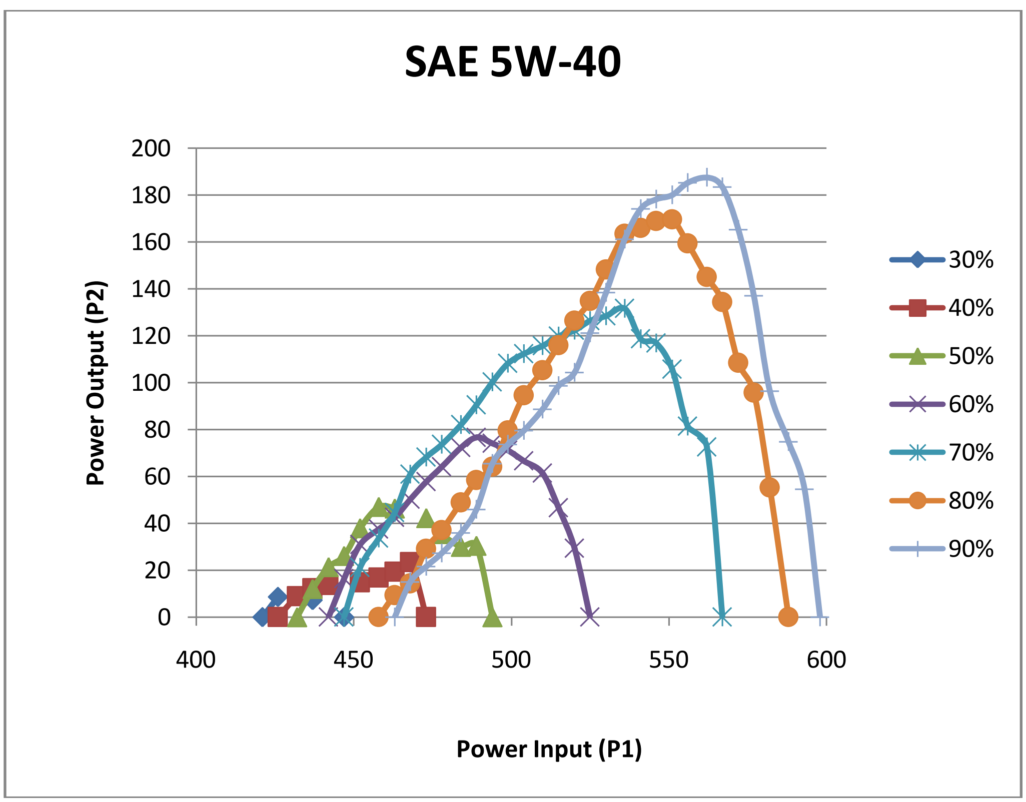
Graph.1

Comparison of power ratios at different filling % for SAE 0W-40 Oil



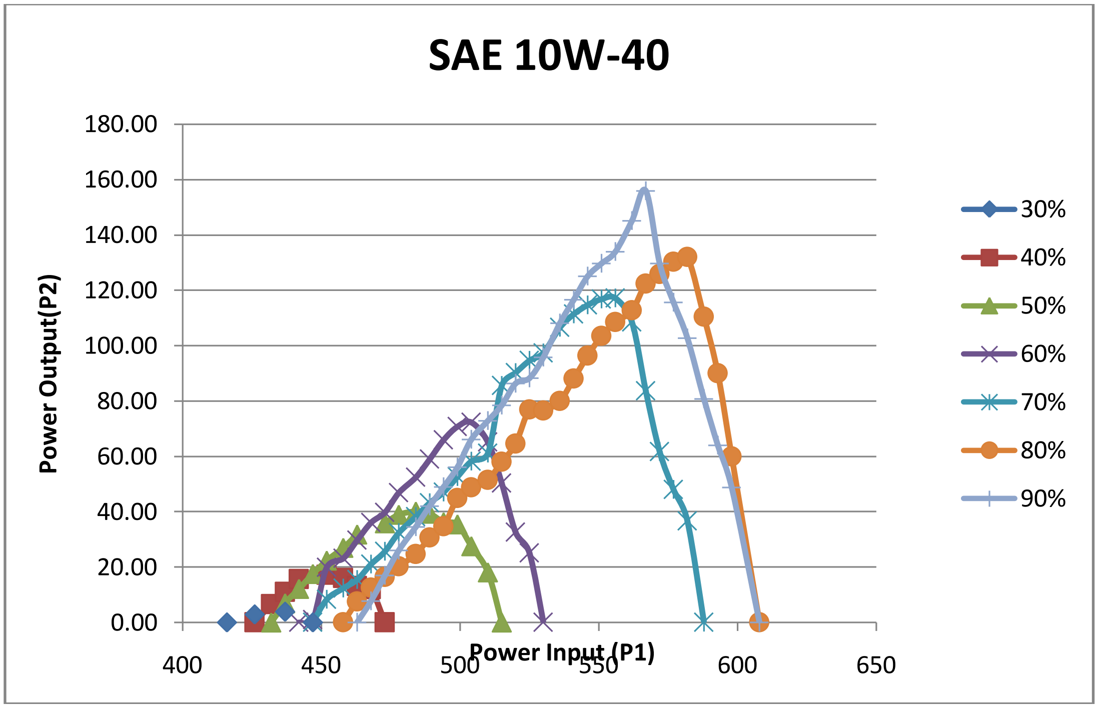
Graph.2

Comparison of power ratios at different filling % for SAE 5W-40 Oil



Graph.3

Comparison of power ratios at different filling % for SAE 10W-40 Oil



Graph.4

Results and Discussion

On the basis of the above test results of the experimental studies on Fluid Coupling with different fluids, the following conclusions are prepared:

- It is observed that the output shaft starts rotating when the fluid coupling is filled up to30% capacity only.
- It is noticed that viscosity of a fluid plays a major role in power transmission, and the fluid with lower viscosity can transfer more power.
- It is observed that the power is increasing with increase in fluid filling.
- It can be noticed that Low viscous fluids transfer higher power.

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