International Journal of Industrial Engineering and Technology.
ISSN 0974-3146 Volume 9, Number 1 (2017), pp. 57-65

http://www.irphouse.com

Optimization of Fluid Coupling performance for Efficient Power Transmission System

V.Narasimha Reddy[1], Dr. P. Ram Reddy[2], Dr. Syed Nawazish Mehdi[3]

[1]Assoc. Professor, Dept. of Mechanical Engineering, Malla Reddy Engineering College, Maisammaguda, Secunderabad-500 100, India.

[2]Professor in Mechanical Engineering & Former Registrar, JNTU-Hyderabad, 500 072, India.

[3]Professor in Mechanical Engineer, MuffakhamJah College of Engineering and Technology, Banjara Hills, Hyderabad. 500034, India.

Abstract

This paper presents the testing of a Fluid coupling system for effective and efficient Power transmission with fluids having different viscosities at various filling capacities.. A specific prototype is designed and built to carry out the performance tests. The objective lies in developing an efficient fluid coupling which would transfer the mechanical power with minimum transmission losses. This fluid coupling would transfer the power from the main source, namely the Induction motor or any other source of power and then transmit it to the output shaft through the Fluid medium. The fluid coupling has an advantage over the mechanical coupling in the following aspects, like, Effective dampening of shocks, load fluctuations and torsional vibrations. Smooth and controlled acceleration without jerks in transmission of the power, wear-free power transmission system because of absence of mechanical connection [no metal-to-metal contact] between the Impeller (input) and Runner (output) element. The effect of fluid percentage in the Fluid Coupling casing on output speed is carried out and analysed.

Keywords: Fluid coupling, Impeller, Runner and Working Fluid.

INTRODUCTION:

Fluid couplings are used in engineering applications due to their unique features in flexible transmission of shaft torque between a pair of driving and driven shafts. Fluid coupling operates on the hydrokinetic principle without mechanical contact between driving and driven shafts. A fluid coupling principally consists of a pump impeller, turbine runner and working fluid enclosed in an oil tight chamber or casing. The driving wheel works as a pump impeller, imparting angular momentum to the working fluid, while the driven wheel works as a turbine runner, receiving the angular momentum from the fluid. Therefore, a flexible transfer of shaft torque is realized from the driving pump impeller to the driven turbine runner through the working fluid without mechanical contact. The chamber is filled with fluid, and a circulation is established in the coupling circuit which leads to exchange of angular momentum between the impeller and runner through fluid. The impellor of the fluid coupling is directly connected to the prime mover like motor or I.C.Engine by mechanical coupling. The impellor is power input component of the fluid coupling. The runner is directly connected to the machine by mechanical means like Belt drive, gear drive or a mechanical coupling. The runner is power output component of the fluid coupling.

Working fluid of the fluid coupling is the important parameter of the system. The working fluid in the fluid coupling is filled between impellor and runner which gets energies by rotation of impellor and converts impellors energy in the kinetic energy of the fluid, this kinetic energy of the fluid get absorbed while striking on runner. And by this energy the runner rotates and power transmitted to the machine.

The present investigation is aimed to analyze various factors, which affect the performance of fluid coupling. The parameters under investigation are fluid with varying viscosities, filling capacity of fluid in fluid coupling and speed ratio between driving and driven members.

MODEL DESCRIPTION:

In a typical fluid coupling used, the pump impeller and turbine runner are geometrically identical and mounted back to back with little separation between the leading and trailing edges. A simple radial vanes having 24 vanes with 15^0 face angle is used which is common utilized in most conventional pumps or turbines.

Test setup for performance test consist of the following components:

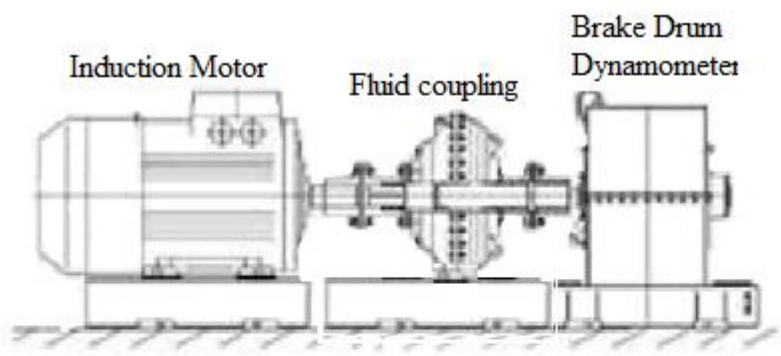


Fig 1. Test setup arrangement

Motor: the electric motor worked as prime mover for test model. Technical specifications of the motor are as follows

Input Power of the Motor	0.5 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

Speed	Upto 1500 RPM
Type	Brake Dynamometer-Belt
Cooling	Water cooled
Brake Drum Diameter	120 mm
Belt thickness	6mm

Fluid Coupling: The fluid coupling used in this experiment is made of mild steel and its ratings are as follows.

1. **Impeller/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

2. **Casing (Acrylic)**

Outer Diameter	139mm
Inner Diameter	130mm
Thickness	5mm
Length	49mm

3. **Shaft (Impeller and Runner)**

Length	140mm
Outer Diameter	17mm

4. **Impeller/ Runner Housing**

Outer Diameter	170mm
Inner Diameter	130mm
Groove depth	5mm

Working Fluid:

The viscosity grade of a lube oil (Fluid) is determined by the Society of Automotive Engineers (SAE). Oils can be separated into multigrade oils and monograde oils. Multigrade oils must fulfill two viscosity specifications, their viscosity grade consists of two numbers, e.g. 10W-40: 10W refers to the low-temperature viscosity ("Winter"), 40 refers to the high-temperature viscosity ("Summer"). Currently, most automotive engine oils are multigrade oils. The oil used should be antioxidant and anti-foaming.

The properties of oils like viscosity, density, ISO Grade and equivalent SAE Grade are given in following table.

Table 1. Kinematic Viscosity for different ISO Grade oils with equivalent SAE Grade

ISO Grade	**Equivalent SAE Grade**	**Kinematic Viscosity (*centiStokes)***		**Density (*kg/m³*)**
		40 °C	***100 °C***	
32	10	32	5.4	857
46	20	46	6.8	861
150	40	150	15	872
680	90	680	18.75	893
1000	140	1000	32.46	901

Test Procedure:

The step-by-step performance test procedure is detailed below.

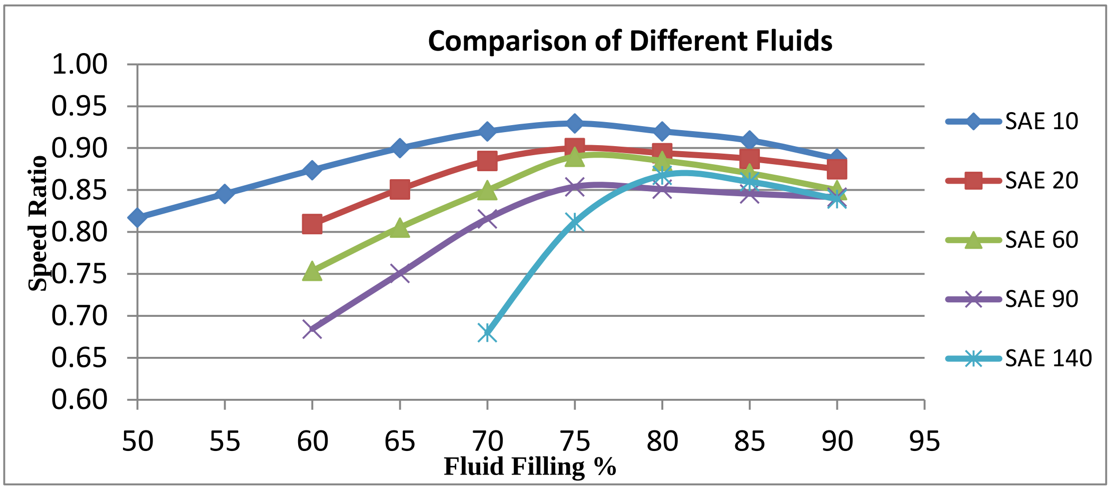
1. Fill the fluid coupling with oil under test. The quantity of oil is taken to give a said Percentage of oil filling capacity of Fluid Coupling chamber.
2. Start the motor and wait until it reaches steady state and then apply the load on Dynamometer. Wait until the speed reaches for steady state. Note the readings of input RPM, output RPM and dynamometer load.
3. Now change the load on dynamometer and take all the readings again.
4. Stop the motor and increase the oil quantity into the fluid coupling and perform the same test procedure.
5. Now dismount the fluid coupling from the test bench and fill with different Fluids like SAE 20, SAE 40, SAE90, SAE140 and repeat the same test procedure.

TEST RESULTS AND ANALYSIS:

The performance test is carried out with different fluids. The results observed with the fluids are as follows.

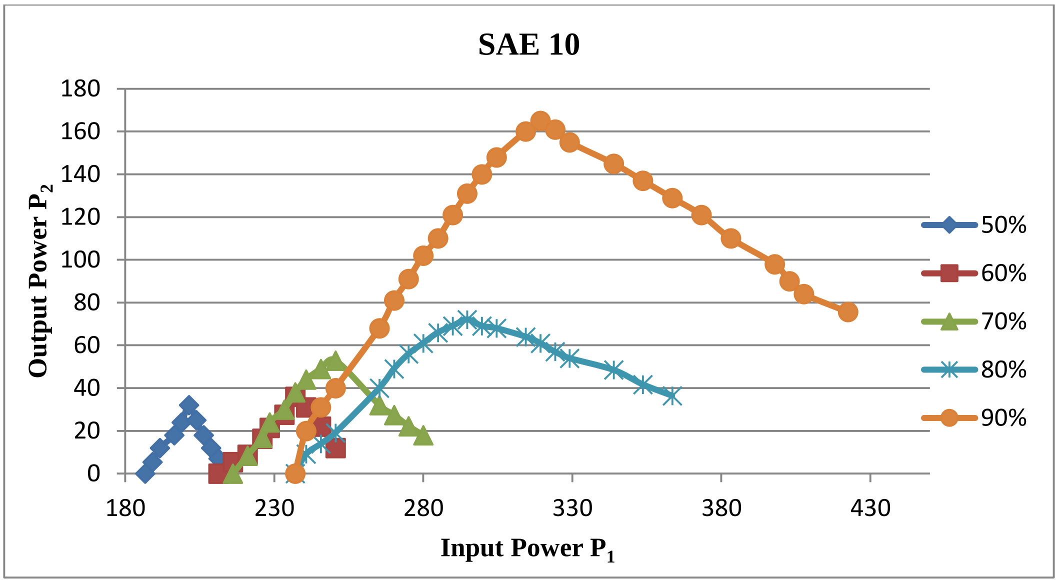
Table 2. Speed ratio for different filling capacities for various fluids

Fluid Filling %	**Speed Ratio (N_2/N_1)**				
	SAE10	**SAE20**	**SAE60**	**SAE90**	**SAE140**
50	0.82				
55	0.85				
60	0.87	0.81	0.75	0.68	
65	0.90	0.85	0.81	0.75	
70	0.92	0.89	0.85	0.82	0.68
75	0.93	0.90	0.89	0.85	0.81
80	0.92	0.89	0.89	0.85	0.87
85	0.91	0.89	0.87	0.85	0.86
90	0.89	0.88	0.85	0.84	0.84

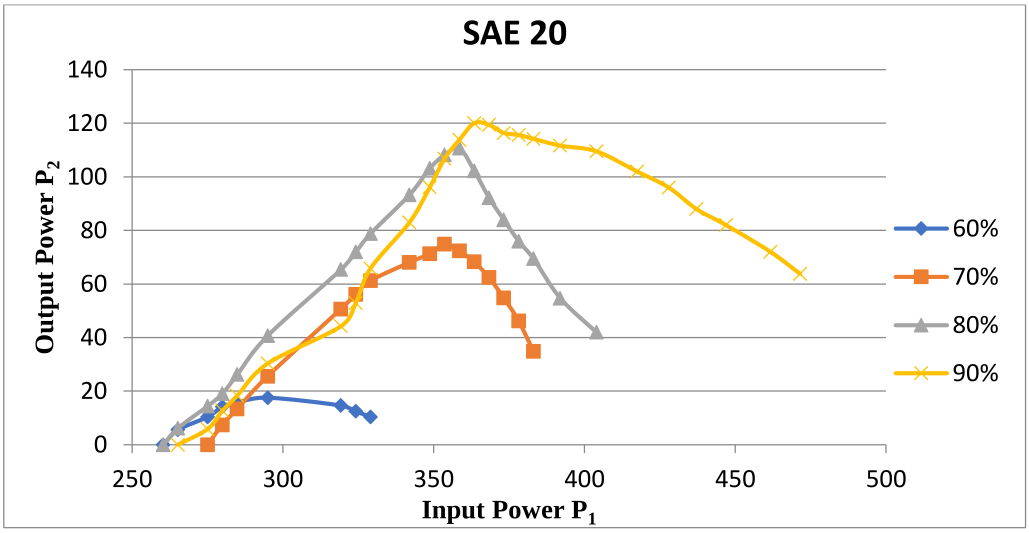


Graph 1. Speed ratio for different fluids at different filling capacities

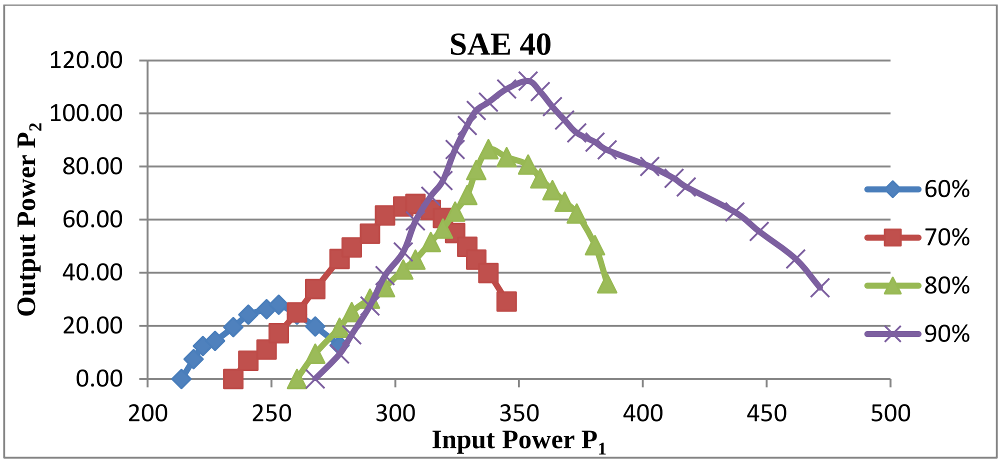
Graph 2.a to 2.e: Variation of input power with output power for different oils at different filling capacities



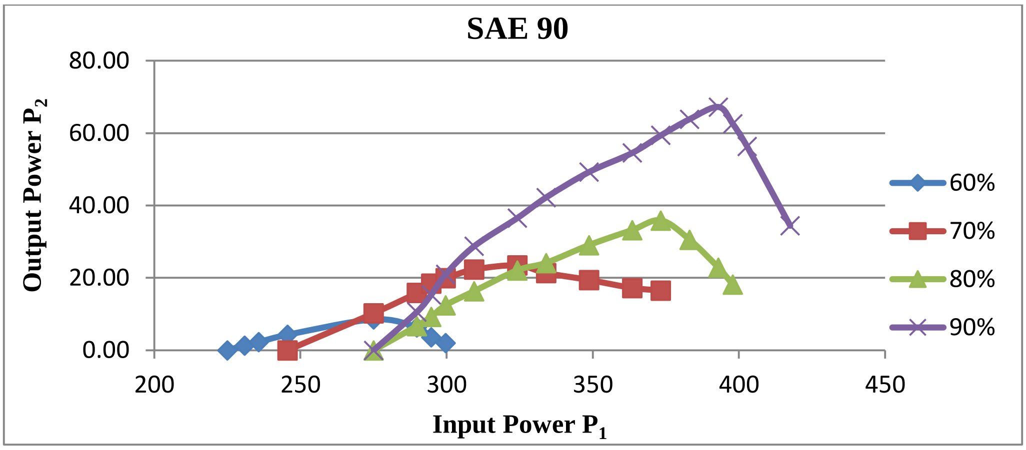
Graph 2.a



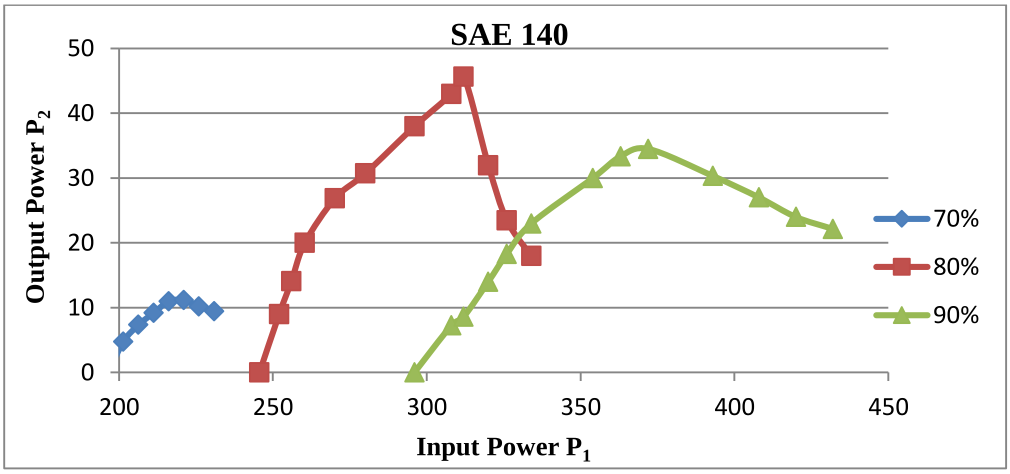
Graph 2.b



Graph 2.c



Graph 2.d



Graph 2.e

RESULTS AND CONCLUSION:

On the basis of the above test results of the experimental investigations on Fluid Coupling with different fluids, the following conclusions are made.

1. With reference to Fig. 1, the effect of viscosity of fluid on speed ratio is determined and it is observed that the speed ratio increases with reduction in viscosity.
2. With reference to Table 2, it is observed that the output shaft starts rotating when the fluid coupling is filled upto 50% capacity only
3. With reference to Fig. 1, 75% fluid filling in the casing is the most suitable for higher speed ratio.
4. The speed ratio reduces from the 80% of fluid filling in the casing.
5. From Fig. 2a to 2d, It is observed that the power is increasing with increase in fluid filling.
6. It can be observed that Low viscous fluids transfer higher power.

ACKNOWLEDGEMENTS:

This project is sponsored by UGC under Miner Research Project programme, the author is gratefully acknowledged the UGC.

REFERENCES:

[1] "Comparative Study of Fluid Coupling for Oil and water as working fluid" International Journal of Engineering Research and Development, *e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com Volume 9, Issue 6 (December 2013), PP. 56-61*

[2] "Design and performance analysis of hydro-kinetic fluid Coupling" International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 2, Issue 4, July-August 2012, pp.227-232

[3] "A theoretical model for the performance prediction of fully filled fluid coupling" International journal of mechanical Science, Volume 20, Issue 6, 1978, Pages 335-347. F. J. Wallance, A. Whitfield, R. Sivalingam.

[4] "Hydraulic Analisys of a Reversible Fluid Coupling" Charles N. McKinnon, Danamichele Brennen, Christopher E. Brennen.

[5] Dr. R.K. Bansal, *fluid mechanics and hydraulic machines*

[6] "Mathematical modeling of partially filled fluid coupling behavior" , A. M. Maqableh, International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering Vol:5, No:12, 2011