

# Kinetic Coefficient of Friction Testing Machine using Arduino

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**ABSTRACT:** This topic is based on friction and design of a machine to test the kinetic coefficient of friction. The main purpose is to design and manufacture the experimental setup to determine the coefficient of the friction. Friction is the force resisting motion of solid surface, fluid layers, and material elements sliding against each other. Kinematic energy is converted into thermal energy whenever motion with friction occurs. This experimental project will help in calculation kinetic coefficient of friction and its behavior's when the lubricant used

**KEYWORDS:** determination of the kinetic coefficient of friction, lubricant, friction, centrifugal force.

## I. INTRODUCTION

Friction is that the force resisting the relative motion of solid surfaces, fluid layers, and material components slippery against one another. once surfaces to bear move relative to every alternative, the friction between the 2 surfaces converts mechanical energy into thermal energy (that is, it converts work to heat. This property will have dramatic consequences, as illustrated by the utilization of friction created by rubbing items of wood along to begin a fireplace. mechanical energy is regenerate to thermal energy whenever motion with friction happens, for instance once a viscous fluid is stirred. Another vital consequence of the many styles of friction may be wear, which can result in performance degradation or injury to parts. Most experimental studies on friction and wear are involved with finding qualitative and quantitative relationships between friction and wear knowledge and numerous governing parameters and conditions, for instance, the properties of bulk and surface layer materials, the roughness of the surfaces to bear, the strain levels, the slippery speed, the temperature, the atmosphere, the properties of the lubricants and correlations found in those experimental works are sometimes assumed to be intrinsic characteristics of the interfaces tested for the ranges of parameters and conditions thought of. Difficulties on the dependableness of friction knowledge with totally different experimental equipment below similar conditions, and dependence of the results of damage tests on the dynamic properties of the instrumentation, however solely within the previous few years increasing attention has been paid to the experimental study of those effects. the main target of analysis throughout the twentieth century has been to know the physical mechanisms behind friction. Friction and wear are caused by sophisticated and multiplex sets of microscopic interactions between surfaces that are in mechanical contact and slide against one another. These interactions ar the results of the materials, the geometrical and topographic characteristics of the surfaces, and therefore the overall conditions below that the surfaces are created to slip against one another, e.g., loading, temperature, atmosphere, a form of contact, etc. All mechanical, physical, chemical, and geometrical aspects of the surface contact and therefore the the} close atmosphere have an effect on the surface interactions and thereby also the tribologicalFriction is that the force resisting the relative motion of solid surfaces, fluid layers, and material components slippery against one another.for many surfaces in relative slippery or rolling contact, space|the world|the realm} of real contact is far smaller than the nominal contact area. The applied load is carried by many little native asperities creating up the realm of real contact, and therefore the friction and wear behavior results from the interactions between these the regions of those native contacts, the conditions are characterized by terribly high pressures and shear stresses; usually well higher than the yield stress of the materials, high native (flash) temperatures of short period, and perhaps additionally terribly high degrees of deformation and high shear rates. below such conditions, the native mechanical properties of the materials are also terribly totally different from what's found, for

The importance of compound layers, little amounts of contaminants, native section transformations, etc., is additionally abundant larger than in large-scale mechanical testing. Consequently, the properties of fabric within the real contact areas are also aloof from those measured in traditional mechanical testing procedures, and therefore the coupling between wear and friction properties and ancient mechanical properties, like modulus of elasticity and yield strength, is weak. Tribology comes from the Greek tribes that mean "friction".once 2 surfaces square measure in touch along, mechanical engineering happens. the most domain of mechanical engineering is friction, wear, adhesion, and

lubricants. Adhesion could be a tendency by that the surfaces tend to take hold of one another. The adhesion is divided into many sorts, among that the chemical, static, and mechanical adhesions. Friction is that the development chargeable for the force against the relative slippy of the 2 surfaces in touch. Wear is that the progressive harm, involving material loss, that happens on a surface slippy on another surface. Lubricants square measure substances, like grease or oil that cut back friction and wear between 2 surfaces in touch. In 1773, Coulomb planned the planned mathematical friction model. throughout the late eighteenth century, Coulomb additionally determined that the force needed to maneuver a sled is over the force needed to take care of the movement. He, therefore, planned a two-state model of friction, the friction being either static (sticking) or kinetic (sliding). Coulomb laws of friction square measure still widely used. Duke of Edinburgh Bowden and David Tabor gave a physical clarification of the laws of friction. They showed however the \$64000 space of contact is far minor than the apparent contact space. Indeed, the \$64000 space of contact is made by surface asperities from each material that square measure in touch. They showed that the upper the traditional load is, a lot of the asperities square measure compressed, and therefore the higher the \$64000 space of contact is. Consequently, the adhesion (that is proportional to the \$64000 space of contact) is incontestable as being the foremost part of the friction force. This experimental setup ensures to work out the wet friction i.e. the kinetic constant of friction between 2 comparatively moving elements with a layer of lubrication in between them. This can be the foremost economical technique to seek out wet friction employing a tinny spherical ball on a rotating circular disc and lubricating substance in between the 2 surfaces of disc and ball. victimization totally different lubricants, it will facilitate to seek out the behavior of lubricating substance at totally different speed condition. additionally changes within the constant of friction because of the utilization of lubricating substance in between the contact. it'll even be addicted to the thickness of the lubricating substance. this will facilitate within the choice of correct lubricants with appropriate properties for a specific application of moving elements having contact with alternative {one another} and moving relative to every other. Previously, the tester uses to work out the dry constant of friction and principally static constant of friction however this setup ensures the wet friction. With the fast development of industrial enterprise, friction and wear reduction between 2 slippy bodies needs the constant presence of a lubricating substance inside the contact space to scale back and management friction and wear, therefore reducing energy consumption, extending the service life of mechanical systems and enhancing their dependability and safety. In several things the lubricating substance is mechanically fed into the contact space by the relative movement of the friction try itself.

## II. RELATED WORK

The following literature review presents the elaborate work and analysis done associated with the project. It consists of detail on friction, its development, and factors poignant the constant of friction. It describes however the planned analysis is expounded to previous analysis in statistics. It shows the originality and relevancy of your analysis drawback. Specifically, your analysis is totally different from different statisticians. It justifies your planned methodology. It demonstrates your readiness to finish the analysis.

Federici, Matteo & Straffelini, Giovanni & Gialanella, Stefano. (2017). Pin-on-Disc Testing of Low-Metallic Friction Material slippy Against HVOF Coated solid Iron: Modelling of the Contact Temperature Evolution. *mechanical engineering Letters*. 65. 10.1007/s11249-017-0904-y It states that -Pin-on-disc (PoD) testing is wide wont to investigate the slippy behavior of materials and relevant wear mechanisms underneath totally different tribological conditions. The approach has been conjointly profitably applied to the characterization of materials for brake systems to get on the wear and tear mechanisms. within the gift study, the transient thermal analysis of a pin created with a friction material dry slippy against HVOF coated and uncoated pearlitic iron disc in a piece of very PoD equipment was investigated utilizing a finite part analysis at the side of experimental measurements. The investigation aimed to model the surface contact temperature during this slippy system to focus on the role of the various surface conditions, i.e., coated and uncoated, on the evolution of the pin and disc temperatures throughout slippy. Also, we have a tendency to propose a simplified analytical equation for estimating the common temperature rise within the contact region throughout slippy, by extending the Kennedy approach to be ready to give a fast analysis of the contact temperature for this sort of couplings, what's terribly useful once characterizing an outsized range of systems in numerous contact conditions.[2]

Pin-on-disc (PoD) tribological tests are unremarkably wont to investigate the wear and tear behavior of materials in touch with a slippy motion. The approach is especially suited to check the relationships existing among wear mechanisms and such parameters like contact pressure, slippy speed, environmental conditions. Proper calibration of the boundary conditions and, especially, of the warmth is needed to get a reliable metallic element model, in an exceedingly shut agreement with the experimental records of the pin temperatures evolutions. within the conditions below study, the 2 HVOF cermet coatings have an effect on the temperature have an effect on within the slippy

bodies by inducement totally different friction mechanisms at the slippery contacts and additionally, notwithstanding to a lesser extent, by modifying the native thermal properties.

Hua, Xijun & Puoza, full general & Zhang, Peiyun & Xie, Xuan & Yin, Bifeng. (2017). Experimental Analysis of Grease Friction Properties on slippery rough Surfaces. *Lubricants*. 5. 42. 10.3390/lubricants5040042. there's comprehensive work on the tribological properties and lubrication mechanisms of oil stuff used on rough surfaces, however, the employment of grease lubrication on rough surfaces is very new. This analysis article presents an Associate in Nursing experimental study of the resistance behaviors of grease-lubricated slippery contact below mixed lubrication conditions. The influences of surface texture parameters on the resistance properties were investigated employing a disc-on-ring tribometer. The results showed that the friction coefficient is essentially enthusiastic about texture parameters, with higher and lower texture density leading to the next friction the next texture depth. The reduction of friction is principally due to the formation of a stable grease lubrication film composed of oil film, transfer film, and deposited film, and also the fluid mechanics pressure impact of the surface texture, which will increase the sex activity gap and reduces the likelihood of asperity contact. This result can facilitate in understanding the tribological behavior of grease on a rough surface and in predicting the lubrication conditions of slippery bearings for higher operation in any machinery.[3]

In this analysis, a series of experiments were conducted to explore the impact of surface texture parameters on resistance properties of lithium-based grease below slippery conditions. The circular dimples on the contact surface of the ring were designed with totally different dimple depths and densities. The experiments expedited Associate in the Nursing understanding of the tribological behaviors of grease on rough surfaces. In general, the friction coefficient is essentially enthusiastic about texture parameters, with lower and better texture densities leading to the next friction the next texture depth. Higher load and speed increase the grease shear stress, apparent consistency, and stuff concentration, which facilitates the formation of a protecting film and a smoothing development, that square measure believed to be to blame for the reduction in friction. The reduction in friction by the surface texture and also the main mechanism could also be attributed to the fluid mechanics pressure impact, which will increase the sex activity gap and reduces the likelihood of asperity contact.

Öztürk, Erkan & Yıldızlı, K. & Memmedov, Royal & Ülgen, Ahmet. (2018). "Design of Associate in Nursing experimental setup to see the constant of static friction of the inner rings to bear with the outer rings of radial spherical plain bearings." *mechanical engineering International*. 128. 10.1016/j.triboint.2018.07.007. during this study, a brand new experimental setup was designed and made to see the constant of static friction (COFs) for polyoxymethylene (POM)/steel spherical contact surfaces in radial spherical plain bearings. The experimental setup will live the resistance moment. The POM/steel COFs equations from the resistance moment measurements were obtained. A sequence of tests dynamical the conventional force below the dry slippery condition for 3 totally different axis angles was performed.[4] The calculated POM/steel COFs minimized with increasing traditional force until adequate tightness was ascertained for all axis angles. Then, the POM/steel COFs remained stable. The static and dynamic coefficients of friction for the spherical contact of various material couples could also be any investigated employing a methodology like this study. This study tried to see the POM/steel COFs between the outer and inner rings for the radial SPB. With this experimental setup, the resistance moment was calculated from the instant made from the adorned weights and also the slippery weight on the cantilever. The conversion from the resistance moment to the POM/steel COFs on the contact surface was provided once the instant equilibrium was reached.[4]

This study tried to see the POM/steel COFs between the outer and inner rings for the radial SPB. The conversion from the resistance moment to the POM/steel COFs on the contact surface was provided once the instant equilibrium was reached. Similar friction forces were measured for 3 measurements at every traditional force, and that they all showed increasing friction force with increasing traditional force. once the determination of the friction forces, the POM/steel COFs was calculated. As work the graphs, the COFs minimized with increasing traditional forces up to 450 N, and higher than 450 N, the COFs remained comparatively stable (little decreased). The COFs had negative linear relation with traditional forces for every axis angle in applied math analysis. This negative relation coincided with literature. though the COFs remained stable for tinny material contacts, the COFs decreases with traditional forces for contacts of tinny materials and polymers. Also, the COFs was a touch totally different for the 3 measurements.

### III. METHODOLOGY

The experimental setup comprises of simple mechanism which consists of a rotating disc which is coupled with a motor which variable speed motor. This can be useful to change the speed of the motor, due to which experiment can be

carried out at different speeds. As the speed of the disc will affect the friction created between two surfaces. Due to an increase in speed the spherical ball will try to slide on the disc. The friction developed will increase, wear between two surfaces will also increase.

Main components of the setup are:

- 1) Variable speed motor
- 2) Circular disc with high finishing surface
- 3) Spherical ball
- 4) Force transducer

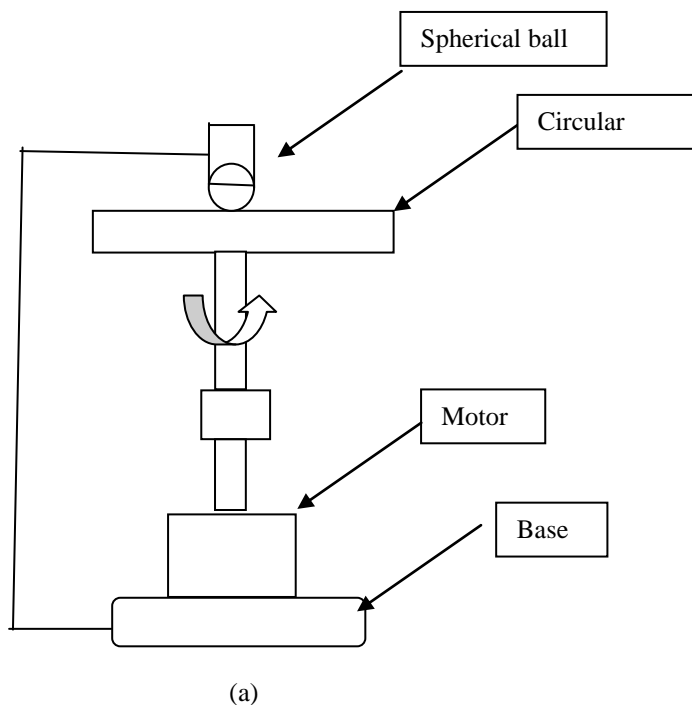


Figure 1. The experimental setup

- We have started working with finding and studying research papers from different portals like science direct.
- Then we collected all the topic related data from these research papers and studied them in a detailed manner along with the standard reference books and academic books.
- Then we finalized the working methodology of our prototype and used CATIA to design the model.
- After the finalization of prototype functioning, we have done the calculations and accordingly detailed force analysis is done, where which type of material is used for the prototype is finalized.
- After the final analysis and material selection we go out in the market to purchase the required components with required specifications.
- In this purchasing process we approximately estimated the cost required to purchase the components and for machining.
- Finally, our product will be manufactured and results and testing will be carried out.

The system is designed in such a manner that at the bottom motor is placed, this motor is rotating with the RPMs that we are giving to it. The RPMs can be controlled with the help of an electronic rpm controller. The whole assembly is supported with the help of the C channel. At the upper side a surface is placed whose coefficient is needed to be determined. A ball attached to the spring is placed on the top of the surface whose coefficient is to be determined. The ball is attached to the spring and force sensor is used to measure the centrifugal force applied due to the circular motion of the disc.

When the motor started rotating it transfers power to the upper surface. The ball attached to the upper surface is moved and the spring attached to it will get stretched. A force sensor is used to find out the amplification occurred due to the force, and finally on the LCD the coefficient of friction is displayed. The controlling system is done by Arduino UNO.

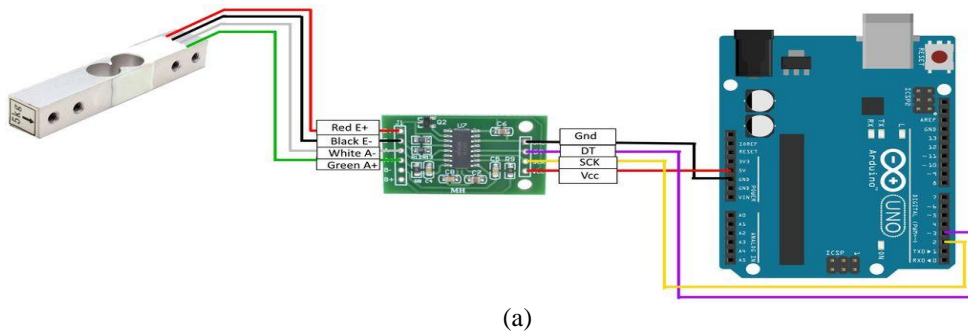


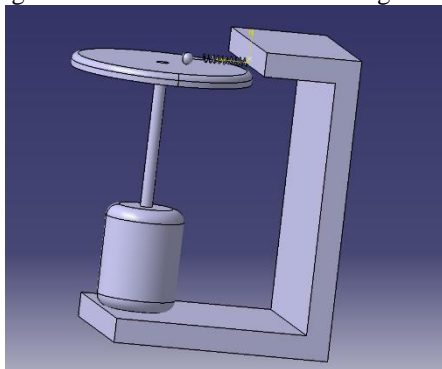
Figure 2. Arduino connected to the force measuring sensor and the motor.

#### ARDUINO UNO-

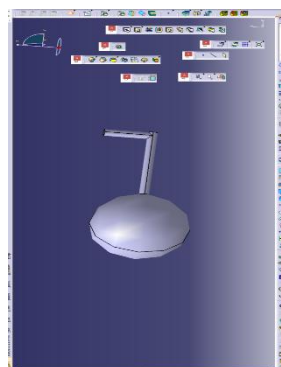
The UNO is the best board to get started with electronics and coding. If this is your first experience tinkering with the platform, the UNO is the most robust board you can start playing with. The UNO is the most used and documented board of the whole Arduino family.

#### IV. EXPERIMENTAL RESULTS

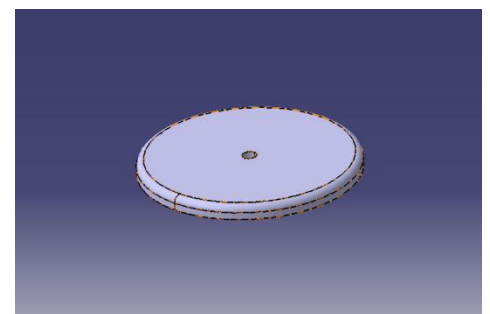
Fig shows the cad model and drafting of the coefficient of friction testing machine with Arduino control.



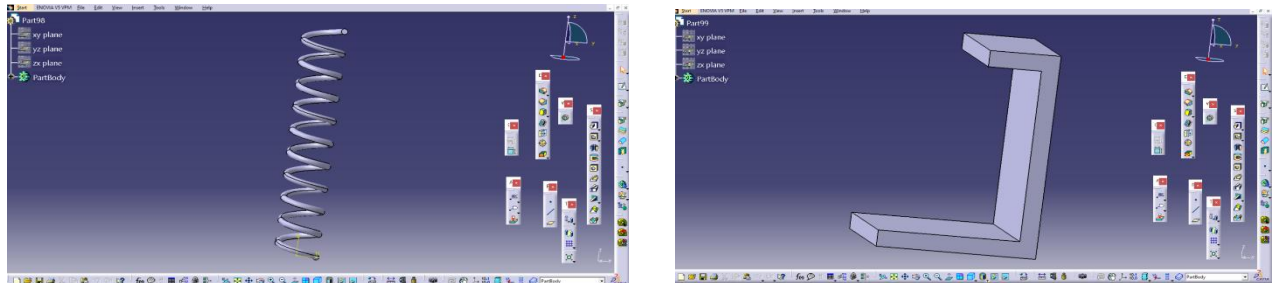
(a)



(b)



(c)



(d)

(e)

Figure 3. The design of the coefficient of friction testing machine

Components of the coefficient of the friction testing machine of the different types of lubricants.

- a) Assembly of the system
- b) Spherical ball
- c) Circular disk
- d) Spring
- e) Frame

## V. CONCLUSION

This project of design and manufacturing of the kinetic coefficient of friction testing machine is fabricated on the idea of literature and research on completely different journal and paper relevant on the market and fancied in accordance, therefore it will offer flexibility in operation. This project of kinetic coefficient of friction testing machine using Arduino is intended with the hope that it's abundantly economical and useful to check the coefficient of friction of different types of lubricant based on their material properties. This innovation is straightforward and less expensive and has lot of room to modify and is economical. On the idea of its design estimating value and handiness it's very cheap and really helpful for the society.

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