**Experiment 5: POWER TRANSMISSION LAB**

**THE BELT FRICTION**

**BACKGROUND: Belt friction** is a term describing the friction forces between a belt and a surface, such as a belt wrapped around a bollard. When one end of the belt is being pulled only part of this force is transmitted to the other end wrapped about a surface. The friction force increases with the amount of wrap about a surface and makes it so the tension in the belt can be different at both ends of the belt. Belt friction can be modeled by the Belt friction equation.

In practice, the theoretical tension acting on the belt or rope calculated by the belt friction equation can be compared to the maximum tension the belt can support. This helps a designer of such a rig to know how many times the belt or rope must be wrapped around the pulley to prevent it from slipping. Mountain climbers and sa

iling crews demonstrate a standard knowledge of belt friction when accomplishing basic tasks.

**Friction Coefficient:** There are certain factors that help determine the value of the friction coefficient. These determining factors are:

* Belting material used – The age of the material also plays a part, where worn ou
* t and older material may become more rough or smoother, changing the sliding friction.
* Construction of the drive-pulley system – This involves strength and stability of the material used, like the pulley, and how greatly it will oppose the motion of the belt or rope.
* Conditions under which the belt and pulleys are operating – The friction between the belt and pulley may decrease substantially if the belt happens to be muddy or wet, as it may act as a lubricant between the surfaces. This also applies to extremely dry or warm conditions which will evaporate any water naturally found in the belt, nominally making friction greater.
* Overall design of the setup – The setup involves the initial conditions of the construction, such as the angle which the belt is wrapped around and geometry of the belt and pulley system.

**Applications:** An understanding of belt friction is essential for sailing crews and mountain climbers.[[1]](https://en.wikipedia.org/wiki/Belt_friction#cite_note-Attaway-1) Their professions require being able to understand the amount of weight a rope with a certain tension capacity can hold versus the amount of wraps around a pulley. Too many revolutions around a pulley make it inefficient to retract or release rope, and too few may cause the rope to slip. Misjudging the ability of a rope and capstan system to maintain the proper frictional forces may lead to failure and injury.

**AIM OF STUDY:** To estimate the coefficient of friction and compare the power transmission of Flat and V-belts. Estimate and compare the power transmissions of Flat and V-belts for assumed rotational speeds of the wheel; 5rpm, 10rpm and 15rpm.

**LABORATORY EQUIPMENT:** The equipment is supported on a wall bracket. Load is placed on the hanger and the weight of the load together with the weight of the hanger constitutes the slack tension. The angle marker is pinned at one of the angles graduated on the wall bracket. The pulley is turned counter-clockwise by means of the handle and the tight side tension recorded on the spring balance is recorded.

**EXPERIMENTAL PROCEDURE:** Set the angle of wrapθ. With a load on the hanger (the slack tension), turn the wheel and read the tight tensions T1 for each of the angles of wrap θ = 20, 60, 90, 120, 150°. The procedure is conducted for the three slack tensions T2 = 0.6kg, 1.1kg and 1.6kg.

**RESULTS AND CALCULATIONS:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | Ω**d**=10rpm |  |  |  |  |
|  |  |  |  |  | V-Belt |  |  |  |  |
|  |  |  | T2=0.6kg |  |  | T2=1.1kg |  | T2= | 1.6kg |
| θ[°] | T1[kg] | P[W] | *Γ*d[Nm] | T1[kg] | P[W] | *Γ*d[Nm] | T1[kg] | P[W] | *T*d[Nm] |
| 30 | 1.5 |  |  | 2.0 |  |  | 3.0 |  |  |
| 60 | 2.0 |  |  | 3.0 |  |  | 4.5 |  |  |
| 90 | 3.0 |  |  | 6.0 |  |  | 8.0 |  |  |
| 120 | 5.0 |  |  | 8.0 |  |  | 12.0 |  |  |
| 150 | 7.0 |  |  | 12.0 |  |  | 16.5 |  |  |
|  |  |  |  |  | Flat Belt |  |  |  |  |
| θ[°] | T1[kg] | P[W] | *Γ*d[Nm] | T1[kg] | P[W] | *Γ*d[Nm] | T1[kg] | P[W] | *Γ*d[Nm] |
| 30 | 1.0 |  |  | 2.0 |  |  | 2.5 |  |  |
| 60 | 1.5 |  |  | 2.5 |  |  | 3.0 |  |  |
| 90 | 2.0 |  |  | 3.0 |  |  | 4.0 |  |  |
| 120 | 2.5 |  |  | 3.5 |  |  | 6.0 |  |  |
| 150 | 3.0 |  |  | 5.0 | ,kj |  | 9.0 |  |  |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | Ω**d**=15rpm |  |  |  |  |
|  |  |  |  |  | V-Belt |  |  |  |  |
|  |  |  | T2=0.6kg |  |  | T2=1.1kg |  | T2= | 1.6kg |
| θ[°] | T1[kg] | P[W] | *Γ*d[Nm] | T1[kg] | P[W] | *Γ*d[Nm] | T1[kg] | P[W] | *T*d[Nm] |
| 30 | 1.5 |  |  | 2.0 |  |  | 3.0 |  |  |
| 60 | 2.0 |  |  | 3.0 |  |  | 4.5 |  |  |
| 90 | 3.0 |  |  | 6.0 |  |  | 8.0 |  |  |
| 120 | 5.0 |  |  | 8.0 |  |  | 12.0 |  |  |
| 150 | 7.0 |  |  | 12.0 |  |  | 16.5 |  |  |
|  |  |  |  |  | Flat Belt |  |  |  |  |
| θ[°] | T1[kg] | P[W] | *Γ*d[Nm] | T1[kg] | P[W] | *Γ*d[Nm] | T1[kg] | P[W] | *Γ*d[Nm] |
| 30 | 1.0 |  |  | 2.0 |  |  | 2.5 |  |  |
| 60 | 1.5 |  |  | 2.5 |  |  | 3.0 |  |  |
| 90 | 2.0 |  |  | 3.0 |  |  | 4.0 |  |  |
| 120 | 2.5 |  |  | 3.5 |  |  | 6.0 |  |  |
| 150 | 3.0 |  |  | 5.0 |  |  | 9.0 |  |  |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | Ω**d**=5rpm |  |  |  |  |
|  |  |  |  |  | V-Belt |  |  |  |  |
|  |  |  | T2=0.6kg |  |  | T2=1.1kg |  | T2= | 1.6kg |
| θ[°] | T1[kg] | P[W] | *Γ*d[Nm] | T1[kg] | P[W] | *Γ*d[Nm] | T1[kg] | P[W] | *T*d[Nm] |
| 30 | 1.5 |  |  | 2.0 |  |  | 3.0 |  |  |
| 60 | 2.0 |  |  | 3.0 |  |  | 4.5 |  |  |
| 90 | 3.0 |  |  | 6.0 |  |  | 8.0 |  |  |
| 120 | 5.0 |  |  | 8.0 |  |  | 12.0 |  |  |
| 150 | 7.0 |  |  | 12.0 |  |  | 16.5 |  |  |
|  |  |  |  |  | Flat Belt |  |  |  |  |
| θ[°] | T1[kg] | P[W] | *Γ*d[Nm] | T1[kg] | P[W] | *Γ*d[Nm] | T1[kg] | P[W] | *Γ*d[Nm] |
| 30 | 1.0 |  |  | 2.0 |  |  | 2.5 |  |  |
| 60 | 1.5 |  |  | 2.5 |  |  | 3.0 |  |  |
| 90 | 2.0 |  |  | 3.0 |  |  | 4.0 |  |  |
| 120 | 2.5 |  |  | 3.5 |  |  | 6.0 |  |  |
| 150 | 3.0 |  |  | 5.0 |  |  | 9.0 |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | T2=0.6kg |  | T2=1.1kg |  | T2=1.6kg |  |
|  | V-Belt | Flat Belt | V-Belt | Flat Belt | V-Belt | Flat Belt |
| θ[°] | Loge(T1/T2) | Loge(T1/T2) | Loge(T1/T2) | Loge(T1/T2) | Loge(T1/T2) | Loge(T1/T2) |
| 30 | 0.9163 | 0.5108 | 0.5978 | 0.5978 | 0.6286 | 0.4463 |
| 60 | 1.2040 | 0.9163 | 1.0033 | 0.8209 | 1.0341 | 0.6286 |
| 90 | 1.6094 | 1.2040 | 1.6964 | 1.0033 | 1.6094 | 0.9163 |
| 120 | 2.1203 | 1.4271 | 1.9841 | 1.1575 | 2.0149 | 1.3218 |
| 150 | 2.4567 | 1.6094 | 2.3896 | 1.5141 | 2.3334 | 1.7272 |

1: Average of the two most agreeing for my analysis (1st and 3rd values of T1 and T2 for both belts):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Flat Belt | θ[°] | 30 | 60 | 90 | 120 | 150 |
| Ωd=10rpm | T2=1.1kg |  | T1[kg] | 1.75 | 2.25 | 3.00 | 4.25 | 6.00 |
|  |  |  | Loge(T1/T2) | 0.4643 | 0.7156 | 1.0033 | 1.3516 | 1.6964 |
|  |  | V-belt | θ[°] | 30 | 60 | 90 | 120 | 150 |
|  |  |  | T1[kg] | 2.25 | 3.25 | 5.50 | 8.50 | 11.75 |
|  |  |  | Loge(T1/T2) | 0.7156 | 1.0833 | 1.6094 | 2.0448 | 2.3685 |

From Graph,

Using

Using

**OBSERVATIONS:**

**PRECAUTIONS:**

**CONCLUSION**