Belt Drive Lab report

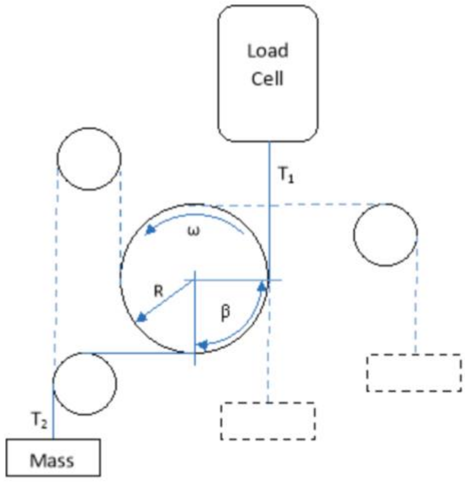
Introduction

Belt Drives are widely used in industry to transmit power from one rotating shaft to another. They are preferred over other forms of power transmission due to their flexibility, ease of installation, and low maintenance.

The efficiency of a belt drive system depends on several factors, including the contact angle between the belt and pulley, as well as the coefficient of friction between the belt and pulley.

Early belts were flat, but recently V-Belts are much more common as they allow more power transmission for a given pulley diameter. The applications of belt drives are hugely varied, ranging from timing belts on car engines, to grain belt conveyors.

Method



Apparatus:

1. Belt drive system set up as shown above, with the central pulley of radius 50mm and a load cell.
2. DC electric motor to provide initial rotational movement of the central pulley, measuring voltage (V) and current (I).
3. Masses, 100g each, to vary the load applied at the free end of the string.
4. Hand-held optical tachometer capable of measuring rotational speed of the pulley.

Procedure

To ensure that the angel of contact between the belt and pulley, the free end of the string was positioned accordingly. The motor supply voltage was then set to 10V, and T2>T1 was verified to ensure that the pulley was rotating in the correct direction. Prior to placing a minimum load of 100g on the free end of the string, the spring balance was zeroed, and measurement of T1 was obtained from the spring balance.

Subsequently, individual 100g masses were added until the maximum mass was reached, and the value on the load cell recorded after each addition. The experiment was then repeated for each angle once the total mass reached 1000g.

During the experiment measure T1 and T2 and the mass on the end of the string. However, when measuring for a belt angle of 270, also record the rotational speed of the drive pulley, as well as the current and voltage from the power supply.

Results:

Belt Contact Angle: 90

Mass/g	T1/N	T2/N
0	0.00	0
100	0.60	0.981
200	1.25	1.962
300	1.90	2.943
400	2.55	3.924
500	3.15	4.905
600	3.80	5.886
700	4.45	6.867
800	5.10	7.848
900	5.75	8.829
1000	6.40	9.81

Belt Contact Angle: 180

Mass/g	T1/N	T2/N
0	0.00	0
100	0.35	0.981
200	0.80	1.962
300	1.25	2.943
400	1.65	3.924
500	2.15	4.905
600	2.55	5.886
700	3.05	6.867
800	3.50	7.848
900	3.95	8.829
1000	4.40	9.81

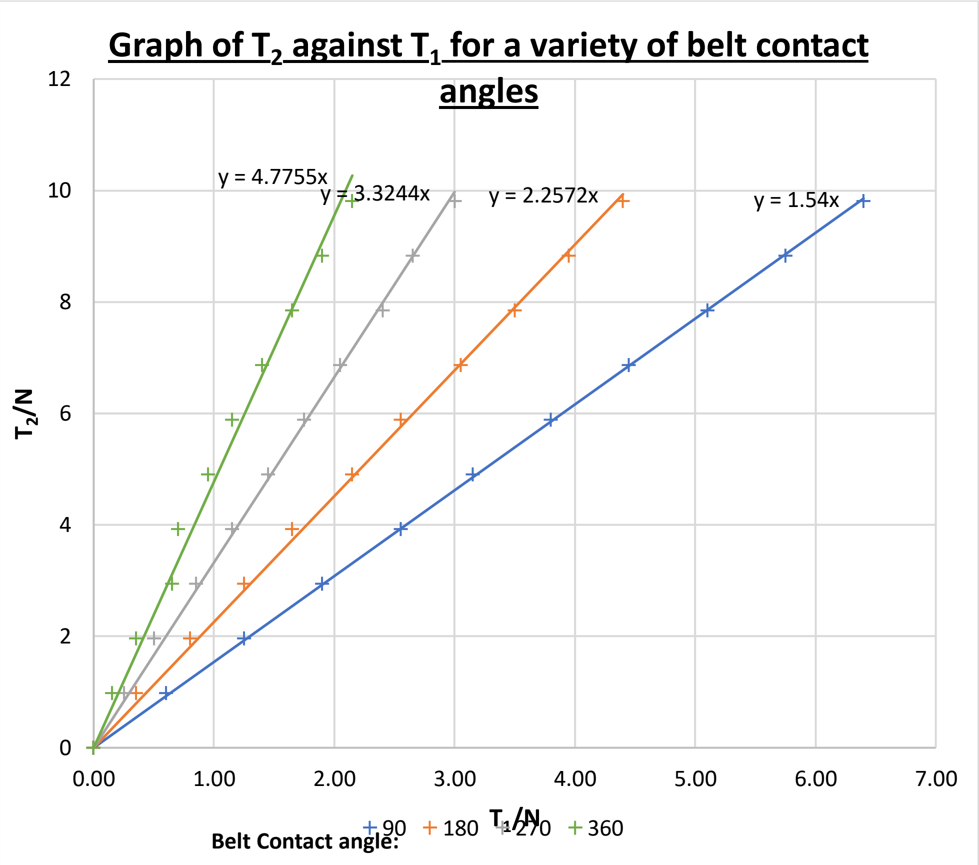
Belt Contact Angle: 270

Mass/g	T1/N	T2/N	Current/A	Volt/V	Speed/rpm
0	0.00	0.00	0.5	11.9	1723
100	0.25	0.98	1.3	11.9	1672
200	0.50	1.96	1.9	11.9	1627
300	0.85	2.94	2.5	11.9	1580

400	1.15	3.92	3.0	11.9	1533
500	1.45	4.91	3.6	11.8	1488
600	1.75	5.89	4.1	11.8	1445
700	2.05	6.87	4.7	11.8	1395
800	2.40	7.85	5.2	11.8	1346
900	2.65	8.83	5.8	11.8	1303
1000	3.00	9.81	6.3	11.8	1256

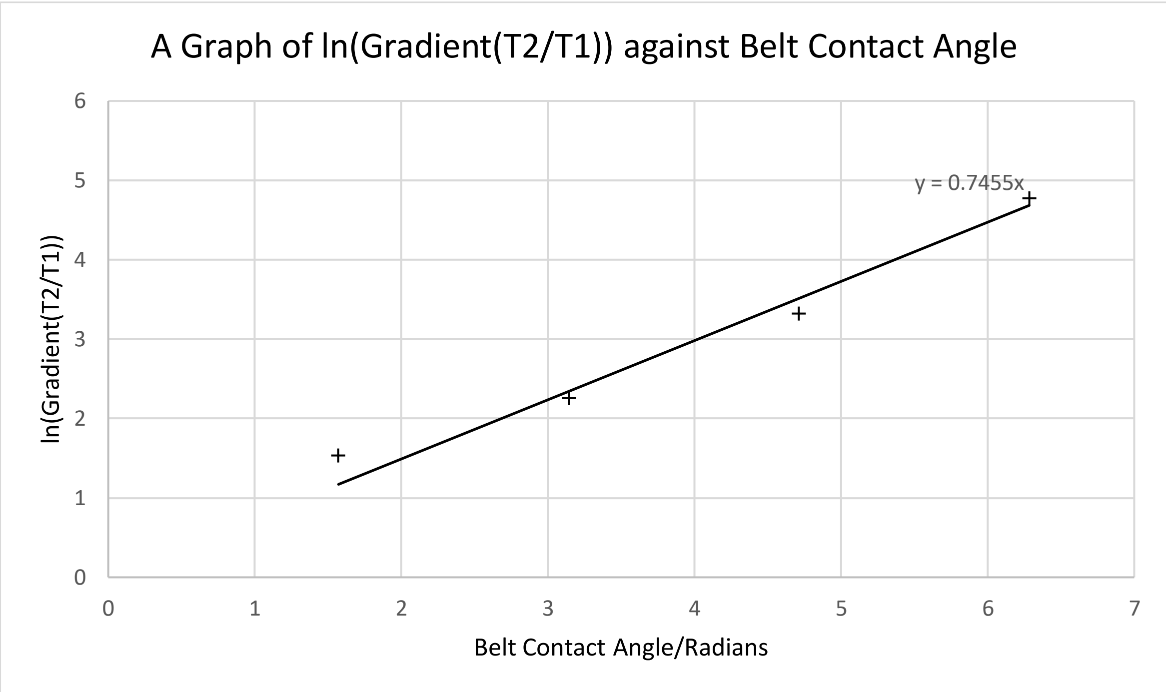
Belt Contact Angle: 360

Mass/g	T1/N	T2/N
0	0.00	0
100	0.15	0.981
200	0.35	1.962
300	0.65	2.943
400	0.70	3.924
500	0.95	4.905
600	1.15	5.886
700	1.40	6.867
800	1.65	7.848
900	1.90	8.829
1000	2.15	9.81



Calculating ln(gradient(T2/T1)

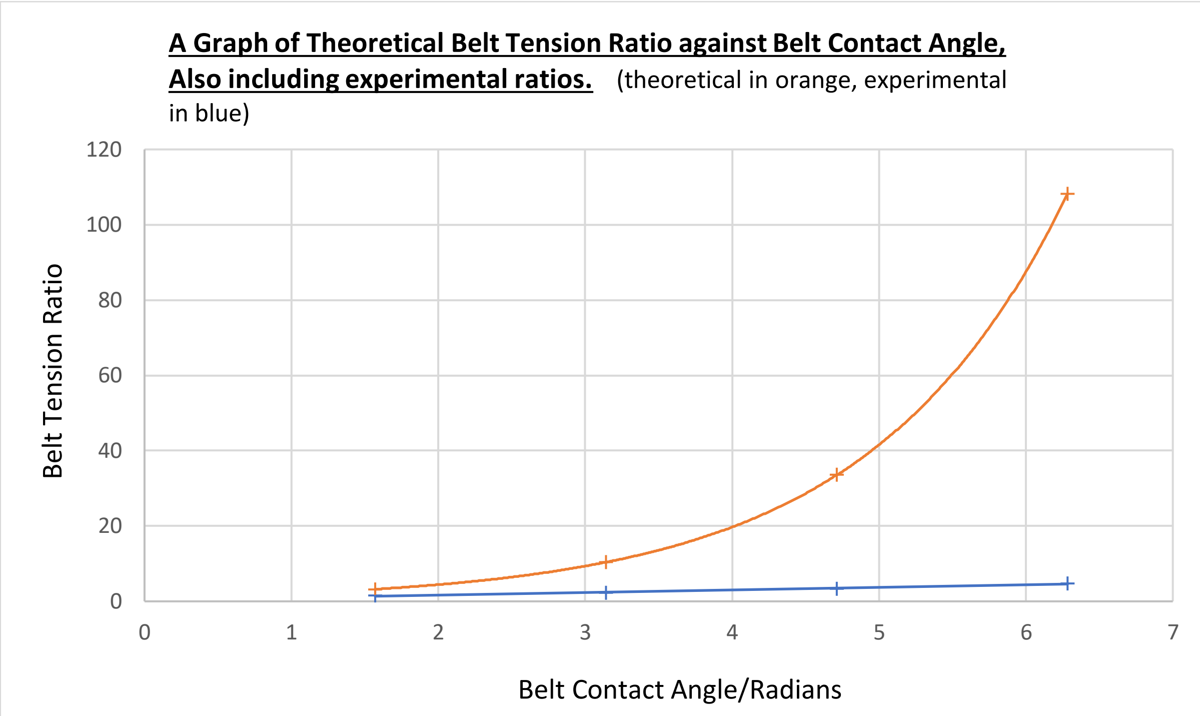
Belt Contact Angle(radians)	Gradient	ln(gradient)
1.570796	1.54	0.431782
3.141593	2.2572	0.814125
4.712389	3.3244	1.201289
6.283185	4.7755	1.563499



According to this graph, the coefficient of Friction between the Pulley and Belt is 0.7455.

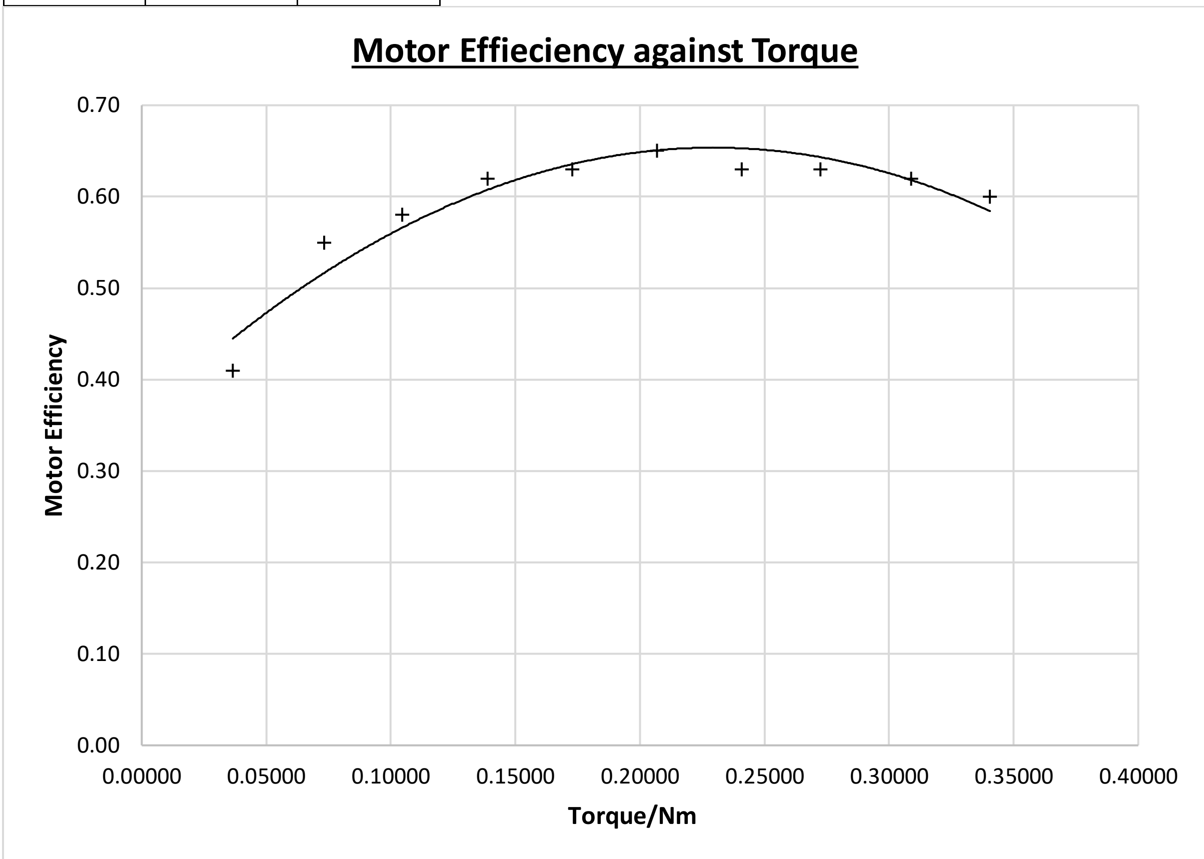
Calculating Theoretical Belt Tension Ratios.

	a	B	u	T2/T1
	1.570796	1.570796	0.7455	3.224917
	1.570796	3.141593	0.7455	10.40009
	1.570796	4.71239	0.7455	33.53943
Theoretical Value	1.570796	6.283187	0.7455	108.1619
		1.570796		1.54
		3.141593		2.2572
		4.71239		3.3244
Experimental Values		6.283187		4.7755



Calculating Motor Efficiencies

Torque	Rad/s	Efficiency
0.00000	180.43	0.00
0.03655	175.09	0.41
0.07310	170.38	0.55
0.10465	165.46	0.58
0.13870	160.54	0.62
0.17275	155.82	0.63
0.20680	151.32	0.65
0.24085	146.08	0.63
0.27240	140.95	0.63
0.30895	136.45	0.62
0.34050	131.53	0.60



Discussion

1. Are the results as expected? If not, why not?

As anticipated, the increase in the angle of contact would result in a decrease in T1 and an increase in the belt tension ratio. This expectation is confirmed by the data points presented, indicating that the experiments results were as predicted.

2. Do theoretical and Experimental Results Agree?

As can be seen in the graph of theoretical and experimental Belt Tension Ratios against Belt Contact Angle, these values do not agree at all. Suggesting an error in the experiment or calculations.

3. Comment on the motor Efficiency and explain the shape of the curve.

It is apparent that the motor efficiency initially increases and then begins to level off as Torque approaches around 0.2300 Nm. This indicates that the relationship between torque and efficiency is not linear but rather parabolic, implying that there is a peak efficiency at each contact angle. Any assumption that the motor driving the pulley is 100% efficient is not realistic since because energy is lost due to friction, cooling, and core losses. Additionally, some efficiency could be gained by using a V-belt in the experiment.

Summary

The transfer of power between machines and system in the industrial setting is of utmost importance, and belt drives offer an inexpensive yet effective means of achieving this. To investigate the belt tension ratio and the efficiency of a pulley, as well as to compare the results with theoretical predictions, a flat belt was fastened around a pulley at four different contact angles, and the tensions before and after the pulley showed that the experimental results were highly comparable to the predicted results, validating the notion that an increase in the contact angle would lead to a rise in the belt tension ratio.

Conclusion

In conclusion, this experiment successfully demonstrated the link between Belt Contact Angle, Efficiency and Tension Ratio. The Efficiency Graph provides evidence that there is an optimum torque of a system to provide maximum efficiency. The results of this experiment are statistically insignificant due to the vast difference between the pulley used compared to the stanard in industry, however this experiment still effectively and clearly showed key relationships between the Belt Contact Angle, Tension Ratio, and Efficiency.