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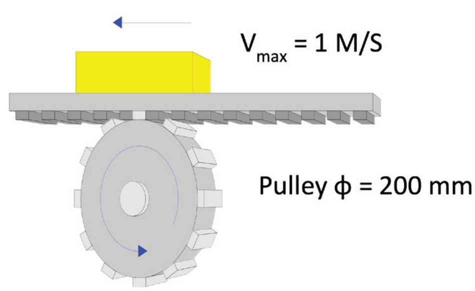
Calculating the Correct Speed Ratio

Understanding the working principle and calculation method of planetary gear ratio can help you choose the appropriate gear ratio for your machinery and maximize its efficiency.

The gear ratio, also known as the transmission ratio of a gear mechanism, refers to the ratio between the input speed and the output speed in the gear mechanism. It is commonly denoted by the symbol "i."

The formula for the gear ratio is as follows: Gear Ratio (i) = Motor Output Speed / Gearbox Output

The first case is quick easy: You want to achieve a maximum motion speed = 1 meter / second in the example below



You simply need to divide the speed by the pulley radius in meter = 0.1 m

It gives you the rotational speed of the pulley in radians /second = 1 / 0.1 = 10 rd/s

If you divide by 2π and multiply by 60 you obtain rotational speed in rpm

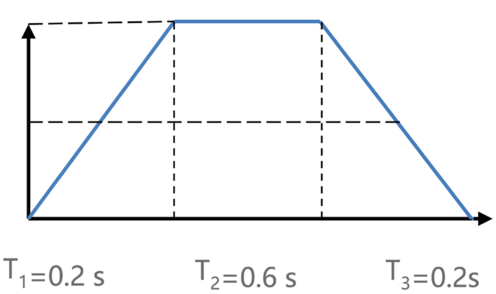
Speed in rpm = (10 ×60) / (2 π) = 95.5 rpm

You have to select a motor speed equal or lower of nominal input speed of gear reducer. For instance, 3000 rpm.

Therefore, the maximum allowable ratio to obtain the load maximum speed is: 3000/95.5 = 31.41

Because 31.41 ratio is not available, you select the one just below: **30** – This is a double stage gear reducer in such case.

The second case will require just a little bit more calculation. You want to achieve a displacement distance of the load in a given time considering acceleration and deceleration time.



With same pulley diameter you want to obtain a displacement of 1 meter in one second.

The displacement average speed will be 1 m / 1 s = 1 m/s but you need to reach a higher maximum speed $V_2 = V_{max}$ because during acceleration and deceleration phase the average speed V_1 and $V_3 = V_{max}/2$

With respective acceleration, motion and deceleration time according to above picture the average speed equation equal:

$(0.5 \times V_{max} \times T_1 + V_{max} \times T_2 + 0.5 \times V_{max} \times T_3) / (T_1 + T_2 + T_3) = V_{average}$ or
$V_{max} \times (0.5 \times 0.2 + 0.6 + 0.5 \times 0.2) / (0.2 + 0.6 + 0.2) = V_{average}$

$V_{max} = V_{average} / 0.8 = 1.25$ M/s

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With this new V_{max} speed, you are back to first case for selecting the gear ratio

1.25 / 0.1 = 12.5 rd/s or 119.42 rpm

The maximum gear ratio = 3000 / 119.42 = 25.12

The closest lower available ratio being **25** you select this one

Note: chosen acceleration and deceleration time have to be coherent with the motor size. Don't select a too short acceleration time with a large motor and gear reducer, as well the opposite. 0.2 second is coherent with a small-medium size servo application

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