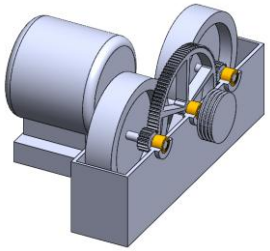
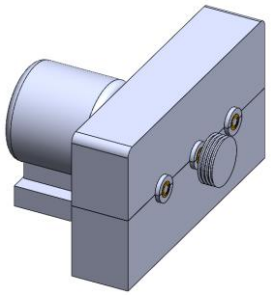


Oil PIC
Pumpjack Inertia Capacitor



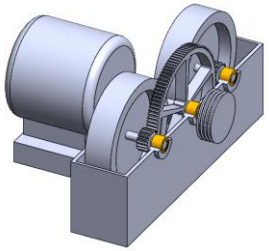
a low-cost, easy-to-manufacture solution for optimizing pumpjack operations and maximizing profits for oil producers

"One of the most significant operating costs (frequently the largest) associated with sucker-rod pumping is the expense of pulling and repairing the rods, pump, and tubing. Many wells are pulled for repairs so often that they are marginally economic."

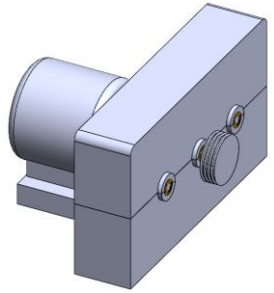
--Paul M. Bommer and David Shrauner, "*Benefits of Slow Speed Pumping.*"

"Even the most sophisticated conventional pump-jack with an AC motor and VFD (variable frequency drive/variable speed drive) does not have the precise rod string control required to help mitigate and resolve many…complex rod pumping issues…"

--Andrew Patrakov, Evan West ,Igor Shulyatikov, Doug Kinnaird, "New Era of Oil Well Drilling and Completions."



The *PIC™* Solution

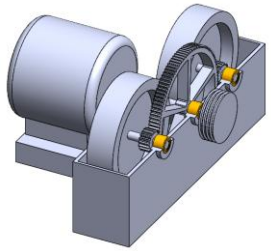


Saves Energy Costs

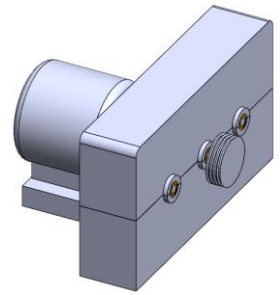
- Prime mover continuously operates at optimal efficiency

Reduces Maintenance Costs

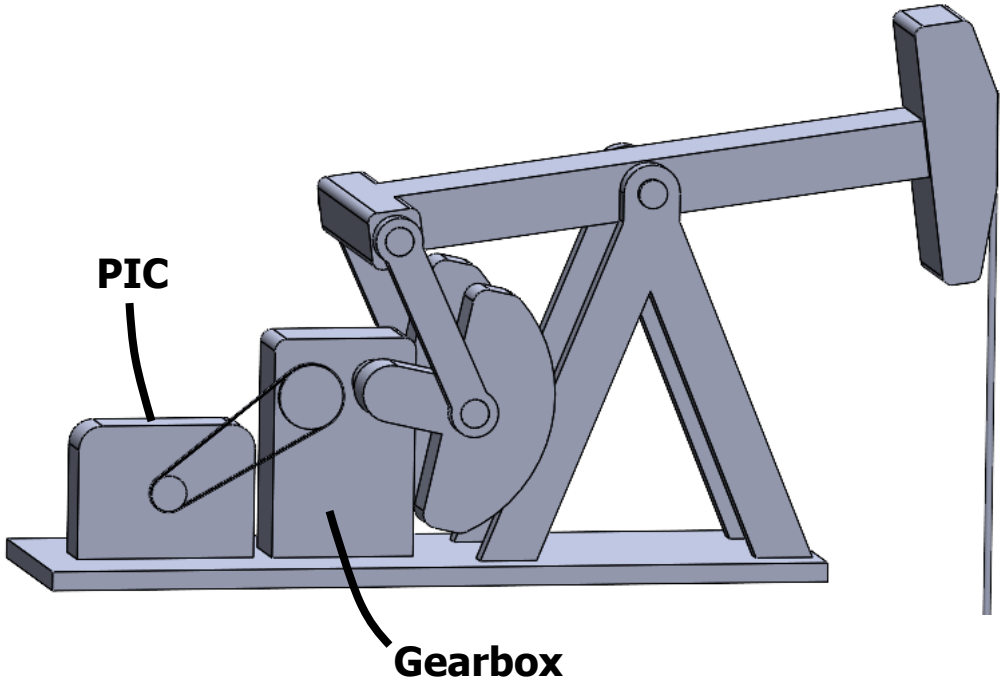
- Extends sucker rod life
- Eliminates the need to adjust an unbalanced pumpjack



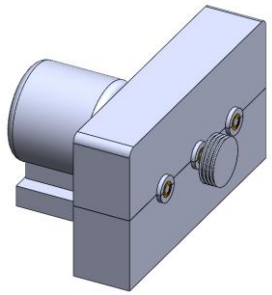
How does *PIC™* work?

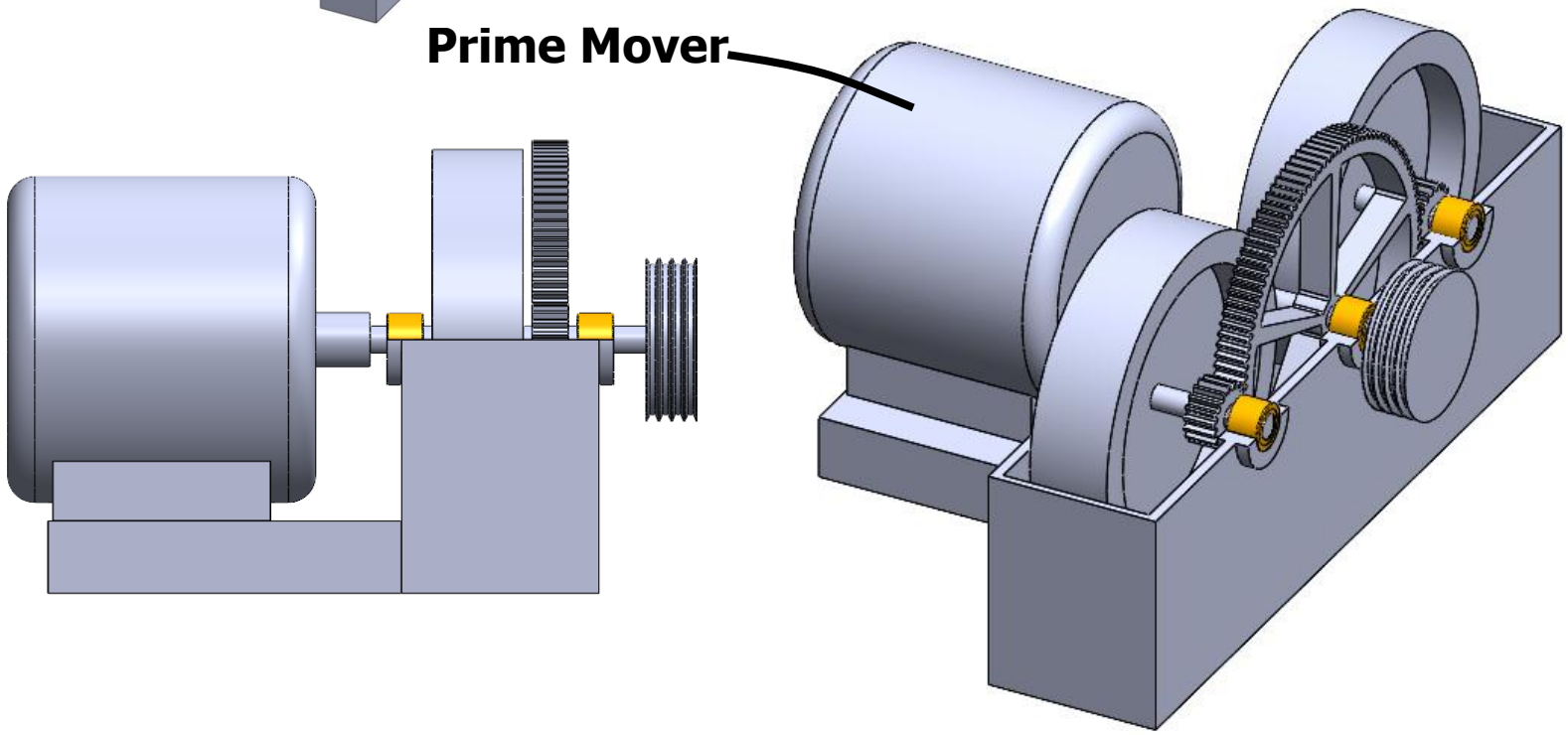


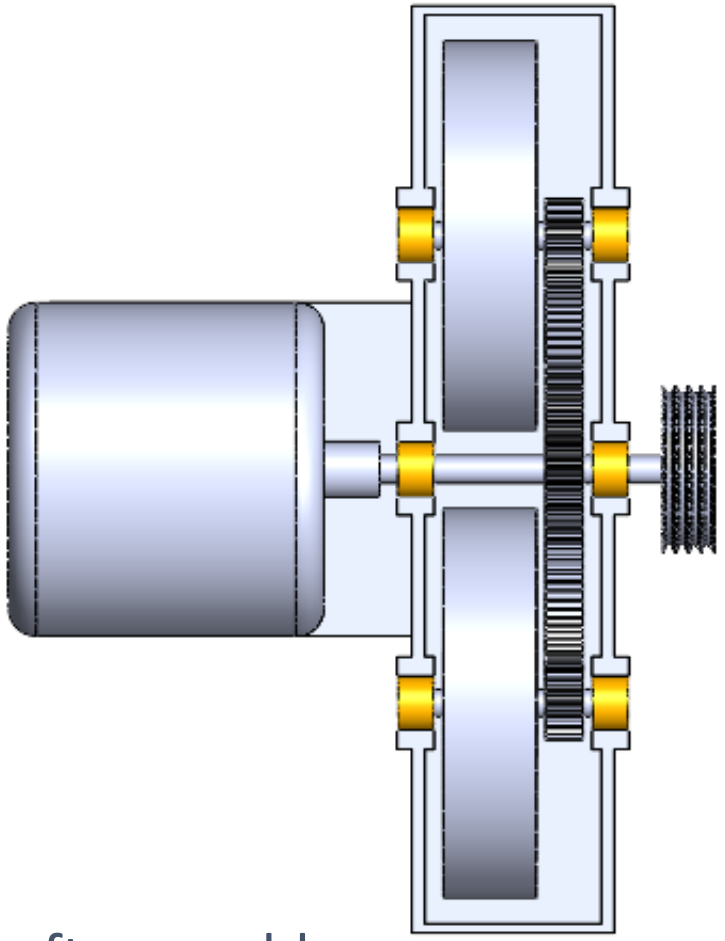
- The *PIC™* design is based on the principle of an energy storage flywheel, which produces smooth, continuous action.
- *PIC™* utilizes one or more flywheels installed in a series configuration between the prime mover (motor) and gearbox.



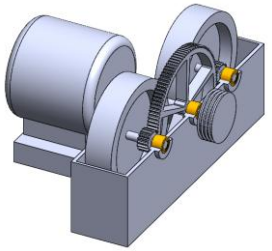
PIC™ Production Assembly



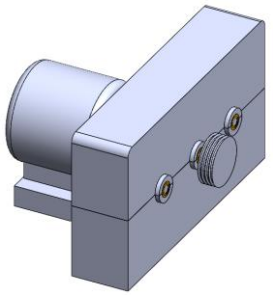




- Prime mover is directly attached to the ***PIC™*** primary shaft assembly
- Size of prime mover is reduced by more than 50% with ***PIC™***
- ***PIC™*** can be retrofitted to any pumpjack

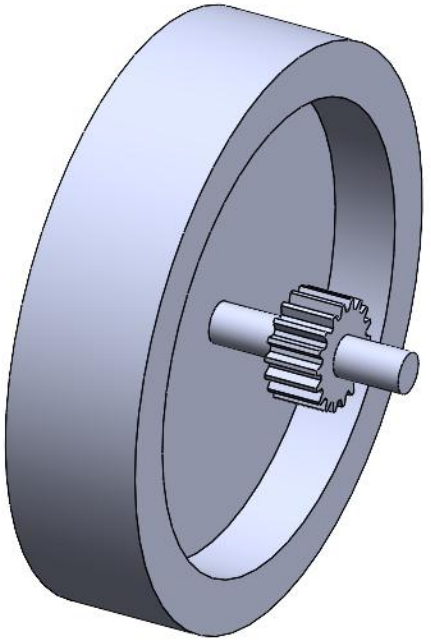


PIC™ Inertia Capacitor (Flywheel)



- Rotating mechanical device used to store Kinetic Energy (KE)

$$KE = \frac{1}{2} I \omega^2$$



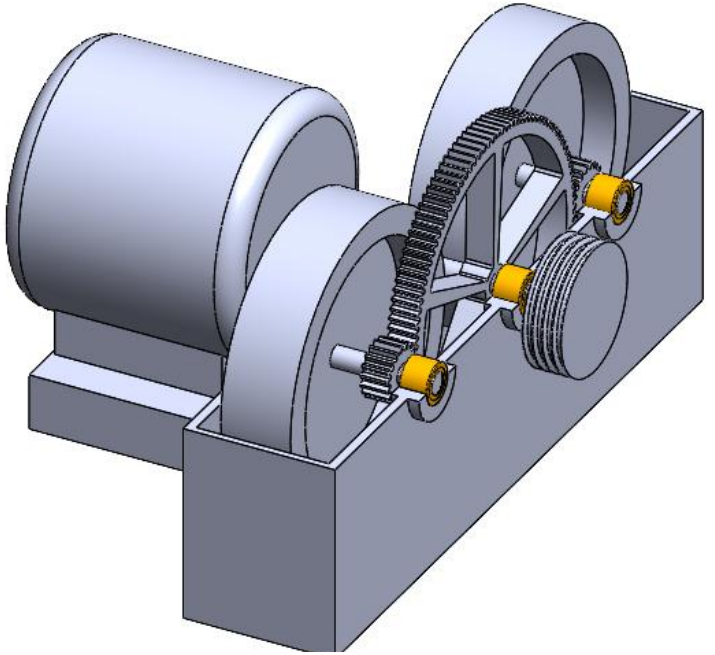
  - Mass Moment of Inertia (**I**) of flywheel
  - Rotational Velocity (**ω**) of flywheel

- Newton's first & third laws of motion

1. Every object in a state of uniform motion will remain in that state of motion unless an external force acts on it.
3. For every action there is an equal and opposite reaction.

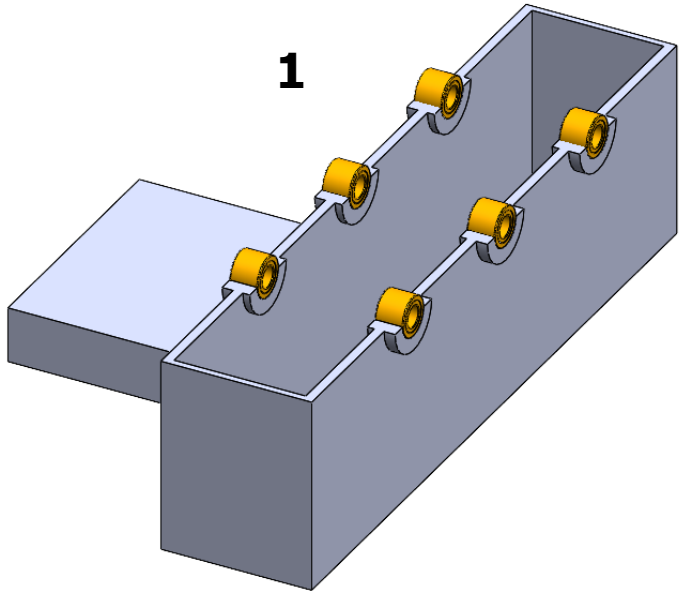
PIC™ Primary Components

1. Frame, Base & Bearings
2. Primary Shaft Assembly
   - Shaft, gear, clutch, pulley & prime mover
3. Two Flywheel Assemblies
   - Shaft, flywheel & gear



(oil lubrication for bearings & gears not shown)

1



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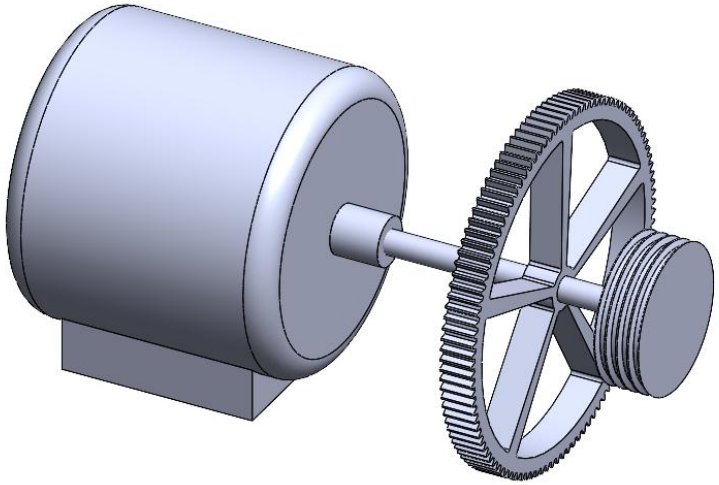

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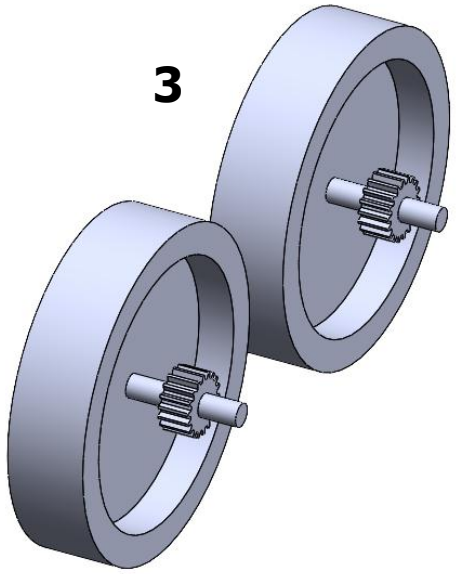
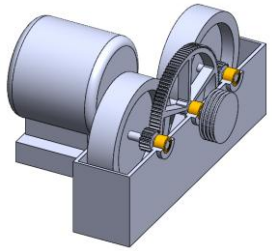
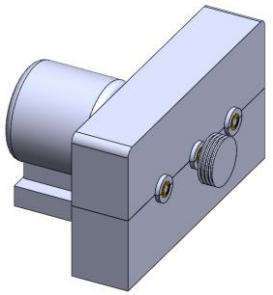
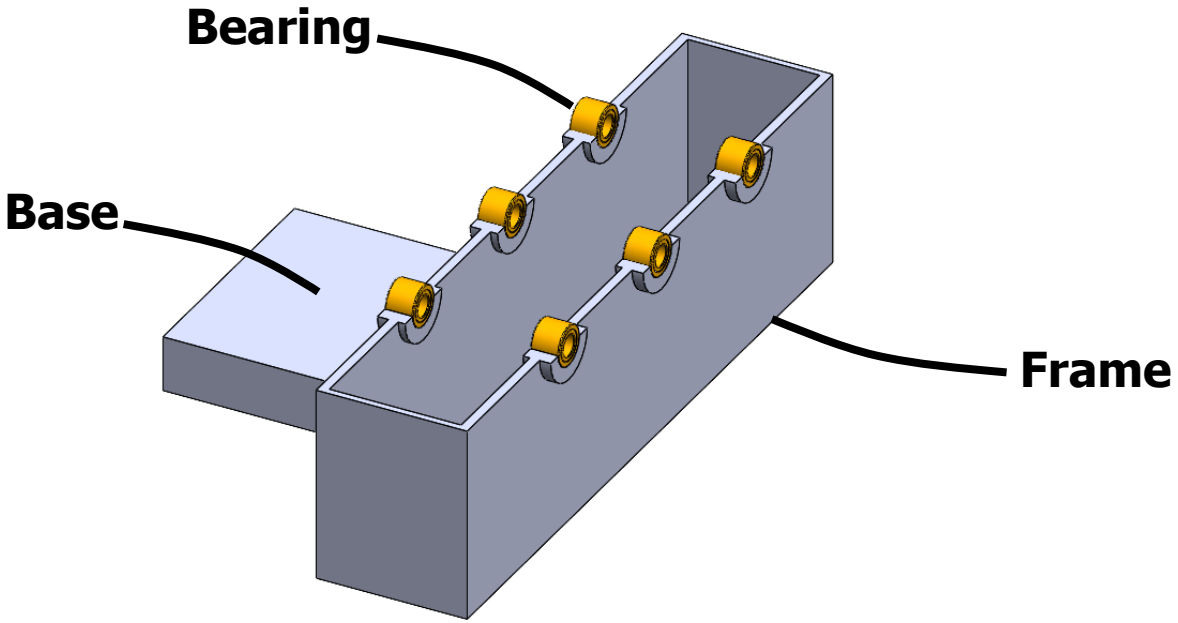


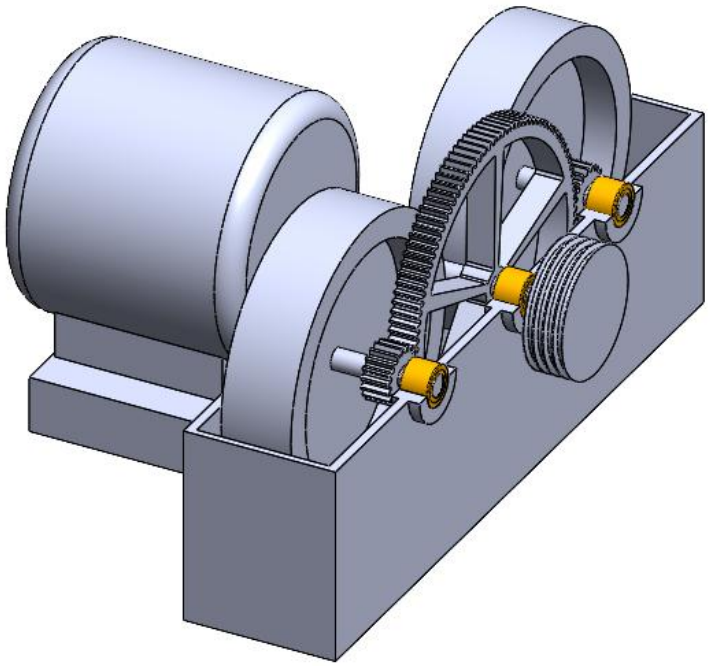


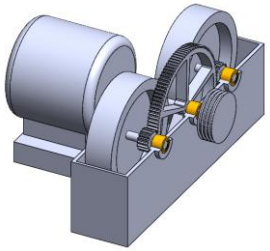
PIC™ Frame and Bearings



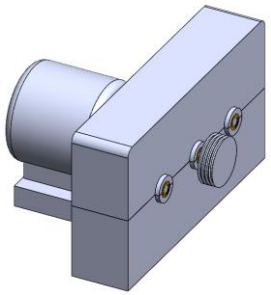
- *Frame*: the support structure with bearing mounts, which is affixed to the pumpjack
- *Bearings*: six bearings hold the three rotating shafts to the frame while reducing the friction between the shafts and the frame
- Base: prime mover support structure affixed to frame



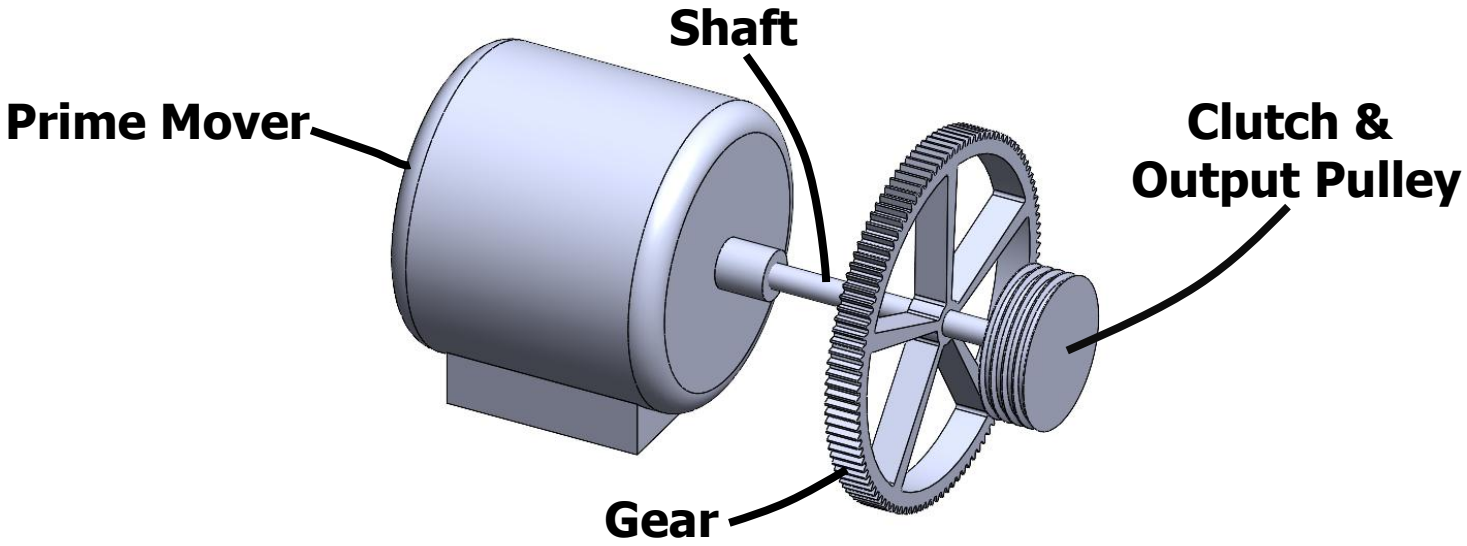


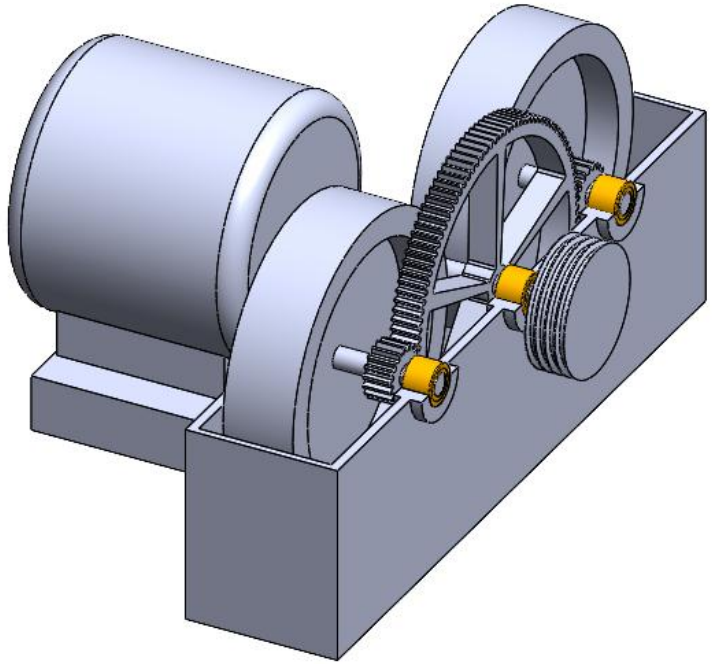


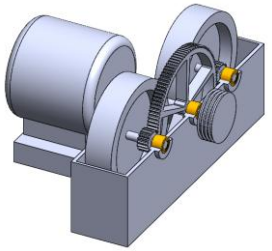
PIC™ Primary Shaft Assembly and Prime Mover



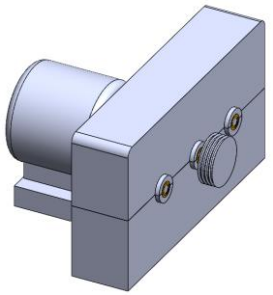
- *Output Pulley*: affixed to shaft & transfers torque to the gearbox
- *Shaft*: rotating support structure
- *Gear*: affixed to shaft and transfers torque to & from flywheel assembly
- *Clutch*: affixed to shaft & output pulley and engages for start-up when the flywheels are rotating at their operational speed
- *Prime Mover*: affixed to shaft & transfers torque



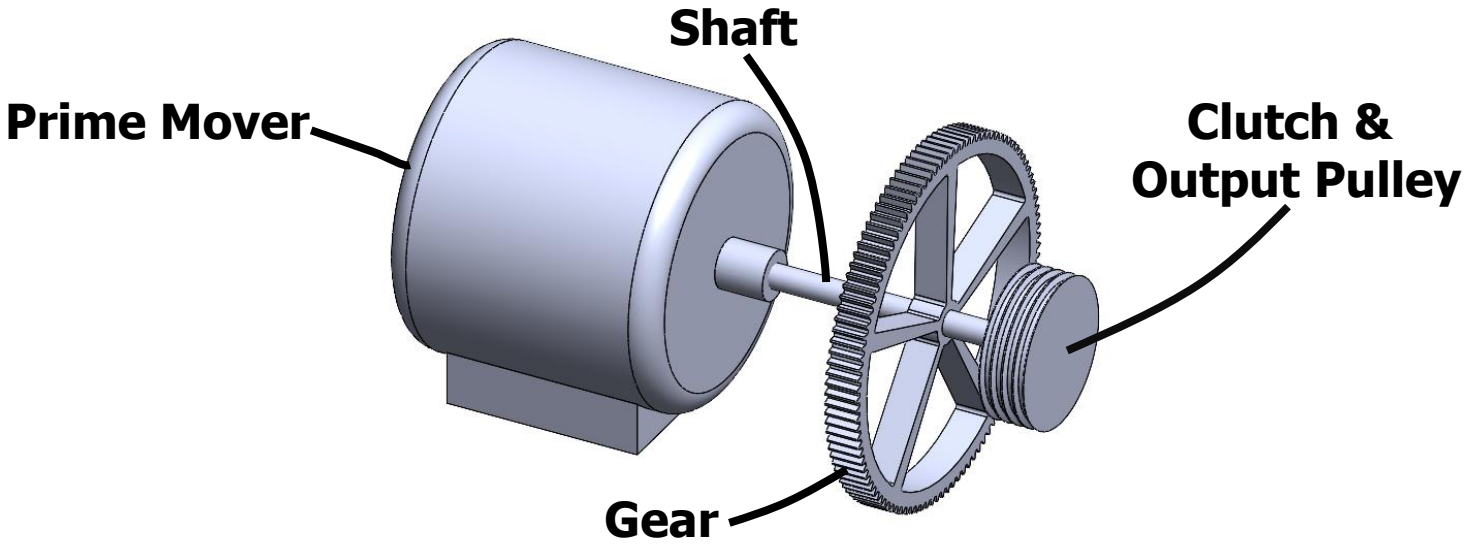


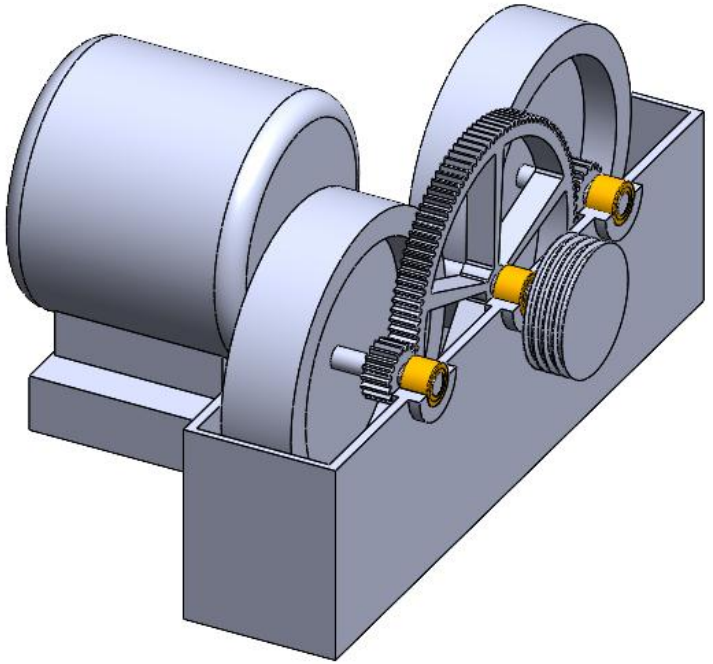


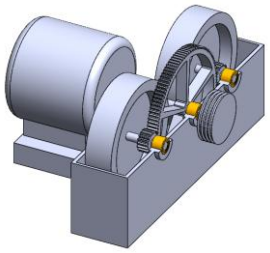
PIC™ Primary Shaft Assembly and Prime Mover



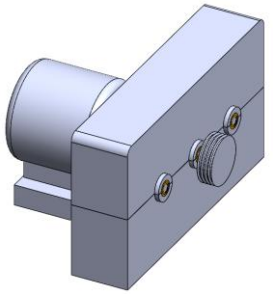
- Clutch is disengaged when the prime mover is turn on and flywheels are accelerating up to operation speed.
- Once the flywheels are at the operation speed the clutch is engaged and remains engaged.



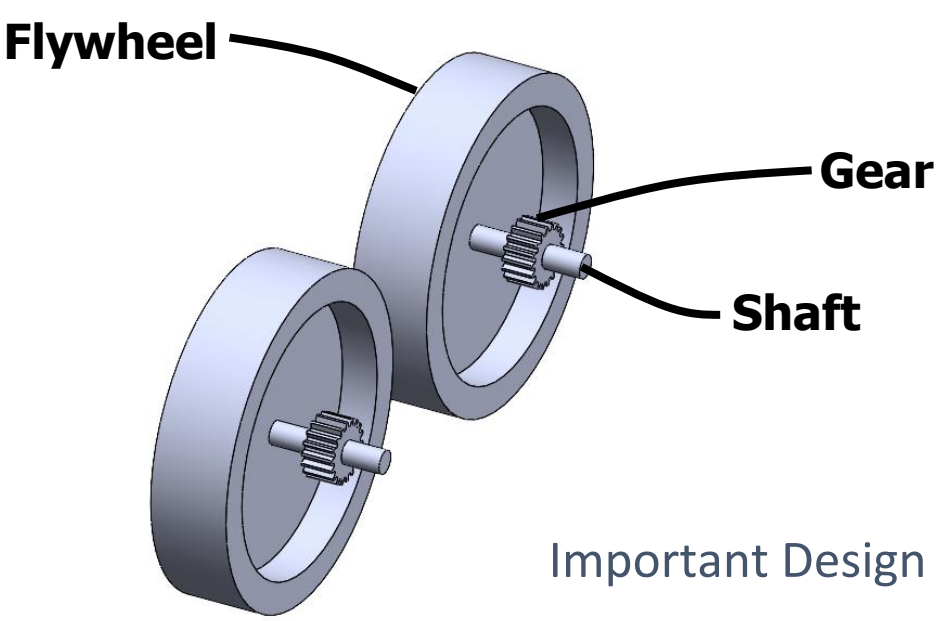


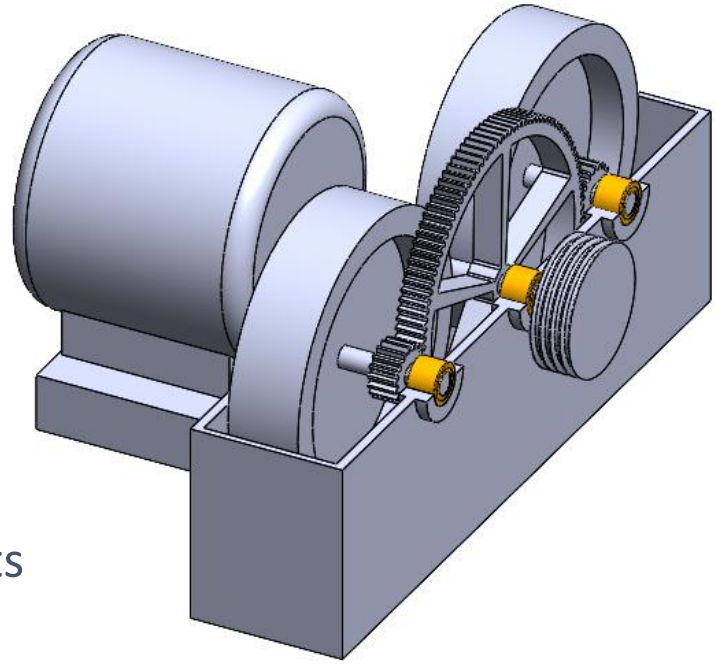


PIC™ Flywheel Assemblies



- *Shaft*: rotating support structure
- *Flywheel*: an inertia capacitor that is affixed to the shaft
- *Gear*: affixed to the shaft and transfers torque

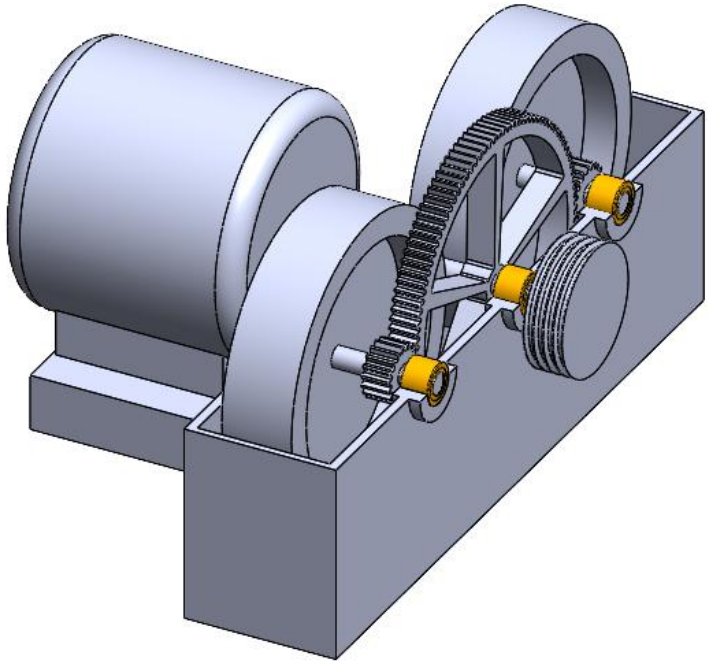




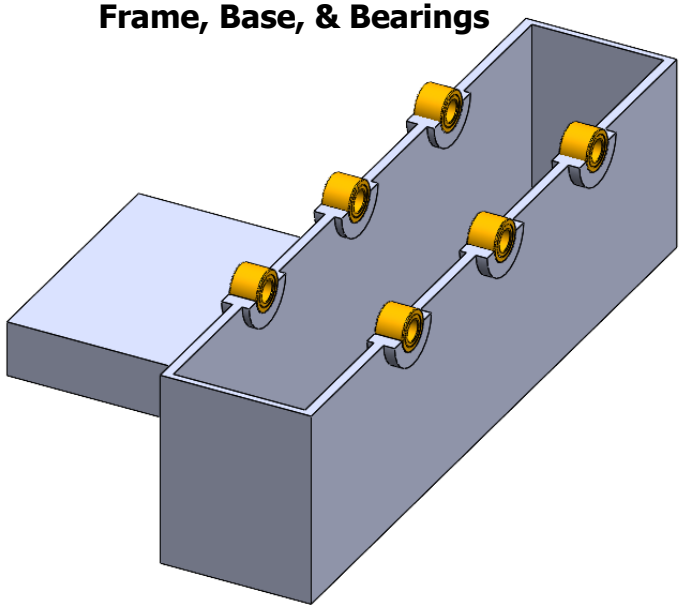
Important Design Facts

- Maximum flywheel rim speed must be subsonic to prevent aerodynamic induced vibration.
- Maximum rim stress of 52.5 ksi, which is approximately 25% of the maximum stress for high strength steel therefore flywheel can be made from high strength steel.

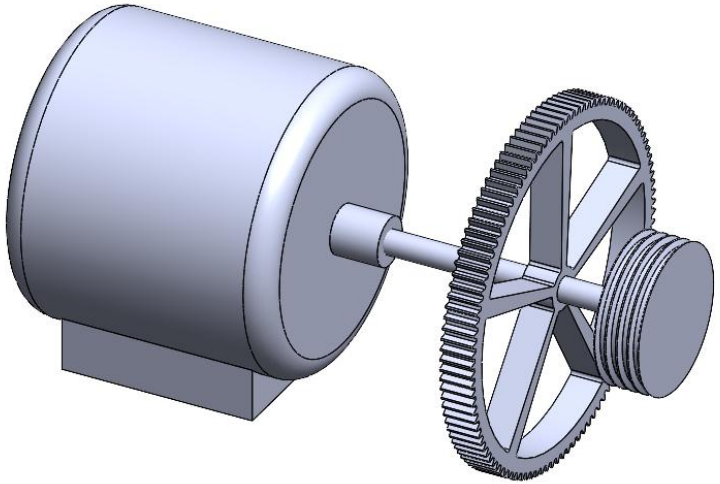
PIC™ design is simple, inexpensive and easy to manufacture



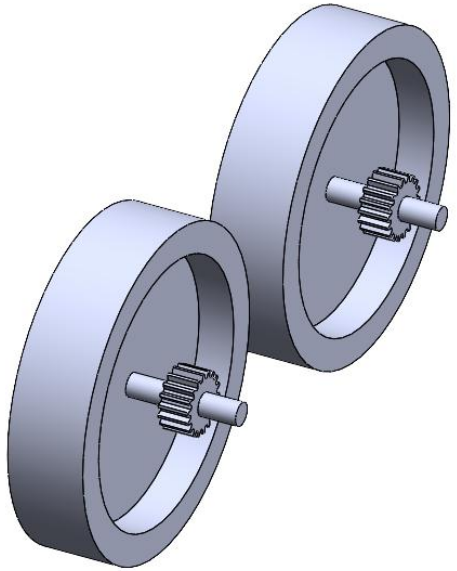
Frame, Base, & Bearings

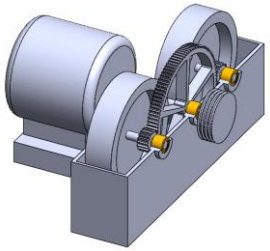


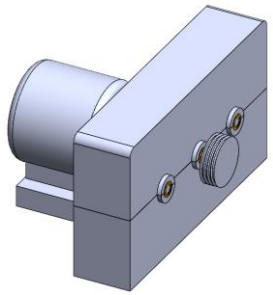
Primary Shaft Assembly & Smaller Prime Mover



Two Flywheel Assemblies

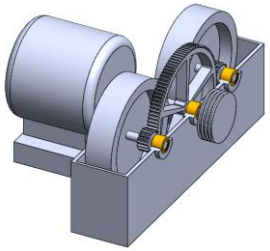




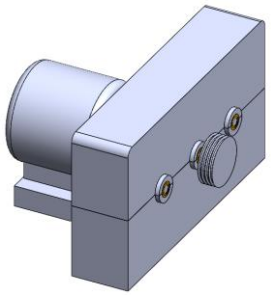


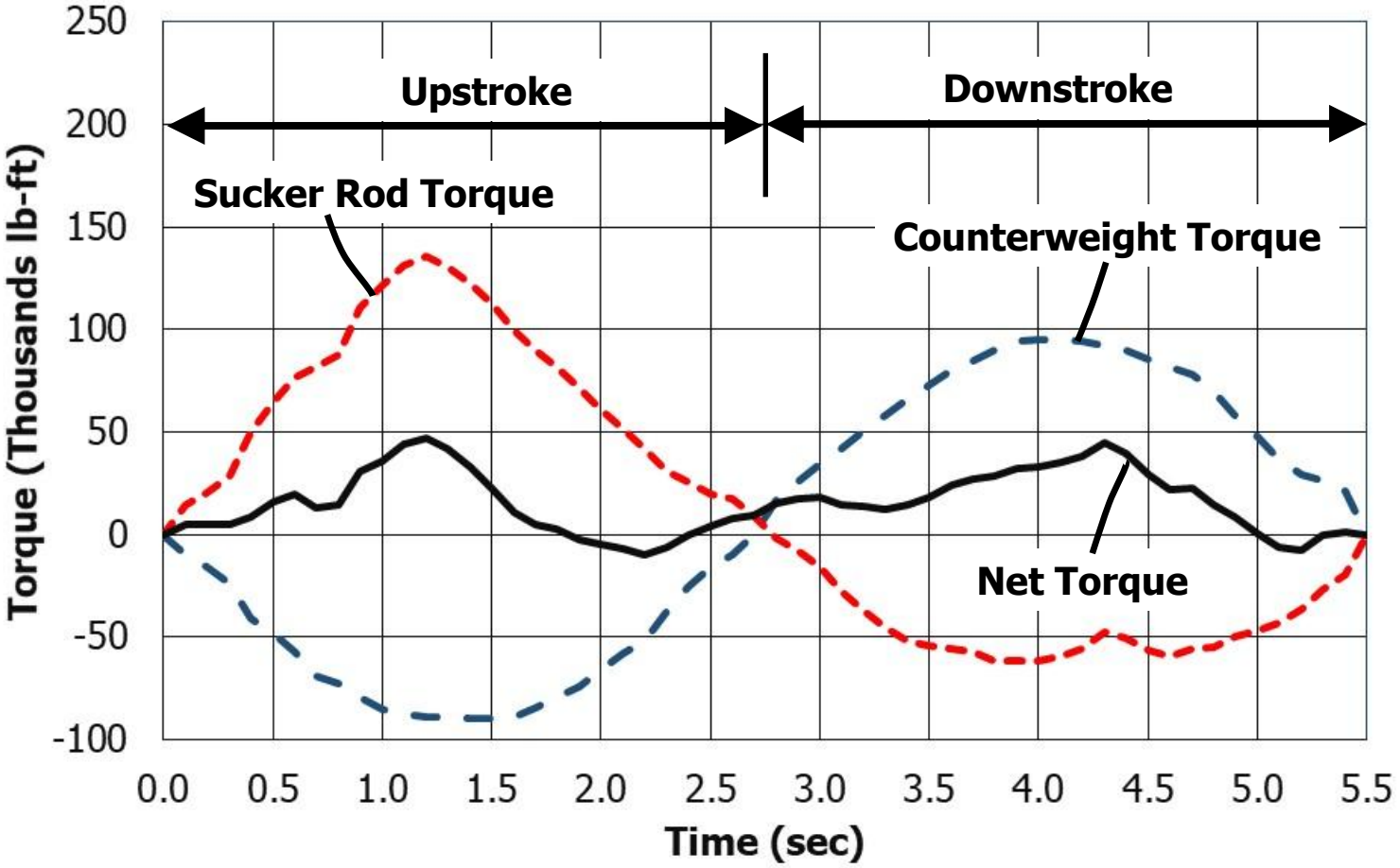
Following slide show example data for one pumping cycle

- ***Net torque is the sum of the sucker rod and counter-weight torques.***
- ***The example data is for a pumpjack with 100 hp prime mover.***

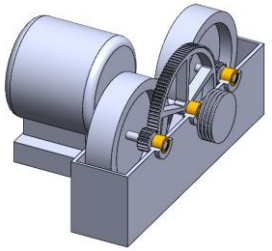


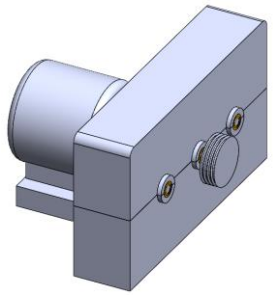
Example: Pumping Cycle Torque For 100 Hp Prime Mover





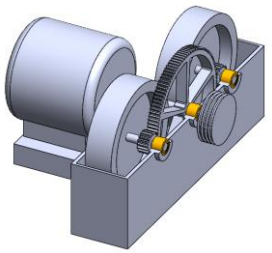
Test data from Lufkin Industries, Inc.



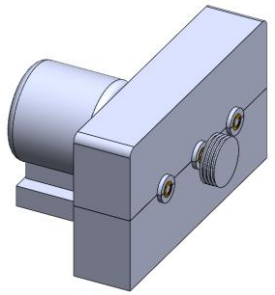


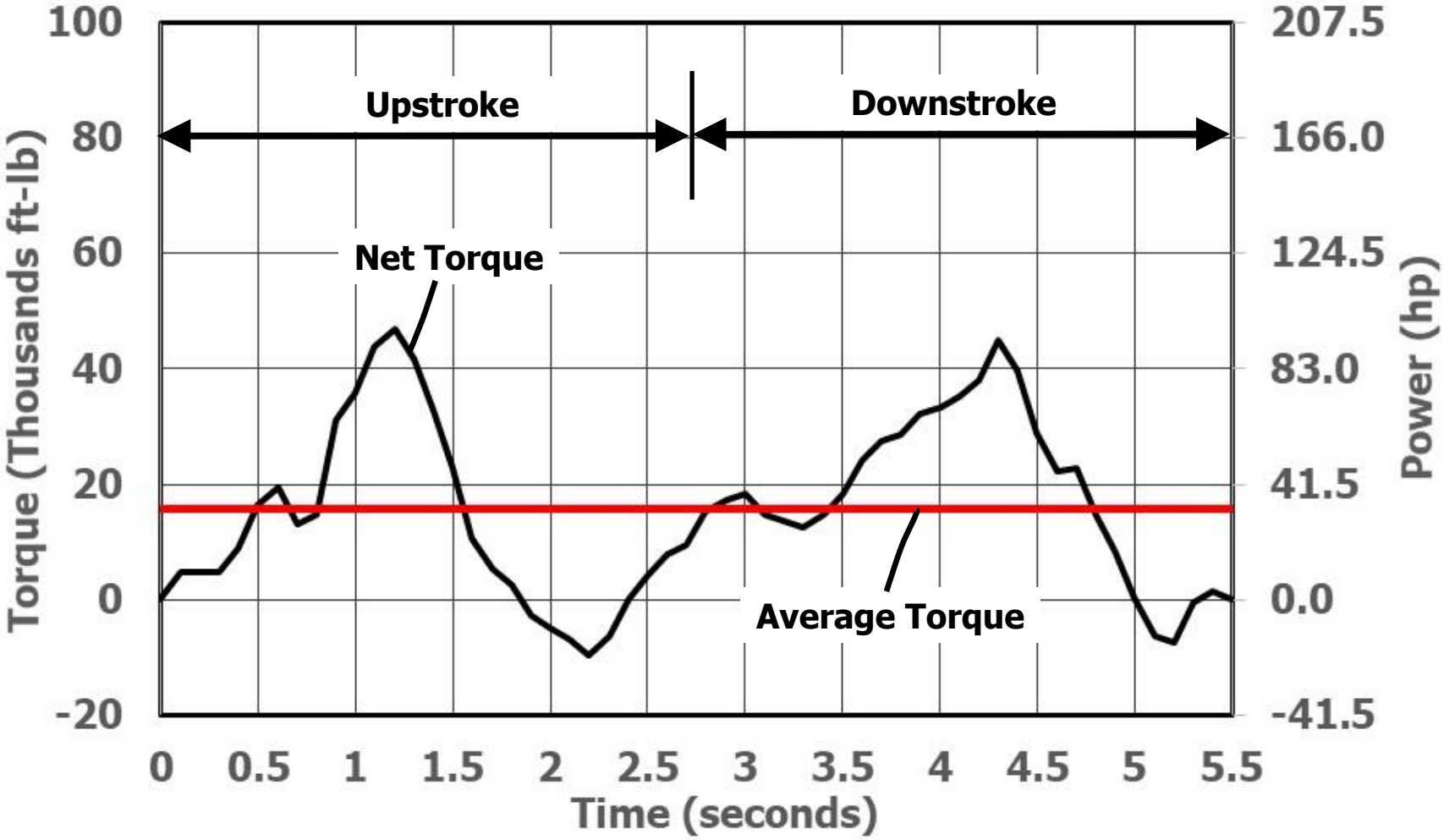
Following slide introduces average torque for one pumping cycle

- ***PIC™ enables the prime mover to continuously operate at constant speed and average torque.***
- ***PIC™ supplies the matching reaction torques gearbox and prime mover to enable the pumpjack to maintain a constant speed.***
- ***Operating at a true constant speed reduces the severity of the dynamic loads to the sucker rods.***

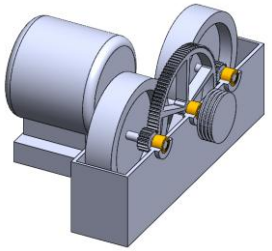


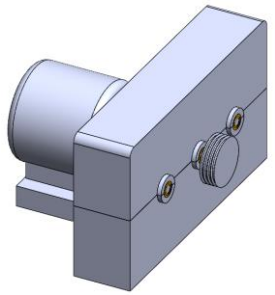
Example: Net & Average Torque & Power





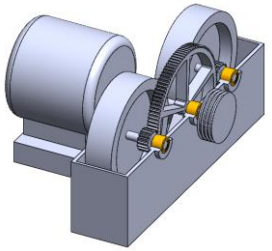
Dynamic loads to prime mover are eliminated



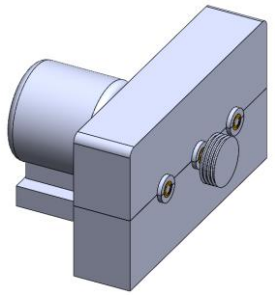


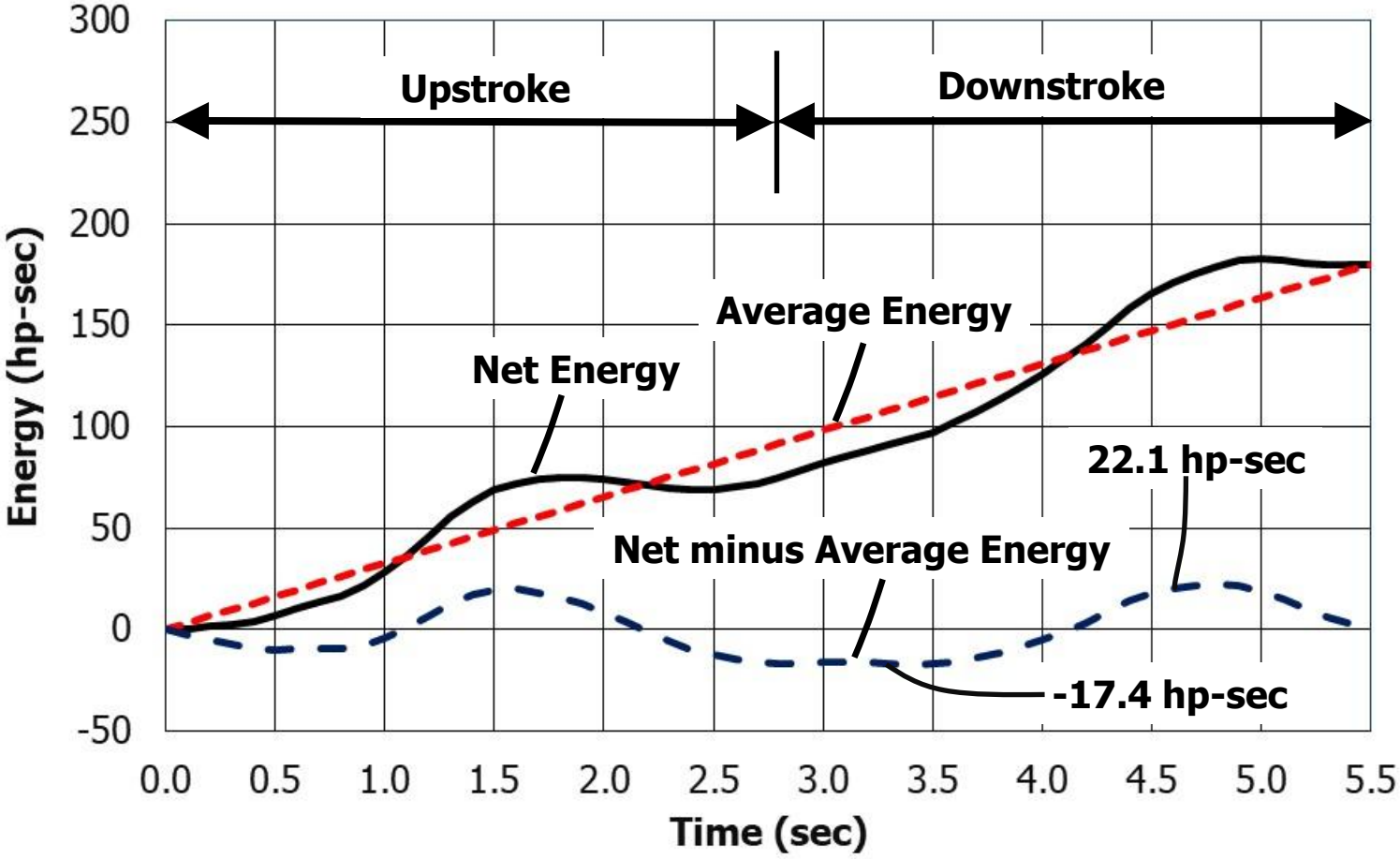
Following slide introduces kinetic energy for one pumping cycle

- ***Relatively small flywheels are needed to maintain constant pumpjack operation velocity.***
- ***Pumpjacks are massive machines but operate at small velocities which results in small kinetic energy amplitudes.***
- ***Net energy minus average energy is small.***

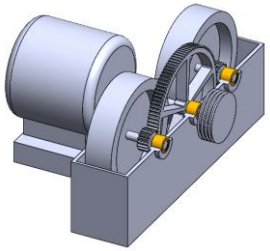


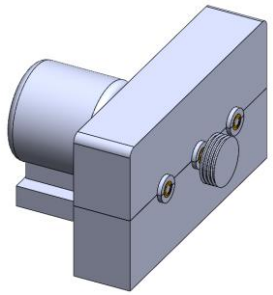
Example: Energy Calculations (hp-sec)





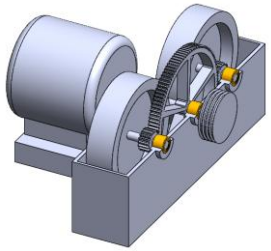
Reduces severity of shock loads to sucker rods



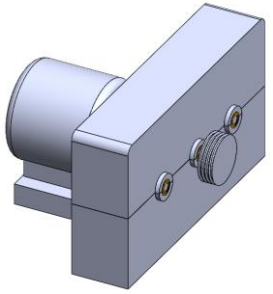


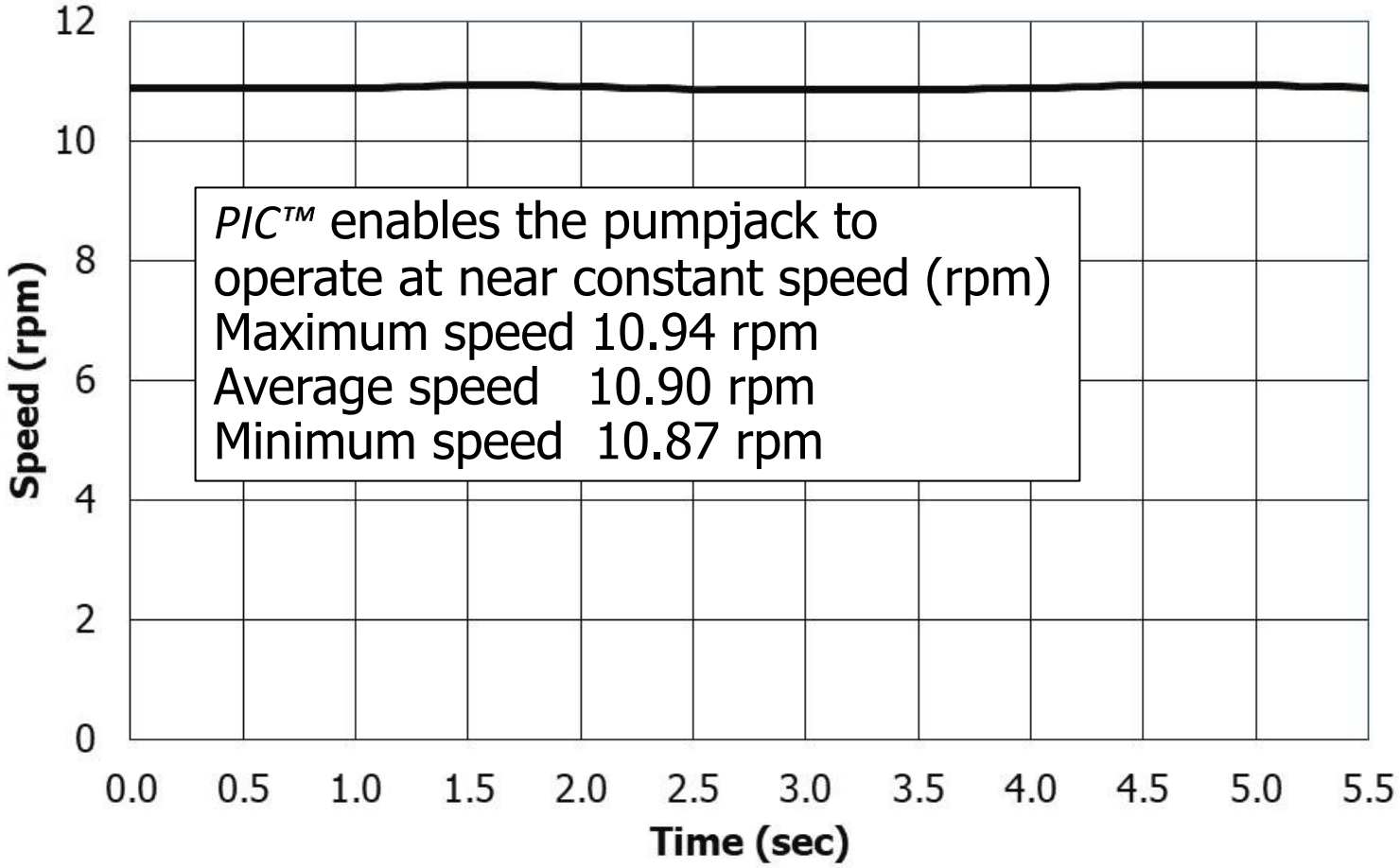
Following two slides shows the pumpjack operation speed

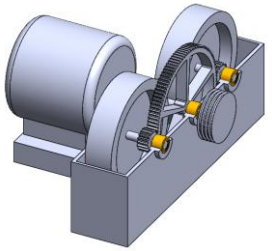
- ***Two different scales of the same data is presented.***

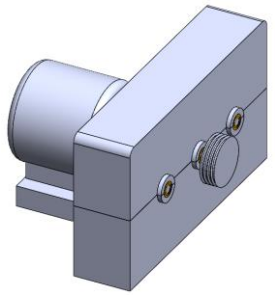


Pumpjack Speed
Expanded scale (0-12 rpm)



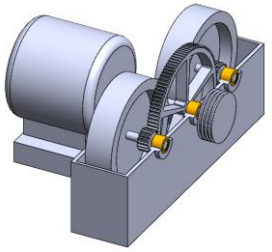






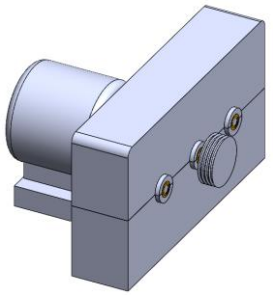
Following slide introduces technical information used to size flywheels

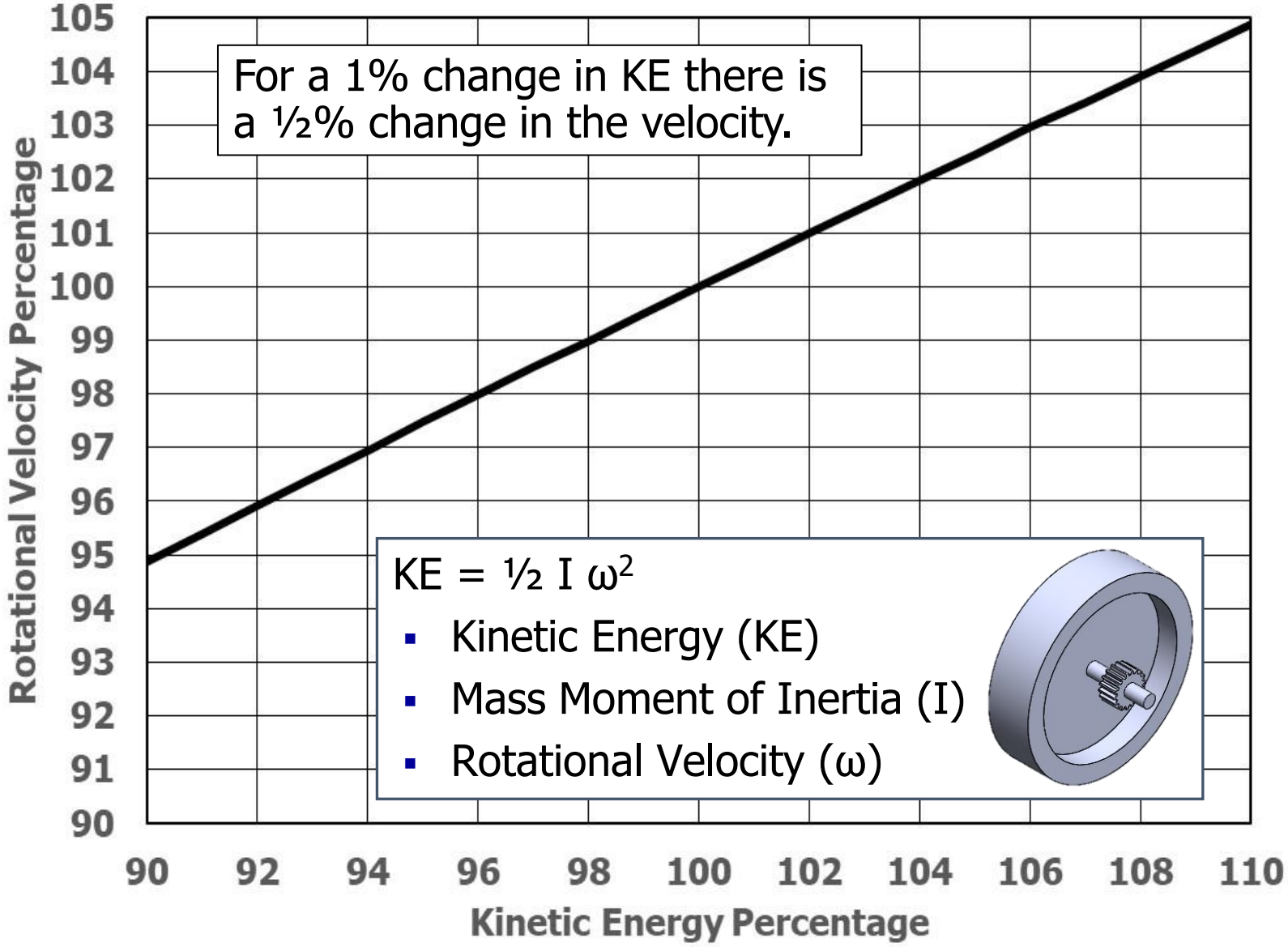
- ***The objective of PIC™ is to maintain constant pumpjack operation velocity.***
- ***The graph shows flywheel relationship between energy and rotational velocity.***
- ***1 percent change in energy results in ½ percent change in rotational velocity.***

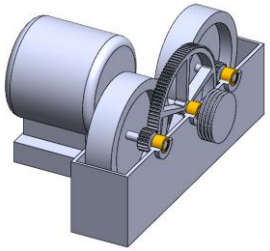


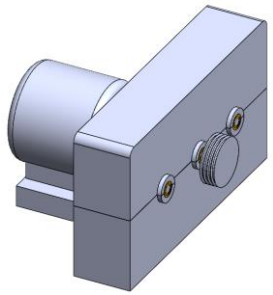
Kinetic Energy vs. Rotational Velocity

(design aid for sizing the flywheels)



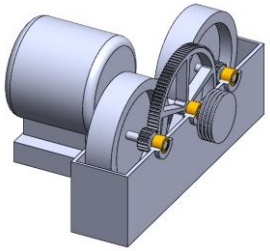






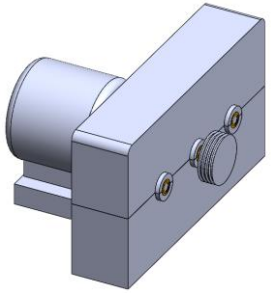
Following slide shows *PIC™* specifications to replace 100 Hp prime mover

- ***PIC™ size and weight is specified.***
- ***If PIC™ was being size to replace a 30 Hp prime mover, the weight of the flywheels would be reduced from 300 pounds to 100 pounds.***



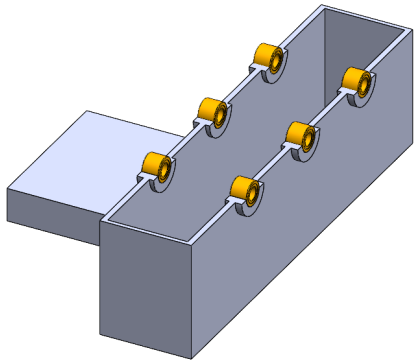
PIC™ Design Parameter Values

Based on the example data from the previous and following slides

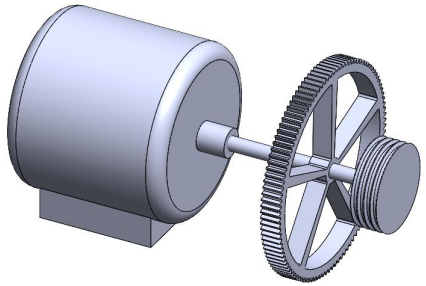


Parameter	Value	Units
Primary Shaft Assembly Speed	1200	rpm
Flywheel Speed	7200	rpm
Pumpjack Speed	10.9	rpm
Total Flywheel Rim Weight	300	lbf
Flywheel Rim Radius	0.75	ft
Flywheel KE	2711	hp-sec
Total Package Weight	600	lbf
Frame Height Dimension	2.0	ft
Frame Length Dimension	4.0	ft
Frame Width Dimension	1.0	ft

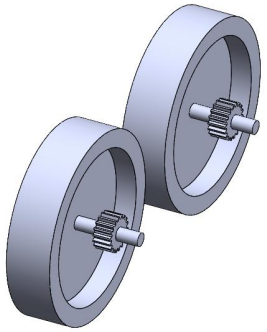
Frame, Base & Bearings



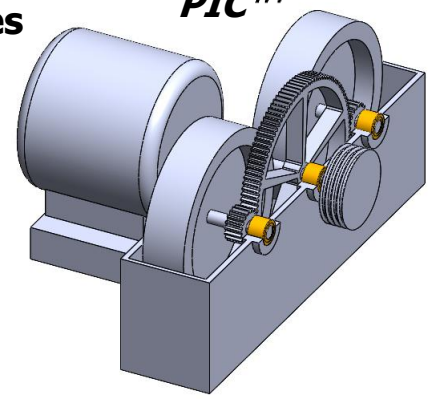
Primary Shaft Assembly & Prime Mover

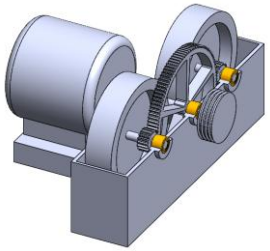


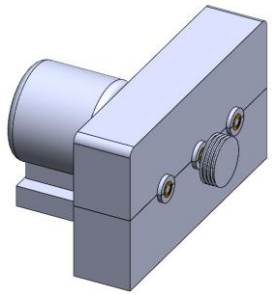
Two Flywheel Assemblies



PIC™

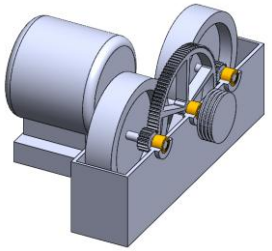




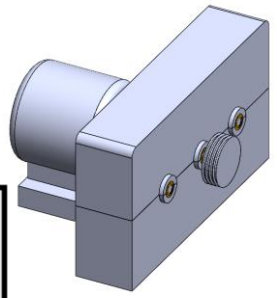


Following slide shows torque and power relationship between the pumpjack and prime mover

- ***If PIC™ was being size to replace a 30 Hp prime mover, then the torque and power data presented would be reduced to 1/3 of the data presented.***



PIC™ Torque & Power Requirements



Based on the example data on the previous and following slides

Equipment	Operating Speed (rpm)	Maximum Torque (lbf-ft)	Average Torque (lbf-ft)	Power Based on Maximum Torque (hp)	Power Based on Average Torque (hp)
Pumpjack	10.9	47000	17500	97.5	36.3
Motor	1200	427	159		

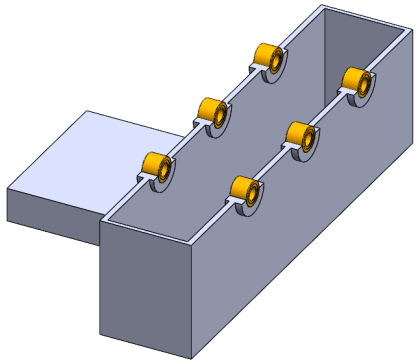
Without PIC ™

- the prime mover (motor) is sized by the *maximum* torque

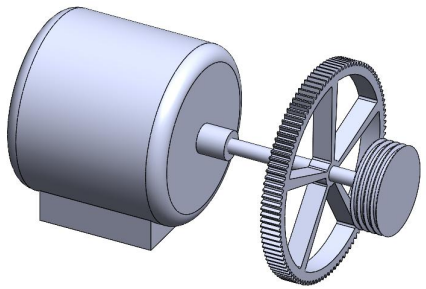
With PIC ™

- the motor is sized by the *average* torque
- the motor size can be reduced by a factor greater than 2

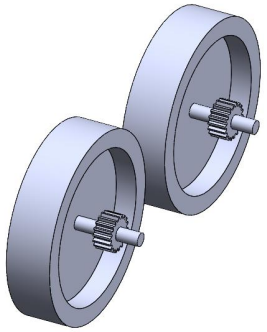
Frame, Base, & Bearings



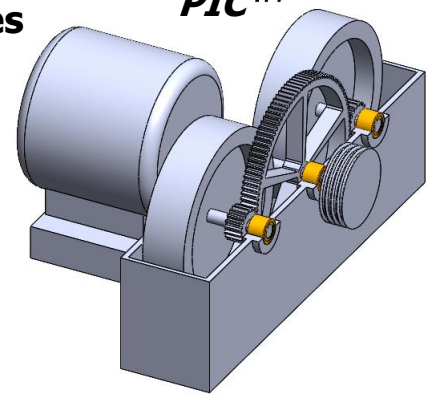
Primary Shaft Assembly & Prime Mover

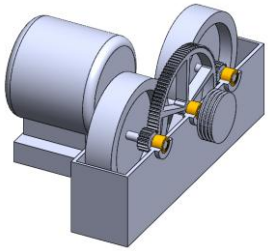


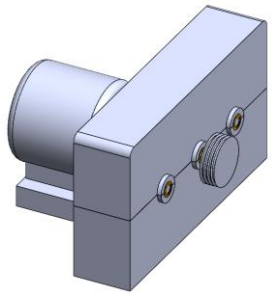
Two Flywheel Assemblies



PIC™

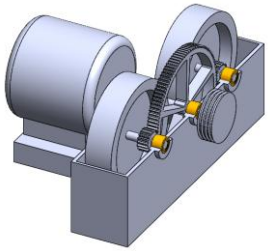




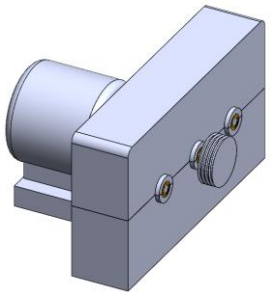


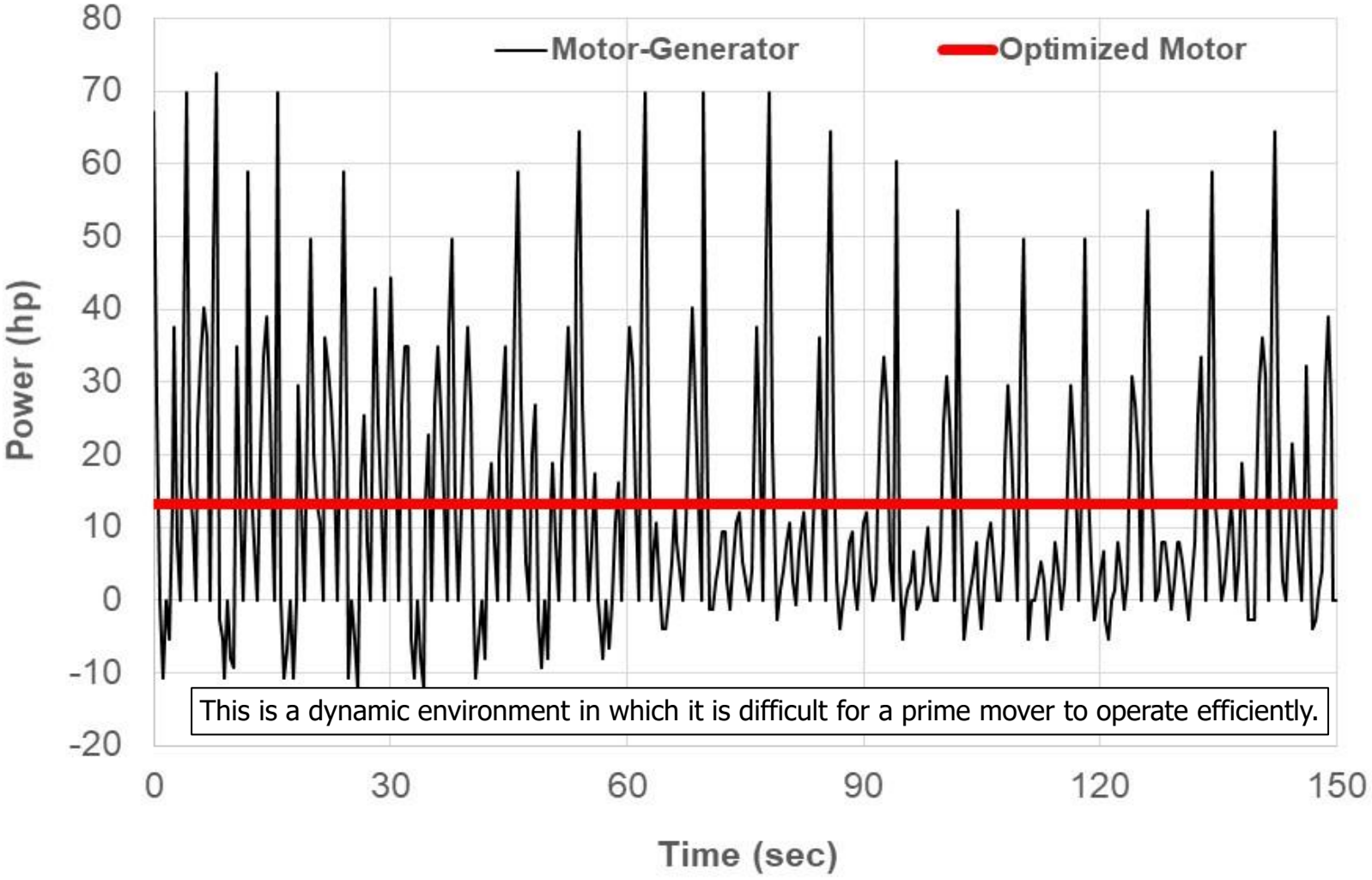
Following slide shows the time history of the dynamic loads

- ***PIC™ will reduce the severity of the sucker rod shock loads which will extend the sucker rod service life.***
- ***PIC™ will reduce operational costs for marginal oil wells.***

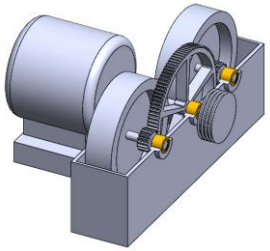


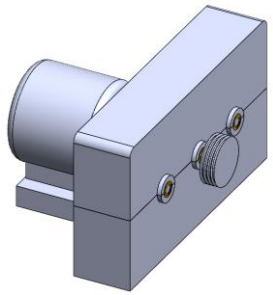
Example: Power Time History Plots





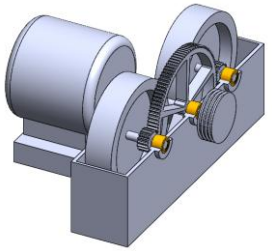
From "EnerSaver Pump-Jack VFD Field Data" presentation by CCW Energy Systems, September 24, 2009



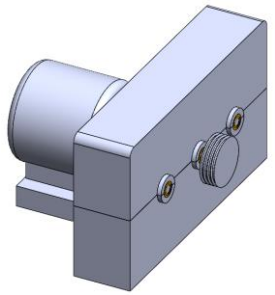


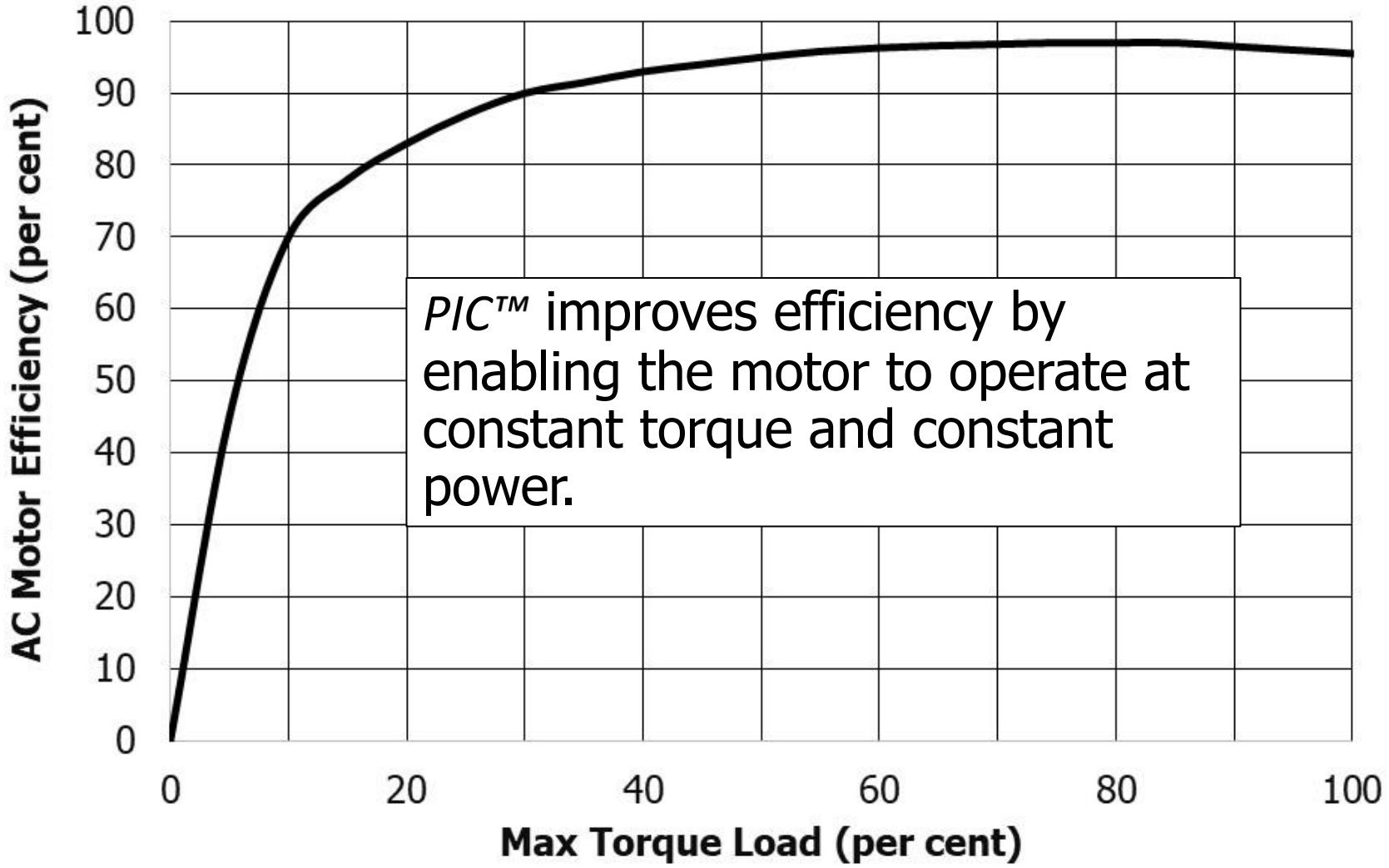
The following slide shows torque data for an unbalanced well

- ***PIC™ enables the prime mover to continuously operate at maximum efficiency.***
- ***PIC™ significantly lower electrical power expenses for prime movers.***



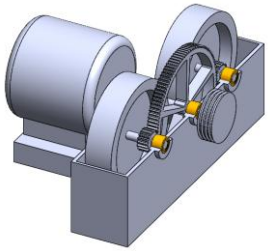
Motor Efficiency vs. Loads

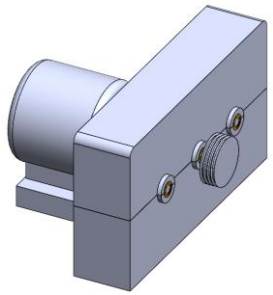




PIC™ improves efficiency by enabling the motor to operate at constant torque and constant power.

From "EnerSaver Pump-Jack VFD Field Data" presentation by CCW Energy Systems, September 24, 2009





The following slide shows unbalance pumpjack torque data

- ***PIC™ enables severely unbalanced pumpjack wells to smoothly operate.***

PIC™ Reduces and Mitigates Imbalances

An unbalanced pumpjack generates severe dynamic torque.

- upstroke unbalanced pumpjack
  - upstroke torque is *greater* than downstroke torque

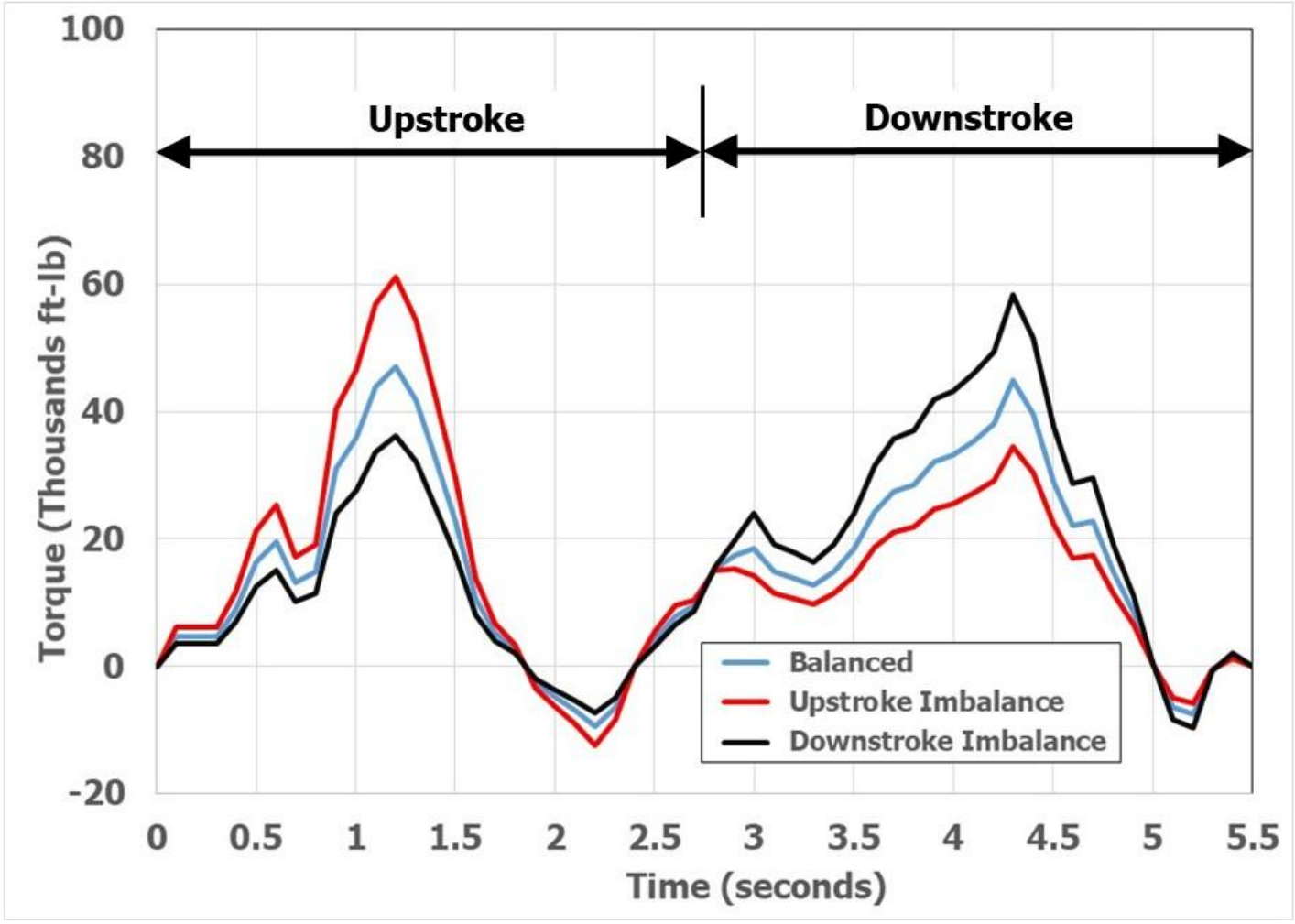
OR

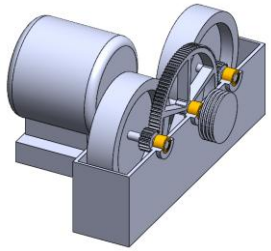
- downstroke unbalanced pumpjack
  - upstroke torque is *less* than downstroke torque

PIC™ absorbs severe dynamic loads and enables continued smooth operation at constant speed even in unbalanced conditions, thereby eliminating the need for expensive servicing for imbalances.

- balanced pumpjack
  - *equivalent* peak torque during upstroke and downstroke

Balanced Pumpjack and Upstroke & Downstroke Unbalanced Pumpjack

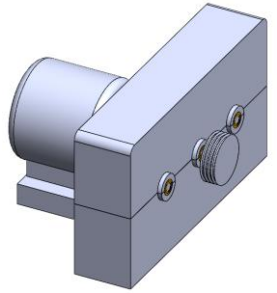




Thank You

The *PIC™* Solution

Patent US 10,859,137

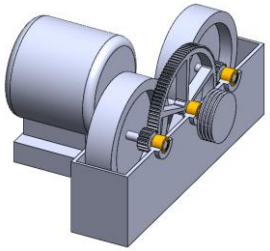


Saves Energy Costs

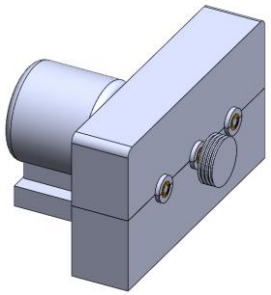
- Prime mover continuously operates at optimal efficiency

Reduces Maintenance Costs

- Extends sucker rod life
- Eliminates the need to adjust an unbalanced pumpjack

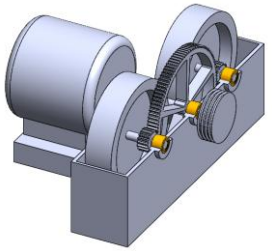


Oil PIC™
Pumpjack Inertia Capacitor

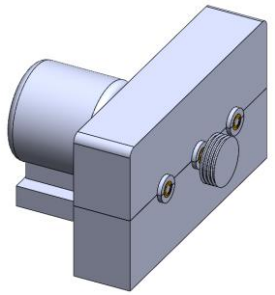


a low-cost, easy-to-manufacture solution for optimizing pumpjack operations and maximizing profits for oil producers

Seeking parties interested in manufacturing and distributing PIC™



PIC™ Contact Info



William “Terry” Lester is the inventor of *PIC™* and holds multiple patents in automotive and wind turbine technology. He has over forty years of experience as an aerospace engineer in the defense industry and has recently retired. He earned his BS and MS degrees in Mechanical Engineering from Oklahoma State University.

Terry Lester

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