How It Works

High-performance worm gears

Every valve needs a means by which it can be operated (i.e., cycled or actuated). There are a variety of options to achieve this, including handwheels, levers, gears, and actuators.

Manual operators, such as gears require little peripheral planning beyond the installation and orientation of operators in the process line. Gears are simple machines that use a series of mechanical parts to increase efficiency—the mechanical advantage that the user gains.

Choices

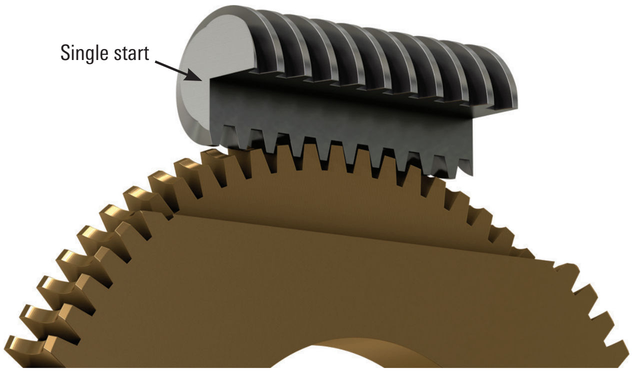
Opening or closing valves can be completed either by manual input or automated devices driven by various energy sources. Manual operators are simple and inexpensive and require little peripheral planning beyond the installation and orientation of operators in the process line. Automated devices, on the other hand, require input energy systems, control systems, additional installation space, and infrastructure for support, operation, and maintenance.

Two concerns considered during the selection of manual operators are the effort required to operate the valve and the number of turns they require. A lot of effort and a high number of turns can result in personnel fatigue, safety concerns, excessive time for operation, and the need for multiple personnel. Another factor influencing the selection of manual operators is the valve's expected frequency of operation and the physical location of the operation (that is, high in a superstructure or situated in an inhospitable environment), which could also present challenges to personnel.

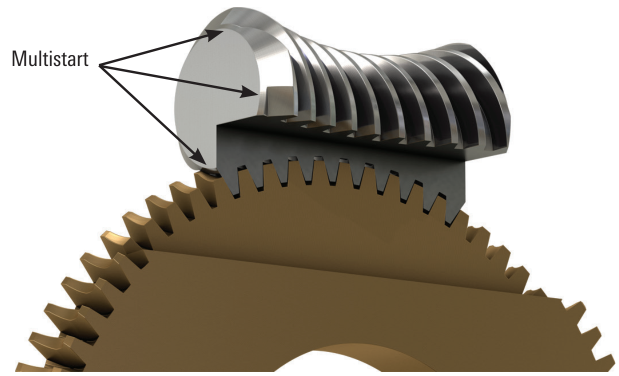
Designers must weigh all of these factors in their decision matrix to receive the most productive yet acceptable selection of how a valve should be operated. Two aspects that primarily define operator selection are human factors and economic factors. Human factors can be defined as the human capability to cycle the valve in a safe, timely, and economically sound manner. These factors require considerations such as the work needed to be done (turns and rim pull, which is the amount of force put on a handwheel) to operate the valve, the environment in which the valve is located, the time required to complete the task, and the health and safety of the personnel involved. Economic factors include the cost of the actuator as well as the cost of infrastructure, which could include wiring, control systems, power, and ongoing maintenance to support automated solutions.

Specifications

The industry defines specifications for the highest values that personnel should exert on levers or handwheels to operate a valve; current API specifications limit pull to 80 lbf [360 N]. Mechanical advantage can be used to decrease the pull required to open or close the valve by increasing the length of the lever or diameter of the handwheel mounted on the valve. However, the maximum lever length or handwheel diameter is also limited by industry specifications.



Single-enveloping worm gear.



Double-enveloping worm gear.

As valve torque increases, maximum limits imposed by industry standards result in levers transitioning to gear units to increase mechanical advantage. However, this increase in mechanical advantage comes with the disadvantage of increasing the number of turns to move the valve across the full stroke distance.

A greater number of turns results in longer time required to cycle the valve at a constant rpm. With significant gear reduction, the number of turns required for full cycle can total in the hundreds. This increased number of turns leads to a greater opportunity for accidents or injury to personnel due to repetitive motion and fatigue. Companies will limit the rim pull and number of turns to reduce the risk. Once established limits are exceeded for turns, it is generally required that the valve be automated.

Communicating what human factor limits might be imposed on valves can provide suppliers the opportunity to recommend the best value of operator for manual valves. Until recently, the valve industry was limited to levers, bevel gears, and traditional worm gears for manual cycling. Once these devices exceeded worker safety limits, a valve purchaser's only choice was to select an automated solution. However, new devices available in the marketplace extend the range of manual operators. These devices can reduce capex and opex while reducing site design complexity.

Cameron solutions

High-performance gears have a much higher level of efficiency compared with standard worm gears with the same level of safety against backdriving. The higher efficiency results in a significant reduction in turns while remaining below acceptable rim pull requirements. Optimizing for number of turns, rim pull, or both can provide a manual operator solution for applications in which traditional worm gears would exceed rim pull or turn limits.

High-performance gears are also especially well suited for applications in which a portable driver may not be readily available, where utilities are not present for an actuator, or where simplicity of design is a priority. These newer gears offer a simple solution for large, high-pressure valves that are infrequently operated but where timely, safe operation is important—such as pipeline isolation or at pig launchers and receivers. High-performance gear units also carry a distinct advantage in subsea applications, where the shortest time possible to cycle a valve is necessary to maximize productivity for divers or ROVs.

As an alternative, manual gear units can be adapted to facilitate a connection between a powered driver and gear input shaft. While convenient and lower in cost than a fully automated solution, this driver system can include risks to personnel if improperly executed. If the adapter or connector is only a drive nut or other mating coupling attach to the handwheel or input shaft of the gear, unnecessary risk to personnel may result. At initial startup, or if there is any stoppage of the valve midstroke, the torque no longer is imparted into the gear. Instead, it is imparted into the person holding the driver.

A safer alternative is mounting the driver to the input shaft of the gear in combination with a torque-arresting adapter. The adapter facilities mounting the driver and reduce the torque transmitted to the user when the gear unit reaches the end of travel. Torque and speed limiters can be set to limit revolutions per minute and input torque to safe levels to avoid gear unit or drive train damage.

The driver system can be designed for portability to allow costs to be divided across a number of valves. The torque driver system provides a cost-effective solution for cycling valves with high numbers of input turns within a reasonable period of time at minimal risk to or effort by personnel. When combined with a high-performance gear operator, this combination offers a cost-effective and efficient alternative to actuators for a wide variety of large valves.

Increasingly, human factors are defining the maximum sizes and pressure classes for manually operated valves. Alternatives to traditional manual operators, such as portable operators or valve automation, carry their own risks or costs. Recent offerings in the valve market including high-performance gears, and torque driver systems present solutions that are simple to plan, easy to implement, safe to operate, and lower in cost.

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