

State of the art of valve gearboxes

The latest technologies

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Introduction: What is a gearbox?

Gearbox is an operating element mounted between actuator and valve

Gearbox functions:

- Valve automation
- Torque transmission
- Increase torque
- Reduce actuator speed
- Limit valve travel
- Guarantee self-locking
- Power split (2 gearboxes operated by 1 actuator)
- Save costs (avoid actuator oversizing)



1/4 turn gearbox for butterfly valve automation

Gearboxes for valves automation

Different gearbox design for different applications

Output Movement	¼ turn	Multi-turn		Linear
Gearbox design				
Gear type	Worm	Bevel	Spur	Spindle
Application	e.g. butterfly and ball valves	e.g. gate valves	e.g. gate valves	e.g. plug valves

Gearbox for valve automation: applications examples



Multi turn gearboxes for weirs/locks (source: AUMA)



Multi-turn gearbox with linear thrust unit for plug valves (source: AUMA)

Gearbox for valve automation: application examples



1/4 turn combined with a multi-turn gearboxes for weirs/locks (Source: CML SRL)



1/4 turn combined with a multi turn gearboxes for weirs/locks (source: AUMA)



Lever gearbox (source: AUMA)

Product Sizing

Proper sizing guarantees valve operability in each defined operating condition

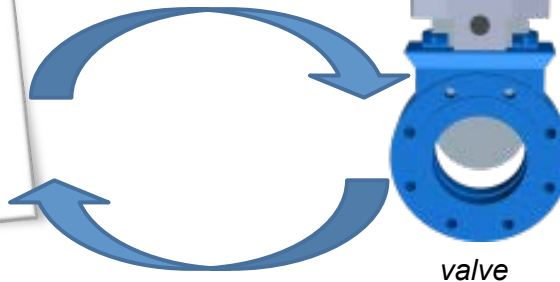
General gearbox sizing rules:

- Deliver torques requested by the application
- Withstand torque delivered by the operator / actuator
- Reach the specified lifetime
- Meet the environmental conditions

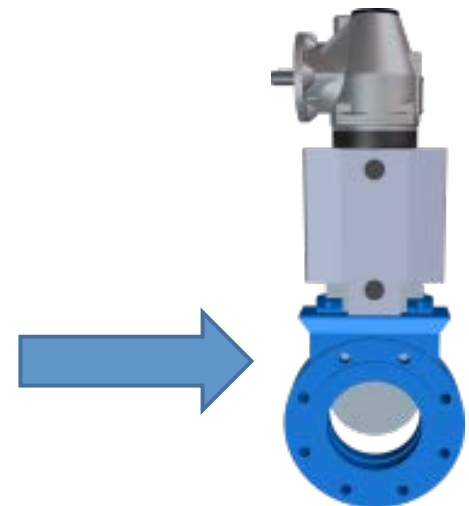
Technical data sheets



Multi-turn gearbox



valve



Automated valve

Modularity

Modular design for high flexibility

- Valve attachment according EN ISO 5210 / 5211
- High parts interchangeability leads to **stock reduction**
- **Easy commissioning** with modular valve coupling
- High number of flange sizes per gearbox size
- Holes for **dowel pins** for flat mounting



Modular flanges

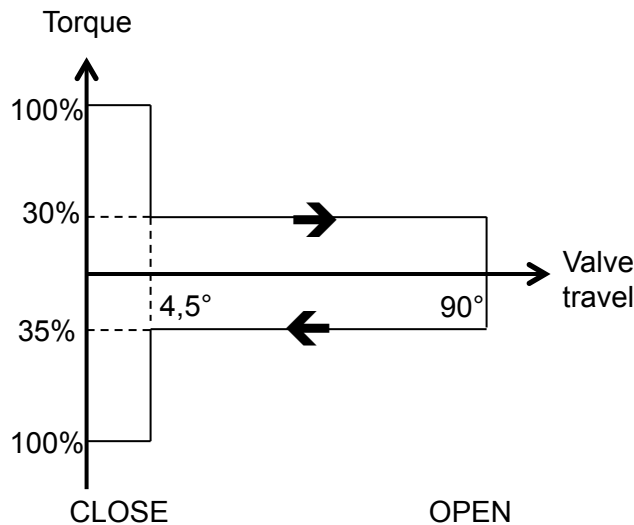


Modular valve coupling

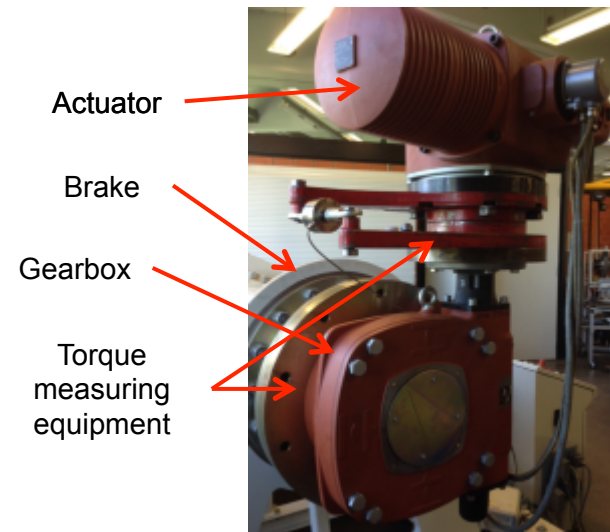
Type testing

Manufacturers have to guarantee gearbox lifetime performances

- “DIN EN 15714-2 Electric actuators for industrial valves” specifies
 - Torque load profiles
 - Lifetime in cycles
 - Maximum output torques per flange size (ISO 5210/11)



Part-turn load profile



Gearbox test bench (source: AUMA)

Corrosion protection

Gearbox shall maintain its integrity even in harsh polluted environment

- Powder coating
 - In use in industrial , automotive, furniture markets
 - Suitable for C5-M¹⁾ and Im²⁾ classes according **EN ISO 12944-2**
 - Protection layer is applied to the individual parts and baked
 - Mounted faces are powder coated beyond the joints
 - Housing parts are coated individually for assembly work no paint layer needs to be cracked/damaged
 - Valve attachment is also powder coated



*Powder coating process
(source: AUMA)*

C5-M¹⁾ = Area with high salinity, almost permanent condensation and high pollution

Im²⁾ = Underground application or immersed in water

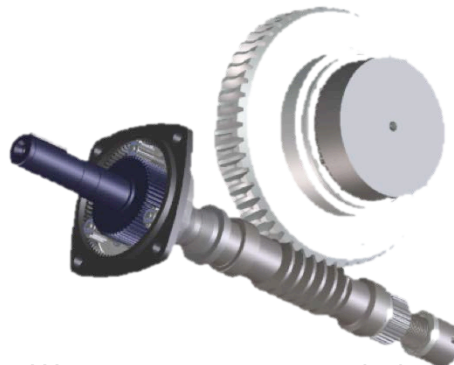
Gear materials

Appropriate material selection for parts included in power transmission

- Application oriented **material matching** to guarantee high efficiency, good heat transfer and long lifetime
 - e.g. bronze (BZ) with spheroidal cast iron (EN-GJS) for modulating duty
- State of the art **machining** to reach high surface quality and low friction
 - e.g. for worm wheels casting → turning → rolling → grinding
- State of the art **surface treatment** to increase wear resistance, fatigue strength, lubricity and corrosion protection e.g. gas, salt bath or plasma nitriding



Bronze welded worm wheel (source: AUMA)



Worm gear power transmission



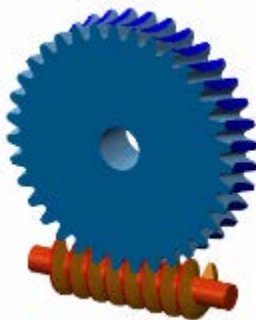
Bronze (BZ) worm wheel (source: AUMA)

Gear geometry for $\frac{1}{4}$ turn gearboxes

High end machining technologies allows complex gear geometries

- Worm gearbox: globoidal gear
 - More teeth in contact
 - Increased load capacity
 - High production cost

Globoidal worm wheel



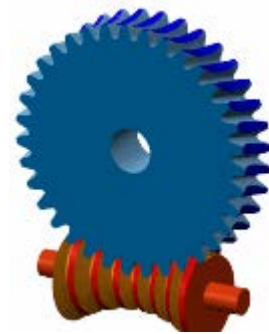
Cylindrical worm shaft

Cylindrical worm wheel



Globoidal worm shaft

Globoidal worm wheel



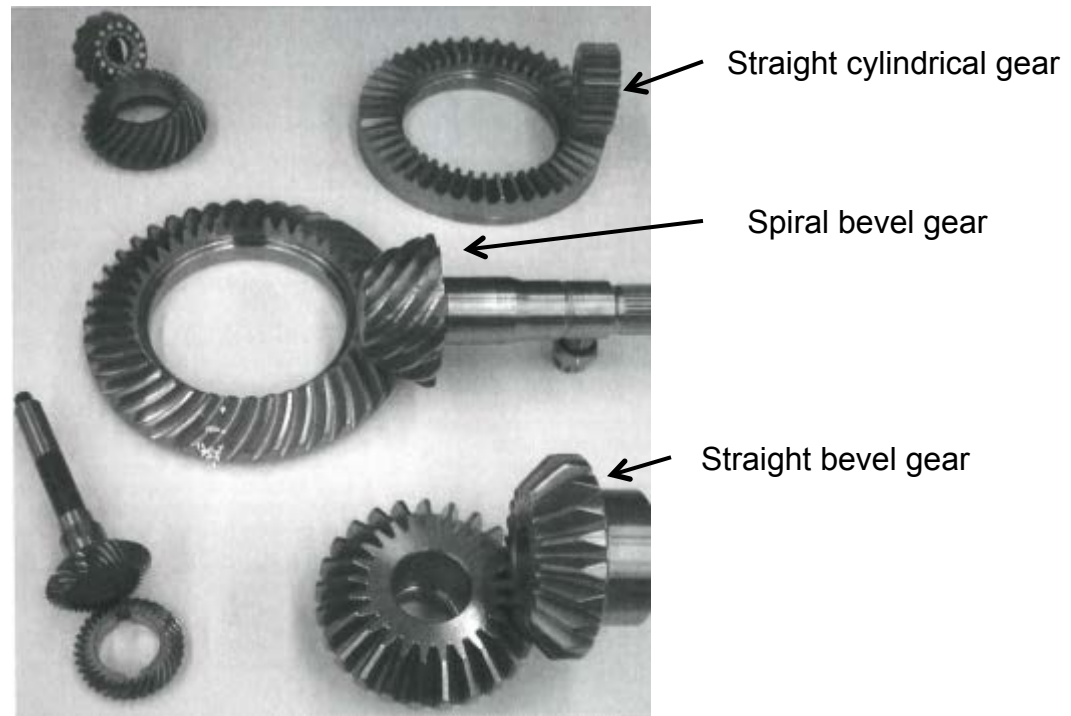
Globoidal worm shaft

Picture source: www.ahoefer.de

Gear geometry for multi-turn application

High end machining technologies allows complex gear geometries

- Spiral bevel gear
 - High operating speeds
 - Increased load capacity
 - Noise reduction
 - High production cost

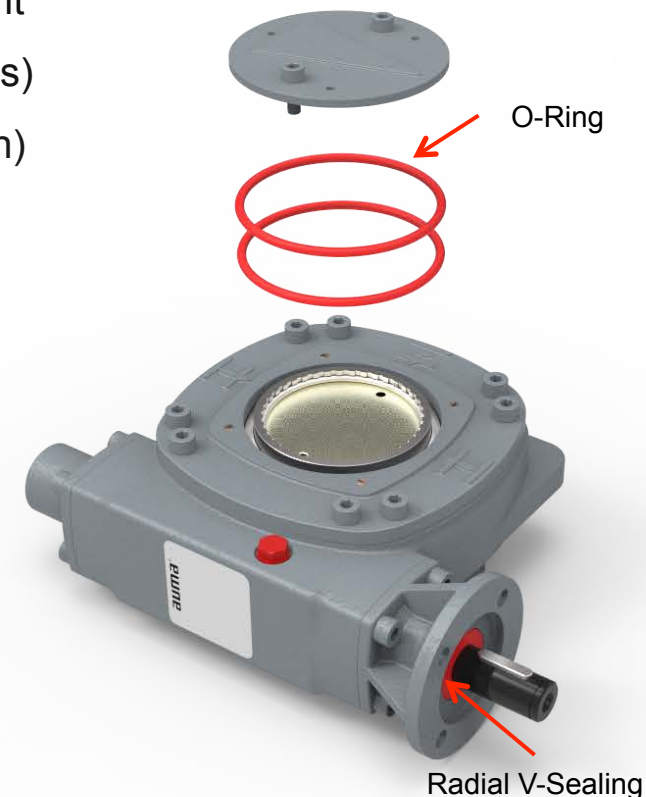
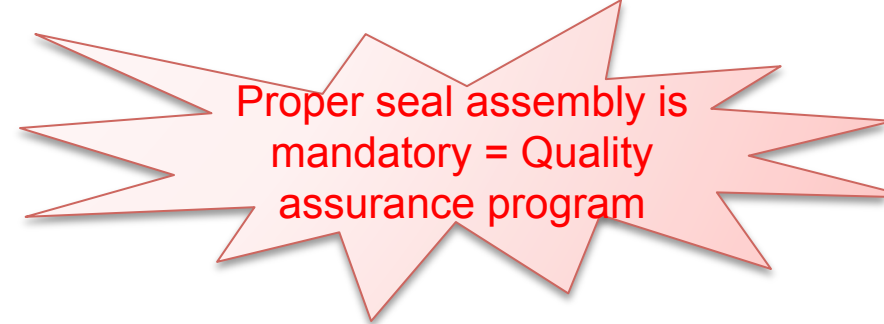


Bevel gear types (Source: Gleason)

Sealing

Avoid lubricant leakage and water, humidity, dust infiltration

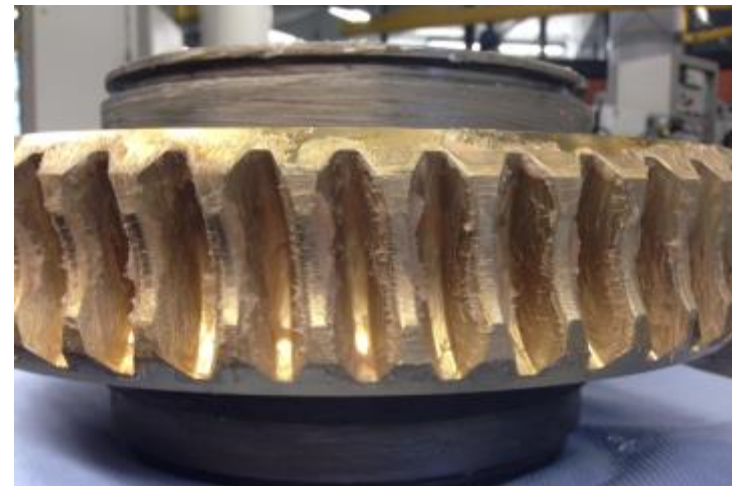
- Seal materials
 - Seals should maintain their properties in each environment (Low/high temperatures, polluted and marine atmospheres)
 - E.g. EPDM (Ethylene propene), NBR (Nitrile) , FPM (Viton)
- Seal types
 - Adequate seal types for “dynamic” and “static” sealing should be selected
 - E.g. OAB, OBC, MSC



Lubrication

Long life lubrication

- Lubrication influence:
 - Gear efficiency
 - Lifetime
 - Heat exchange
 - Noise
 - Allowable temperature range
 - Torques and loads
 - Operating speeds
- Lubricant selection should match with the application and the environment (Sun exposition, drinking water, irradiation etc..)



Worm gearbox: lubricated worm wheel (Source: AUMA)

Lubrication

Grease instead of oil

- Grease is a nonfluid oil composed of oil and a thickener
- Grease characteristics are reached with addition of additive compound
- State of the art lubrication with adhesive grease
 - No leakage caused by oil bleeding
 - User and environmentally friendly

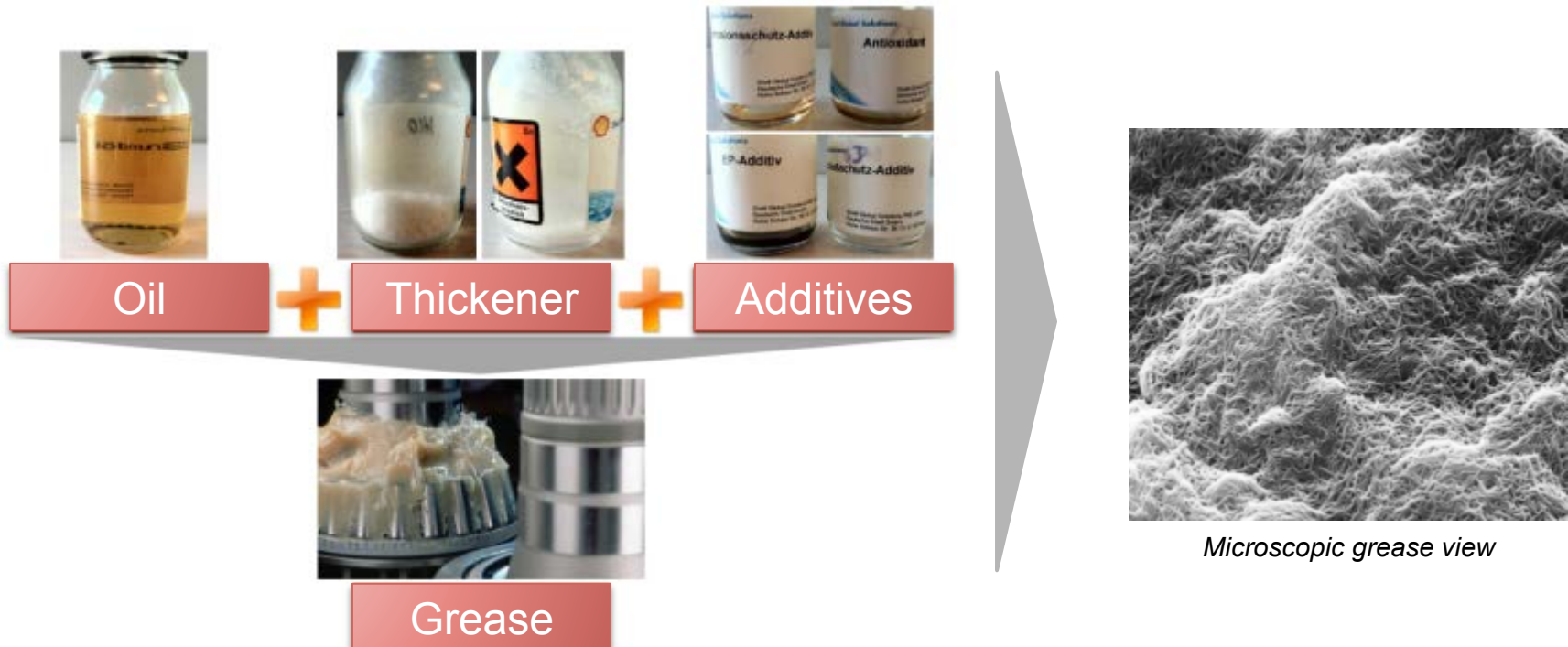


Comparison of conventional and adhesive lubrication (source: AUMA)

Lubrication

Grease characteristics

- Grease contains a thickener (soap fibres) which hold a lubricating oil in suspension
- Length, form, orientation of the fibres defines grease properties (-60°C to +200°C)



Lubrication

Leakage free lubrication

- Cause of leakage n°1 : Gearbox tightness

- Wrong seal material
- Seal missing or damaged during assembly
- Functional housing parts out of tolerances



QA program including
tightness test after
assembly

- Cause of leakage n°2: Static oil bleeding or oil puddling

- Oil release during storage as a result of temperature changes or vibration



Adhesive
grease

- Cause of leakage n°3 = cause n°1 + cause n°2 +...

End stops

Guarantee the valve integrity in case of actuator off-switch failure, and limits the valve travel in manual operation

- Two end stops design:
 - Travelling nut technology
 - End stop screws
- AWWA 506¹⁾ standard specifies end stop rigidity
- Withstand operator forces by manual operation
- Withstand actuator tripping torque
- Maintain operability before, during and after actuator tripping torque

¹⁾ AWWA = American Water Works Association



*Travelling nut
(source: AUMA)*



*End stop screws
(source: AUMA)*

Signalisation

Remote position signalisation

- Actuator redundancy
- Position indication of hand operated valves
- Mechanical or inductive position acquisition
- End position indication
- Intermediate position indication
- Remote 4-20 mA position indication
- Explosion-proof certification
- SIL certification



*Gearbox remote position indication device
(source: AUMA)*



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