State of the art of valve gearboxes
The latest technologies

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SIPOS AKTORIK DREHMO VALVE ACTUATORS GFC haselhofer actuators

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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)

¼ 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)

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

Gearbox for valve automation: application examples

¼ turn combined with a multi-turn gearboxes for weirs/locks (Source: CML SRL)

¼ turn combined with a multi turn gearboxes for weirs/locks (source: AUMA)

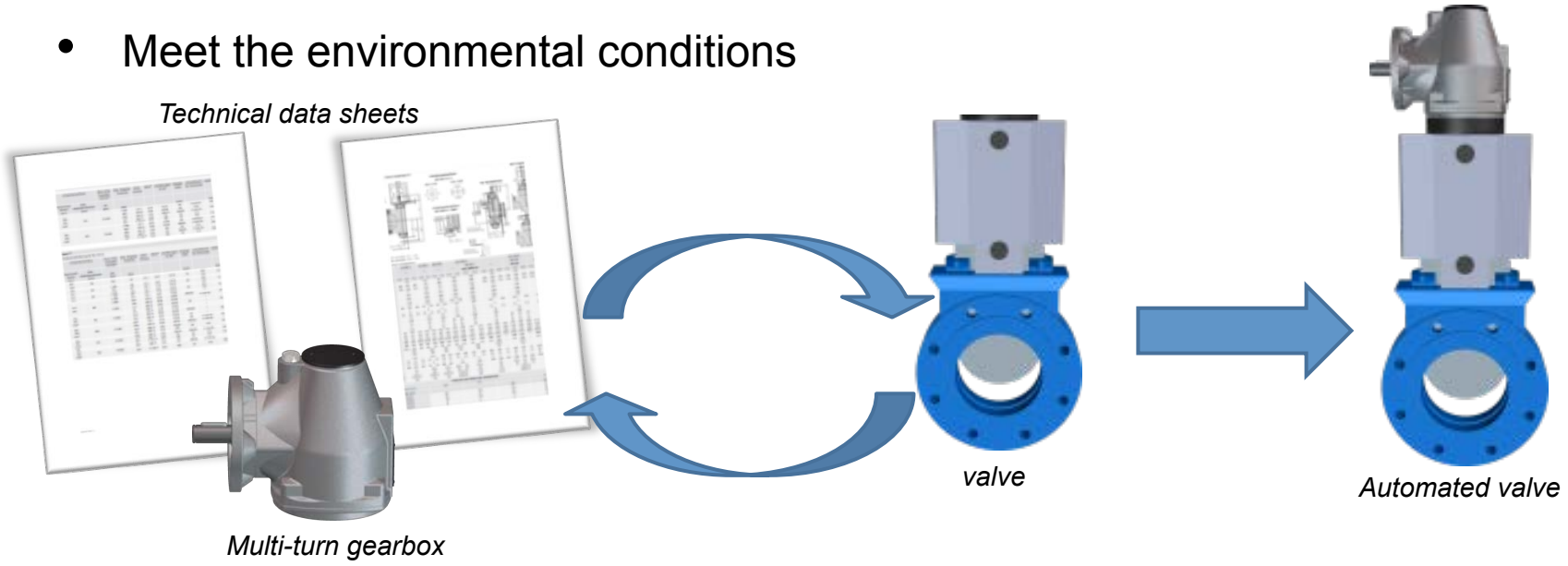
Lever gearbox (source: AUMA)

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



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

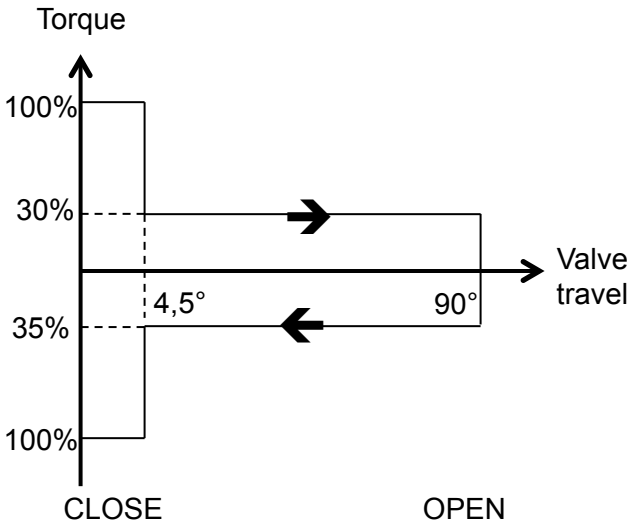
Modular valve coupling

No international standard specific to a gearbox exists

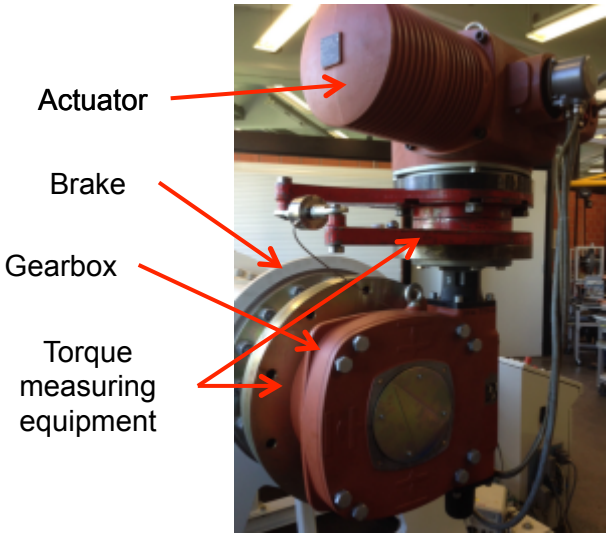
Type testing

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-M[1)] and Im[2)] 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-M[1)] = Area with high salinity, almost permanent condensation and high pollution

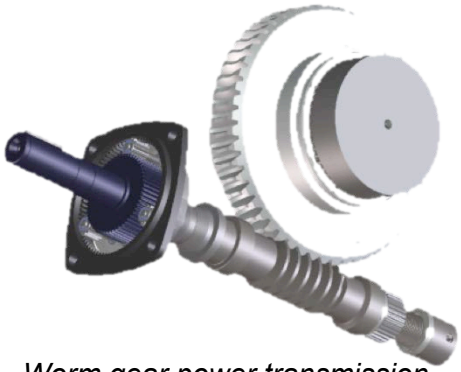
Im[2)] = Underground application or immerged in water

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 nitriting

Bronze welded worm wheel (source: AUMA)



Worm gear power transmission

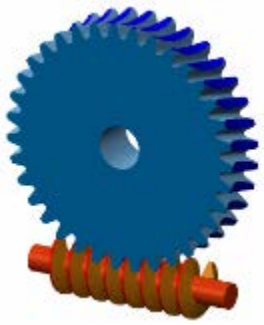
Bronze (BZ) worm wheel (source: AUMA)

Gear geometry for ¼ turn gearboxes

High end machining technologies allows complex gear geometries

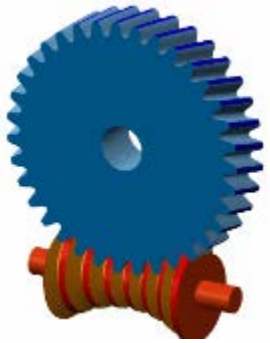
- Worm gearbox: globoidal gear
  - More teeth in contact
  - Increased load capacity
  - High production cost

Globoidal worm wheel



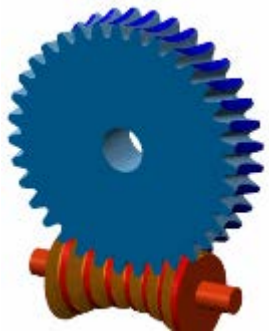
Cylindrical worm shaft

Cylindrical worm wheel



Globoidal worm shaft

Globoidal worm wheel



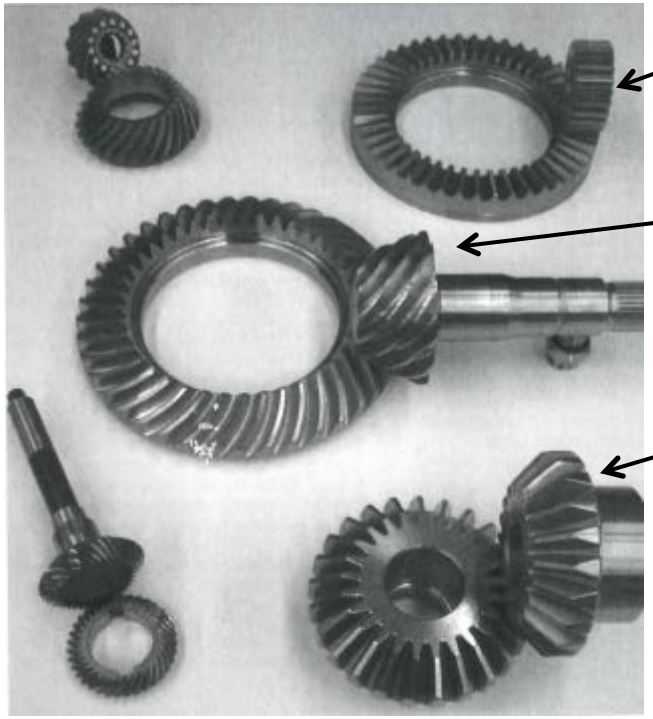
Globoidal worm shaft

Picture source: www.ahoefler.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)

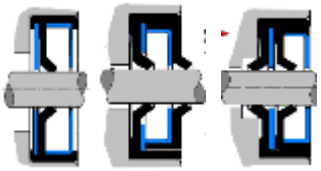
Proper seal assembly is mandatory = Quality assurance program

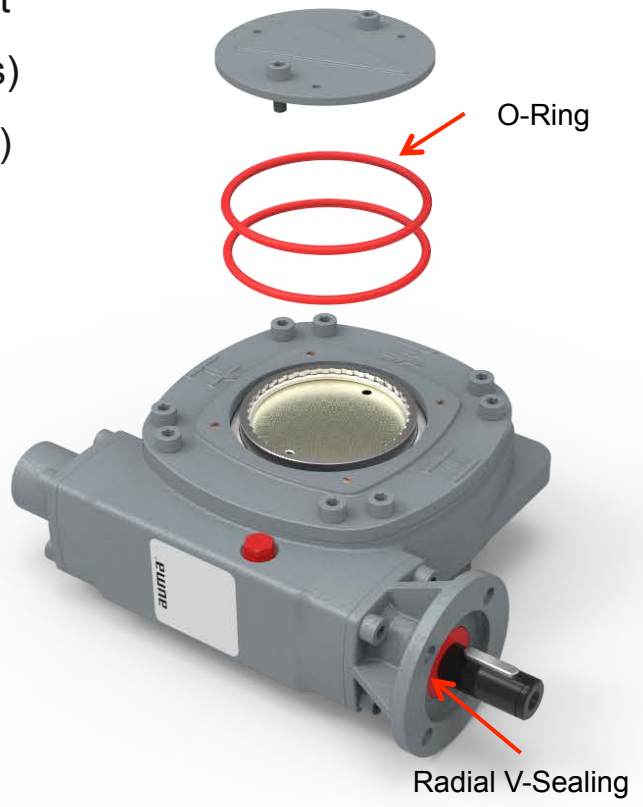
Sealing

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

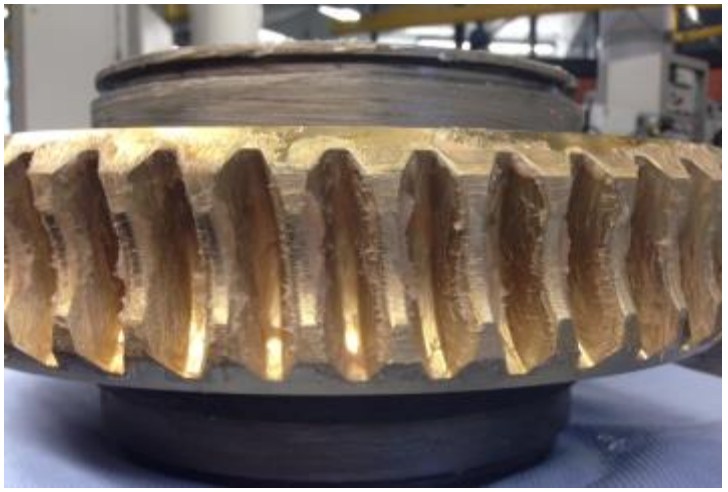




Lubrication

Long life lubrication

- Lubrication influence:
  - Gear efficiency
  - Lifetime
  - Heat exchange
  - Noise
  - Allowable temperature range
  - Torques and loads
  - Operating speeds



Worm gearbox: lubricated worm wheel (Source: AUMA)

- Lubricant selection should match with the application and the environment (Sun exposition, drinking water, irradiation etc..)

Lubrication

Grease instead of oil

- Grease is a nonfluid oil composed of and oil and a thickener
- Grease characteristics are reached with addition of additive compound

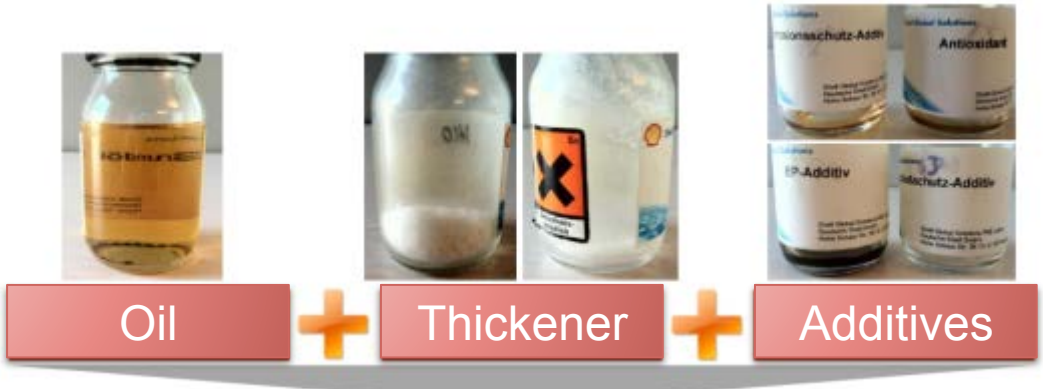
- State of the art lubrication with adhesive grease
  - No leakage caused by oil bleeding
  - User and environmentally friendly

Comparison of conventional and adhesive lubrication (source: AUMA)

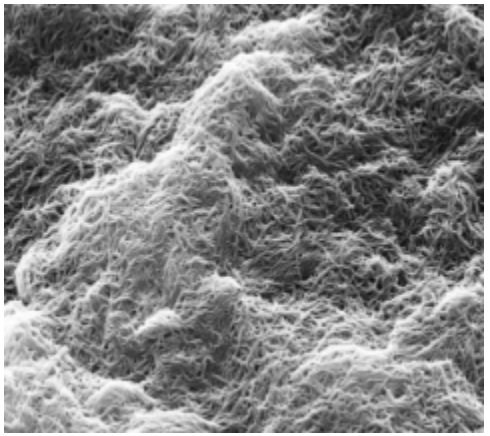
Lubrication

Grease characteristics

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



Source: Shell Oil GmbH



Microscopic grease view

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 506[1)] standard specifies end stop rigidity
- Withstand operator forces by manual operation
- Withstand actuator tripping torque
- Maintain operability before, during and after actuator tripping torque

Travelling nut (source: AUMA)

End stop screws (source: AUMA)

[1)] AWWA = American Water Works Association

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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