Vertical Gearmotors for pumping

Innovative solution for vertical pumping applications

Vertical Gearmotors for pumping

Innovative solution utilizing proven technology

- Integrated combination of a highly efficient Dodge planetary gearing module with a low-pole motor module
- Low-speed, vertical pumping applications
- Gearing module reduces the speed and multiplies the torque of the low-pole motor
- Reduced capital cost
- Reduced maintenance costs
- Lowers total cost of ownership

Vertical Gearmotors for pumping

Features Dodge industry leading gearing technology

- More than 125 years of history
- Leading manufacturer of high torque planetary gearing
- Over 3,500 units in service worldwide

Controlled Start Transmission - CST

MagnaGear

Vertical Gearmotor

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Vertical Gearmotors (VGM) as a pump drive option

VGM w/low-pole motor option

Large high-pole, low-speed motor option

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Potential VGM applications

Low speed / high volume vertical pumping applications

- Low-speed Vertical pumps
  - 60 Hz ~ 100 RPM to 512 RPM
  - 50 Hz ~ 75 RPM to 430 RPM
- KW ratings ~ 200 KW (270 HP) to 20,000 KW (27,000 HP)
- High torque: ~ 34,000 Nm (300K in-lbs) to 790,000 Nm (7,000K in-lbs)
- Gear ratios ~ 4:1 to 10:1 ratios

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VGM value proposition

- **Innovative new design with proven technology**
  - **ABB / Dodge uniquely positioned with gearing and motor expertise**
- **Lower CAPEX and maintenance costs**
- **Focus on reliability**
- **Energy efficiency**
  - **Advantage of low-pole motor efficiency & power factor**
- **Smaller footprint and less weight**
- **Provides the best TCO solution**

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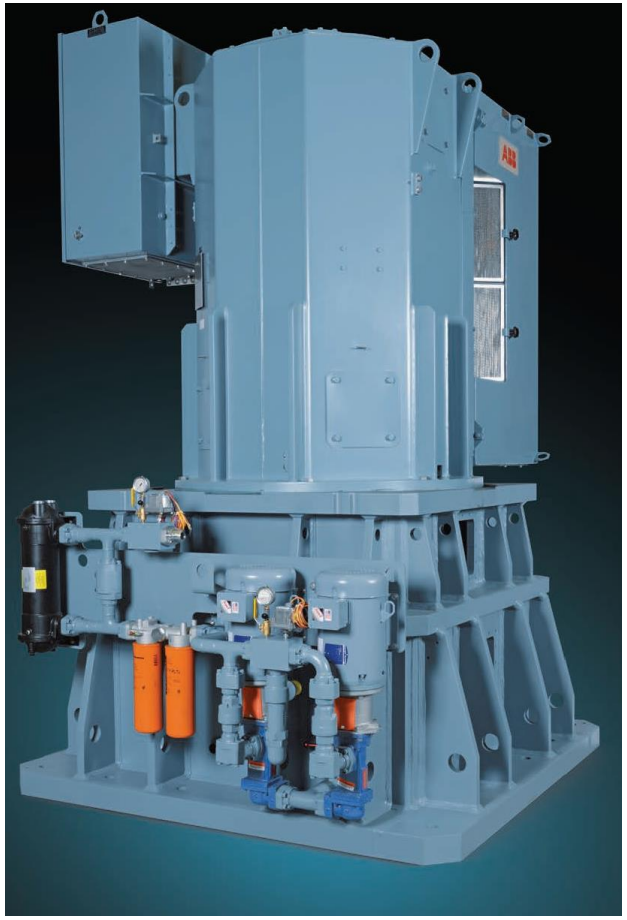
Capital cost savings with VGM

Potential savings will vary by application

- **CAPEX cost for the VGM can be significantly less than high pole motor options. Typical savings of 20% to 50%**
- **VGM is lighter than high-pole motors and a smaller footprint is normally required**
- **Particularly for new installations, power density can result in significant savings in civil works and structures**
- **Motor can be mounted after connection of gearing to pump shaft. Less weight to be handled and simplifies alignment**
- **Thrust loading is accommodated by reducer**



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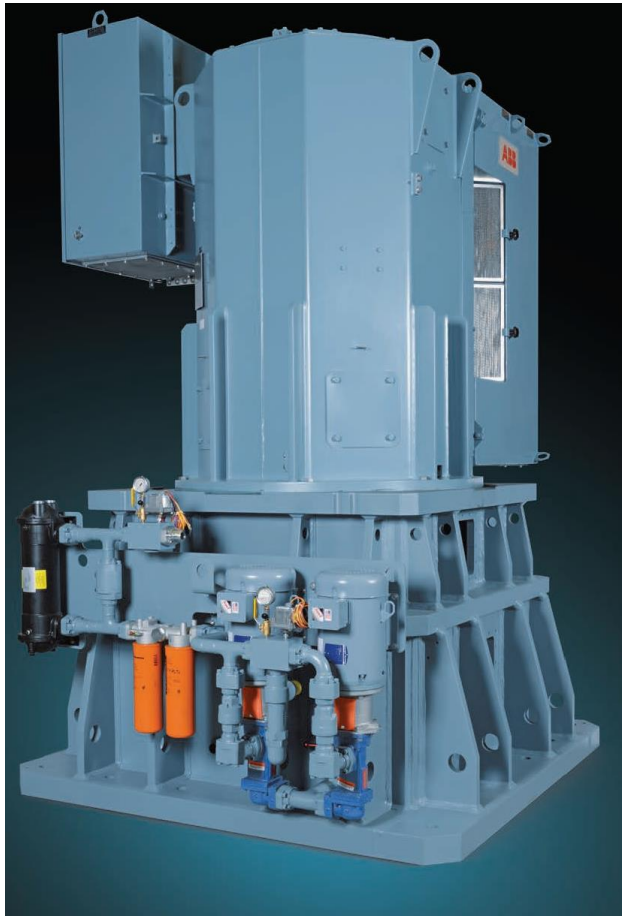
VGM focus on reliability

Designed for extremely long service life

- **Gearing designed to 5 times American Gear Manufacturers Association (AGMA) standards**
- **Drywell design assures no seal leakage/replacement**
- **Normal motor service / replacement cost is lower for low-pole motor vs high-pole motor**
- **Gearing can be designed for the exact speed impeller speed required to operate at the desired BEP of the pump**



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High efficiency and power factor

Improved operating costs

- Realize the higher efficiencies and Power Factors of low-pole induction motors vs high-pole induction motors
- Highly efficient and power dense planetary gearing
- Lube system minimizes oil level and churning losses
- Overall gearing losses are < 1%

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Alternative to horizontal motors and right angle reducers

- **Eliminates alignment issues between motor and reducer**
- **Higher efficiency planetary gearing vs helical and bevel gearing**
- **Cost effective**
- **Can be smaller and lighter – reduced support structure and facility cost**
- **Single source and complete drive package**

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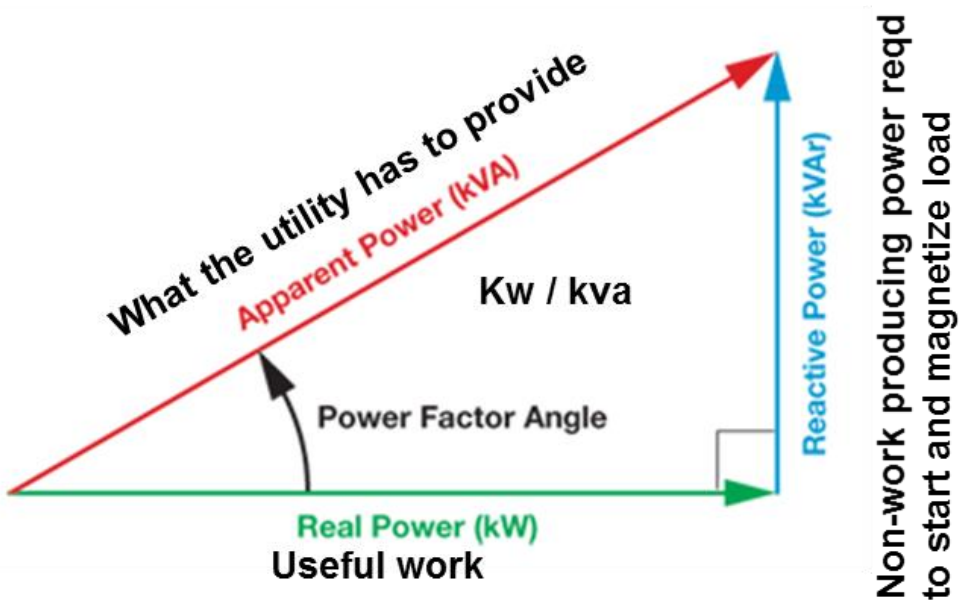
Power Factor benefit of low pole motors

Importance of Power Factor

- **Power Factor (PF) is the ratio of real power performing useful work to the apparent power required by the equipment**
- **Because a utility must deliver more amperage to a customer with a low PF system, the utility will normally charge a higher rate per KW-hr if the customer has a low PF**
- **High pole count induction motors have a lower PF than low pole count induction motors - more KVA must to be delivered to the motor to supply the real power needed**
- **Can result in significant utility surcharges**



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VGM allows selecting the optimum pump impeller speed

Motor Pole Count	RPM @ 60 Hz	RPM @ 50 Hz
14	514	429
16	450	375
18	400	333
20	360	300
22	327	273
24	300	250
26	277	231
28	257	214
30	240	200
32	225	188
34	212	176
36	200	167
38	189	158
40	180	150

Ratio designed for specific application

- **The base speed of a motor is set by the frequency and discrete number of poles**
- **Operating outside that speed requires variable frequency drives**
- **Use of gearing allows more flexibility in operating at the exact output speed required**

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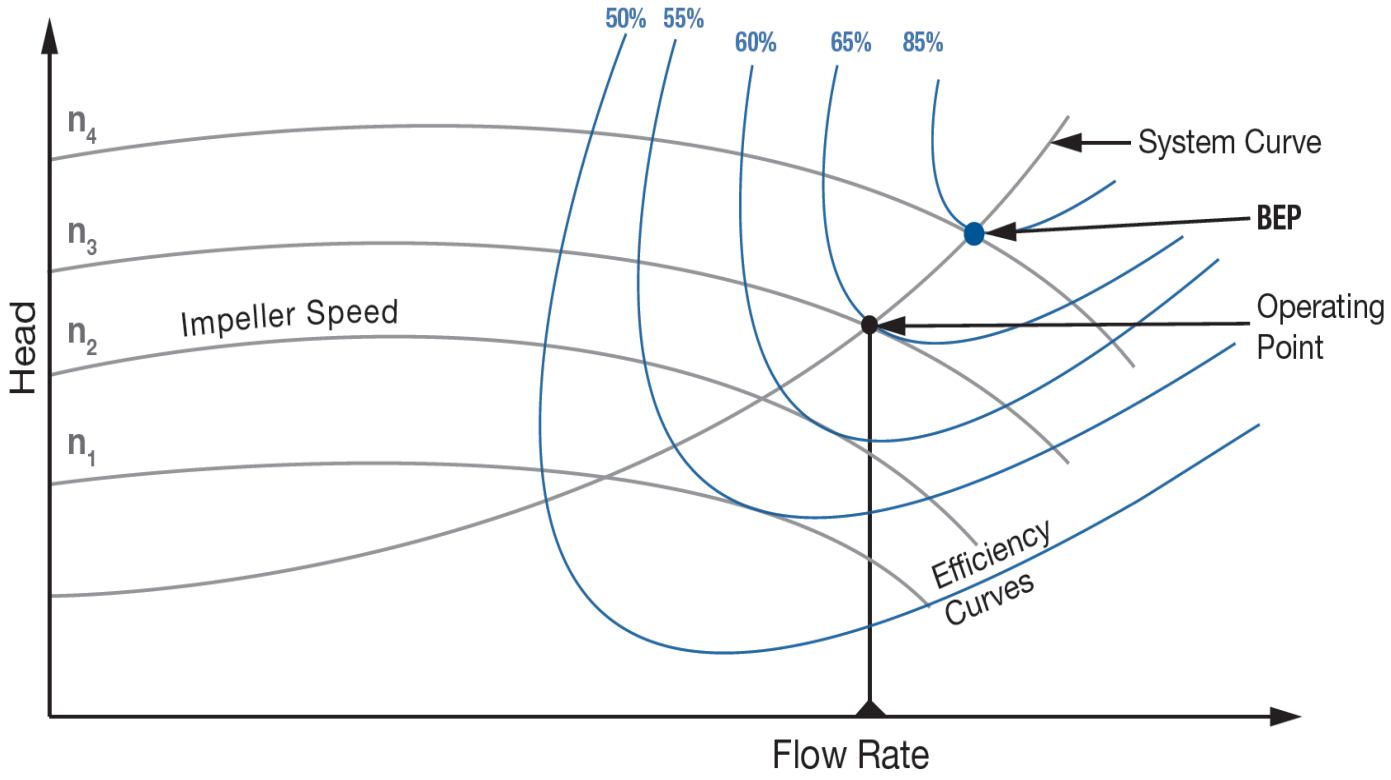
Impeller speed effects pump efficiency

Effects of impeller speed on pump efficiency

Small changes from optimum pump speed can mean large decreases in efficiency

- **BEP is Best Efficiency Point**
- **Impeller speed is a factor in determining operating point of the pump**
- **Moving the operating point away from the BEP dramatically reduces pump efficiency**

Select gear ratio for desired speed



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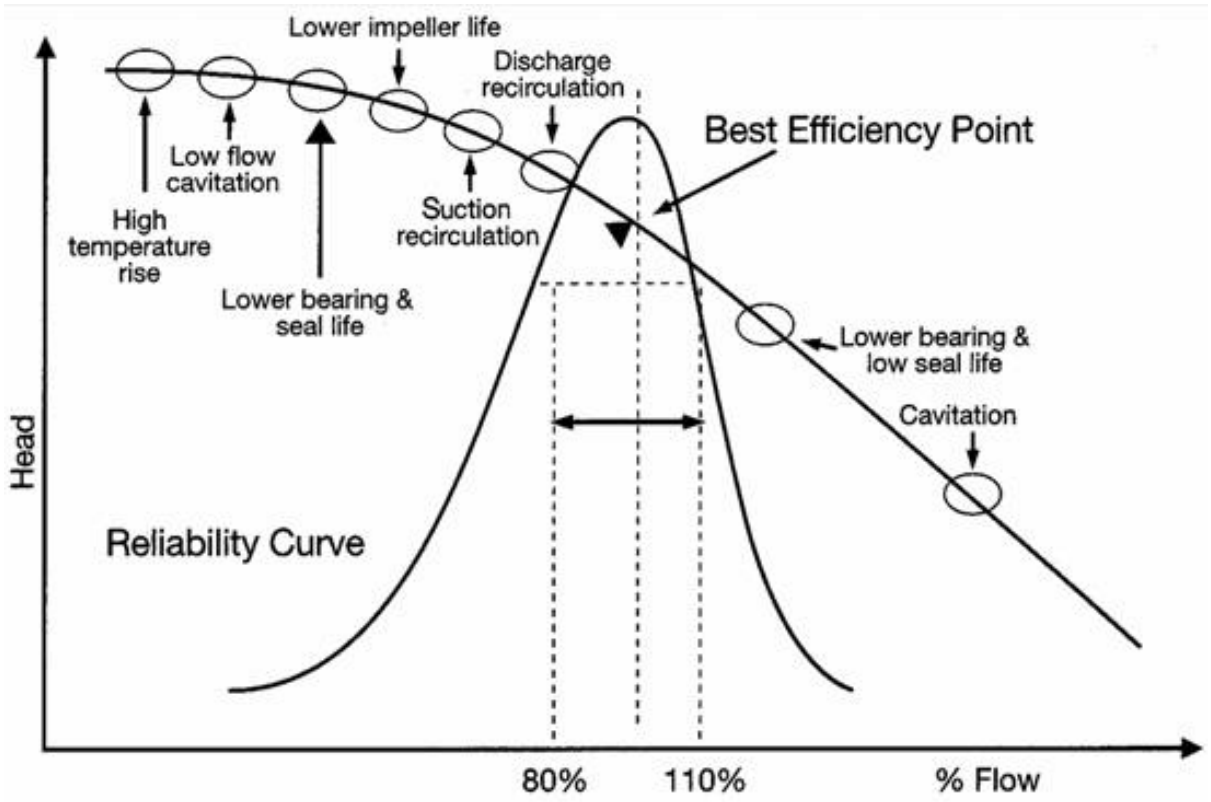
Impeller speed effects pump reliability

Effects of impeller speed on pump reliability

- **Centrifugal pumps are designed to operate at or near the design rated conditions of head and flow (BEP)**
- **Pump operation at excess capacity (flow > BEP) and lower head create bearing and shaft seal problems**
- **Pump operation at reduced capacity (flow < BEP) and higher head result in accelerated deterioration and pump failures**

Select gear ratio for desired speed



Vertical Gearmotors for pumping

VGM product family

Power rating for each size is dependent on output speed

Approximate power ratings from 200 kW (270 HP) to 20,000 kW (27,000 HP)

VGM Size	Torque Rating (in-lbs)	Torque Rating (Nm)	Continuous Thrust Rating (lbs)	Continuous Thrust Rating (Kg)
VGM 300	300,000	34,000	35,000	16,000
VGM 550	550,000	62,000	52,000	24,000
VGM 1000	1,000,000	113,000	83,000	38,000
VGM 1700	1,700,000	192,000	110,000	50,000
VGM 2400	2,400,000	271,000	142,000	64,000
VGM 4100	4,100,000	463,000	220,000	100,000
VGM 7000	7,000,000	790,000	320,000	145,000

Values in table are approximate rating by size
Ratios can be produced to accommodate specific requirements. Approximate ratio rang from 4:1 to 10:1
Approximate design output speed range from 100 RPM to 512 RPM

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Permanent Canal Closure Project (PCCP) in NOLA

US Army Corp of Engineers project using VGMs

- **10 x 3,750 kW (5,000 HP) VGMs**
- **7 x 1,900 kW (2,500 HP) VGMs**

Total system capacity ….17 Vertical Gearmotors
41,100 cubic meters (11,000,000 gallons) per minute
Fill Olympic size pool in < 4 seconds

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3,750 kW (5,000 HP) VGM on test stand and installed on pump base

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PCCP project – London Avenue Canal

VGMs Installed

- **4 x 3,750 kW (5,000 HP)**
- **2 x 1,900 kW (2,500 HP)**

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PCCP project – Orleans Avenue Canal

VGMs Installed

— **3 x 1,900 kW (2,500 HP)**

Vertical Gearmotors for pumping

PCCP project – 17th Street Canal

VGMs Installed

- **6 x 3,750 kW (5,000 HP)**
- **2 x 1,900 kW (2,500 HP)**

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Benefit summary

- High Reliability
- Lower CAPEX cost
- Higher efficiency using low-pole induction motors
- Better power factor than high-pole induction motors
- Lower maintenance cost for low-pole motors
- Smaller physical size reduces facility requirements
- Less weight reduces freight, handling and support structure costs
- Optimized pump speeds through gear ratios for system efficiency
- Thrust can be accommodated by the gearbox at a lower cost, simplifying motor design

VGM benefit generally increases at lower pump speeds