

Gearless Drives For Medium Power Conveyors: Benefits and Operational Data Review From a Commercial Installation

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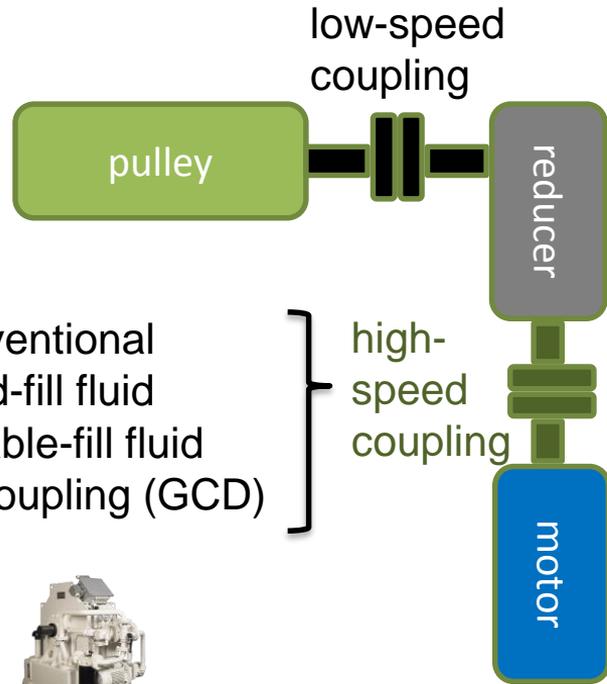
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Overview

- Conveyors Drive Train Configurations
- Technology vs. Conveyor Size
- 270 HP Direct Drive project data, field measurements
- Summary



Conveyors Drive Train – Mining Configurations



- Conventional
- Fixed-fill fluid
- Variable-fill fluid
- No coupling (GCD)



- Conventional gearbox
- Controlled Start Transmission (CST)
- No reducer (GCD)



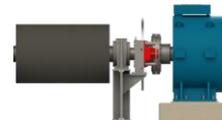
- Squirrel Cage Motor, Across the Line
- WRIM, Stepped or Liquid Resistor Starter



- Squirrel Cage Motor, VFD



- Gearless Conveyor Drive (GCD), VFD



Technology vs. Conveyor Size

High
Power



Conveyor power

> 13,000 HP

Motor power

3,300 – 12,000 HP
50 – 60 rpm

Medium
power



GCD for medium power

4,000 – 13,000 HP

800 – 4,000 HP
60 – 140 rpm

Low
power



< 5,300 HP

130 – 1,300 HP

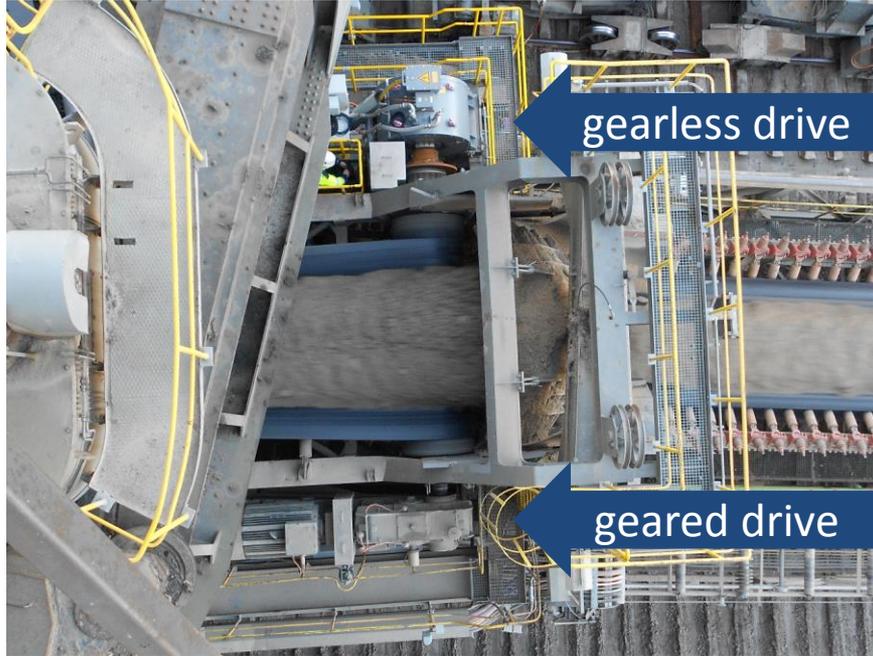
270 HP (200 kW) Direct Drive



Location and site data

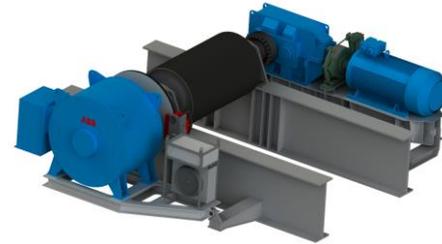
- Bucket Chain Excavator, discharge belt
- LEAG Mine “Jaenschwalde” near Cottbus, Germany
- **Ambient conditions:**
 - Rought conditions of open pit mine
 - 500,000 ft³/hour
 - sand with partially large rocks (ice age “foundlings”)
 - Design Temperature: - 13 °F ... + 104 °F
 - Harsh Shock and Vibration (2g/1ms; 0,25g (1 ... 100Hz))
- Limited space

270 HP (200 kW) Direct Drive



Installation setup

- Gearless retrofit for one of the two existing drives
- Geared and gearless drives running in parallel
- Perfect case for benchmarking
- Retrofit project meets and exceeds all technical challenges found in new installations
- Motor ratings: 270 HP, 80 rpm, 17.6 ft-lb, 18 poles, 9,866 lb



19-months of operation summary

- The mass and footprint balance is positive
- Gearless drive saves about 5...7% energy (measured)
- Gearless drive motor sound pressure level is as low as 66,3dB(A) (measured)
- Amount of motor cables can be reduced by 25%
- No maintenance or repair activities needed so far
- No brake down, damage or unexpected failure so far
- Content of rotational frequencies and vibration in mechanical drives train is reduced by gearless drive

Retrofit – Before and After

Existing geared drives



New gearless drive (MP-GCD)



Skid / Torque Arm From the Workshop



Mass Balance



1 drives including surrounding structure and pulley

		gearless - geared
• Original design (WRIM)	13.974kg	-182kg
• After upgrade to (SqCageIM)	11.766kg	+2.026kg
• Gearless drive 2017	13.792kg	

Summary:

Considering the conservative dimensioning of the pilot drive we can say that the mass balance is positive.

As an estimation, the mass of the direct drive could be further reduced by about 1.5tons.

The mass balance of larger installations shows further advantages for the gearless drive.

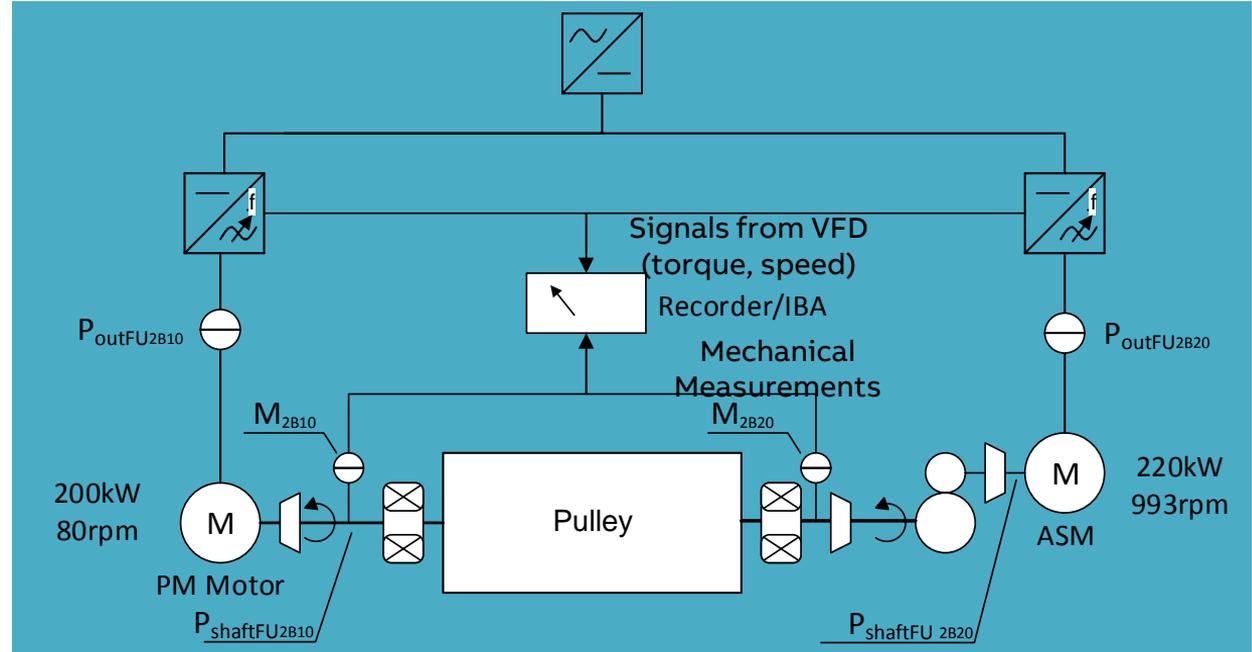
Measurement Points

Measurement system

High speed recording of:

- Mechanical sensors
 - Torque at pulley shaft
 - Speed and position of PM motor shaft
- Frequency converter
 - Motor torques
 - Motor speeds
 - Speed and torque references
 - Belt load

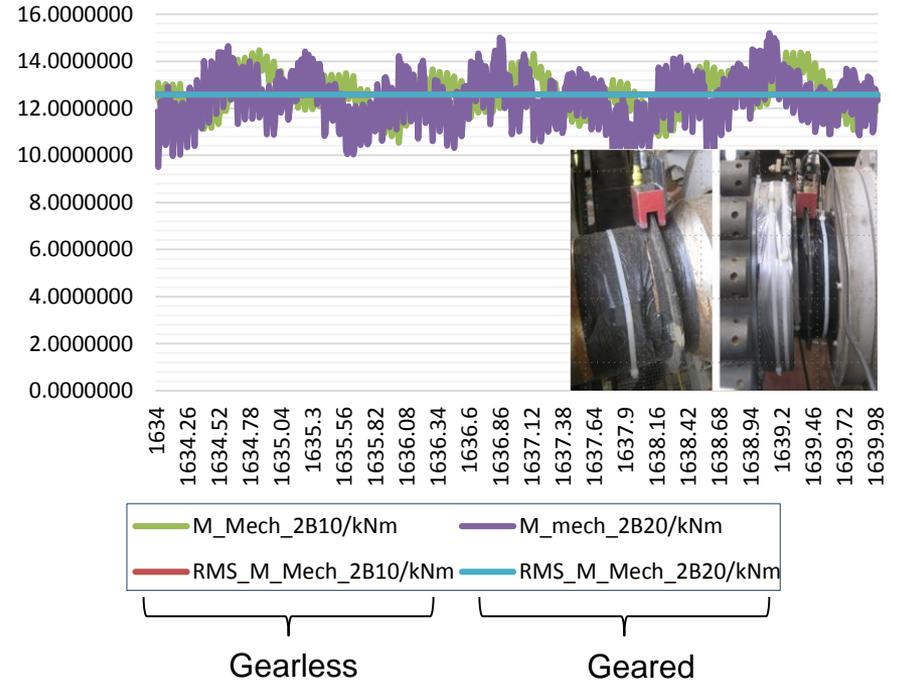
Validation in real environment



Pulley shaft torque measurement

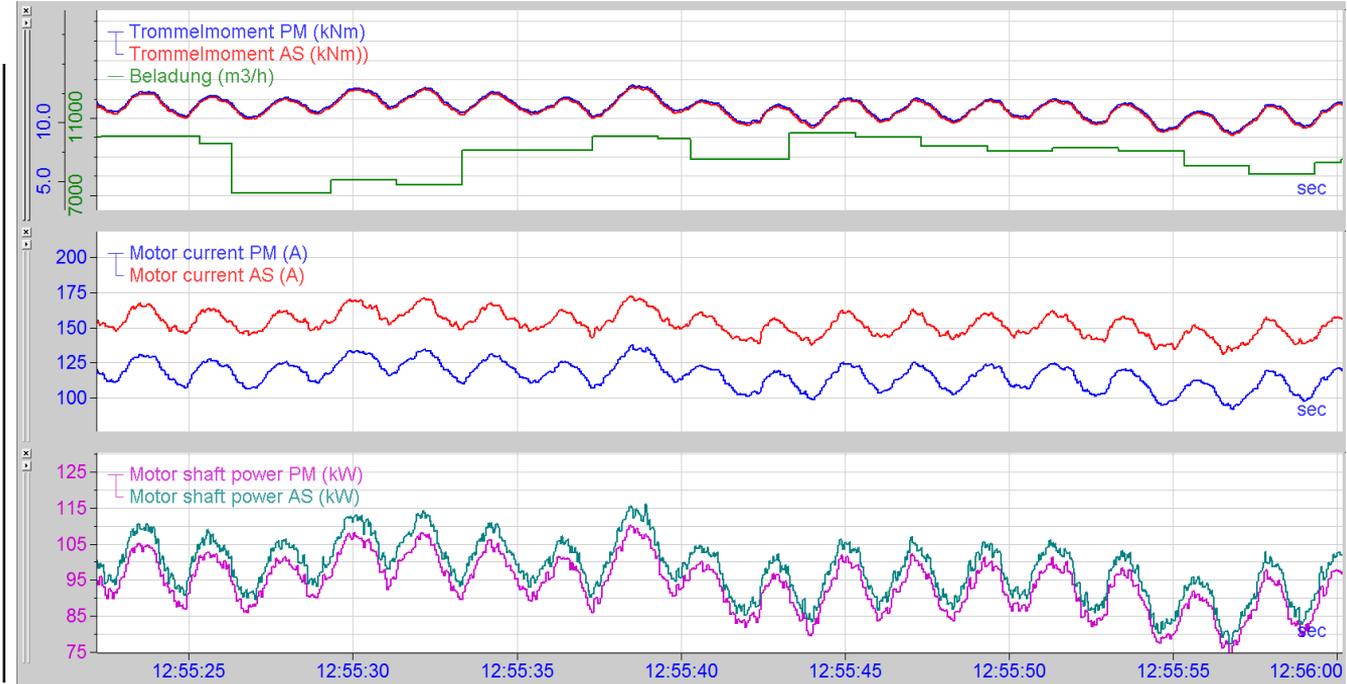
Drive measurement

- The mechanical torques are equal at rated load points
- Oscillation analysis:
 - 1. $f=16,6$ Hz rotational frequency of induction motor (geared side, balancing issue)
 - 2. $f= 0,45$ Hz unloading frequency of buckets (ca. 2,2 s)
 - 3. $f= 1,3$ Hz rotational frequency of pulley
- Summary:
 - Rotational oscillations are caused by the geared drive. In GCD is same frequency but less amplitude
 - There is no obvious oscillation caused by the gearless drive
 - Gearless drive creates much less oscillation/ vibration issues



Motor currents and powers

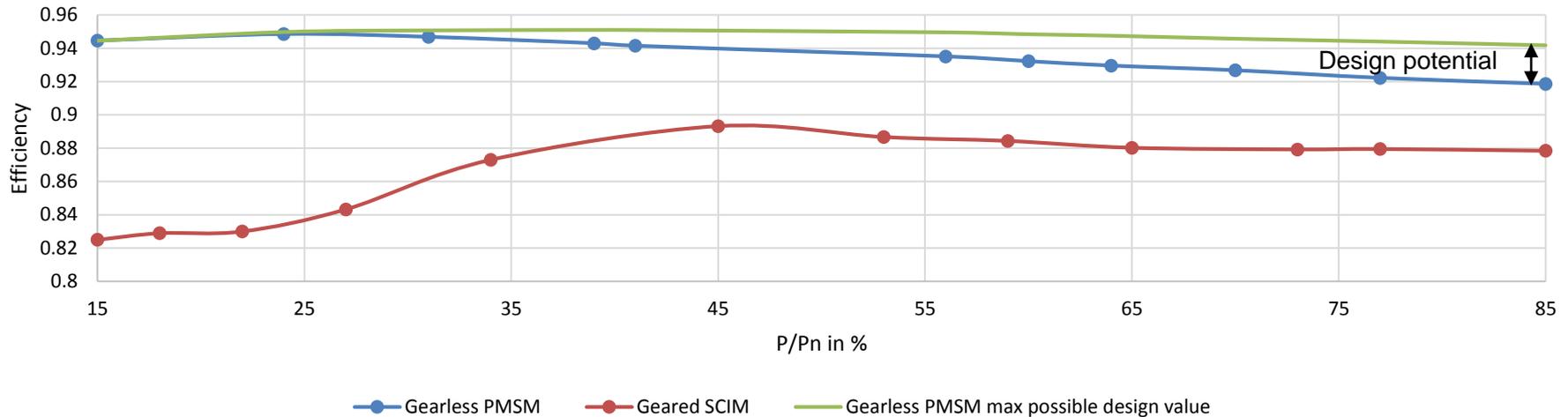
- Measurements at full load operation
- Absolute pulley shaft torque are equal on both sides
- Motor current of PM-Motor is appr. 37A lower (25%)
- Less motor cables are required for gearless drive



Appr. 25% lower motor current → 25% less motor cables

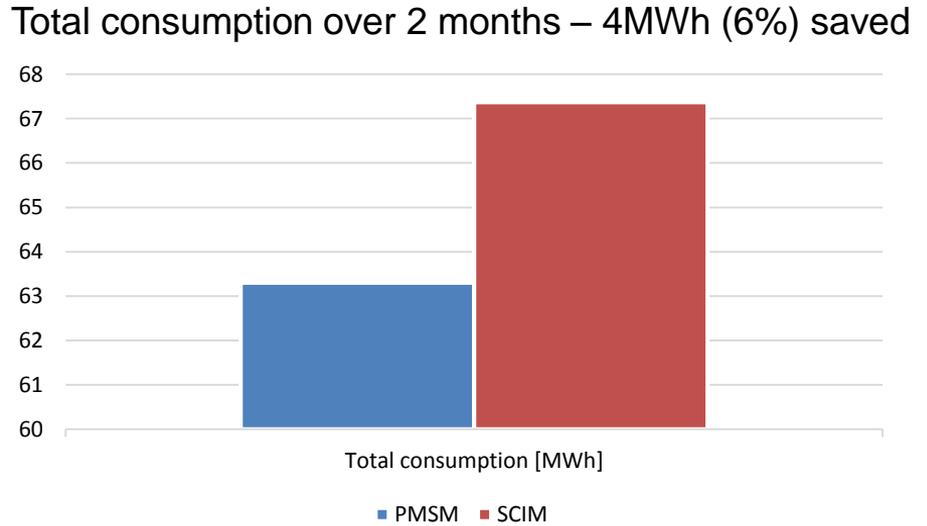
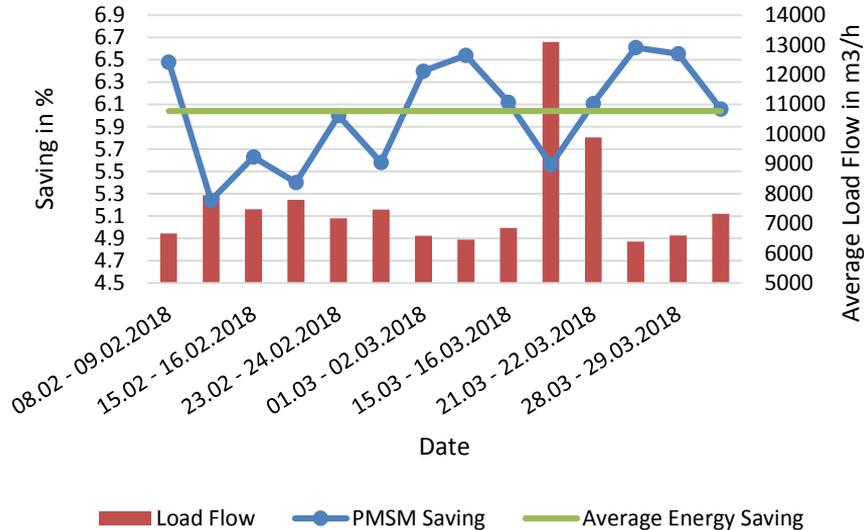
Efficiency – measured and projected

System Efficiency (includes motor inverter, motor, gearbox)



Potential efficiency increase is 6 to 8%points

Energy Balance over 2 months



> 5,2%...6,5% lower power consumption with gearless drive

Maintenance

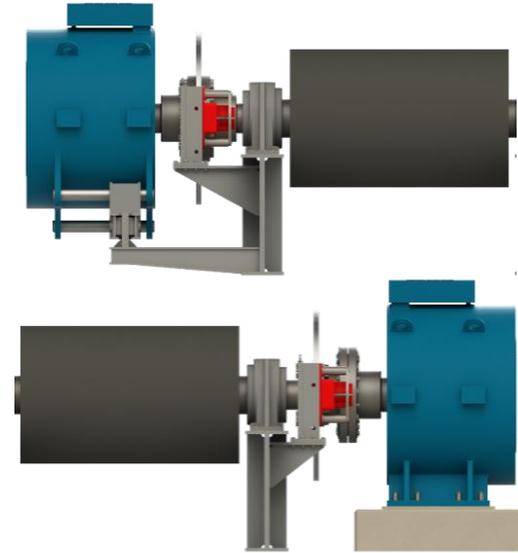
- A direct drive PM motor has basically just two wear and tear parts:
 - bearings
 - cooling unit.

Note: there are no slip-rings!

- Bearings are typically of anti friction type with life time greasing or interval greasing, similar to the conveyor pulley bearings. Because of the low rotational speed, bearing life can be designed for 5 to 10 years (50.000 ... 100.000 hours)
- Cooling unit visual inspections on a monthly basis, heat exchanger cleaned on a yearly basis. Note: no chiller used for cooling water.

Gearless Upgrade with Permanent Magnet Motor

- All benefits of variable speed solutions
- >50% lower failure rate
- >30% reduction of energy losses
- Ideal in cases when existing gearbox and motor are not in good condition
- Pulley shaft or foot mounted options
- Liquid cooled or air cooled motor (only foot mount)
- 5-10% higher CapEx than conventional gearbox + motor + VFD
- Lowest OpEx/ cost per ton solution, typical payback in less than 1 year
- Suitable for 800hp to 4,000hp motors



Mounted to pulley shaft and foot mounted motor options

Thank you for
your attention

