Hubbell Industrial Controls

Steel Industry – Metal shredder case study

Steel industry training – Metal shredder case study

Torque achieved with voltage

HUBBELL®
Industrial Controls Division

Direct Online Induction motor driving a scrap metal shredder

- A metal shredder is usually a high-power motor (up to 3000hp) where the torque applied to the shaft that is turning the shredding discs is maximized with gears
- It is assumed that the shredder uses a direct online motor (DOL)
- A metal shredder might jam if it is fed with too much scrap metal
- The jamming causes the motor to be stopped for safety reasons
- This case analyses how dynamic reactive power compensation prevents jamming

DOL induction motor operation

- Direct On-Line AC motor does not have grid interfacing power electronics such as drives do
- There is usually some sort of a soft starter which is used to lower the inrush current when the motor is starting to help maintain the voltage
- The motor speed is proportional to grid frequency (60Hz) and is not controlled in any way.

DOL induction motor operation

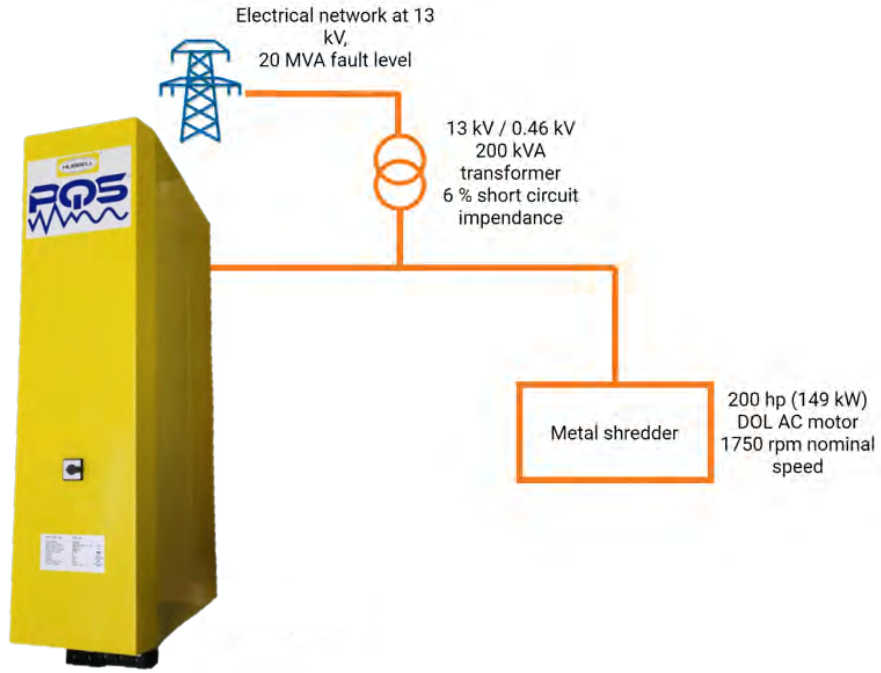
- The maximum torque and the mechanical power of the motor is quadratically dependent on the motor terminal voltage
  - $\mathrm{T} \sim P \sim V^2$
- The motor requires a lot of reactive power for the magnetization of the stator and rotor windings. The reactive power need is higher if the machine needs to produce more torque

200hp DOL AC motor

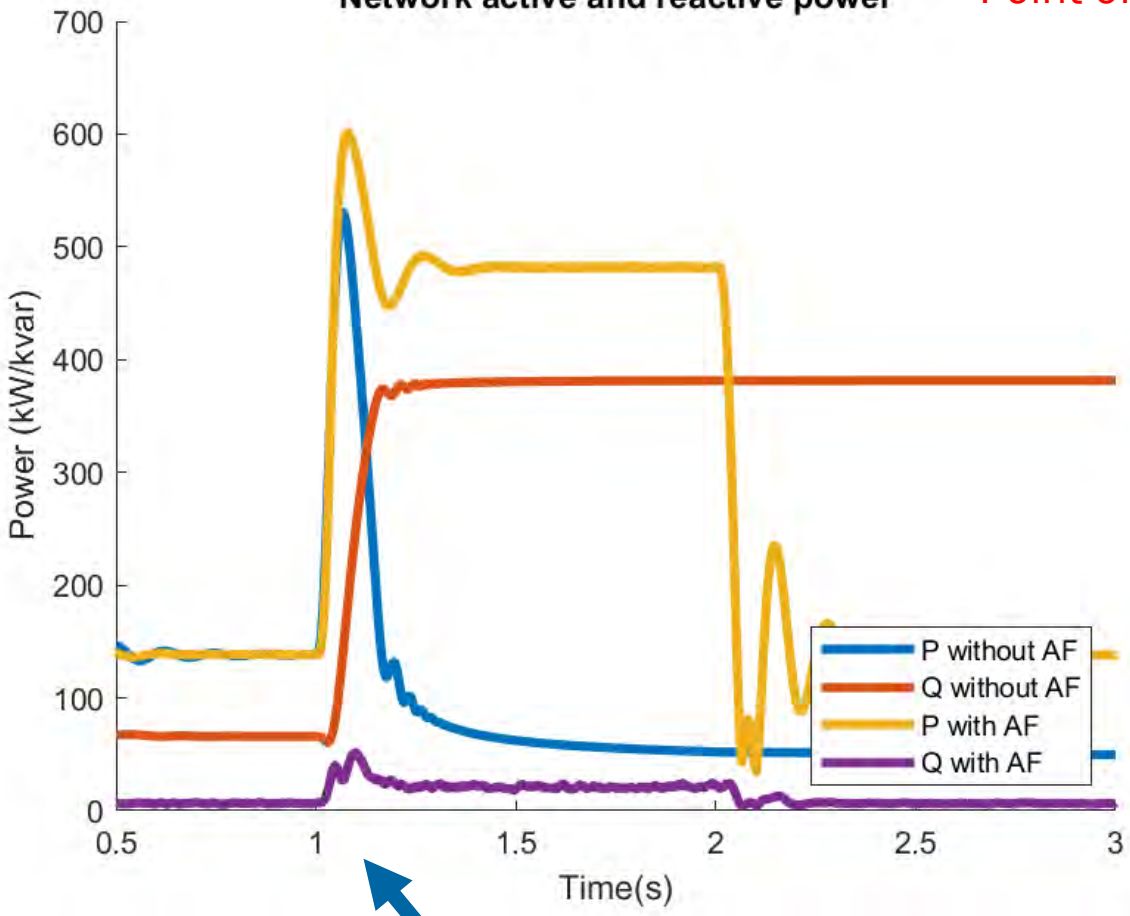
Operation in sudden load torque rise

A big metal chunk is fed to the shredder which is equivalent to a momentary rise in the load torque.

The ability of the motor to produce enough torque to crush the chunk is based on the terminal voltage.

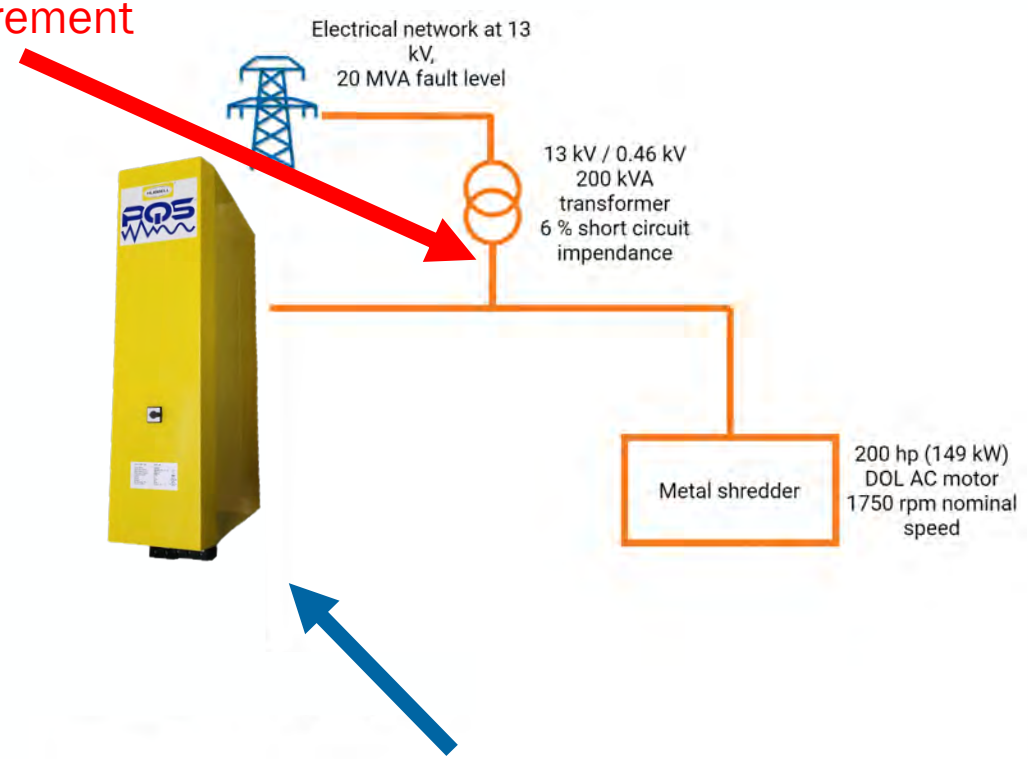


DOL AC motor in sudden load torque rise



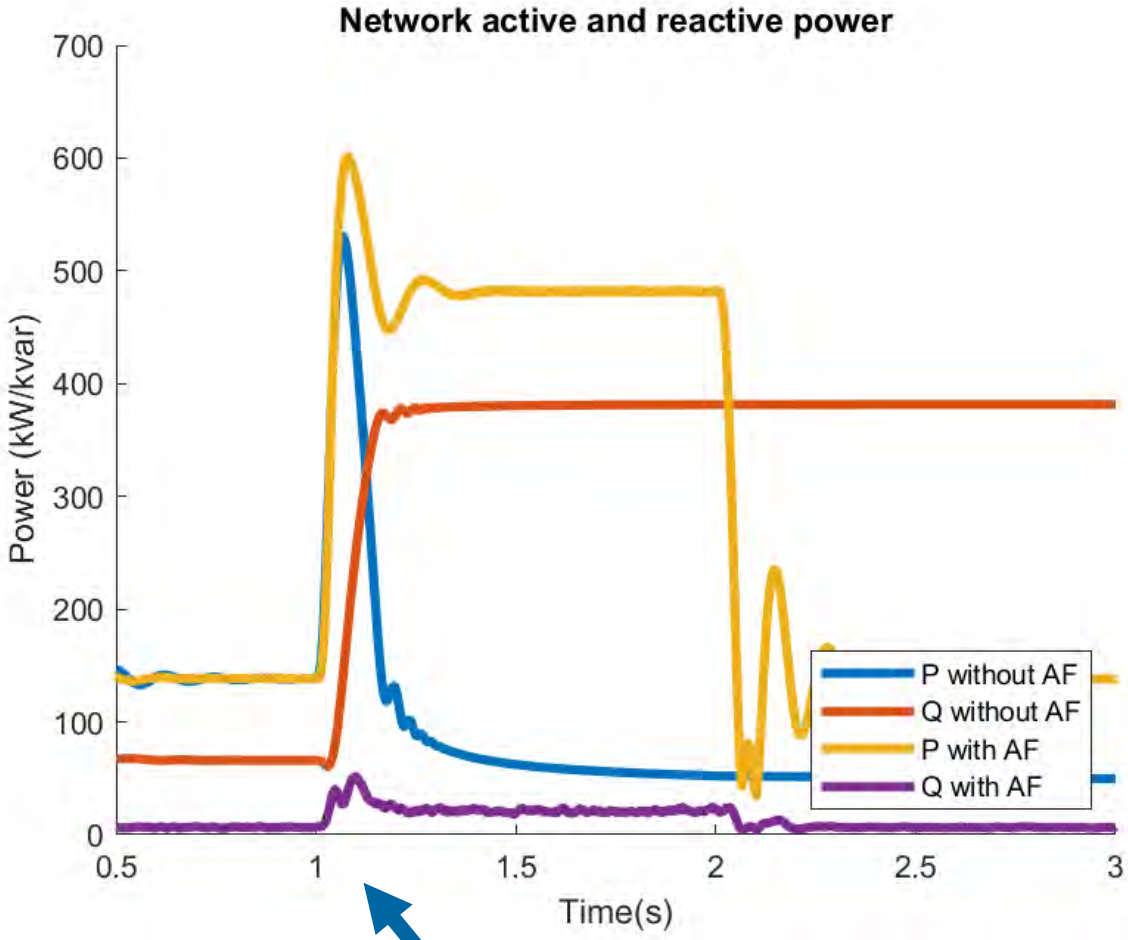
Load torque is suddenly increased to 3 times the nominal for 1 second

Point of measurement

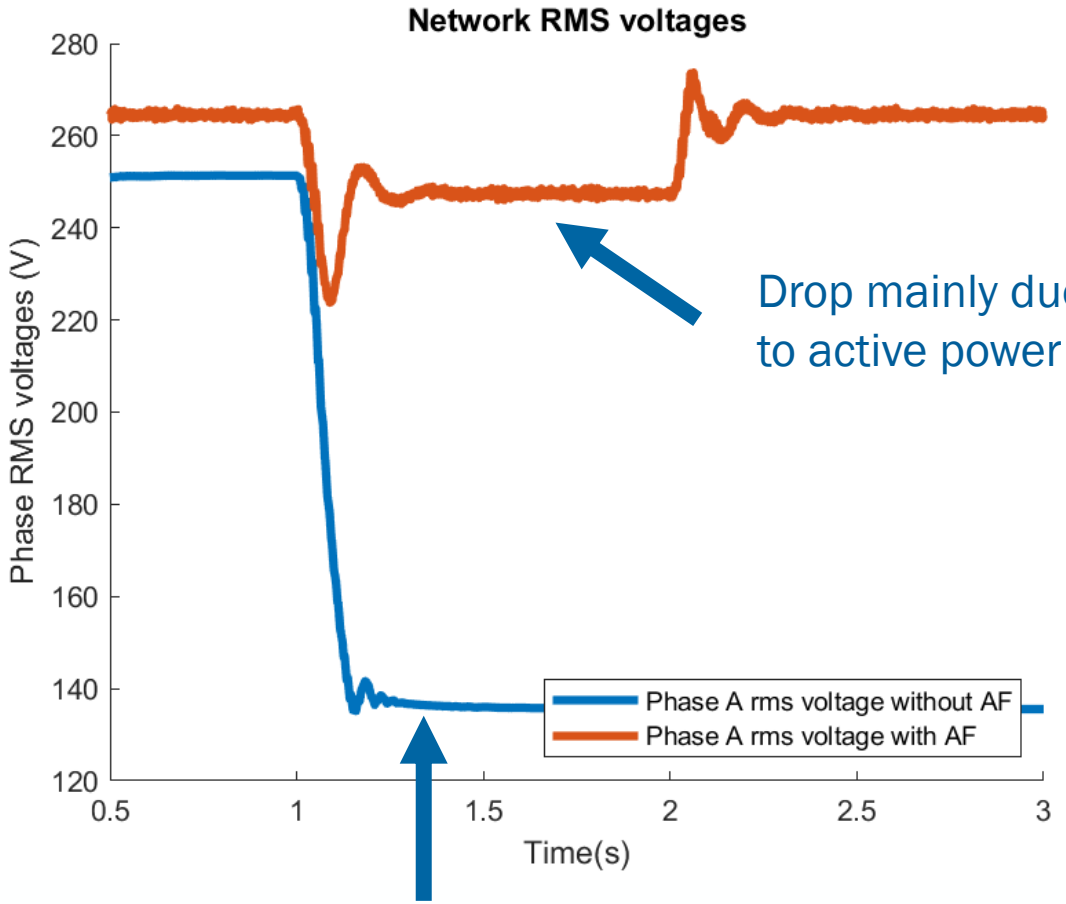


The active filter is used in dynamic reactive power compensation

DOL AC motor in sudden load torque rise



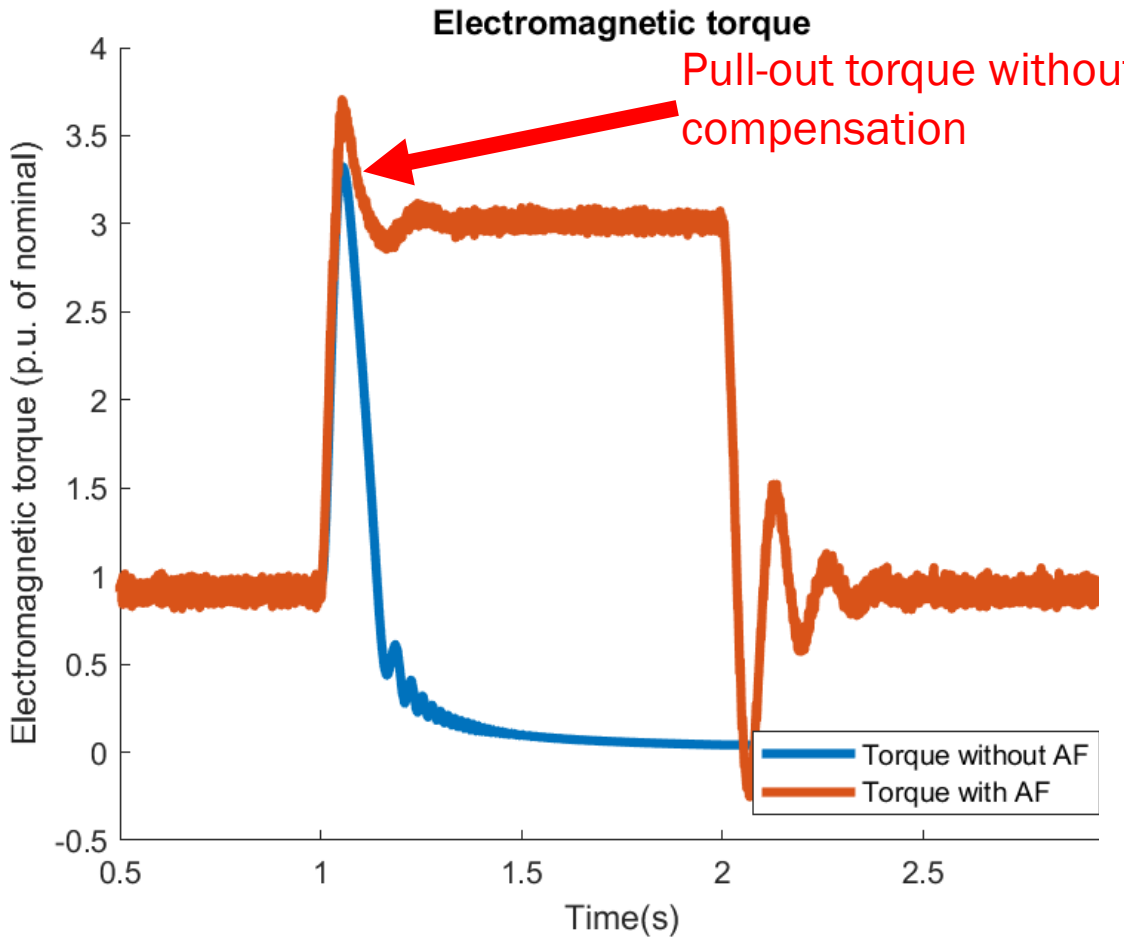
Load torque is suddenly increased to 3 times nominal for 1 second

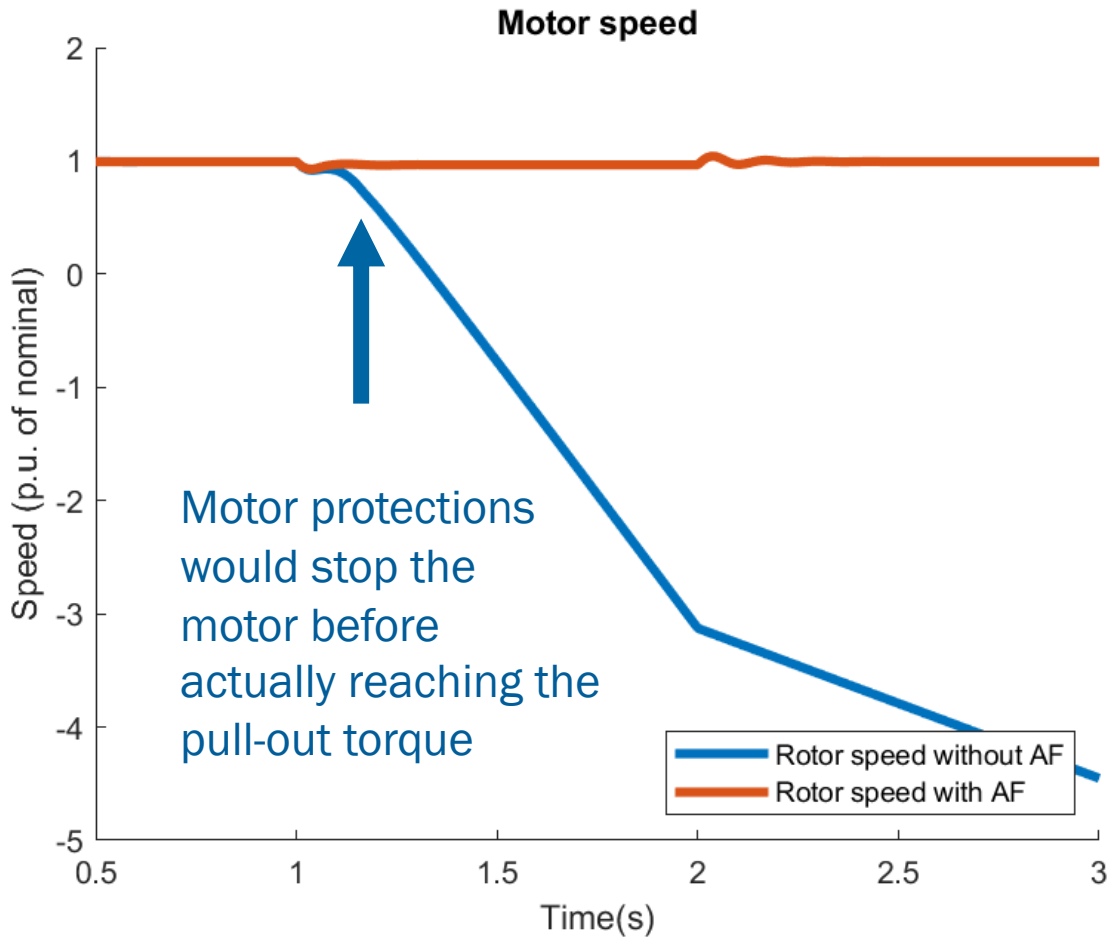


Drop mainly due to active power

Drop mainly due to reactive power power

DOL AC motor in sudden load torque rise





Payback

- **Increased payload** in crusher in case the voltage is down from nominal in normal operation
- Voltage is maintained at nominal level in the whole plant network – **other electric equipment do not suffer problems**
- **Less downtime** on the plant by avoiding jamming of the motor
  - The procedure of removing the jammed scrap metal takes a lot of time and has to be done manually by plant operators, which implies hazardous work

Key takeaways

- **In a DOL AC motor the maximum torque has a quadratic relation to the voltage**
- **The voltage at the motor terminals can be kept stable with a reactive compensation system**
- **If the motor reactive power demand suddenly increases the voltage at that bus goes down without a compensator**
  - All equipment connected to that bus experience the same voltage drop
  - In case of a weak grid or medium voltage connected motor, the voltage drop will be seen on the MV voltage side as well

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