Electric drives in agricultural machinery

Experiences and visions of an implement manufacturer

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RAUCH Landmaschinenfabrik GmbH - a family company

State of the art – Motivation for a new drive

Conventional Power Transmission vs. Electrical Interface

Example: RAUCH-Twin-disc fertiliser spreader

Potential electric drives for different agricultural machinery

Summary, prospects and vision
RAUCH Landmaschinenfabrik GmbH

Founded in 1921
Family owned enterprise 100 %
Turnover 2009/10 43 Mio. €
Export share 65 %
Staff 310
Students 25

Shareholders & executives:
Hermann Rauch
Joachim Rauch
Norbert Rauch
RAUCH sites

Administration still in Sinzheim, the old production halls are now destroyed

New production site at the Baden-Airpark
1999-2009: 10 Years, 10 Medals

Gold for AXERA-H EMC
Silver for AXERA-H

Gold and Silver for AXIS

Gold für AXIS EDR

Silver for AGT Spreader

Gold for the CCI Terminal
RAUCH "care for grain"

Core competence:

Metering and Distributing of grains

- Mineral Fertilizer
- Seed
- Salt, Sand, Grit
RAUCH the Range of Success

Seedtechnology

Fertilizerspreaders: Disc-/Boomtechnology

Wintertimespreaders
State of the art – Motivation for a new drive

Mechanical Drives
- Fixed relationship with the tractor engine speed
- Difficult power distribution on complex agricultural machinery

Pro: High power density and robustness

Hydraulic Drives
- Unfavourable efficiency, high oil heating levels
- Limited speed regulation options
- Potential for oil leakage

Pro: High force density
State of the art – Motivation for a new drive

Electrification of agricultural machinery offers another innovative interface:

- Optimum controllability
- Good power density with gearbox
- Simple power distribution across complex agricultural machinery
- Reliability in agricultural application
- Combination with navigation and automation

An innovative solution for higher productivity, safety and convenience

We have to learn about all the opportunities!
Hydraulic interface vs. electrical interface

The principle is still the same

- Tractor = Power source
- Generator = Hydraulic pump
- Frequency converter = "Electrical control block"
Alternative Architectures

Generator on the implement
Regulation and distribution on the implement= scenario for "old" tractors

Important: Compatibility of the architectures!
"Standardisation"

"Large" number of drives on the implement:
Generator on the tractor + Regulation and distribution on the implement
Twin-disc fertiliser spreader with hydraulic drive

Spreader adjustment can be set Right/Left independently
- Disc speed - low controllability
- Spreading point
- Dosage

Automatic fertiliser flow regulation:
- Speed sensor on the spreader discs
- Pressure sensors on the hydraulic motors
- Return pressure sensor - sensors needed
Spreading Technology of Twin Disc Fertilizer spreaders
Spread pattern and overlapping

Controllability of disc speed is needed
Step response: hydraulic vs. electrical drive of a spreader disc

Step response - Spreader disc speed

hydraulic vs. electrical main drive

- Target speed: 900 rpm
- Response hydraulic driven
- Response electric driven

Disc speed [rpm]

0 300 600 900

25 27 29 31 33 35

Time [sec.]

Club of Bologna 13.11.2010
1. No sensors needed
2. Torque measurement
   = Current/Voltage

Disc drive
900 RPM

12 V Eccentric agitator drive
17 RPM

Disc drive
900 RPM

Gearbox
5,5:1

480 V motor
5000 RPM

480 V motor
5000 RPM

Gearbox
5,5:1
RAUCH EDR Twin-Disc Fertiliser Spreader

Very good efficiency with optimum setting options
Prospects for AGT Pneumatic Fertiliser Spreader

Working Width 36m - GPS-Controlled

- Hydraulic fan drive with PTO-driven pump
- Oil container with cooling
- Very low efficiency of the hydraulic drive
- Hydraulic cam wheel drive
  - 6 hydraulic motors
Prospects for a pneumatic seed drill

Very low efficiency of the hydraulic drive

12 V metering device drive

Hydraulic fan drive

Hydraulic push-fit pump
… continue on the "proved and tested" path?
... or an "integrated solution" as a vision for the future

Easy operator input via the ISOBUS display
Summary and Prospects

Electric drives open up new perspectives for agricultural machinery

- Drives precisely regulated on an as-required basis
- Increased system level efficiencies
- Reduced consumption of fossil fuels (diesel, hydraulic oil)
- Easier power distribution
- Safe and fast coupling of attachable and towed agricultural machinery
- Optimised operation using the ISOBUS terminal
Summary and Prospects

Introduction of "electric" tractor/machinery combinations

- The advantages of electrification will increase the amount of available agricultural machinery
- Electrification will optimise processes and reduce energy requirements and consumption.
- Coordinated development of a consistent interface is required (the hydraulic interface is a disaster!)
- Interim scenarios must make it possible to efficiently use electric agricultural machinery with older tractors too.
Summary and Prospects

High degree of potential for self-propelled agricultural machinery

- Optimum and easy power distribution
- Energy-saving drives and regulated in an optimum way

Electric drives, satellite navigation and automation

- Unknown new options for process optimisation
- Reduction in the costs of agricultural products
- Increase in productivity in agricultural production
Visions in future machine generations for agriculture

• Agriculture is the pioneer in production and use of renewable energies.

• Every farm will produce its own electric energy.

• Storage of energy by batteries will be simple, reliable and cost-efficient.

• The self-produced energy will be used in all electrical agricultural machines and tractors.

• Modern electronic information- and sensor-based control systems will provide a highly efficient and sustainable production.

• Maintenance, extended life-time of machines and recycling will save also not renewable materials.
Vision 2030-2040-2050

- Tramlines used to add underground power lines for vehicles, batteries and the agricultural processes
- Wireless power supply with conducting paths between the tramlines “Controlled traffic” via electromagnetic induction
- Sustainable power supplies, e.g. wind power, could be used, in particular in the field’s proximity
Vision 2030-2040-2050

• Is there a path leading to future agricultural systems working in a field and state-of-the-art tram lines today?
• WEB-Site from Bombardier.com:
• The PRIMOVE`s outstanding feature:
• Safe and contactless inductive power transfer.
• Supply components invisible hidden in the vehicle and underneath the track.
• Reliable and wear resistant
• Operates in all weather and ground conditions
• Power levels from 100 kW to up to 500 kW

Let`s think beyond
"The question is no longer if electric drives will come into use in agriculture; but rather, how quickly this will take place."