Fuel cell air supply systems
Agenda

• My background

• Opcon and Autorotor

• Our fuel cell air supply systems

• Project examples, also on trains!
  – Series production
  – Prototype design and evaluation
  – Co-operation and R&D

• Hydrogen Sweden
Dr. Cecilia Wallmark

- Opcon, Svenska Rotor Maskiner, Autorotor
  - Manager Fuel cell air supply systems, since 2005

- Hydrogen Sweden
  - Head of the board, since April 2010

- Researcher Fuel cell systems, e.g.
  - PhD thesis 2004: Design and evaluation of stationary polymer electrolyte fuel cell systems
  - Paper 2005 on Key factors in hydrogen energy systems
OPCON - an industry group
with technology for energy and environment
Opcon business areas - **Companies** - **Brand names** - (products)

**Renewable Energy**

- **Opcon Energy Systems**
  - **Opcon Powerbox**

**Opcon Bioenergy**

- **Saxlund** (biofuel combustion plants, transportation systems)
- **SRE, Renergi** (flue gas cleaning and condensation)

**Svenska Rotor Maskiner**

- **SRM** (twin screw compressor and energy gas handling systems)
- **REF Tech** (industrial cooling)
- **Mitec Instrument** (measurement equipment and analysis)
- **Autorotor** (fuel cell air supply systems)

- **SEM** (electronic ignition systems)
- **Opcon Tech**, Suzhou

- **REAC** (actuators)
- **Balle**

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**Opcon**

- Approx 400 persons in Sweden, Germany, UK, China and Denmark
- Turnover target 1 000 MSEK 2010
100 years of Industrialization
Compressor development for demanding applications

The world’s leading technology centre for screw compressors and screw expanders,

offering outstanding development, prototype production, advanced testing and licensed production worldwide.
Compressor/Expander Motor testing

- 4 separate labs for testing
- Max. 500 kW DC-motors/dynos
- Closed loop and open test rigs.
- Capacity for testing all types of refrigerants and other gases.
- Reference testing according to standard ISO-procedures.
Development projects
with Opcon as fuel cell air supply system supplier

• A well experienced partner with 18 years in the fuel cell area

• Customized solutions and iterative development in line with the real fuel cell market progress

• The twin screw technology gives a flexible system with no efficiency degradation and overall high efficiencies
Exclusive product advantages

- Proven technology in fuel cell systems
- Overall high efficiencies
- Reliable operation and control
- Broad pressure and air flow ranges
Example for fuel cell systems: Compressor OA1050 with intermediate casing and electrical motor mounting
Example of recent product improvement: Water injection in compressor, OA1050

The water injection
- Humidifies the cathode air without additional equipment need
- Implies control of the compressor outlet air temperature
- Increases partial load efficiencies of compressor with up to 5 % units
Customers

- Europe
- North America
- Asia

- Car industry
- Fuel cell system integrators
- Fuel cell test labs, universities
- R&D projects
E.g. CUTE – Clean Urban Transport Europe, 27 FC buses

“The buses have travelled over 3 million km and have accumulated over 100,000 hours of operation and provided transportation to over 5 million passengers” [2006]

Reliability proven!
HYDROGEN FUEL CELL LOCOMOTIVE
HYDROGEN FUEL CELL LOCOMOTIVE
• Fuelcell and Traction Battery “Equivalent” to 1.5 MW [2000 Hp] Locomotive

• 240 kW [320 hp] (continuous net) fuelcell prime mover

• 70 kg hydrogen at 350 bar [5100 psi]
FUELCELL POWERPLANT

RADIATOR MODULE

BALLARD® FUEL CELL STACK MODULES

BALANCE OF PLANT

POWER ELECTRONICS
AIR SUBSYSTEM

• Belt drive of Opcon OA3150 compressor
• Max flow/pressure: 300 g/s @ 3.2 bar(a)
Fuel cell train, reasons

- Less investments than when electrification needed
- Less emissions than diesel engines
- More power than only batteries can provide
- Backup power supply opportunities
- Hydrogen waste in some industry areas today
EU HyTRAN project (2004-)

Two fuel cell systems:
- Car drive train
- Truck APU

Opcon supplied the air supply systems!

The HyTRAN project partners:
Volvo (S), Centro Ricerche FIAT (I), Renault (F), Volkswagen VW (D), Daimler Chrysler DC (D), DAF Trucks N.V. (NL), Nuvera Fuel Cells (I), Johnson Matthey JM (GB), Opcon Autorotor (S), Tenneco Automotive (D), Weidmann-Plastics WPT (CH), adrop (D), Inst. für Kraftfahrwesen der RWTH Aachen (D), Energy Research Centre of the Netherlands ECN (NL), Politecnico di Torino Polito (I), Paul Scherer Institute PSI (CH), Inst. Für Mikrorechnik Mainz IMM (D), Imperial College of Science, Technology and Medicine ICSTM (GB), Environment Park (I)
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www.vatgas.se
Clustering stations in Metropolitan Regions

Few/small stations in Corridor Regions, closing the corridor

- In operation (7)
- Under construction (3)
- Under planning (7)
- Clean Energy Partnership
- Metropolitan Area
- Corridor Region
- X km Road distance between Regions

“The network is required by 2015 and should be built-up from metropolitan areas via corridors into area-wide cover-age.”

OEM 2015 statement
Conclusions

• Trains with fuel cells are already here, and have important tasks to fulfill in the future

• Opcon is a fuel cell air supply system supplier and co-operation partner, already also for fuel cell trains in US and EU

Good luck with your projects wishes me, Opcon and Hydrogen Sweden!