

**The main economical advantages
between chopper and inverters in
trolleybuses**

**1st International Workshop to Push
Forward Your Trolleybus System**

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Solutions & Services

Trolleybuses

Equipment with resistor regulation

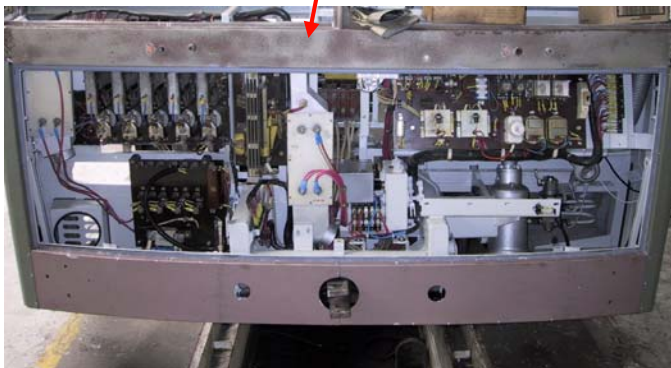


- Utilized till the end of 70´ s
- **Advantages**
 - Simplicity, robustness
 - No need of complicated regulation
- **Disadvantages**
 - Uneconomical operation
 - High need of maintenance
 - High electricity consumption
 - Regenerative braking impossible
 - Twitching at starting and braking
 - Delay in braking effect



Trolleybuses

Equipment with chopper



- Utilized since the end of 70's
- **Principle**
 - Regulation of the DC traction motor DC voltage mean value through elements of power electronics
 - Contactors are necessary
- **Chopper**
 - Development utilizing power electronics (thyristors, GTO thyristors, IGBT transistors)
- **Vehicle accelerations**
 - Smooth running and braking
 - Analog regulation of chopper

Trolleybuses

Equipment with chopper

- **Advantages**

- Considerable electricity savings
- Little maintenance of chopper required
- Regenerative braking possible
- Smooth operation of vehicles

- **Disadvantages**

- Maintenance of DC motors and contactors required
- DC motor of open construction – risk of worsening the insulation condition



Trolleybuses

Equipment with chopper



- **Trolleybuses refurbishment** with resistor or pulse regulation
- Possibility of utilizing existing DC traction motors



- **New trolleybuses**
- Possibility of utilizing DC traction motors of local production

Trolleybuses

Equipment with voltage inverter



- **Principle**

- Inverter supplied from DC intercircuit, forming 3-phase system of AC traction motors
- Regulation of 3-phase system through variable frequency and effective voltage value



- **Voltage inverter**

- 4-quadrant voltage inverter utilized IGBT transistors

- **Vehicle acceleration**

- Smooth running and braking
- Microprocessor regulation of voltage inverter

Trolleybuses

Equipment with voltage inverter



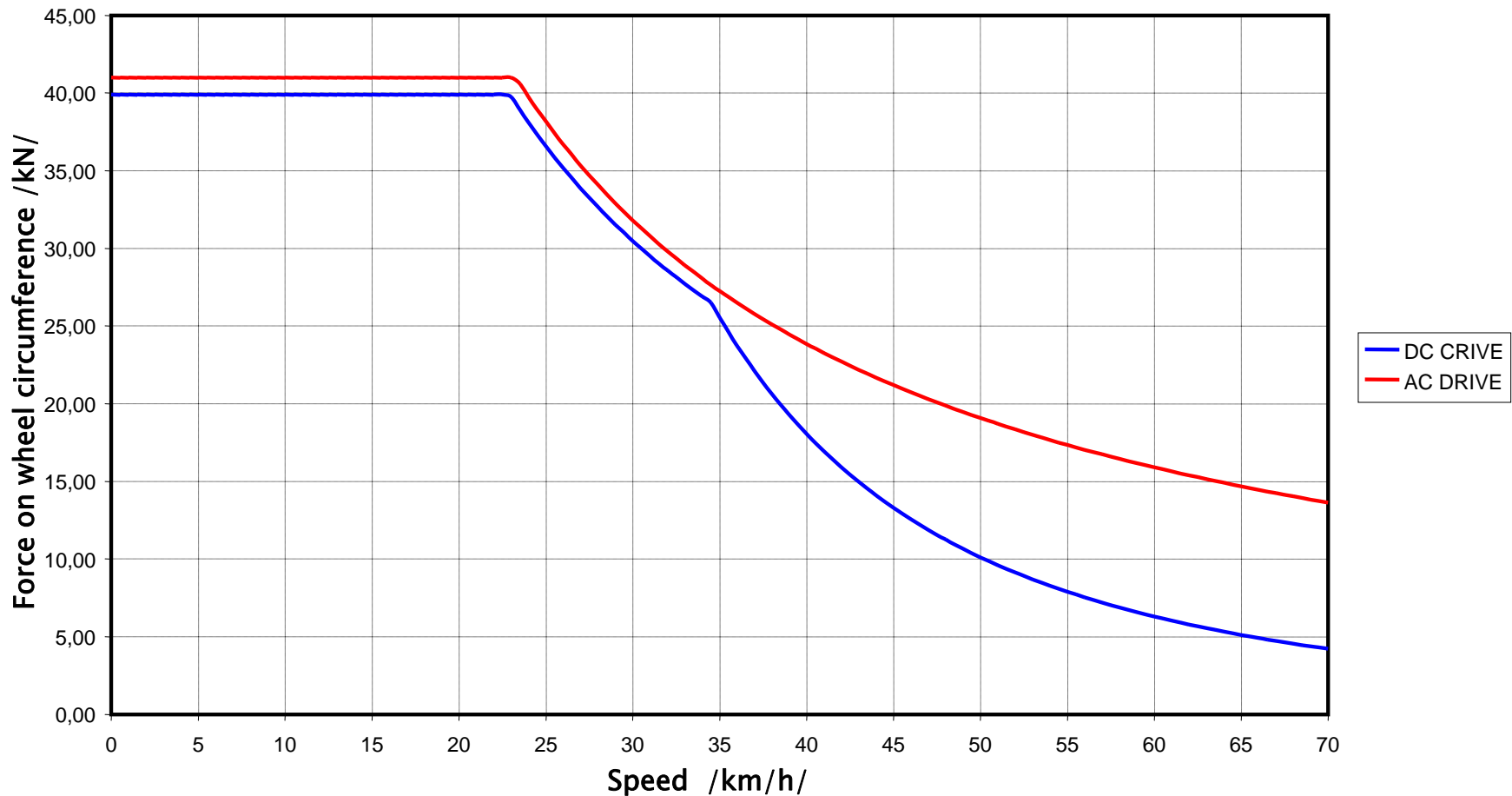
- Utilized since 90´ s
- Exclusively used for new vehicles
- **Advantages**
 - Considerable electricity savings
 - Implicit regenerative braking
 - Maintenance-free AC motor of closed construction
 - Reliability
 - Smooth running and braking, electrodynamic brake up to 0,5 km/h
- **Disadvantages**
 - Complexity of microprocessor regulation → skilled maintenance staff is necessary



Traction motors of trolleybuses Comparison



TRACTIVE EFFORT CURVE
COMPARISON DC DRIVE / AC DRIVE



Traction motors of trolleybuses Comparison



Characteristics of the development and transition from DC to AC traction motors

- Solution of the mechanical commutator problem



- Simplified construction of voltage inverters



- Minimization of dimensions and maintenance costs



- Reduction of power losses



The most advanced driving unit for trolleybuses

Traction equipment of trolleybuses

Comparison



Characteristics of the development and transition from choppers to voltage inverters

- Start of new switching elements
- ↓
- Simplified construction of voltage inverters
- ↓
- Solution of the microprocessor regulation problem
- ↓
- Reliable and simple solution



The most advanced traction equipment for trolleybuses

Comparison between chopper and voltage inverter

Purchase price of the voltage inverter

- Higher ca by 10 %
 - Applicable for new vehicle
 - Not applicable for trolleybus refurbishment → new AC traction motor has to be bought
-
- **Electricity savings**
 - Voltage inverter comparable with the chopper



Comparison between chopper and voltage inverter



- **Running qualities**
 - Better utilization of power output in higher speeds
- **Maintenance costs**
 - Lower by voltage inverter
- **Commercial/political influences**
 - Possibility of supplies without components, e.g. DC traction motor of domestic production



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Thank you for your attention