

Traction force control and slip control (1)

- Desired tractive effort is obtained independent of
 - Speed changes
 - Load
 - Disturbances
- Dynamic system – output depends on both the input and the state of the system
- Mix of servo system and control system
- Disturbances
 - Varying line voltage
 - Poor current collection
 - Insufficient adhesion
 - Varying running resistance

Factors that influence friction in addition to the slip speed

- Weather conditions
- Contamination on the rails (dirt, ice, rust, oil, leaves)
- Vehicle speed
- Condition of tread and track

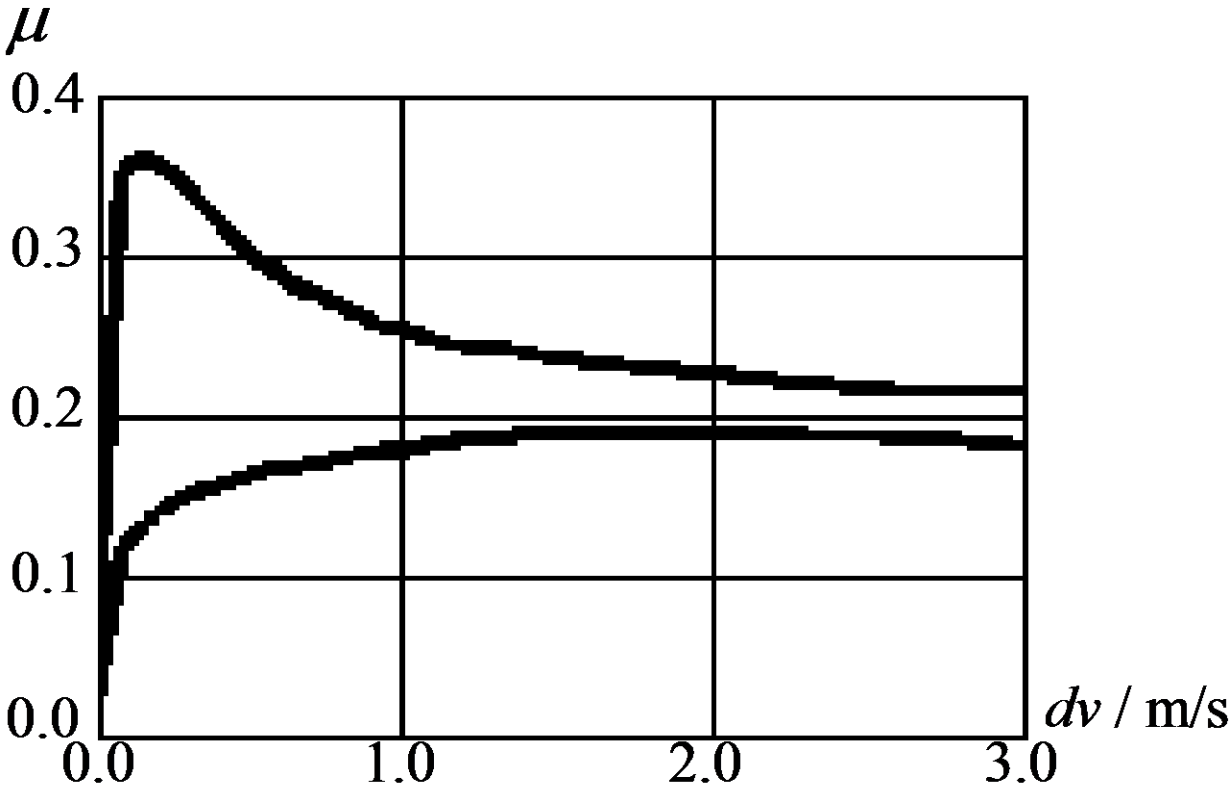
Traction force control and slip control (2)

- The system contains of two parts
 - Necessary conditions (line voltage, cooling, control voltage etc.)
 - Dynamic control
- Two important characteristics of the system is
 - Accuracy (in measurements)
 - Speed
 - Rise time (depends on the amplitude of the control signal)
 - Settling time
- Converter band width

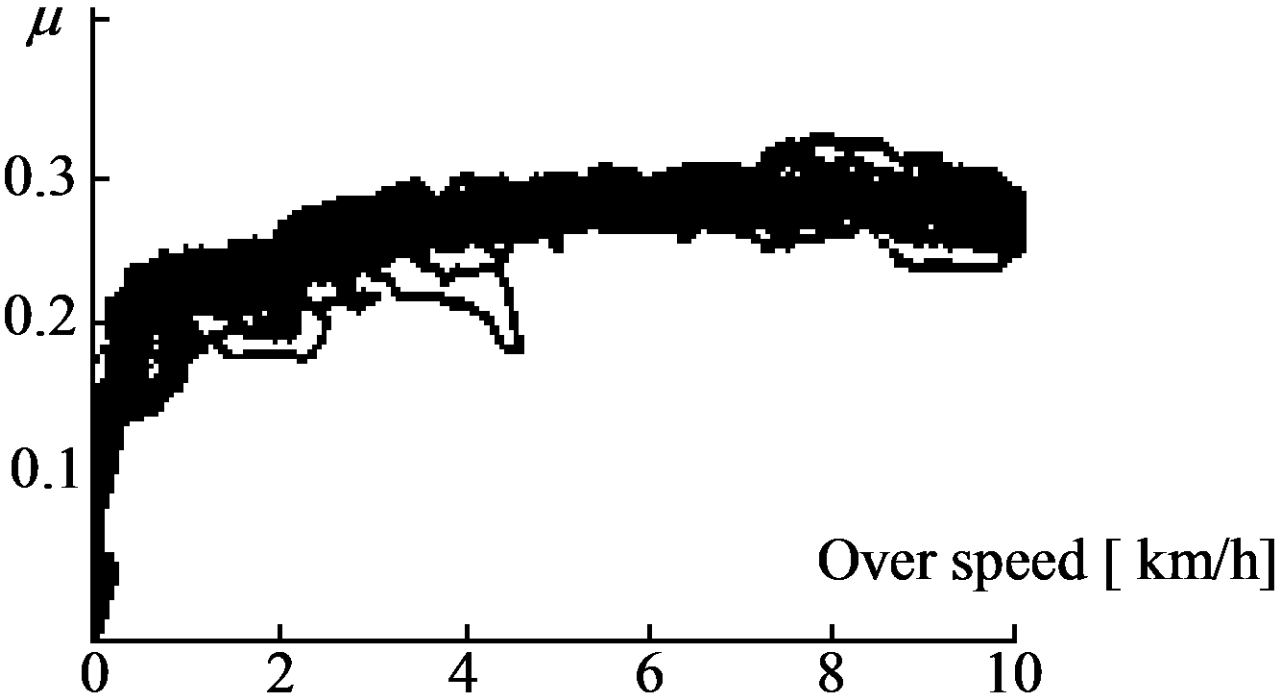
Traction force control and slip control (3)

- The tractive effort has to be adapted to the adhesion to avoid sliding
- Measuring the peripheral speed of the wheels
 - Varying wheel radius
- Measuring of the slip speed requires estimation of the true speed of the train
 - Difficult with locomotives

Adhesion curve



Example of a measured adhesion curve



Measurement of slip speed

- A measuring wheel or other undriven wheel on the train that does not slip
- Estimation of true speed based on train weight, tractive force and expected acceleration
- Reduction of tractive force on one of the axles to ensure that it does not slip
- Contact-free measurement, e.g. using Doppler radar and correlation measurement.
- GPS

Track force control and slip speed control

