Das virtuelle Walzwerk – Weg zum Cyber-Physical System

Dr. Maksim Klinkov
(1) Achenbach Buschhütten – a family company

(2) Rolling mill - challenges in optimization

(3) Cyber mill - architecture

(4) HiL possibilities - R&D and problem solution tool
Aachenbach is one of the oldest family companies in Germany.

Today Achenbach is a system supplier for non-ferrous rolling mills and foil slitting machines:
Objective:
- Stable processes
- Short commissioning time

Challenges:
- Machine complexity
  mechanical
  electrical
  hydraulic/pneumatic aggregates
  and measurement components
Objective:
- 7/24 availability
- highest quality by fast production

Challenges:
- Highly dynamic process (fast speed 2500 m/min, huge masses 32t coils)
- Minimum failure tolerances - high costs (scrap material, outage)
Cyber mill architecture (1)

- Data records
- Process Data Acquisition (PDA)
- Model
- VIS
- PDA
- Rolled Coils Data
- Mill Model
- Database of Virtual Coils
- Mill Model Task
- Mill Controllers

MathWorks Simulink & M-Target
Cyber mill architecture (2)
HiL possibilities - R&D and problem solution tool

R&D
- New controllers design and test
- Generation of virtual data
- Better understanding of rolling physics
- Faster commissioning
- Failure probability reduction

Troubleshooting and Learning tool
- Modeling and replaying of new situations
- Validation of detected problems
- Scrap free practice for mill Operators
- Maintenance personal
Thank you for your kind attention – Keep On Rolling!

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Process data acquisition

Entry Thickness (time)

Entry Thickness (length)
Mill HMI and coils handling DB

The Virtual Rolling Mill

Database of Virtual Coils
Mill model - time varying model (1)
Mill model - time varying model (2)

Internal model

1. Xuncoiler
   - Hen_upstream
     - Vcoil
     - Tens_up_str
   - UncMTorque
     - Unit: N.m
     - Xentry_strip
2. Inter threaded element Strip
   - Ventry
   - Tens_down_str
   - Hen_down_str
3. Xstand
   - GapSetting
     - Unit: mm
   - RollSpeed
     - Unit: m/s
4. Inter threaded element Strip
   - RecMTorque
     - Unit: N.m
   - Xexit_strip
5. Xrecoil
Controller models constructed based on:
- physical principles (mill stand, actuators and sensors dynamics)
- heuristic principles (speed effect – disturbance model)

Regulator algorithm computes a sequence of future actions (MV’s):
- to minimize an "objective" function (Gauge error)
- to respect the constraints (actuators)
Mill controllers

THE VIRTUAL ROLLING MILL