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The assessment and control of the flowability of Self-Compacting Concrete

A research project and its first results

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Wolfgang Kusterle

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Introduction of Self-Compacting Concrete

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Definitions

- No additional compacting
- Self-deaeration
- Proper embedment of reinforcement
- Self-levelling

Introduction of Self-Compacting Concrete

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Benefits

- No vibrator required
- Placement of complicated formwork
- No noise and vibration
- Better surface appearance

Benefits

- Time saving
- Reduction of costs
- Better durability
- Reduction of execution errors
- Application in the rehabilitation of structures

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Current Situation

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The request

Named benefits

+ simple production
+ cheap production
+ use of common materials
+ use of common batching and mixing equipment and testing procedures

Current Situation

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Problems during production

- Dosing accuracy at the concrete plant
- Moisture content of (fine) aggregate
- Changing properties of constitutive materials

  (grading curve, super plasticizer, chemical properties etc.)

➢ deviation of fresh concrete properties

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Aim of the project

- Automatic detection of fresh concrete properties at the concrete plant
- Online data processing
- Automatic correction at the plant to achieve the required flowability

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Partners

Schleibinger Geräte

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

ROHRDORFER ZEMENT

RUHR-UNIVERSITÄT BOCHUM

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Rheological properties of SCC

- Correlation of different measurement instruments
- Development and evaluation of new measurement instruments

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Readjustment of SCC

- Starting point: stiff mixture
  - Reduced water and superplasticizer at the beginning
  - Subsequent adding of water and / or superplasticizer
- Starting point: mixture with a too high slump flow
  - Higher water content at the beginning
  - Subsequent adding of sand

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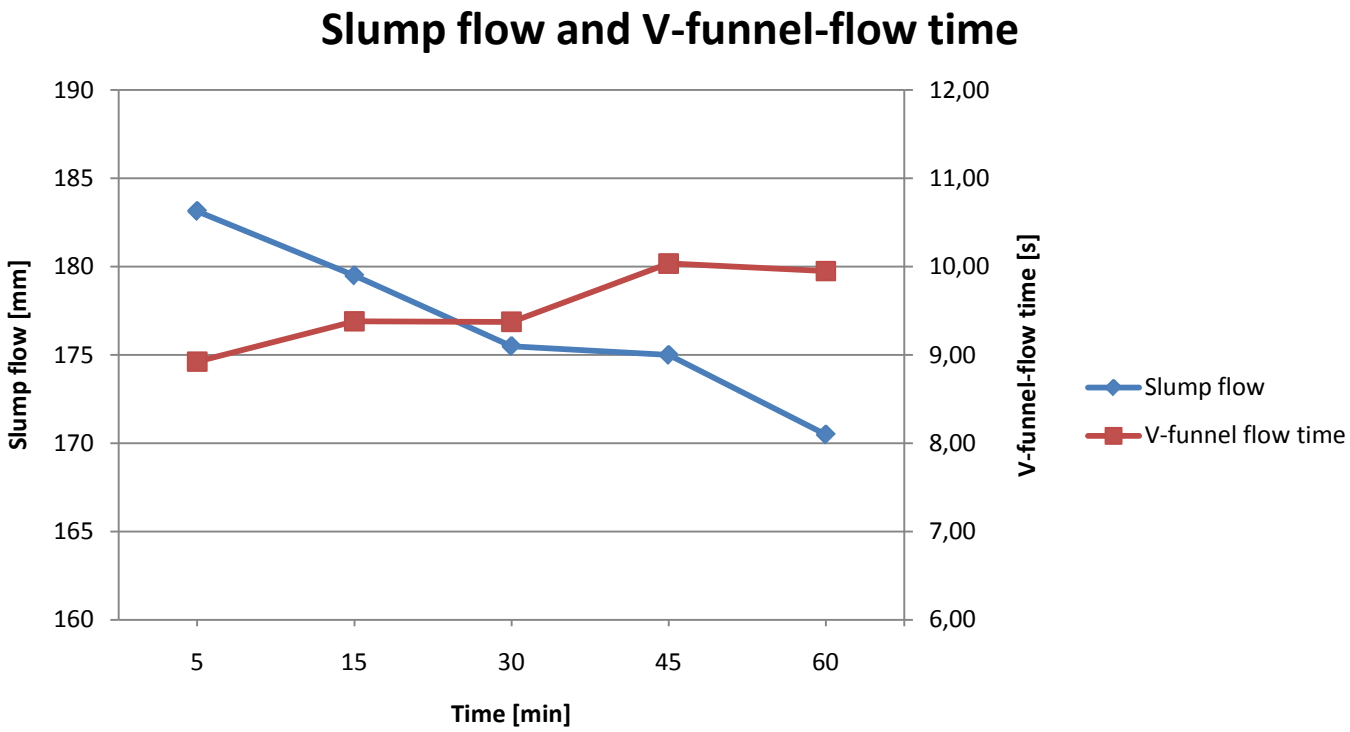
Interpretation of shear rate profiles

- Different shear rate profiles
  - Measurement profiles
  - Way of mixing
- Consequence for rheological properties

First Results

Reference mixture

- CEMII/A-S 42,5R, fly ash, Sand 0/2, w/p = 0,87; SP (PCE)



First Results

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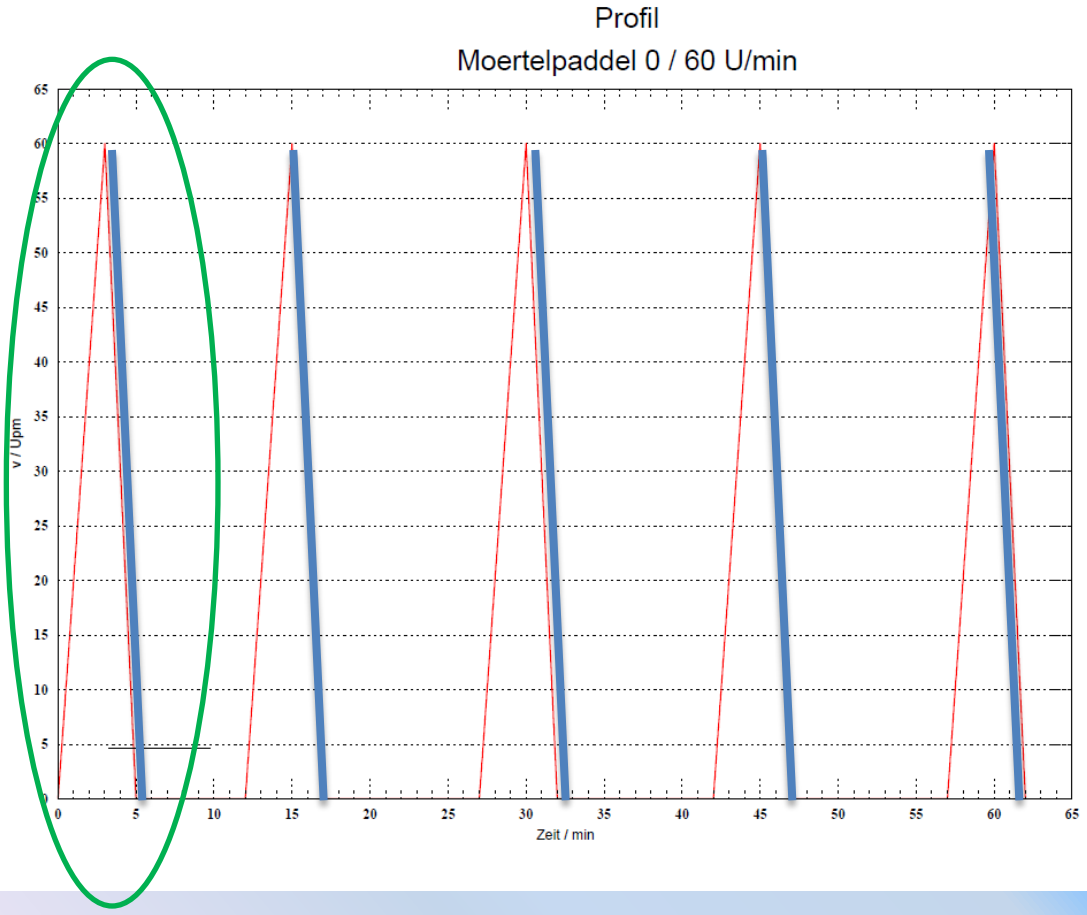
Shear rate profile v = 60 rpm



First Results

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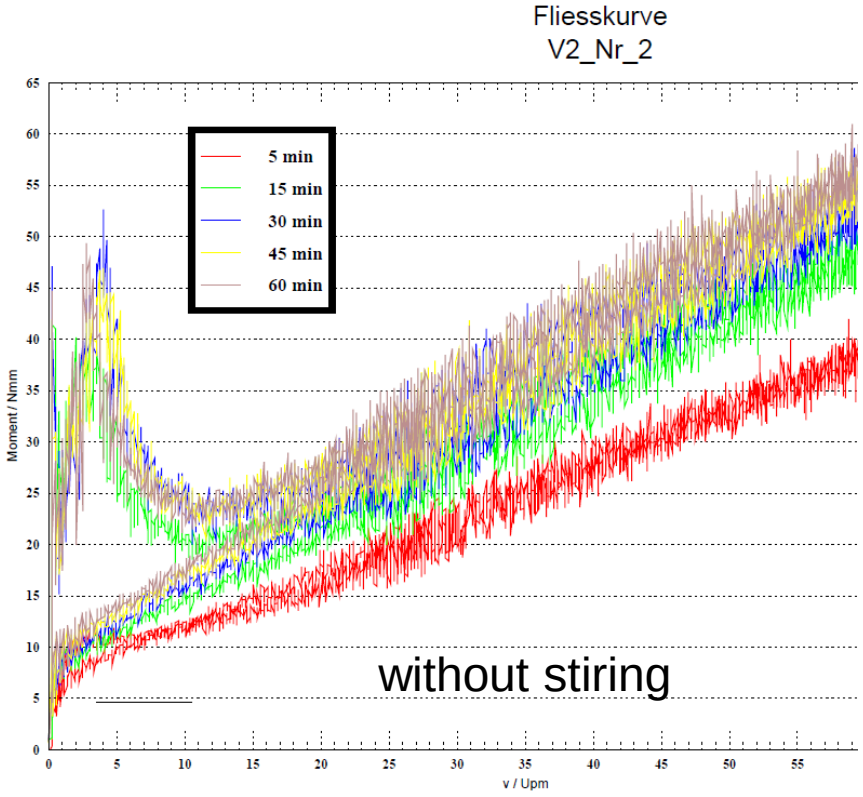
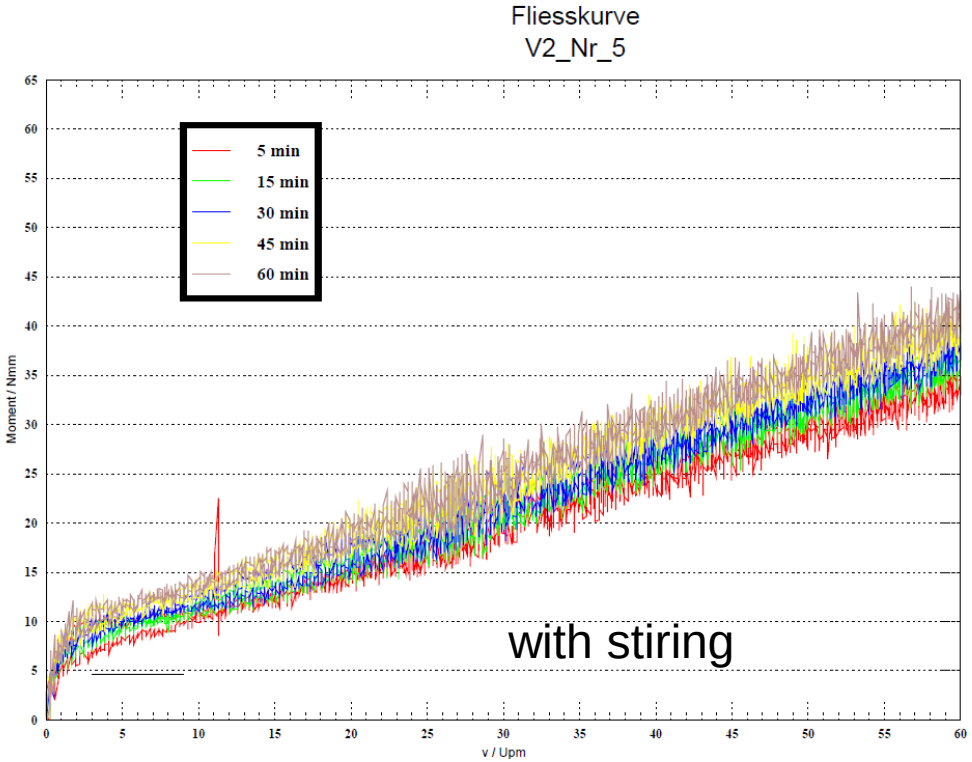
Flow curves





First Results

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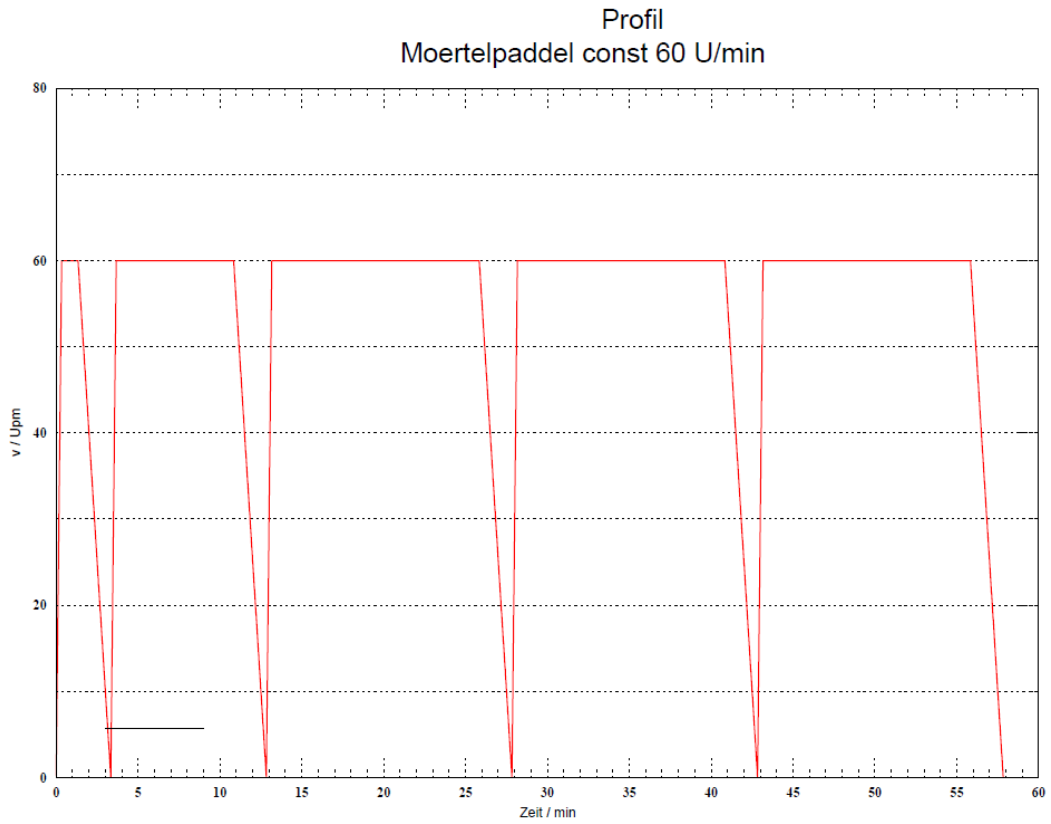
Shear rate profiles v = 60 rpm



First Results

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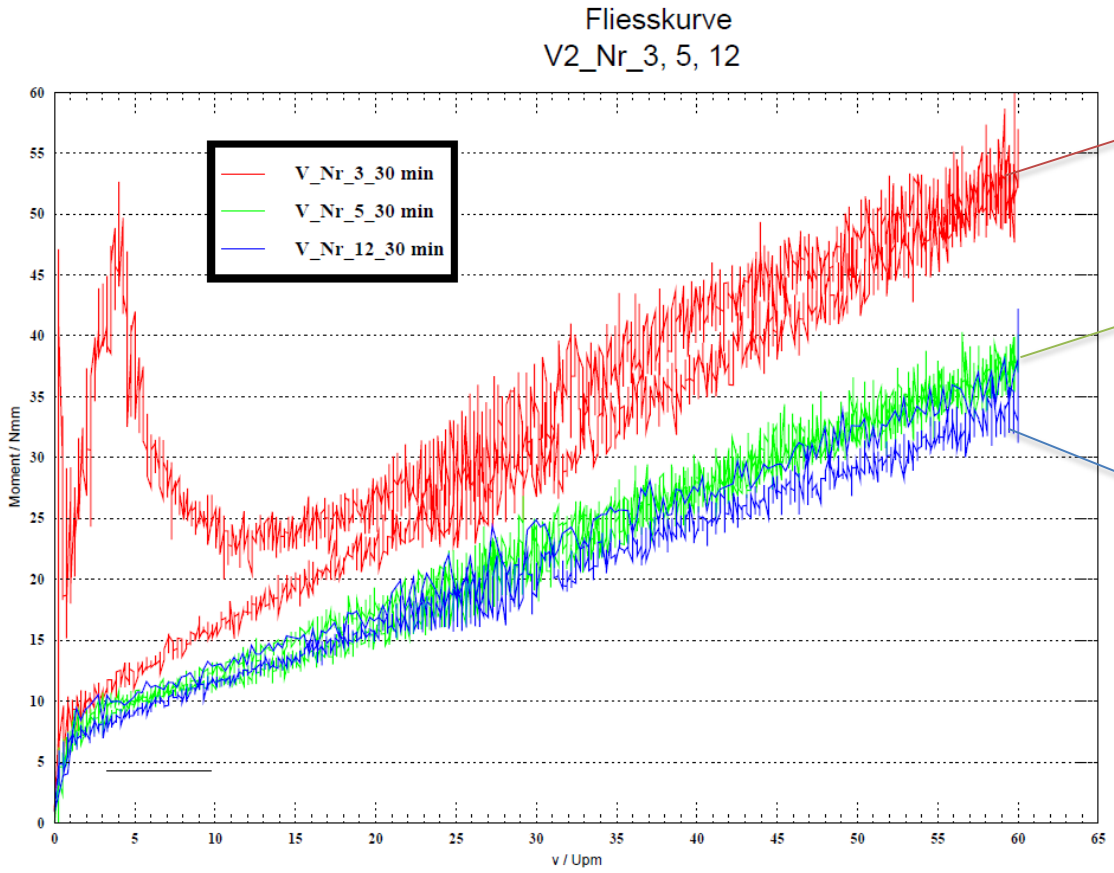
Flow curves



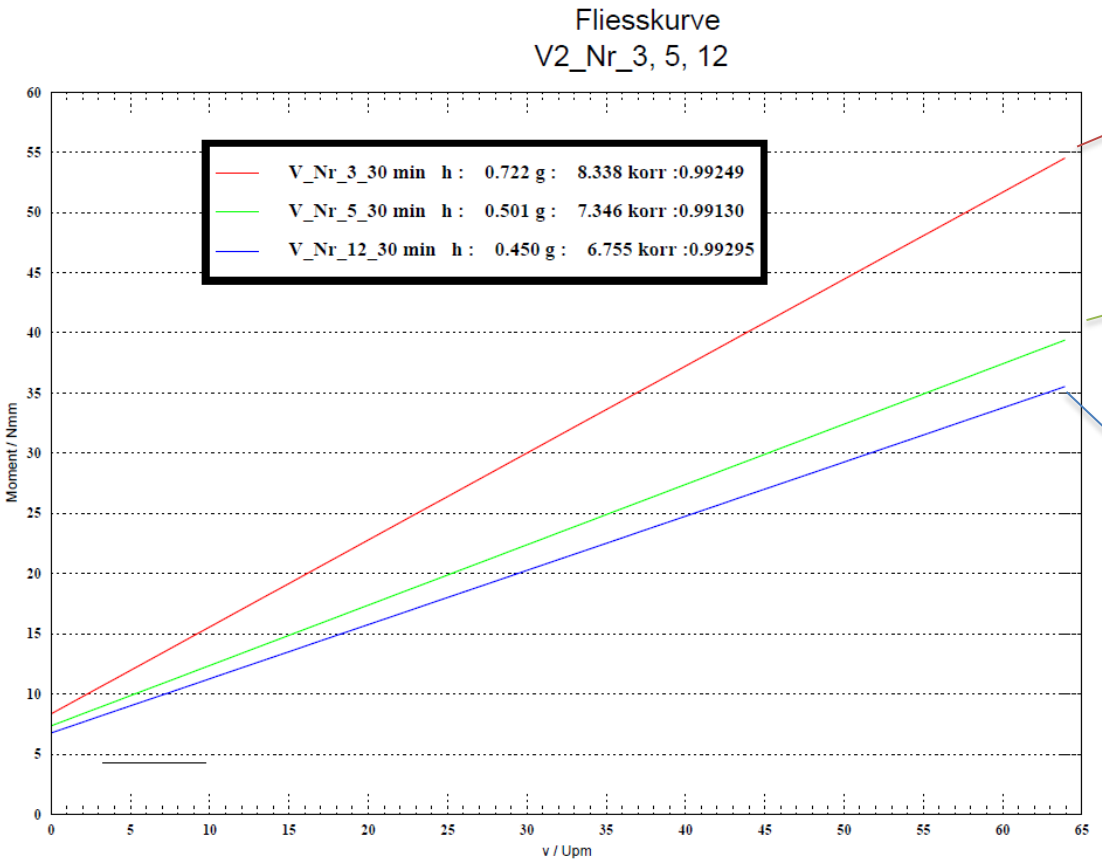
without stiring

with stiring

const. 60 rpm

First Results

Flow curves



without stiring

with stiring

const. 60 rpm

First Results

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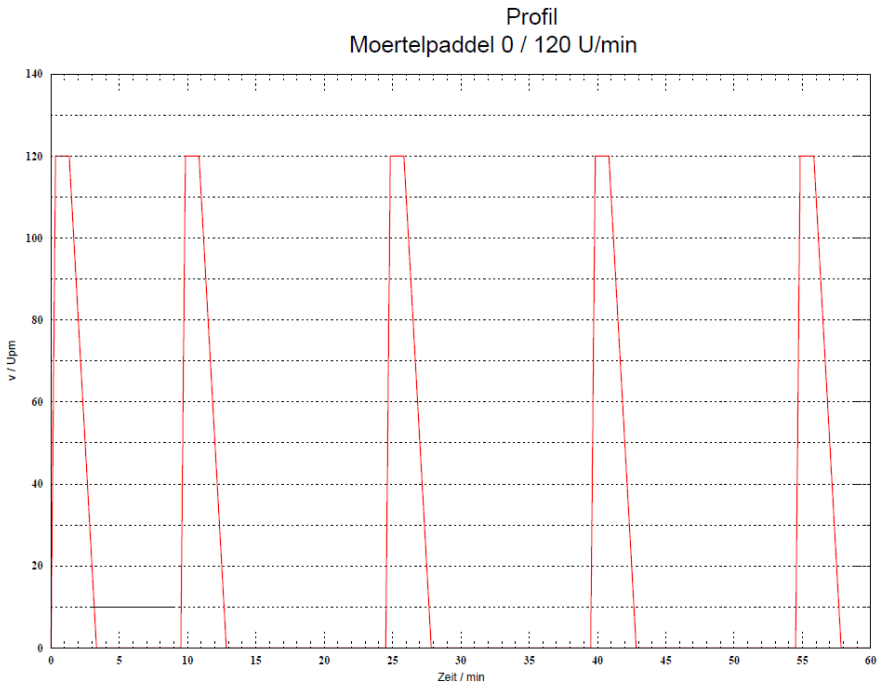
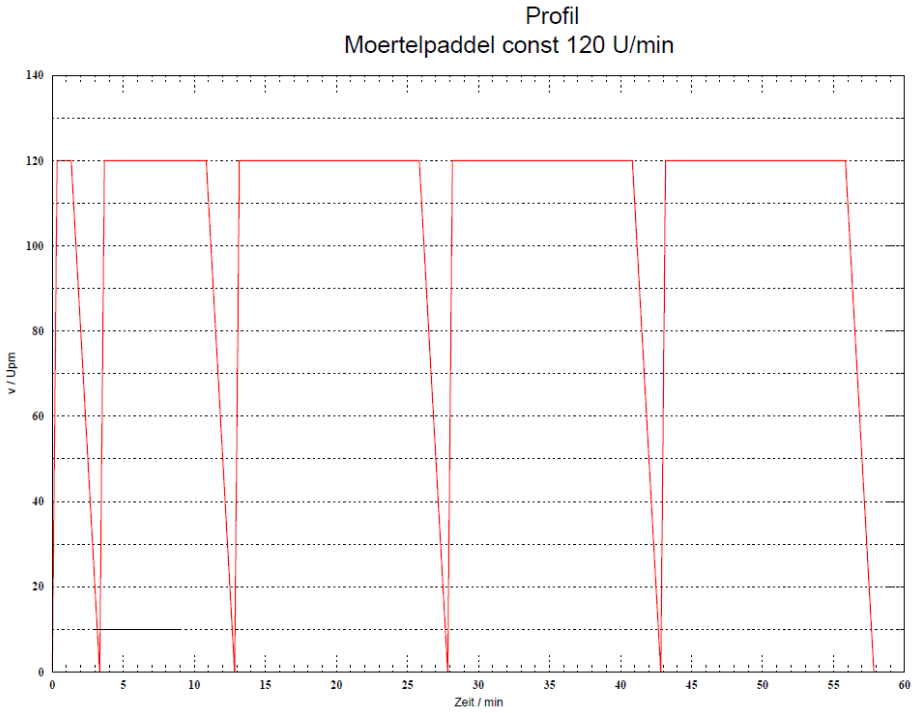
Shear rate profiles v = 120 rpm





First Results

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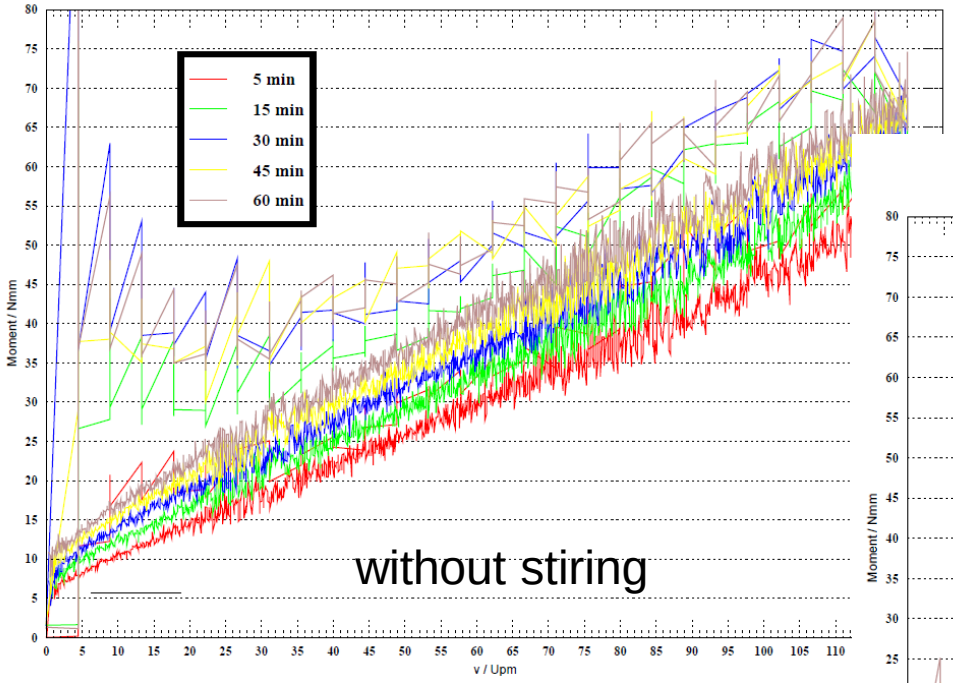
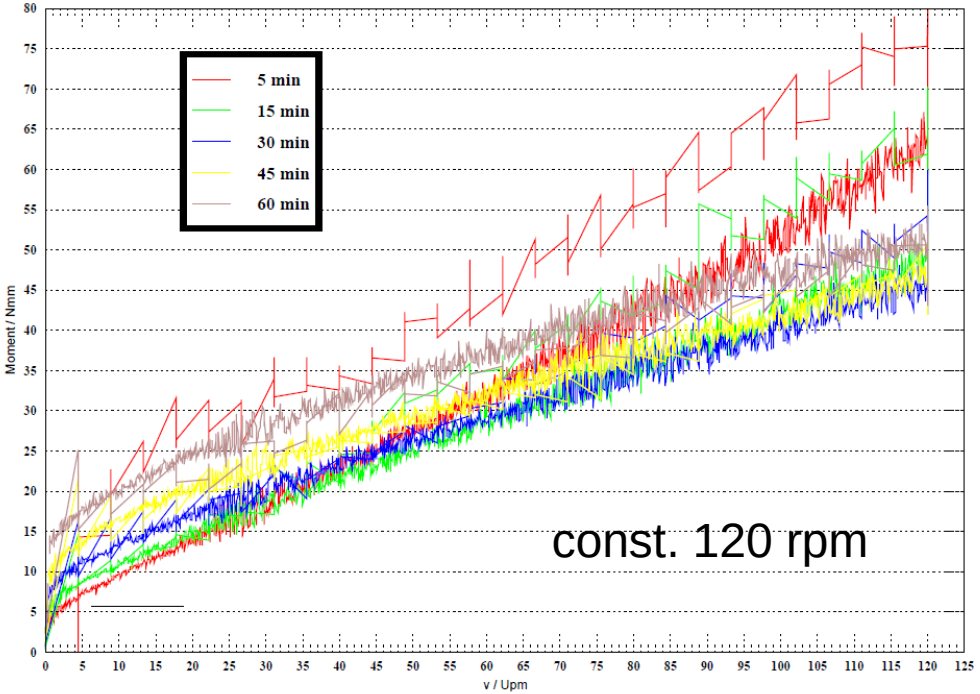
Flow Curves

Fliesskurve
V2_Nr_2



Fliesskurve
V2_Nr_11



*Note: insufficient measurement points and a low resolution at the ascending curve

First Results

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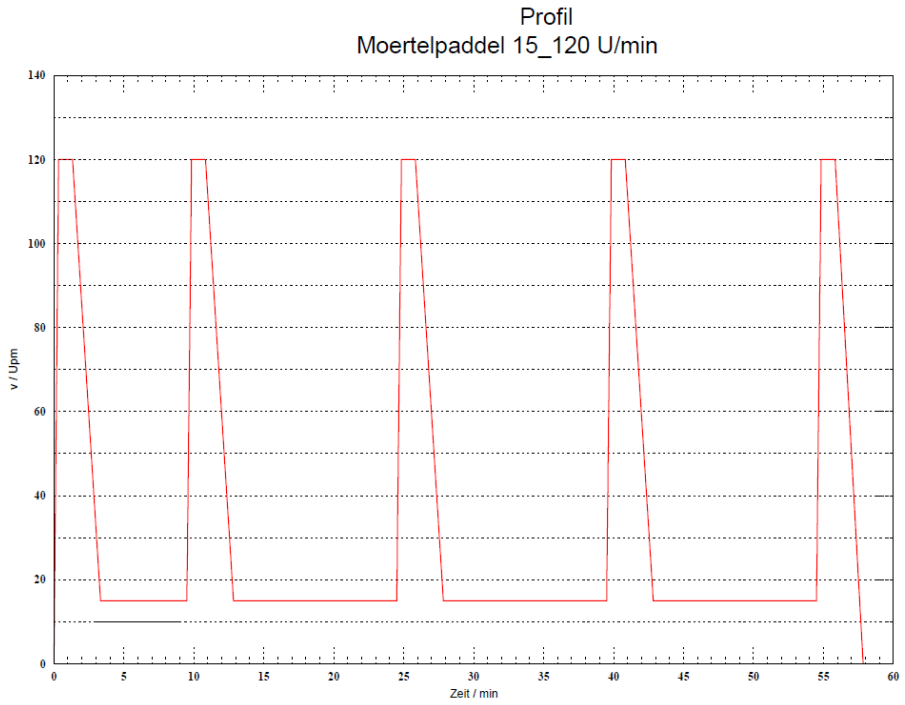
Shear rate profiles v = 120 rpm



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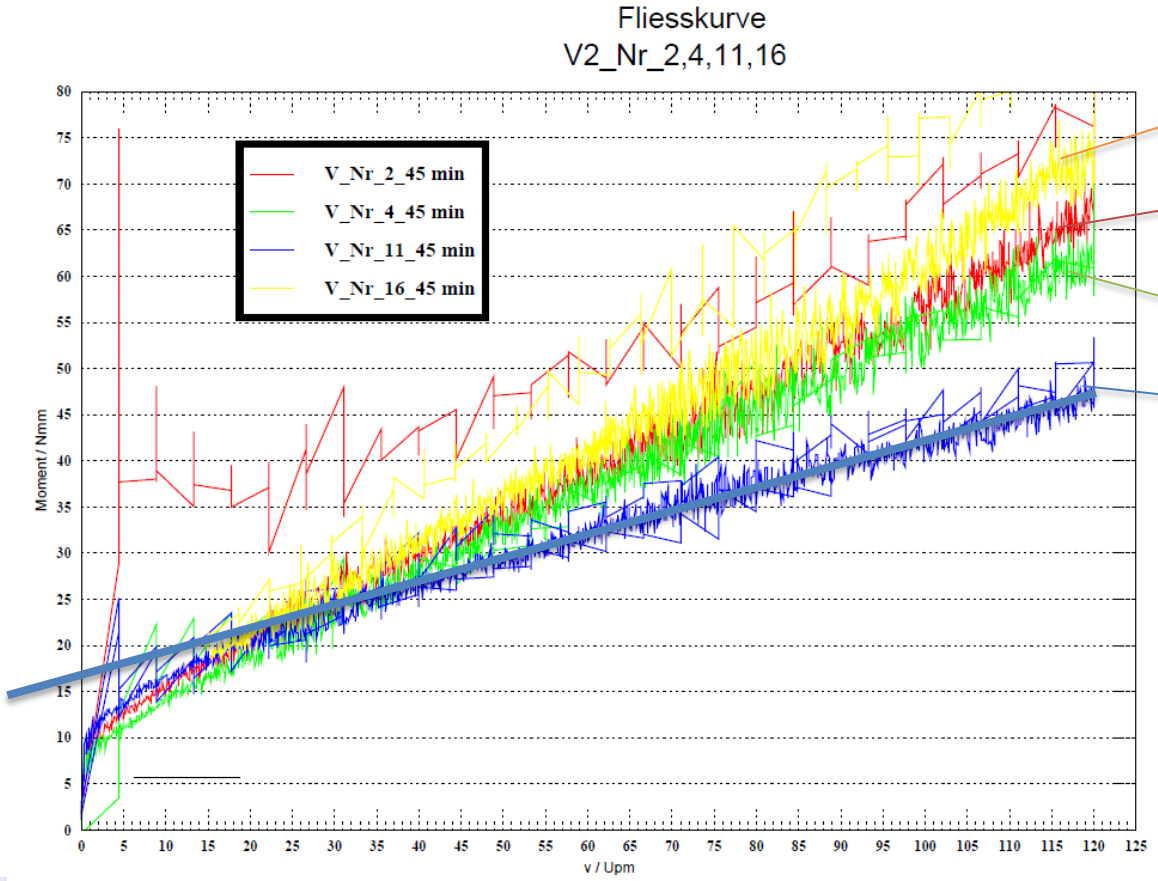
Flow curves



const. 15 rpm

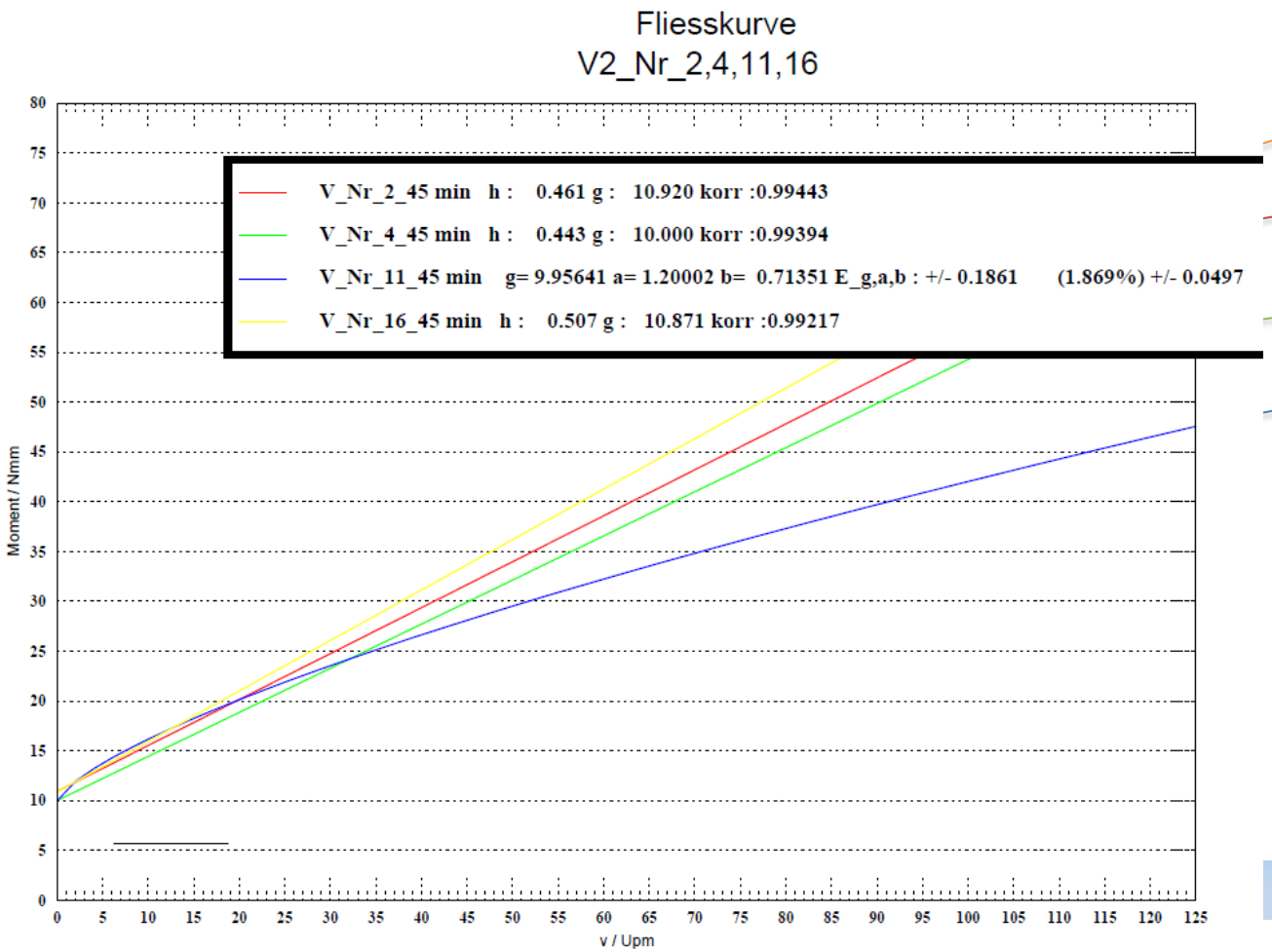
without stiring

with stiring

const. 120 rpm

First Results

Flow curves



const. 15 rpm

without stiring

with stiring

const. 120 rpm

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Conclusion

- Different flow curves despite of constant reference mixture and same measurement system
- Viscosity depends on shear rate profile
- Yield stress depends marginally on shear rate profile
- Shear rate profile has to be known to evaluate the flow curve

First Results

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Conclusion

- Thixotropy increases significantly after every mixing break
- Constant high shear rates lead to shear-thinning behaviour
- „Bingham“ model for determination of the yield stress not always applicable

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Thank you for your attention