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Information on the model of the polymer calendering process

1. Calendering

Calendering is a process in the plastics and rubber industries in which materials—specifically plastics or rubber—are processed into thin layers or films using rollers. This process is primarily used to manufacture flat products such as foils, sheets, and webs (KI).

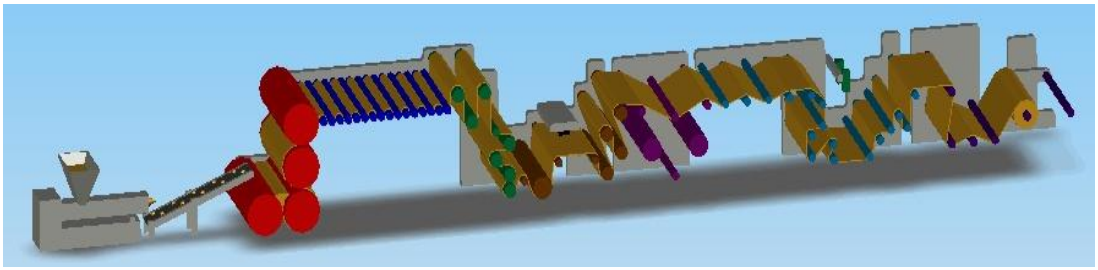

Figure 1: Typical film calendering line with a 4-roll L-type calender

For various applications in the packaging, construction, or technical film industries, 3- to 5-roll calenders are available in I, Z, F, or L configurations.
The process is highly versatile and complex to control:

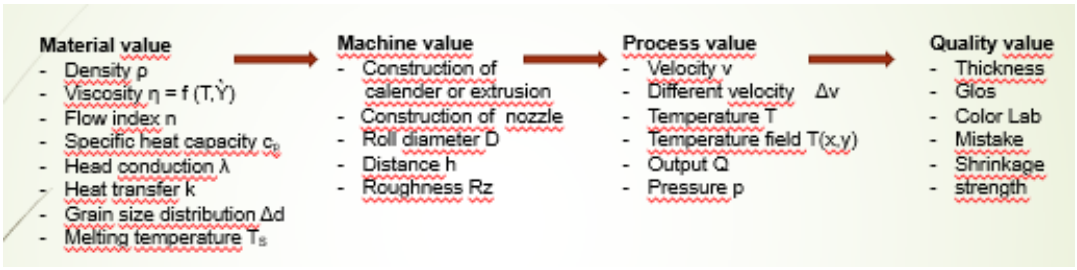

Figure 2: Influencing factors and objectives of a calender line

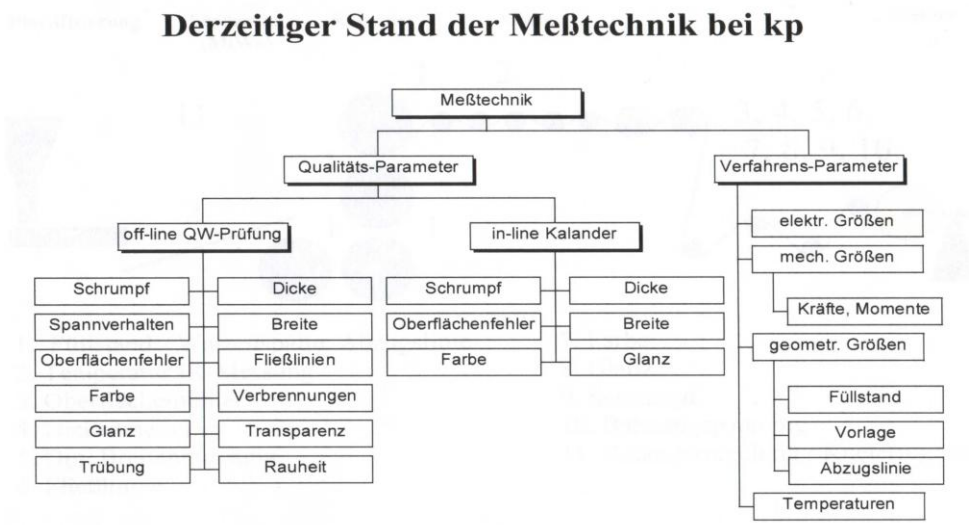

Figure 3: Measurement capabilities

The process can be continuously monitored using various measurement techniques.

2. Modeling of the calendering process

Using the mass balance, momentum equation, heat balance, and rheological equation of state, it is possible to predict flow lines, pressure profiles, and throughputs, as well as to determine expected average film thicknesses, shrinkage forces, roll contact forces, and optimal settings for roll bending and roll tilting.

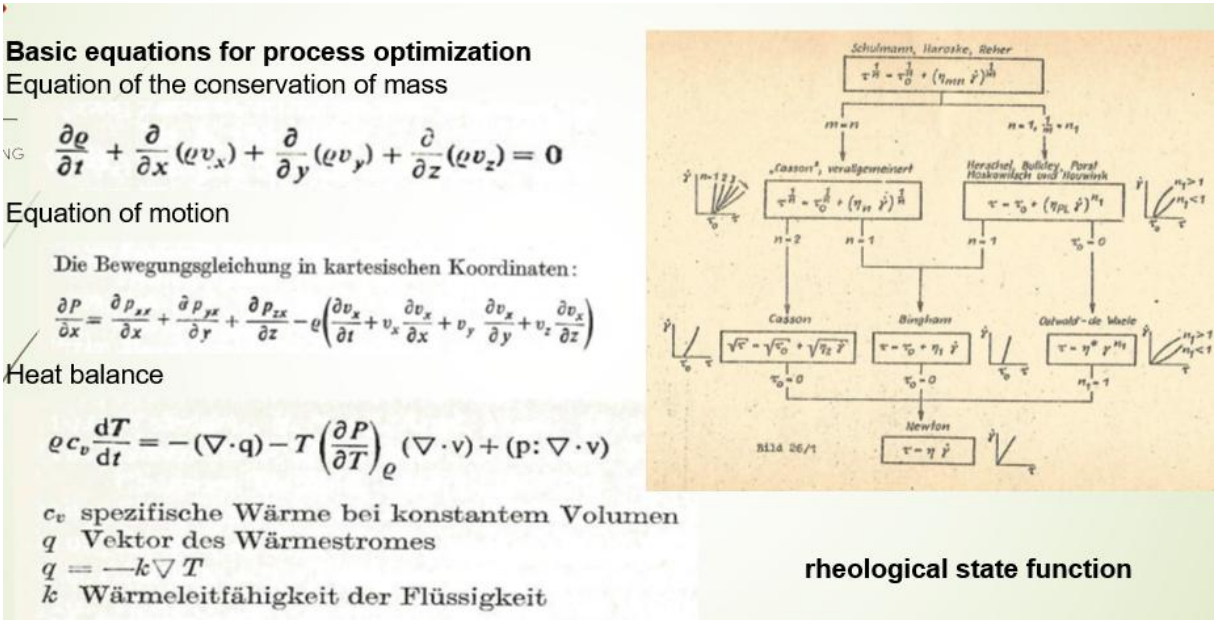

Figure 4: Fundamental equations for calculating polymer processes

This is particularly important for process optimization and the training of new calender operators without using production calender lines.

3. Use of VR goggles to optimize calendering technology

Over the past decade, the author has developed a model in collaboration with St. Petersburg Technical University—drawing on master's theses and dissertations in the field of information technology—to calculate flow processes within the roll gaps of calendering systems. By first determining boundary conditions, roll surface slip characteristics, the rheological state functions of polymer blends, and heat transfer properties, the model allows for the advance calculation of film characteristics critical to the operator, such as:

- Average calendered film thickness
- Width of the film as it passes over individual rolls
- Expected throughput
- Minimum thickness tolerance achieved through the optimization of roll bending and roll crossing
- Expected film shrinkage in the longitudinal and transverse directions

This enables process engineers to optimize quality and changeover times, and allows newly training operators to undergo training without using active calendering lines.

The model can be used directly on a laptop or applied via VR goggles, displaying images of the calender line in use to simulate the perspective of standing right there in the production process.

Figure 5: VR headset for visualizing the calendering process model

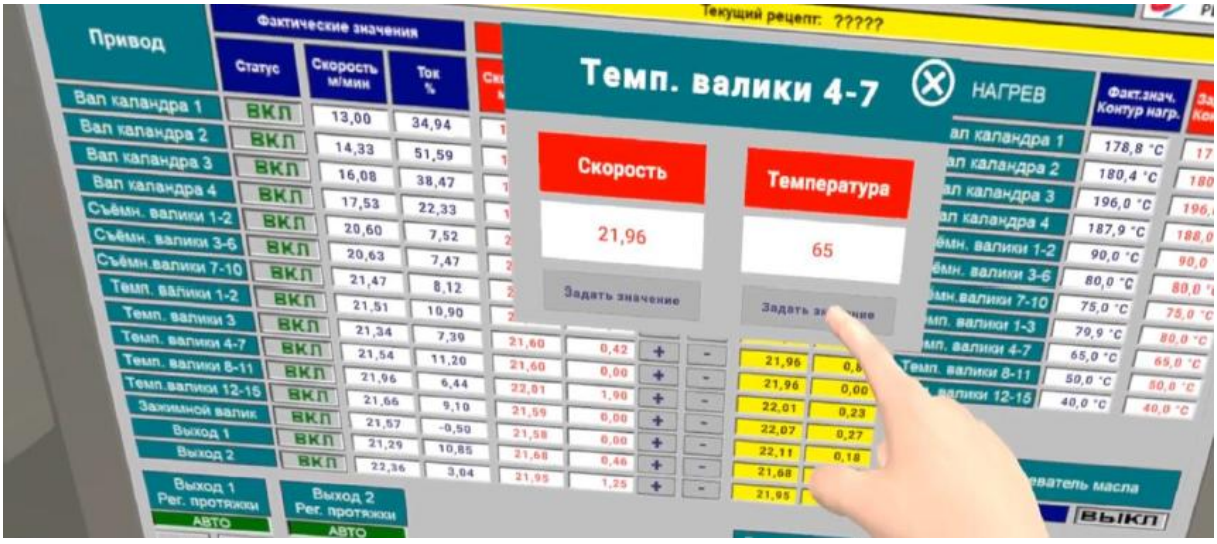

Figure 6: Data entry via VR headset at the K2 from kpRus

Figure 7: Representation of thickness distribution before and after changing process parameters (Task: Switch from 240 µm to 300 µm)

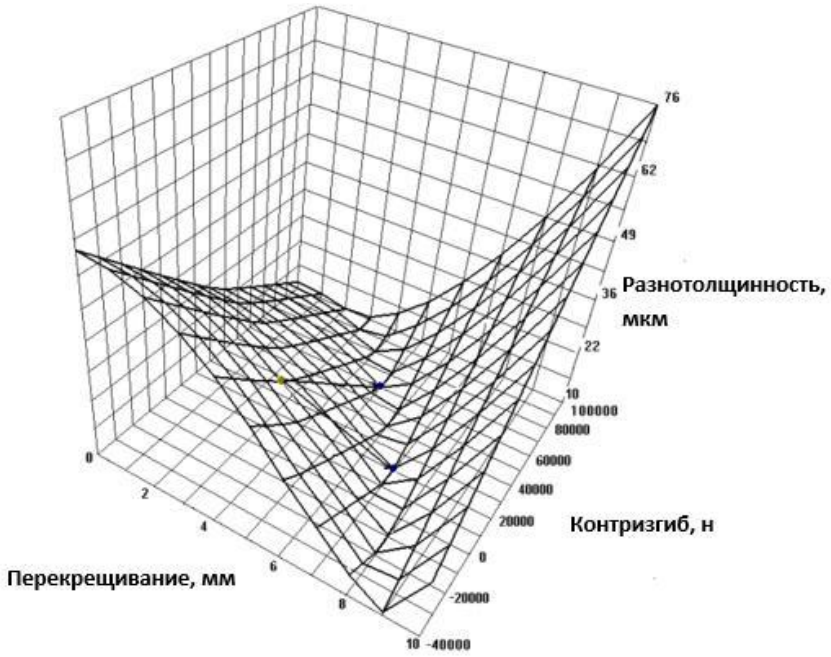

Figure 8: Optimization of roll bending and tilt adjustment for minimal thickness tolerance

Literature:

1. C.Kohlert, T.Chistyakova; Innovationen in der Folienindustrie Kindle-Verlag, 2024, ISBN:978-3-00-077262-7
2. C.Kohlert, T.Chistyakova: Innovations in Film Manufacture, Hanser-Verlag,2026, ISBN:978-1-56990-440-4

Those interested in further information or a practical demonstration, please open the link wwith: strg + https://1drv.ms/v/c/f3949eacedbf4b91/IQDlTc6jYbTHRZ1-do8i0EteAf6PjpagUsxSmCmp6KiFN2M?e=ezynU3

or contact us: **Info@kohlert-consulting.de**