Sean Kohl

Director of Global Sales

TMI

Testing Machines, Inc.

UNITED TESTING SYSTEMS

United Testing Systems

25 - 27 September · Chicago
LABELEXPO
AMERICAS 2018
www.labelexpo-americas.com

In-House Testing of Inks for On-Press and End-Use Performance

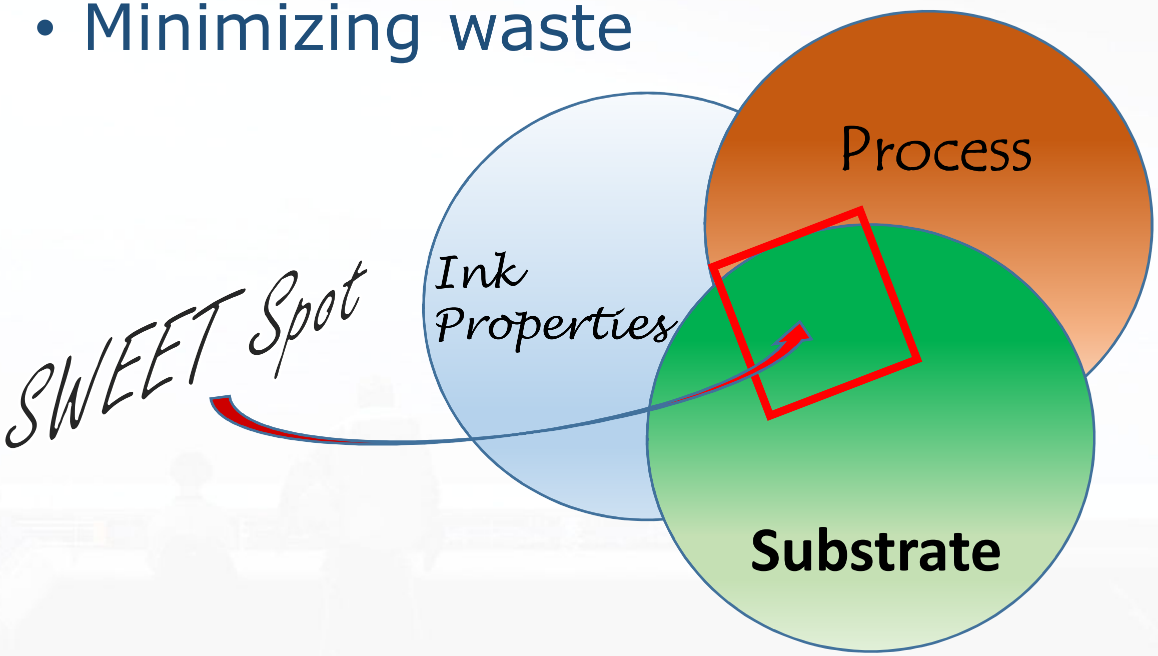
Quality Assurance = …

- Continuous assessment of 'ingredients', processes and final product across the arc of the manufacturing process
  - Confirm ingredients are 'to spec' = suitable to process and environment
  - Confirm process is being run 'to spec' = suitable for selected raw materials and environment
  - Detect defects and correct – ideally in pre-production - or before excessive off-specification product is manufactured
    - **<u>Product is 'in spec'</u>**

In-House Testing of Inks for On-Press and End-Use Performance

Offline (Lab) Quality Assurance

- Problems should be solved off press – anticipated in pre-press
  - Minimizing press down time
  - Minimizing waste



In-House Testing of Inks for On-Press and End-Use Performance

Offline (Lab) Quality Assurance

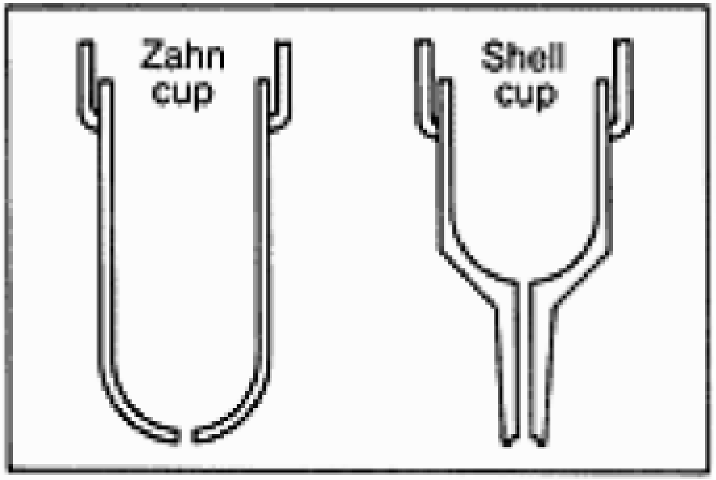
- Measurement techniques should be…
  - Easy to perform, easy to replicate, operator independent
  - Measure…
    - Ink and substrate properties
    - Simulation of the print process
    - Simulation of end-use performance
    - Produce data that lends itself into SQC process and program of continuous improvement.

In-House Testing of Inks for On-Press and End-Use Performance

- What measurements?
  - Ink
    - *Viscosity*
  - Substrate/Ink
    - *Contact Angle / Surface Energy*
    - *Coefficient of Friction*
  - Process = "Color and Quality"
    - *Print Proofing*
  - End-Use
    - *Rub /Abrasion*
    - *Coefficient of Friction*

Viscosity Testing

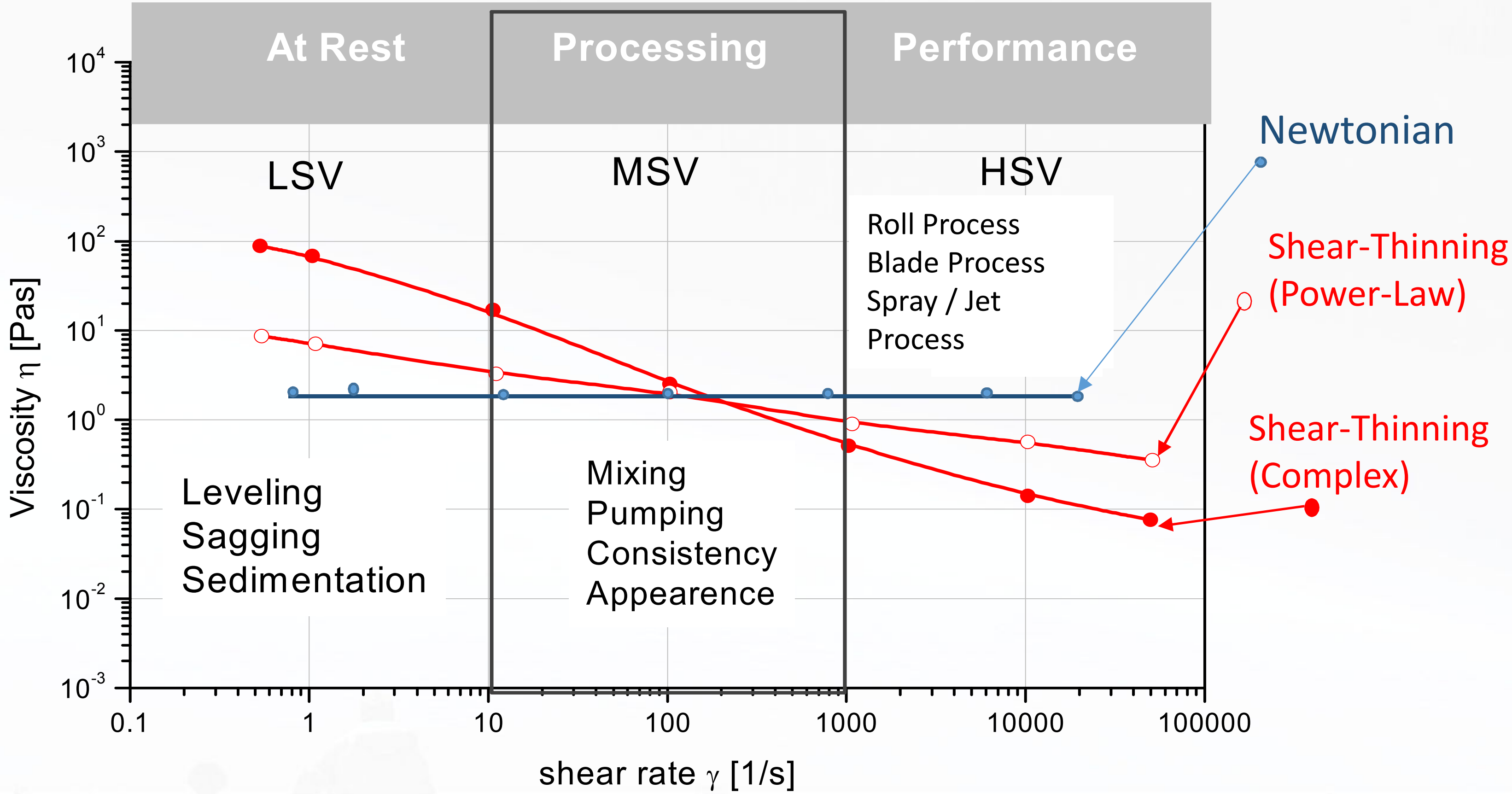
- **Classic Ink Viscosity: Efflux Cups: Zahn, Shell, Ford**
  - **Pro's:** Simple … Robust … Low Cost



- Immerse cup in ink and prepare timer
- Remove cup from ink while starting timer and observe ink stream from the cup exit and record time at which a break in the ink stream is observed
- Stress applied = gravity
- Shear rate is not controlled

- **Cons:**
  - Operator dependent
  - Provide only relative viscosity – not absolute
  - Provide viscosity at only a single shear stress/rate –far lower than process relevant rate

Viscosity Testing: Meet the Flow Curve



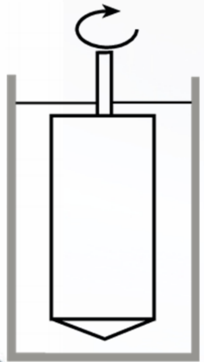
- Efflux cup "measures" only one data point on this curve and these are low shear viscosity (LSV) to medium viscosity (MSV) data

25 - 27 September · Chicago
LABELEXPO AMERICAS 2018
www.labelexpo-americas.com

Viscosity Testing

$$\eta = \frac{\tau}{\dot{\gamma}}$$

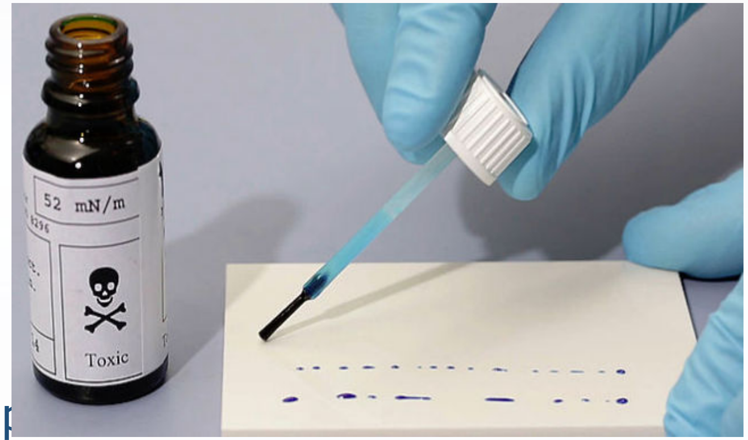
- Controlled Rate 'Spindle' Viscometer
  - Pros:
    - Moderate cost and robustness
    - Easy to use and relatively operator independent
    - Provides absolute viscosity and ability to generate 'flow curve'
    - Accommodates temperature control
    - Accommodates time-based measurement
  - Cons
    - Require routine maintenance and calibration
    - Higher level of training for lab techs



Contact Angle / Surface Energy

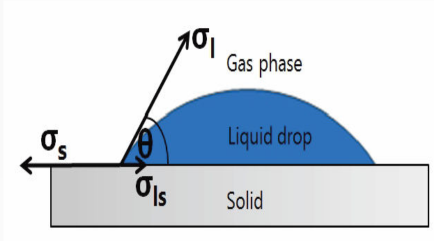
- Untreated plastics and other hydrophobic substrates have low polarity and low surface free energy (SFE)
  - Poor wetting and poor surface adhesion
  - Surface treatment required (plasma/corona/flame/etc)

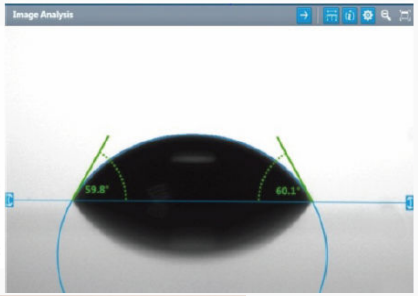
- Classic Surface Energy Testing
  - Dyne Pens / Test Inks
    - Pro’s
      - Simple to perform
      - Low cost
    - Con’s
      - Operator dependent
      - Relative measurement
      - Lack of discrimination – p
      - Inks are toxic and unstable
      - Fundamentally incorrect assumption about SFE correlation: SFE ≠ SFT at full wetting

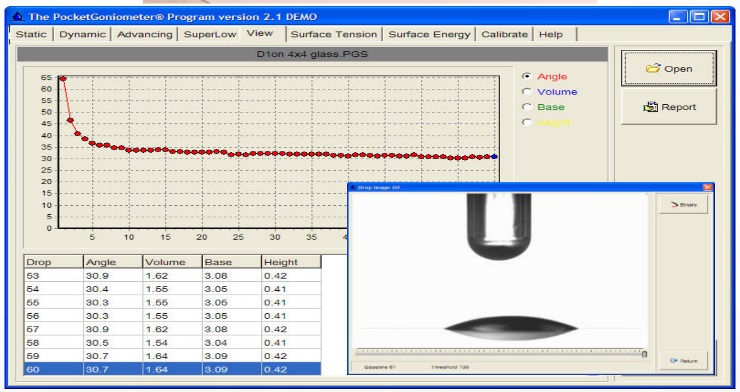


Contact Angle / Surface Energy

- Contact Angle / Surface Energy
  - Pro's:
    - Absolute, quantitative measurement of surface energy
    - High resolution between surfaces
    - Easy to use and operator independent
  - Con's
    - High comparative cost of acquisition (however, no consumables cost)







Laboratory Print Proofing

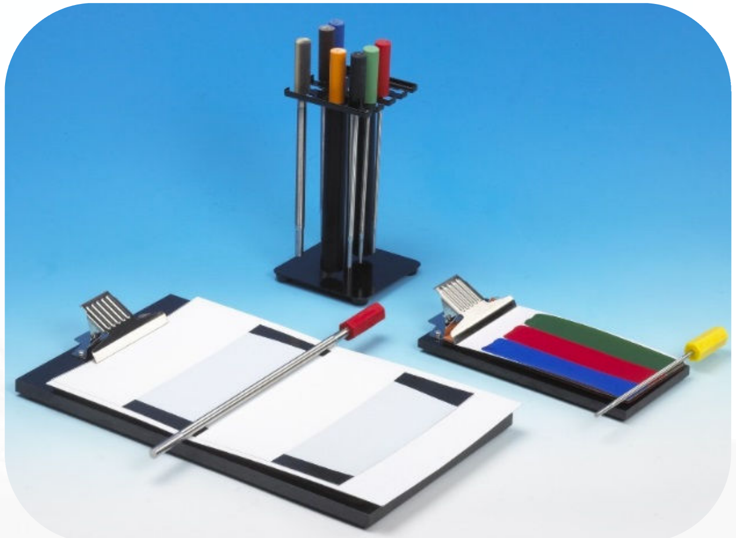
Print Proofing = Reverse Engineering

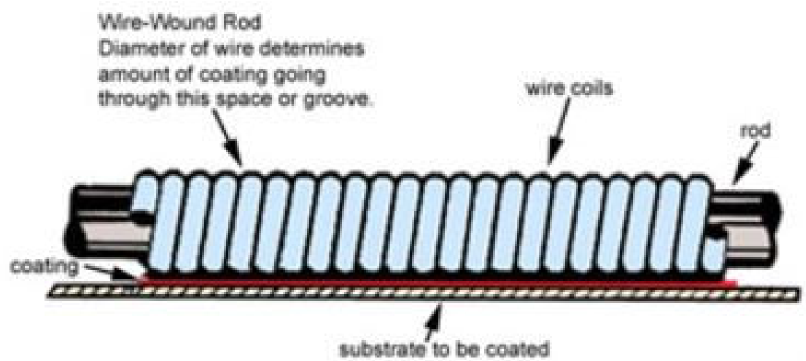
- Generation of a ink/substrate sample that is close to the product of a production process
  - Utilizes production ink and substrate
  - ‘Proof’ is run pre-production on laboratory scale proofing device that simulates the critical elements of the production
  - Evaluation of proof allows pre-press adjustments
    - Color /Density / Visual Quality
    - Coefficient of Friction
    - Rub/Abrasion
    - Development ‘benchmark’ proofs for evaluation of final product.

Laboratory Print Proofing

Basic / Manual Draw-down / Meyer Bar Systems

- Pro's:
  - Easy to use, robust and low cost
  - Precision of wire/winding – excellent reproducibility
- Con's:
  - Operator dependent – manual control of pressure and draw speed





25 - 27 September · Chicago
LABELEXPO AMERICAS 2018
www.labelexpo-americas.com

Laboratory Print Proofing

Automated Draw-down / Meyer Bar Systems

- Pro's:
  - Easy to use and robust
  - Precision of wire/winding = excellent reproducibility
  - Controlled delivery of pressure and coating rate independent of operator
  - Options include:
    - Heated beds, vacuum beds
    - Interchangeable heads (Bird, blade, etc.)
- Con's:
  - Bar/bed does not simulate the surface/ink interactions generated during normal printing processes

Laboratory Print Proofing

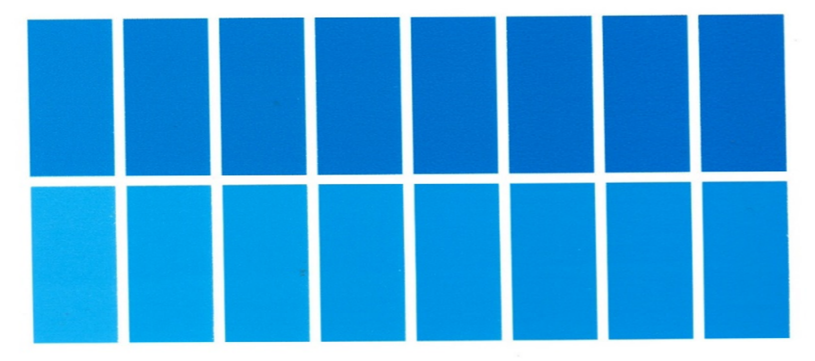
Basic / Manual Hand Flexo Proofers

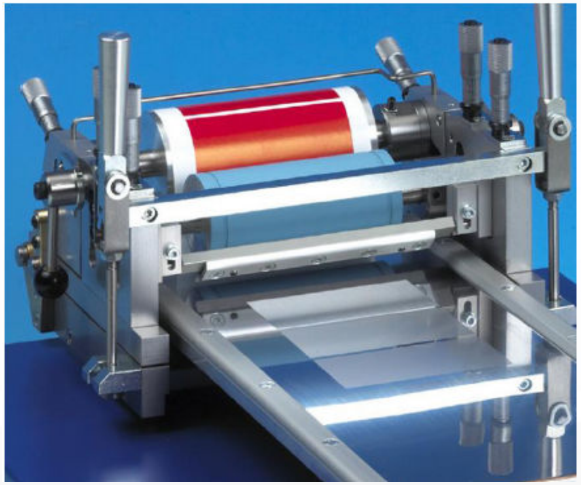
- Typically use an engraved anilox roll to meter ink
  - Mechanically engraved & chrome plated
  - Laser engraved ceramic
- Units may operate with or without doctor blade
- Pro’s:
  - Easy to use, robust and relatively low cost
- Con’s:
  - Operator dependent – manual control of pressure and draw speed

Laboratory Print Proofing

Automated Gravure and Flexo Proofers

- Pro's:
  - Easy to use, robust
  - Simulates primary production process with limited operator variability
  - Wedge plates allow full density color proofing



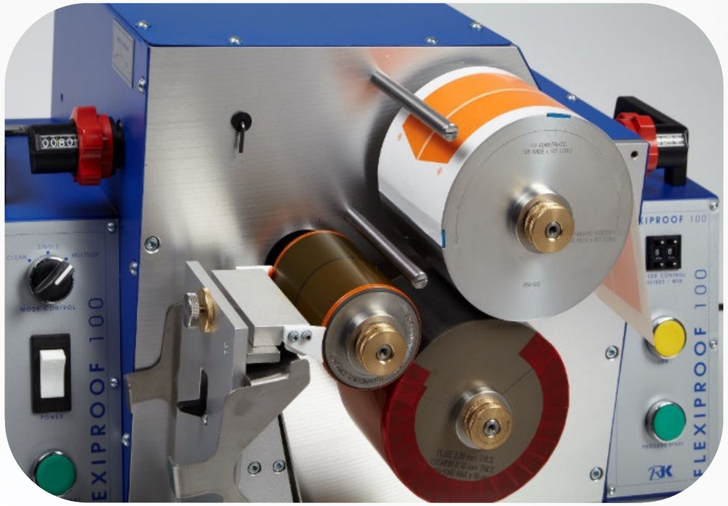


25 - 27 September · Chicago
LABELEXPO AMERICAS 2018
www.labelexpo-americas.com

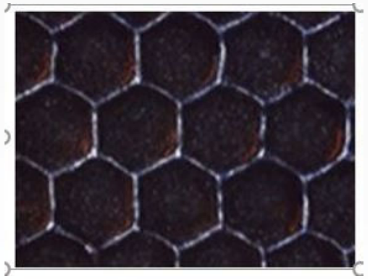
Laboratory Print Proofing

High Precision Flexo Proofers

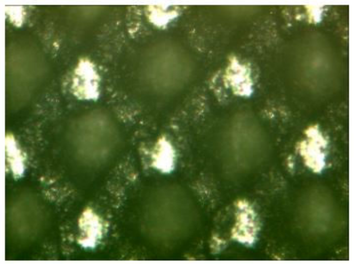
- Pro's:
  - Easy to use, robust
  - Closest simulation of actual flexo process and environment
    - Customize anilox and print plates
    - Superior control and reproducibility of process variables
  - Some models accommodate UV configuration
- Con's:
  - Comparatively high cost



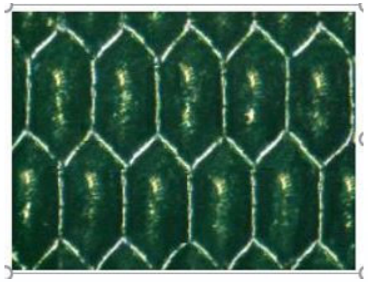
Ceramic Engraving Cell Structures



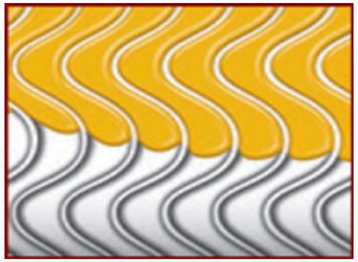
60° Hexagonal



Twinflo

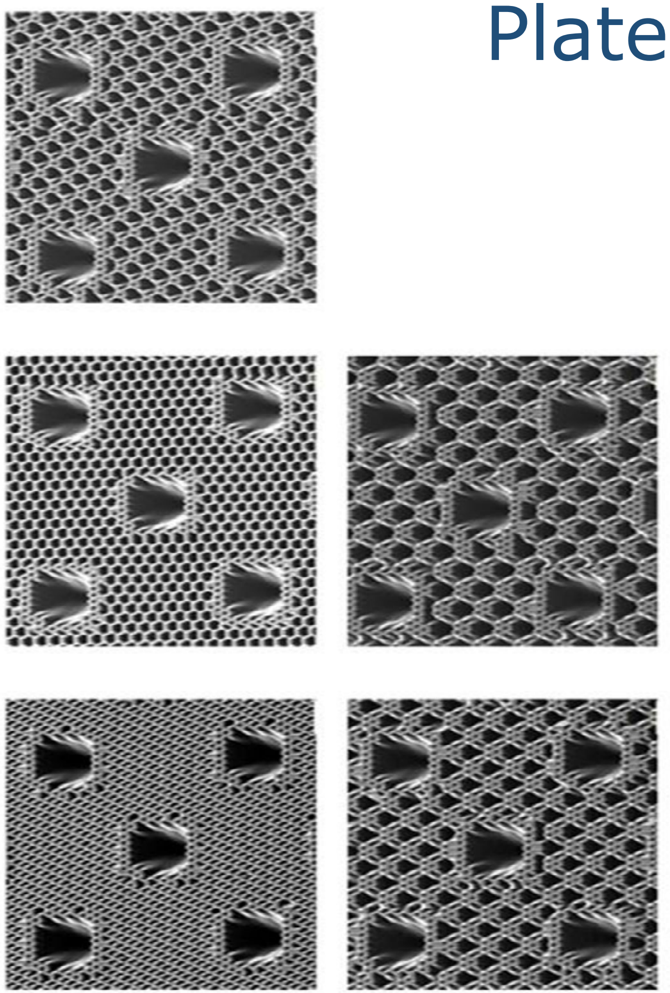


Maxflo



GTT

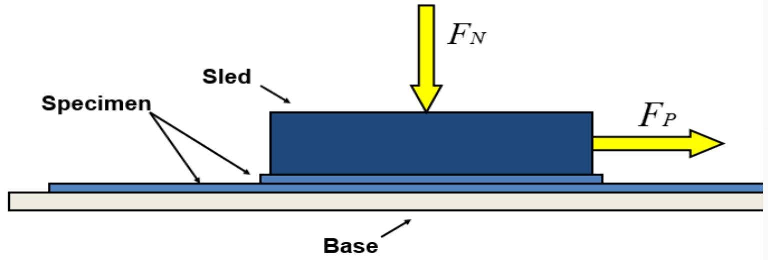
Texturized Surface Plates



Coefficient of Friction (COF)

- One of the most broadly used measurements in printing, paper and flexible packaging
- COF = Resistance to Slip

$$\mu = \frac{F_P}{F_N}$$



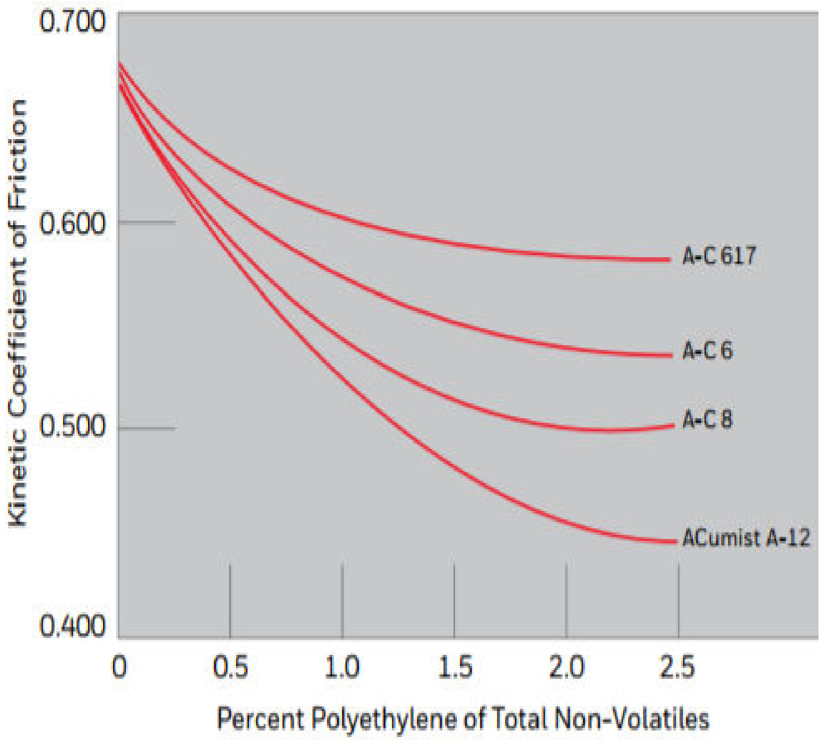
Coefficient of Friction: Importance to Process & Handling

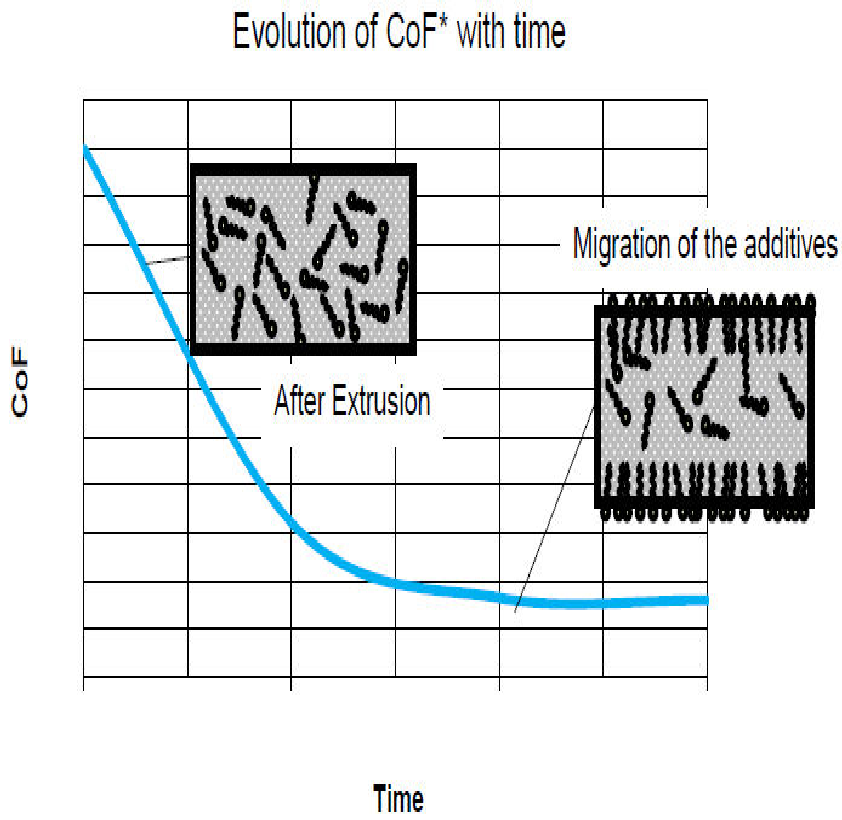
Situation	Desired Effect	Importance
Film passes over HFFS fin wheel deck plates.	Low outside friction, film-to-metal	Prevents drag and film jams.
On VFFS, film enters forming collar as horizontal flat web and is transformed into a vertical tube.	Low outside friction, film-to-metal	Prevents film squealing, inconsistent film feeding and inconsistent bag lengths.
Filled packages are being stuffed into corrugated shipping boxes.	Low outside friction, film-to-film	Allows packs to slide against each other and settle for easy carton closing.
On friction belt drive VFFS, servo-driven belts push and move film against inside tube.	Moderate outside friction, low inside friction	Belts must "grab" outside surface to move film, while inside surface must slide over stationary tube to prevent jams.
Filled packages slide down a chute to reach downstream packaging operations.	Low outside friction, film-to-chute	Keeps products moving.
Filled packages are carried on an inclined conveyor belt.	Moderate or high outside friction, film-to-conveyor	Keeps product from losing placement or falling off conveyor.

Table 7: Examples of various applications requiring different fictional properties

COF: Importance to Process and Final Properties

A-C polyethylenes decrease the coefficient of friction of a typical ink.



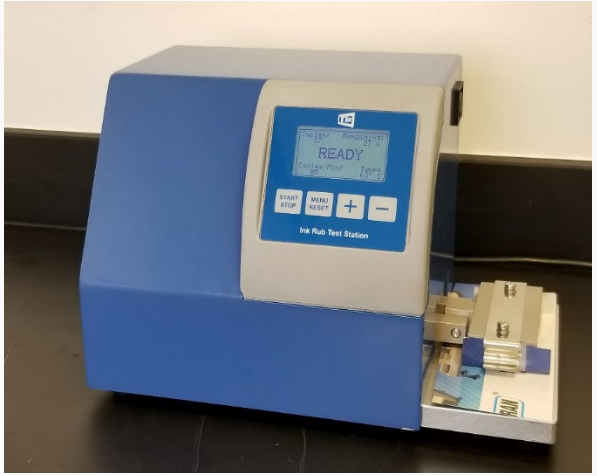


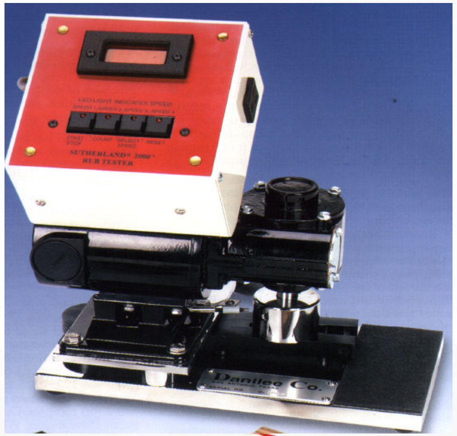
Coefficient of Friction: Importance to Process & Handling

INKS AND OVERPRINT VARNISHES	BENEFIT
Gravure/Flexographic Water Based Ink	Rub Resistance Coefficient of Friction Reduction Blocking Resistance
Gravure/Flexographic Solvent Based Ink	Rub Resistance Coefficient of Friction Reduction Blocking Resistance Trapping
Lithographic	Rub Resistance Coefficient of Friction Reduction Blocking Resistance
Overprint Varnish	Coefficient of Friction Reduction Blocking Resistance Mar & Abrasion Resistance

End-Use Performance: Rub & Abrasion

- A wide range of instruments exist for applying controlled abrasion to material surfaces
  - Various standards exist for applying the abrasion – based on type of material, mechanics of abrasion
  - No standard exists for assessment of the results!
- "Sutherland" style ink rub method
  - Most common method for printed surface quality assessment

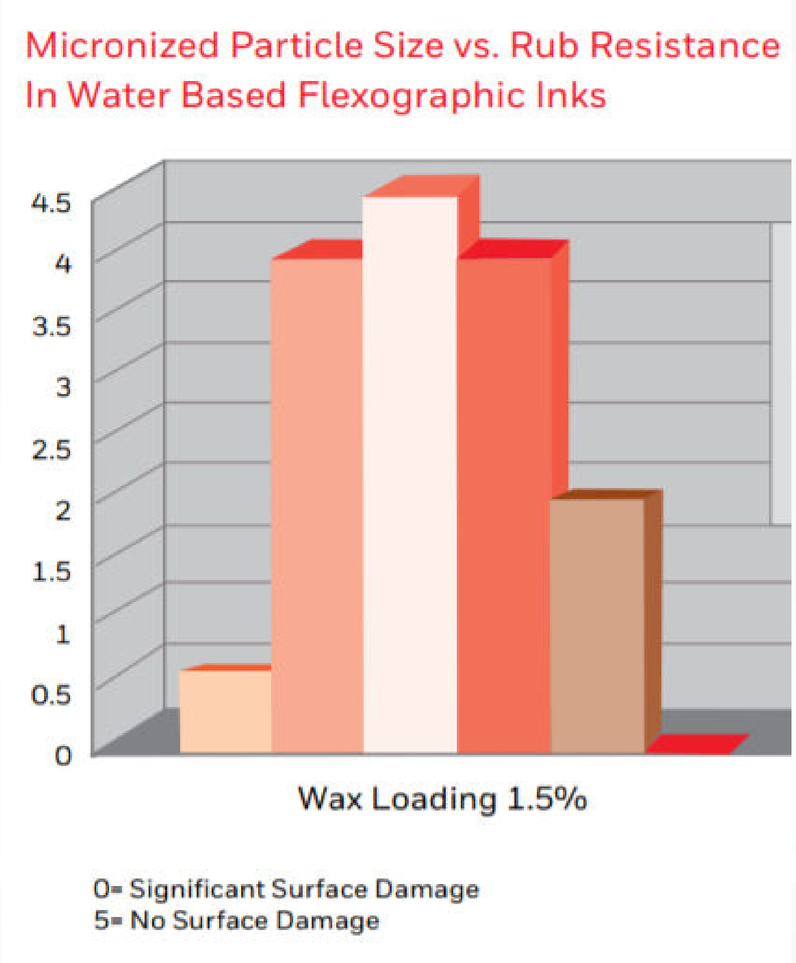




Scuff and Wear/Rub Testing

Sutherland Style Rub Methods (ASTM & TAPPI)

- **Dry Rub Method -** Determine the amount of ink transferred from one dry surface to another. Using two dry samples, looking for sign of ink transfer after 10 strokes.
- **Wet Rub Method -** Determine the amount of ink transferred from one wetted surface to another. 3 to 6 drops of water are placed on the printed surface prior to test and repeated until transfer or sign of fuzz or abrasion.
- **Wet Smear Method –** A water saturated blotter is laid on the sample & a sled is used to weight this down. Apply 'rub cycle' before checking the sample for ink transfer.



In-House Testing of Inks for On-Press and End-Use Performance

- How will my ink perform…
  - In process…
    - Viscosity
      - Surface Energy / Contact Angle
        - Print Proofing
  - Visual quality and surface properties…
    - Print Proofing
      - Coefficient of Friction
  - Post process…end use..
    - Coefficient of Friction
      - Rub & Abrasion

In-House Testing of Inks for On-Press and End-Use Performance

- Simple, robust test methods are available for predicting ink and substrate interactions and response to process controls
- Smart investment in key measurement techniques and trained lab staff can significantly improve quality and reduce down time, off-spec product and raw materials waste
- Current methods and instrumentation are easy to use, reliable and reduce operator variability compared with some ‘classic’ methods
- Data is usually quantitative and integrates well into modern SQC and quality programs

Thank You !

Sean Kohl

Director of Global Sales

Testing Machines, Inc.

United Testing Systems

INDUSTRIAL PHYSICS

Our brands protect your brand