Theoretical BCF-process-training
BCF (BCF S8; S+) Plant
PP PET
- Mono - Tricolour -

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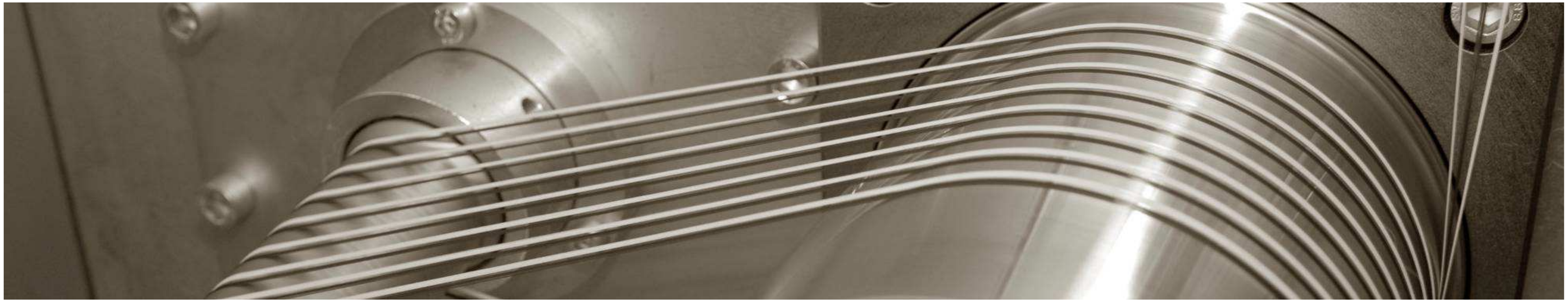
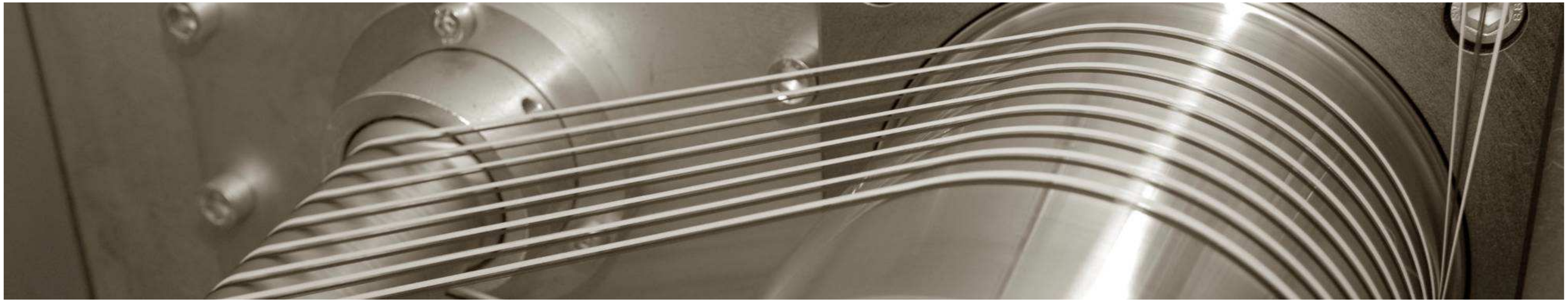
Version 1.5.4

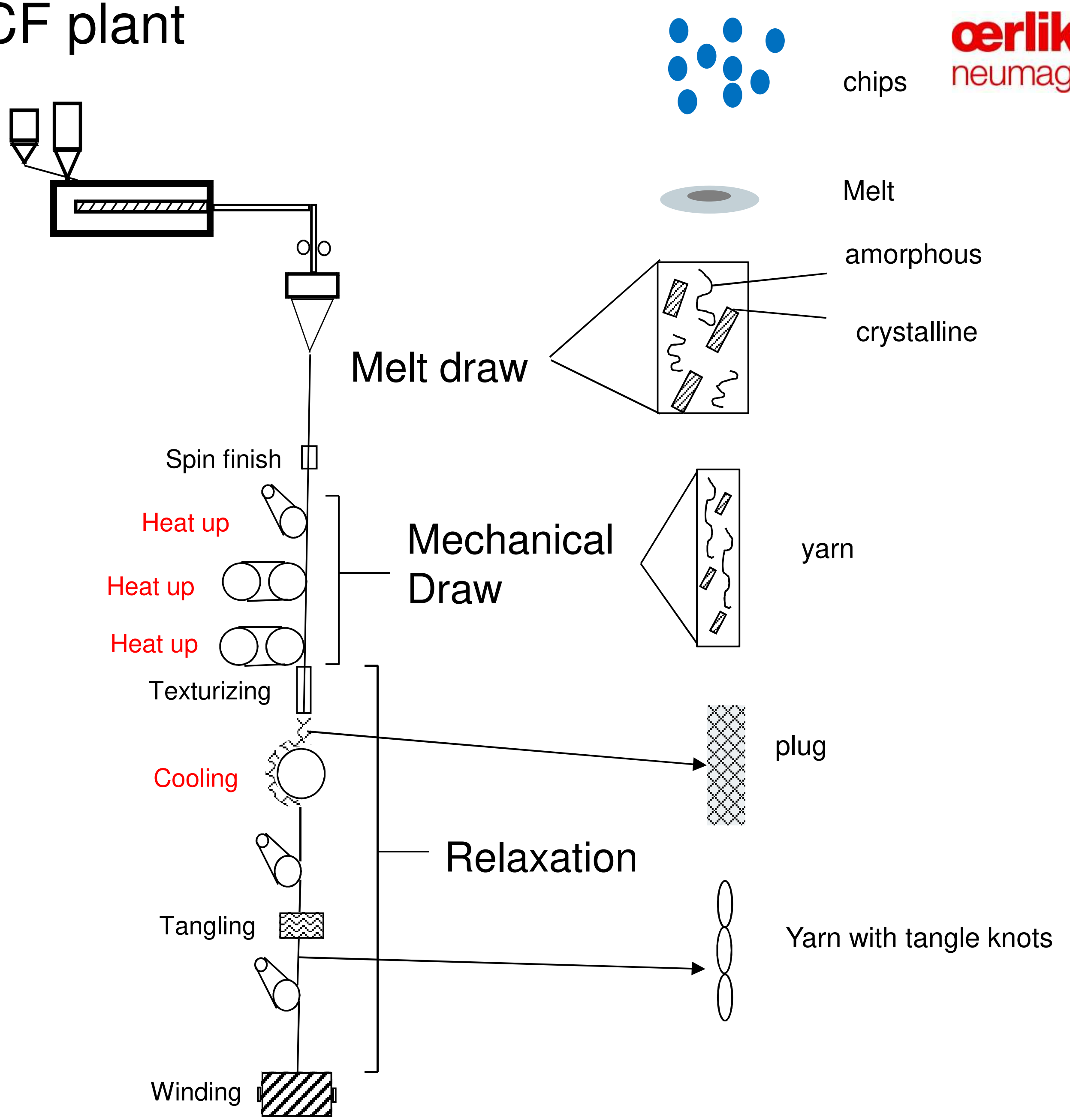


Session 1
streaks in carpet and maintenance

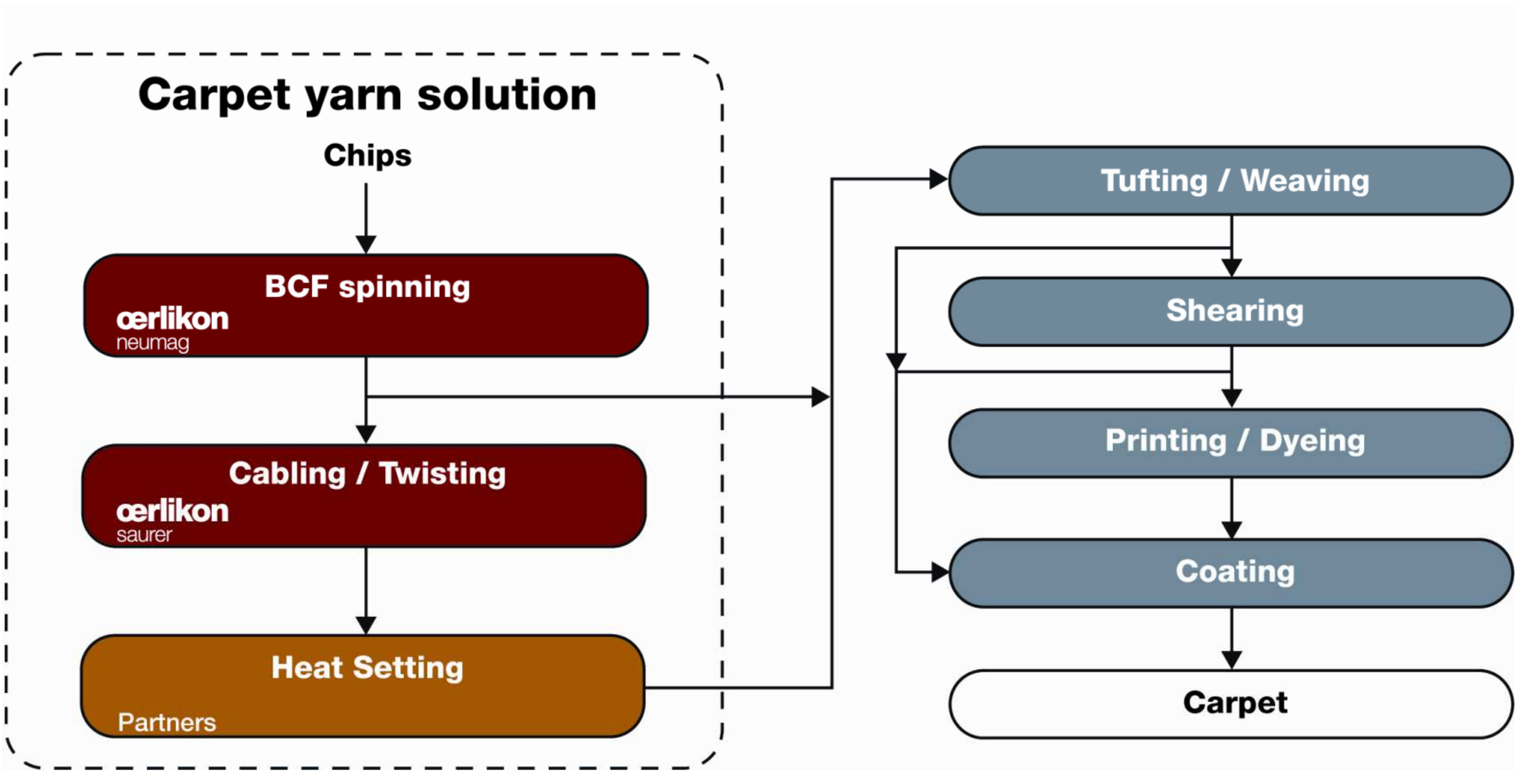


General overview S+ plant mono

Principle of a BCF plant



General overview of process steps



Stripes can be made in every process step and often they are caused by not optimized process parameters → Today: concentration to BCF-spinning (chips to bobbin)

What are the different kind of Carpet defects ?

Definition:

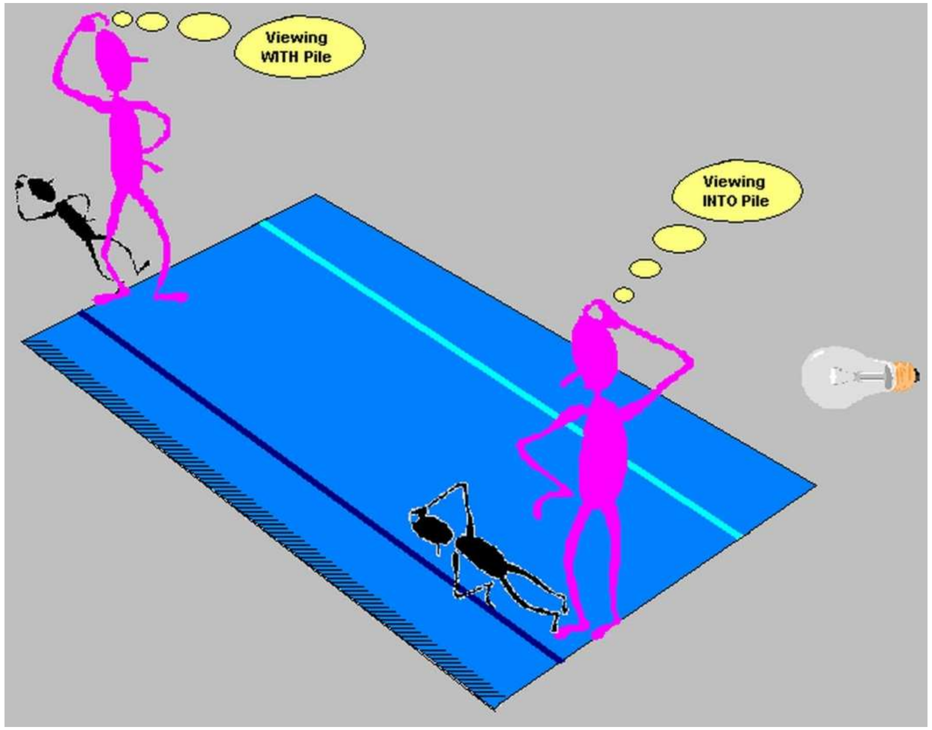
<u>Colour differences</u>
Yarn appears different
inside a carpet with structure or colour

Types:

<u>Stripes:</u>
Continuous darker or lighter appearing yarn
inside a carpet or different colour

<u>Stips:</u>
Short, darker defects with a length of
< 10mm

<u>Flames:</u>
Short defects in loop pile three-colour
carpets where one colour is dominating
for 10 – 25 mm.



What influence does every BCF parameter have?

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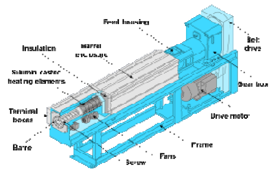
Raw materials

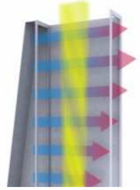
- Polymer
- Master batch
- UV Stabilizer
- TiO²
- Spinfinish

→



Extrudertemp.
Melt temp.
Extruder speed
Spinpump speed
Spinning Temp.
Spinneret

→



Quench air speed
Quench air temp.
Quench air humidity
Monomer suction

→

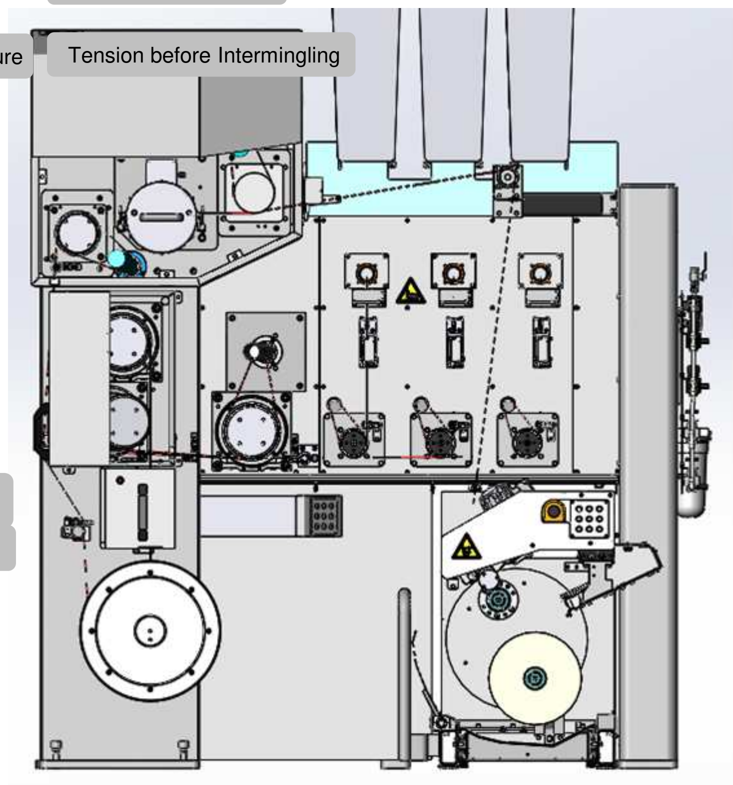
Spinning height
Melt stretch ratio

Speed draw off 1
Speed draw off 2
Intermingling pressure
Tension before Intermingling

Temp. Pre Draw
Speed Pre Draw

Temp. Main Draw
Speed Main Draw

Texturing temp.
Texturing pressure
Texturing equipment
Roller speed
Tension after Cooling drum
Cooling drum vacuum
Cooling drum speed
Cooling drum yarn angle



Main draw ratio
Pre draw ratio

Preintermingling pressure
Spinfinish applicator
Spinfinish rpm

Temp. inlet godet
Speed inlet godet

Tension before winder
Winder speed
Winder traverse freq.
Winder traverse ampl.
Winding angle

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Carpet categories

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- Contract
  - floor covering: cinemas, theatres, stores, restaurants, offices, hotel reception halls, entrance areas, department stores, corridors, air terminals, airplanes, trains, busses
  - mainly: mainly PA6 and PA66 (partly PET and PP)
  - typical: PA6 900 to 1200 den (90 to 140 filaments); coares: PA6 1100f50 dtex; PA6 1000f40 dtex

- Residential (domestic)
  - floor covering: bedrooms, living rooms
  - mainly: PP, PET and PA6 (PTT)
  - typical: PET 1500 to 1800 den with 150 filaments; also low dpf products (soft touch: 1200f360 dtex)

- Rugs
  - carpets on hardfloors (e. g. bathrugs; bedside rug)
  - sometimes also used in offices: carpet flagstones
  - PP, PET, PA6, PTT
  - low dpf products

- Automotive
  - direct tufted (no heat-setting, no cabling or twisting)
  - high requirements on eveness of the quality
  - solution dyed (mainly black, grey, anthracit)
  - mainly PA6
  - typical products: PA6 1000f68 dtex, PA6 1000f42 dtex, PA6 1200f120 dtex; PA6 1000f140 dtex

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Carpet constructions

Cut Pile

Cut pile carpets are manufactured by cutting the yarn loops which produces an upright pile that has a more luxurious, formal look than loop pile

- Plush Pile:
  - A soft velvet appearance and even upright finish that make for a formal look.
    - The pile is short and slightly twisted
    - Sometimes called velvet or velour carpet
    - Can display tracking from footprints and vacuuming
- Saxony:
  - A smooth and luxurious looking finish, similar to plush pile but with a higher pile height and a little more twist in the yarn.
    - Fibers are densely packed together for a luxurious look.
    - Can display tracking from footprints and vacuuming.
- Cut Pile Twist
  - A luxurious feel with a more textured finish.
    - The pile is highly twisted and lies in different directions
    - Hardwearing and maintain their finish, so ideal for high foot traffic areas
    - Textured finish is less likely to show shading or tracking
- Frieze
  - A luxurious feel and a stylish, less formal, almost shaggy appearance.
    - The long pile lies in different directions providing a deep texture
    - Extremely durable
    - Made in variations of thick and thin as well as long and short pile
    - Carpets with longer pile than Frieze are known as “shag piles”

[https://www.godfreyhirst.com/na/carpet/carpet-explained/carpet-types]

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Carpet constructions

Loop Pile

Loops of yarn create a stylish finish with a soft, smooth feel and can have a range of distinctive patterns created by a combination of higher and lower loops.

- Level Loop Pile:
  - A distinct textured loop finish created by a simple loop.
    - Well suited to heavy traffic areas
    - Does not show footprints

- Mutlilevel Loop Pile:
  - A textured finish made using loops of various heights.
    - This style is also sometimes called High-Low Loop pile
    - Can be used in a random or sequenced design to create textures or patterns
    - Extremely durable

- Sisal
  - A textured loop pile that is made in straight rows.
    - Comes in a variety of patterns and textures
    - Loop heights can vary to produce different patterns and textures

- Berber
  - Usually a thicker loop pile in neutral shades from browns to beiges with occasional flecks of different shades throughout.
    - Thicker than usual loops of yarn
    - Hard wearing with flecks that can hide soiling
    - Can also be a made as a cut pile

[https://www.godfreyhirst.com/na/carpet/carpet-explained/carpet-types]

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stain vs. soil resistance

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difference between staining and soiling:

- staining occurs when a substance comes into contact with the fiber and attaches to open dye sites in the fiber (altering the fiber's appearance). Example: glass of red wine spilled on carpet

- soiling is caused by a residue left on fiber. Either from a cleaning solution that was not fully removed or from oils on the bottom of your feet. The residue coats the fiber, and attracts and traps dirt. The build-up of dirt leaves the appearance of a stain.

[http://rugsandcarpets.about.com/od/Carpet-Fibers/fl/Nylon-vs-Polyester-Carpet-Fiber.htm]

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PET vs. Nylon carpets

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PA6

- well known as very durable: high resiliance
- strong fiber: stands up very well to abrasion
- resiliency: due to hydrogen molecule it can be revived by hot water extraction
- average UV-resistance

- high price in comparison to PET and PP
- more dull in comparison to PET
- stain resistance: Nylon is absorbent, so it soaks in liquid, and thererfore soaks in spills.
  → additional stain treatment is needed (example solution dyed nylon)

PET

- higher stain resistance in comparison to PA6: PET is a hydrophobic fiber compared to PA6, which means that the fiber itself actually repels liquid (for sure not completely stain-proof: soiling can happen)
- „enviromental feature“: recycling is more easy in comparison to PA6
- high-lustre apperance in comparison to PA6
- good UV-resistance

- generally considered to be a less durable fiber than nylon (first signs of foot traffic in less time than nylon) -> today durably gap between polyester and nylon has been drastically reduced

[http://rugsandcarpets.about.com/od/Carpet-Fibers/fl/Nylon-vs-Polyester-Carpet-Fiber.htm]

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PP carpets

PP

- wool-like appearance (often used in looped berber and area rugs)
- can range from low lustre (matte) to a high sheen
- Highly stain-resistant, but not very soil-resistance: PP is hydrophobic, meaning that it does not absorb liquid (not dyeable it needs to be solution dyed); PP is oelophilic, meaning that it attracts oils
    - → Only oil-based spill or residue will not easily be cleaned from carpet fibers
- because of hydrophobic PP is often used for outdoor or marine carpet
- PP is more hydrophobic than PET
- Often used for damp basements: quick-drying and mold-resisiting qualities
- low cost to produce (compared with PET and PA6)

- not as resilent as other fibers (meaning it does not have the same ability to „bounce back“ after beeing compressed by foot traffic)
- not last as long as a PA6 or PET carpet
- low UV-resistance

[http://rugsandcarpets.about.com/od/Carpet-Fibers/fl/Nylon-vs-Polyester-Carpet-Fiber.htm]

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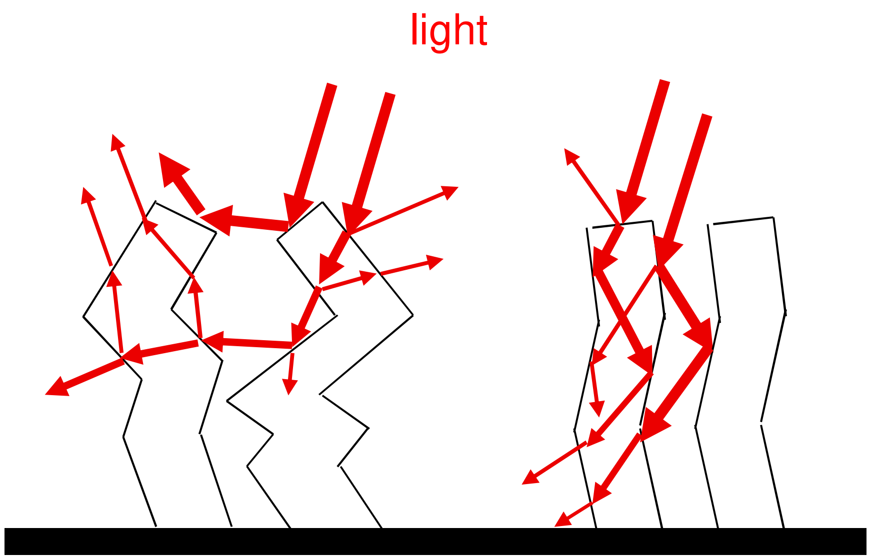
Why is the yarn structure so important for carpet?

- The human eye sees the reflected light of the carpet surface

- The human eye can differentiate better green, blue and red colours shades

- Part of the light is absorbed by pigments/polymer creating a “colour”
  - Pigments (or absorbed dye)
  - Polymer absorption behaviour
  - Cross section (dpf) : thicker = darker

- Part of the light is reflected depending on available surfaces at different parts of the fibre
  - Cross section (shape)
  - Orientation of the fibre cross section to light source and observer
  - Height of reflecting surface
  - Reflection at filament sides: light
  - Reflection at cut surface: dark



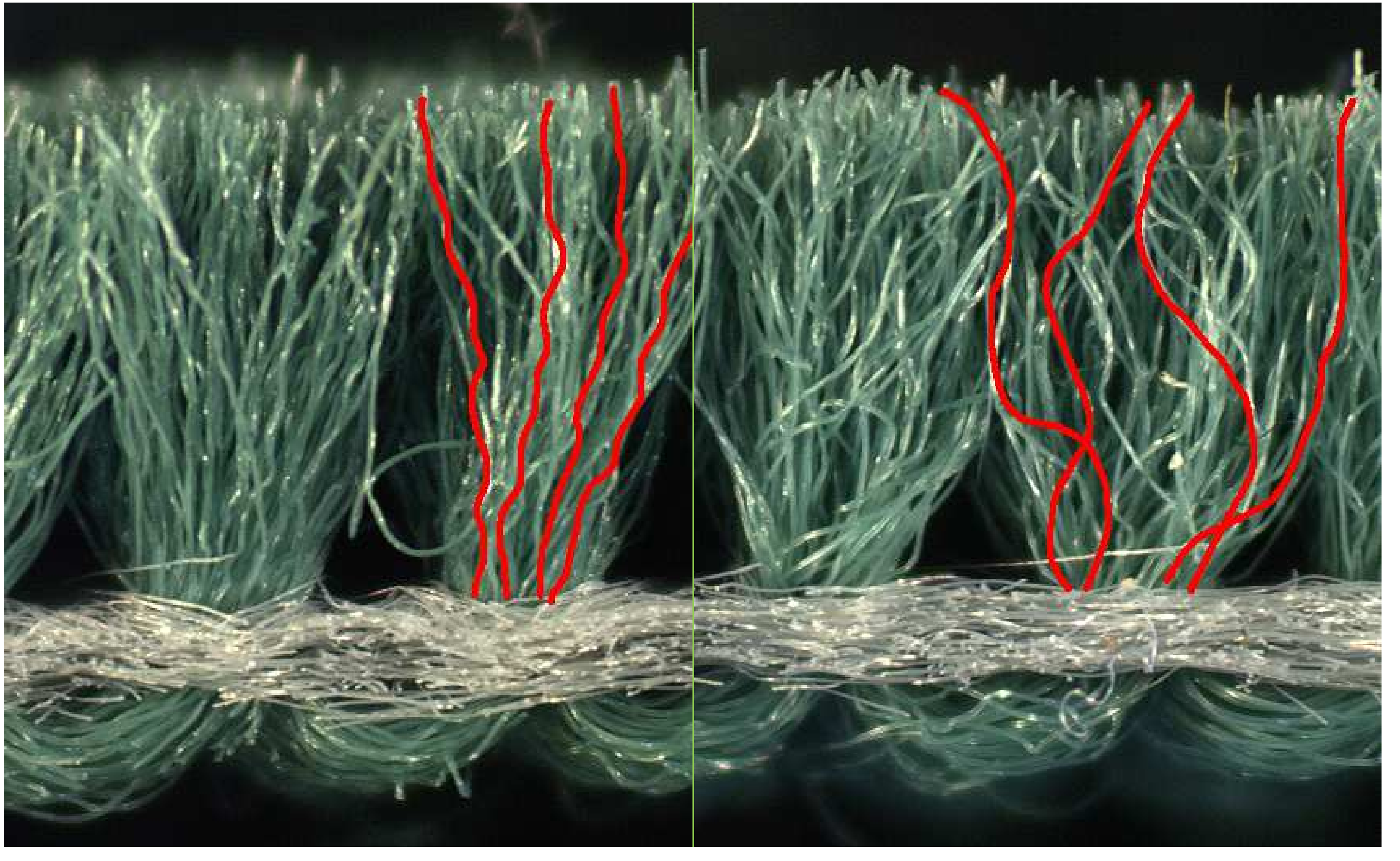
randomly oriented filaments filaments

parallel, vertical oriented filaments

principle of light reflection

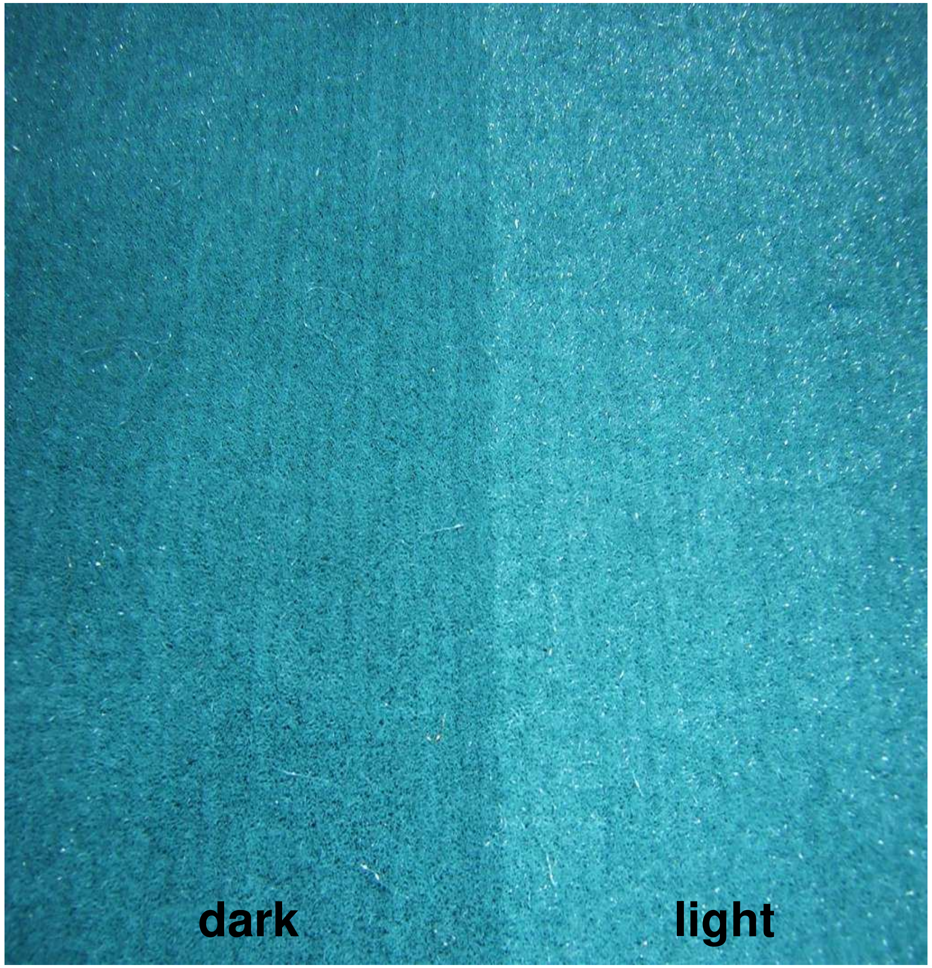
Example of different light reflection

darker brighter



Example of different light reflection

PP: Same amount of pigments but different crimp structure



DUO 135 °C Texturizing 150 °C	DUO 120 °C Texturizing 100 °C

together tufted

Length of defects tell about time at production

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Example:
Defect of 1 cm in carpet repeats every 40 cm

<u>Defect in yarn:</u>
1 cm carpet includes usually 5…15 cm of yarn. Depending on Stitch Rate, Pile Height, Gauge Font and Carpet style.

For this example 10 cm of yarn (1 cm carpet length includes 10 cm yarn of the bobbin)

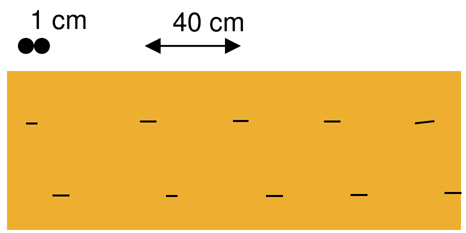
<u>**Defect time** at production :</u>
At 3000 m/min winder the **10 cm yarn** = 1 cm carpet length defect will be produced in :

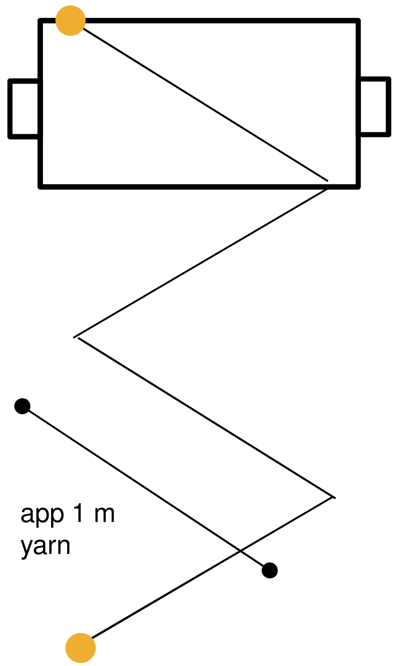
3000m/min = 50 m/sec → 0,1 m / 50 m/sec = 0,002 sec or 2 ms = contact time for the defect.

<u>**repeating time** at production :</u>
At repeating pattern of 40 cm means approx. every **4 m a defect in the yarn on bobbin**. For the repeating time follows:

4 m / 50 m/sec = 0,0016 sec or 160 ms

Look always for pattern (repetition, steady distances) and for time excludes often possible reasons!





a problem with the traversing unit

What can cause a different light reflection?

- <u>Different twist levels</u>:

  lower Twist = lighter

  higher twist = darker

- <u>Different crimp structure</u>:

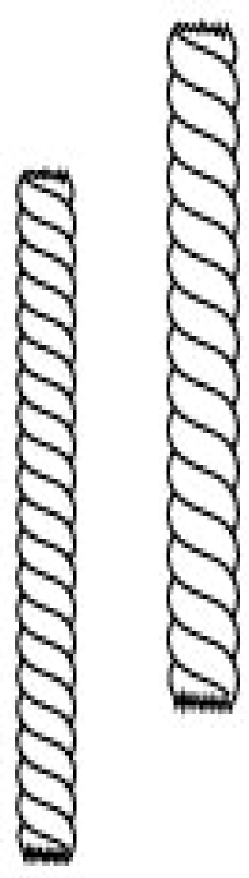
  open yarn appears lighter

  more closed yarn darker

- <u>Different yarn density</u>:

  higher density = darker

  lower density = lighter



(different point effect in Heat-set yarns, different titer)

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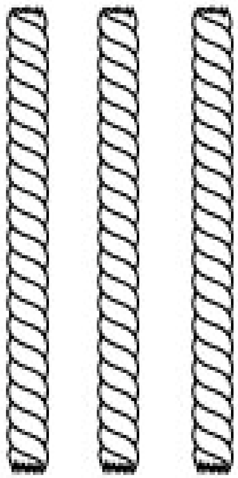
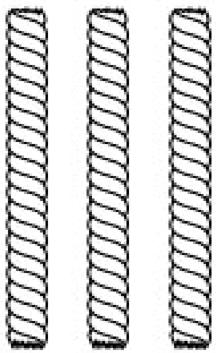
Heat set

Whatever happens to the pile height of a BCF carpet will also happen to yarn length and after heat – setting!

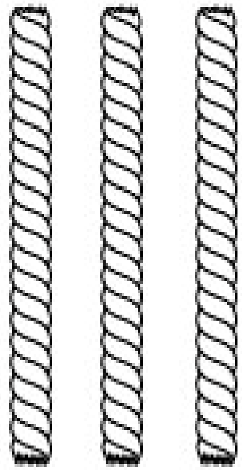
Yarn with high shrinkage before heat setting



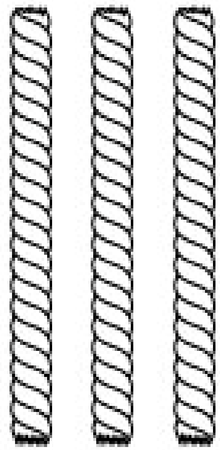
Yarn with high shrinkage after heat setting



Yarn with low shrinkage before heat setting



Yarn with low shrinkage after heat setting



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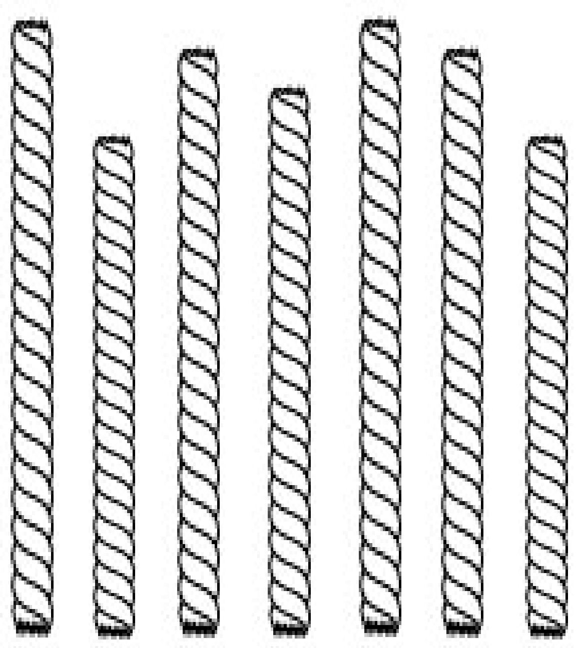
Heat set



High shrinkage yarn will not shrink evenly. This leads to pile height differences from end to end as well as to differences is tip definition.

Shrinkage needs to be reduced: heat set settings!

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Optimizing of textile characteristics – PP

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Fibre shrinkage + crimp	Thermal influence			Mechanical influence
	godet duo:	Texturizing	Godet 2/3	Drawing
Shrinkage higher	↓	↓	↕	↕
Shrinkage lower	↑	↑	↕	↕
Crimp higher	↑	↑	↕	↕
Crimp lower	↓	↓	↕	↕
Parameter sensitivity of fibre shrinkage	50%	20%	20%	10%
Parameter sensitivity of crimp	50%	30%	10%	10%
Quality limits				
Recommendation BCF	120 °C	80°C (Sytec: 125°C)	60°C	
Limit low BCF	110 °C	60°C (Sytec: 120°C)	50°C	
Limit high BCF	125 °C :	120°C (Sytec: 135°C)	80°C	
Recommendation Heatset	130°C	135°C	80°C	
Limit low Heatset	120 °C :	120°C	60°C	
Limit high Heatset	135 °C :	170°C	90°C	
Recommendation loop pile	135 °C :	135°C (Sytec: 160°C)	60°C	
Limit low loop pile	110 °C :	120°C	50°C	
Limit high loop pile	145 °C :	170°C	80°C	
General limit low	100°C	60°C	50°C	
General limit high	145°C	170°C	100°C	

Optimizing of textile characteristics – PET

Fibre shrinkage + crimp	Thermal influence			Mechanical influence
	DUO	Texturizing	Godet 2/3	Drawing
Shrinkage higher	↓	↓	↕	↕
Shrinkage lower	↑	↑	↕	↕
Crimp higher	↑	↑	↕	↕
Crimp lower	↓	↓	↕	↕
Parameter sensitivity of fibre shrinkage	40%	20%	10%	20%
Parameter sensitivity of fibre crimp	40%	20%	10%	20%
Quality limits				
Recommendation	180 °C	200 °C	105 °C	
Limit low	165 °C	180 °C	90 °C	
Limit high	190 °C	220 °C	110 °C	

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Typical Carpet defects, cutpile with BCF

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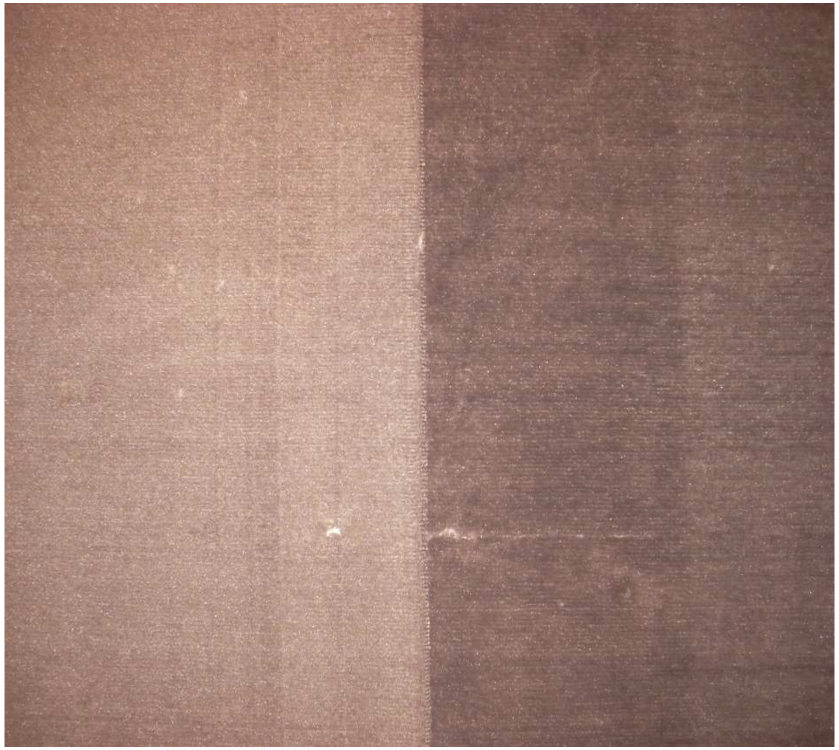
- „Aging“ or „Relaxation“ effect of PA6 BCF

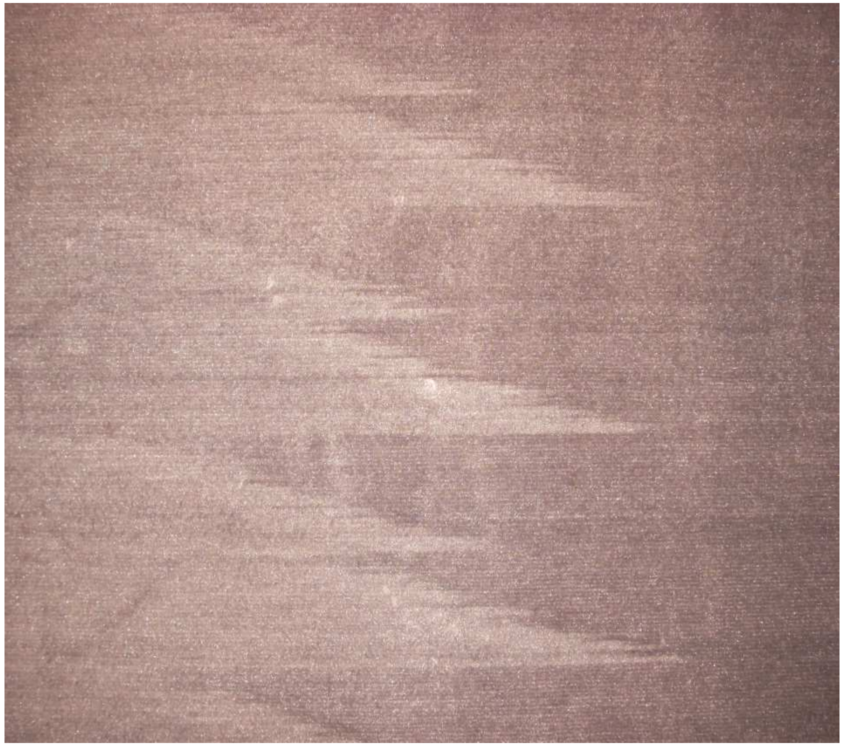
Yarn was stopped in tuft needles
-> impact of „aging“

Tufted 24 hrs. Start Tufting



Yarn was stopped in tubing and reached the carpet after stop

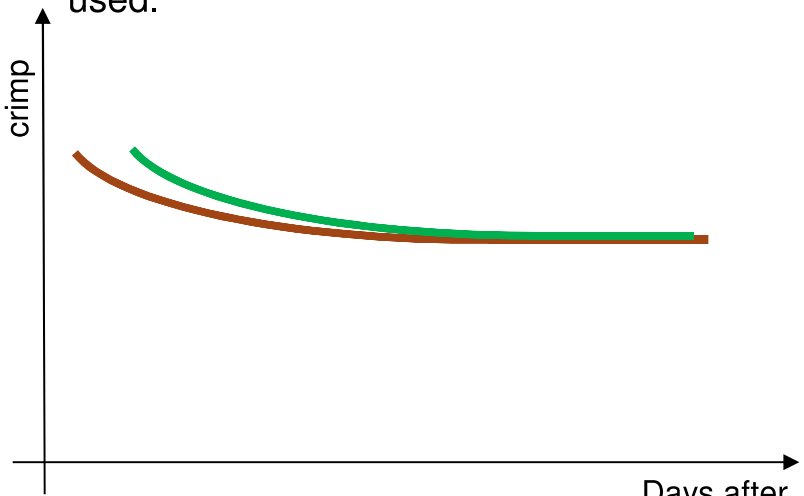
Yarn in tubing tuftmachine Yarn from bobbin



tuft direction →

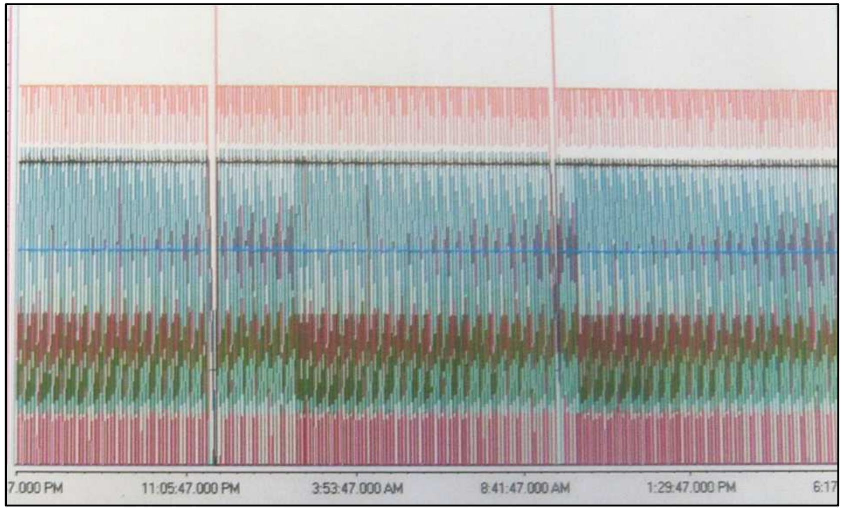
Yarn relaxation and take up area conditions

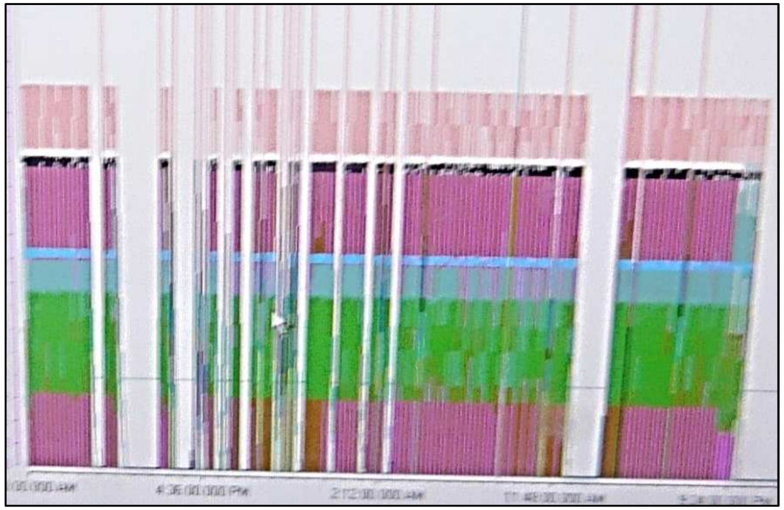
- Uniform take up area and even storing conditions are needed for PA6 and PET (especially for PA6 !) to ensure same moisture pick up for each bobbin
- Too short relaxation time in-between the process steps can cause big performance and quality problems.
- Normally the yarn should relax at least 2 days in-between the process steps (PP) or 3..4 days (PA6; PET) under same conditions
- The necessary relaxation time depends on the ambient temperature and the kind of packing used.



material	Recommended Take up area - temperature	rel. humidity
PP	18°C – 30°C; +/-2°C	60% - 80%
PA6 ; PA6.6	20°C – 24°C; +/-2°C	70% - 75%
PET	18°C – 25°C; +/-2°C	70% - 75%

Maintenance: indicators

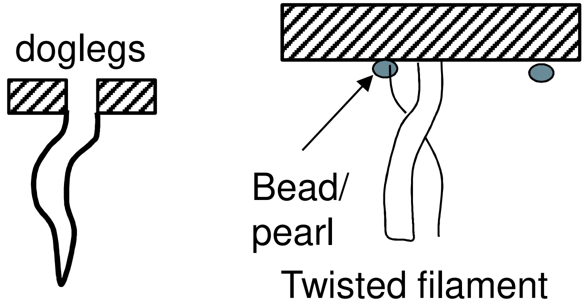




- experience/ maintenance intervalls
- efficiency of process
- increased number of yarn breaks/missdoffs
- loss of yarn tension before nozzle
- change of twist between godet and texturizing nozzle
- changings of plaiting angle of cooling drum (depends on process)
- changings of crimp
- changings of shrinkage
- Missing tangle nodes
- Missmatch with masterbobbin

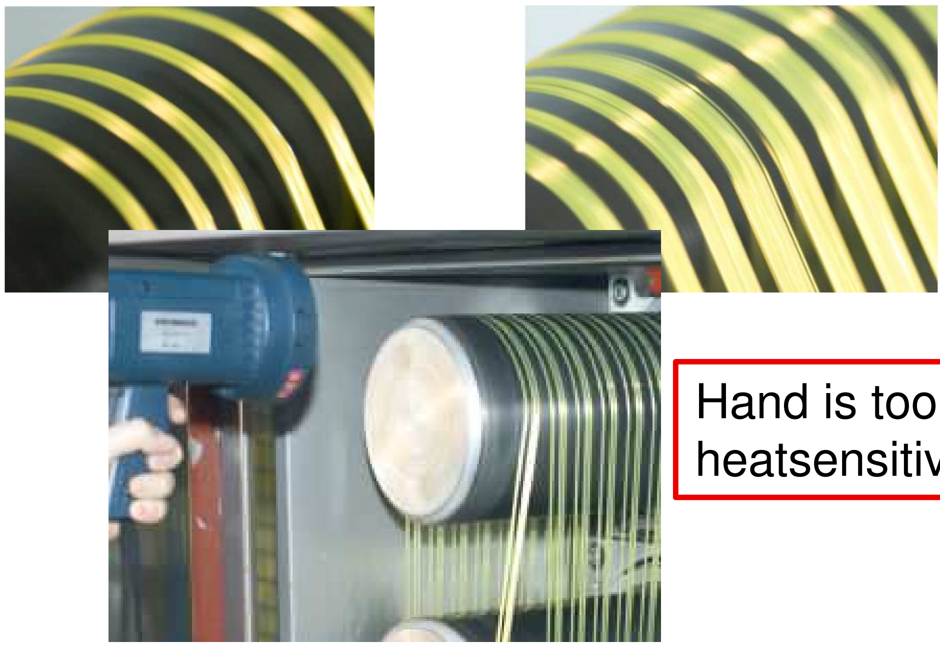
Maintenance: process check

Spinnerets:
- dirty/ degraded deposits
- Pearls
- Twisted filaments
- doglegs

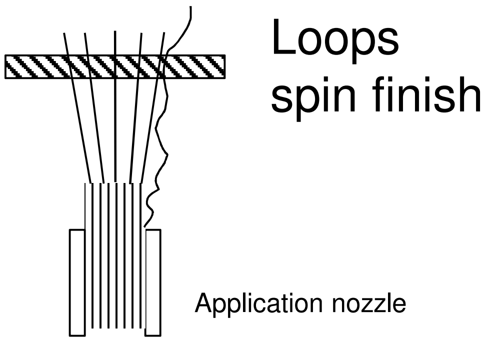


Take up Unit
- Loops in spin finish
- Flaring on inlet godet
- Fishtailing
- Loops on Pre Draw
- Breaks/min DUO
- Tensions

Strobe light is the most important process tool !



Hand is too heatsensitive!



Maintenance: process check

All : on the texturizing head

- Centrical yarn inlet in texturizing nozzle (guide)
- Twist of yarn between godet and nozzle
- Yarn tension before nozzle and after cooling drum

Bitex & Friction

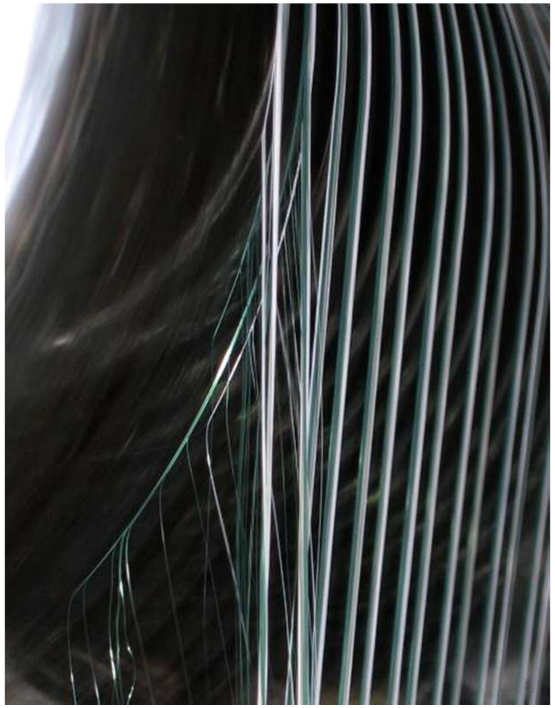
- Underpressure fluctuations (manometer and pressure gauge)
- Lowest plug formation vacuum
- Underpressure / vacuum

All : vaccuum

- vacuum CD
- vacuum exhausting tangling

All : yarn

- Crimp
- Shrinkage
- Tenacity
- Elongation



Process check

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- Check and record the **breaks on the DUO**
  - PP/PA6/PA6.6: max. 1 break per minute
  - PET: max. 1-2 breaks per minute
- Check **twist of texturizing nozzles**.
- Check and record the **draw off point of the cooling drum**
  - ∢ CD: ± 1 h
- Check and record the important **yarn tensions**

Yarn tension at	Allowed tolerance
Before/after Spin finish	± 10 % of mean
Before Texturizing	± 5 % of mean
After Cooling drum	±10 – 15 % of mean
Before Tangling	± 10 % of mean
Before Winder	± 10 % of mean

Check one time per shift all ends and record the data

Spin Pack

The packs should be cleaned frequently:

- Example PA6:
  - every 24 hour spinneret cleaning could be necessary -> depending on MB quality, process, spinnerets…..
  - Every 1 to 2 weeks spin pack change is needed (change always all packs on position)

The surface should be metallic clean in order to get a good running performance.

Heat stable silicon spray should be used after cleaning in order to prevent that filaments can stick on the spinneret surface.

If there are scratches on the spinneret Surface which are touching a hole it is likely that the spinneret will cause a run ability problem.

Use brass scraper !

Abrasive Pad!

Spray!

Spin Pack – Cleaning Videos

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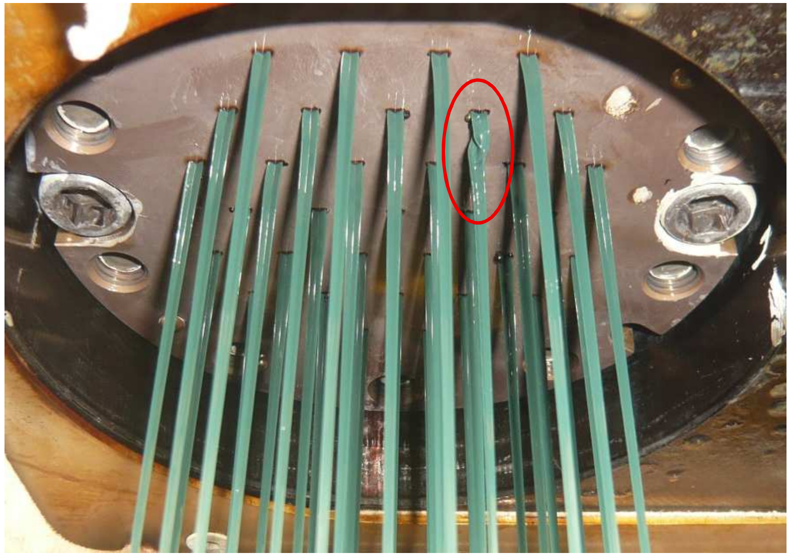
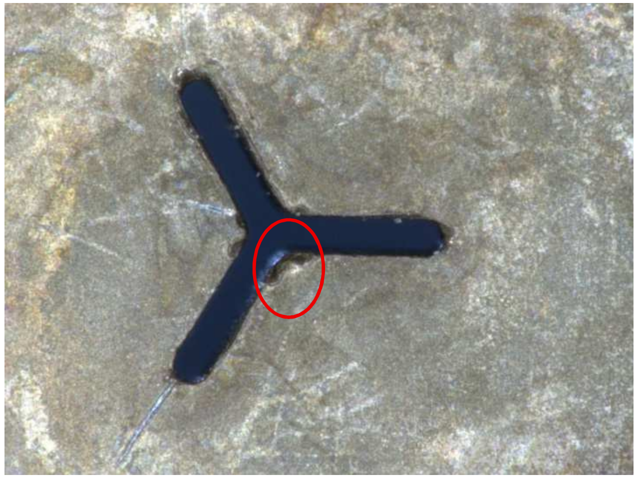
Spin Pack

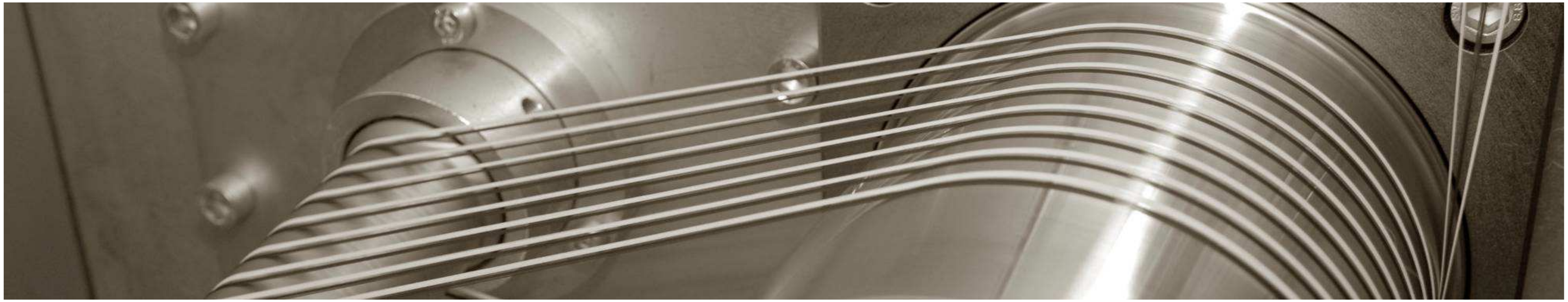
dogleg

twisted filament





Session 2
maintenance and tricolor



Remove deposits wherever you find them

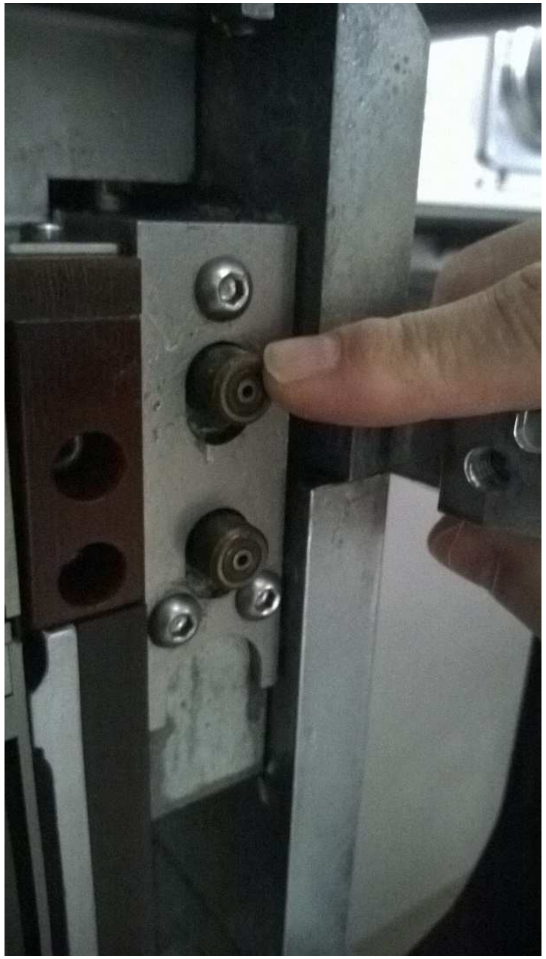
- deposits in monomer suction nozzle
- deposits on godet shells
- deposits on texturizing nozzle
  (yarn channel and air inlet)
- deposits on lamella
- deposits in lamella chamber housing / slotted chamber
- deposits in texturizing head
- deposits in cooling drum suction – vacuum drops
  - minimal: 25 mbar
  - Δ ± 2 mbar
- deposits in vacuum suction and air channels
  (e. g. intermingling suction)

Clean-up texturizer

oerlikon
neumag

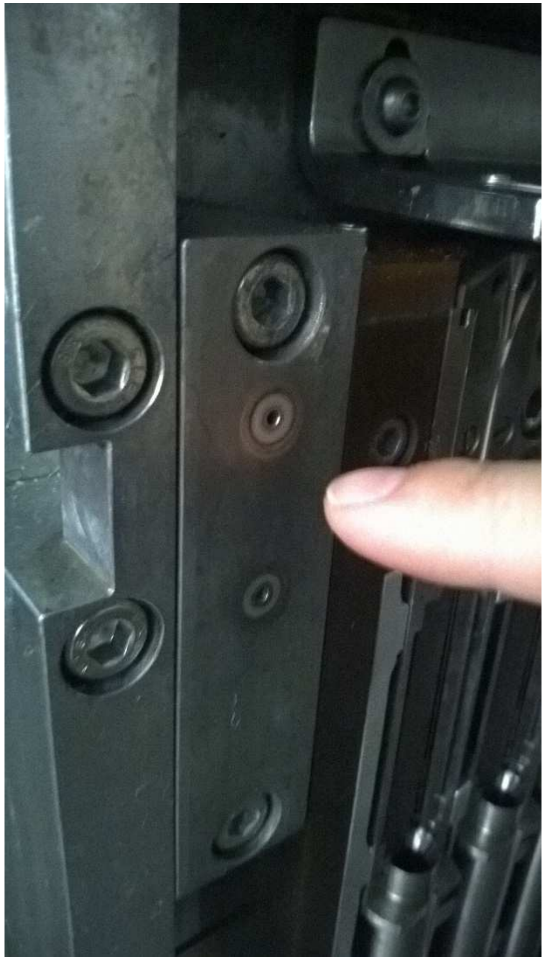
Hinge for Tex Jets

has slack



O-ring sealing of air transfer is okay.

Bushing spring action is ok



Counter surface is clean

Information only

Clean-up Jets

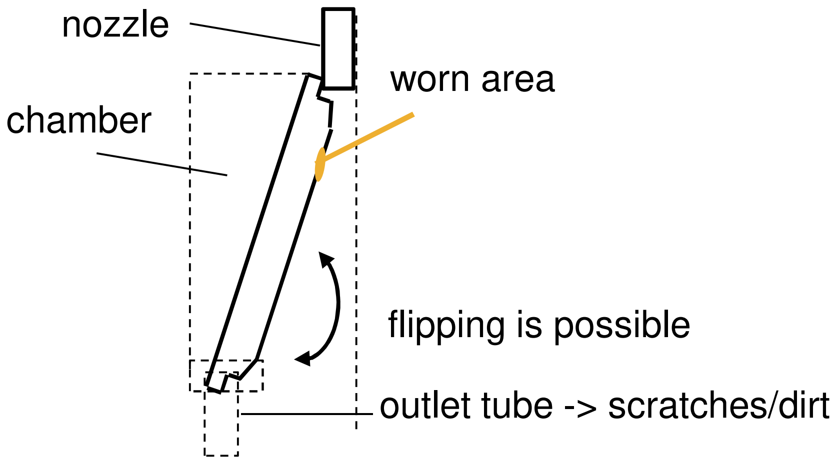
not ok!

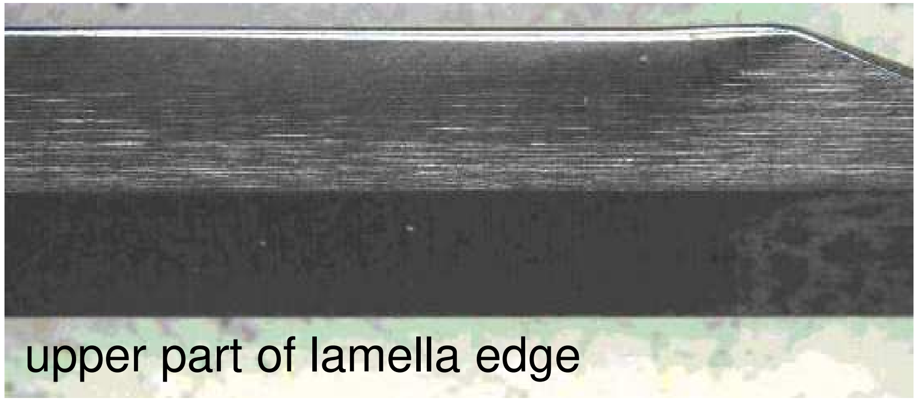
Check also the ultrasonic bath!

Tear and wear of yarn contact parts

oerlikon
neumag

Worn steel lamella





Texturizing nozzles

1. impingement point
2. yarn outlet
3. yarn inlet (tricolor)
4. step in yarn channel

Worn area

Jet Damages

- Burr in yarn channel or air channels
- Yarn outlet of texturizing nozzle deformed
- Excess length of wrong screws over contact level → mark on door nozzle half
- Contact surfaces of texturizing nozzle or lamella chamber not levelled or flat

Typicial reasons:

- Falling down (handling, too hot)
- Wrong tools
- Too long in machine
  → degraded deposits

⇒ skilled technician instead of operator
⇒ regular maintenance (one time per week)

Component check - Texturizing

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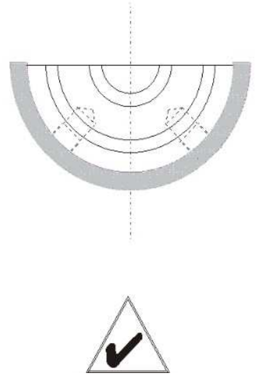
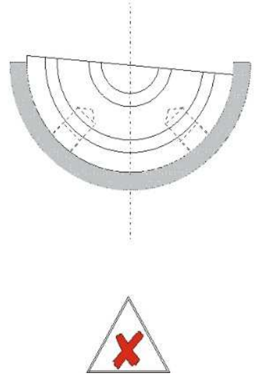




- Sight inspection of texturizing nozzles
  - dirt
  - deposits
  - scratches
  - wear
- matching numbers of nozzle; matching numbers of lamella chambers / slotted chambers
- Sight inspection of individual lamella (bending, finger nail test: burr on cutter,..) or slotted chamber

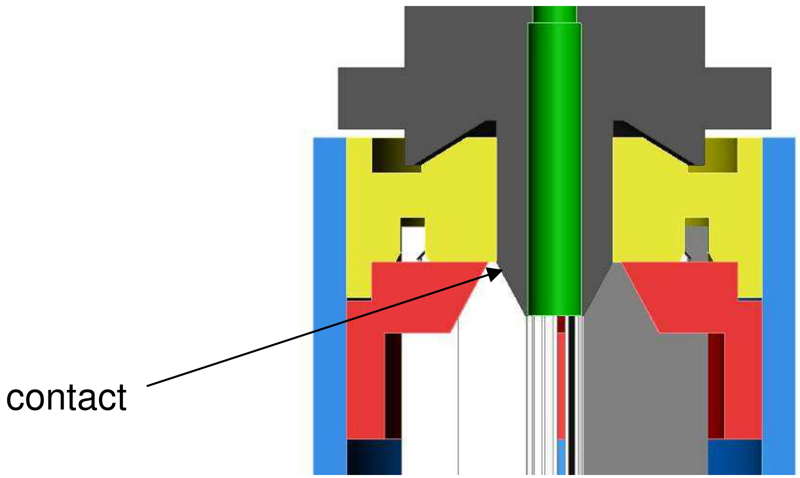
recommendation: microscope/magnifying glass
⇒ reference nozzle and reference lamella chamber (both unused) for comparison reasons

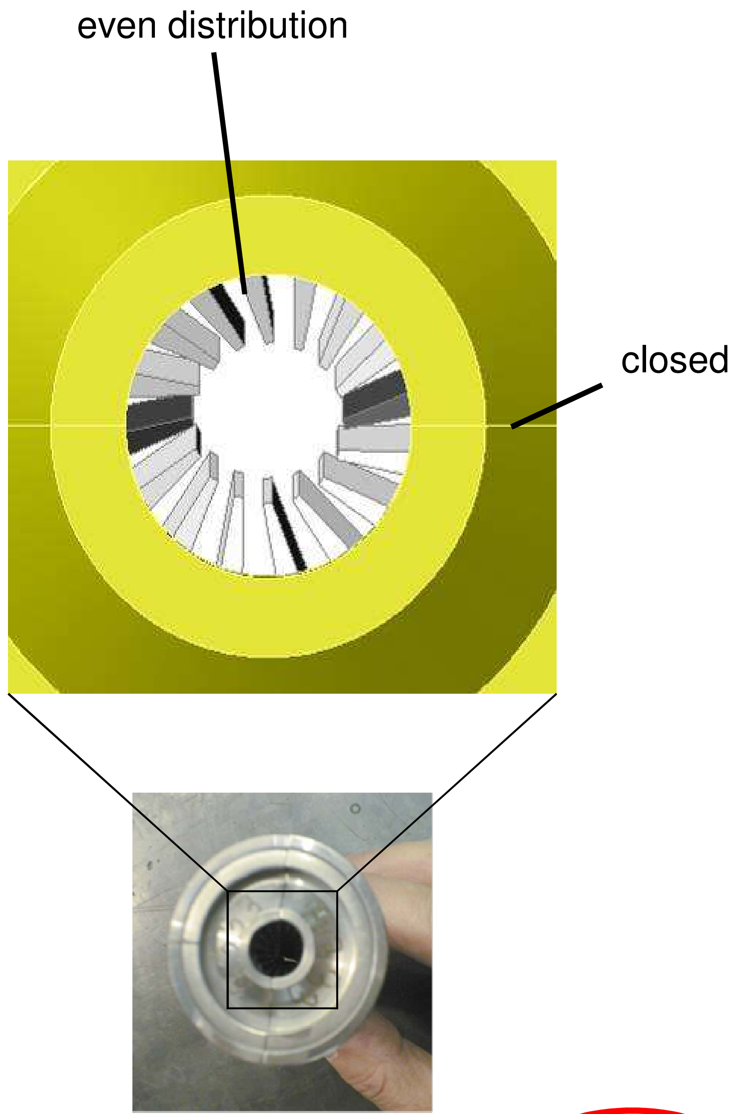
Information only

Component check - Texturizing

Bitex & Friction

- Lamella chamber with mounted lamella: sight inspection on deformed lamella and dents
- Contact nozzle : yarn outlet - lamella slant when mounted





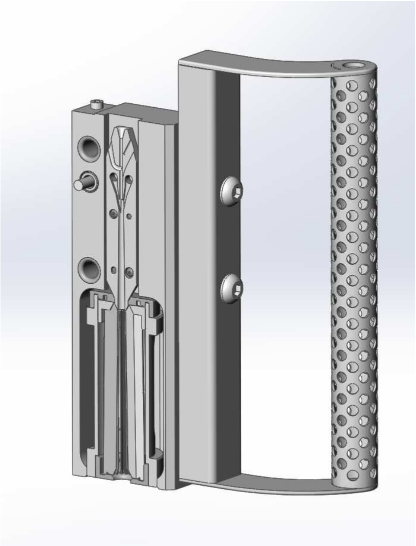
Information only

Texturizing - Cleaning

Example: Draw off Points on CD are different!

Step1: Clean the texturizing holder with pressured air

Step2: If the texturizing is still too dirty, clean it in a US-bath. Do not use the same US-bath like for spinnerets. (One time per week recommended)



- Loose the safety screw of the texturizing holder
- Put the two texturizing holder parts for 1 to 2 minutes in US-Bath (not longer than 2 Minutes). Lamella chamber and texturizing nozzle should never contact metal/other parts in US bath!
- Clean the texturizing holder parts with clear water
- Dry the parts with compressed air
- Put a little bit new grease on two pins (Use only the special grease KLUEBER BARRIERTA L55/2)

Be careful with the texturizing equipment!

Information only

Texturizing - Cleaning

Put a little grease (BARRIERTA L55/2) on pinsafter cleaning

Check the sealing!

Put the safety screw back into position.

Information only

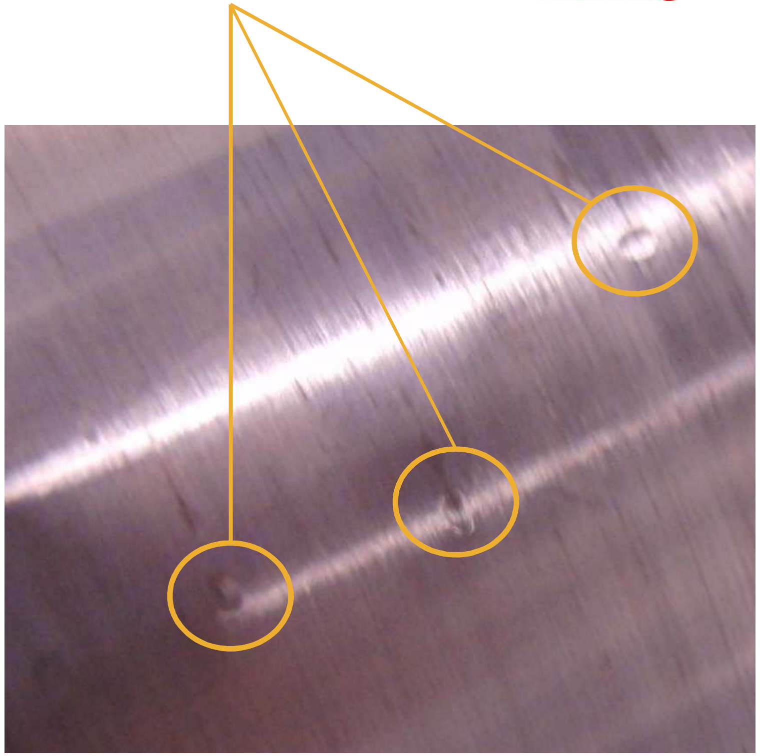
Frequent damages

Spinnerets:
- worn (doglegs, breaks)
- scratches because of screwing
  ⇒ lapping of spinnerets is possible

Spin finish:
- polish worn out/burnt
- blocked (gel)
- interlacer damaged

Godets
- *chips*
- *Worn out /polished*

Thread guides:
- polish worn out/burnt
- micro rifts
- broken



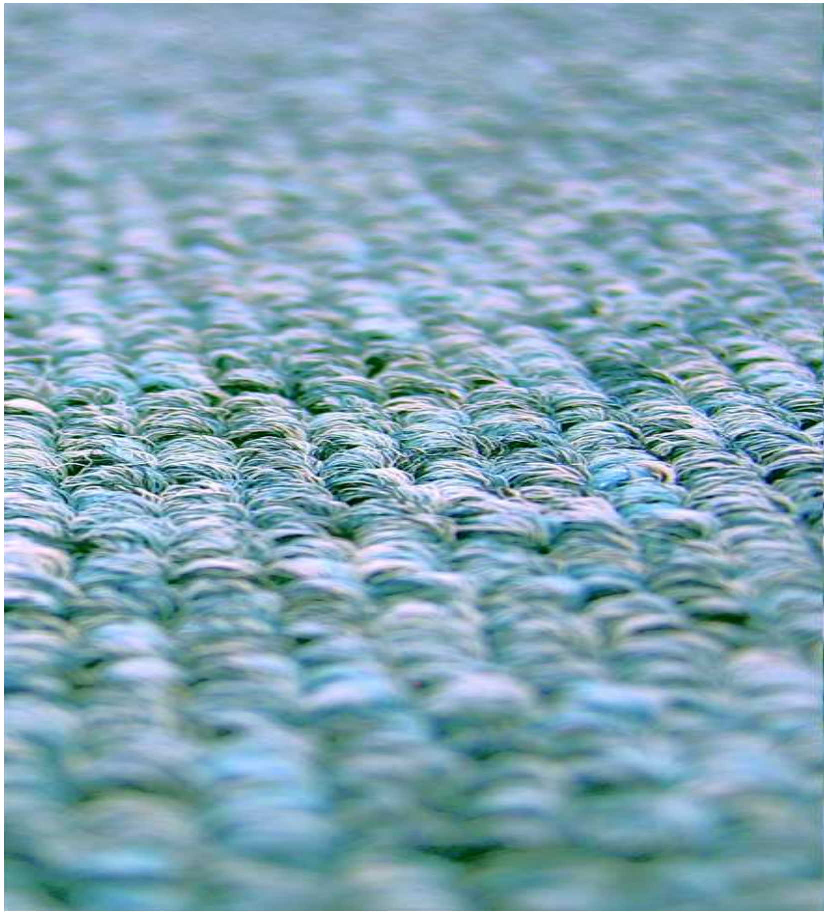
Winder:
- wing tops damaged
- wings damaged
- thread up plate worn in
- cylinder tight

Tricolor methods

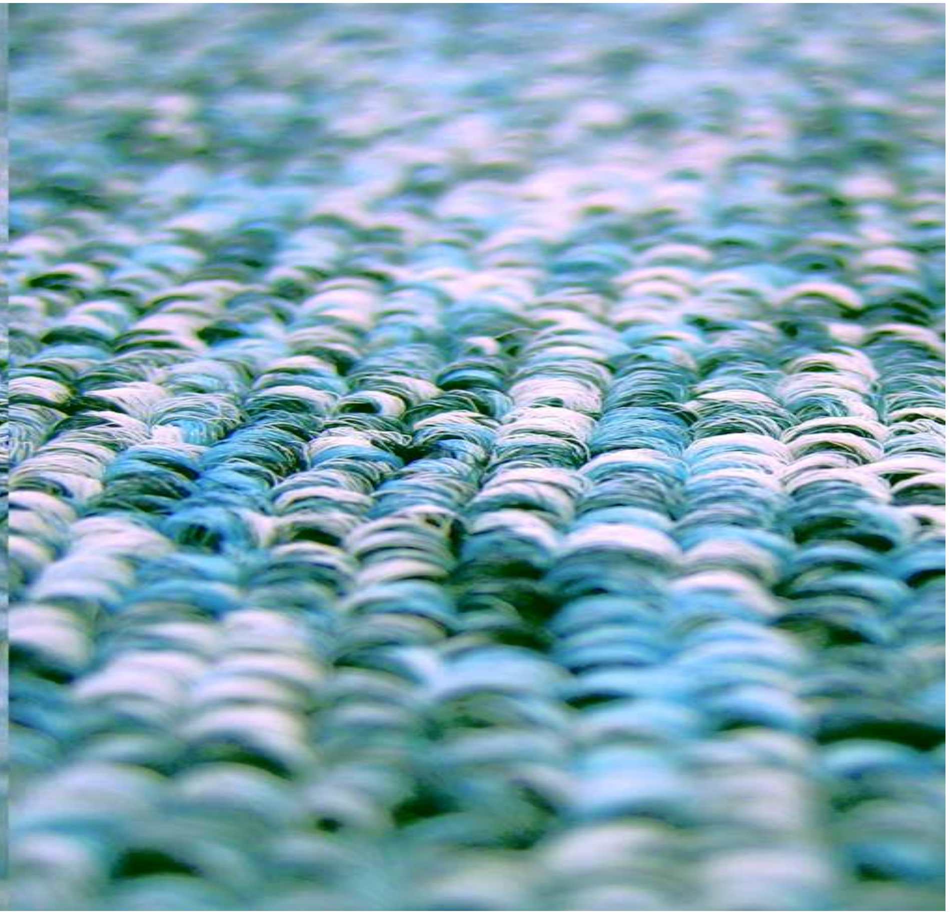
1. Polymer Data
2. Components of a BCF-position
3. Stringing Up
4. Process calculation
5. Process optimization
6. Process data sheet
7. Textile Measurements
8. Maintenance
9. Streaks in carpet
10. Tricolor methods

Tricolor methods

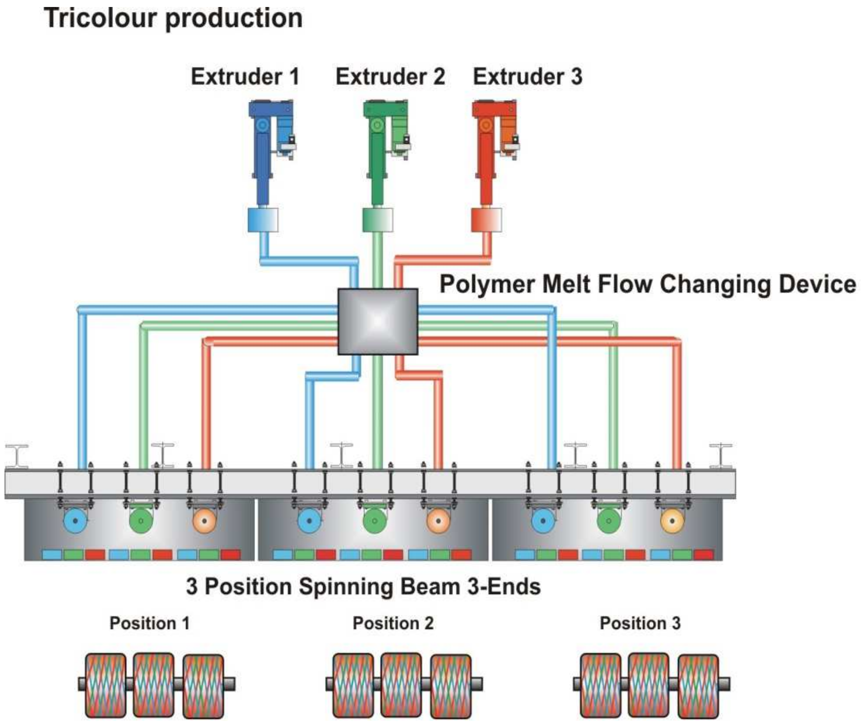
Well mixed colours

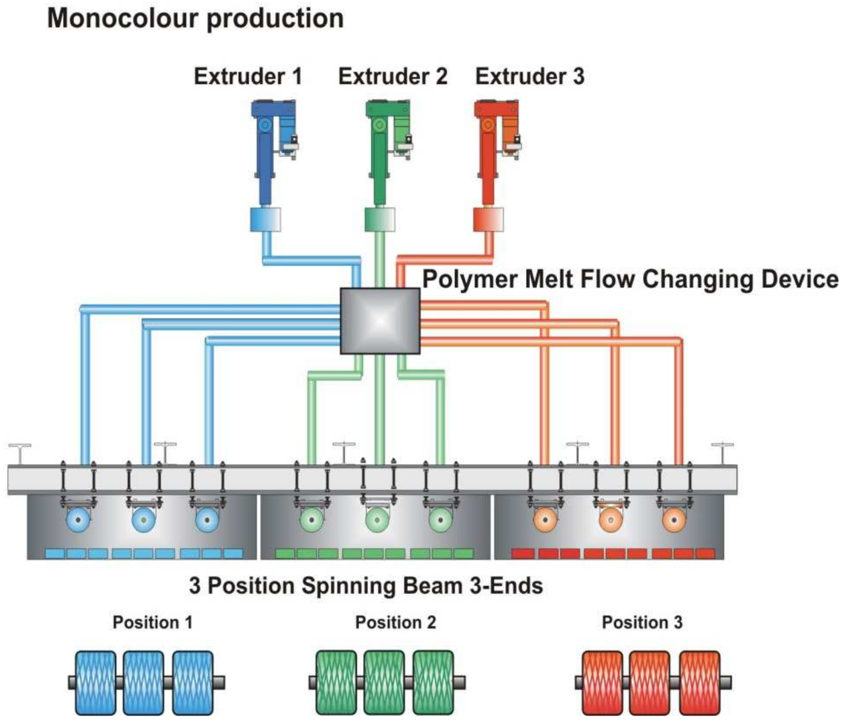


Very high colour separation



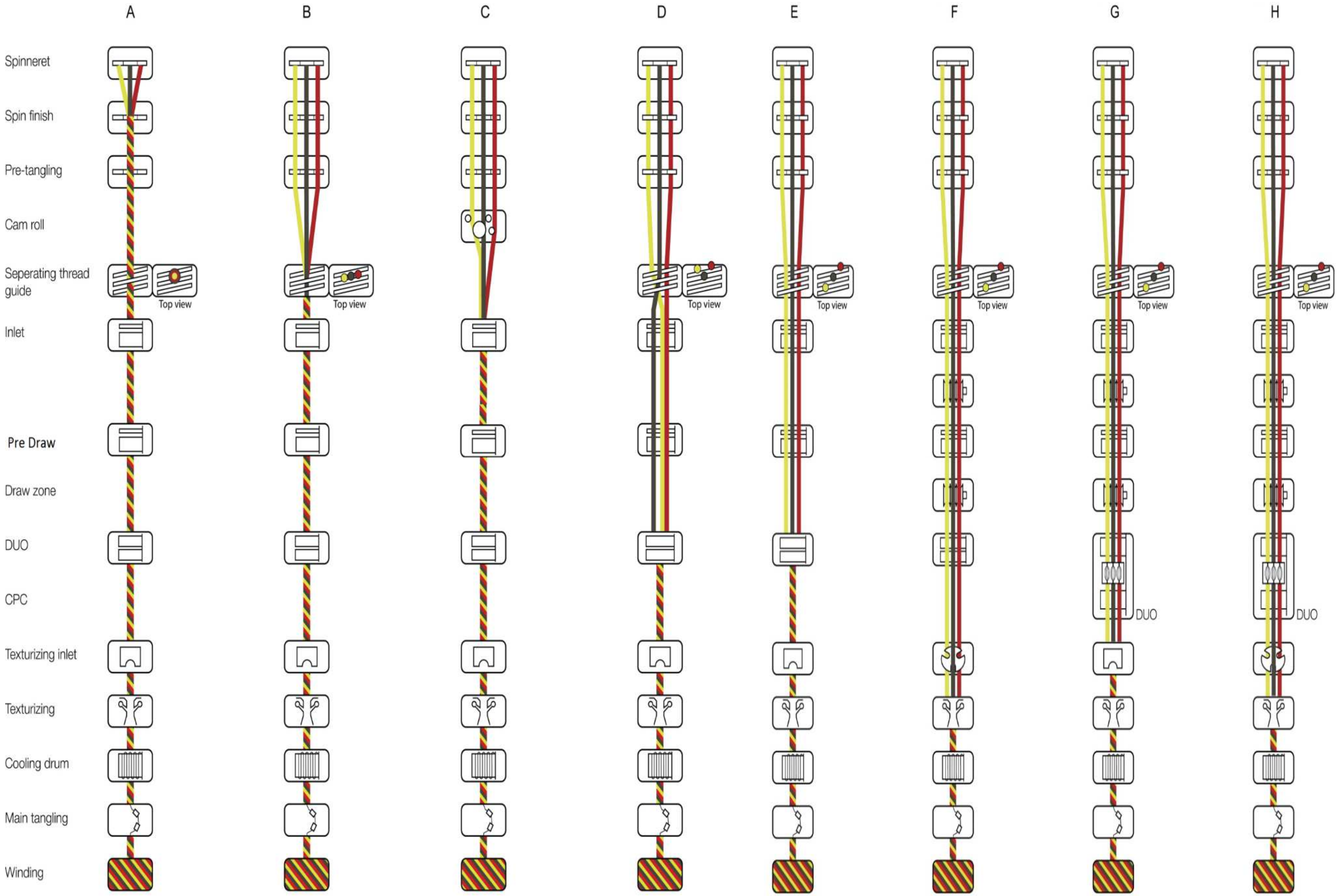
Variomelt





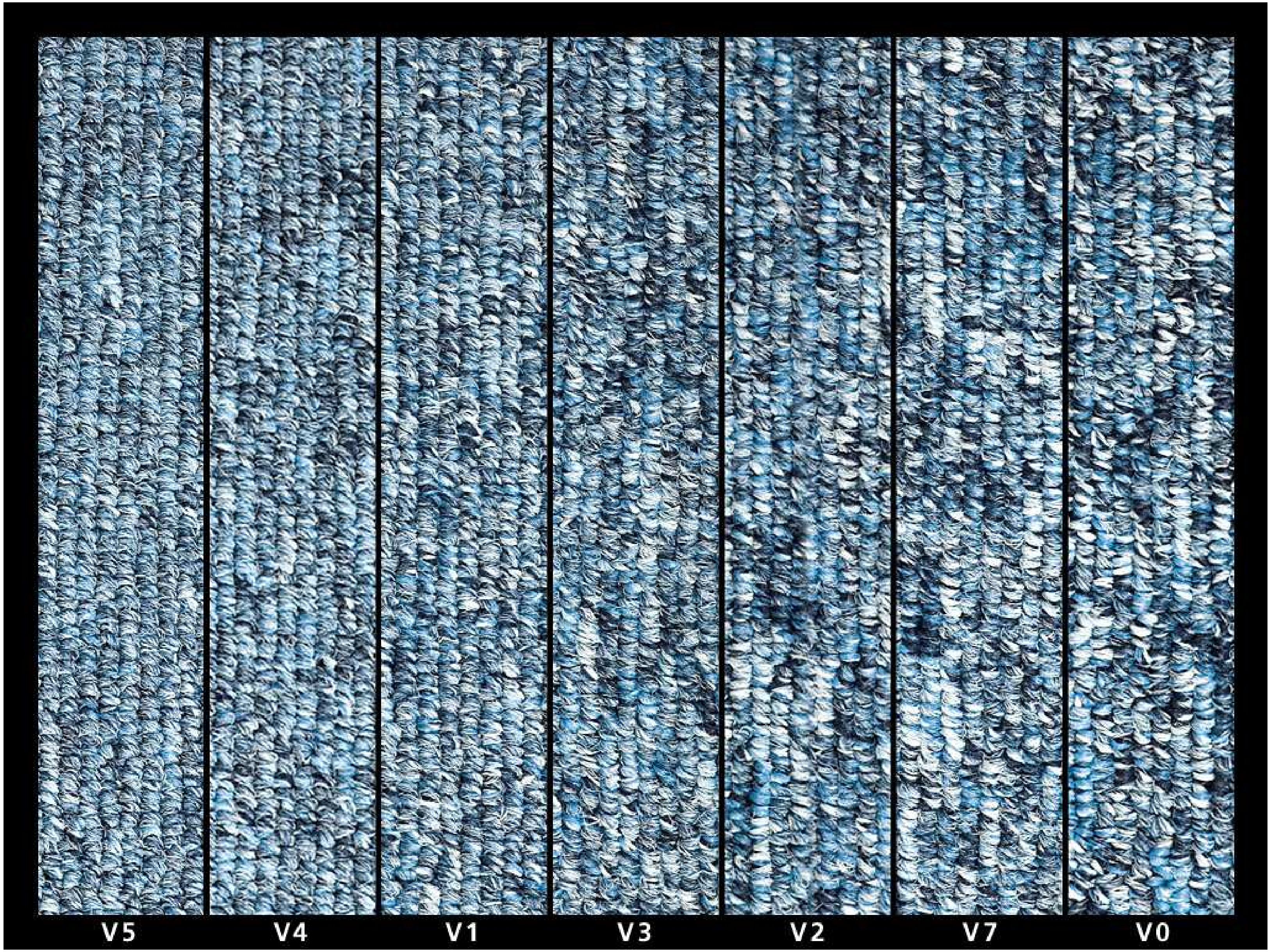
Information only

Tricolor methods

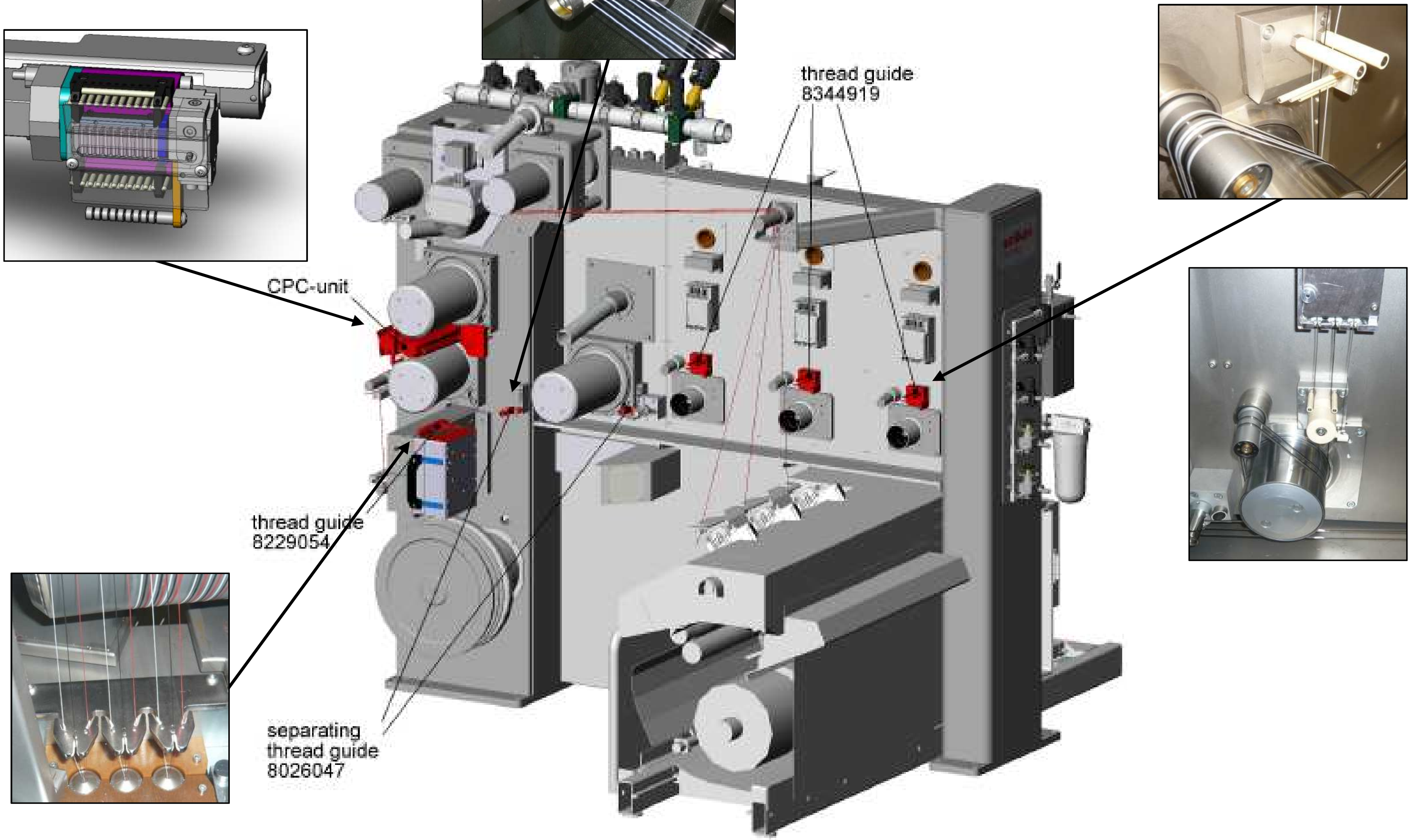


Tricolor methods

C/D C/D D D/E E/F G G



Tricolor methods



Tricolor methods: Thread separation

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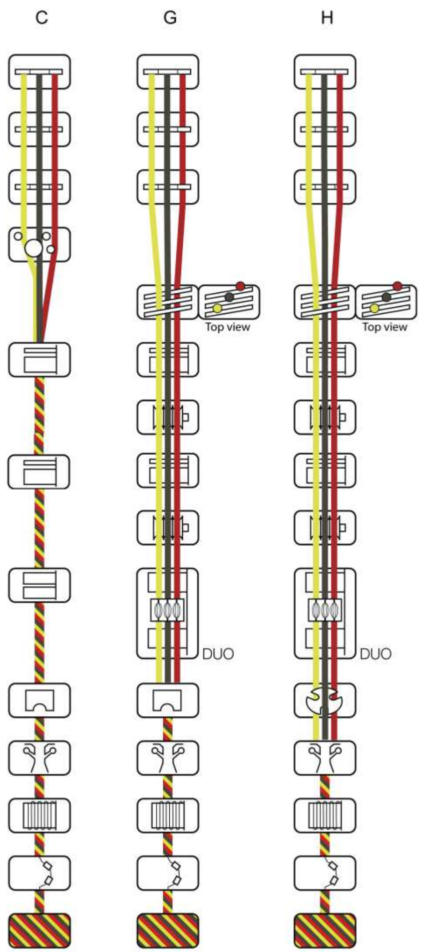
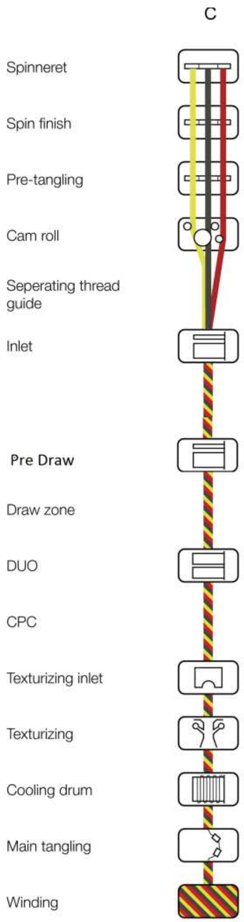


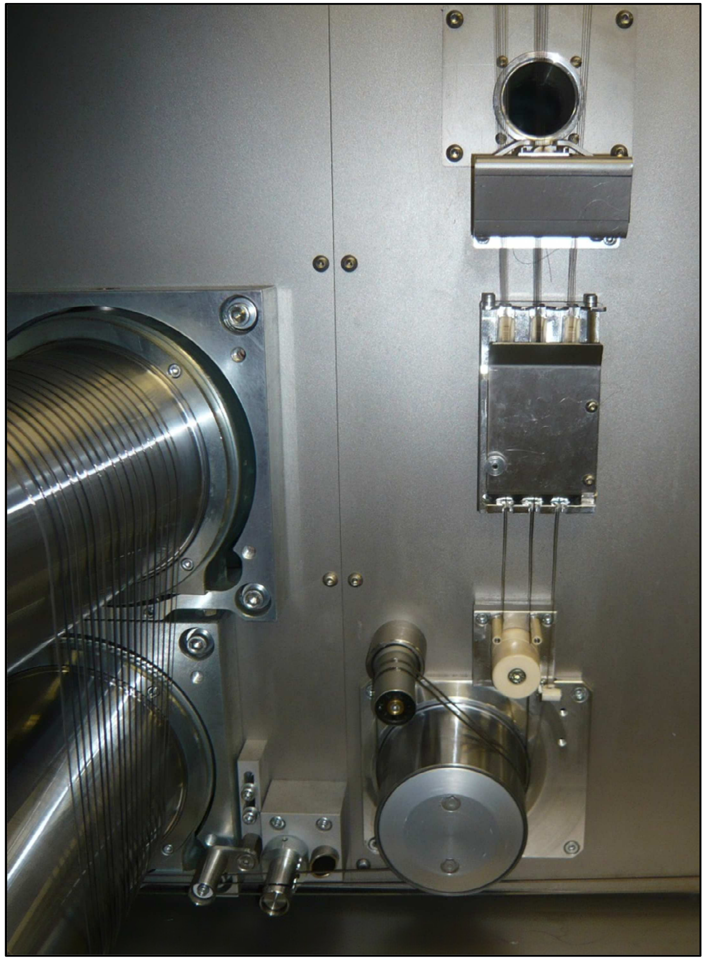
Recommended summary thread separation	C – Cam roll	G - CPC	H - CPC
Oiler	colors separated	colors separated	colors separated
Pre-intermingling	colors separated	colors separated	colors separated
Cam roll	yes	no	no
Thread guides	-	back/center/front	back/center/front
Inlet godet	colors together	colors separated	colors separated
Guide in draw zone	3 colors together	9 separated colors	9 separated colors
DUO	3 ends = 3 threads	3 ends = 9 threads	3 ends = 9 threads
CPC	no	yes	yes
Seperation plate before texturizing	no	no	yes
Texturizing	together	joint	joint
Texturizing equipment	standard	standard	Nozzle with sufficient draw
Tangle unit	Neumag dual tangl.	Neumag dual tangl.	Neumag dual tangl.

Information only

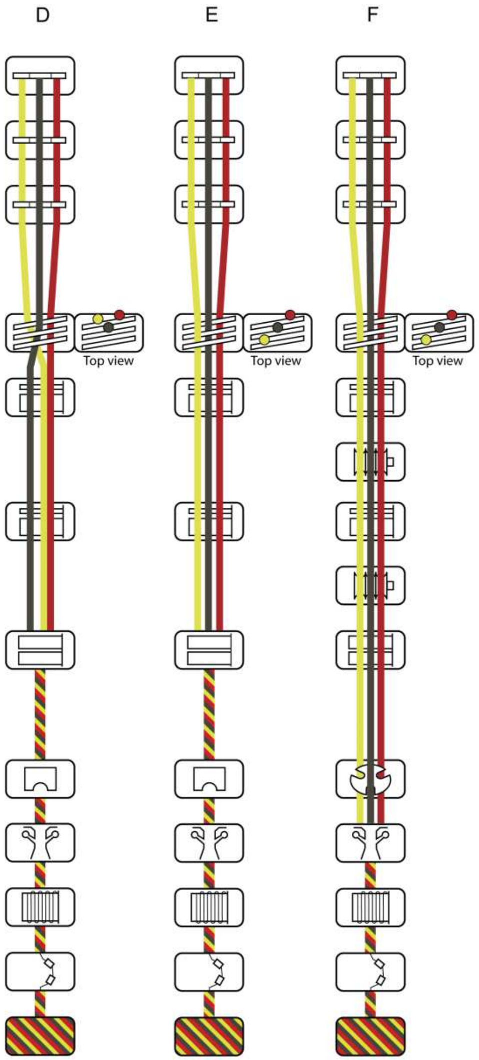
Tricolor methods: C - cam roll

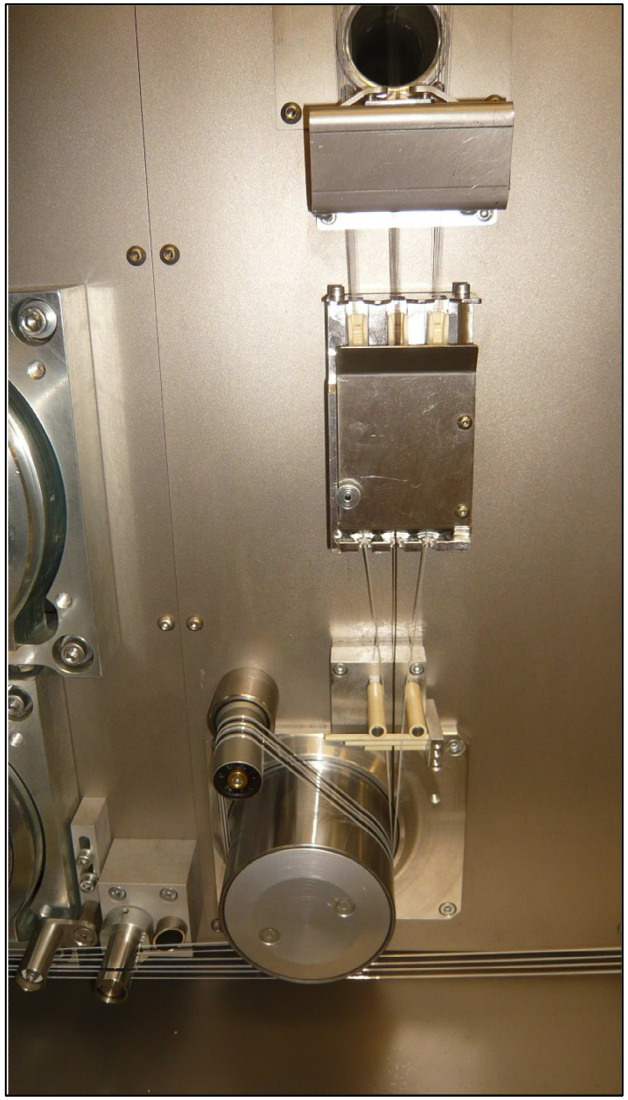
- Cam roll
  - Speed 0 – 200 1/min, typical 80 – 120 1/min
  - The higher the cam roll speed, the greater the colour change frequency = mixing



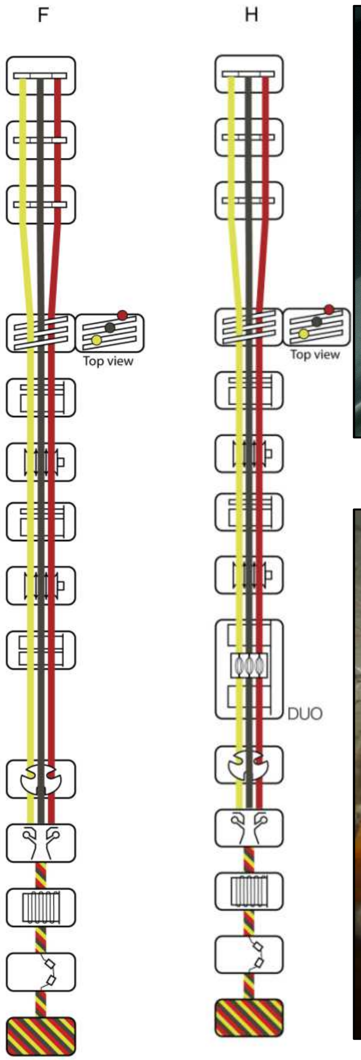


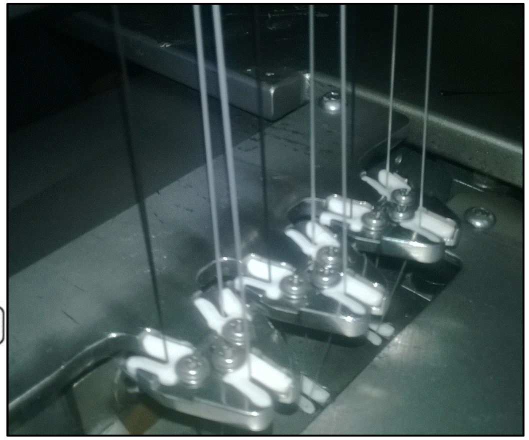
Tricolor methods: D to F (separated yarn path)

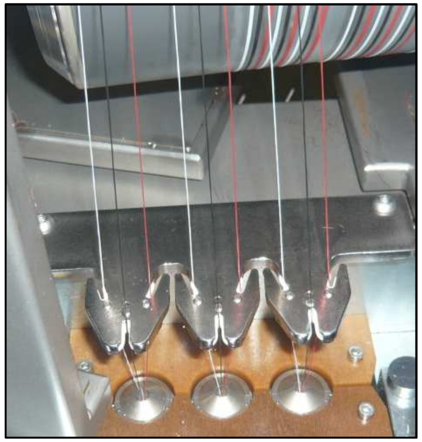


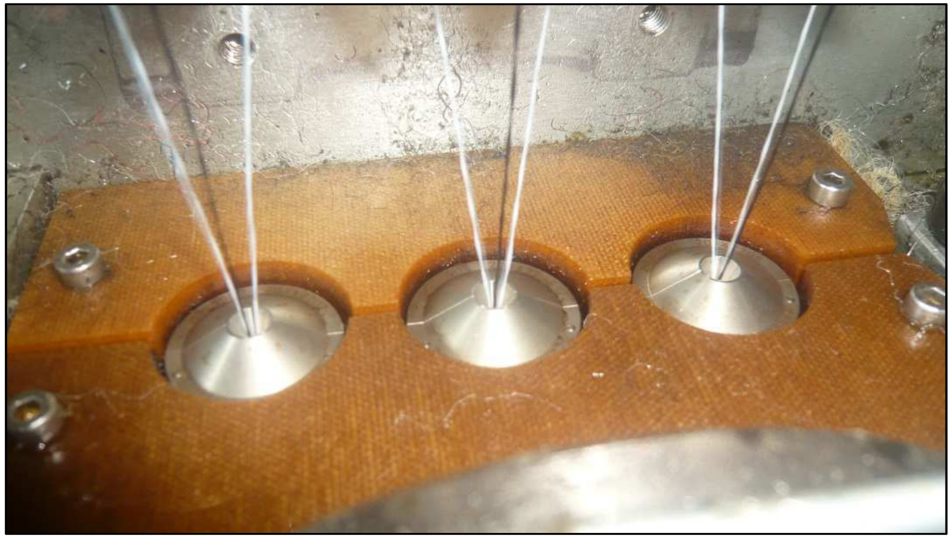


Tricolor methods: F and H (separation guide)

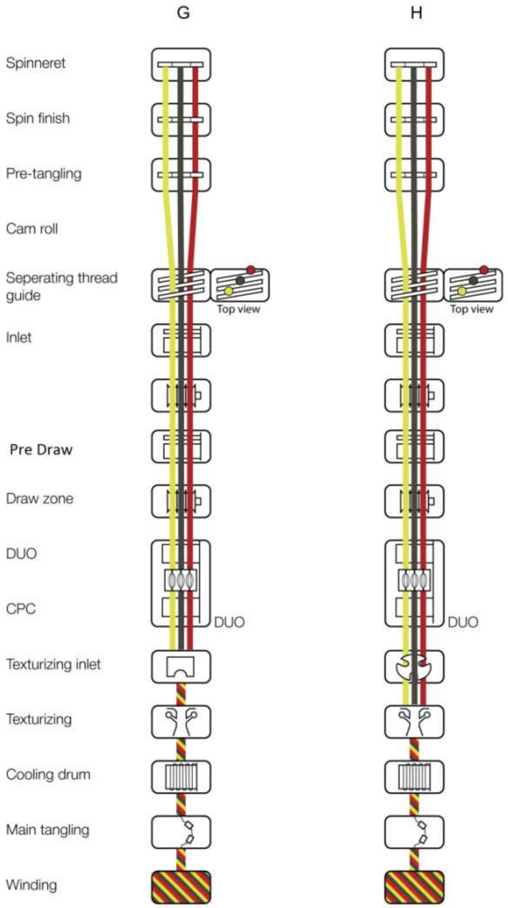




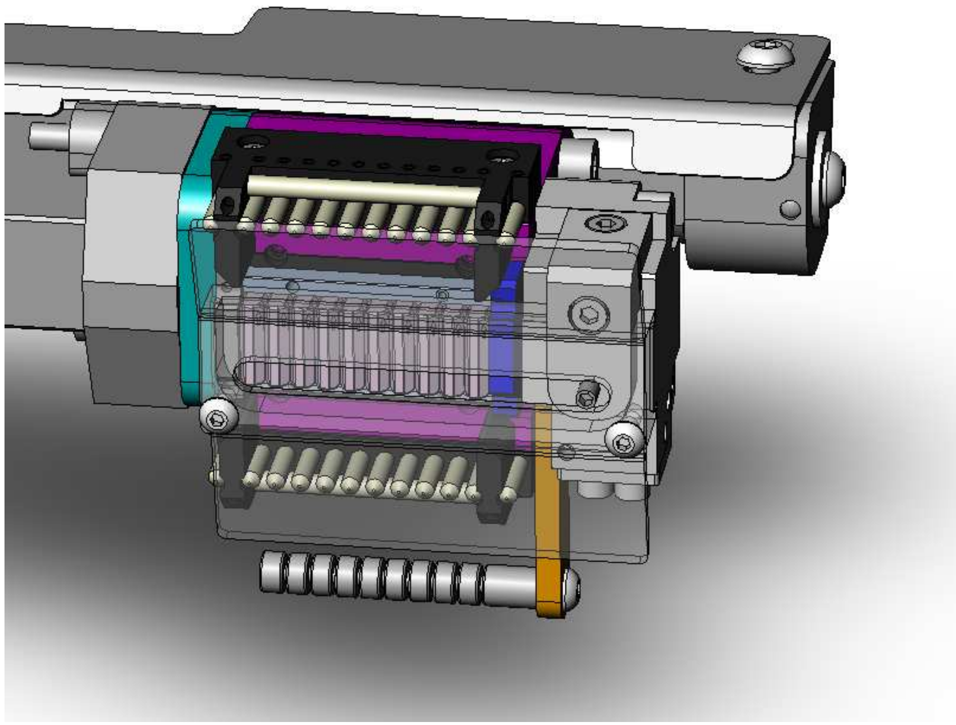




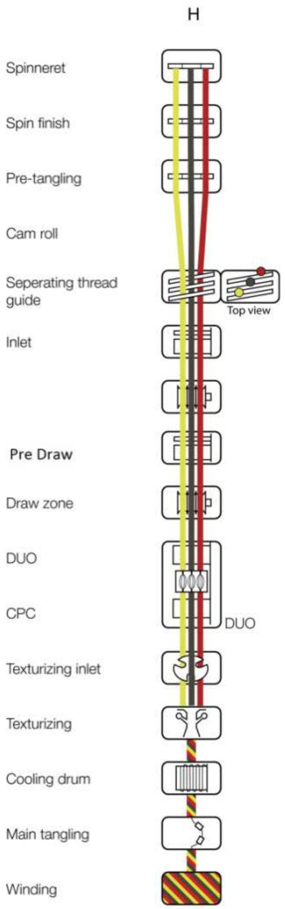
Tricolor methods 6: G-H CPC

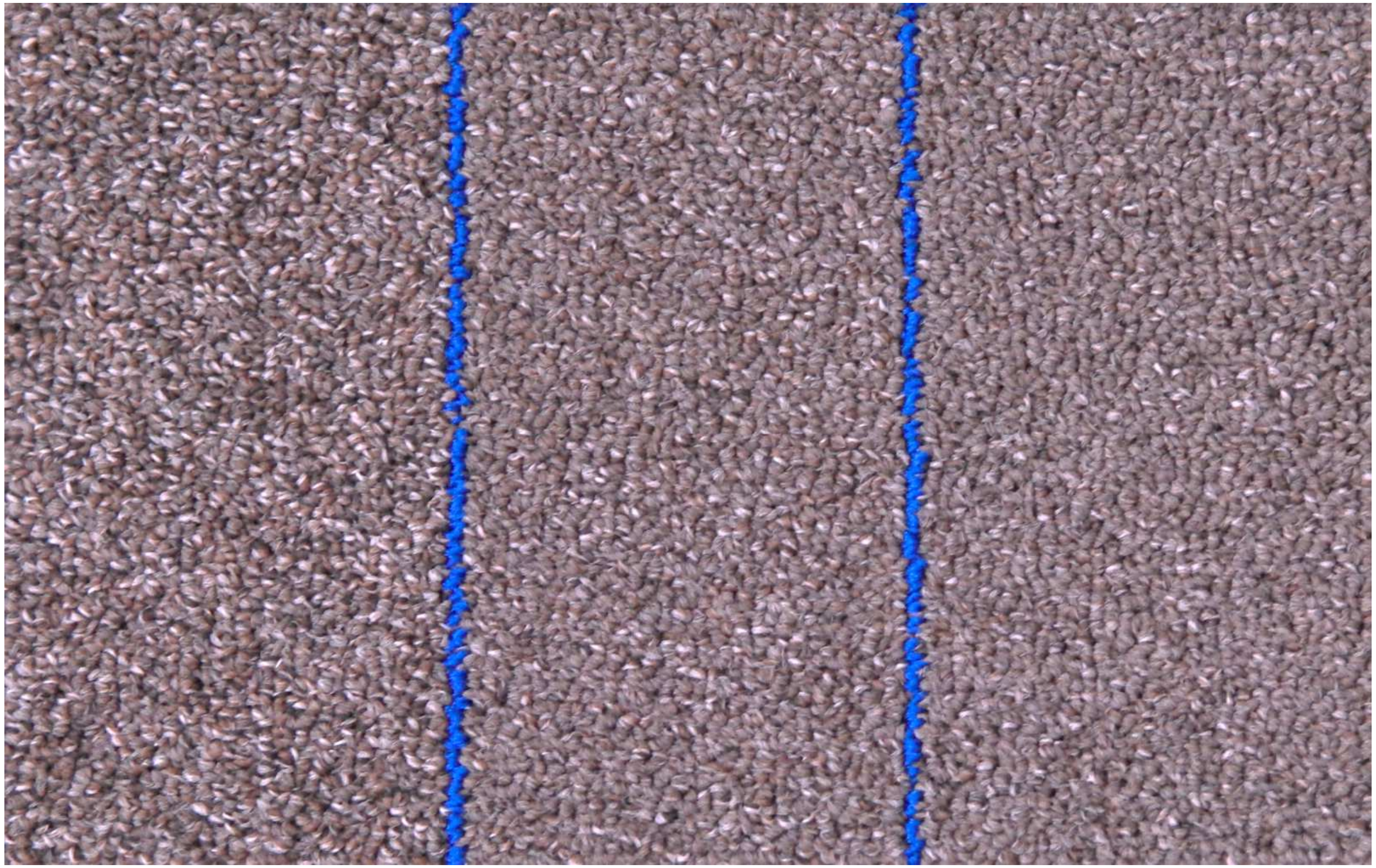


- CPC for PP and PET (**not for PA6**)
  - Only for tricolour for separating the colours
  - 1,5 – 5,5 bar depending on titer, speed and filaments
  - 5 wraps on DUO -> 6th wrap in CPC
  - Proper adjustment (manual)
  - 3end: only 6 mm gauge
  - 2end: 6 or 8 mm gauge



Different CPC pressure adjustments





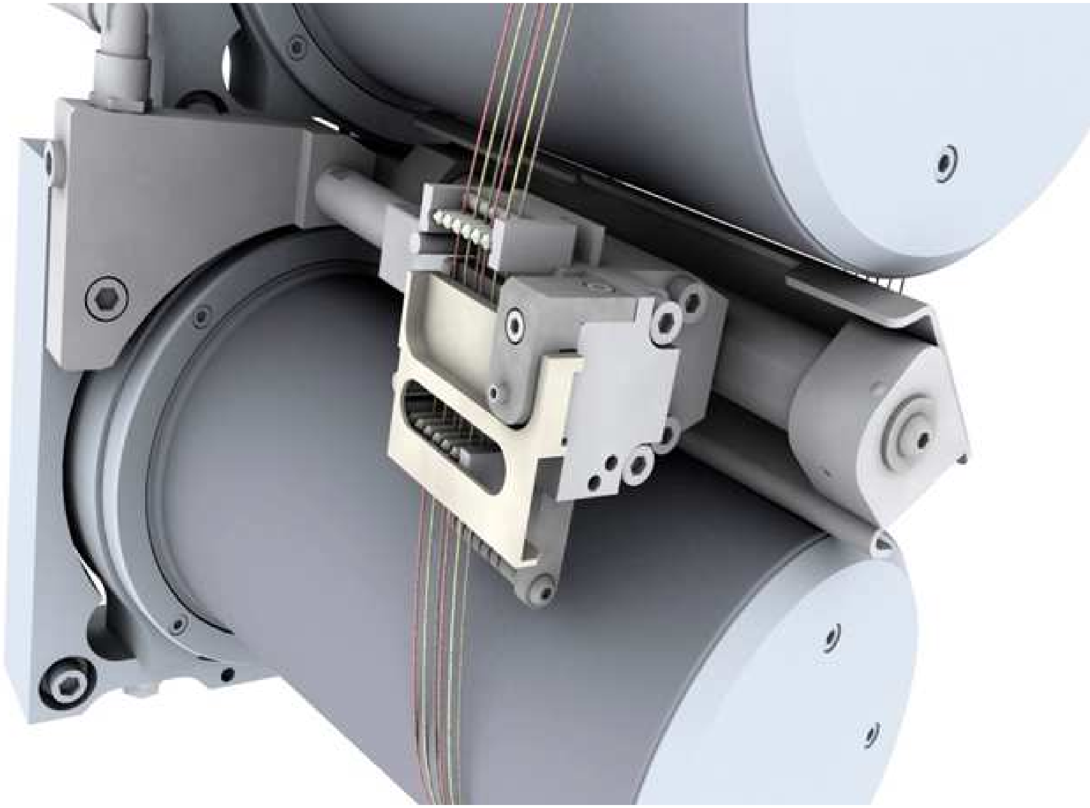
CPC pressure 4.2 bar 2.5 bar 1.0 bar

Max. CPC pressure is depending on the product/process (dpf, speed, resin, spin finish…)

Example: PP 1800f144 dtex

Information only

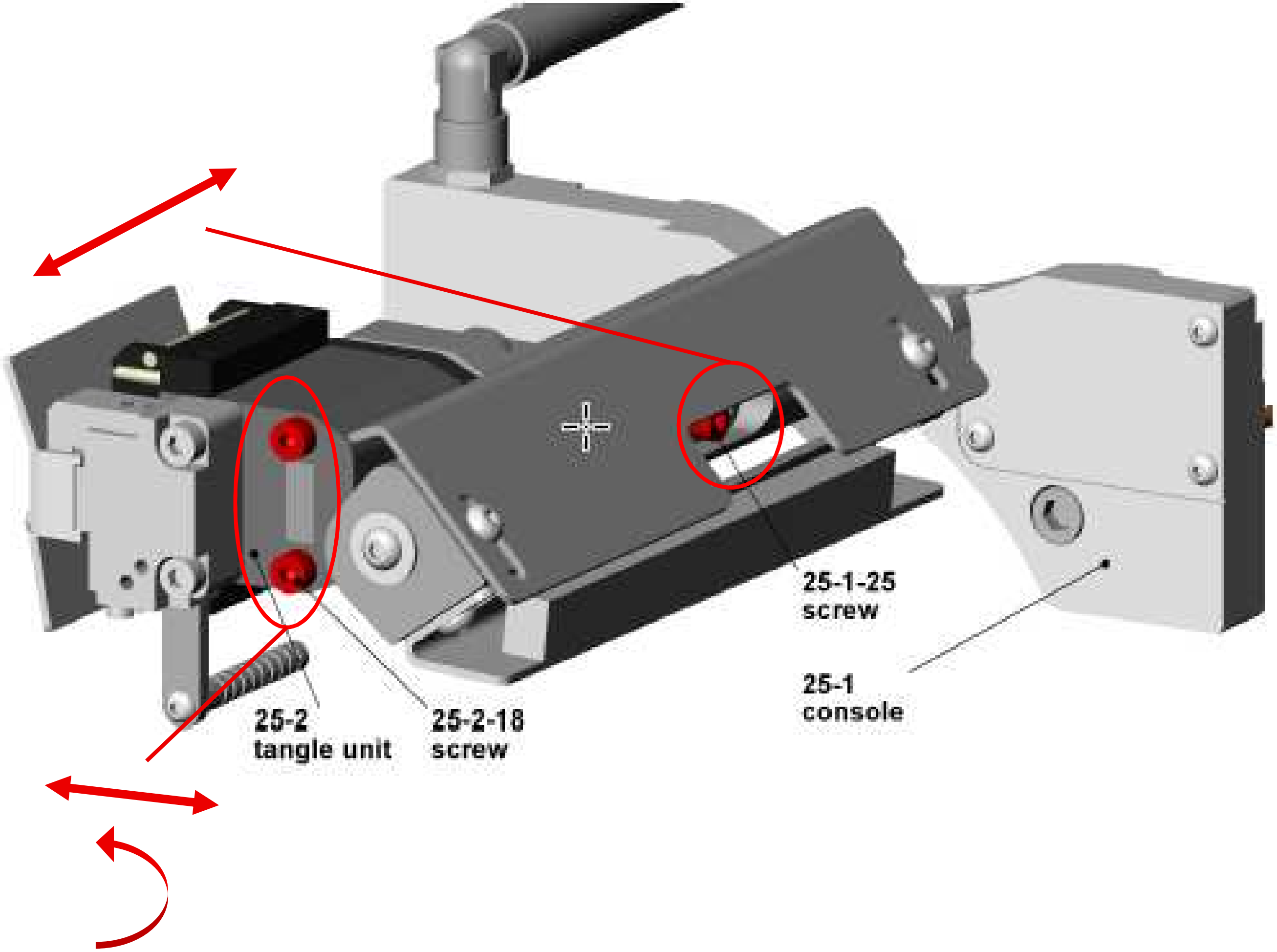
CPC - wrapdetector



Adjustment of the wrapdetector needed!

See manual of the CPC!

CPC – mechanical adjustment of the CPC



CPC – mechanical adjustment of the CPC

- normal products: 5 wraps on DUO/6th wrap in CPC
- low dpf products: 4 wraps on DUO/5th wrap in CPC could be beneficial

- Steps for basic adjustment:
  - Pre-adjust the DUO for 6 wraps

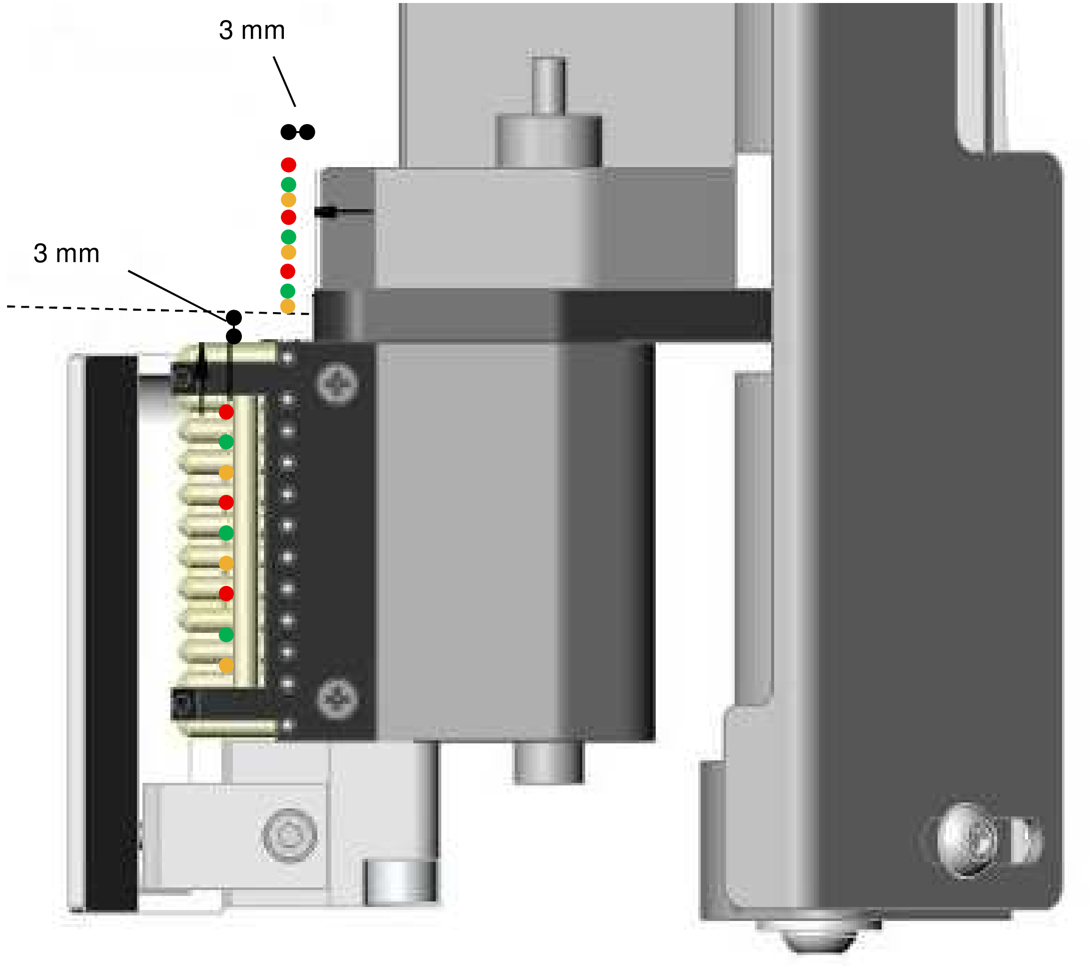
    For a basic adjustment disassembling the DUO hood could be helpful.
    If the color ends touch the lower DUO godet, adjustment of the upper godet could be necessary.
    Hint: Please adjust the godets in production mode!
    Adjust also the threads guides/spin finish applicator for a good yarn path.

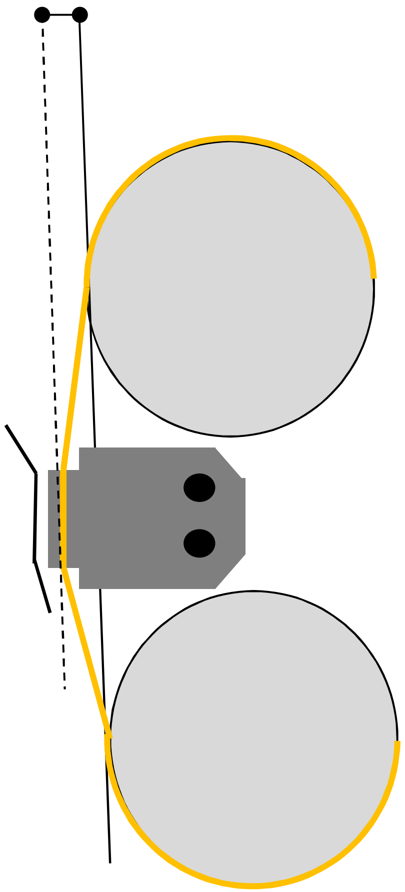
  - Assemble the CPC (stop the position for assembling)

  - String up (in production mode) till the CPC (5 wraps), adjust the CPC and the godet positioning (with the lower godet) in a way so that:
    - Straight yarn path from the CPC in the texturizing
    - Correct distances (shown on the next page)

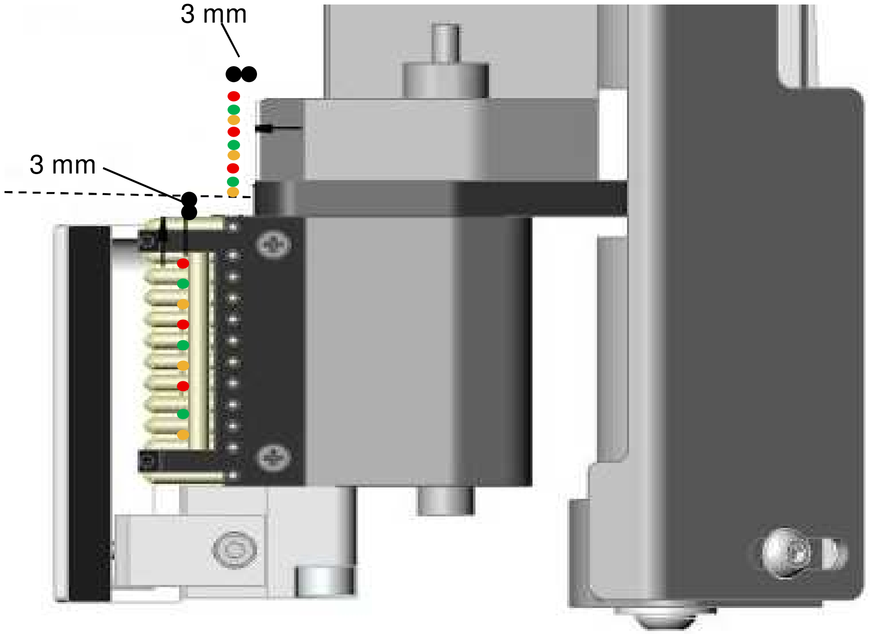
Information only

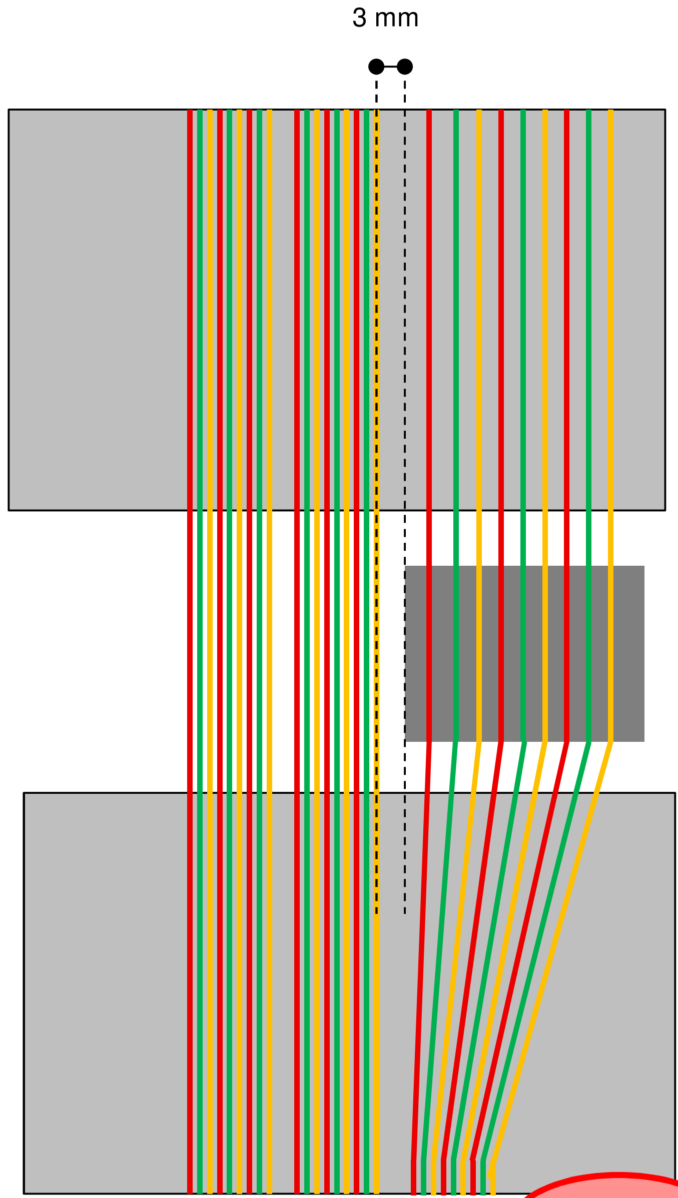
CPC – mechanical adjustment of the CPC





CPC – mechanical adjustment of the CPC





Information only

CPC – mechanical adjustment of the CPC

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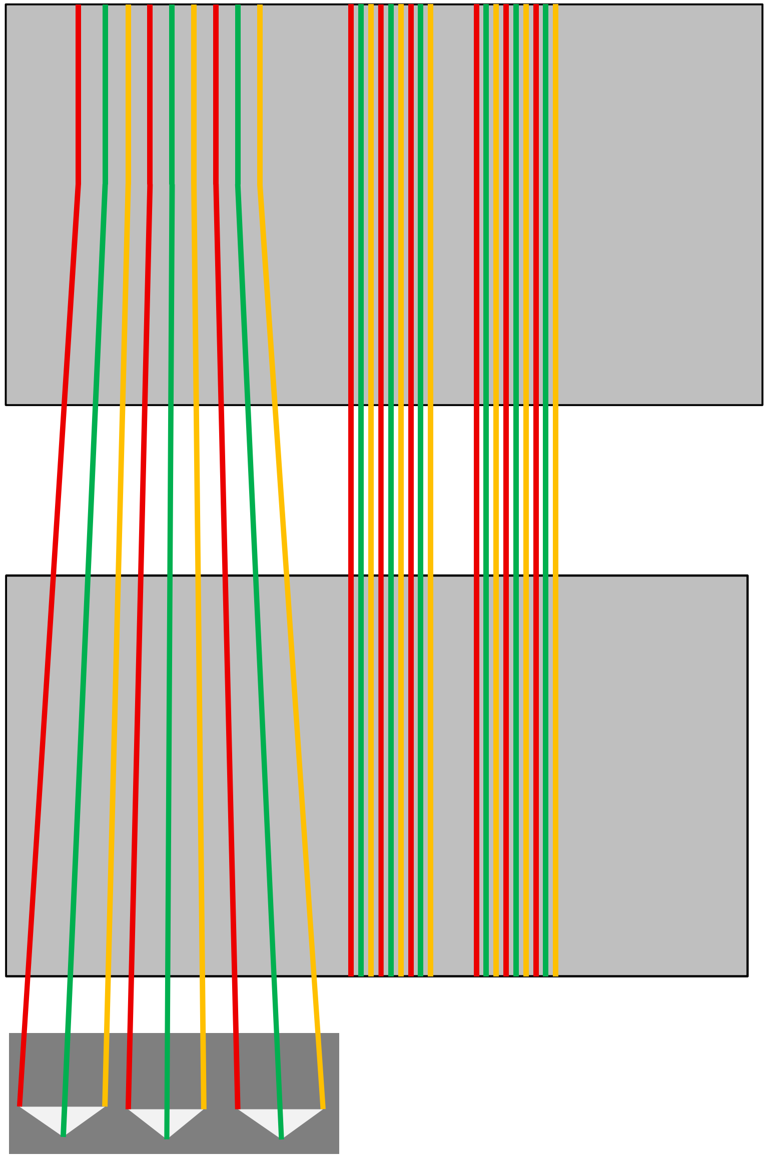
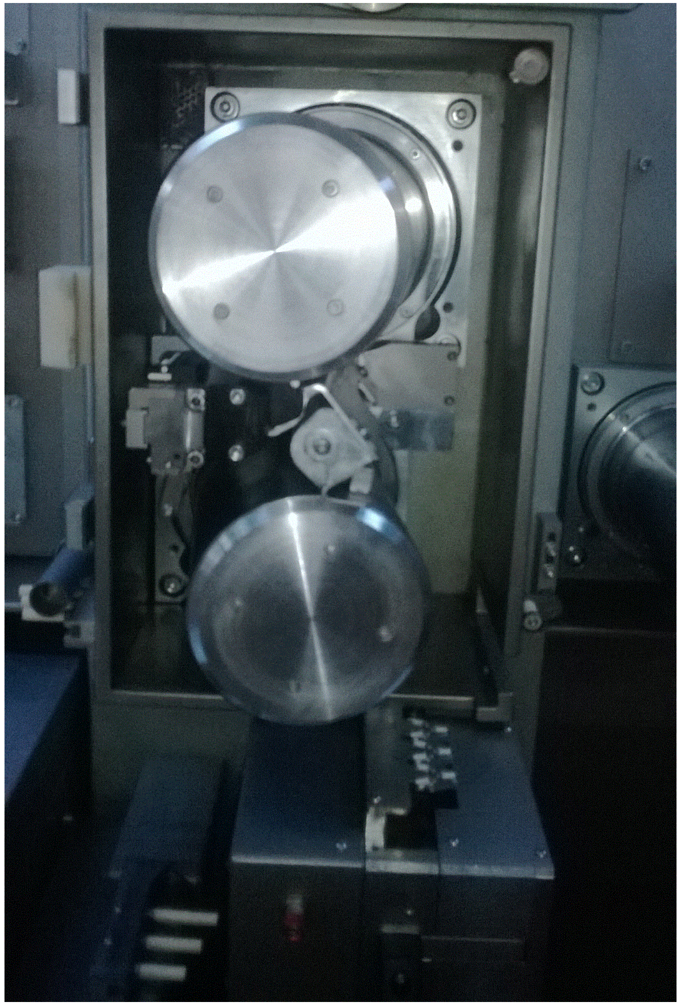


Straight yarn inlet in the texturizing head is important to avoid jumping over!

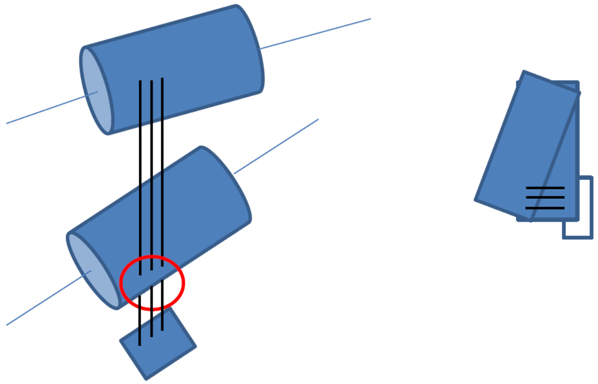
Information only

 confidential

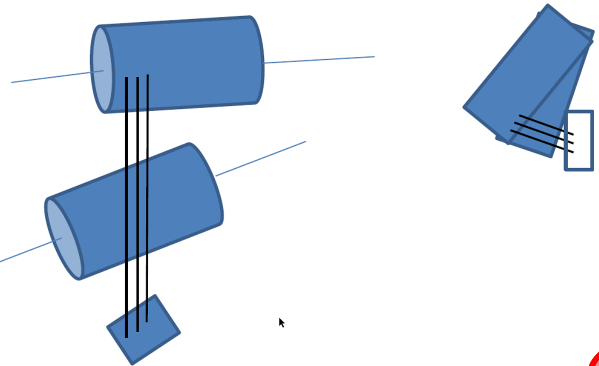
CPC – mechanical adjustment of the CPC



too strong crossing of the lower godet could cause a contact point filaments to lower godet

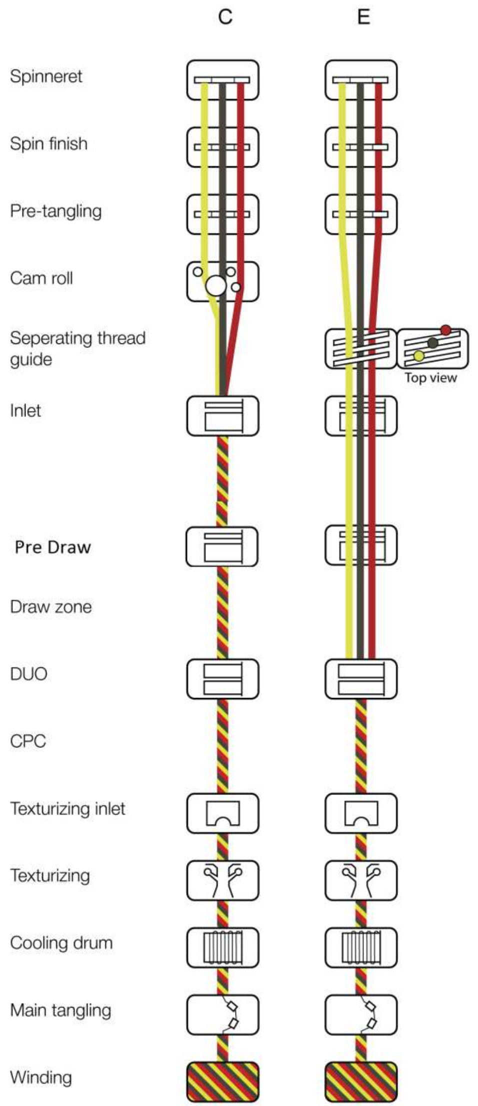


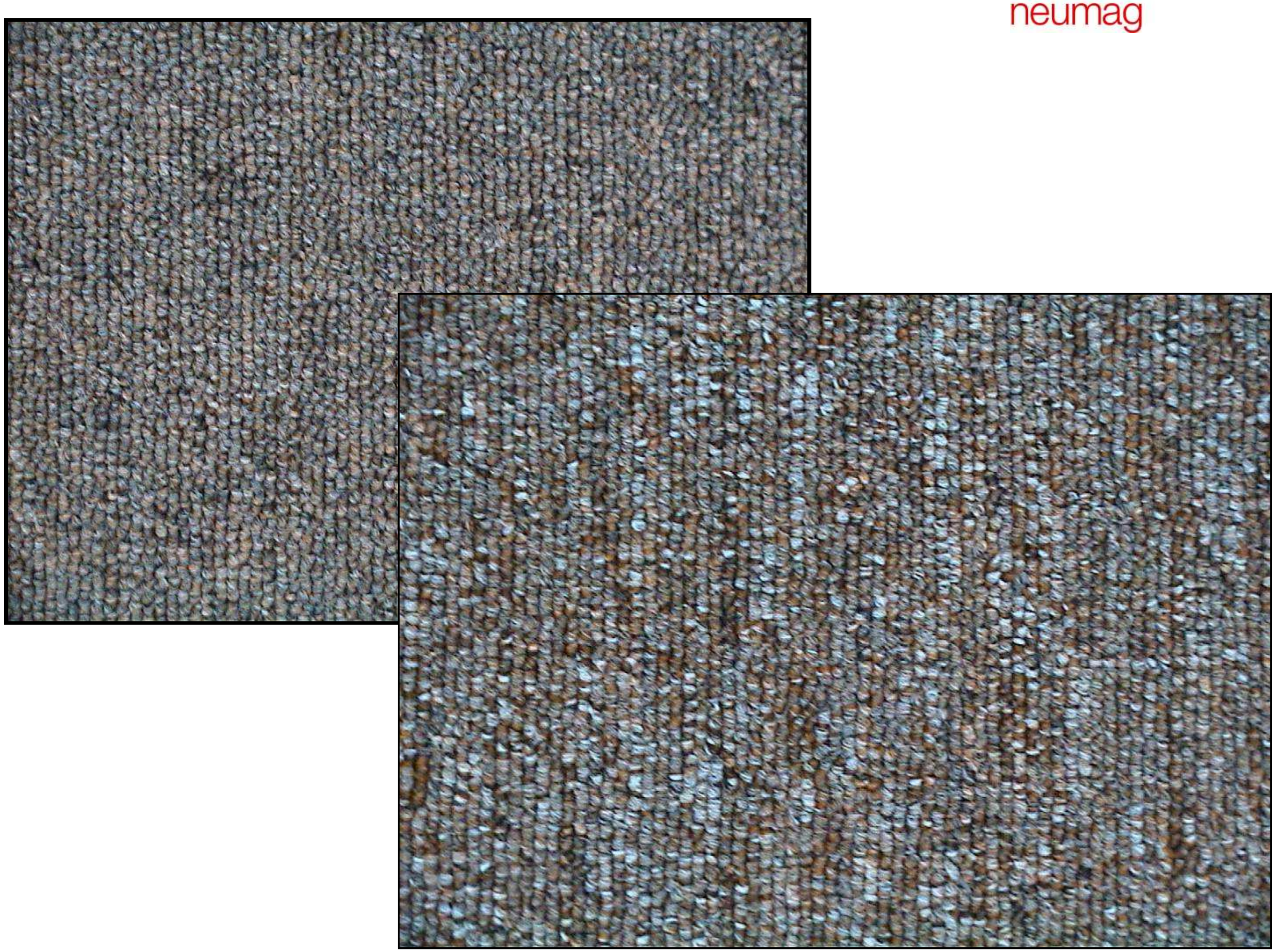
change positioning of the upper godet: normally the upper godet is adjusted so that a straight yarn path in the texturizing is ensured. For running lower number of wraps a readjustment could be necessary.



Information only

Tricolor methods





Very mixed „C“ (dull) vs. Separated „E“ with tendency to „flames“

To avoid flames: recommendation for tangle nodes →
maximum 1 failure node on 15 meter yarn

Information only

Tricolor methods

Colour match card (manual wraped or with a wrap winder)

Information only

Tricolor methods

Colour match

Use sides!!

Not circumferential!

Information only

Typical Carpet defects or desires, looppile Tricolour

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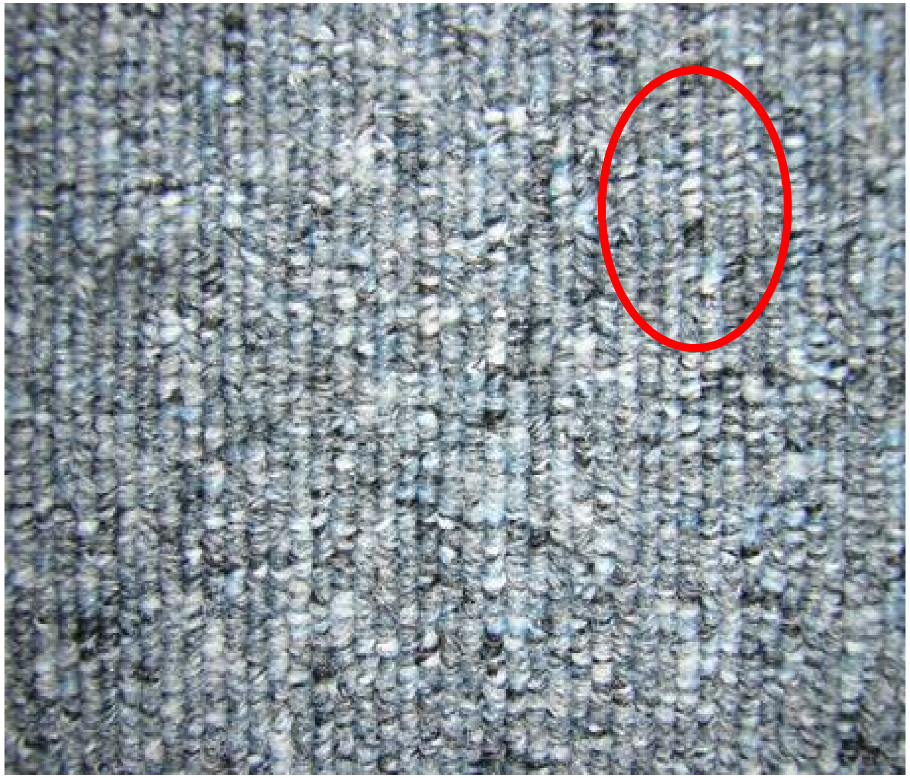
- Tricolour yarns are mostly used for looppile constructions and therefore less sensitive for:
  - Colour dosing unregularities
  - Crimp differences

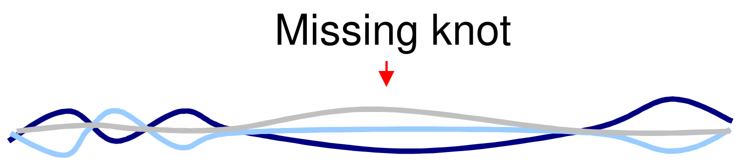
- Carpet defects are moreover related to the aspect of the carpet:
  - Colour mixing effect
  - use of mixing rolls between spinfinish application and first roll
  - parallel or mixed running of the different colours on the godets
  - use of CPC unit to prevent colours to mix-up in the texturation unit
  - yarn tension and pressure at the tangling unit
  - missing tangling knots
  - Too high production speed (missing tangling knots)

Typical Carpet defects or desires, looppile tricolour

- Tufted looppile carpet with tricolour BCF
  - Strips, 15~30 mm long, distributed over the carpet



Occurence:
- light or dark strips unregulary
- Missing tangling knots
- One of the three colours remains at the carpet surface



Possible cause:
- Too low tangling pressure
- Too high production speed
- Too high/low yarn tension at tangling unit

Tricolour

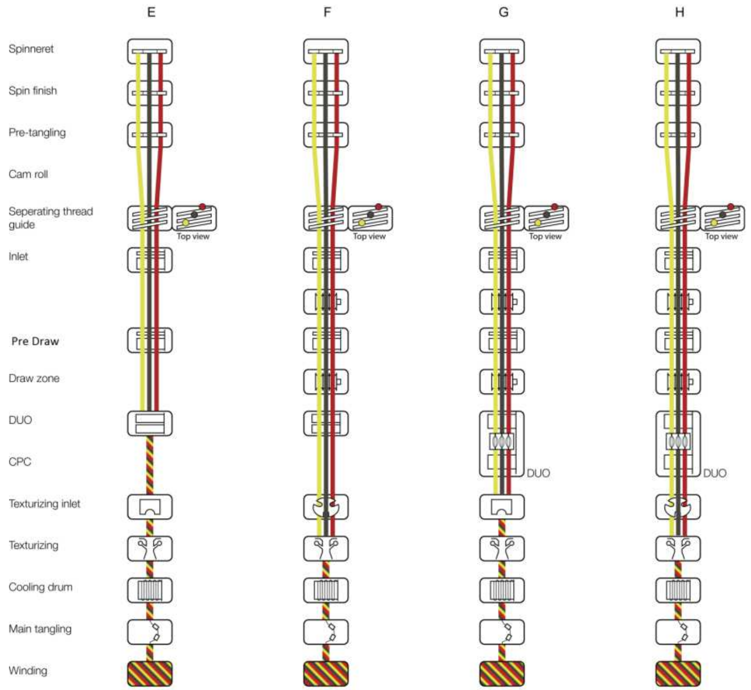
General notes:

- Tangle node interruptions of more than 5 cm create more or less strong "flames". These are sometimes desirable and sometimes not.
- Tangle node interruptions longer than 15 cm create "stripes".
- The thread tension after the cooling drum is decisive for the tangle capability of the yarn. The thread tension must be kept constant: approx. 100-120 cN
- The thread tension before the tangle unit (twist) is decisive for avoiding tangle interruptions. It must be between 110 and 140 cN (below 70 cN and above 160 cN tangle interruptions result).
- The thread tension before the winder is important to prevent the tangle node from undoing again. It must be between 100 and 150 cN (above 200 cN tangle interruptions are possible).
- Dependent on the bobbin design the bobbins can look very different: A winder tending to thrown off ends (spider webs) the bobbin clearly looks more colour-separated on the side than on a smooth bobbin.
- High tangling pressure required to create even nodes.

Tricolour

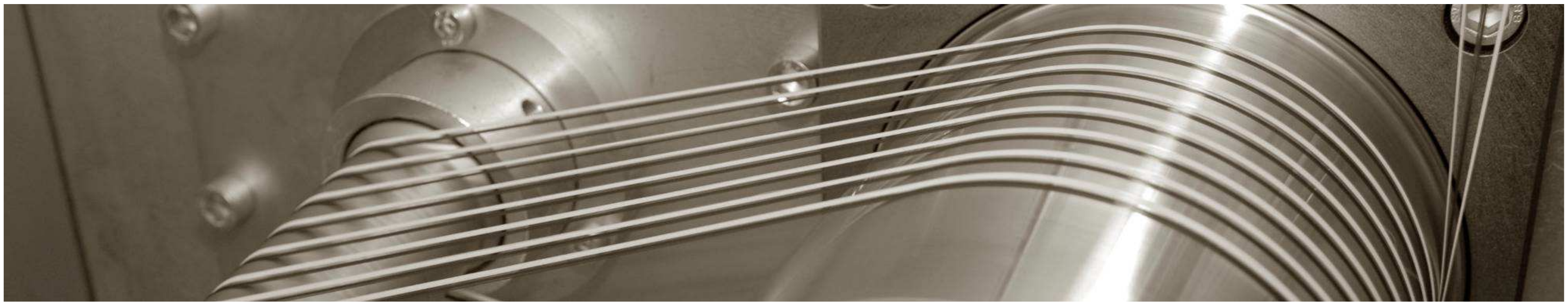
Special notes on high colour separation ("E" to "H"):

- For spotted yarn without flames: Tangle nodes have an even higher importance for the appearance of the carpet than in operations where the texturizing still acts as "mingling organ": Max. 1 tangle interruption per 5 m is permissible and this must not be longer than 5 cm between the tangle nodes.

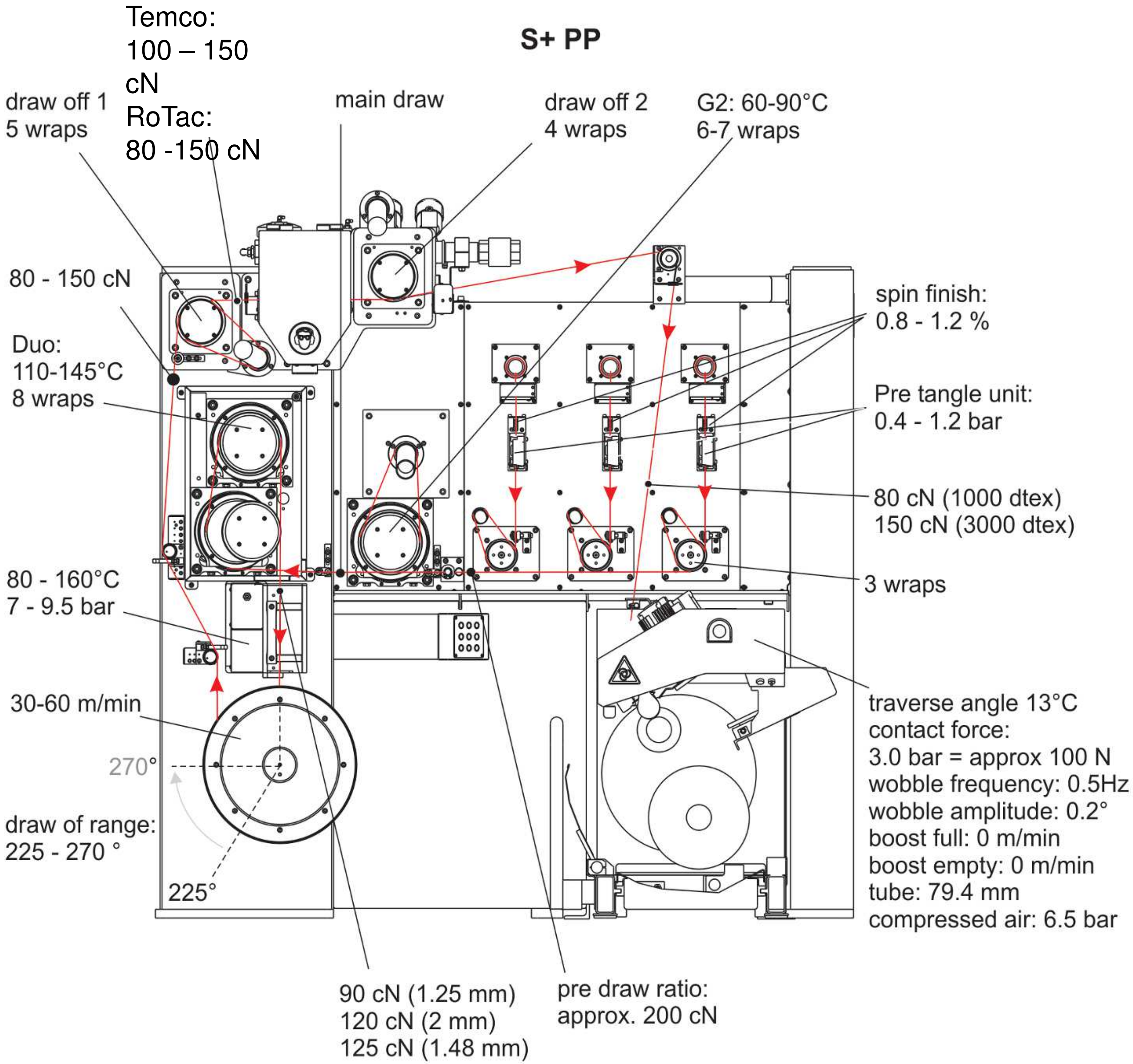


- For colours with strong contrast the speed must be reduced to colours with poorer contrast (see notes to "F").
- Very high tangling pressure required to create even nodes.
- Tangle node number above 28 nodes per m with tangle node stability of above 90 % required to prevent flames.

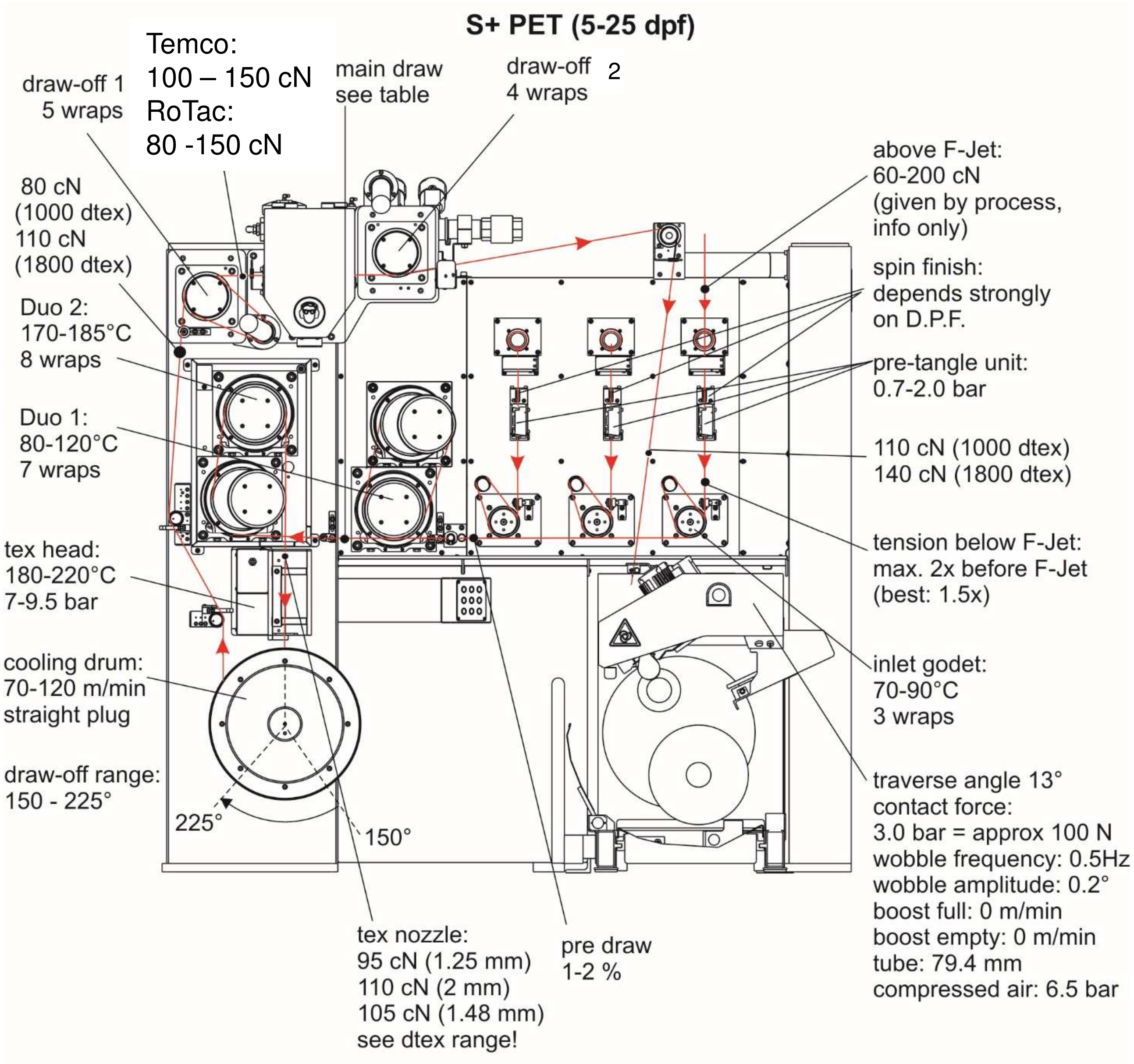
Session 3
process optimization



Overview S+ take up PP



Overview S+ take up PET



Information only

Overview BCF-S8 take up PP

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S8 - PP

pre draw
7 to 10 wraps
80°C to 120°C

pre draw
1% to 2%

pre tangle unit
3 mm or 4 mm
0,2 bar to 2 bar

spin finish
pin vs. dimple oiler
emulsion vs. neat oil

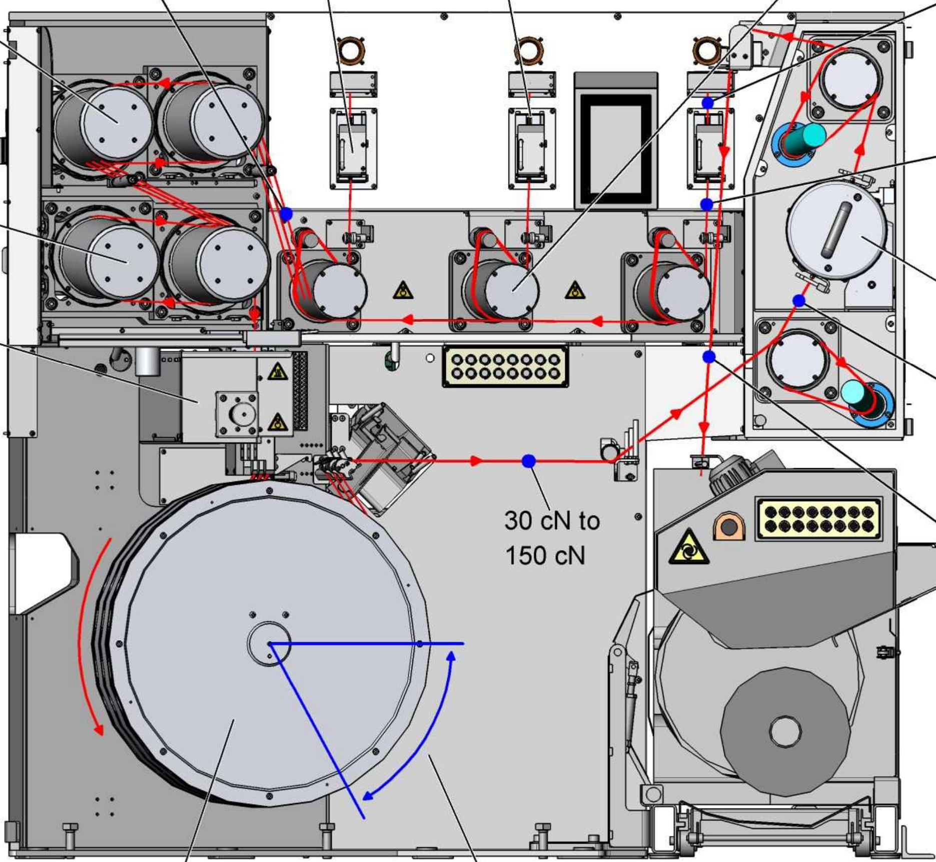
unheated inlet godet
L-wrap (low dpf),1 wrap,
3 wraps

main draw
8 to 10 wraps
110°C to 140°C

tex. head:
80°C to 140°C
7 bar to 9,5 bar

nozzles:
1,25 - 90 cN
1,48 - 100 cN
2,05 - 95 cN
(depending on
product titer and
production speed)

chambers:
3,0 / 4,5
3,6 / 6,0
4,0 / 7,0



above F-Jet
60 cN to 300 cN

behind F-Jet
1,2 to 2,5 times
value from above
F-Jet

RoTac
6, 9, 12 holes
4 bar to 9 bar

before RoTac
60 cN to 180 cN

before winder
60 cN to 200 cN

cooling drum speed
30 m/min to 150 m/min

plaiting angle
210° to 270°

Information only

Overview BCF-S8 take up PET

S8 - PA6

pre draw
7 to 10 wraps
50°C to 90°C

pre draw
1% to 5%

pre tangle unit
3 mm or 4 mm
0,2 bar to 4 bar

spin finish
pin vs. dimple oiler
emulsion vs. neat oil

unheated inlet godet
L-wrap (low dpf),1 wrap,
3 wraps

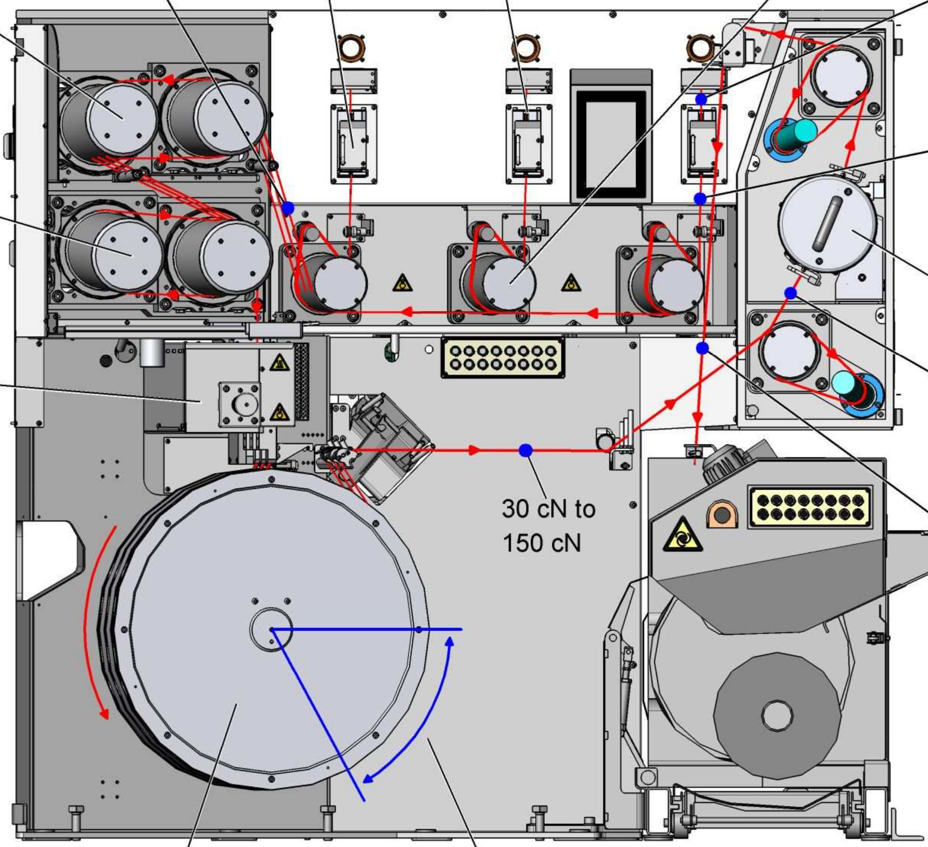
above F-Jet
60 cN to 200 cN

main draw
8 to 10 wraps
165°C to 190°C

behind F-Jet
1,2 to 2,5 times
value from above
F-Jet

tex. head
170°C to 220°C
6,5 bar to 9,5 bar

RoTac
6, 9, 12 holes
4 bar to 9 bar



<u>nozzles:</u>
1,25 - 90 cN
1,48 - 100 cN
2,05 - 95 cN
(depending on
product titer and
production speed)

before RoTac
80 cN to 150 cN

before winder
80 cN (1000 dtex)
to
180cN (2000 dtex)

<u>chambers:</u>
3,0 / 4,5
3,6 / 6,0
4,0 / 7,0

cooling drum speed
30 m/min to 120 m/min

plaiting angle
210° to 270°

Information only

Process optimization

1. Polymer Data
2. Components of a BCF-position
3. Stringing Up
4. Process calculation
5. Process optimization
6. Process data sheet
7. Textile Measurements
8. Maintenance
9. Streaks in carpet
10. Tricolor methods

Process optimization
step overview

- Step 1: Entering set points
- Step 2: Find and set the optimum draw ratio
- Step 3: Finding a setting for the texturizing head
- Step 4: Set the speed of the draw-off godet 1
- Step 5: Set the yarn tension before the tangle unit and before winder
- Step 6: Make textile measurement for checking the yarn properties!

Process optimization – Step 1

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Step 1: Entering set points

- the determined parameters (first calculation) can be entered into the process control system as set points
  → this first calculation is only a good starting point for the optimization

- the quench air speed and the vacuum for the friction texturizing needs manual setting
  → see next steps

- the number of wraps on the godets depending on product
  → take a look at the process parameter overview
  → mechanical adjusting of the godets could be needed

Information only

Process optimization – Step 2

Step 2: Find and set the optimum draw ratio

- Start with the calculated value for the Draw Ratio
- If necessary adjust the pre intermingling pressure (typically 0.4 – 1.2 bar) for a closed run of the thread → avoid splicing on godets
- Check for filament breaks at the godet duo (one minute with **strobe light**, hand is too heat sensitive).
- One end vs. three end

PP/PA6 / PA6.6: max. 1 break per minute
PET: max. 1-2 breaks per minute

PA6 or PET: do NOT long time check while winding: → heat loss WILL create different crystallinity and therefore dye take up! After opening hood fully for 30 sec it does take 2 min to restore heat! (hood with window recommended)

Process optimization – Step 2

Step 2: Find and set the optimum draw ratio

- no filament breaks
  - For maximum tenacity:
    - ➢ Increase the draw ratio gradually until first filament breaks occur
      → try to keep the main draw speed constant
      → maximum possible draw ratio
    - ➢ set the draw ratio with a "safety distance" (less than maximum)

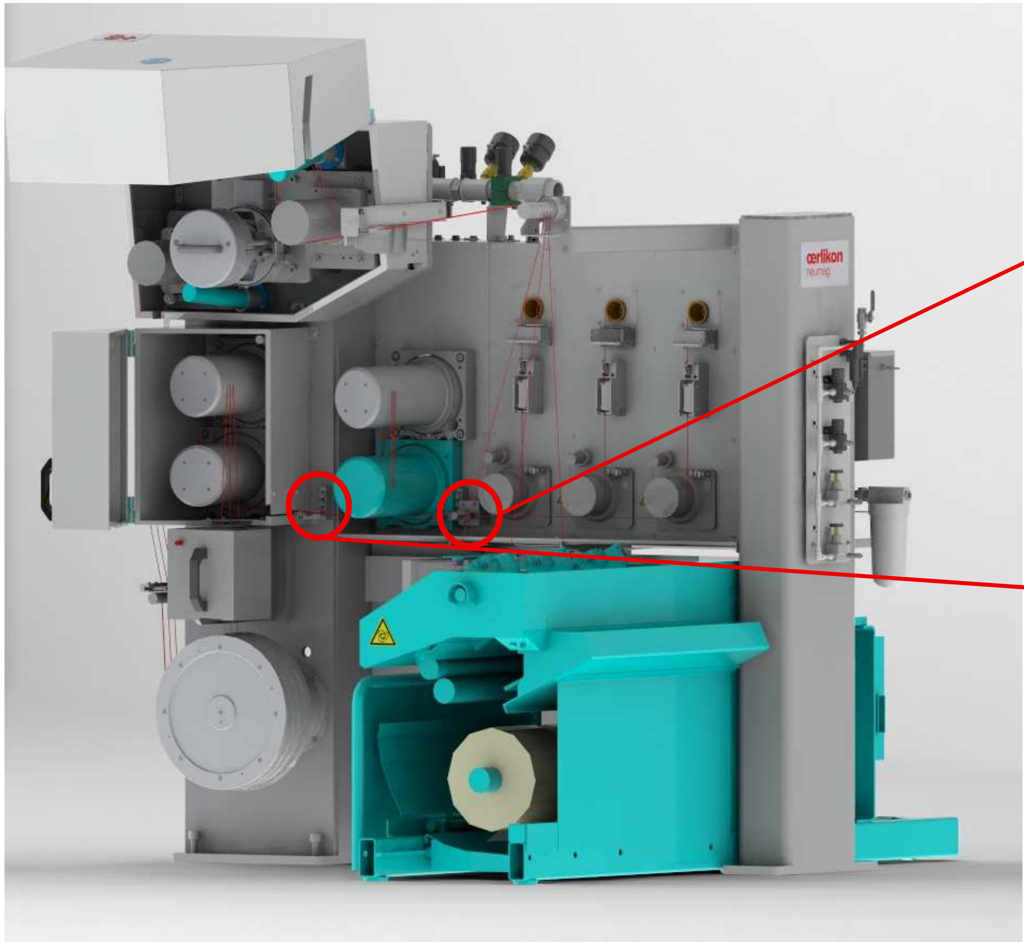
Product	PP BCF	PP Heatset	PA6 / PA6.6	PET
recommended safety distance	0.1 - 0.15	0.2 - 0.3	0.2 - 0.3	0.1

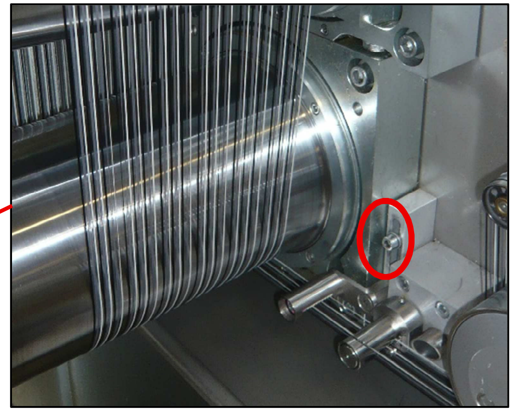
  - Required tenacity:
    - ➢ Adjust the draw ratio until the required yarn tenacity/elongation is reached
- If filament breaks are already present the draw ratio must be gradually reduced accordingly.

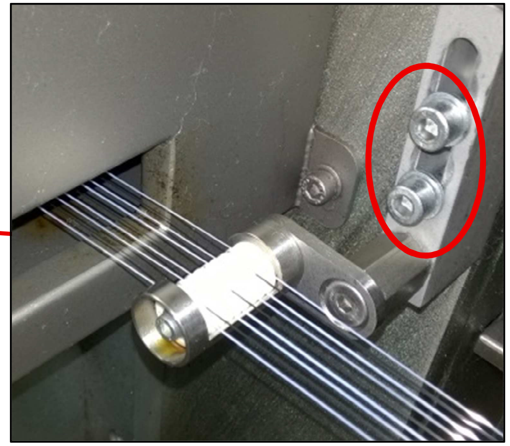
- If the elongation and tenacity are not yet as desired, it should be attempted to achieve them via the **quench air velocity** and **godet temperatures (**pre draw and infeed).

Process optimization – Step 3 – S+

The maximum possible draw ratio is depending on the thread guides







Thread guide positon influence the yarn coherence and the max. DR.

Overview Texturizing: Example PP

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neumag

PP (S+)	lamella chamber 3.0 / 4.5 mm		lamella chamber 3.6 / 6.0 mm			l. c. : 4 / 7 mm
	outlet: 7 mm *	outlet: 8 mm *	outlet: 7 mm *	outlet: 8 mm *	outlet: 9 mm *	outlet: 11 mm *
texturizing nozzle: 1.25 mm						
15 - 25 dpf	800 - 1200 dtex	1200 - 1600 dtex	-	1600 - 2000 dtex	-	-
10 - 15 dpf	500 - 1100 dtex	1100 - 1300 dtex	-	1200 - 1800 dtex	-	-
5 - 10 dpf	500 - 1000 dtex	-	800 - 1200 dtex	1200 - 1600 dtex	-	-
texturizing nozzle 1,48 mm (8225902), see Figure 4-5, “1,48mm-texturizing nozzle No. 8225902” [69]						
15 - 25 dpf	-	-	-	-	see diagram	1900 - 3000 dtex
10 - 20 dpf	-	-	-	-	1000 - 1900 dtex	-
texturizing nozzle 2,0 mm						
15 - 25 dpf	-	-	-	1600 - 2200 dtex	2200 - 4500 dtex	4500 - 6000 dtex
10 - 15 dpf	-	-	-	1600 - 2200 dtex	2200 - 4000 dtex	-
5 - 10 dpf	-	-	-	1600 - 2200 dtex	2200 - 3500 dtex	-
texturizing nozzle 2.3 mm (8345200)						
15 - 25 dpf	-	-	-	-	-	6000 - 8000 dtex
10 - 15 dpf	-	-	-	-	-	-
5 - 10 dpf	-	-	-	-	-	-
* for friction texturizing there is only one size of outlet pipe						

also for PET and PA6 /PA6.6 available

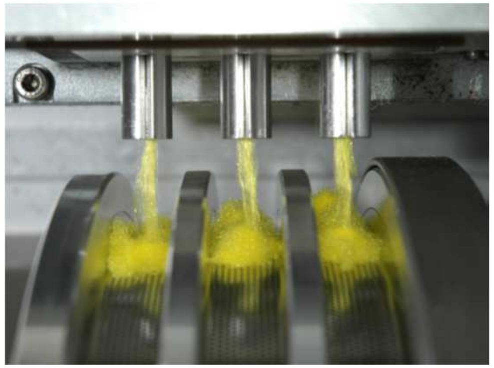
=» see process manual (chapter 4.4)

Process optimization – Step 3

Step 3: Finding a setting for the texturizing head

- As soon as filament breaks disappear, the yarn can be put through the texturizing.
- Adjust the plugging vacuum (friction)/speed of roles (Bitex) until the yarn is properly plugged and texturized properly.

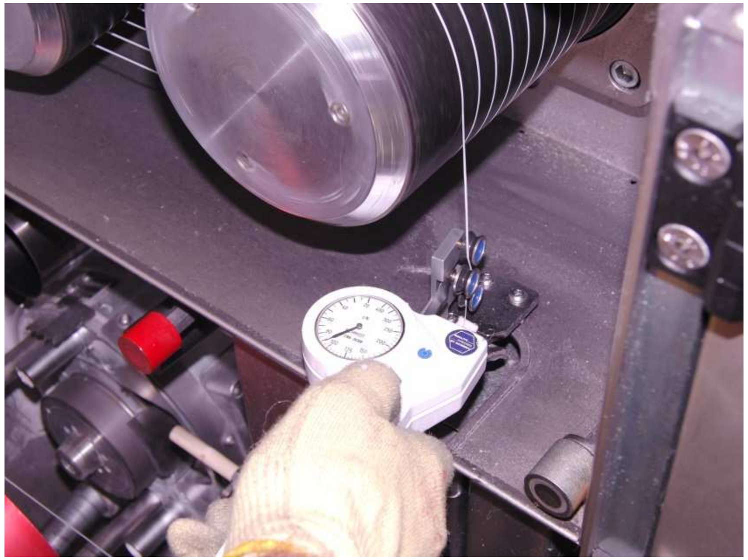
☺ 

 ☹

- Check the yarn tension before texturizing, if necessary adjust the texturizing pressure until the correct yarn tension is reached.

Optimizing – Texturizing pressure

Yarn tension behind DUO



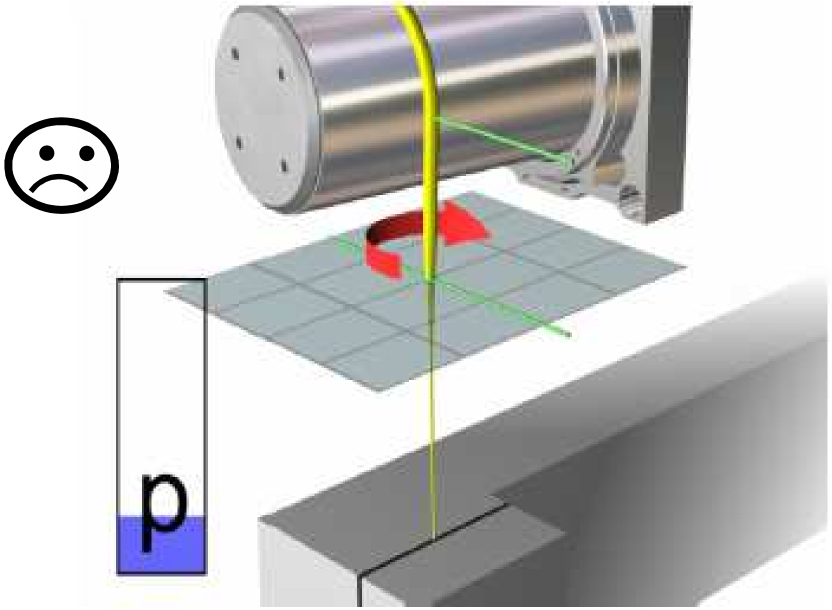
Sytec

1.25 mm nozzle: 80 to 100 cN
1.48 mm nozzle: 100 to 125 cN
2.00 mm nozzle: 110 to 130 cN

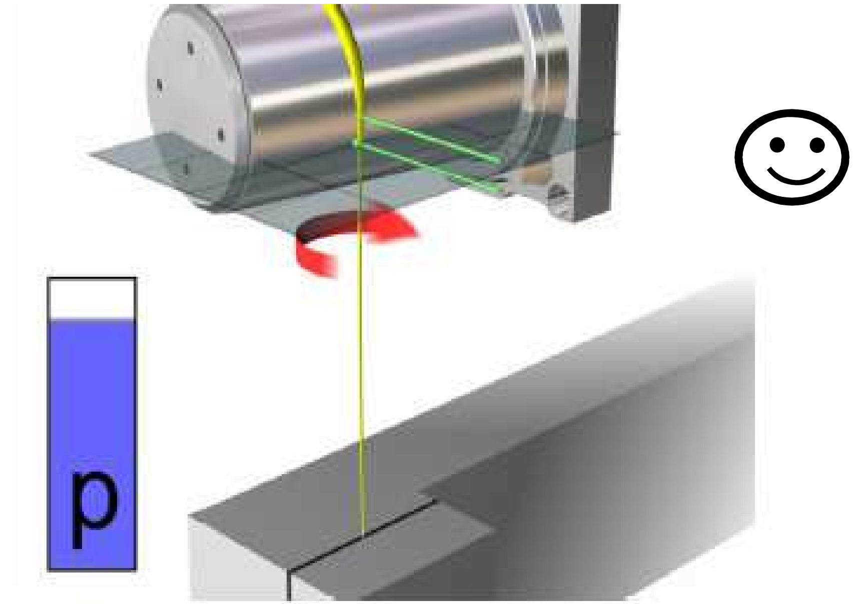
Adjustable with texturizing pressure!

S+

Texturizing: nozzle pressure

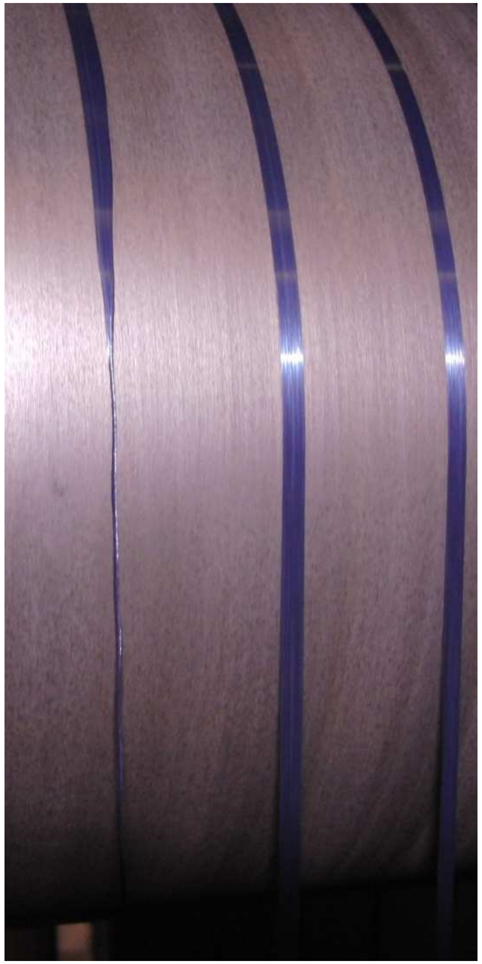


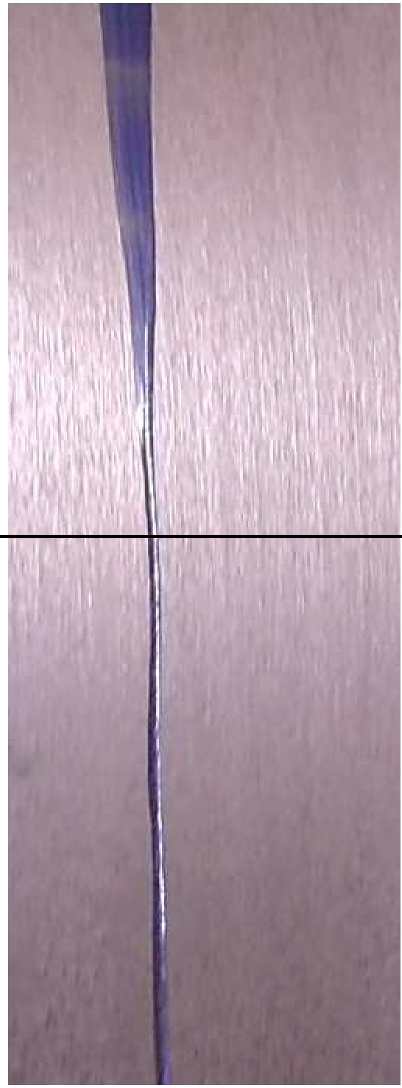
Low nozzle pressure and twist



High nozzle pressure and twist

Process optimization step 3: good twist





Twist strenght

+

0

-

Run off position from godet

Process optimization step 3: too low twist

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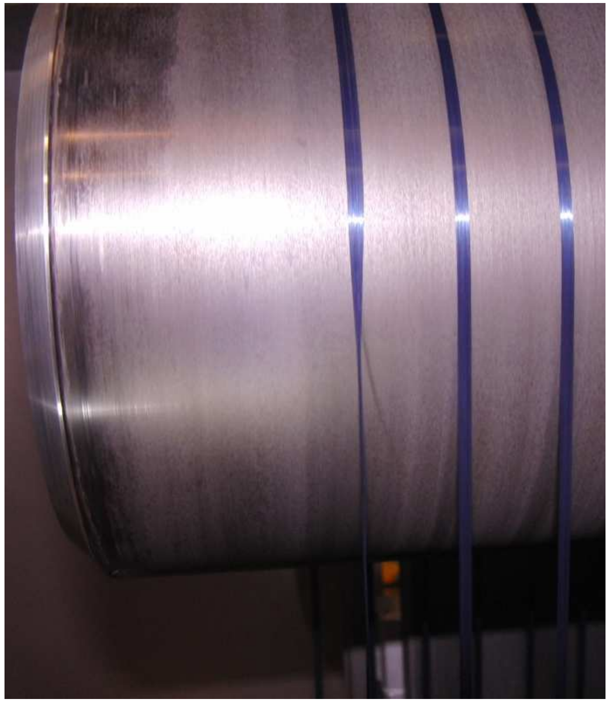

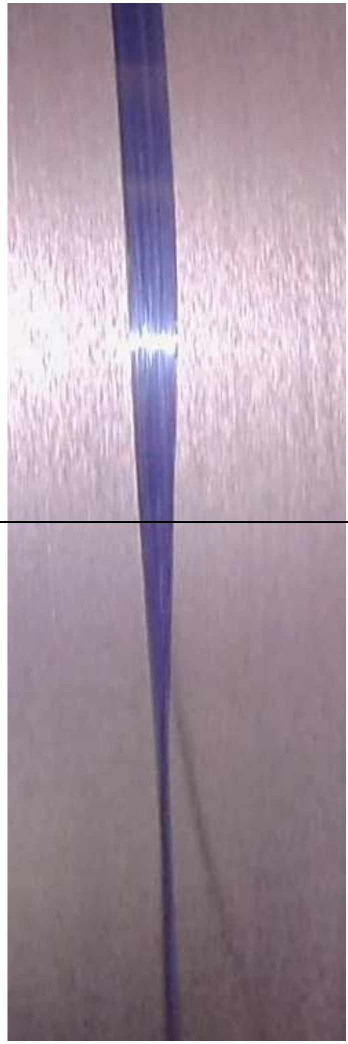

Twist strenght

+

0

-

Run off position from godet

Information only

 confidential

Process optimization step 3: Friktion

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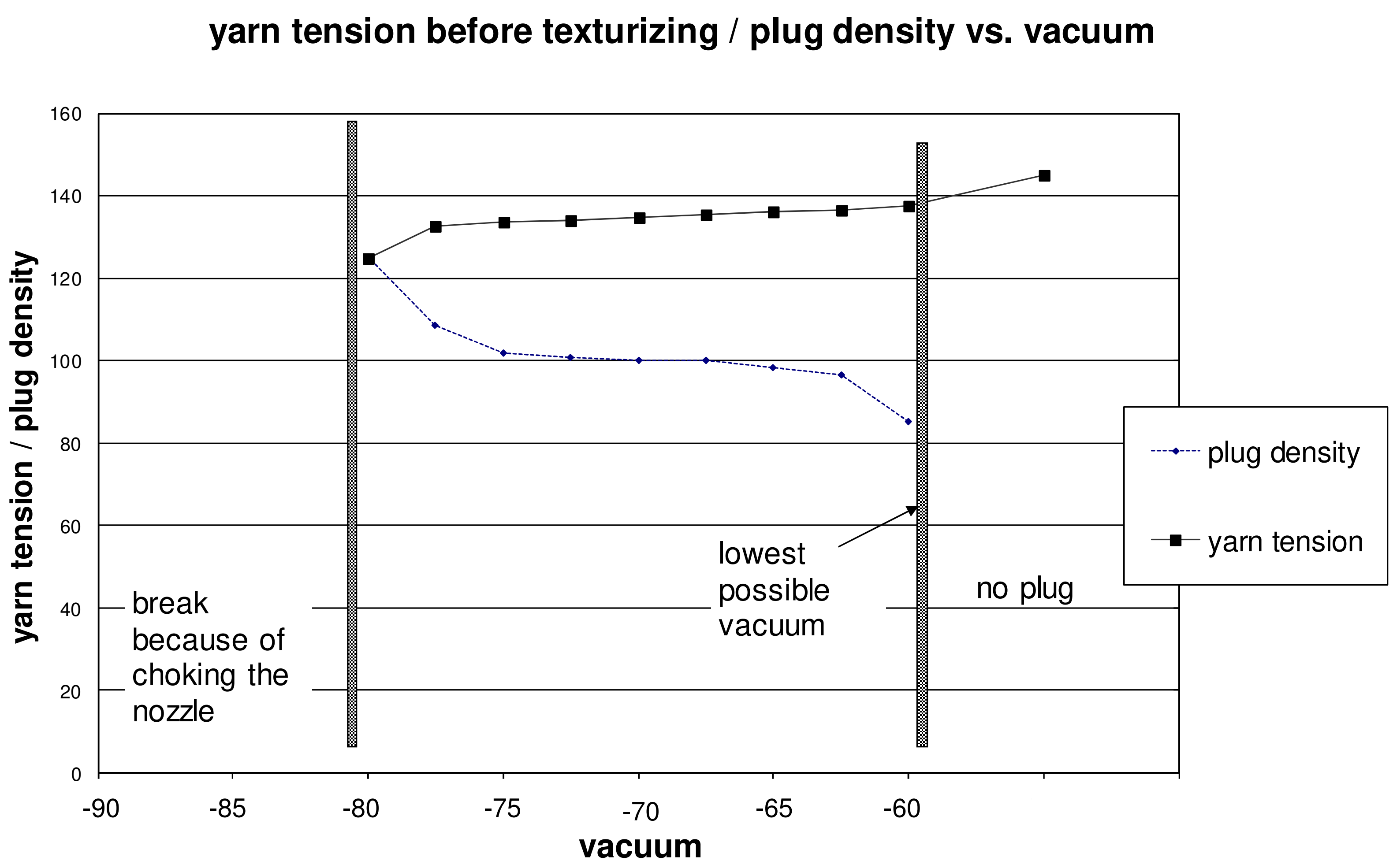


only an example -> exact values depending on product

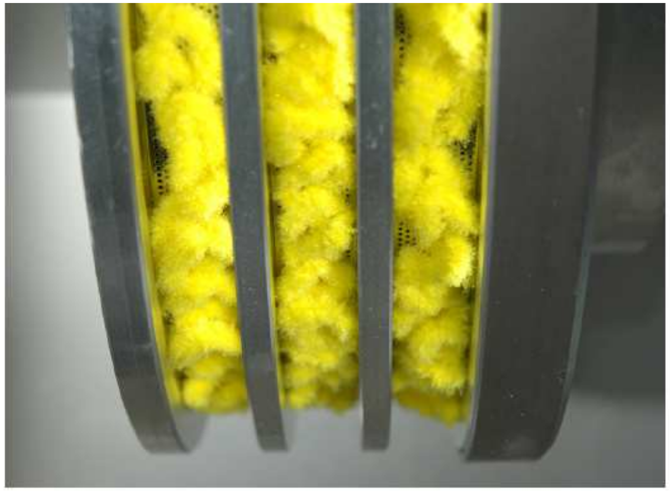
Information only

 confidential

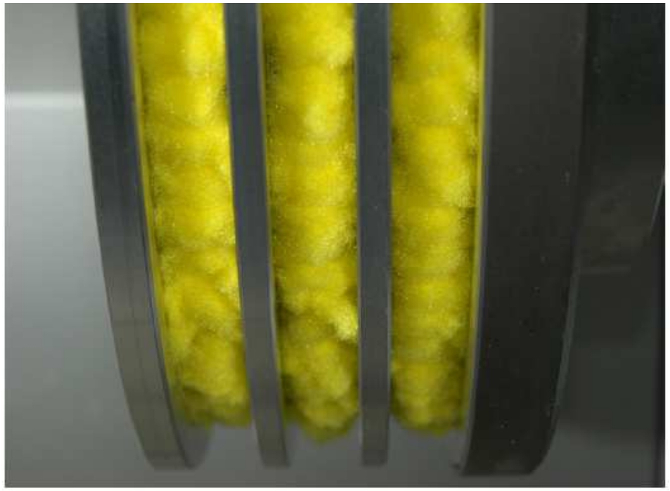
Friktion texturizing

Friction: Good plugging

Friction: No plugging



Cooling drum with correct plugging



Cooling drum with incorrect plugging

Information only

Process optimization step 3:
Bitex roller speed : step order

a) Before adjusting roller speed of Bitex it is neccesary to adjust texturizing pressure and vacuum of vacuum generator correctly with disabled roller function (like friction type texturizer)

Disabled roller function means they are too fast to allow the plug to block texturizing nozzles:
- Choose extreme high roller speed to prevent blocking texturizing nozzle by too low roller speed (approx 30..40 % above expected roller speed)
- Set vacuum on vacuum generator full time on (for normal friction type function)
- cooling drum to avoid loops fast

→ Set pressure and vacuum of vacuum generator

b) texturize roller speed as described next page (with vacuum generator full time to standard of 15 sec)

c) adjust cooling drum speed to a dense plug without loops

Information only

Process optimization step 3:
Bitex roller speed

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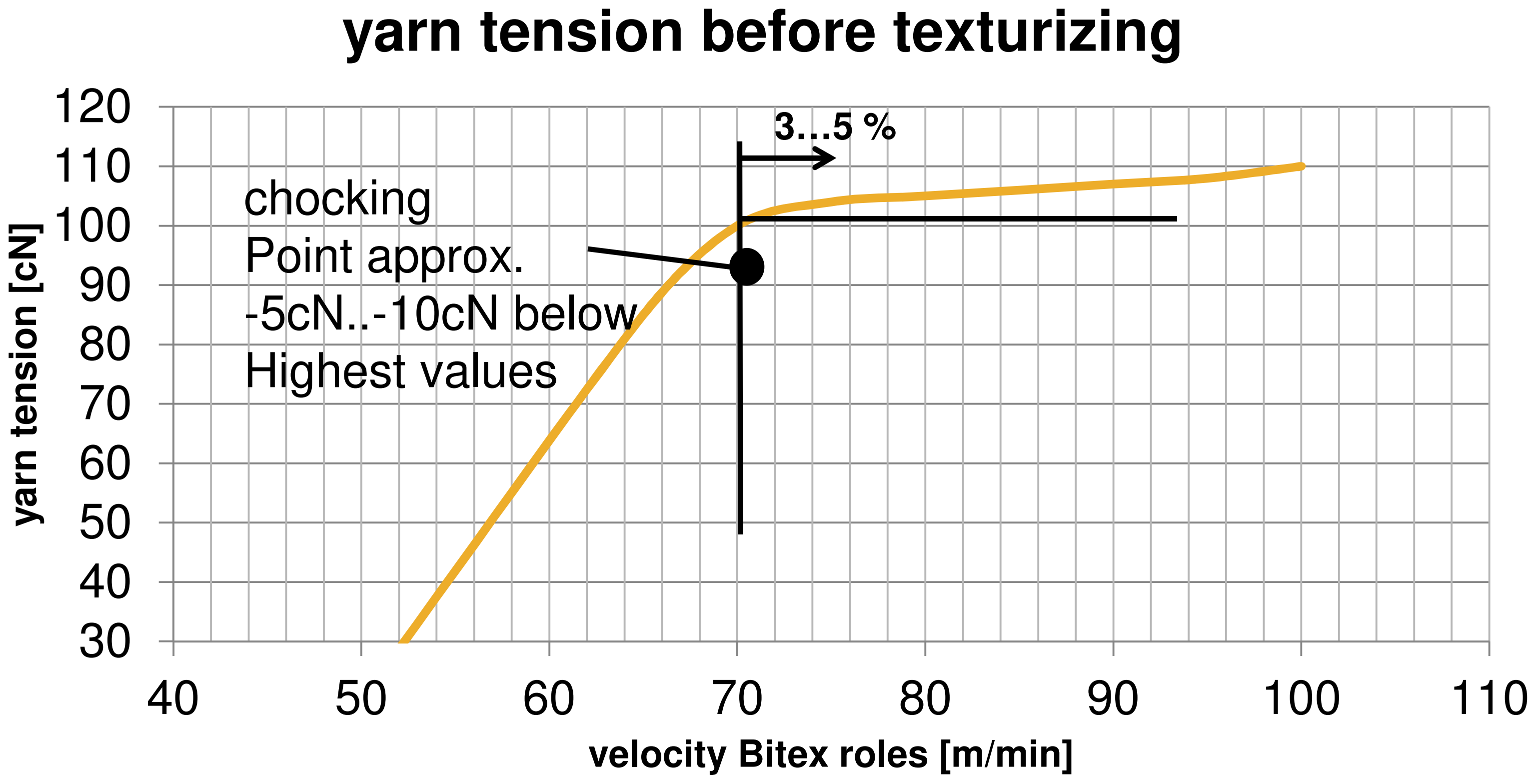
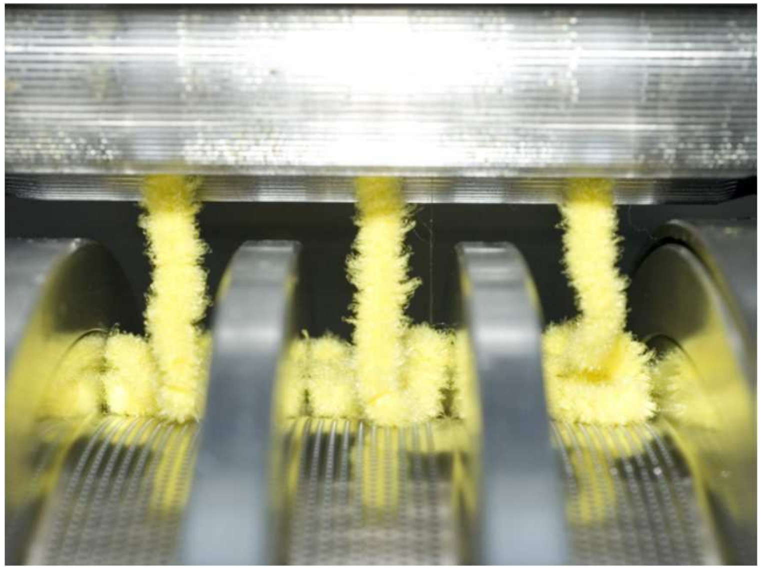


Note:
only an example -> exact values depending on product

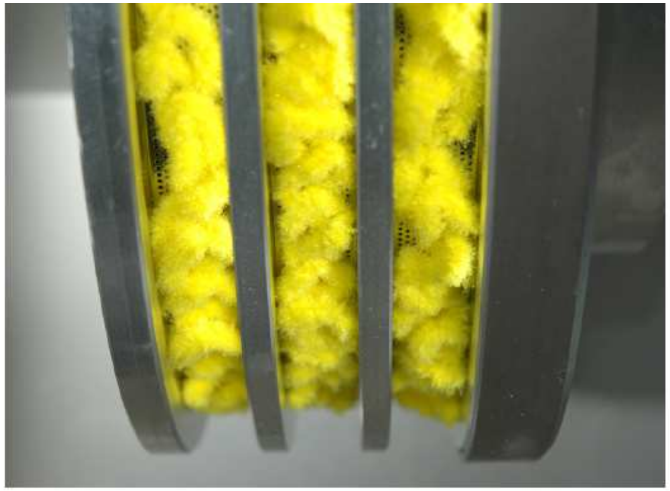
Information only

Texturizing: Bitex texturizing

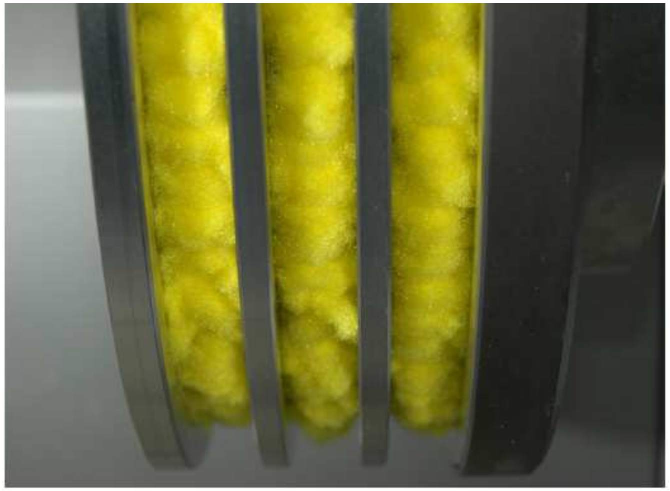


BITEX: Good plugging

BITEX: No plugging



Cooling drum with correct plugging

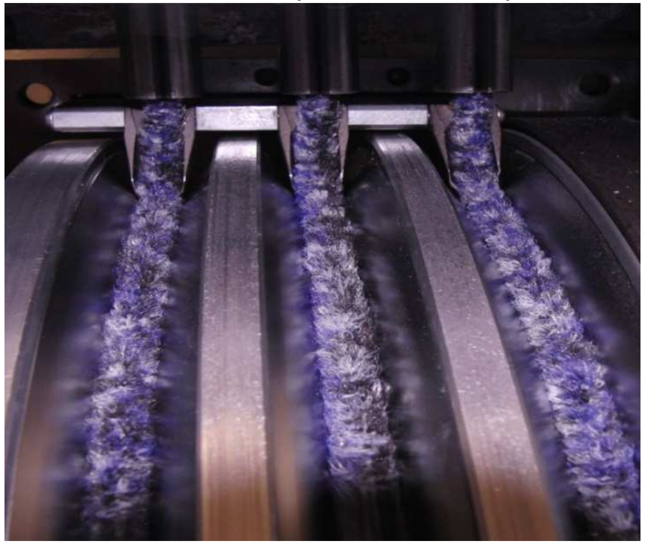


Cooling drum with incorrect plugging

Information only

Step 3: Cooling drum

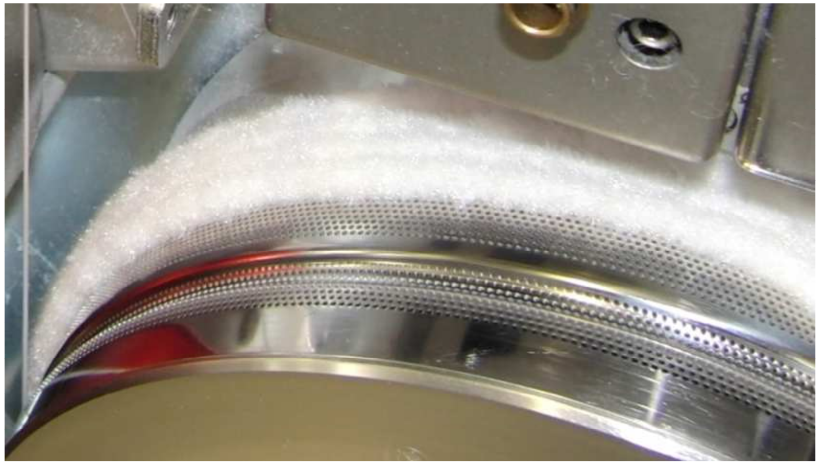
S+ V-Grove (PET, PA6)



For PA6 / PET uniform cooling is more important than cooling time:

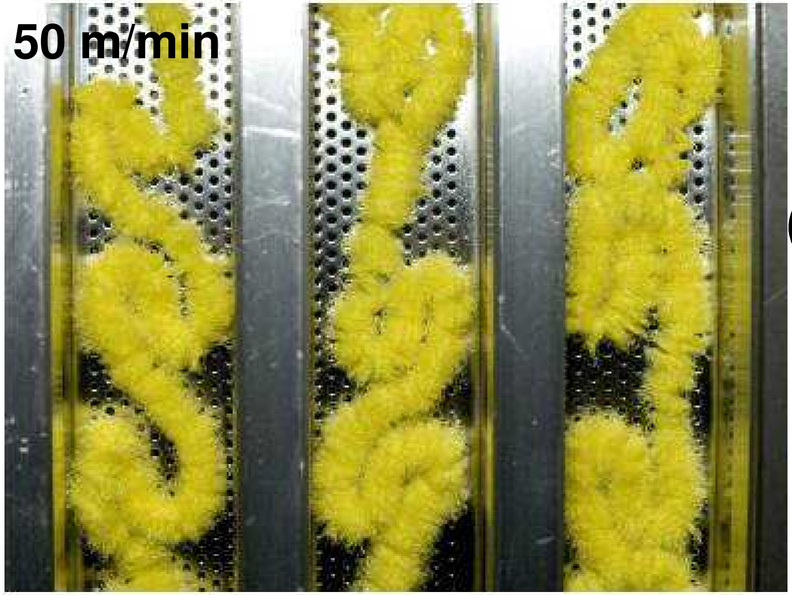
- cooling drum speed depends on plug speed (no flip overs)
- Sufficient vacuum above 25 mbar
- tension behind cooling drum influences tangle result strongly

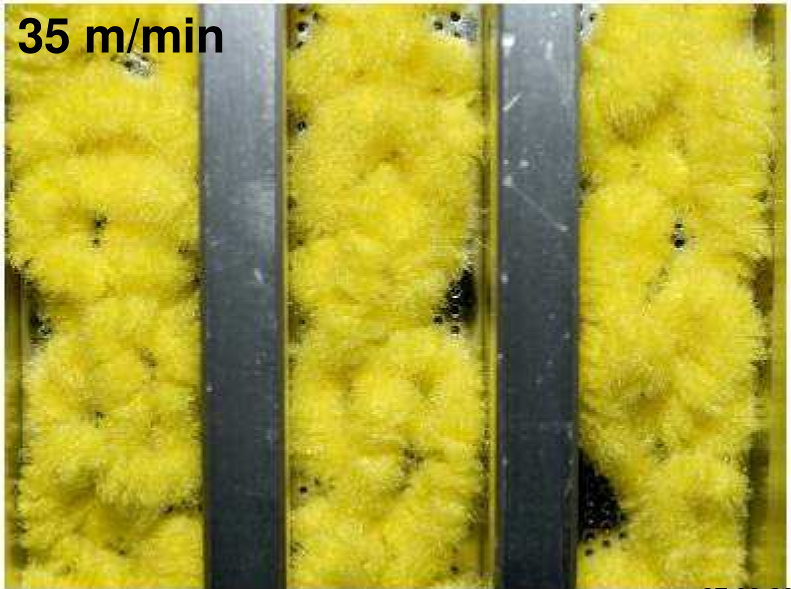
Sytec multiple wrap CD



Cooling drum – PP S+

Cooling drum speed

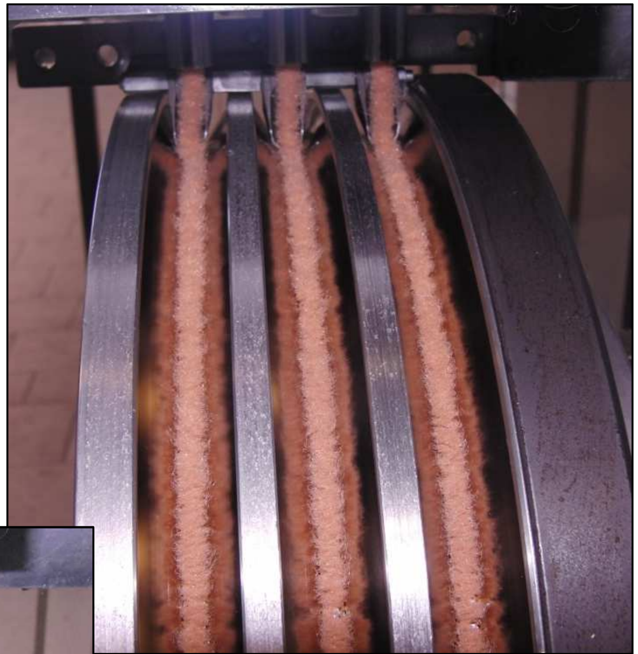




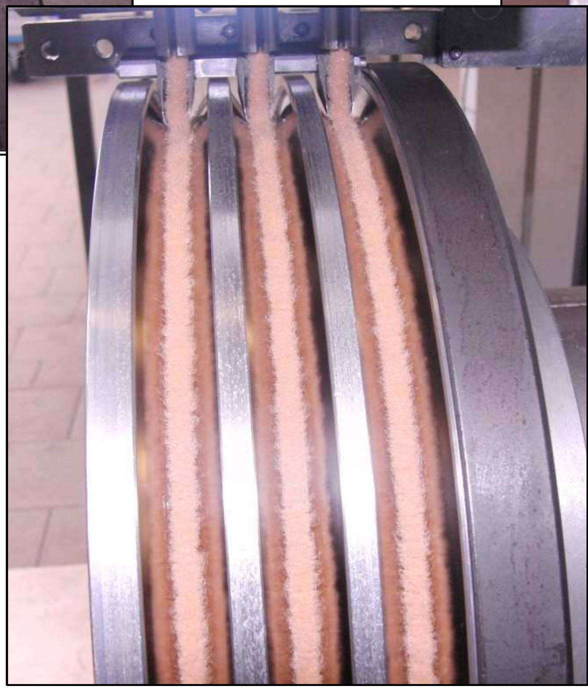
when CD to slow
-> loops in tangeling

Cooling drum – PET/PA6 S+

too slow



too fast



Use the strobe light
for checking the plug!

Optimizing cooling drum

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plaiting angle / yarn tension behind cooling drum

- influence process stability (tangeling)
    - too high yarn tension -> yarn is too hot -> coating of CD wears out
    - too low yarn tension -> loops in tangeling/ thread will open in tangeling -> uneven tangeling result
- influence crimp by possible crimp loss
- pulling out crimp if yarn isn´t cooled proper
- Important is yarn tension after cooling drum and process stability
- The CD-vacuum is important for process stability (e. g. if the CD vacuum is too low, the plug starts flipping)

Yarn tension after the CD is depending on the product
-> see Process Manual (chapter 5.1)

Process optimization – Step 5

Step 5: Set the yarn tension before the tangle unit and before winder

- The higher the draw-off 1 speed, the lower is the plaiting angle on the cooling drum. The lower the draw-off 1 speed, the greater the plaiting angle.

- Adjust important yarn tensions (depending on the product and machine -> see process parameters overview)
  - Draw1-Draw2 (before tangling):
    RoTac: 80-150 cN
    Temco: 100-150 cN
  - Draw2-winder: (depending on product)
    PP: 80 – 150 cN
    PA6: 140 – 170 cN
    PET: S+ 110 - 140 cN; Sytec 200 – 250 cN

- After adjusting the winder speed, it could be needed to adjust the speed of spinning pump.

Process check

- Check and record the **breaks on the DUO**
  - PP/PA6/PA6.6: max. 1 break per minute
  - PET: max. 1-2 breaks per minute
- Check **twist of texturizing nozzles**.
- Check and record the **draw off point of the cooling drum**
  - ∢ CD: ± 1 h
- Check and record the important **yarn tensions**

Yarn tension at	Allowed tolerance
Before/after Spin finish	± 10 % of mean
Before Texturizing	± 5 % of mean
After Cooling drum	±10 – 15 % of mean
Before Tangling	± 10 % of mean
Before Winder	± 10 % of mean

Check one time per shift all ends and record the data

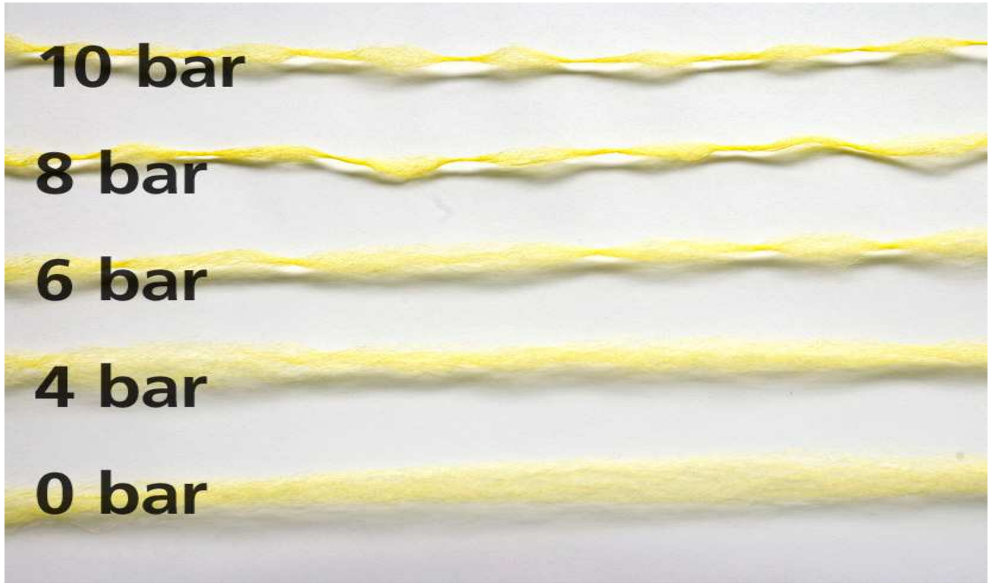
Tangling

Direct tufted or weaved BCF yarn needs more intermingling nodes than a Heatset yarn.

Heatset yarn can even be produced without intermingling nodes as long as the unwinding performance during twisting or cabling is okay.

Stronger nodes do reduce crimp and can even remove crimp completely
→ stips or streaks with strong node variation
→ Monitoring of tension in front of tangling and tangle pressure

For different titer different intermingling jets may needed.

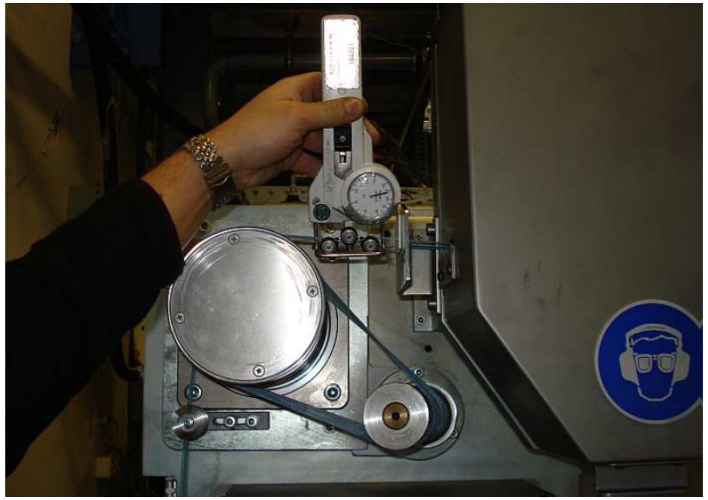


Temco

Titer [dtex]	Insert
800 to 2100	LD4.03
1500 to 3200	LD4.04
2100 to 4000	LD4.05
3200 to 6400	LD4.06

Tangling

S+



Sytec

The optimum tension is usually between 80cN to 150 cN (depending on the product).

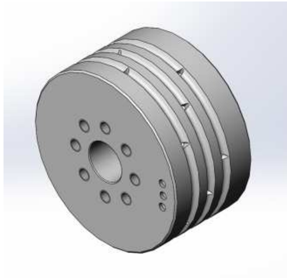
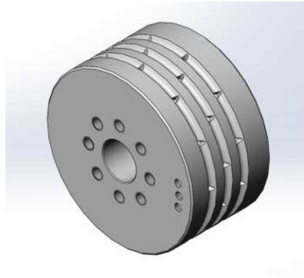
If the tension is to low it can cause an irregularity of the intermingling nodes.

If the tension is to high it is difficult to get proper intermingling nodes into the yarn.

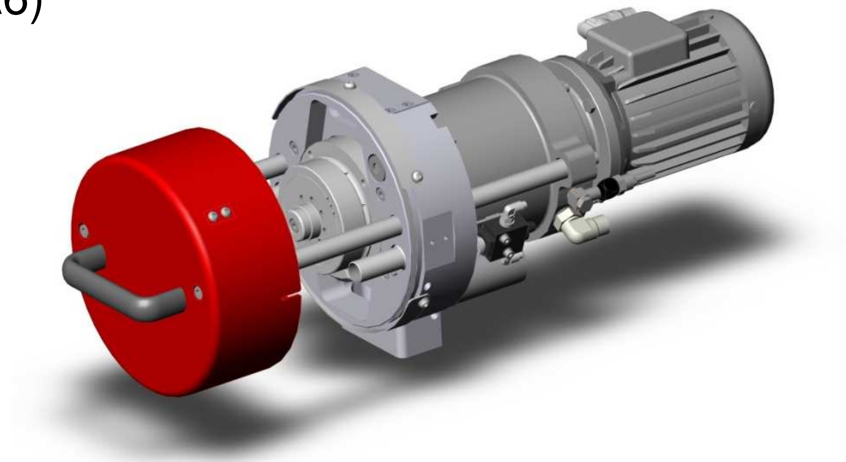
If the tension is to low it can further come to wraps on the first draw of Godet just shortly after winder doffing.

Information only

Adjustment of RoTac

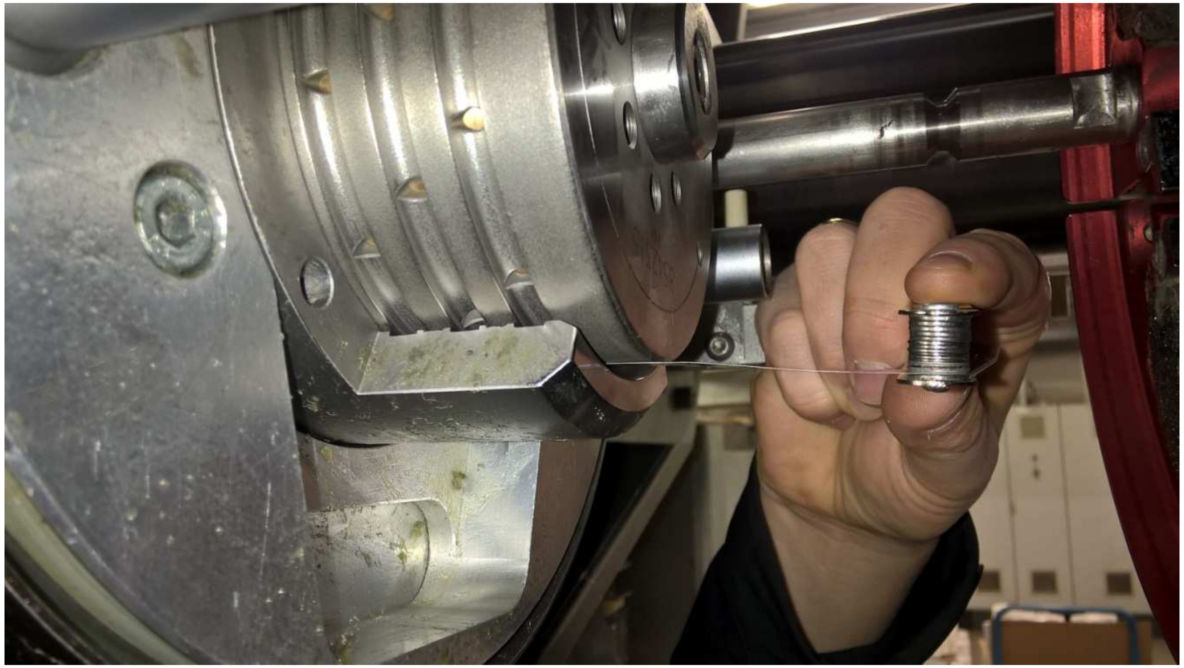
Tangel result depends on:
- RoTAC tangle pressure
    - 6..9 bar (depending on the needed strength)
- RoTAC speed (1000 m/min up to 3000 m/min):
    - approx. 60..75 % of winderspeed (PET, PP)
    - approx. 80..100 % of winderspeed (PA6)
- Yarn tension:
    - between 100…150 cN (PET)
    - between 80… 150 cN (PA6, PP)
- Nozzle jacket (number of holes)
- Distance cover-ring to nozzle ring: 0,1 mm



nozzles in nozzle ring	6	9	12
expected number of knots per meter	12-20	18-25	22-30

Information only

Adjustment of the gap – RoTac



The distance between nozzle jacket and cover ring should be 0.1 mm.
The distance is adjustable with the position of the cover ring.

With wrong adjustment of the distance jumping colors (e. g. at Tricolor yarn) are possible.

Information only

RoTac process optimization

Problem	Process optimization
Higher number of knots	Higher RoTac speed (if necessary nozzle jacket with higher hole number); pressure adjustment could be needed
Lower number of knots	Lower RoTac speed (if necessary nozzle jacket with lower hole number); pressure adjustment could be needed
Tighter knots	Higher RoTac pressure
Lighter knots	Lower RoTac pressure
Too high number of missing knots	Higher RoTac pressure (if necessary lower winding speed or nozzle jacket with higher hole number)

Hint: After changing the nozzle jacket a mechanical readjustment of the distance nozzle jacket to cover ring could be needet (gap should be 0.1 mm)

Information only

Process optimization – Step 6

- **Step 6: Make textile measurement for checking the yarn properties!**

→ Adjust the parameters, after textile measurements!

Tenacity/Elongation	Drawing
Elongation higher	↓
Elongation lower	↑
Elongation 10% drop of force higher	↓
Elongation 10% drop of force lower	↑
Tenacity higher	↑
Tenacity lower	↓

Quality limits can be found in the process manual
→ see chapter 6.4.2 Quality

DTEX adjustment

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Example:

- DTEX should be 1700 dtex
- Textile measurement gives 1650 dtex
- Winder speed 2800 m/min
- Spin pump speed of 19.2 rpm

$$new\ spin\ pump\ rpm =$$

$$\text{old spin pump rpm} * \frac{DTEX_{spec}}{DTEX_{measured}} = 19.2\ \text{rpm} * \frac{1700\ dtex}{1650\ dtex} = 19.8\ rpm$$

Information only

Calculation of winding time

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Example:

- Goal 4.5 kg bobbins
  - DTEX 1700 dtex
  - Winder speed 2800 m/min

$$throughput =$$

$$\text{winder speed} * \frac{DTEX}{10000\,m} = 2800\,m/min * \frac{1700\,dtex}{10000\,m} = 476\,{}^{gr}/_{min}$$

$$winding\ time =$$

$$\frac{needed\ kg}{throughput} = \frac{4500\,gr}{476\,gr/min} = 9.45\,\min = 567\,sec$$

Information only

Quality Limits – PP

Limits, process quality PP	Limits, textile data measured according to TM41		
	Elongation	**Tenacity: dpf > 10**	**Tenacity: dpf < 10**
Limit low BCF	30%	1.7 cN/dtex	2.0 cN/dtex
Limit high BCF	80%	No high limit	No high limit
Recommendation BCF	35 – 45 %	> 2.1 cN/dtex	> 2.5 cN/dtex
Limit low Heatset	30%	1.7 cN/dtex	2.0 cN/dtex
Limit high Heatset	120%	No high limit	No high limit
Recommendation Heat-set	40 – 60 %	> 1.9 cN/dtex	> 2.3 cN/dtex
Limit low loop pile	30%	1.7 cN/dtex	2.0 cN/dtex
Limit high loop pile	80%	No high limit	No high limit
Recommendation loop pile	35 – 45 %	> 2.1 cN/dtex	> 2.5 cN/dtex
Process limits			
Limit low	30%	1.7 cN/dtex	2.0 cN/dtex
Limit high	120%	No high limit	No high limit

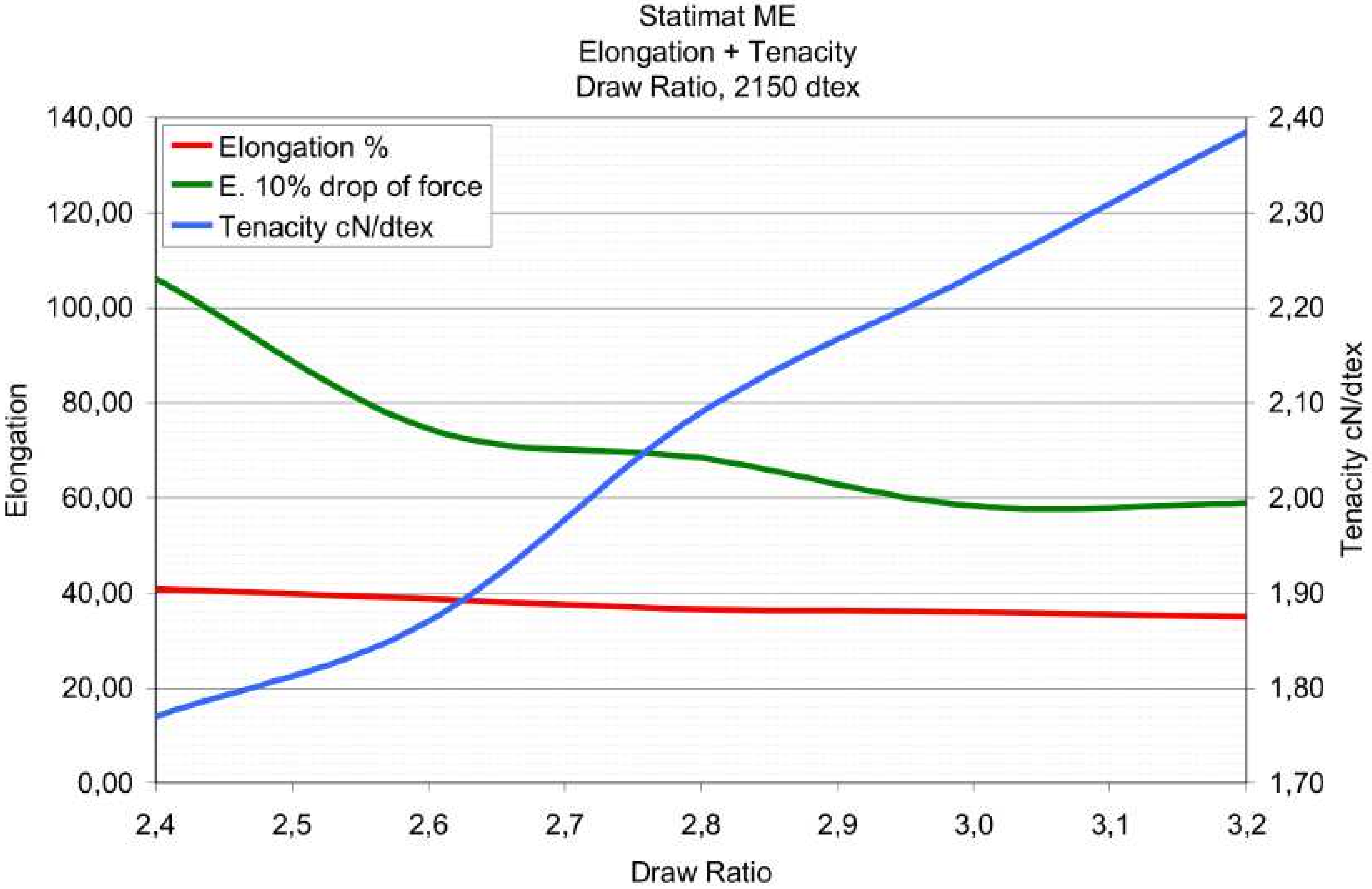
Quality Limits – PET and PA6 / PA6.6

Limits, process quality PET	Limits, textile data measured according to TM41 (dtex)		
	Elongation	Strength: dpf > 10	Strength: dpf <10
Recommendation BCF/Heatset	30 – 32%	> 2.7 cN/dtex (3.0 g/den)	> 3.0 cN/dtex (3.3 g/den)
Limit low BCF/Heatset	30 %	2.5 cN/dtex (2.7 g/den)	2.7 cN/dtex (3.0 g/den)
Limit high BCF/Heatset	36 %	No high limit	No high limit

Limits, process quality PA6 / PA6.6	Limits, textile data measured according to TM41 (dtex)		
	Elongation	Strength: dpf > 10	Strength: dpf <10
Recommendation BCF	30 – 35%	> 2.5 cN/dtex (2.8 g/den)	> 2.7 cN/dtex (3.1 g/den)
Limit low BCF	30 %	2.2 cN/dtex (2.5 g/den)	2.4 cN/dtex (2.7 g/den)
Limit high BCF	40 %	No high limit	No high limit
Recommendation Heatset	30 – 35 %	> 2.5 cN/dtex (2.8 g/den)	> 2.5 cN/dtex (2.8 g/den)
Limit low Heatset	30 %	2.2 cN/dtex (2.5 g/den)	2.3 cN/dtex (2.6 g/den)
Limit high Heatset	40 %	No high limit	No high limit

Information only

Optimizing PP – Tenacity vs. Elongation



Information only

Process optimization – Step 6

- **Step 6: Make textile measurement for checking the yarn properties!**

→ Adjust the parameters, after textile measurements!

Fibre shrinkage + crimp	Thermal influence			Mechanical influence
	DUO	Texturizing	Godet 2/3	Drawing
Shrinkage higher	↓	↓	↕	↕
Shrinkage lower	↑	↑	↕	↕
Crimp higher	↑	↑	↕	↕
Crimp lower	↓	↓	↕	↕

Setting/Quality limits can be found in the process manual
→ see chapter 6.3.5 to 6.4.2

Optimizing of textile characteristics – PP

Fibre shrinkage + crimp	Thermal influence			Mechanical influence
	godet duo:	Texturizing	Godet 2/3	Drawing
Shrinkage higher	↓	↓	↕	↕
Shrinkage lower	↑	↑	↕	↕
Crimp higher	↑	↑	↕	↕
Crimp lower	↓	↓	↕	↕
Parameter sensitivity of fibre shrinkage	50%	20%	20%	10%
Parameter sensitivity of crimp	50%	30%	10%	10%
Quality limits				
Recommendation BCF	120 °C	80°C (Sytec: 125°C)	60°C	
Limit low BCF	110 °C	60°C (Sytec: 120°C)	50°C	
Limit high BCF	125 °C :	120°C (Sytec: 135°C)	80°C	
Recommendation Heatset	130°C	135°C	80°C	
Limit low Heatset	120 °C :	120°C	60°C	
Limit high Heatset	135 °C :	170°C	90°C	
Recommendation loop pile	135 °C :	135°C (Sytec: 160°C)	60°C	
Limit low loop pile	110 °C :	120°C	50°C	
Limit high loop pile	145 °C :	170°C	80°C	
General limit low	100°C	60°C	50°C	
General limit high	145°C	170°C	100°C	

Optimizing of textile characteristics – PET

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Fibre shrinkage + crimp	Thermal influence			Mechanical influence
	DUO	Texturizing	Godet 2/3	Drawing
Shrinkage higher	↓	↓	↕	↕
Shrinkage lower	↑	↑	↕	↕
Crimp higher	↑	↑	↕	↕
Crimp lower	↓	↓	↕	↕
Parameter sensitivity of fibre shrinkage	40%	20%	10%	20%
Parameter sensitivity of fibre crimp	40%	20%	10%	20%
Quality limits				
Recommendation	180 °C	200 °C	105 °C	
Limit low	165 °C	180 °C	90 °C	
Limit high	190 °C	220 °C	110 °C	

Information only

Shift Report S+

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Shift Report

Shift Leader:			Date:	
Position/Winder			shift-start:	

Shift Hour	**Breaks:** W – winder break; P – Process break S – Service break	Process check every 4 hours
0 to 1		
1 to 2		
2 to 3		
3 to 4		**Remarks:**
4 to 5		
5 to 6		
6 to 7		
7 to 8		**Remarks:**
Total Breaks in Shift	Winder: Process: Service:	

Process check (printed twice, for hours 0–4 and 4–8):

Tex. Vakuum			mbar
Yarn tensions	Winder		cN
	RoTac		cN
	Cooling drum		cN
Draw Off Points CD	Front		o'clock
	Middle		o'clock
	Rear		o'clock
Moisture PET			ppm

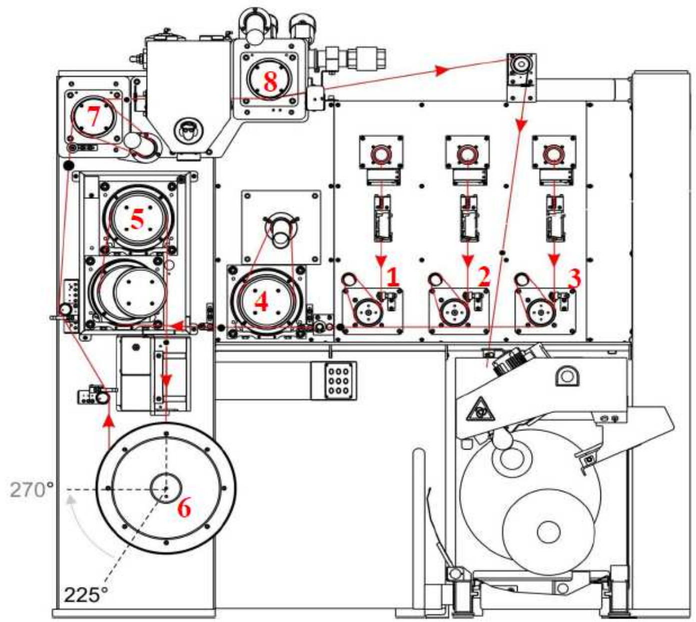
Recommendation of a shift report

process breaks:

Example:

$P_{1,4,7}$ means that wraps were on godets 1, 4 and 7 after a break

$P_{7,8}$ means that wraps were on godets 7 and 8 after a break



Winder breaks:

W_F no yarn on front tube

W_M no yarn on middle tube

W_R no yarn on rear tube

W_A no yarn on all tubes

W_W wrong positioned tube

W yarn on all tubes

Process checklist

Check List

- [ ] Color is flushed in?
  Let down rates?
- [ ] Adjust the needed process setting:
  - [ ] godet speeds and speed of spin finish
  - [ ] Quench air setting: Speed, Temperature, Humidity?
  - [ ] spin pump speeds
  - [ ] texturizing-equipment right?
  - [ ] texturizing pressure ok?
  - [ ] texturizing vacuum ok?
  - [ ] texturizing and godets temperatures?
  - [ ] winder setting:
    - Speed
    - Traversing
    - Boost setting
    - Doffing diameter/time
- [ ] Check the broken filaments on DUO: ok?
- [ ] Check all yarn tensions and adjust it:

☐	In front of the winder	cN
☐	In front of the RoTac	cN
☐	Behind CD: are the draw off points of the CD ok?	cN / o'clock
☐	In front of the texturizing? (all three ends)	cN
☐	Double check the texturizing vacuum	mbar

- [ ] Check the textile data

☐	DTEX	dtex
☐	Tenacity and Elongation	% cN/dtex
☐	Color Check?	
☐	Entanglement ok?	Kn/m
☐	Spin finish level?	%

- [ ] Check the bobbin size/bobbin weight ____ mm ____ kg

Process data sheet

Process datasheet

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Neumag		Customer	
Mail to:	hotline@oerlikon.com	Customer Name:	
Fax to:	+49 4321 3054133	Contact Person:	
Date:		Machine No.:	
		Tel. No.:	
		Fax No.:	
		E-Mail:	

Carpet style
Yarn is used for:
Polymer — Product I.D. — Lot

titer	dtex		
no. of filaments	pcs.		
no. of ends	pcs.		
Polymer		set	actual
material manufacturer			
type			
viscosity [MFI, IV or RV]			
moisture [ppm]			
Extruder 1		set	actual
Additiv/Masterbatch 1			
carrier material			
type			
color			
concentration	%		
moisture	ppm		
Additiv/Masterbatch 2			
carrier material			
type			
color			
concentration	%		
moisture	ppm		
Extruder 2		set	actual
Additiv/Masterbatch 1			
carrier material			
type			
color			
concentration	%		
moisture	ppm		
Additiv/Masterbatch 2			
carrier material			
type			
color			
concentration	%		
moisture	ppm		
Extruder 3		set	actual
Additiv/Masterbatch 1			
carrier material			
type			
color			
concentration	%		
moisture	ppm		
Additiv/Masterbatch 2			
carrier material			
type			
color			
concentration	%		
moisture	ppm		

Extruder 1		set	actual
Extruder zone 1 temp.	°C		
Extruder zone 2 temp.	°C		
Extruder zone 3 temp.	°C		
Extruder zone 4 temp.	°C		
Extruder zone 5 temp.	°C		
Extruder zone 6 temp.	°C		
Screen changer temp.	°C		
Melt temperature	°C		
Extruder pressure	bar		
Extruder rpm	rpm		
Extruder load	KW		
Pres. in front of sp.pump	bar		
Pres. behind spinnpump	bar		
Extruder 2		set	actual
Extruder zone 1 temp.	°C		
Extruder zone 2 temp.	°C		
Extruder zone 3 temp.	°C		
Extruder zone 4 temp.	°C		
Extruder zone 5 temp.	°C		
Extruder zone 6 temp.	°C		
Screen changer temp.	°C		
Melt temperature	°C		
Extruder pressure	bar		
Extruder rpm	rpm		
Extruder load	rpm		
Pres. in front of sp.pump	bar		
Pres. behind spinnpump	bar		
Extruder 3		set	actual
Extruder zone 1 temp.	°C		
Extruder zone 2 temp.	°C		
Extruder zone 3 temp.	°C		
Extruder zone 4 temp.	°C		
Extruder zone 5 temp.	°C		
Extruder zone 6 temp.	°C		
Screen changer temp.	°C		
Melt temperature	°C		
Extruder pressure	bar		
Extruder rpm	rpm		
Extruder load	KW		
Pres. in front of sp.pump	bar		
Pres. behind spinnpump	bar		

Remarks:

Process datasheet

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Spinning and quench		set	actual
spinneret			
profile (Delta,Triloba, Round)			
width of spinneret hole	mm		
length of spinneret hole	mm		
no. of mesh per	cm²		
Spinning pump size	cm³/rpm		
waste spinnning pump rpm	1/min		
reduced spinnning pump rpm	1/min		
Prod. spinning pump rpm	1/min		
Throughput per end	g/min		
Dowtherm temperature	°C		
Spinning beam temp.	°C		
Condenser temp top / bottom	°C		
Quench air pressure	mbar		
Air temperature	°C		
Air humidity	%rH		
Air velocity top	m/s		
Monomer air velocity	m/s		
Spinfinish		set	actual
spin finish manufacturer			
type			
Active content	%		
Density	g/cm³		
Spinfinsih Pump size	cm³/rpm		
reduced spinfinishpump rpm	1/min		
Prod. spinfinishpump rpm	1/min		
Theorethical Oil Pick Up	%		
Oiler configuration			
Oiler width top / bottom	mm / type		
Machine		set	actual
Pre interlace unit			
Pre interlace presure	bar		
reduced Camroll speed	m/min		
Camroll speed	m/min		
Temperature godet G 1	°C		
Temperature godet 2/3 (G 2)	°C		
Temperature godet 2/3 (G 3)	°C		
Temperature DUO (G 4)	°C		
Temperature DUO (G 5)	°C		
reduced speed godet 1	m/min		
reduced speed godet 2/3	m/min		
reduced speed DUO	m/min		
reduced speed cooling drum	m/min		
reduced speed draw-off 1	m/min		
reduced speed draw-off 2	m/min		
Speed godet 1	m/min		
Speed godet 2/3	m/min		
Speed DUO	m/min		
Speed cooling drum	m/min		
Speed draw-off godet 1	m/min		
Speed draw-off godet 2	m/min		
Lay down CD			
No. of CD wraps			
Pre Draw Ratio			
Main Draw Ratio			
Cooling drum angle	°		
Vacuum coolingdrum	mbar		

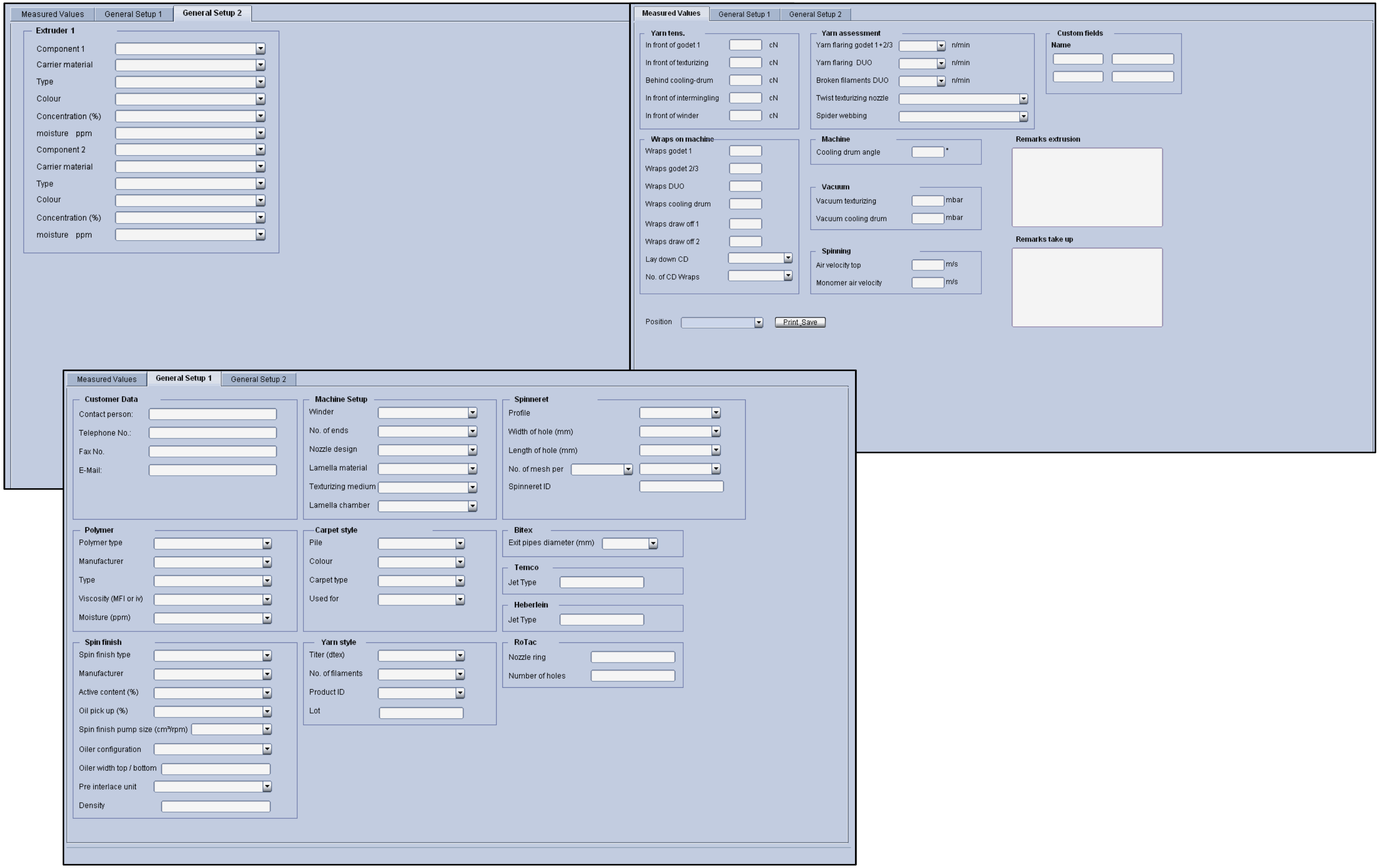
texturizing general		set	actual
Nozzle design			
Lamella material			
texturizing medium			
lamella chamber			
Texturizing pressure	bar		
Texturizing temperature 1	°C		
Texturizing temperature 2	°C		
Texturizing temperature 3	°C		
only Bitex Texturizing		set	actual
Injector pressure Texturizing	bar		
Time Injector pressure	sec.		
Speed roller	m/min		
Exit pipes diameter	mm		
only Friction Texturizing		set	actual
Vacuum Texturizing	mbar		
Heberlein Intermingling		set	actual
Jet type			
Temco Intermingling		set	actual
Jet type			
RoTac Intermingling		set	actual
nozzle jacket			
number of holes			
RoTac speed	m/min		
pressure intermingling		set	actual
Pressure main	bar		
Pressure top (Heberlein)	bar		
Winder		set	actual
type			
Winder speed	m/min		
Traversing angle start	°		
Traversing angle 1	°		
Bobbin diameter 1	mm		
Traversing angle 2	°		
Bobbin diameter 2	mm		
Traversing angle 3	°		
Bobbin diameter 3	mm		
Traversing angle Doffing	°		
Amplitude traversing	°		
Frequency traversing	Hz		
Paper tube diameter	mm		
Doffing time	sec		
Doffing diameter	mm		
1st contact pressure	bar		
2nd contact pressure	bar		
Boost full	m/min		
Boost empty	m/min		
Boost treading	m/min		
combined boost	m/min		

Process datasheet

process remarks		
in front of godet 1	cN	
in front of texturizing	cN	
behind cooling-drum	cN	
in front of intermingling	cN	
in front of winder	cN	
wraps godet 1	n	
wraps godet 2/3	n	
wraps DUO	n	
wraps cooling drum	n	
wraps draw off 1	n	
wraps draw off 2	n	
yarn flaring godet 1+2/3	n/min	
yarn flaring DUO	n/min	
broken filaments DUO	n/min	
twist texturizing nozzle		
Spider webbing		

Remarks:

Process datasheet - PLS



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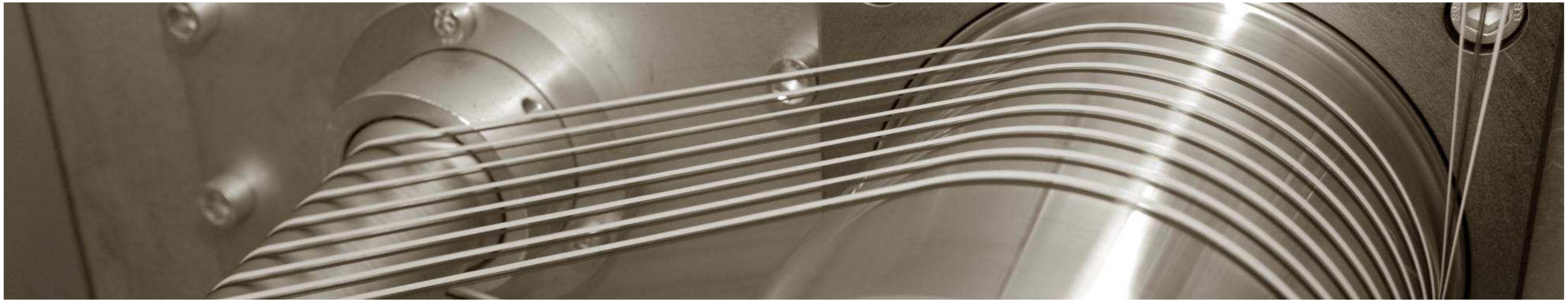
Session 5
polymers and extrusion to fiber



Polymer Data

1. Polymer Data
2. Components of a BCF-position
3. Stringing Up
4. Process calculation
5. Process optimization
6. Process data sheet
7. Textile Measurements
8. Maintenance
9. Streaks in carpet
10. Tricolor methods

Polymer data

1. Polymer data
   a) Degradation
   b) PP
   c) PET
   d) PTT
   e) PA6
   f) PA66

Polymer data

Polymer		PP	PET	PTT	PA 6	PA 66
Viscosity (Typical)		MFI 25	IV 0.65 – 0.86	IV 0.92, 0.96, 1.02	RV 2.68 – 2.78	RV 44 - 48
Melt density	[g/cm³]	0.74	1.15 – 1.2	1.21 – 1.26	1.04	1.01
Nitrogen blanking		-	Yes	Yes	Yes (< 20ppm O_2)	Yes (< 20ppm O_2)
Chips humidity	[ppm]	- (not wet)	< 30	< 30	400 - 800	600 - 1000
Extrusion Temperatures (Last zone)	[°C]	220 - 240	290 - 300	250-260	265 - 270	285 - 300
Downtimes (line or position stop)		- (months)	<10min (no Prob.) <30min (Pos.) <2h (Line)	<10min (no Pro.) <30min (Pos.) <2h (Line)	- (months)	< 30min
Flushing polymer		PP	PP	PP	PA6, PP	PA6, PP; no stop !

Polymer data

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Polymer		PP	PET	PTT	PA 6	PA 66
Solid density	[g/cm³]	0.90 - 0.92	1.33 – 1.38	1.33-1.37	1.12 – 1.15	1.13 – 1.16
Melt density	[g/cm³]	0.74	1.15 – 1.2	1.21 – 1.26	1.04	1.01
Tg (Glass-transition temperature) humidity dependent PET, PTT, PA6, PA66	[C°]	-15 – 25	70 – 80	45 – 55	50 – 60	50 – 60
Tm (Melting temperature)	[C°]	160 - 175	255 - 265	226 – 229	220 - 230	255 - 265
Crystallinity	[%]	60 - 70	30 - 40	30-40	30 - 40	35 - 45
UV resistance		Weak	Good	Good	Average	Average
Moisture pickup [@ 23°C / 50% r.h.]	[%]	-	0.2 – 0.5	0.3	2.5 – 3.5	2.5 - 3
Electrostatic Chargement		Low	Average	Average	High	High

Information only

Most important temperature to PA6 and PET

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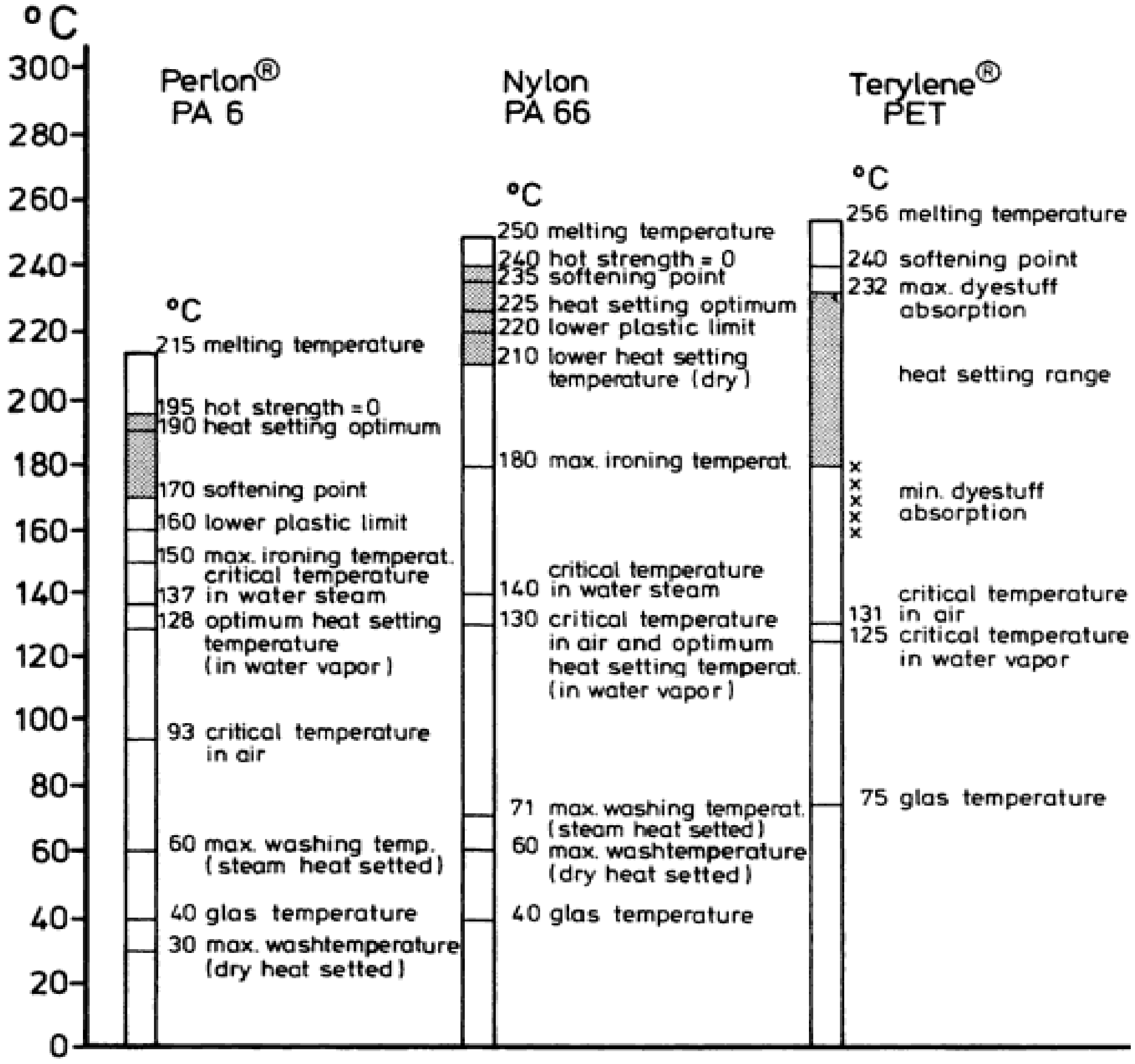

Fourné: „Synthetic fibres“ ; page 219; Hanser Verlag; 1999

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Yarn relaxation and take up area conditions

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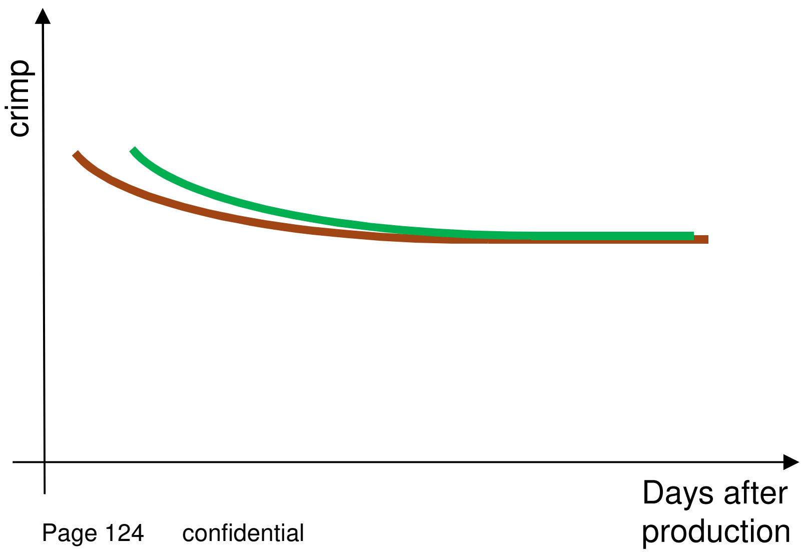
- Uniform take up area and even storing conditions are needed for PA6 and PET (especially for PA6 !) to ensure same moisture pick up for each bobbin
- Too short relaxation time in-between the process steps can cause big performance and quality problems.
- Normally the yarn should relax at least 2 days in-between the process steps (PP) or 3..4 days (PA6; PET) under same conditions
- The necessary relaxation time depends on the ambient temperature and the kind of packing used.



material	Recommended Take up area - temperature	rel. humidity
PP	18°C – 30°C; +/-2°C	60% - 80%
PA6 ; PA6.6	20°C – 24°C; +/-2°C	70% - 75%
PET	18°C – 25°C; +/-2°C	70% - 75%

Polymers - Definition

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- **Polymerisation:**
  Is a chemical reaction in which monomers - under the influence of catalysts and with the resolution of the multiple bond - react to form polymers.
  Homopolymerisation – only one type of monomer is converted
  Co-Polymerization – two or more different monomers are brought to reaction

- **Polycondensation:**
  Polycondensation is the chemical linkage of monomers under elimination of water (or other small molecules) to form a polymer.

- **Melting point**
  Melting temperature at which the crystalline phase passes into the liquid state (in semi-crystalline materials).

- **Glastransition Temperature**
  Temperature range at which the amorphous ranges of semi-crystalline thermoplastics exchange from a hard into a flexible phase. The molecular chains become mobile without liquefying the plastic.

Information only

Polymer Data

1. Polymer data
   a) Degradation
   b) PP
   c) PET
   d) PTT
   e) PA6
   f) PA66

Degradation mechanism

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Polymers under goes various types of degradation (especially PA6, PA6.6, PET and PTT):

o no influence; + small sensitivity; ++++ high sensitivity

Degra-dation	Temperature	Effect	Observation	PP	PA6	PA6.6	PET	PTT
Thermal	Above melting temperature	▪ Molecular weight loss		+	+ if dry	+ if dry	+ if dry	+++
Thermal-oxidative	≥ Tg, depending on time and water content	▪ Molecular weight loss ▪ gelation	Already Slight degradation causes yellowing	o	++++	++++	+++	+++
Hydrolytic	Starts at 25 °C in water	▪ Breaking off intermolecular hydrogen bonds		o	+	+	++++	++++
Mechano-chemical	Extrusion	▪ Molecular weight loss		+	+	+	+	++

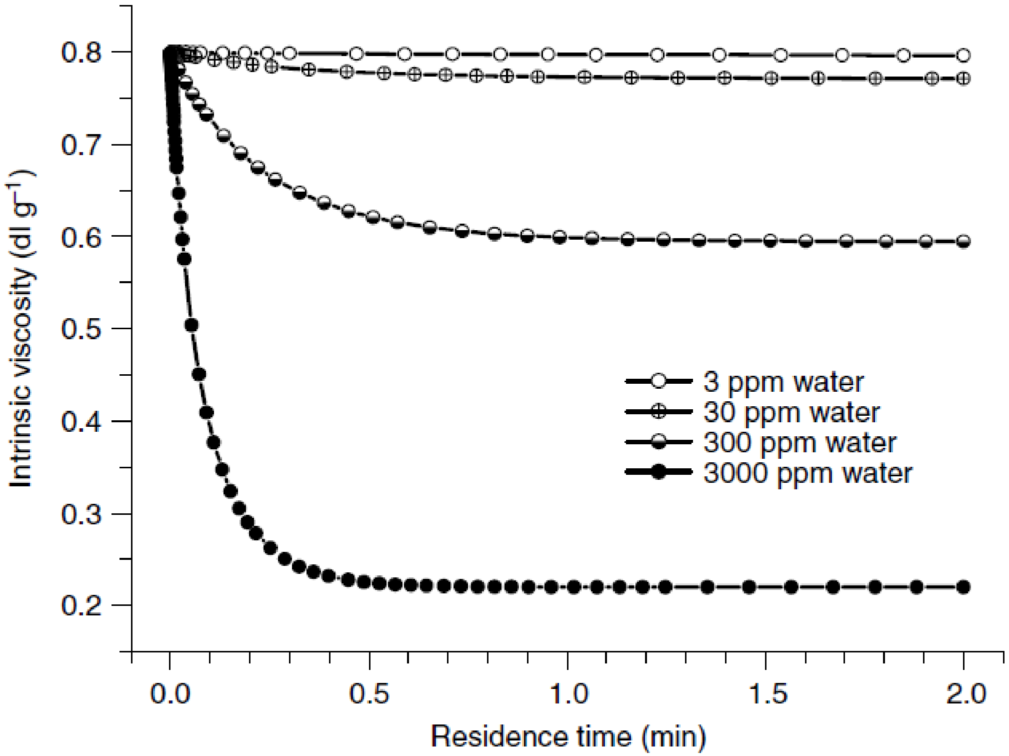
[B.L. Deopura, A.K. Mukherjee: „Nylon 6 and nylon 66 fibres“ in V.B. Gupta, V.K. Kothari „Manufactured fibre technology“, Chapman&Hall, 1997]; e.g.

PET: Influence IV

Melt

Influence of the **humidity** on the IV:

- The IV of PET is reduced by water, since the polymer degrades, the polymer chain length and therefore the molecular weight decreases:
  - ≤ 30 ppm after drying needed



Intrinsic viscosity of the polymer melt as a function of extruder residence time and initial water content for a temperature of 280 °C.

[T. Rieckmann, S. Völker in „Modern Polyesters“, Editors J. Scheirs, T.E. Long]

Polymer Data

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1. Polymer data
   a) Degradation
   b) PP
   c) PET
   d) PTT
   e) PA6
   f) PA66

Information only

 confidential

PP
general requirements

- MFI (Melt flow index): 18 – 27 typical 25
- MWD (Molecular weight distribution): medium
  (5-6 with GPC [gel-permeations-chromatography])
- Xylene solubles not yet specified
- % of atactic PP
- Gel contents not yet specified
- Gas fading
- UV-stability

In addition: consistency!

As neumag only specifies MFI and MWD a reference list is important!

Information only

Polymer Data

1. Polymer data
    a) Degradation
    b) PP
    c) PET
    d) PTT
    e) PA6
    f) PA66

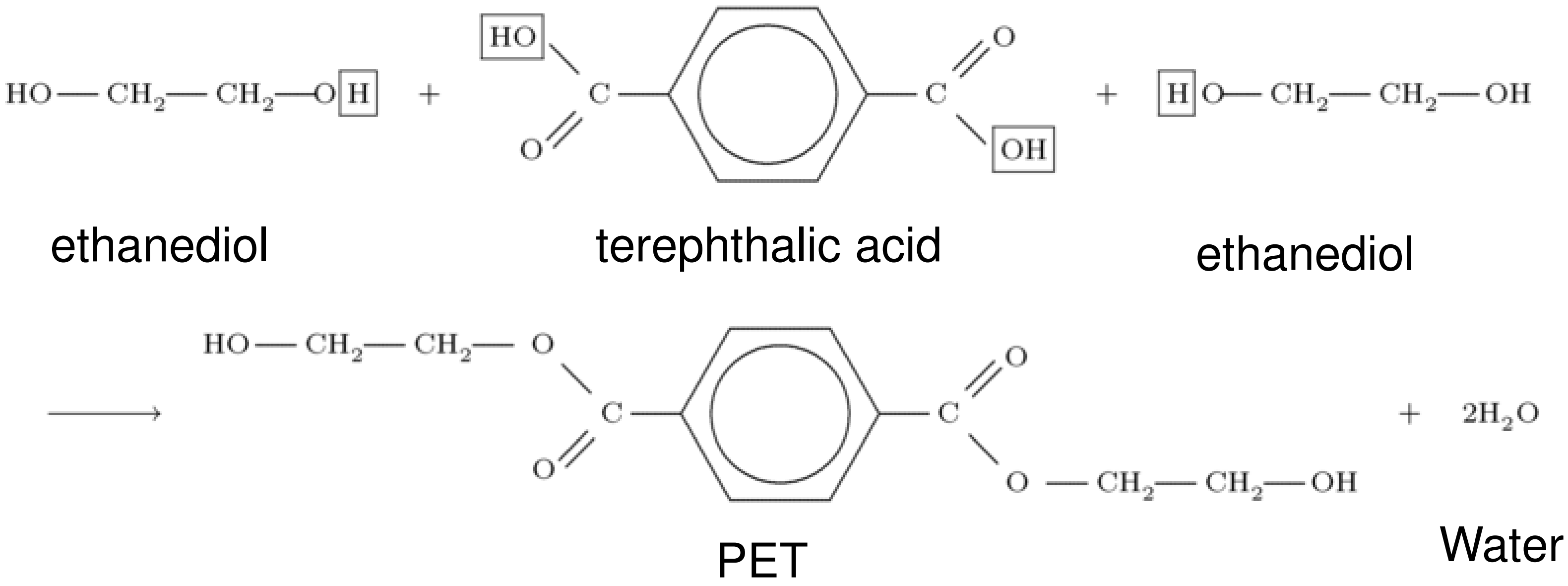
PET types
Further labels

The actual state of the PET chips, amorphous or crystalline, has to be clarified by the supplier, since suppliers also can offer crystallised low IV PET or high viscose PET which is only partly crystallised.

Non or partly crystallised material has to be crystallised before used in extruders

- Fibre grade or textile grade PET
  - IV 0,62 – 0,66
- Film grade PET
  - IV 0,6 – 0,7
- Bottle grade PET
  - IV 0,76 – 0,84
- PET flakes (regrind bottle flakes)
  - IV 0,76 – 0,84
  - Partly crystallised, not completely

PET types
Materials



Polycondensation: water is generated while PET is polymerized

→

Water (humidity) degrades PET in the spinning process:

Drying needed

Information only

PET types
Materials

A-PET, amorphous PET (crystallisation unit needed):

- Clear - transparent, non crystalline
- Production process multistage condensation polymerisation:
  - E.g. reactors of Lurgi, Zimmer Polymer Technology, also specially for industrial yarn production:

medium	IV	0,50 – 0,66	(standard polycondensation)
high	IV	0,66 – 0,96	
very high	IV	0,90 – 1,00 (semi-amorph)	

S-PET or C-PET, crystallised PET:

- Opaque, dull
- Production process e.g. solid state polycondensation (SSP)

very high	IV	0,76 – 1,2

Information only

PET: Influence IV

Melt

Calculation of the water influence on the IV:

- The effect on the average molecular weight will be as follows after reaction with x wt% water:

$$M'_n = \frac{M_n}{1 + \left(\frac{x M_n}{1800}\right)}$$

- The IV in OCP is connected to the number-averaged molecular weight (Mn) of the polymer by the Mark–Houwinck formula for PET:

$$IV_{OCP} = 1.7 \times 10^{-4} (M_n)^{0.83}$$

In BCF a minimal IV is needed to ensure the spin ability. The degradation is percentage higher for higher IV never the less the minimal value is faster reached by PET with a low IV. Therefore the operation range in smaller for the low IV PET.

[G. Reese in „Modern Polyesters“, Editors J. Scheirs, T.E. Long]

Information only

PET types
Further labels

An other PET classification is based on the optical properties. The grades are adjusted with different TiO_2 concentrations, from full dull to super bright respectively clear (without TiO_2). TiO_2 is also a nucleation point in the crystallisation of PET.

In general fibre grade PET has often a concentration of 0,03 – 0,4 wt% TiO_2.

Classification and TiO_2 concentration often vary depending on the supplier, e.g.:

Producer	Classification	TiO_2	IV η	Application
Alltex	Semi bright	0.05 %	0.63	Textile
	Semi dull	0.28 %	0.63	Textile
Invista (F008)	Semi dull	0.4 %	0.75	Textile
Lagam	Bright	0.03 %	0.64	Textile
	Semi dull	0.30 %	0.64	Textile
Precolor (Pretiox)	Micro mat	0.05 %		
	Semi dull	0.15 - 0.4 %		
	Full dull	0.5 - 1.75 %		

Information only

PET: Influence IV
Process properties

Influence of the IV on the process properties:

Intrinsic Viskosität	Draw ratio	Spinning speed	Process range	Process speed	Durability of the fibre	Tenacity
IV higher	↓	↑	↑	↑	↑	↕
IV lower	↑	↓	↓	↓	↓	↕

TiO_2

Next to the IV also the TiO_2 content has an influence on the fibre properties.

The crystallisation of the PET and therefore the spinning behaviour is affected. “Semi-dull” PET contains contrary to “clear” or “super bright” PET TiO_2 particles, that react as nucleation point during crystallisation. Due to that more and therefore smaller crystals are formed, which has a positive effect on the spinability and in particular on the drawing.

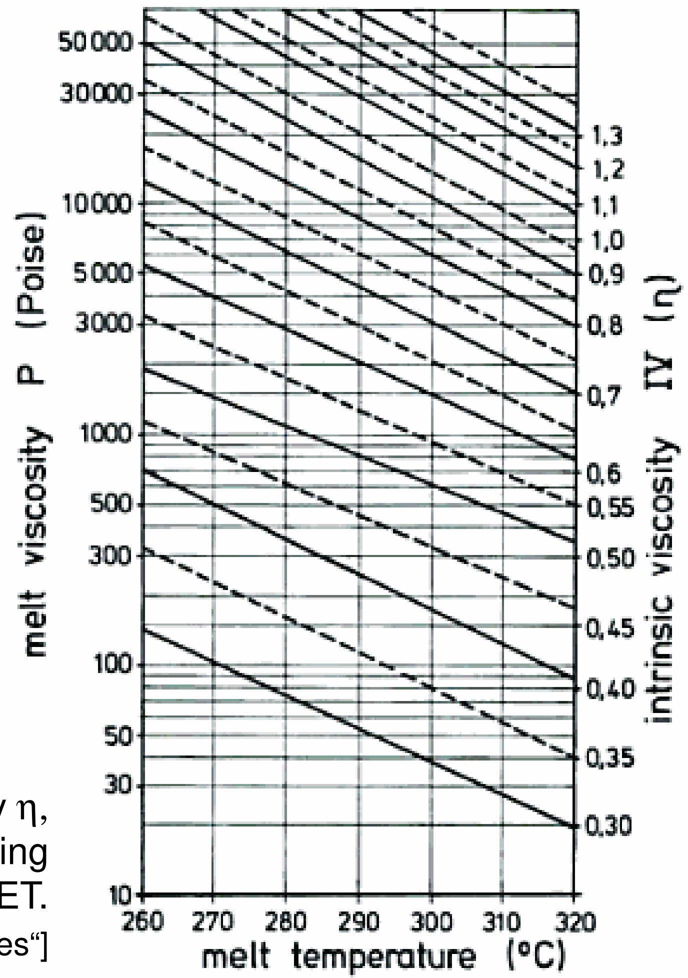
Without TiO_2 or any other as nucleation point acting particle the process speed is slower. If PET contains crystallisation inhibitors spinning might not be possible at all without TiO_2 or other pigments.

[W. Göltner in „Modern Polyesters“, Editors J. Scheirs, T.E. Long]

Influence IV
Melt

IV and it influencing variables:

- IV is direct proportional to the molecular weight (M_n), which is defined by the production process.
- At the same temperature the melt is more fluid for a PET with a lower IV:
    - A critical low level of viscosity is reached earlier
    - The process operation window is smaller.
    - The process is more difficult to adjust.
    - More filament breaks occur.



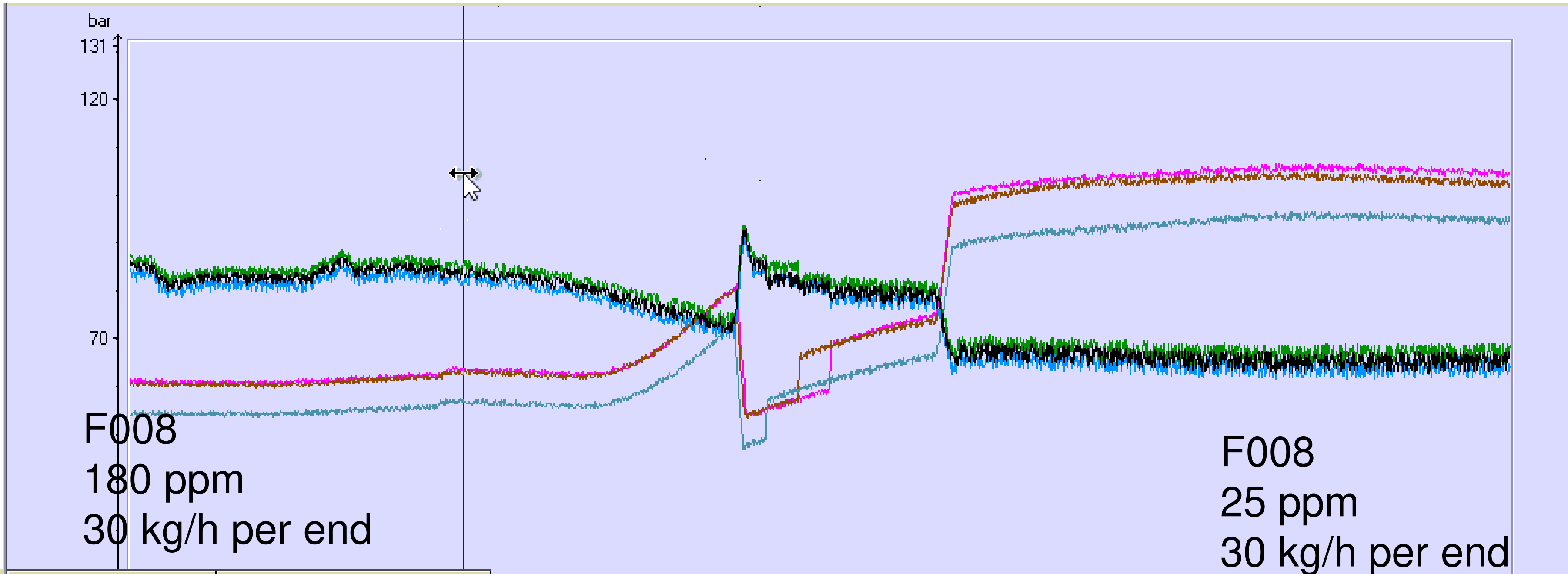
Relation between melting viscotity η, intrinsic-viscosity [η] = N and the melting temperature T (°C) of PET.
[Fourné „Synthetic Fibres“]

Information only

PET: Influence IV

Melt

Influence of the **humidity** on the IV: Example influence of the chip humidity on spin pack pressure



Trend	Value
In front 1	82
In front 2	85
In front 3	82
In front 4	0
Behind 1	57
Behind 2	62
Behind 3	63
Behind 4	0

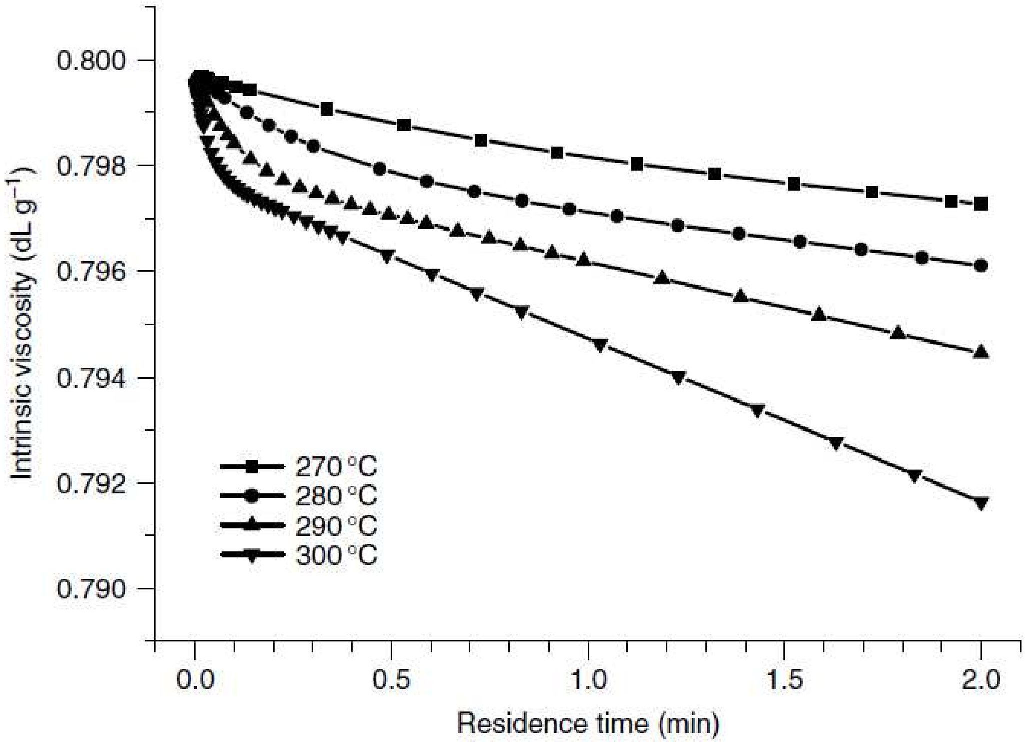
Trend	Value
In front 1	67
In front 2	67
In front 3	64
In front 4	0
Behind 1	96
Behind 2	104
Behind 3	106
Behind 4	0

Information only

PET: Influence IV
Melt

Influence of the **temperature** on the IV:

- At low water content the PET nevertheless thermally decomposed / depolymerises. This reaction is temperature and time depending:
  - Spin pump therefore should run all time if possible.



Intrinsic viscosity of the polymer melt as a function of extruder residence time and temperature for an initial water content of 3ppm.
[T. Rieckmann, S. Völker in „Modern Polyesters“, Editors J. Scheirs, T.E. Long]

Information only

PET – Power Failure - 1

PET – Power Failure

How long was the Power failure?

< 10 min

- Restart of the line
- Spinnerets do not need to be changed, but flushing could be needed

< 2 hours

- Spinnerets need to be changed
- Restart of the line
- Flushing without spinnerets is needed

>2 hours

- Remove Spinnerets
- Getting dry PET will take longer time
- PET in unit is frozen -> two possibilities for the line
  - Recommendation: flush over to PP
  - “Last chance”: Freeze the PET until Dryer and Cryztallizer are ready to start (lower temperatures at PCS)

Shut down procedures - PET

See process manual chapter 2.6.4

Example mechanical stop at extrusion

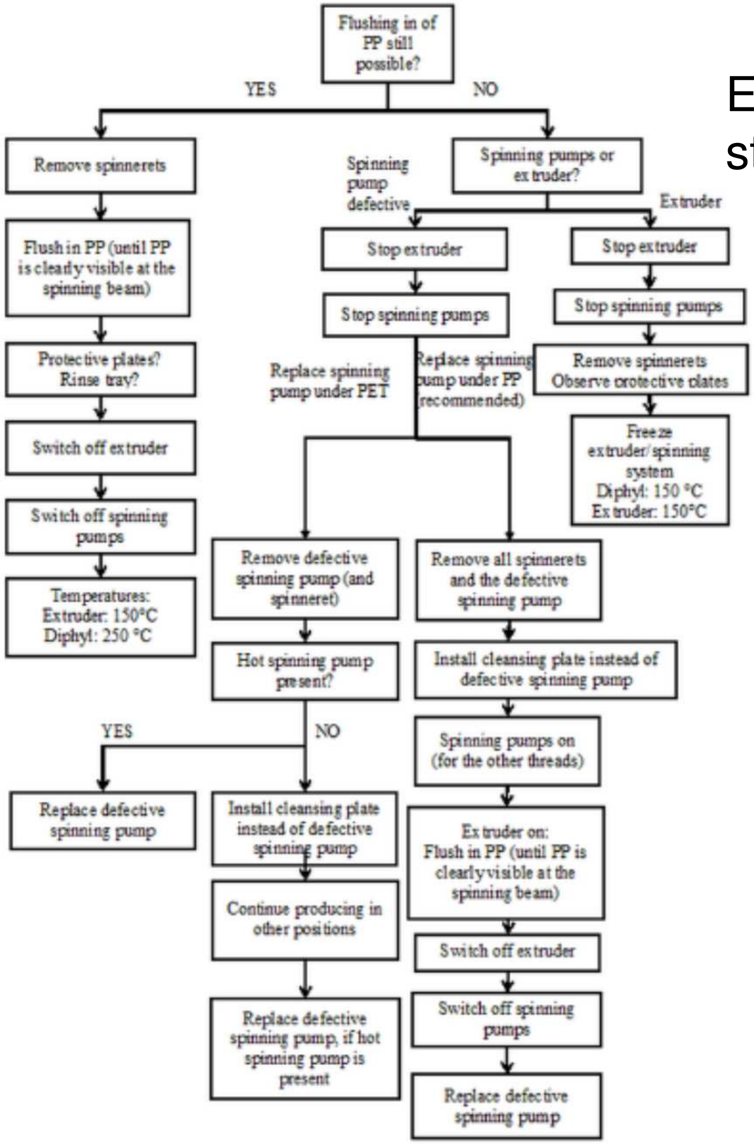


Figure 2-6: Stop at the extrusion - schedule

PET – Power Failure - 2

Restart of the line after Power Failure

- Reset the E-Stop (it could be that the blue light is off)
- Start the PCS
- Reset the faults on the line
- Switch on all heating: spin beam, meltpipe, extruder
- restart the dryer/crystallizer
- Restart the metering units
- Check the temperatures on the PLS! (spin beam, extruder, melt pipe)
- If temperatures are ok: start flushing, observe the extruder pressure (blocked melt pipe)
- Start the line back to production. (if needed change spinnerets)

Information only

Change over procedures

See process manual
chapter 2.3

Example PET to PP

Flush over PET to PP

1. Stop the chip conveying
2. Change the conveying to PP
3. Use low throughputs for flushing
4. Stop the metering. Clean the metering unit well form PET remnants.
5. Fill PP in the metering unit.
6. Clean the extruder inlet and start metering unit with PP, when PET is emptying at the extruder inlet.
7. As soon as PET reaches the inlet of extruder, set the zone1 and zone2 to 230° and 240 °C.
8. Rinse until the PP is clear/the PET is out.

Information only

Change over procedures

See process manual
chapter 2.3

Example PP to PET

Flush over PP to PET

1. Set the extrusion, meltpipe and spinning temperatures to PET temperatures except the Zone1 and Zone 2 of the Extruder (Zone 1 to 240°C and Zone 2 to 250°C avoiding back flushing of the PP). Wait until all temperatures are reached and stayed for 15 Minutes.
2. Ensure that the conveying is changed to PET
3. Start Flushing with PP (with the rest PP in metering) at low throughput
4. Emptying the Metering Unit. Stop the metering unit and clean it well from PP remnants
5. Fill PET in metering unit.
6. Clean the extruder inlet and start the metering unit with PET, when PP is emptying at the extruder inlet.
7. As soon as PET reaches the inlet of extruder, set the zone1 and zone2 to PET temperatures.
8. Rinse with PET

Information only

PET: Influence IV

Process parameters

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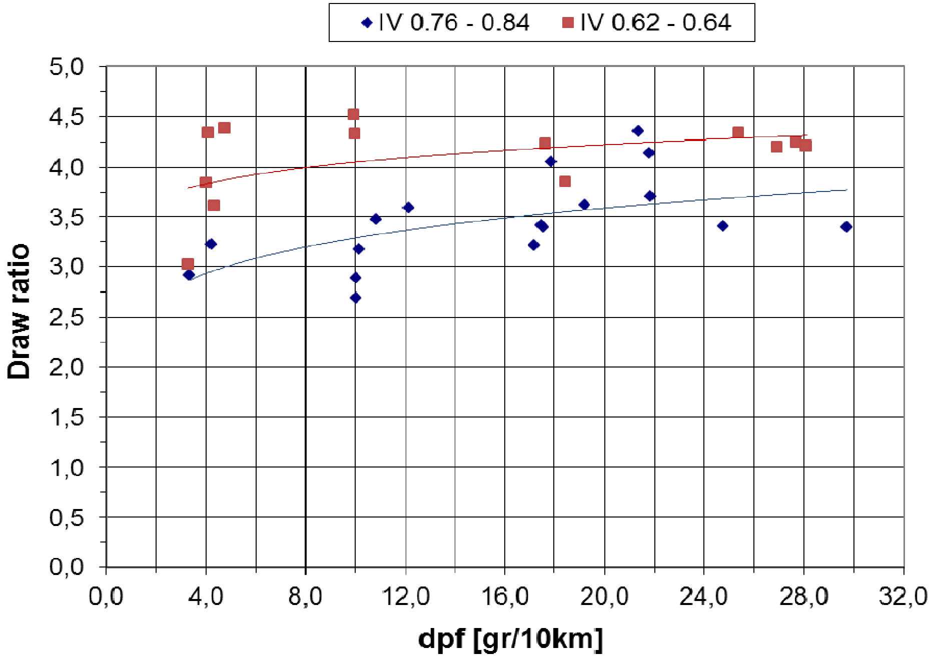
The IV also has an influence on further BCF process parameters. PET with a low viscosity has to be drawn slower from the spinning section. This corresponds with the increase in melt strength (resistance of melt against deformation) and melt stability due to an increasing of molecular weight described in the literature.

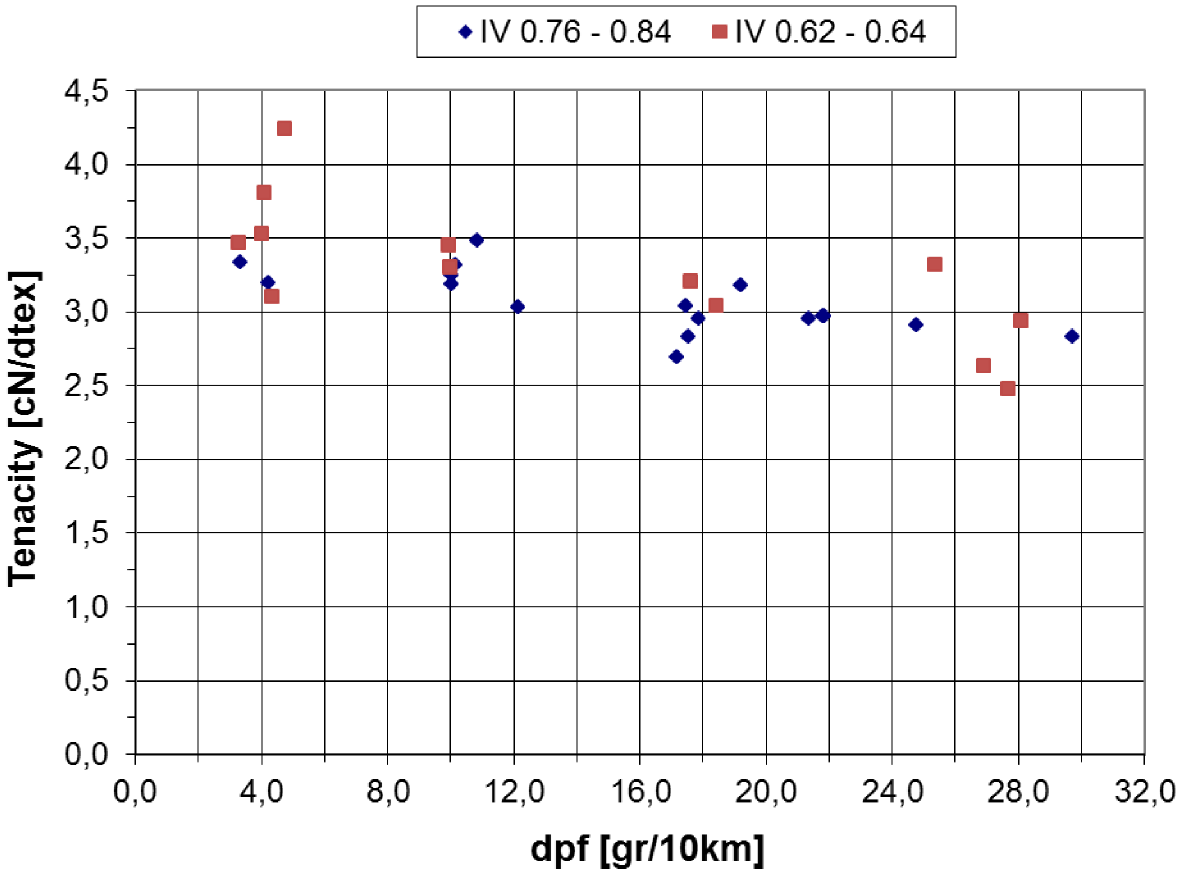
Due to a higher melt stretch (higher spinning speed) the PET with a high IV has already a higher degree of crystallisation than the low IV PET, which needs to be spun slower. Therefore the PET with a lower IV can be drawn more hence has a higher draw ratio.



PET: Influence IV

Fibre strength

Are the fibres spun and drawn well there is no difference in the resulting tenacity at the same D.P.F. between the low and the high viscose PET, but the melt stretch and the draw ratio are different.



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PET: influence of heat set temperature to dye take up

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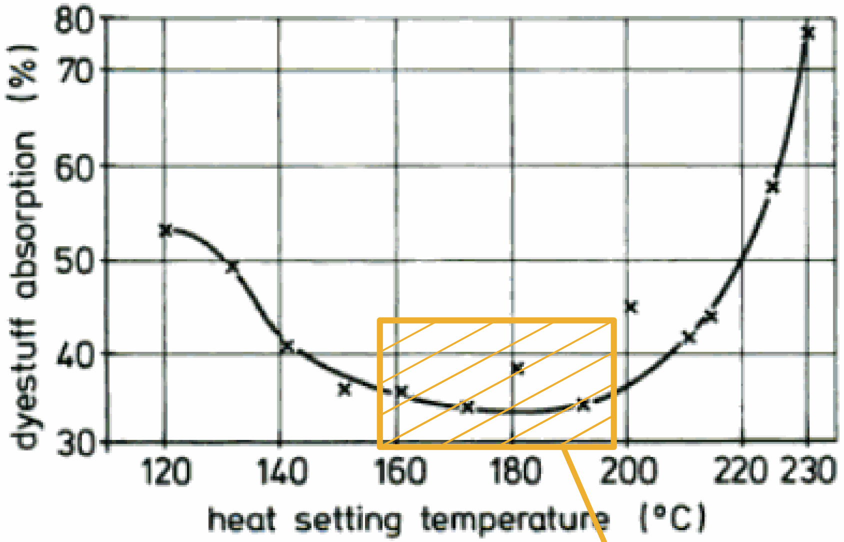


heating up to ~180°C:
crystallinity increase and
dyestuff absorption decrease

temperatures higher 180°C:
free volume in armophous
areas and dyestuff absorption increase

Figure 9.25
Effect of setting temperature on the dye uptake of Terylene (=PET, dyed using 2% Dispersol Scarlet B 150 for 90 min at 100°C [28])

Fourné: „Synthetic fibres" ; page 731; Hanser Verlag; 1999

Explanation: Reason why DUO-temperature and heat set temperature should be in this temperature range. (marginally slope → small temperature variation have only little influence on dying)

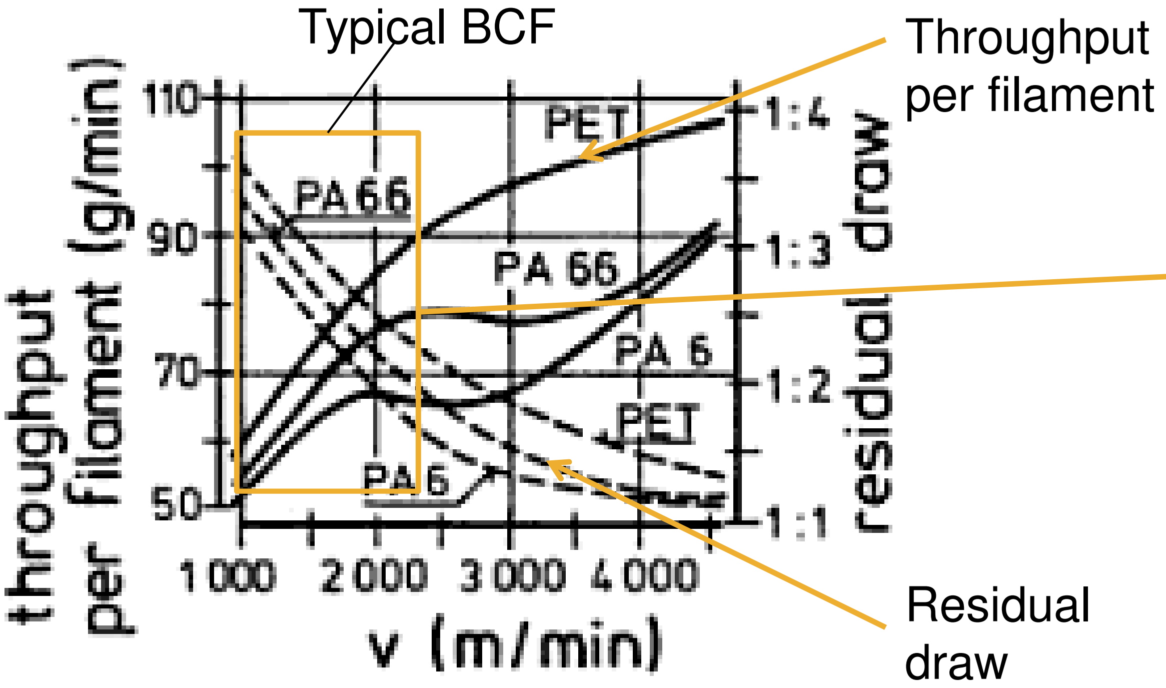
Information only

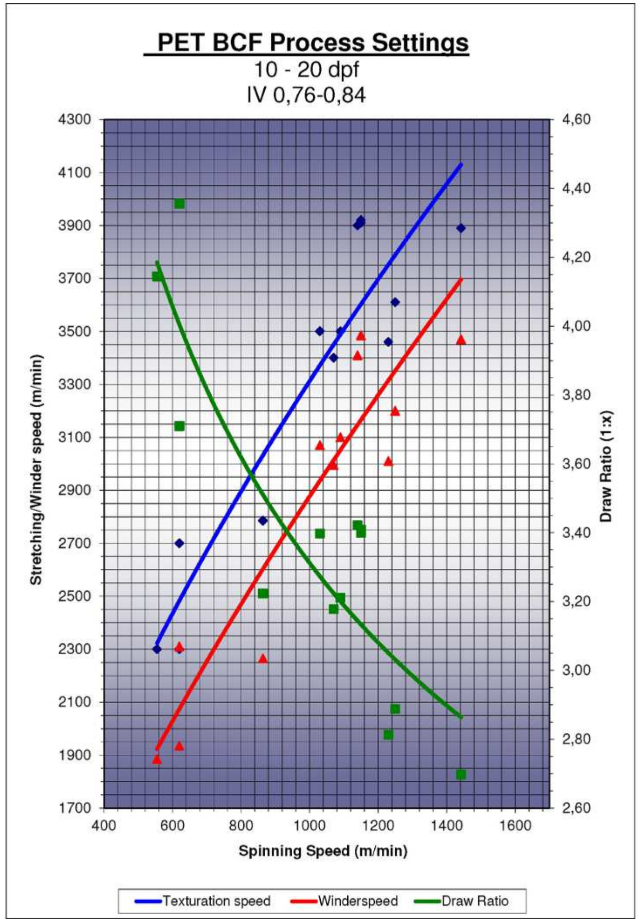
PET: Spinning process

Process parameters

The residual draw of PET fibres is decreasing with increasing spinning speed. Especially in the range of the BCF spinning process 500 m/min – 4 000 m/min the influence is significant.

- It is important to adapt all process speeds according to the spinning speed.





Residual draw of PET and PA6 filaments 1 : (1+x) as a function of the spin take-up speed with the parameter relative solution viscosity in a linear diagram. [Fourné „Synthetic Fibres“]

Information only

PET
general requirements

- Intrinsic Viscosity: 0.62 to 0.84
- DEG (Diethylene Glycol) content not specified
- Content of COOH not specified
- Humidity 0.5% before drying, 30ppm after drying
- Content of TiO_2 less than 1%
- TiO_2 > 0.05 % recommended for spinning process

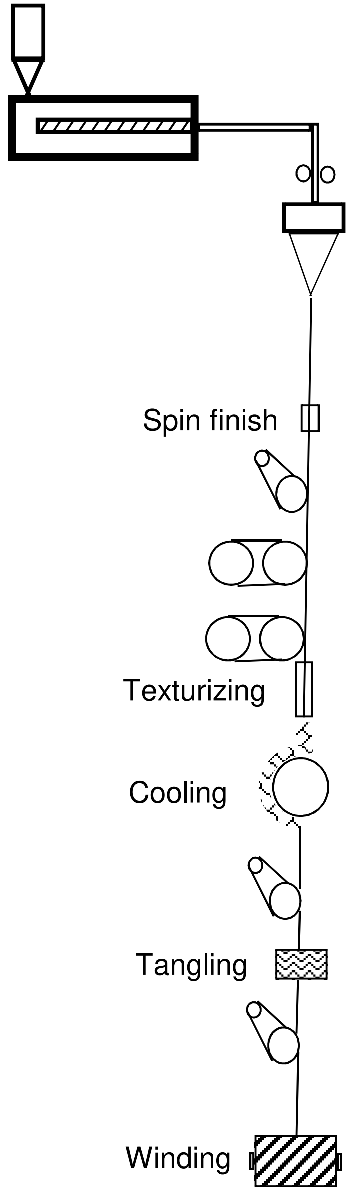
In addition: consistency!

As NEUMAG only specifies few parameters a reference list is important!

Components of a BCF-postion

Components of a BCF position

2. Components of a BCF position
   a) Dosing
   b) Extrusion/spinning
   c) Overview Take up Unit
   d) Spin finish
   e) Godets
   f) Texturizing
   g) Cooling drum
   h) Tangle unit
   i) Winder



Dosing

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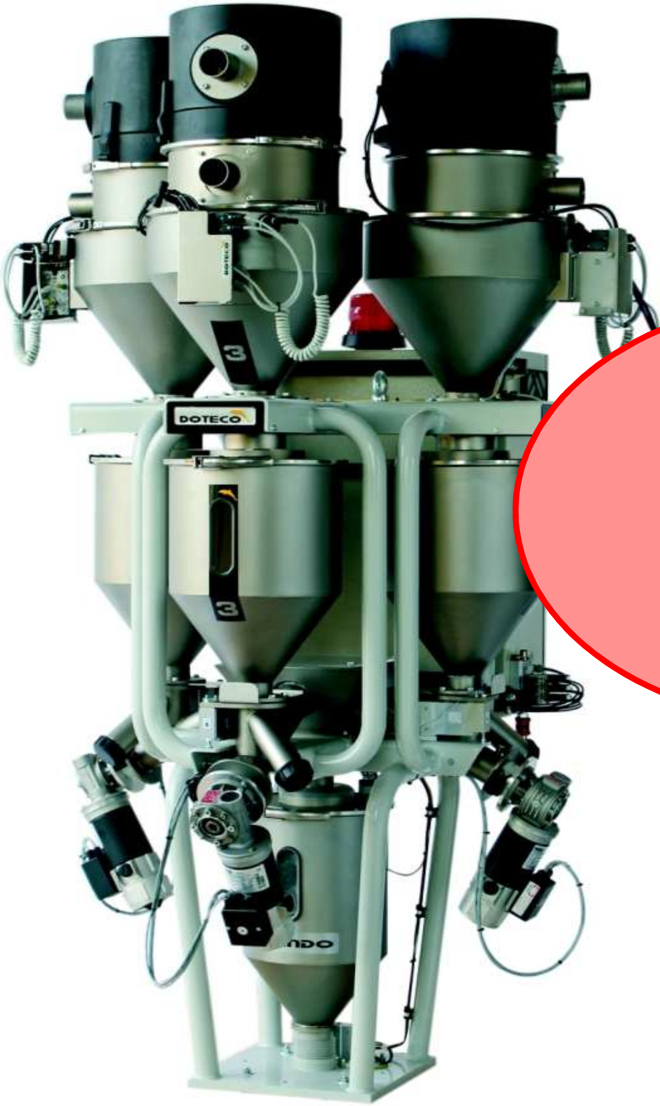
2. Components of a BCF position
   a) Dosing
   b) Extrusion/spinning
   c) Overview Take up Unit
   d) Spin finish
   e) Godets
   f) Texturizing
   g) Cooling drum
   h) Tangle unit
   i) Winder

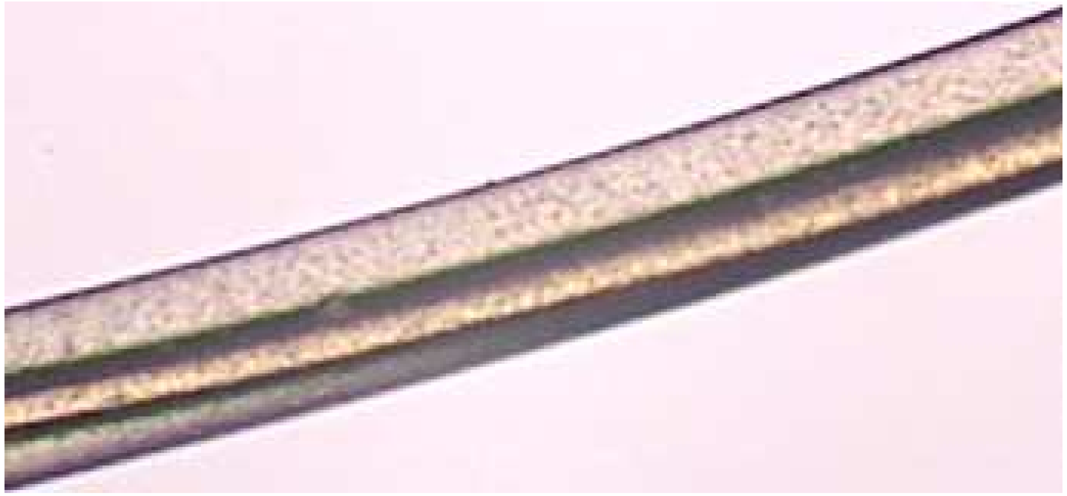
Example Doteco dosing unit



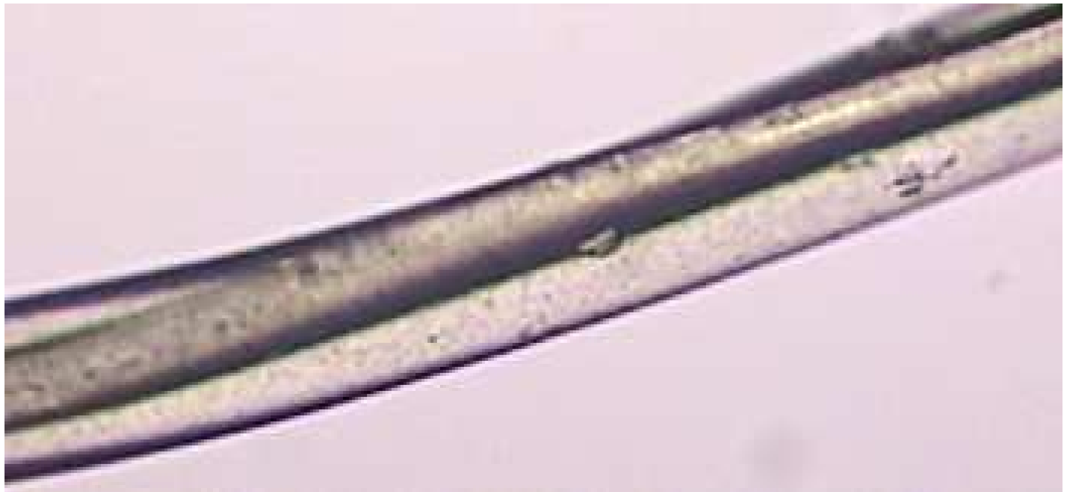
Separate session

Dosing: influence of pigments

darker, more Pigments



lighter, less Pigments



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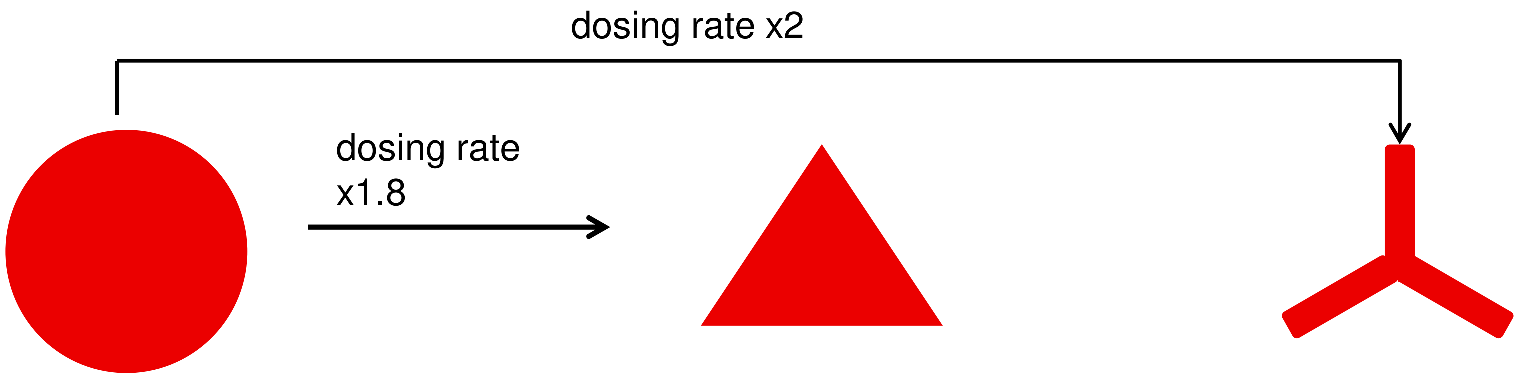
Relation between nozzle cross-section and color strength

round nozzle | triangular nozzle | trilobal nozzle



High color strength | low color strength | lowest color strength

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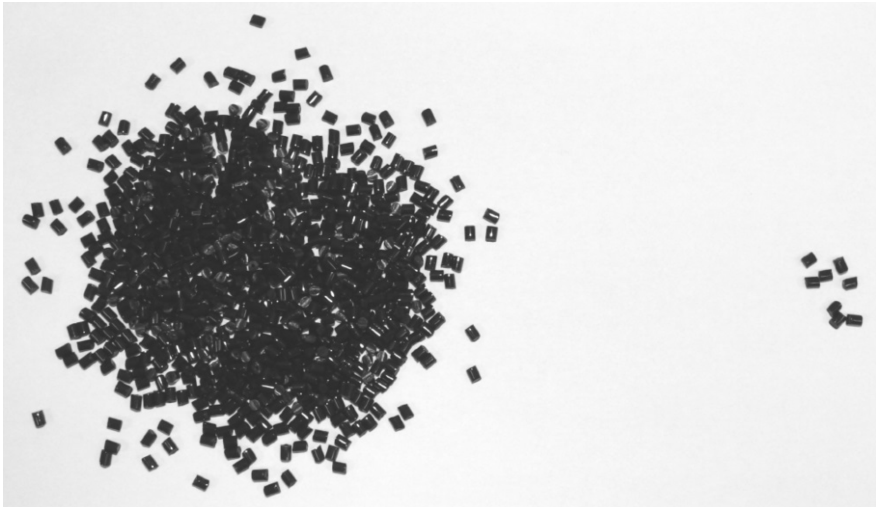
Dosing: influence to colour

- Required pigment accuracy depends on end-use (cabled, heat set or BCF); colour and on carpet construction (cut; loop; cut-loop,…): sometimes for low dosing rates the accuracy of dosing unit is not high enough
- → For sensitive products were very high accuracy is needed: higher dosing rate as high as 6…8 % or more with same total pigment amount equalizes dosing differences



- Proper cleaning of feeder, hopper and screw
- Do not touch hopper or place dosing unit near ventilation
- Ensure damping and decoupling is working
- Short term fluctuations (<30 sec.) are partially compensated due to mixing in extruder)

Extrusion/Spinning

2. Components of a BCF position
   a) Dosing
   b) Extrusion/spinning
   c) Overview Take up Unit
   d) Spin finish
   e) Godets
   f) Texturizing
   g) Cooling drum
   h) Tangle unit
   i) Winder

Extruder

The usual length of the Extruder screw is 30D.

The Extruder shall melt the polymer and mix it proper with the Masterbatch and/or other additives.

The melt temperature should be chosen according to the viscosity of the polymer.

The lowest possible temperature is the best in order to avoid degrading of the Masterbatch if the throughput changes.

Extruder screws can be designed in such a way that they are suitable for different Polymers such as PP, PA6 and/or PET.

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Main Functions of an Extruder screw:

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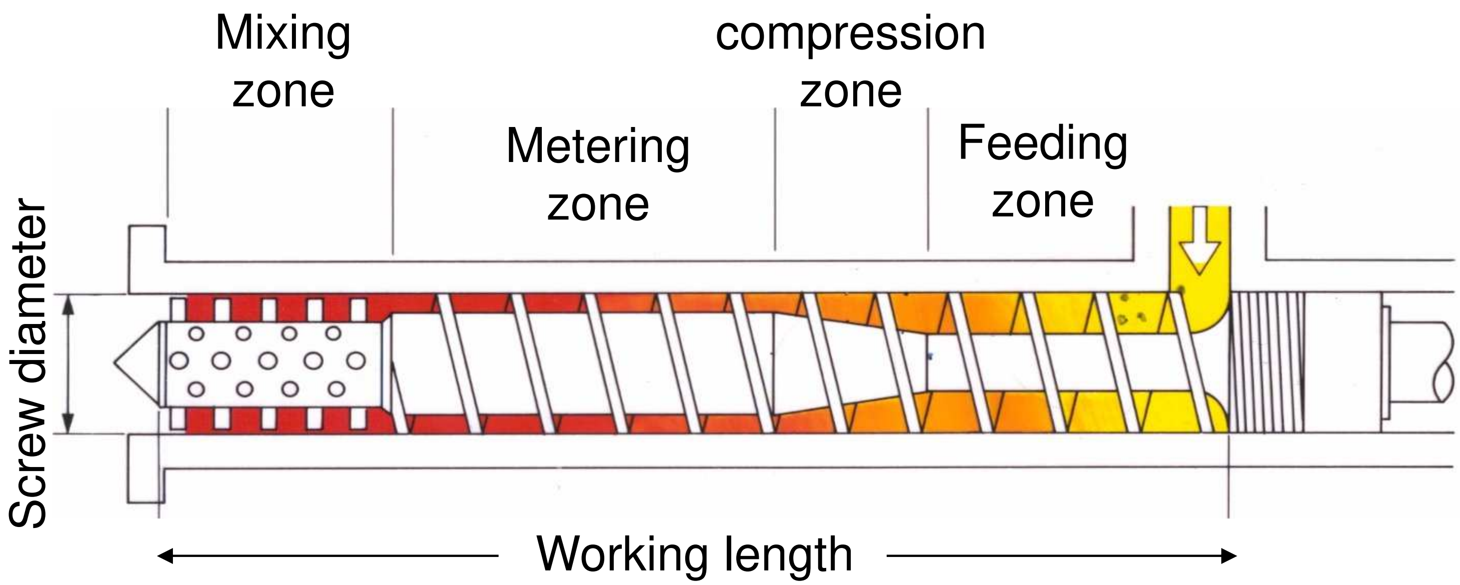

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Extruder screw design

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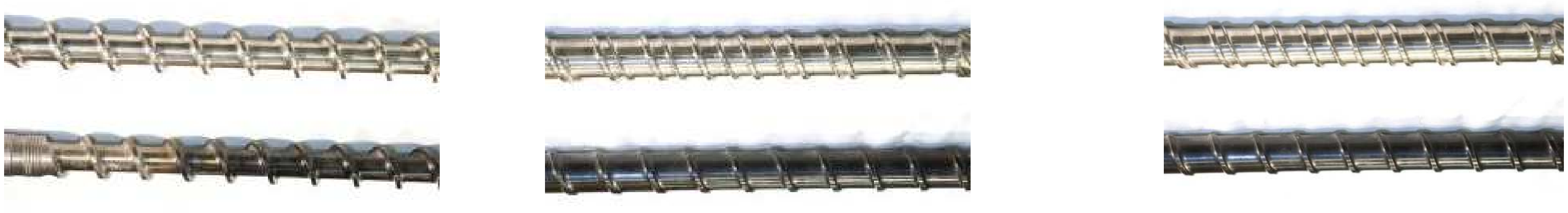
The In feed sections
are similar at both screw designs.
The screw conveys the polymer into the extruder, melting starts

Melting and compressing
In this zone the polymer will be further melted and compression starts in order to get a high output pressure.
Inside the barrier screw mixing starts due to polymer backflow!

Compressing
polymer is further compressed.
The Barrier is still mixing the polymer with the MB.
The 3 – Zone screw needs a mixer at the end of the screw in order to do proper mixing.

barrier screw

3-zone screw



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LTM Barrier Mixer

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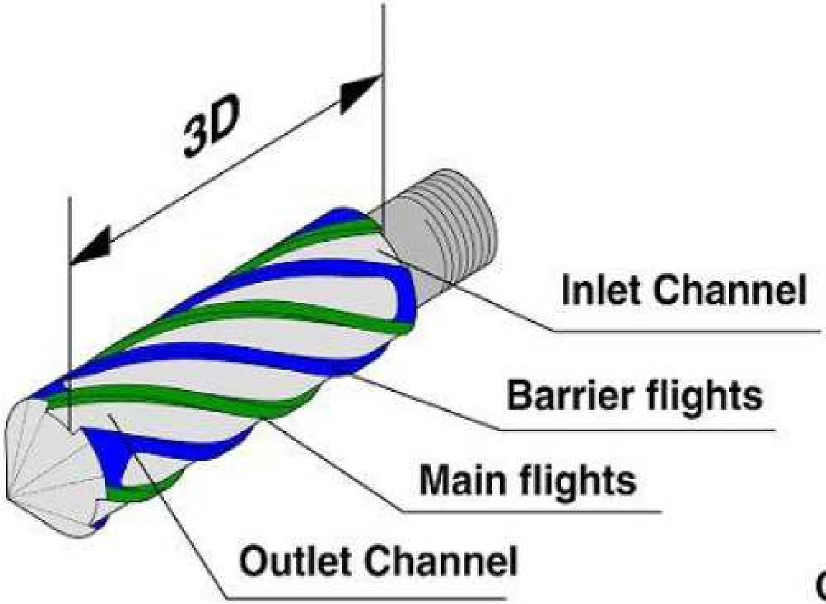
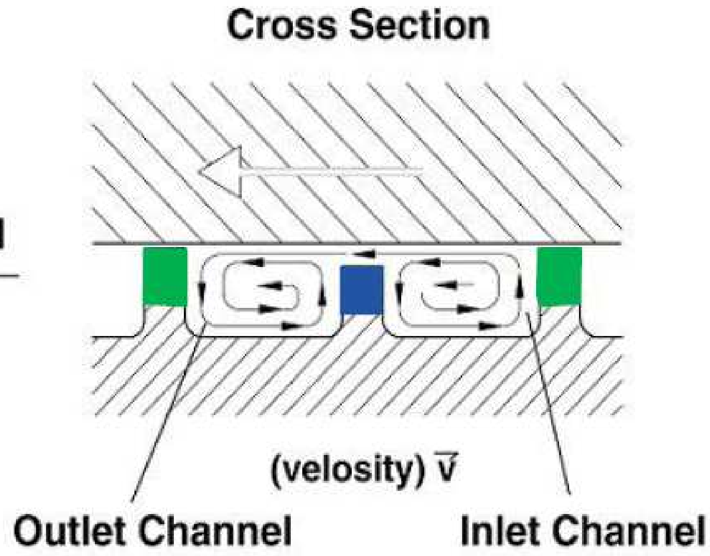




Helical flow and short shear flow
(Melt quality control)

- LTM: Low Temperature Mixing
- Laminar mixing
- Increase of melt capacity
- Low pressure drop

BBE: Presentation Extrusion Technology: Screw Design; June 2015

Information only

Extrusion system

Extruder Temperatures, depending on the MFI; RV or IV:

- Infeed section always on 25 °C
- PA6/PET: typical first zone 20 °C cooler than the last zone

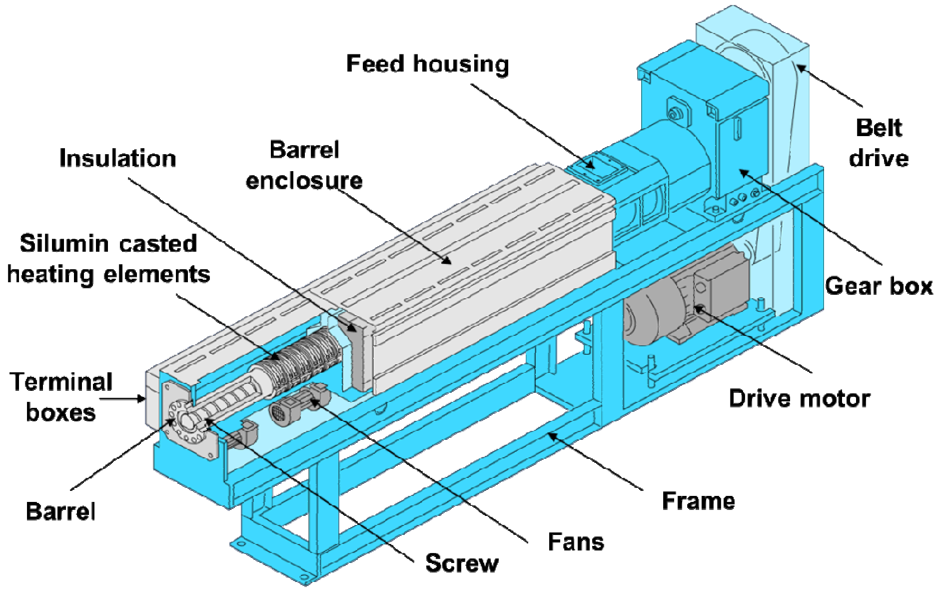
PA6	Max. Extruder Temperature	Dowtherm
RV 2,68-2,76	265 - 270 °C	270 °C
RV 2,9	280 - 285 °C	285 °C

PA6.6	Max. Extruder Temperature	Dowtherm
	290-295 °C	295 °C

PET	Max. Extruder Temperature	Dowtherm
IV 0,62..0,7	285..290°C	290 °C
IV > 0,76	292..295°C	295 °C

PTT	Max. Extruder Temperature	Dowtherm
IV 0.92, 0.96, 1.02	230 – 265 °C	250 °C

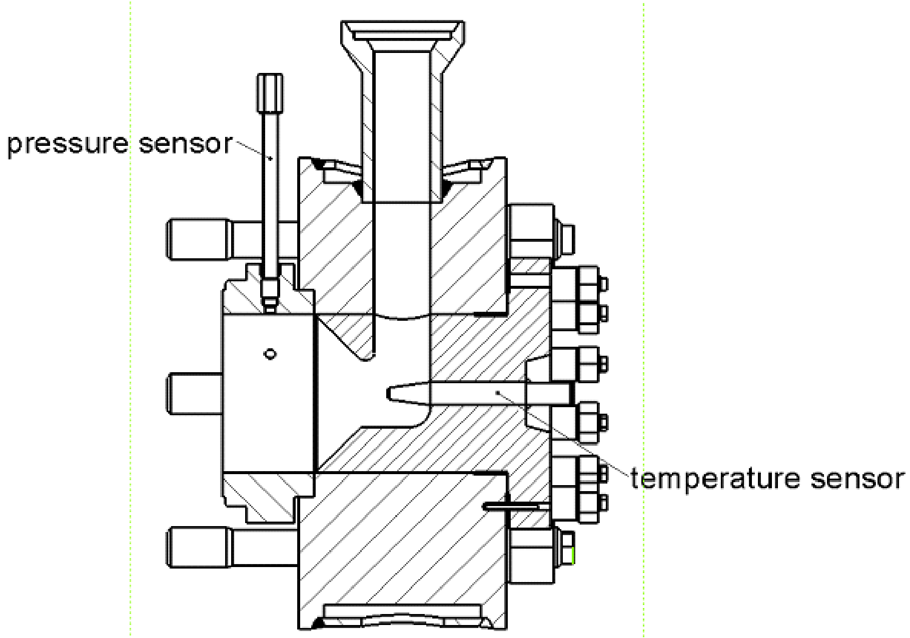
PP	Max. Extruder Temperature	Dowtherm
MFI 12-16	245 °C	245 °C
MFI 17-20	235 °C	235 °C
MFI 21-26	225 °C	225 °C



Measuring Head

The measuring head contains a pressure and a temperature sensor.

The temperature is measured inside a pipe without contact to the melt.
We refer to it also as melt temperature.
The melt temperature is a result of the extruder temperature setting and shear in the extruder!



The melt pressure is measured inside the melt. The sensor is used to control the speed of the extruder. The pressure setting should be chosen in such a way that the pressure in front of the spinning pump is always > 30bar.

Information only

HTM - Heat Transfer Medium

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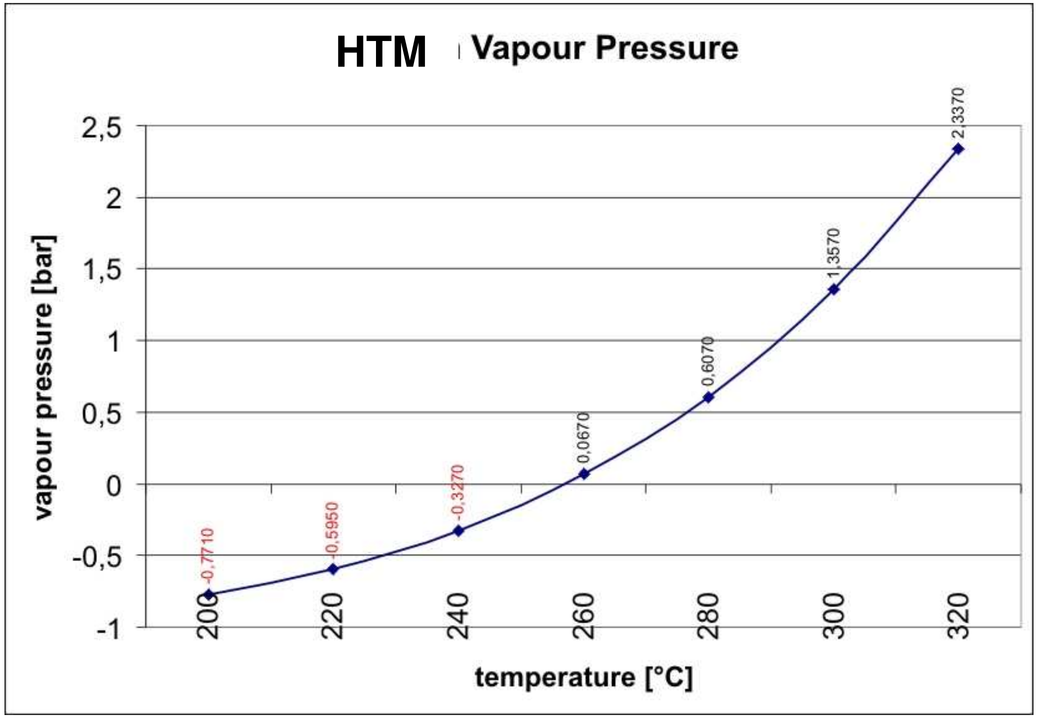
The HTM system does heat the spinning beam, the measuring head, and the melt pipe.

HTM is a heat transfer oil with a boiling point of 256°C.

Above 256°C HTM creates an overpressure, below an under pressure in the system.

The temperature should be about the same like the melt temperature.

Please consider the storage conditions of the HTM.



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Melt Pipe

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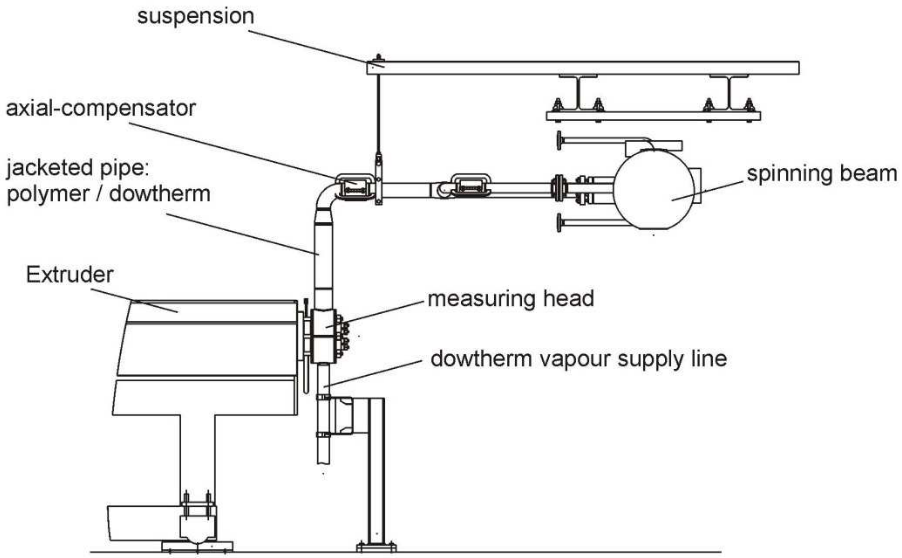
The Melt pipe does connect the measuring head with the spinning beam.

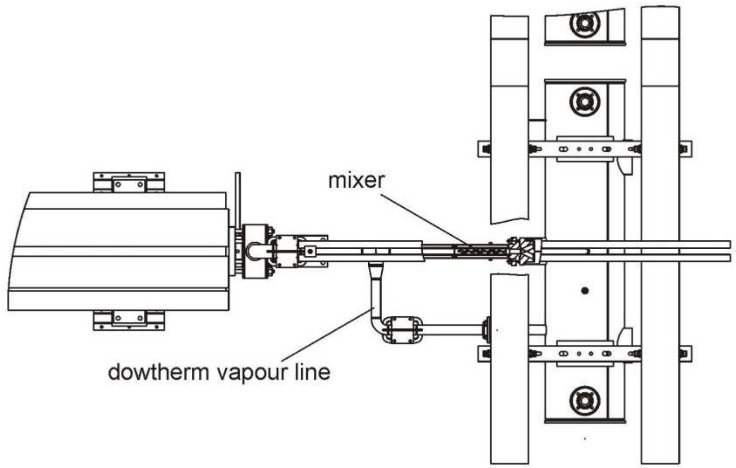
The melt pipe is creating a pressure drop from the Measuring head to the spinning beam.

The pressure drop depends on the length of the pipe , the Polymer which is used and the throughput to the pipe.

The melt pipe contains also the static mixer which does a for the mixing of polymer and Masterbatch.

The pressure before the spin pump should be always > 30 bar.



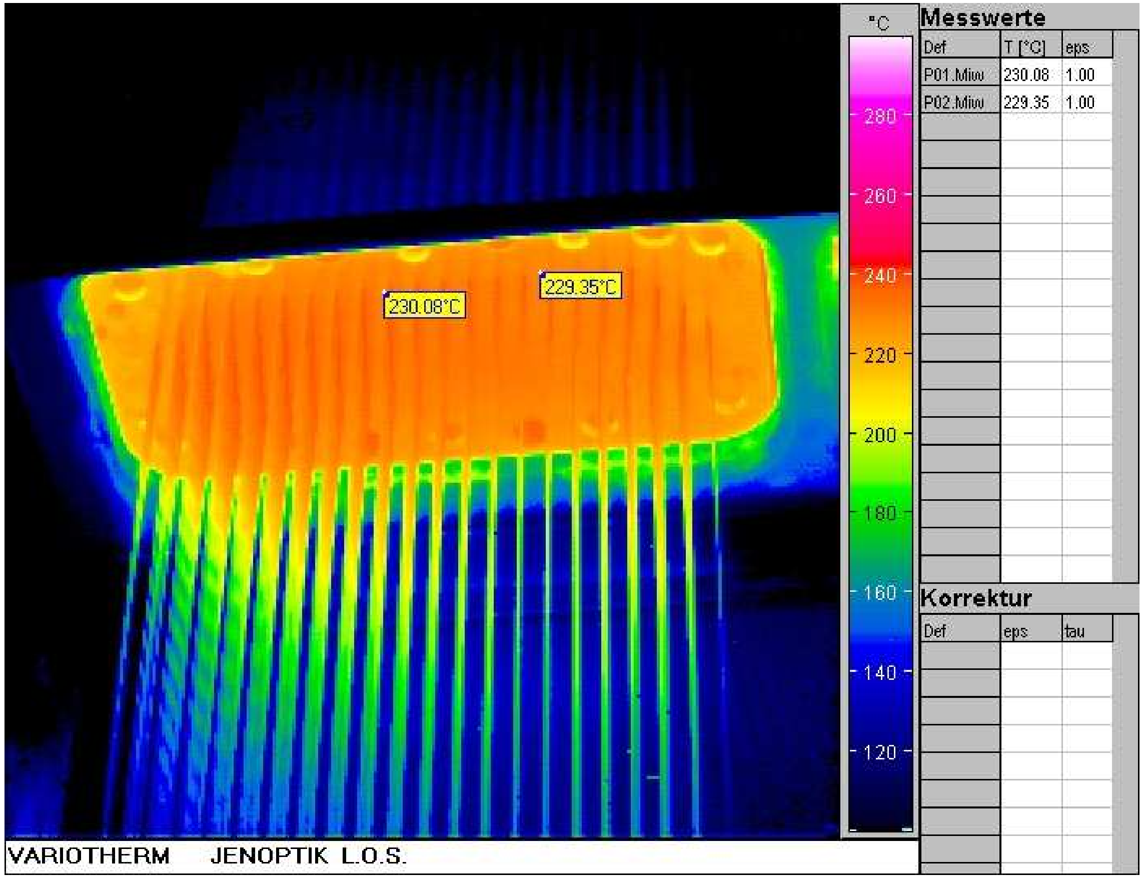


Information only

Spin Pack

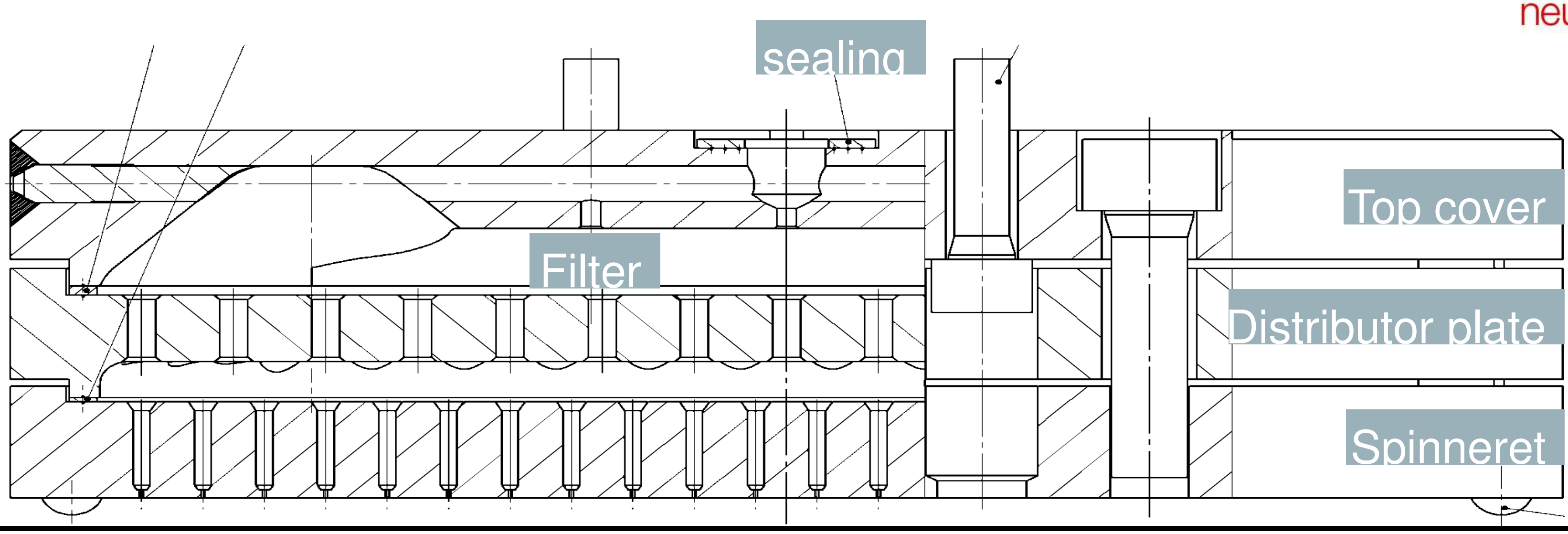
In order to achieve a good run ability the packs have to be as hot as the polymer.

If new packs have to be installed they should be pre heated 20°C above Beam temperature.

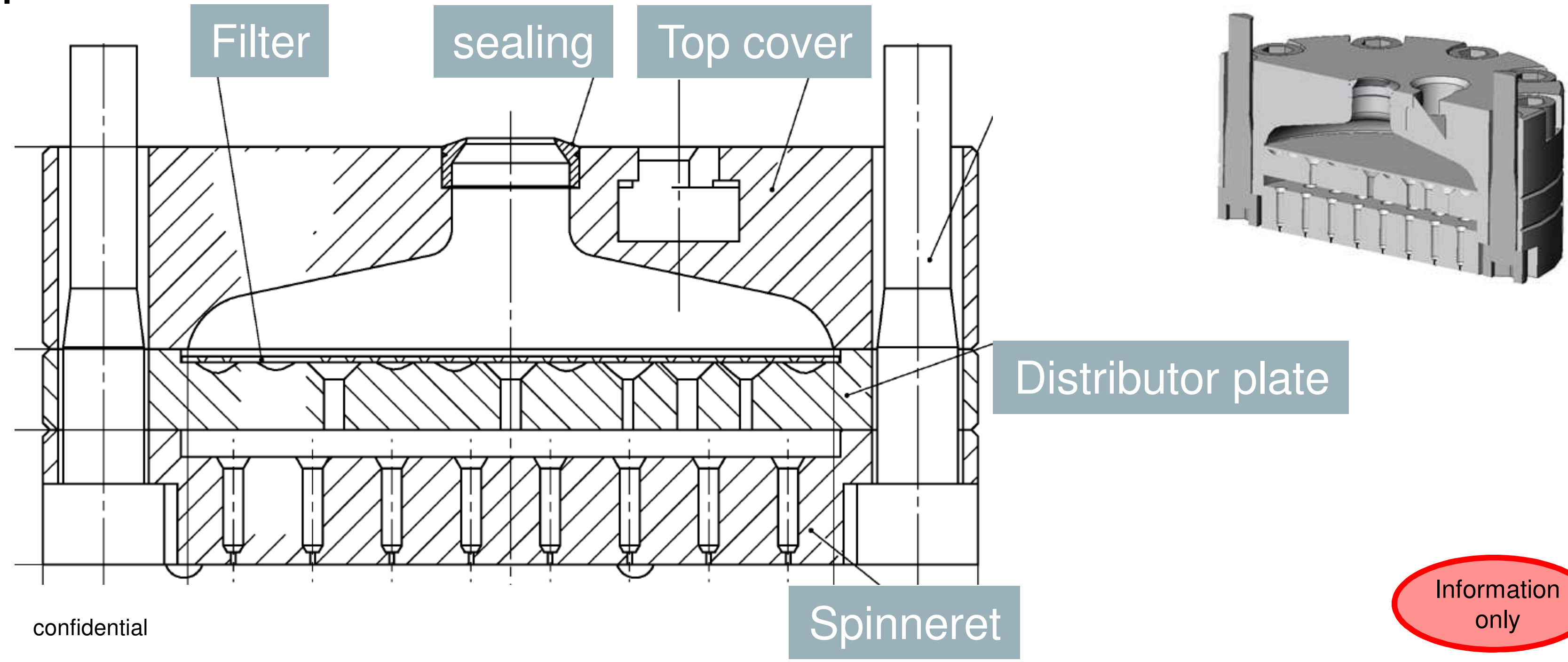


Information only

Spin pack mono

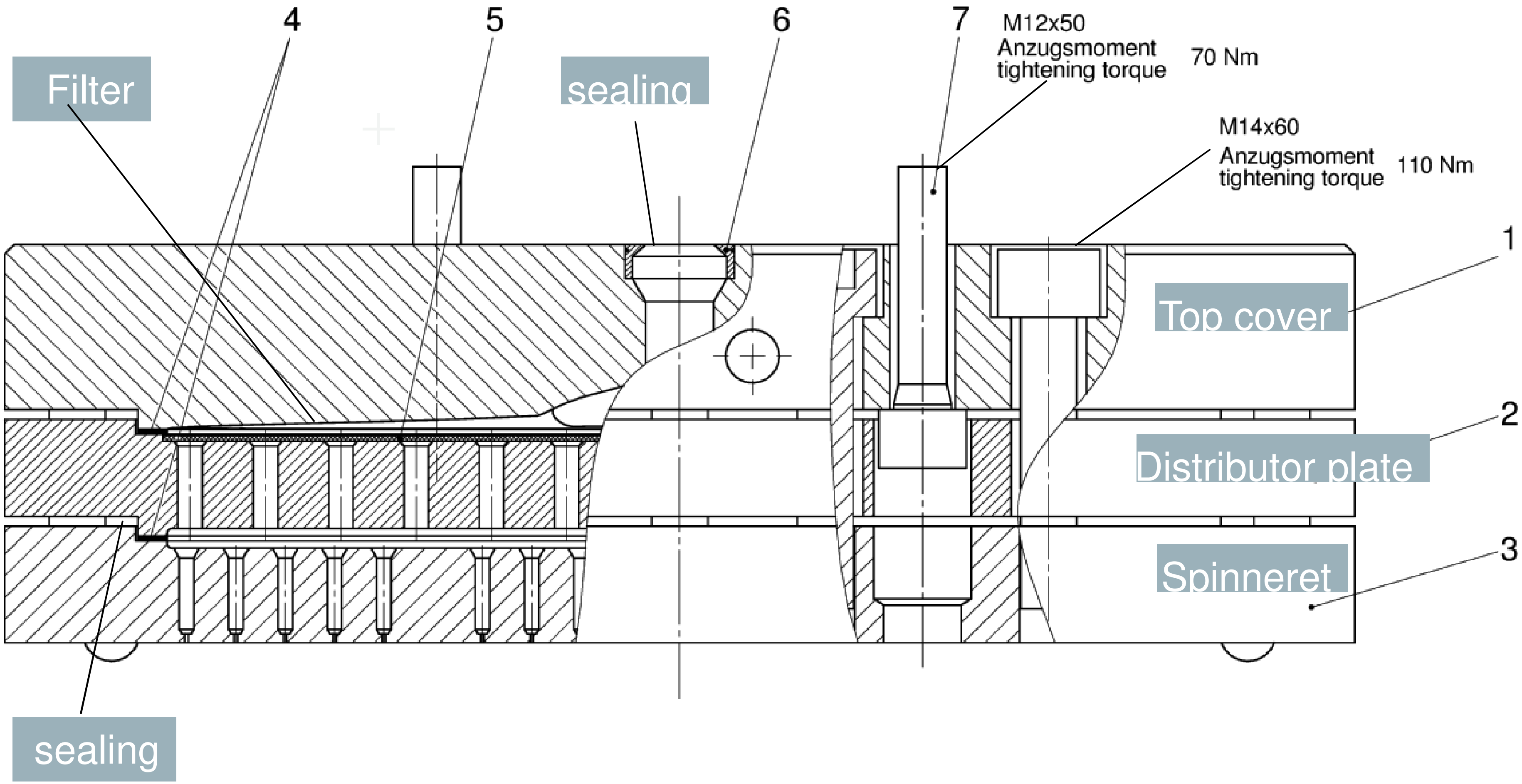


Spin pack trico



Information only

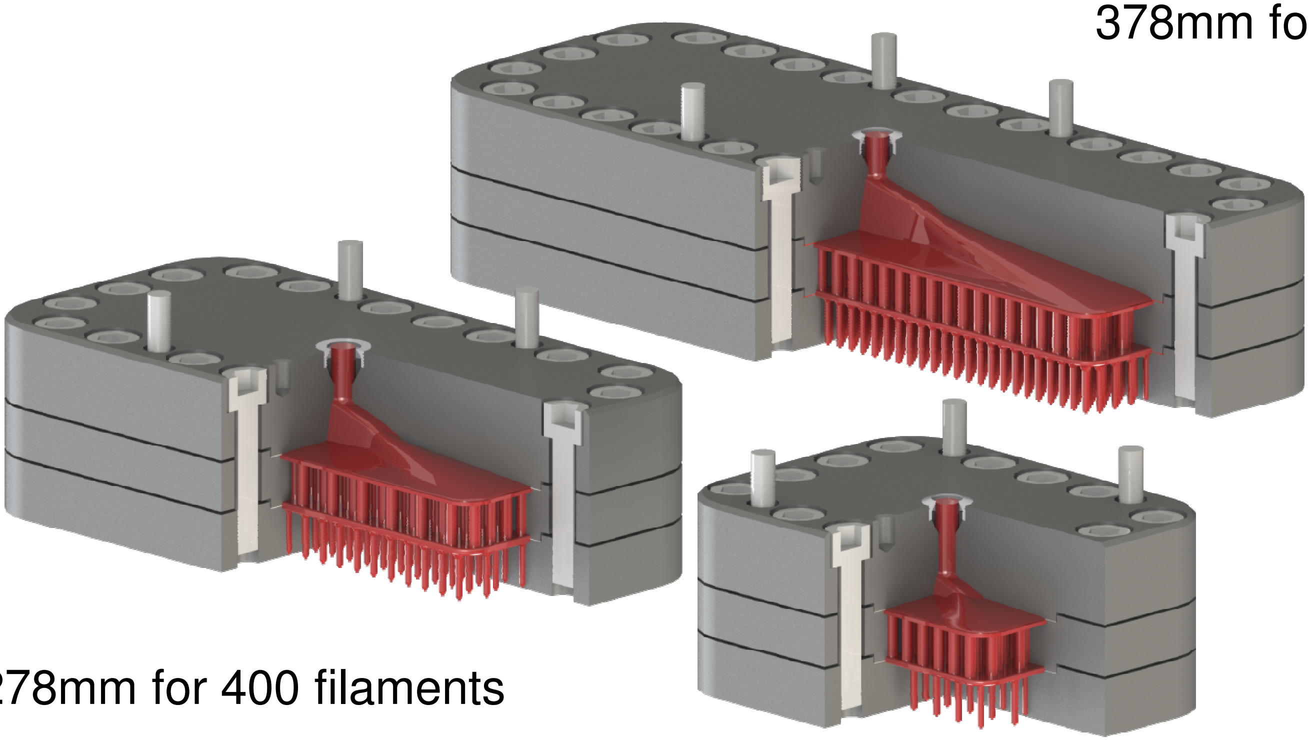
Spin pack mono – BCF-S8



Information only

BCF-S8 Spin Packs

- Different spin packs sizes for different filament counts and/or throughputs
- Pressure fastness of Spin pack ≥ 200 bar (with special sealing)



378mm for 700 filaments

278mm for 400 filaments

178mm for 100 filaments

Information only

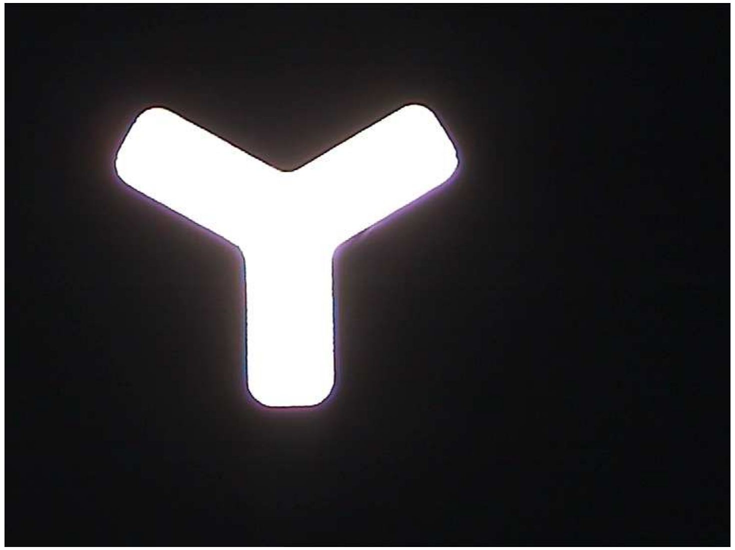
Recommended filters for spin packs

Filter		Polymer	Meshes for virgin
Fineness	[M/cm²]	PP/PET/PTT PA6/PA6.6	5402 – 595 – 61 16435 – 5402 – 548 – 61
Fineness	[mesh/inch]	PP/PET/PTT PA6/PA6.6	187 – 62 – 20 326 – 187 – 60 –20
Mesh width	[µm]	PP/PET/PTT PA6/PA6.6	80 – 250 – 1000 42 – 80 – 315 – 1000
Material seal / mounting		PP/PET/PTT PA6/PA6.6	Al – Mg Cu – nickel-plated

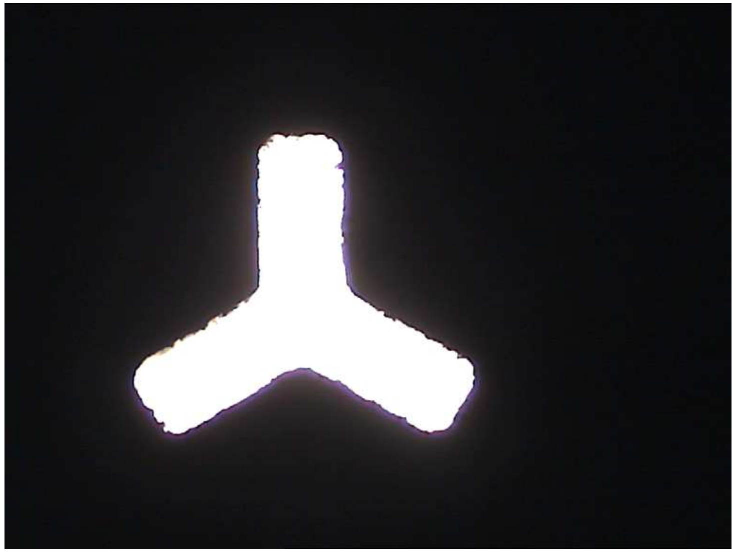
Hint: products < 4 dxpf:
use always 16.435 mesh

Spinning process
Process parameters

Properly cleaned holes



Dirt at the edges of the holes

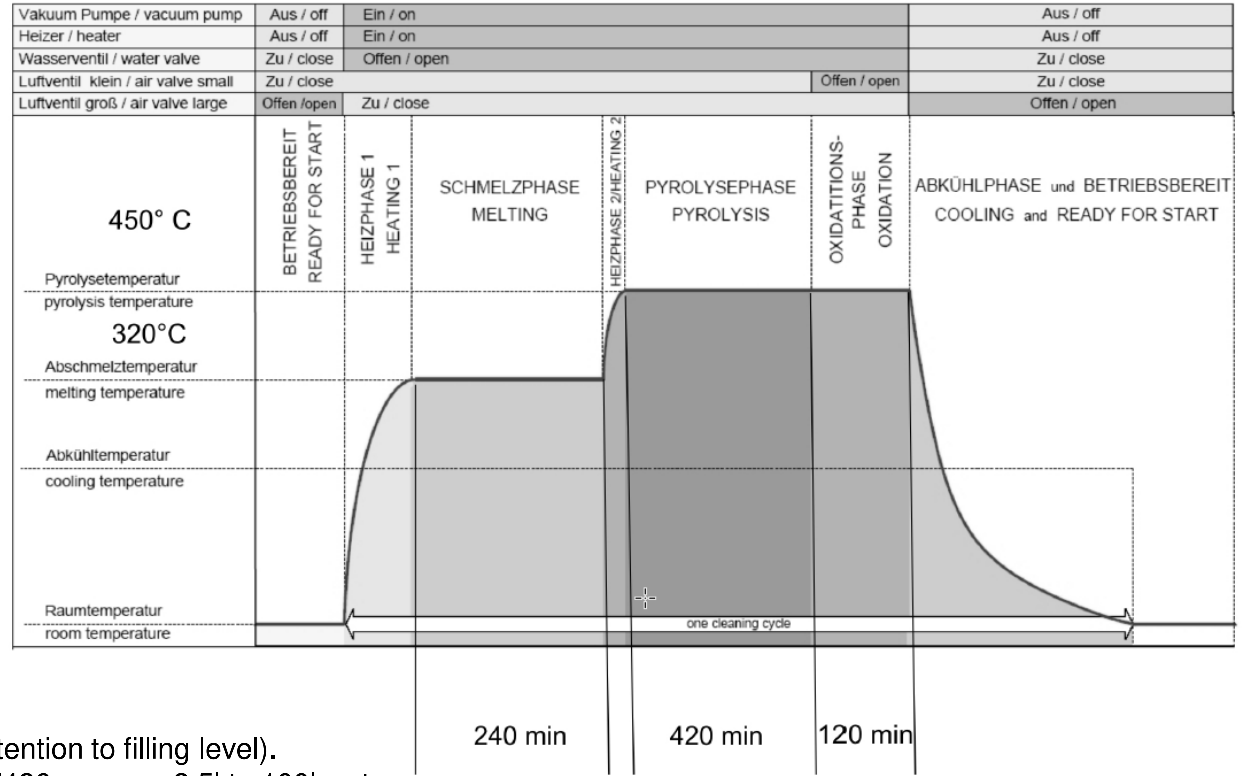


Especially capillary´s for PA6 and PA6.6 are much smaller and require more careful cleaning:

- Doglegs, twisted filaments or spin outs leads to reduced efficiency → more prone to streaks because operator start to work less carefully

Spinning process
cleaning procedure of spinnerets

0. **Disassemble the spin pack in hot state.**
1. Insert the frame with the spin pack parts in a vacuum-pyrolysis-oven.
2. Close the door of the oven and create vacuum.
3. Heat up to 320 °C
4. Temperature of 320 °C for at least 4 hours (= melt off)
5. Heat up to 450 °C
6. Temperature of 450 °C for at least 7 hours (= vacuum pyrolysis)
7. Open a small air-valve while holding the temperature.
8. Hold the actual status for at least 2 hours (= oxidation phase)
9. Cool down < 80 °C while leaving the parts in the oven.
10. Blow out the spinneret holes with compressed air.

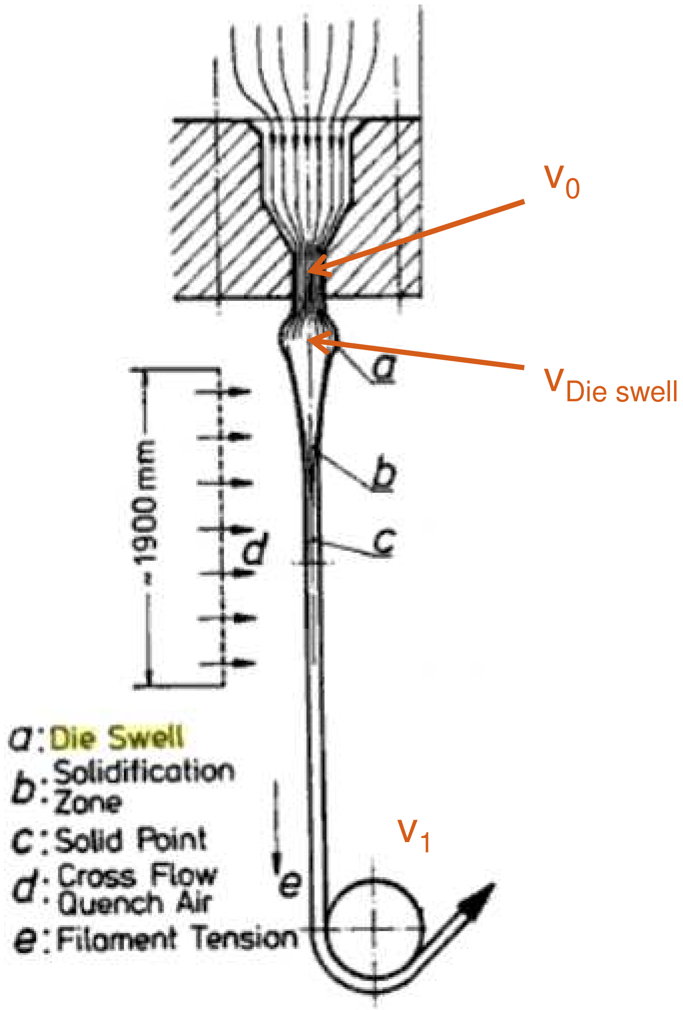


11. Fill ultrasonic bath with clean water (pay attention to filling level).
12. Add Neumag Cleaning Agent no. NE10047426, approx. 2.5l to 100l water.
13. Treat spin pack parts in an ultrasonic bath for approx. 30 minutes at 80 °C water temperature.

Important notes: The spinneret must to be in a horizontal position with outlet side at the top!

14. Drain the cleaning agent. The spin pack parts remain in the bath. Thoroughly rinse spin pack components and bath with clean, preferably warm water.
15. Hereafter dry spin pack parts with clean, filtered compressed air thoroughly.
16. Check spinneret holes with a microscope and document the result with date and name of the operator.
17. Wrap spin pack parts in clean, fuzz free paper. Wrapping in film is not appropriate as water can condense and cause rust.

Spinning



Melt and filament path during spinning process

$\frac{v_1}{v_0}$ is only calculative → approximated

$\frac{v_1}{v_{die\ swell}}$ would be real, but couldn‘t be calculated in advance, because $v_{die\ swell}$ is depending on:

- viscosity
- melt temperature
- polymer
- shear rate
- additive

Please use NEUMAG-designed spinneretts for given product!!!

Example total draw ratio

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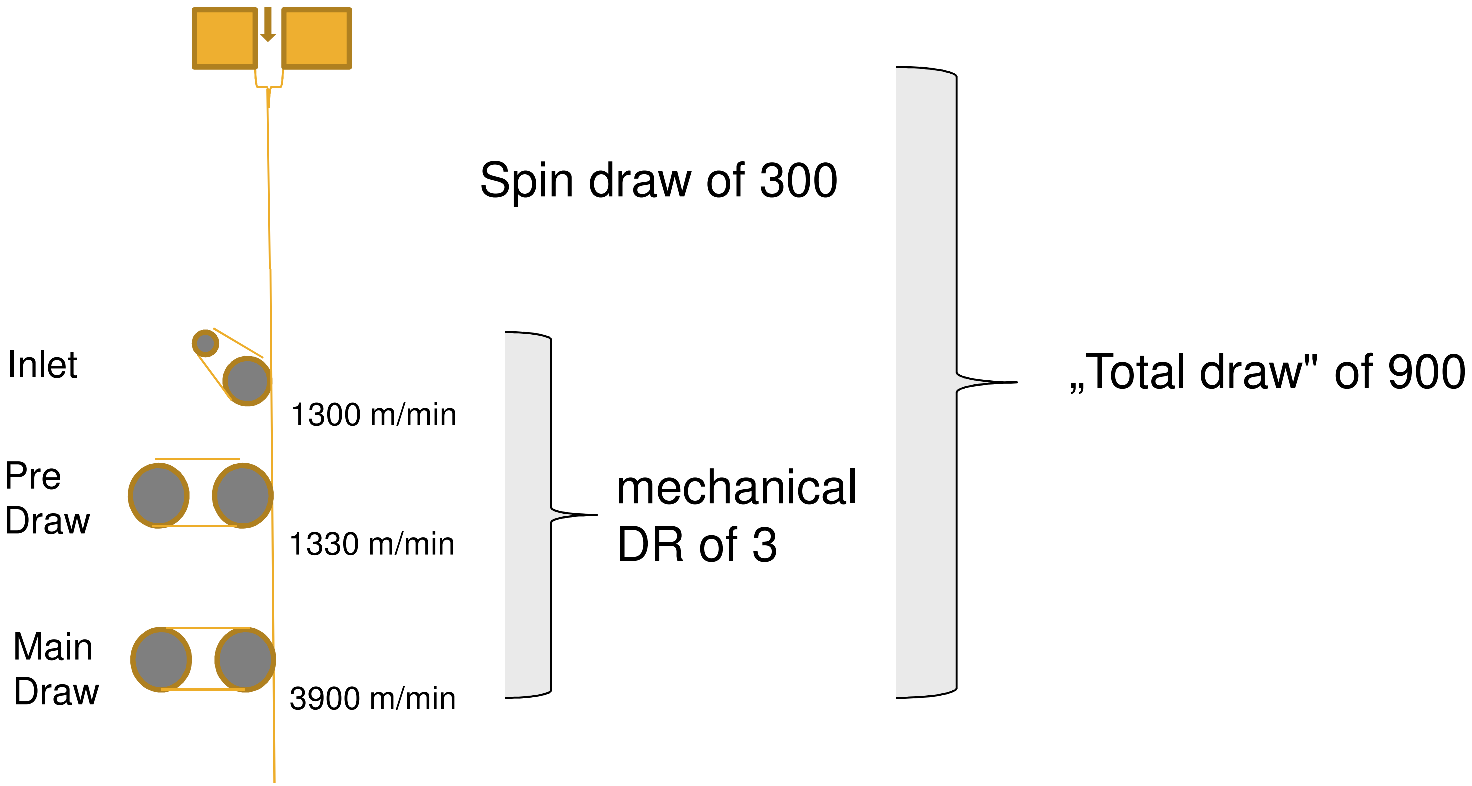


Information
only

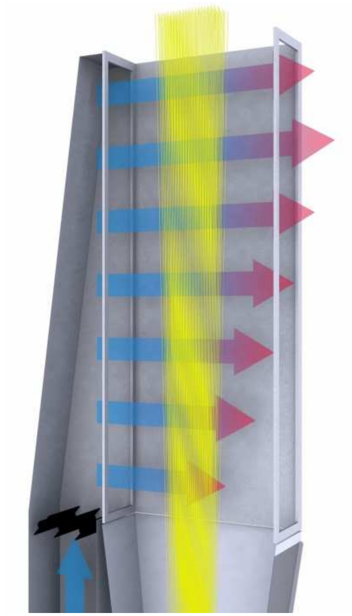
Quenching

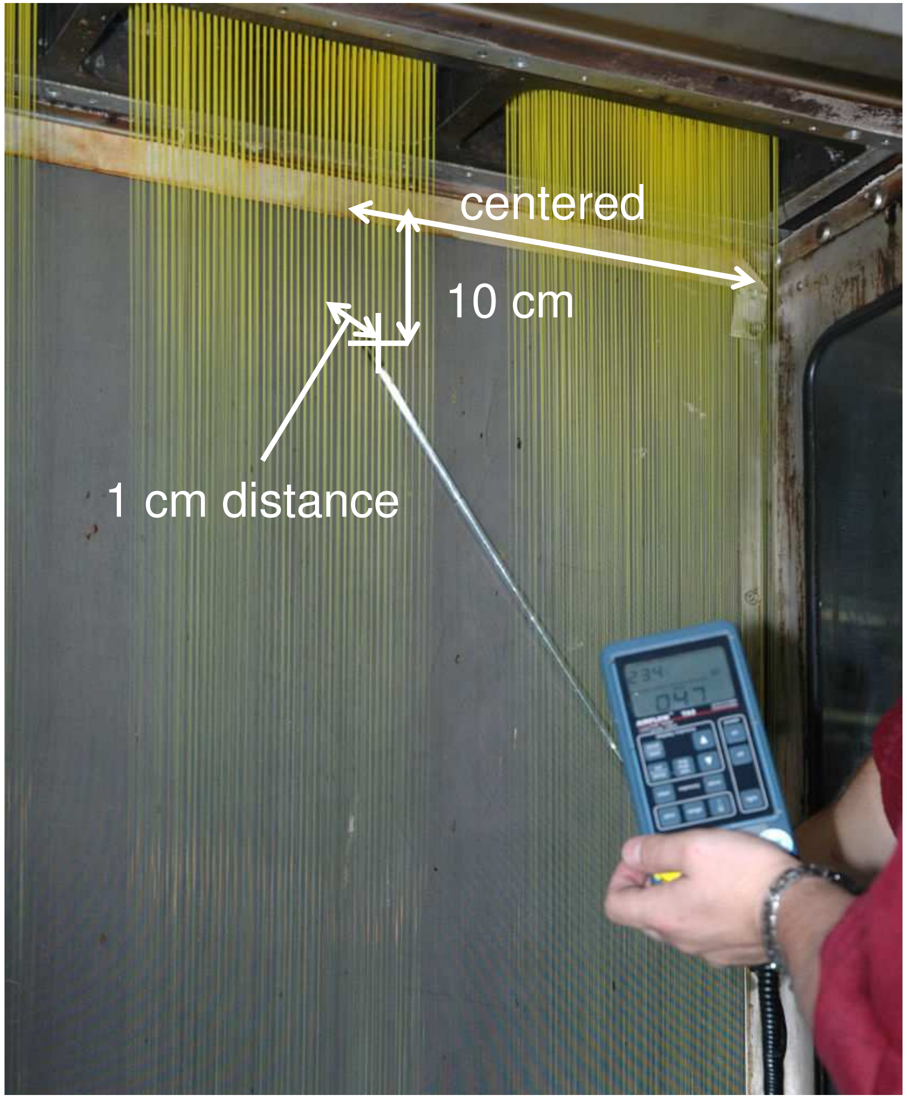
Quenching should give a well running process by:

- Cooling down and supporting before filaments touch each other or first guide
- Avoiding static charging
- Monomer suction
- Providing stationary conditions: change of crystalline structure of PA6/PA6.6 and shape (M/R)

Depending on:

- D.P.F ; Titer
- Process speed
- spinning height





Quenching

Parameters for PP:

- Temperature: 16 -18 °C (17°C)
- Pressure: ~ 3 mbar
- Humidity: ~ 70%

(not as important, not lower than 45%, due to static charging)

Parameters for PA6/PA6.6:

- Temperature: 15 - 20 °C (18°C)
- Pressure: ~ 3 mbar
- Humidity: ~ 70-75% (change in humidity changes dye pick up!)

Parameters for PET:

- Temperature: ~ 17…23 °C (strongly depends on D.P.F.)
- Pressure: ~ 3 mbar
- Humidity: ~ 70%

Parameters for PTT:

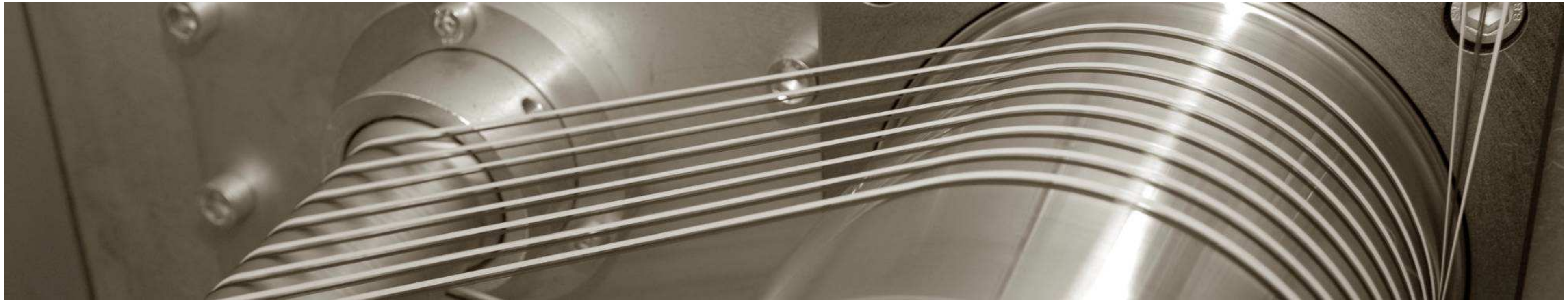
- Temperature: ~ 20…26 °C (strongly depends on D.P.F.)
- Pressure: ~ 2 to 3 mbar
- Humidity: ~ 55 to 75 %

Quenching – depending on D.P.F.

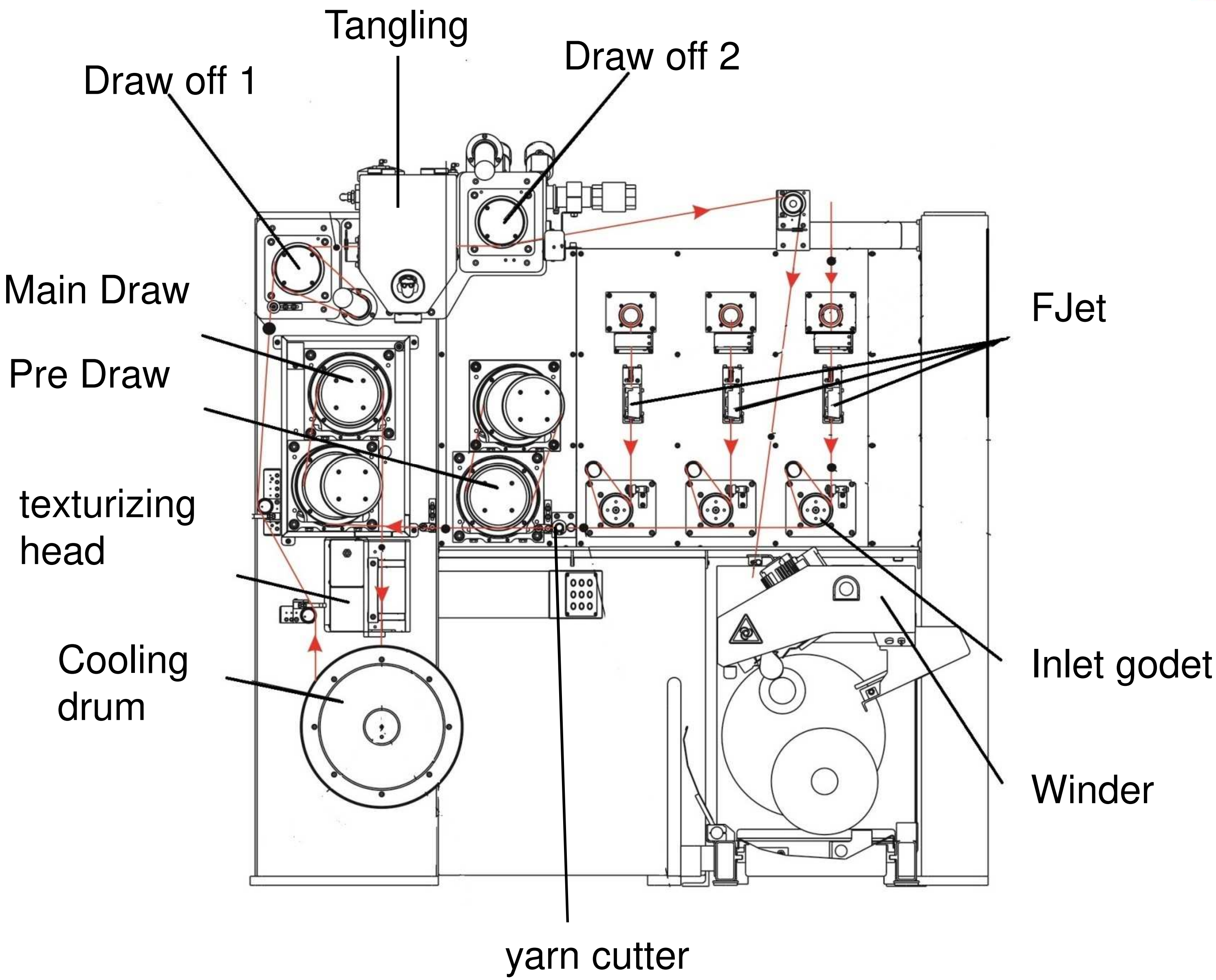
	Individual Filament Titer (D.P.F.) [dtex]	4 - 10	11 - 16	17 - 22	23 - 28
PP	Speed [m/s]	0.3-0.6	0.5-0.8	0.7-1.0	0.9-1.2
PA6/PA6.6	Speed [m/s]	0.4-0.5	0.5-0.6	0.5-0.7	0.7-0.9
PET	Speed [m/s]	0.3-0.5	0.4-0.6	0.5-0.7	0.6-0.8
PTT	Speed [m/s]	0.2-0.4	0.3-0.6	0.5-0.7	0.5-0.8

Values show a good starting point for process optimization.

Session 6
take up: spin finish unit to winder

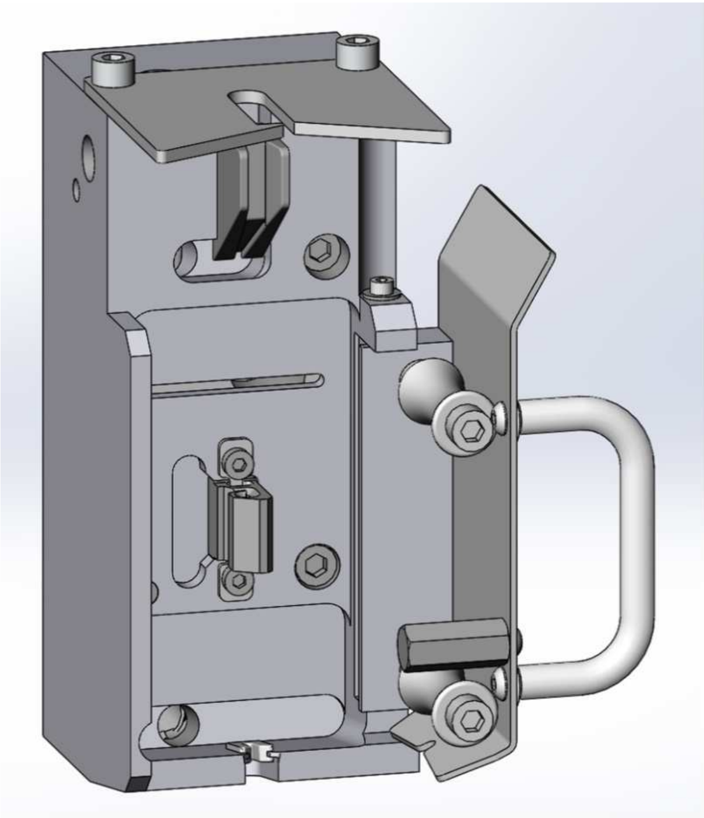


Overview Take Up Unit S+:

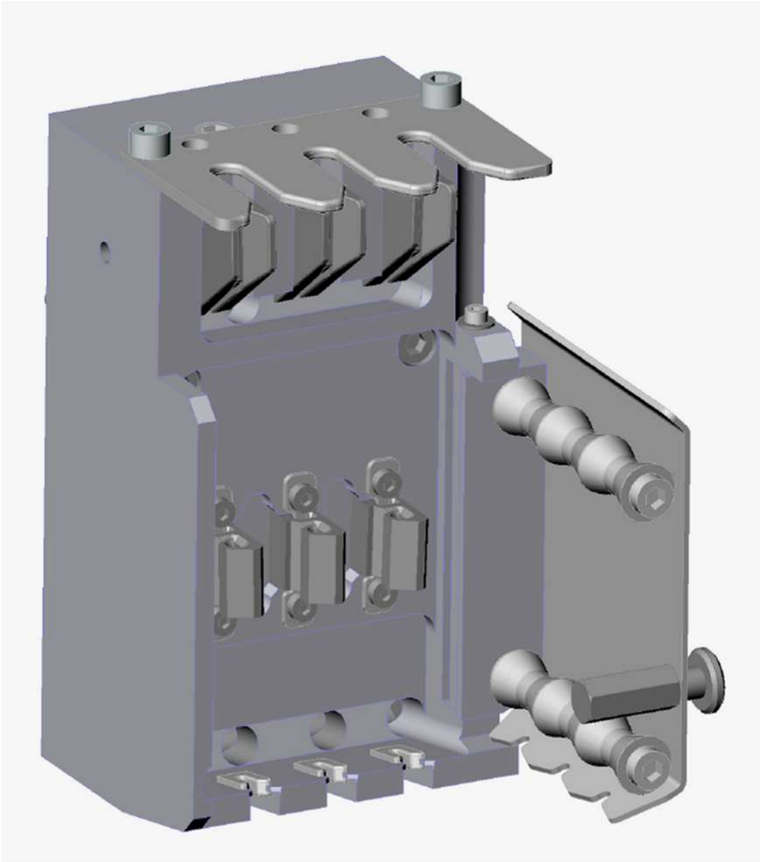


Spin finish application: F-Jet

Mono



Trico



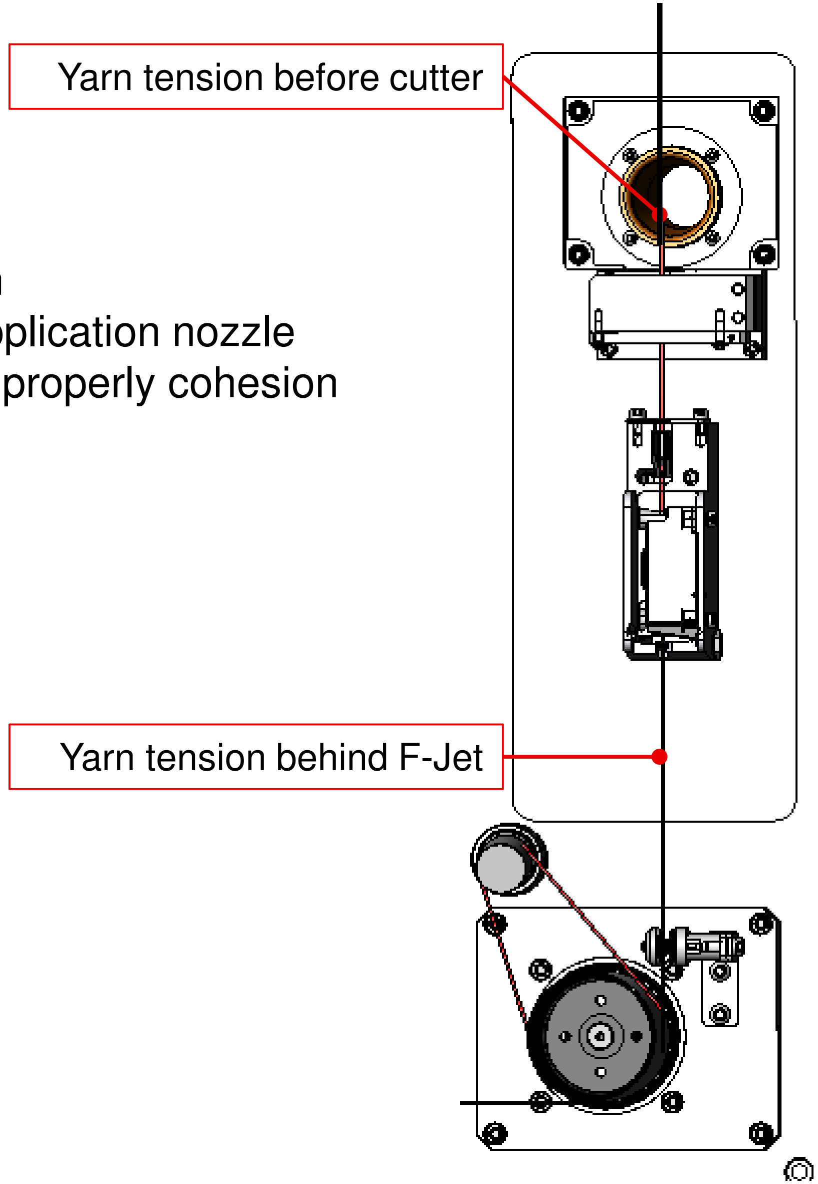
Infeed section
Adjusting F-Jet

Yarn tension behind F-jet needs to be controlled.

- Yarn tension to low:
  - Poor absorption of the spin-finish by the yarn
  - Droplets of spin-finish will run down at the application nozzle
  - The filaments on the godets will not have an properly cohesion
  - breaks

- Yarn tension to high:
  - Heating up of the application nozzle and oil
  - Excessive wear of the ceramic surface
  - Increasingly amount of yarn ruptures

- Influenced by:
  - Quenching conditions
  - dtex
  - D.P.F.
  - Spinning-speed
  - Applied spin finish



Infeed section Adjusting F-Jet

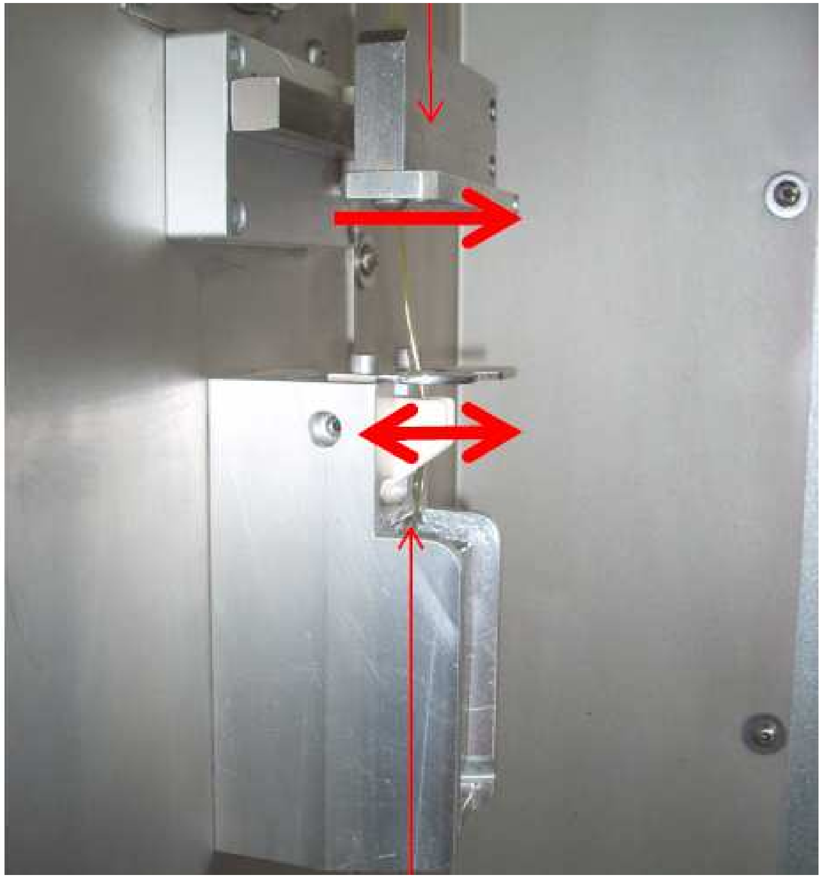
- Mono case: Yarn tension after F-jet should not be about 2.5 times the yarn tension before the yarn cutter. (Normally 1.5 to 2.0 times)
- Positions of yarn guides at yarn cutter and application nozzle needs to be adjusted.
- Tension above F-Jet from end to end needs to be accurate within +/- 5% of mean value
- different spinning tension lead to different crystallization for PA6

Size of application nozzle	**3 mm**	**5 mm**
Titer range	300 dtex –1200 dtex	1000 dtex – 3500 dtex

Use special gauge to transfer adjustment from one end to the other ends!

Yarn tension behind to high for all three yarns:

- Move yarn guides at the cutter to the front.



Yarn tension behind to high for a single yarn:

- Move yarn application nozzle back.

FJet: different applicators S+ and BCF S8

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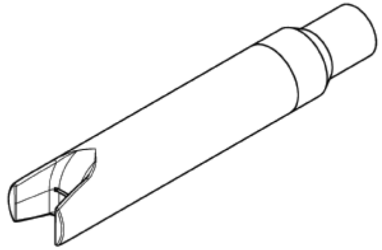
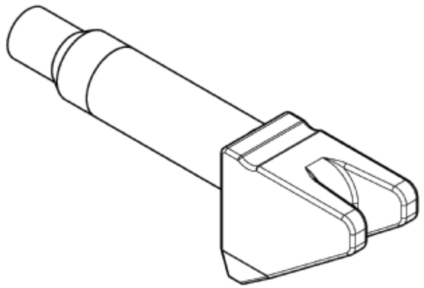
Pin-applicator
- 5 mm
- 2 mm



Dimple-applicator
- 5 mm
- 3 mm

BCF S8
U-applicator
- 5 mm
- 3 mm



Adjustment of the pre intermingling pressure

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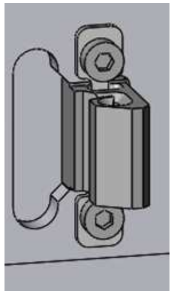
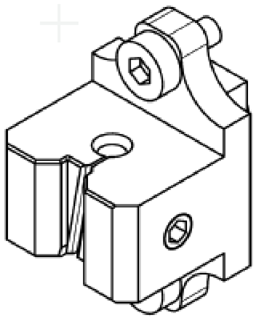
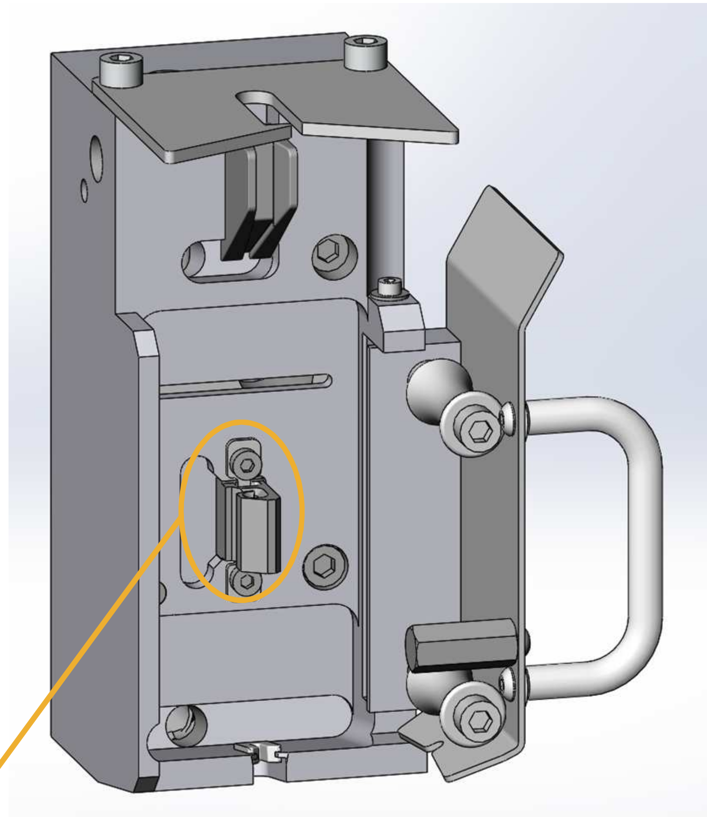
- Pre intermingling in the spin finish unit
  - For stabilising the yarn for coherence on the godets
  - To avoid yarn splicing on the godets
  - Different types of pre interminglings are available
    - S+: Ceramic-Jet



    - BCF S8 TH-Jet
      - 3.2 mm
      - 4 mm



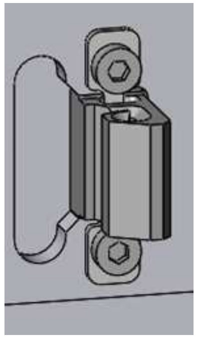
Typical 0.4 – 2 bar
depending on titer and speed

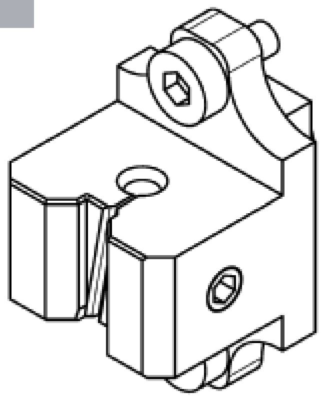


Pre
intermingling

Adjustment of the pre intermingling pressure

Two different types of pre intermingling are available





TH-Jet available in

- 3.2 mm
- 4 mm

pressure is ok
→ Check also yarn coherence

pressure is much too high

Special Adjustment for low dpf-products

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- General: low dpf products are more sensitive regarding friction in comparison to standard products → the higher the friction the higher the yarn is damaged

- handy tips for low dpf products
  - disassemble the pre intermingling
  - disassembling of the upper yarn guide in the door
  - disassembling of both yarn guides in the door (easy to test: let the FJet door open)
  - pin spin finish applicator
  - different pre intermingling?
  - using only a half wrap/L-wrap on the inlet godet
  - usage of emulsion

→ Unfortunately there is not one right way for low DPF products: it is highly depending on the product (if you produce two different colours of the same product two totally different adjustments at the F-Jet could be necessary)

- Especially for PA6 (lower than 6 dpf) emulsion is needed: 10% … 20 % emulsion

Special Adjustment for BCF S8 low dpf-products

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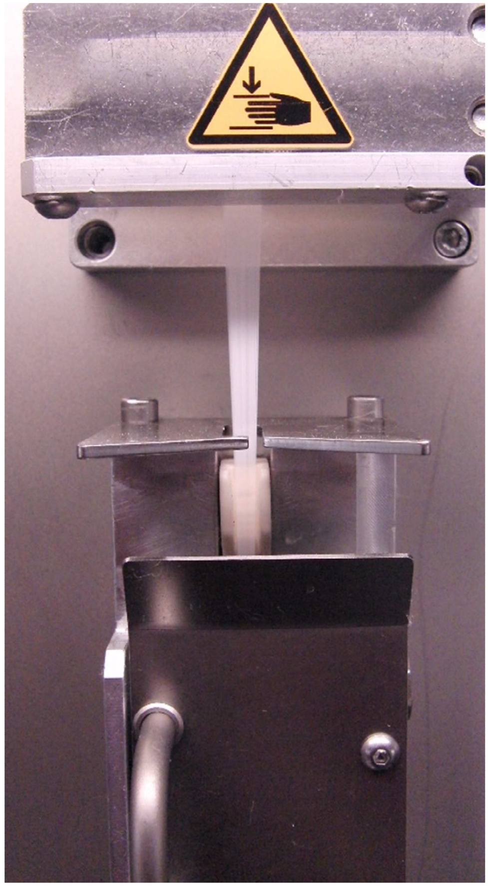
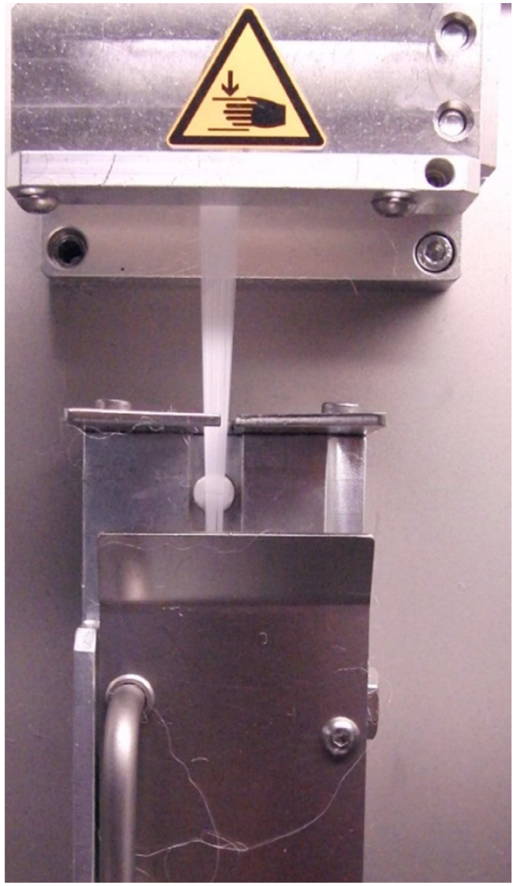
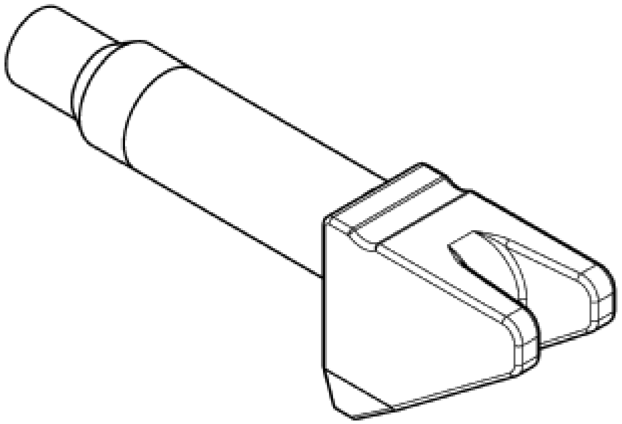
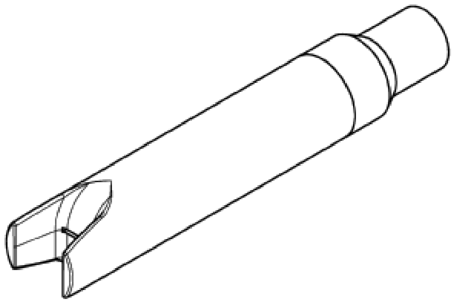
- dimple oiler vs. pin
    - pin: less friction for the yarn
    - dimple: less number of droplets
- the choice of applicator is depending on the product









Information only

Godets

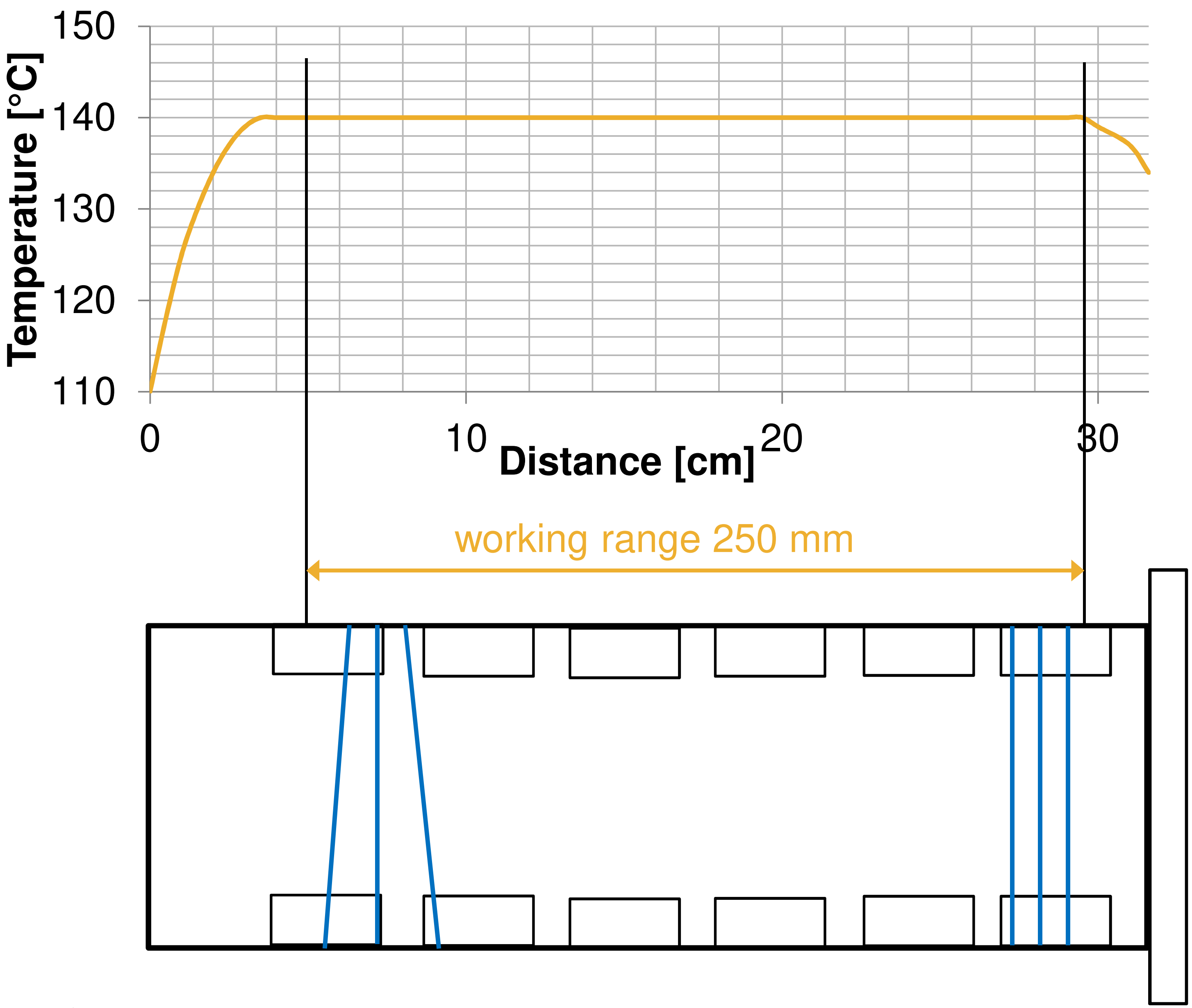
Main Draw
plasma coated

Pre Draw
chrome coated

Recommendation: change the oil (Mobil SHC624) of the oil-air lubrication one time per year.

Information only

Godets: example temperature profile



S+ - Texturizing

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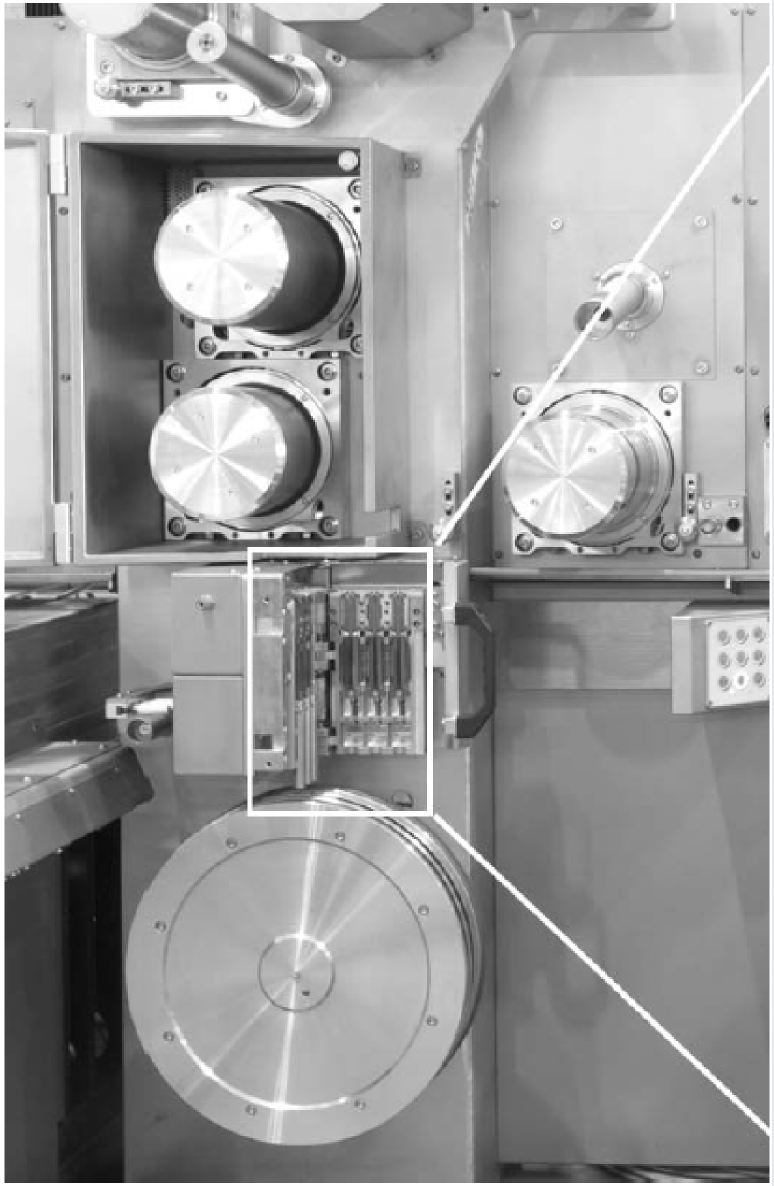
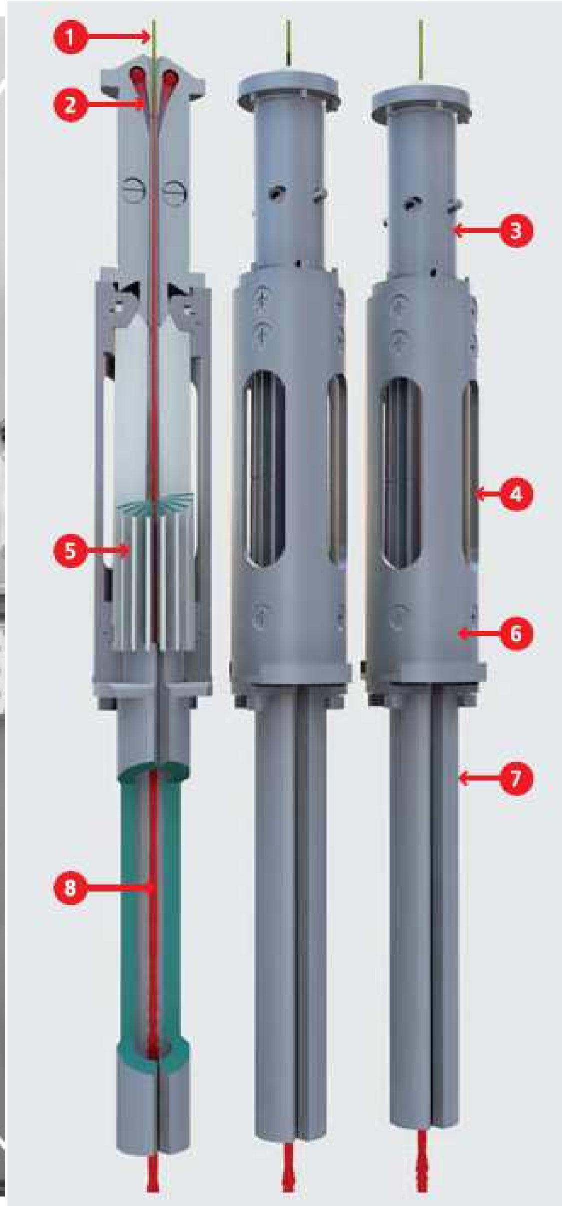




1. Flat yarn from duo
2. Air inlet
3. Texturing nozzle
4. Vacuum
5. Lamella
6. Lamella chamber
7. Exit pipe
8. 3D textured yarn
9. Conveying rollers for plug formation and speed control

lamella materials:

CERMET

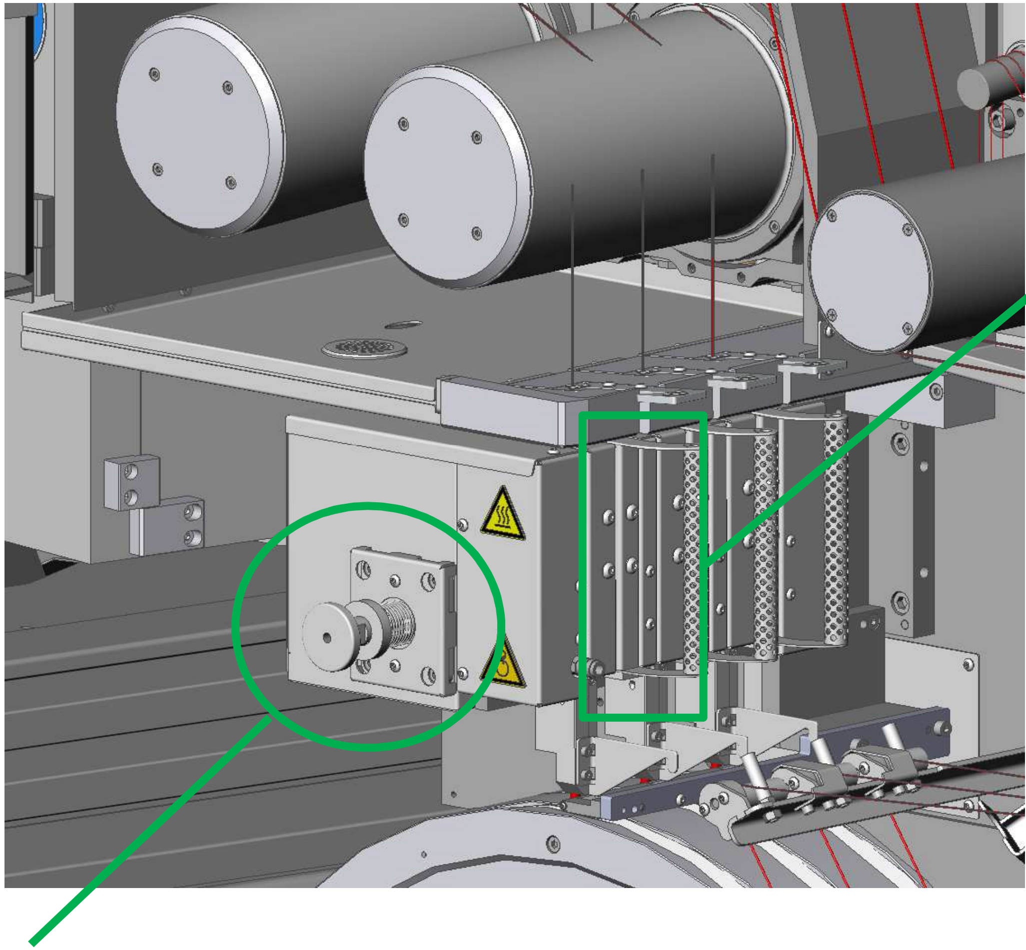
Overview Texturizing: Example PP

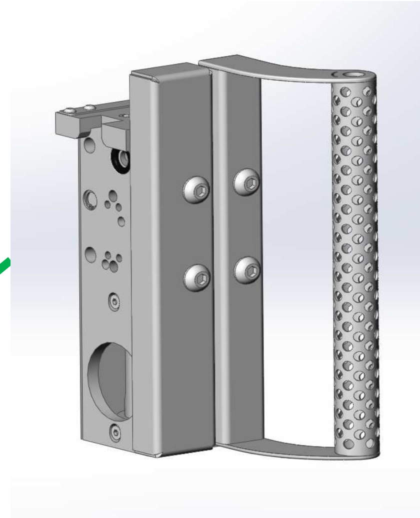
PP (S+)	lamella chamber 3.0 / 4.5 mm		lamella chamber 3.6 / 6.0 mm			l. c. : 4 / 7 mm
	outlet: 7 mm *	outlet: 8 mm *	outlet: 7 mm *	outlet: 8 mm *	outlet: 9 mm *	outlet: 11 mm *
texturizing nozzle: 1.25 mm						
15 - 25 dpf	800 - 1200 dtex	1200 - 1600 dtex	-	1600 - 2000 dtex	-	-
10 - 15 dpf	500 - 1100 dtex	1100 - 1300 dtex	-	1200 - 1800 dtex	-	-
5 - 10 dpf	500 - 1000 dtex	-	800 - 1200 dtex	1200 - 1600 dtex	-	-
texturizing nozzle 1,48 mm (8225902), see Figure 4-5, "1,48mm-texturizing nozzle No. 8225902" [69]						
15 - 25 dpf	-	-	-	-	see diagram	1900 - 3000 dtex
10 - 20 dpf	-	-	-	-	1000 - 1900 dtex	-
texturizing nozzle 2,0 mm						
15 - 25 dpf	-	-	-	1600 - 2200 dtex	2200 - 4500 dtex	4500 - 6000 dtex
10 - 15 dpf	-	-	-	1600 - 2200 dtex	2200 - 4000 dtex	-
5 - 10 dpf	-	-	-	1600 - 2200 dtex	2200 - 3500 dtex	-
texturizing nozzle 2.3 mm (8345200)						
15 - 25 dpf	-	-	-	-	-	6000 - 8000 dtex
10 - 15 dpf	-	-	-	-	-	-
5 - 10 dpf	-	-	-	-	-	-
* for friction texturizing there is only one size of outlet pipe						

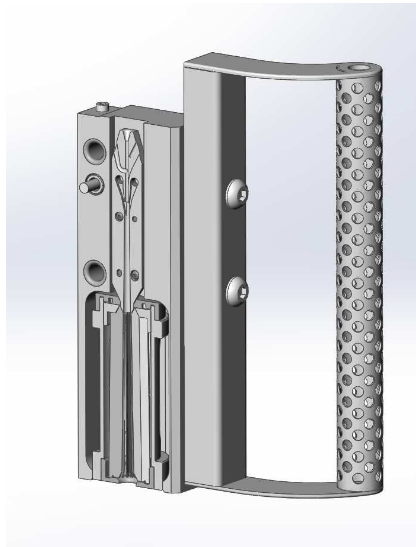
also for PET and PA6 /PA6.6 available

=» see process manual (chapter 4.4)

BCF-S8 - Texturizing







texturizing vacuum
adjustable at the take up.

Information only

BCF-S8 – Texturizing – Picture Example

Tex. vakuum Adjustment with 5 mm allen wrench

Fixing/Contering with a 19 mm open-end wrench

Information only

Texturizing principles: Friction Texturizing

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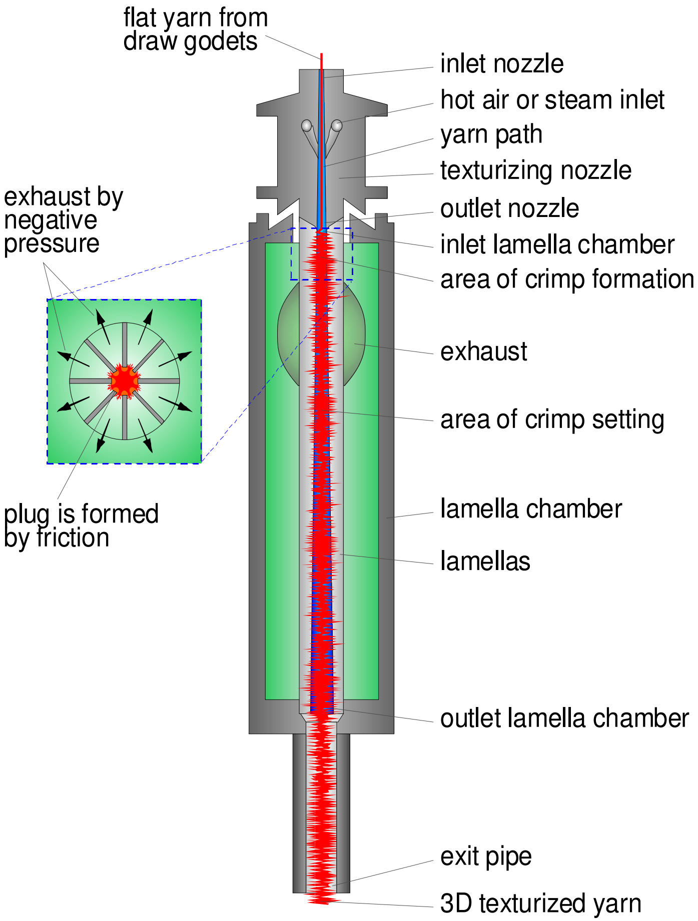
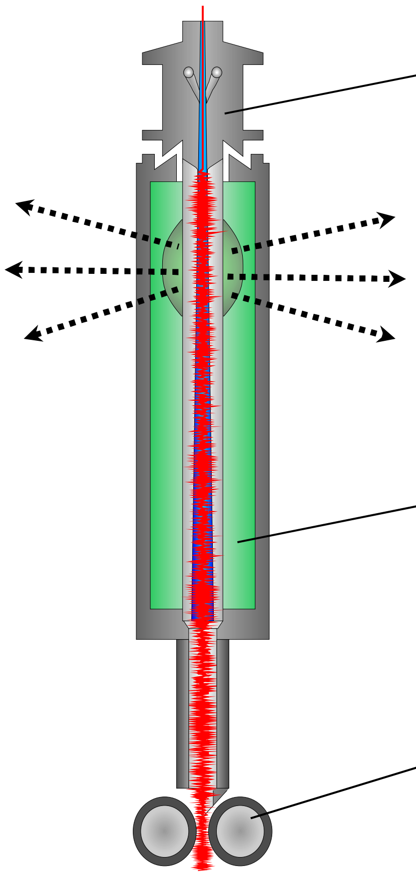


Frictions - Texturizing

- Plug formation by friction force
- Control of outlet velocity of plug by force equilibrium

Information only

Bi Tex - principle



Principle

- Combination of friction type process start and roller typ production
- easy plug formation by friction force
- Adjustment an control of outlet velocity using roller
- No further need for vacuum after plug formation

Information only

Overview Texturizing equipment: BCF-S8

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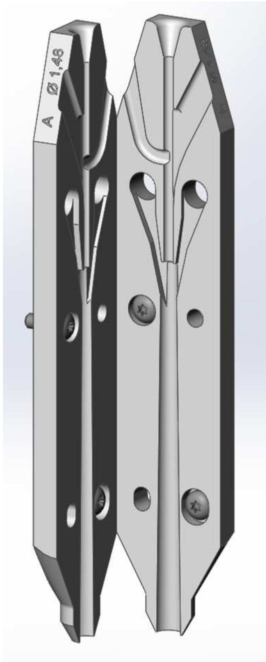
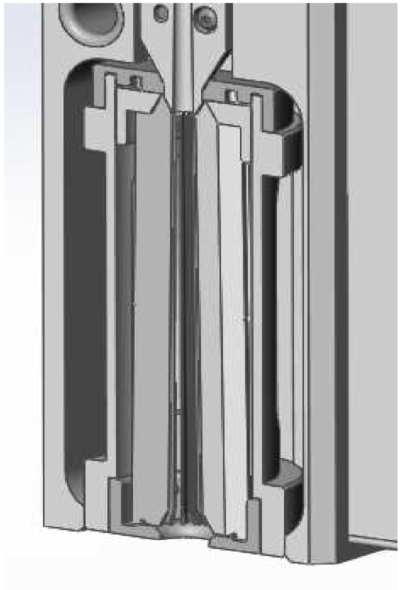
Tex. nozzle



IFS nozzle – inlet funnel suction nozzle

Tex. nozzle
1.25 mm (also IFS)
1.48 mm (also IFS)
2.05 mm



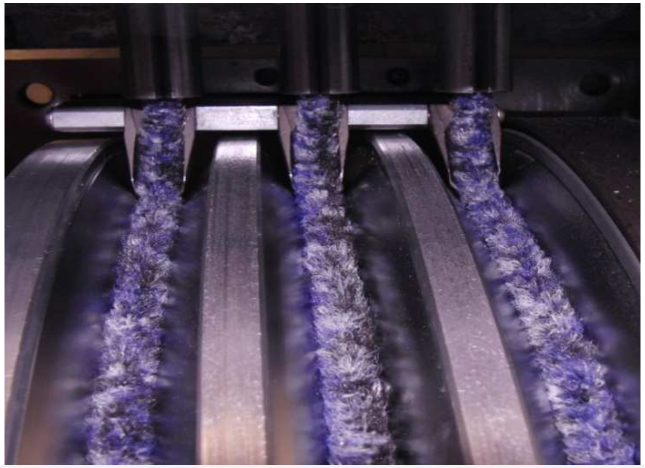
Lamella Chamber	Outlet Pipe
3.0 / 4.0	9 mm
3.6 / 6.0	9 mm
4.0 / 7.0	11 mm
5.0 / 8.0	11 mm

Information only

Cooling drum

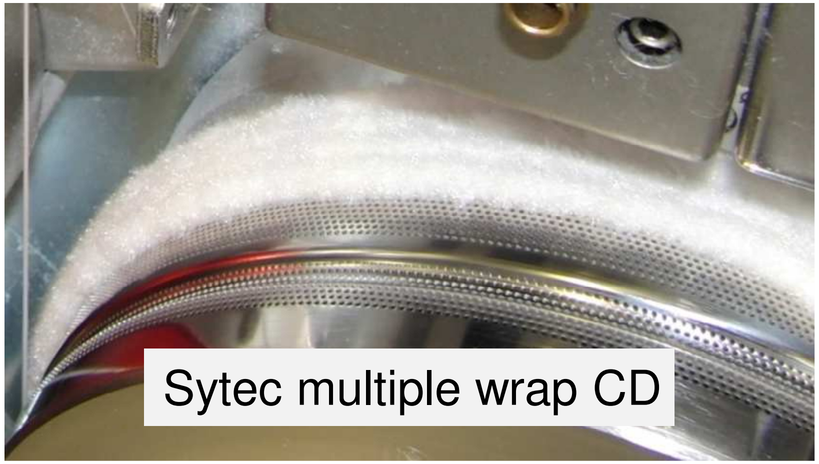
For PA6 / PET uniform cooling is more important than cooling time:

- cooling drum speed depends on plug speed (no flip overs)
- Sufficient vacuum above 25 mbar
- Straight lay down with V-Groove cooling drum (S+)
- Consistent number of wraps at SytecONE (4,5 wraps)
- High PA6 single titer (> 20 dpf): special 1.5 wraps seperated CD at Sytec



S+ V-Groove (PET, PA6, PA6.6)

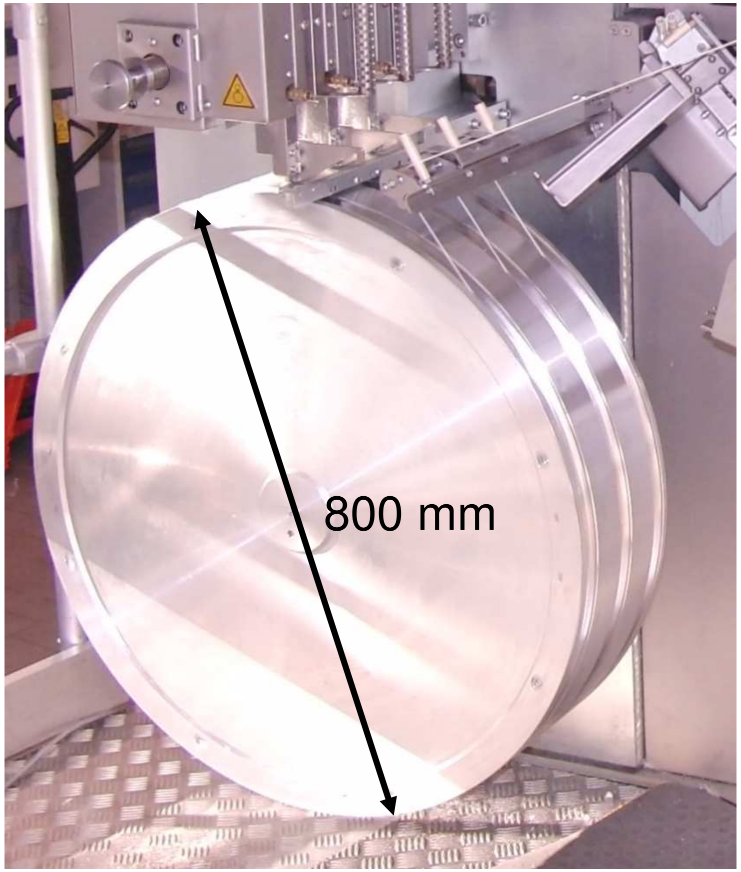
S+ Standard-Groove (PP)

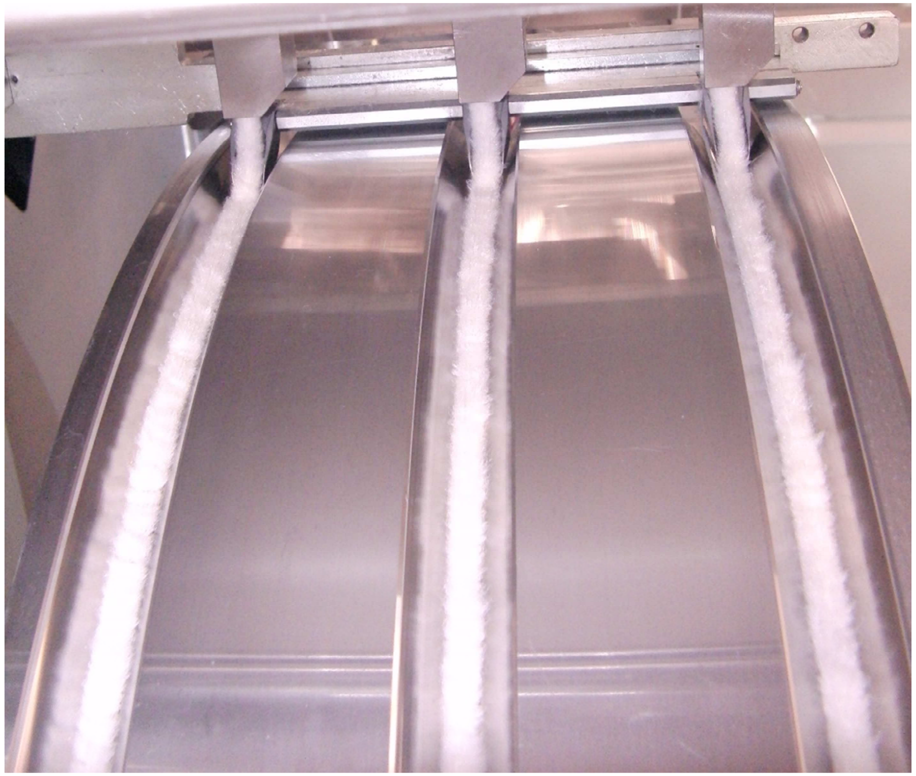


Sytec multiple wrap CD

Cooling drum – BCF-S8

- cooling drum speed depends on plug speed (no flip overs)
- Straight lay down with V-Groove cooling drum (PP, PET and PA6) -> uniform cooling of the plug
- tension behind cooling drum influences tangle result strongly
- vacuum above 30 mbar



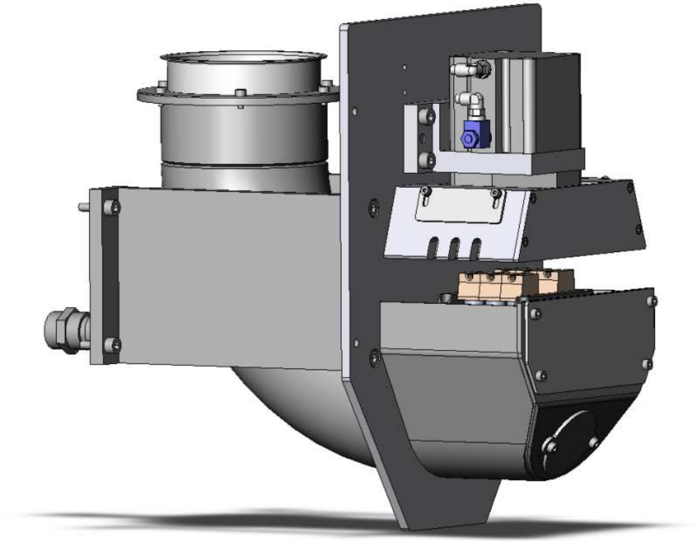


Information only

Tangle Unit

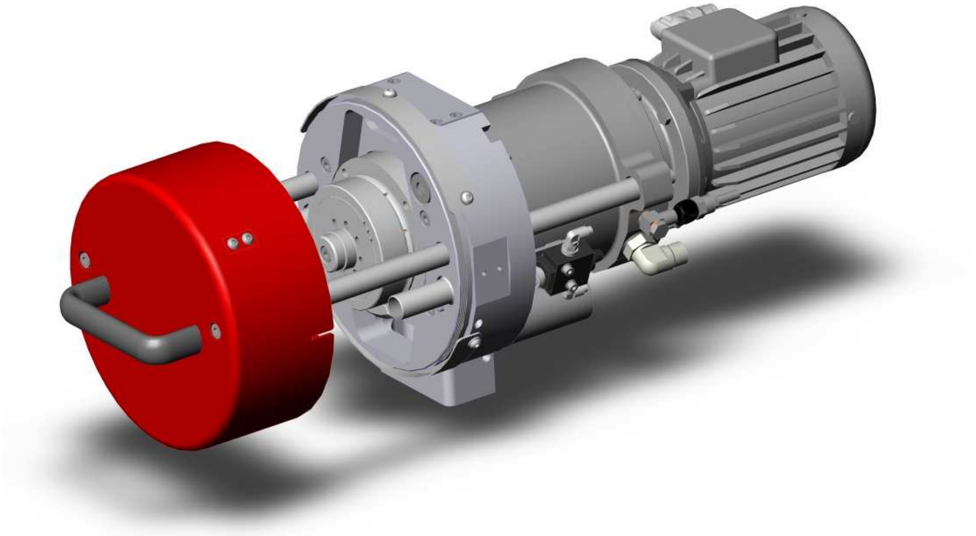
- Main Tangling
  - Creating uniform knots for coherence of the yarn for further processes

Temco-Tangling



parameters:
- air pressure

RoTac-Tangling



parameters:
- air pressure
- RoTac-speed (nozzle ring)

RoTac Tangle Unit: Standard vs. RoTac

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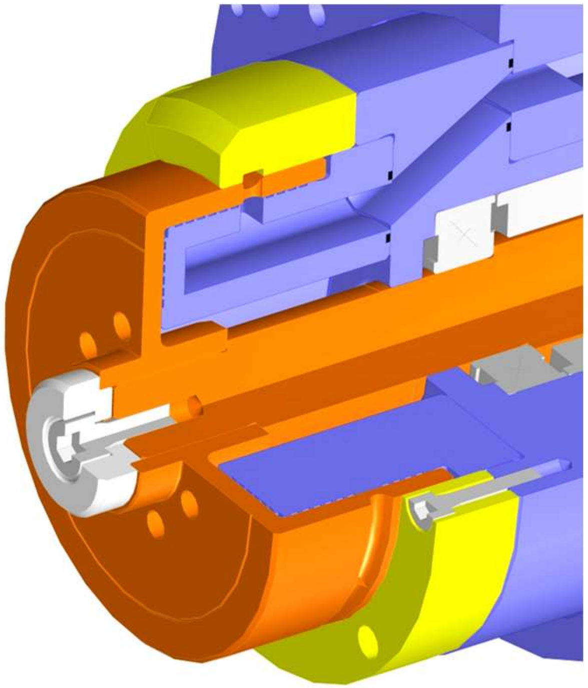
Concept	Standard principle	RoTac principle	Functionality
Airflow	Continuous airflow wastes air with discontinuous nodes	Pulsating air release matches discontinuous nodes	Holes in rotating nozzle ring releases air only when needed
Motion of nozzle	Fixed nozzle limit speed due to too short residence time over holes: Doubled nozzles to reduce missing nodes	Rotating nozzle ring matches yarn speed	Rotating holes increases residence time for better node building



moving parts including nozzle ring

fixed air supply parts

fixed nozzle cover

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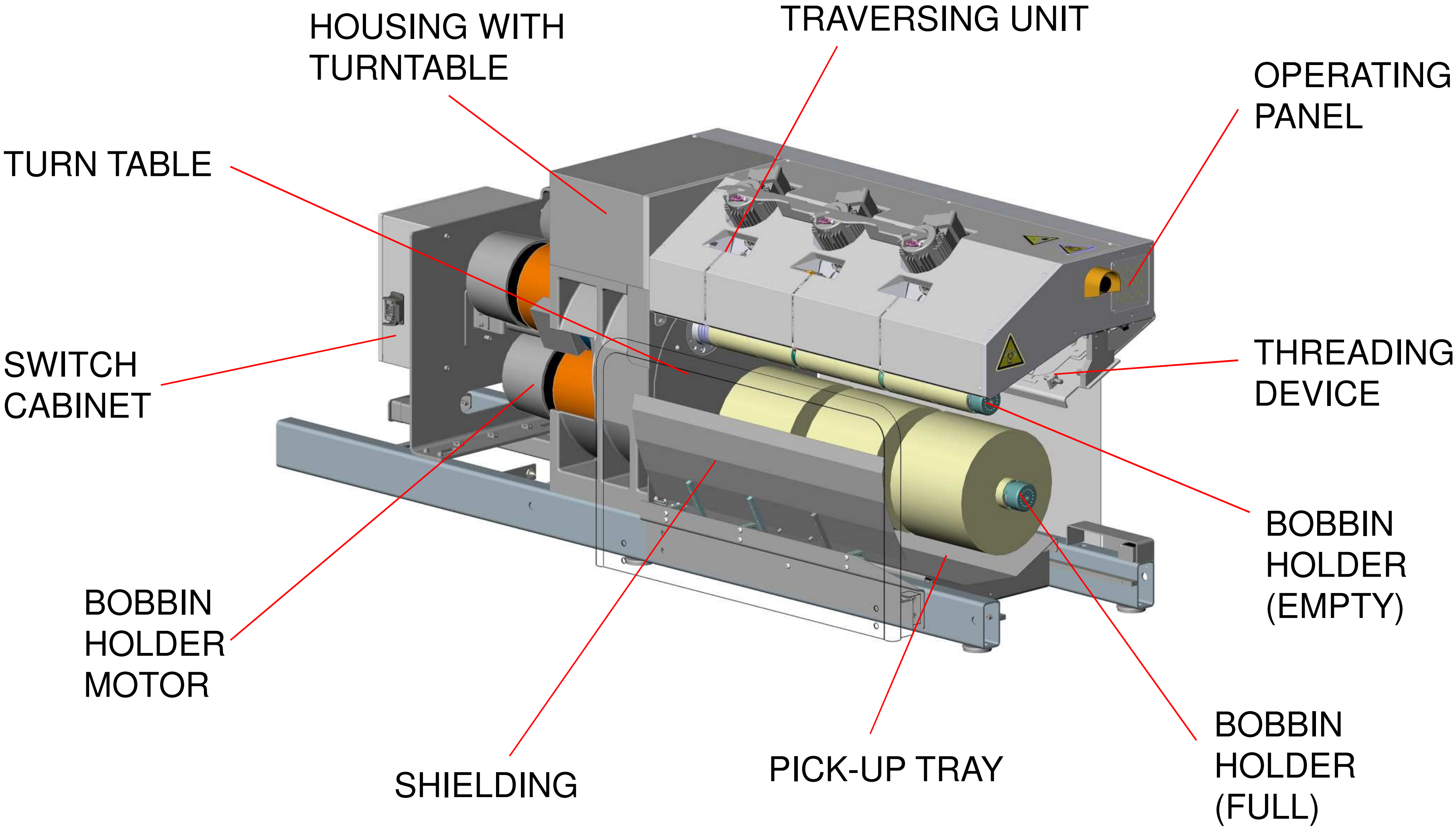
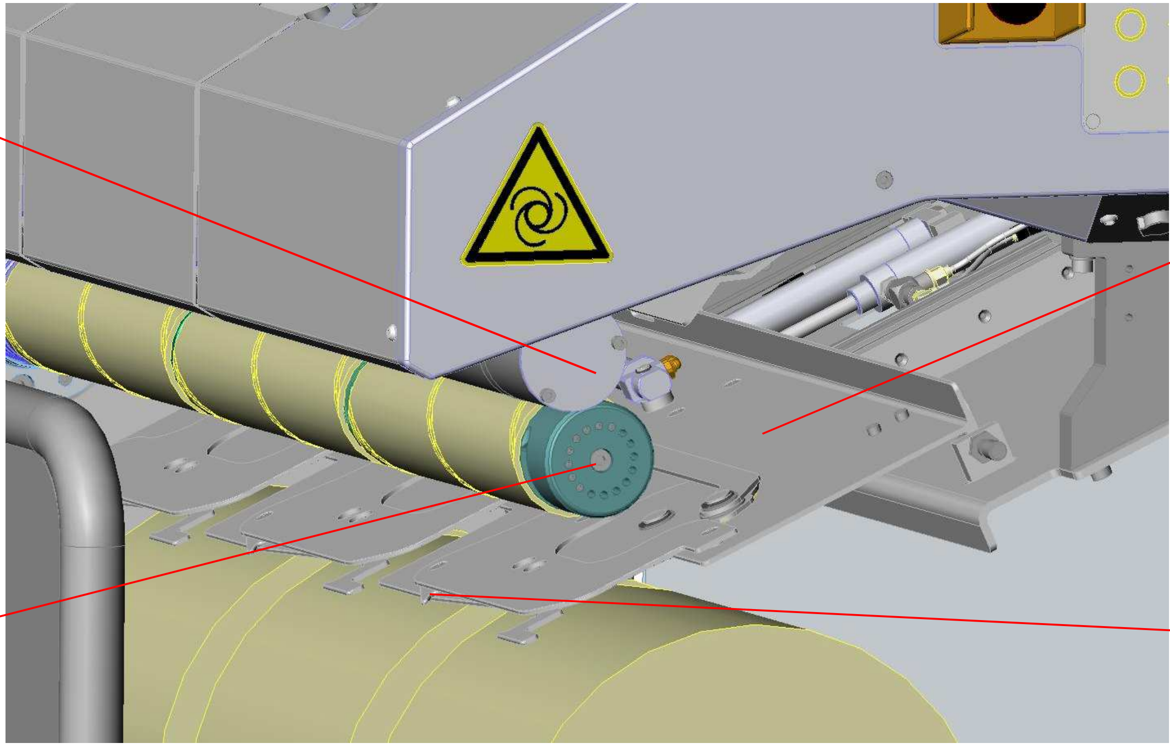
Winder S+ - Components

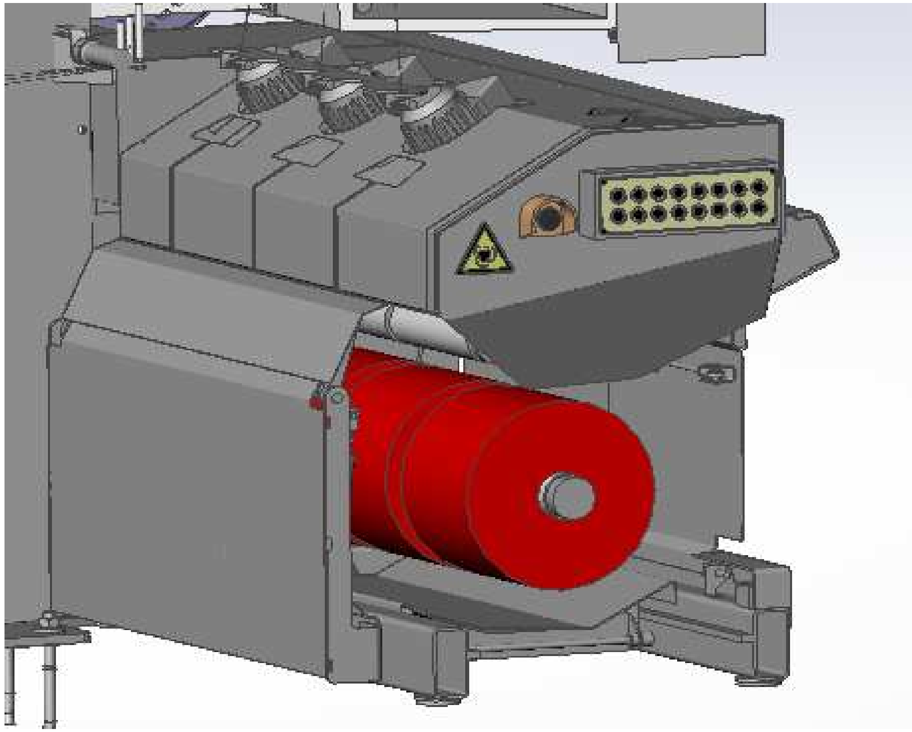


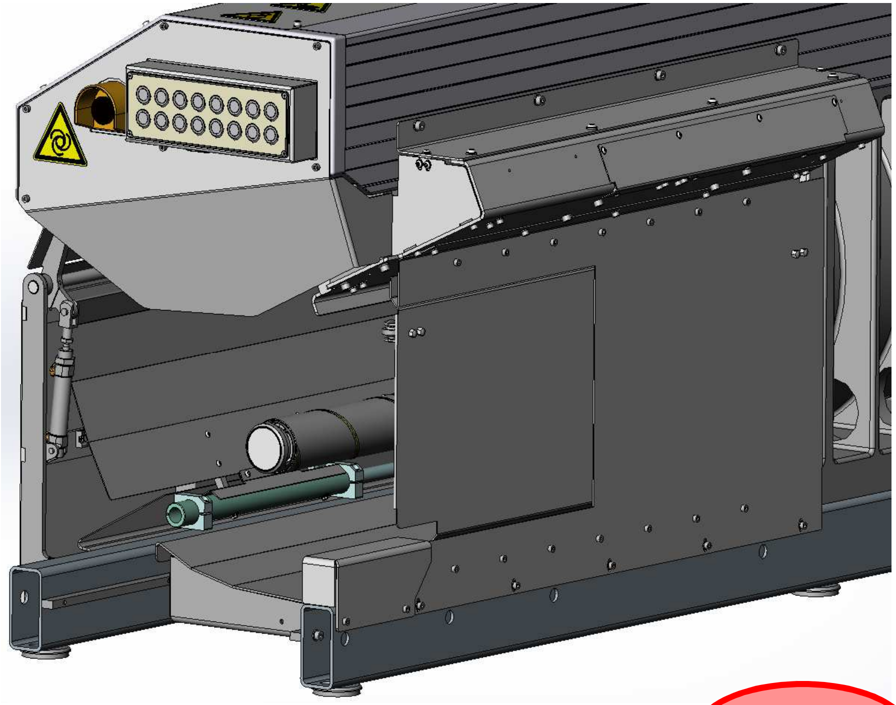
Winder S+ - Components



Information only

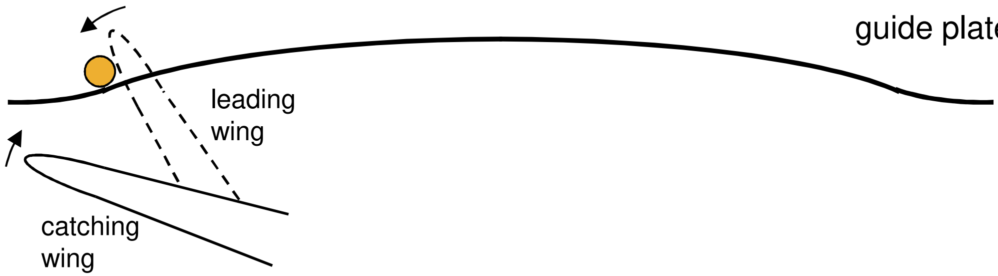
Witras III



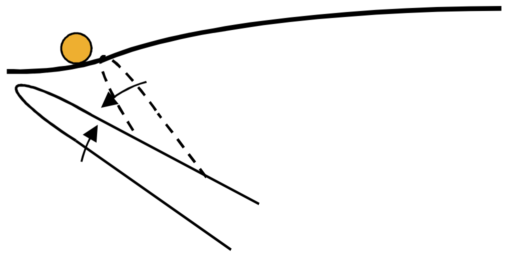


Information only

Basics of winding principle – Handover point



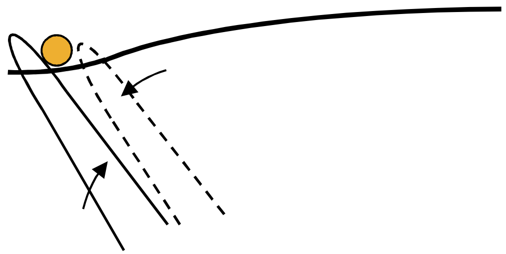
Case A



Leading wing releases the thread before handover:

- \+ smoother for the yarn
- \+ softer bobbin edges
- \- more spider webs

Case B



Catching wing takes the thread before releasing of the leading wing:

- \+ less number of spider webs
- \- harder bobbin edges
- \- more stress for the yarn

Handover behaviour is depending on:

- Positioning of the guide plate
- Wings adjustment

Basics of winding principle – Quickreturn

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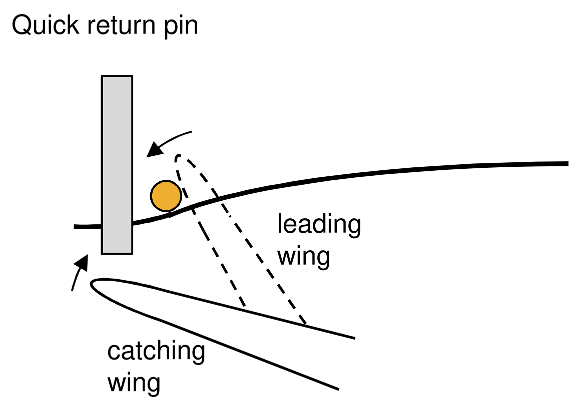
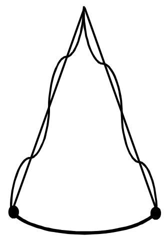
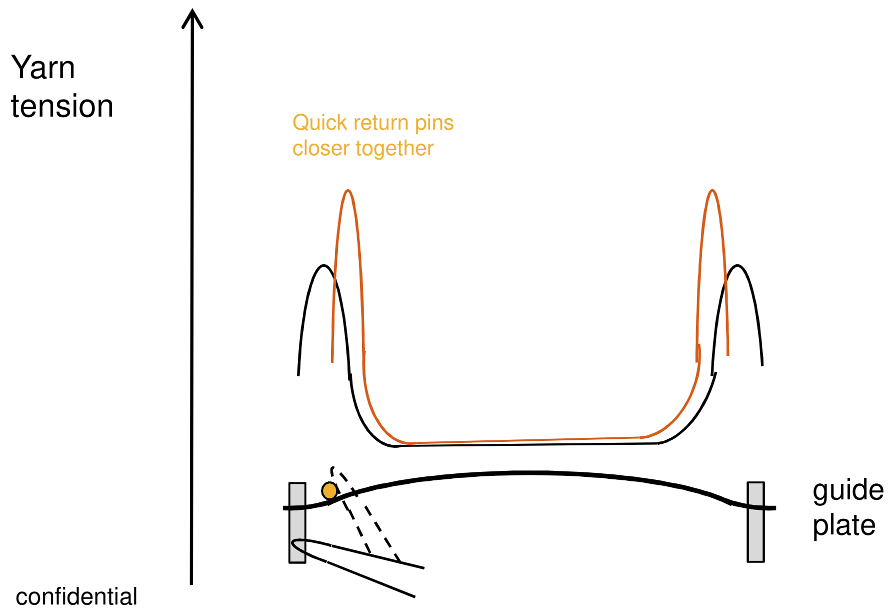


- limit for the yarn stroke
- provides loosely yarn (compare case A)



- overmuch screwed in:
  operates comparable to case B



Information only

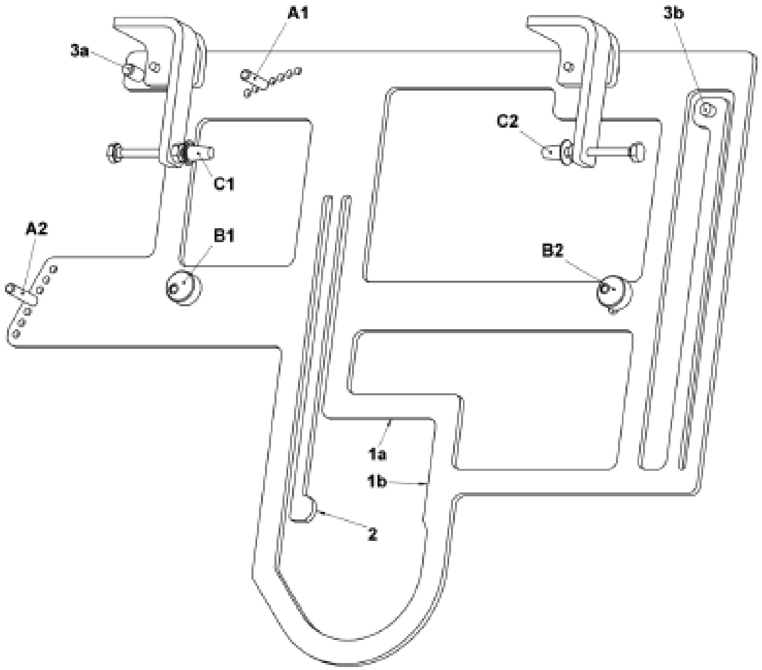
Adjustments of the wings

The mechanical adjustments of the wings have an influence on the shape of the bobbins.

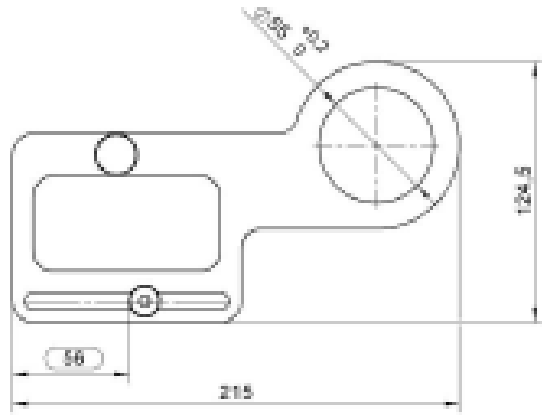
Setting gauge:

- Handover point of the wings is adjustable (A1)
- Quick returns are adjustable (C1)
- Guide plate (B1)

See winder documentation!



setting gauge S+ and SytecONE (below)



Basics of winding – influencing parameters 1

Yarn Tension:

- the higher the yarn tension
  - ➔ the harder the bobbin (loss of crimp, stips)
  - ➔ the harder the bobbin edges (loss of crimp)
  - ➔ the fewer the number of spider webs (less snapping at handover)
  - ➔ the more saddle-shaped is the bobbin

Crimp of the yarn:

- the lower the yarn crimp
  - ➔ less elastic is the yarn
  - ➔ the tighter the bobbin
  - ➔ the harder the bobbin edges
  - ➔ the easier happen spider webs (smoother yarn ➔ change of yarn tension larger)

Basics of winding – influencing parameters 2

DPF (dtex per filament):

- the lower the dpf
  - ➔ the tighter the bobbin
  - ➔ the harder the bobbin egdes
  - ➔ yarn tension should be reduced in comparison to higher DPF

Titer of the yarn:

- the lower the titer
  - ➔ the tighter the bobbin
  - ➔ slower bobbin buildup ➔ bobbin edges are getting warmer
  - ➔ yarn tension should be reduced in comparison to higher DPF

Traversing angle

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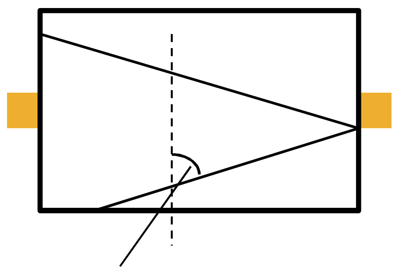
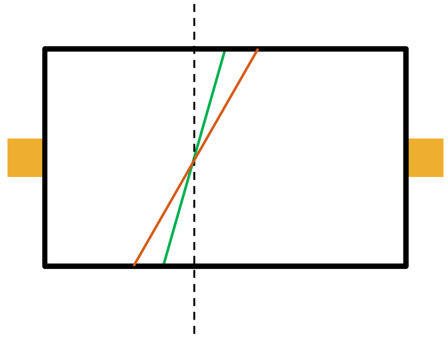


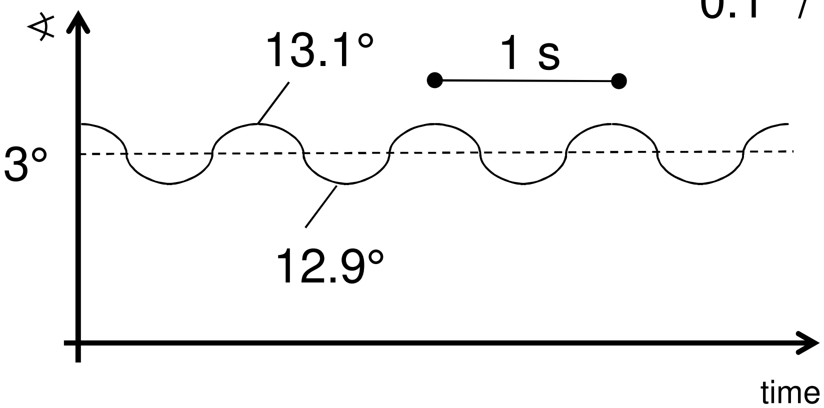


Small ∢ (e. g. 12°)

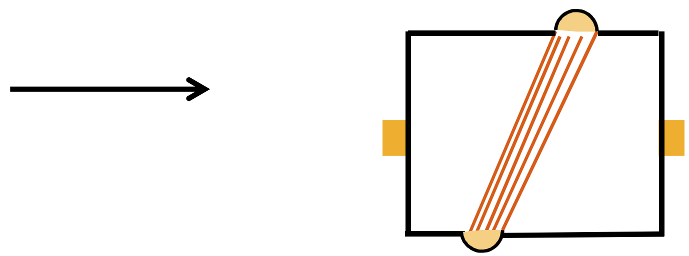
Large ∢ (e. g. 14°)

Wobbling frequency

Example
0.1° /1 Hz



Avoiding mirroring



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Recommendation traversing angle

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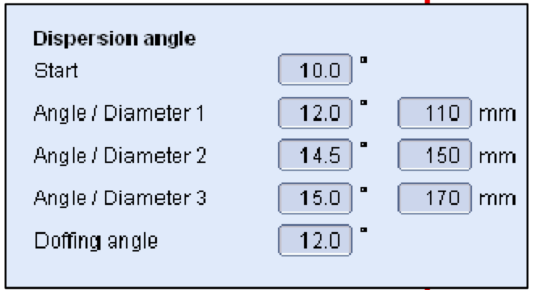
The optimum adjustment of the traversing angle (diameter with their specified angles) is depending on the:

- polymer
- titer
- dpf
- yarn tension before the winder
- winding speed
- tangle knots

A general adjustment of the traversing angle setting couldn‘t be recommended.



S+ PA6 1000f42 dtex @ 2900 m/min 150 cN

mm	∢
Start	11 °
95 mm	14 °
120 mm	14.5 °
160 mm	15 °
doffing	12 °

at day of yarn production
250 mm winding diamater

S+ PA6 1040f90 dtex @ 2900 m/min 190 cN

mm	∢
Start	13 °
90 mm	13 °
110 mm	14.5 °
160 mm	15 °
doffing	13 °

at day of yarn production
250 mm windi[ng diamater]

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Example different traversing angle

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mm	∢
Start	14 °
100 mm	14 °
120 mm	14.5 °
160 mm	15 °
doffing	14 °

S+ PA6 1000f42 dtex
@ 2900 m/min
150 cN

mm	∢
Start	10 °
100 mm	10.5 °
120 mm	11.5 °
160 mm	12.5 °
doffing	12 °

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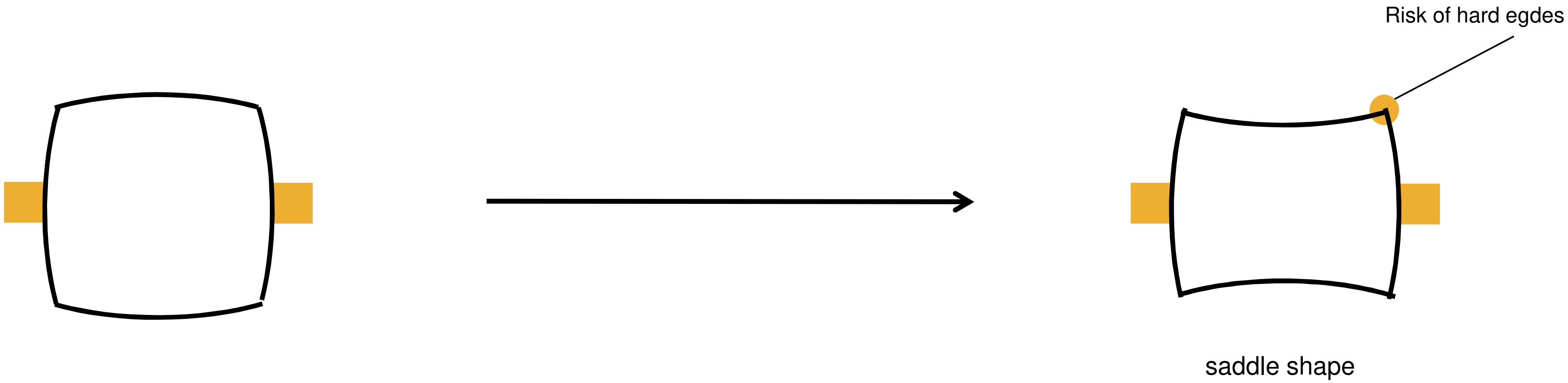
Bobbin shape



- Higher yarn tension
- Higher traversing angle
- Higher shrinkage (yarn property)
- Quick return pins closer together

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Bobbin shape optimization

Step 1: Check the hardness of the bobbins!

- Change the yarn tension in front of the winder (harder bobbin → higher yarn tension)

Step 2: Analyze the bobbin shape

- Measure diameters with abnormalities
  - Mark first traversing angles
- Evaluate these abnormalites and change the traversing angle setting

a) Change/optimize traversing angle setting
   - Higher traversing angle → smaller bobbin width
   - Smaller traversing angle → wider bobbin width
   - Slope changes → different diameter points

b) Change/optimize with speed optimization the yarn tension
   - Higher tension → smaller bobbin width
   - Lower tension → wider bobbin width

Bobbin shape is mainly depending on (same product and same winding speed):

- Traversing angle
- Yarn tension

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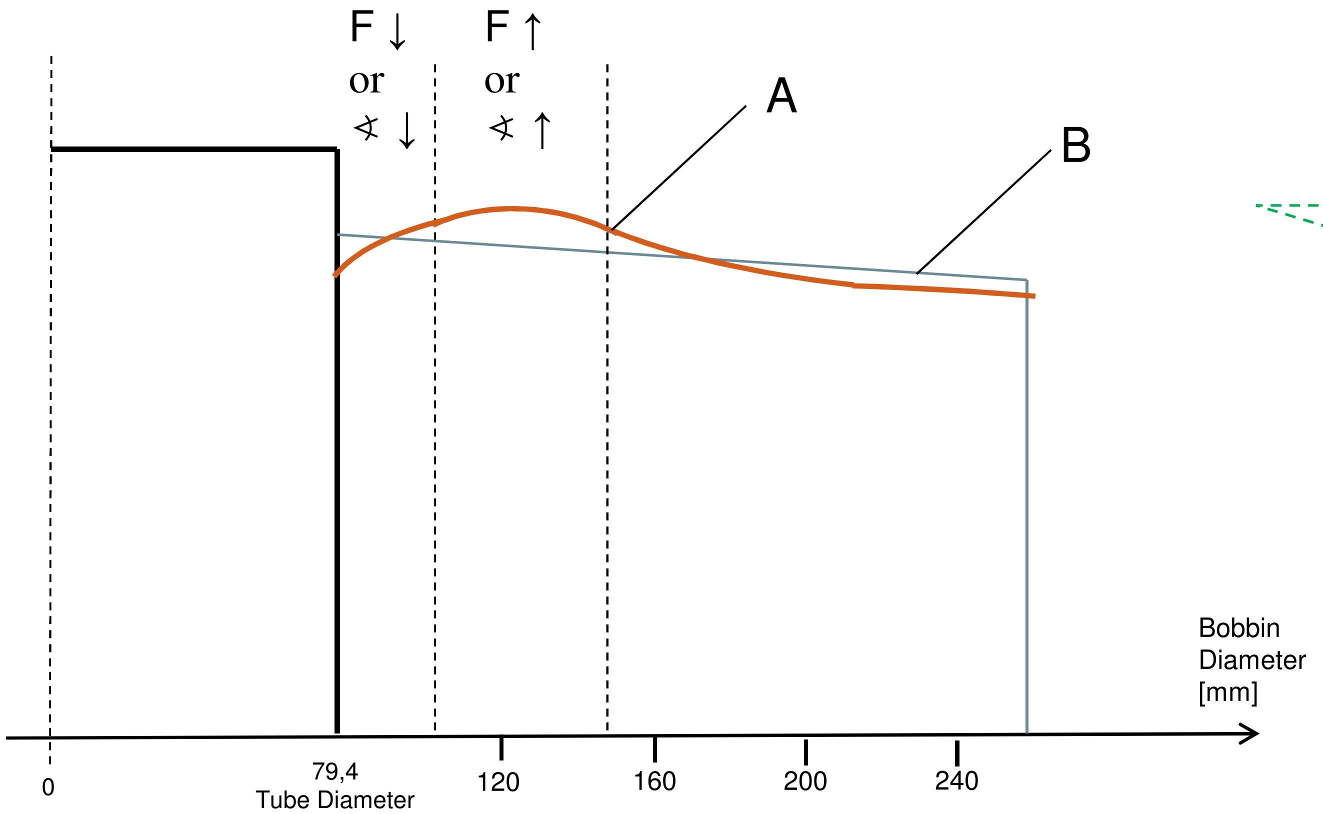
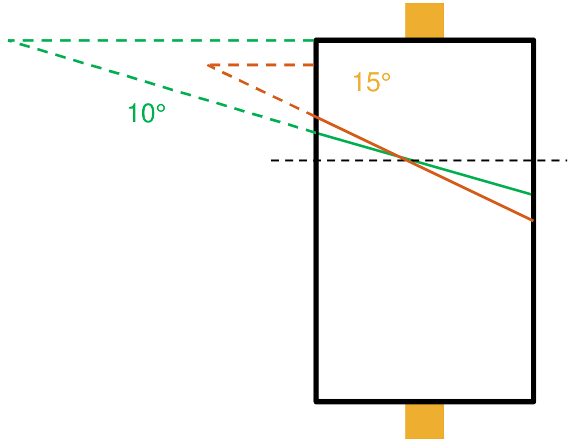
Bobbin shape optimization

- Higher traversing angle
  ➔ smaller bobbin width
- Smaller traversing angle
  ➔ wider bobbin width

- Higher yarn tension
  ➔ smaller bobbin width
- Smaller yarn tension
  ➔ wider bobbin width





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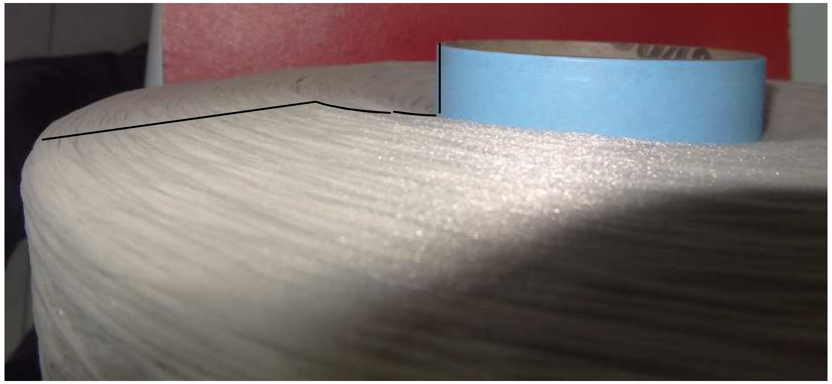
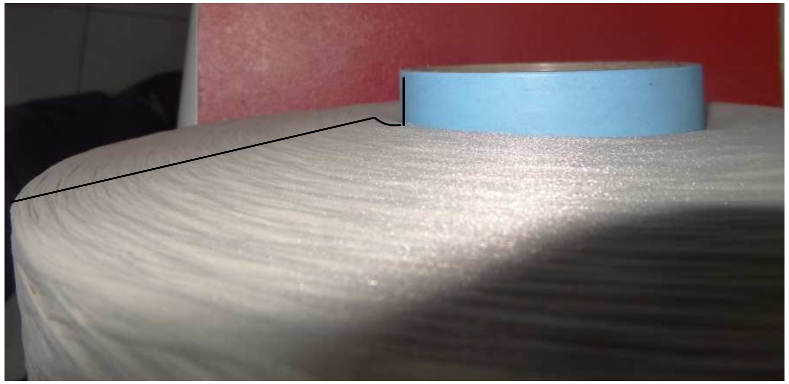
Example bobbin shape optimization

PA6 1000f42 dtex @ 2900 m/min



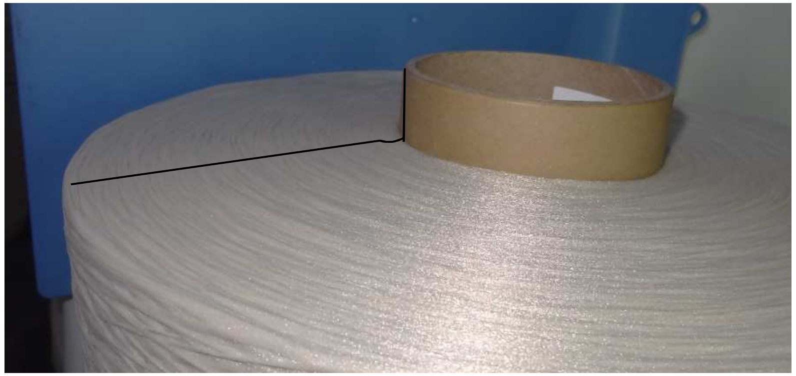
mm	∢
Start	11 °
90 mm	14 °
120 mm	14.5 °
160 mm	15 °

No speed optimization



mm	∢
Start	10 °
110 mm	12 °
150 mm	14.5 °
170 mm	15 °

No speed optimization



mm	∢
Start	10 °
110 mm	12 °
150 mm	14.5 °
170 mm	15 °

mm	Speed offset
Start	-10 m/min
95 mm	-10 m/min
100 mm	15 m/min
125 mm	15 m/min
140 mm	0 m/min
180 mm	0 m/min
190 mm	0 m/min

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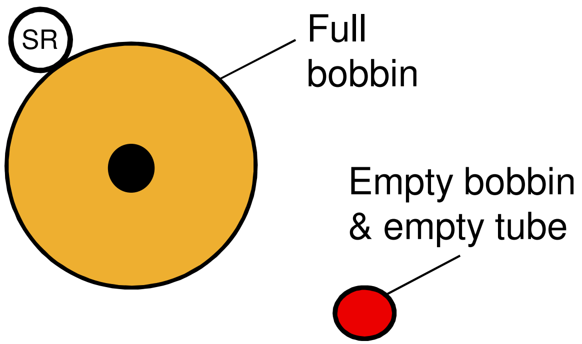
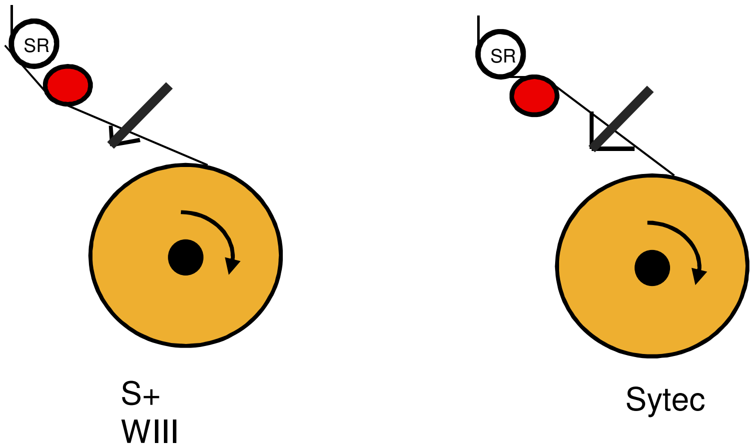
Turning moment

During winding



- Traversing is not working (threads do not touch wings any more)
- All boost‘s settings work as addition to setpoints of winding speed
- Speed regulation includes traversing, tube diameter, boost‘s, offsets...

Turning moment



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Different boost settings

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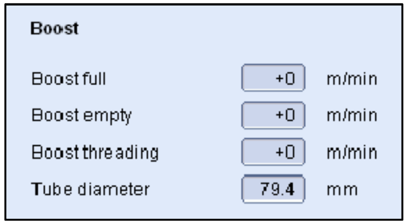
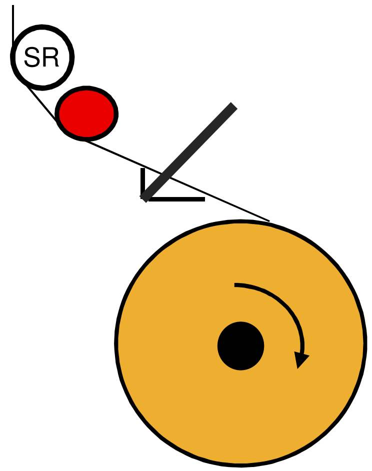


- Empty boost
  - offset on the setpoint winder speed of the empty bobbin holder
  - is active during start of empty bobbin holder until the catching moment
- Full boost
  - offset on the setpoint winder speed of the full bobbin holder
  - is active after yarn flap in position until the catching moment (influenced by ramp times inverters)
- Threading boost is active during string up of the winder
  - Offset on the empty bobbin holder until the catching moment (influenced by ramp times inverters)
- Combined boost (only S+ and SytecONE)
  - Changes the setpoint of winderspeed in PCS
  - Starts with turning turntable and works x seconds after catching (adjustable)
  - Possible speed range :   +/- 100 m/min
  - Possible boost delay :   0..15 sec



Example S+ and WIII

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Empty and Full boost (S+)

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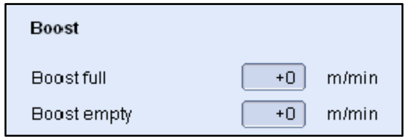

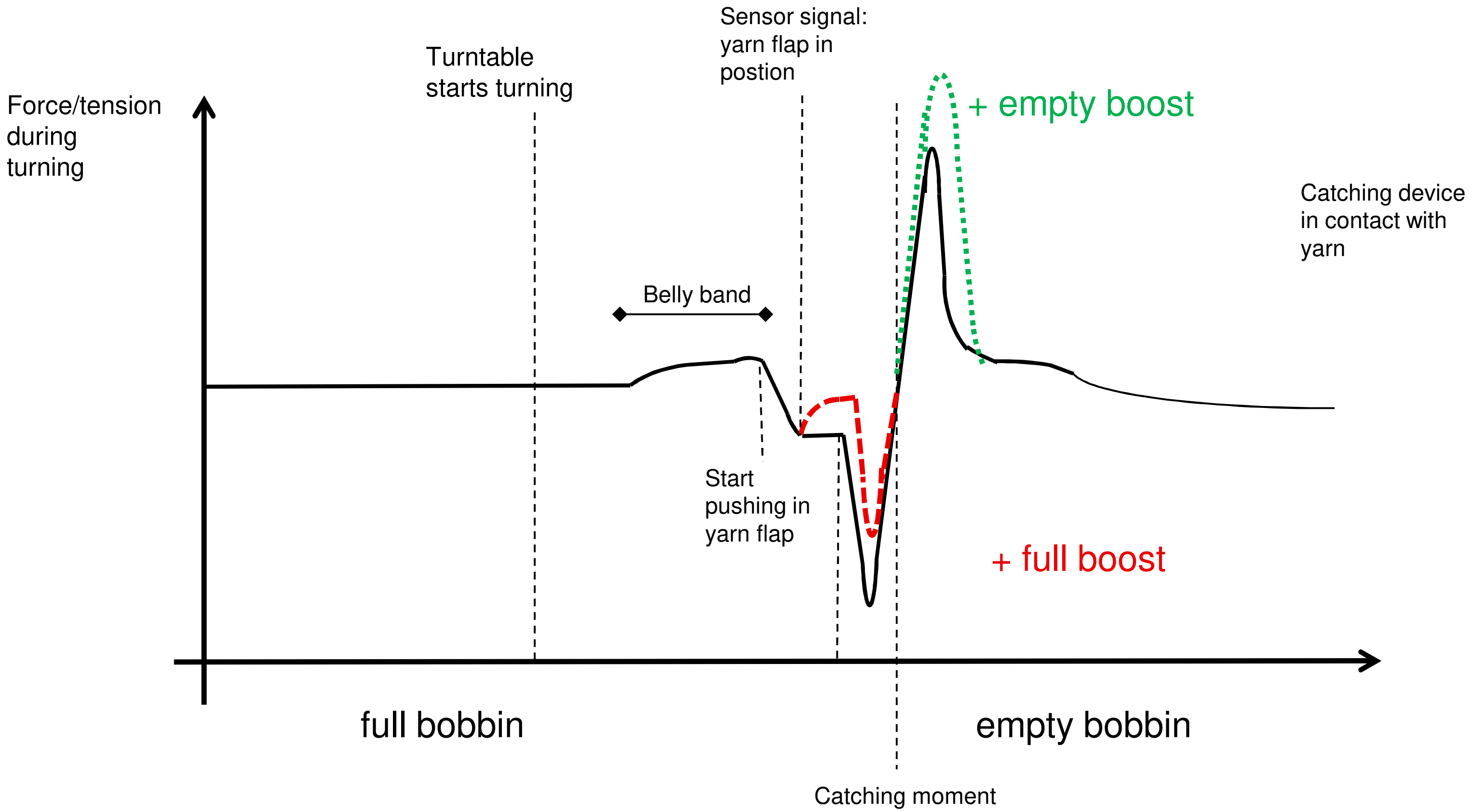

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Combined boost (S+)

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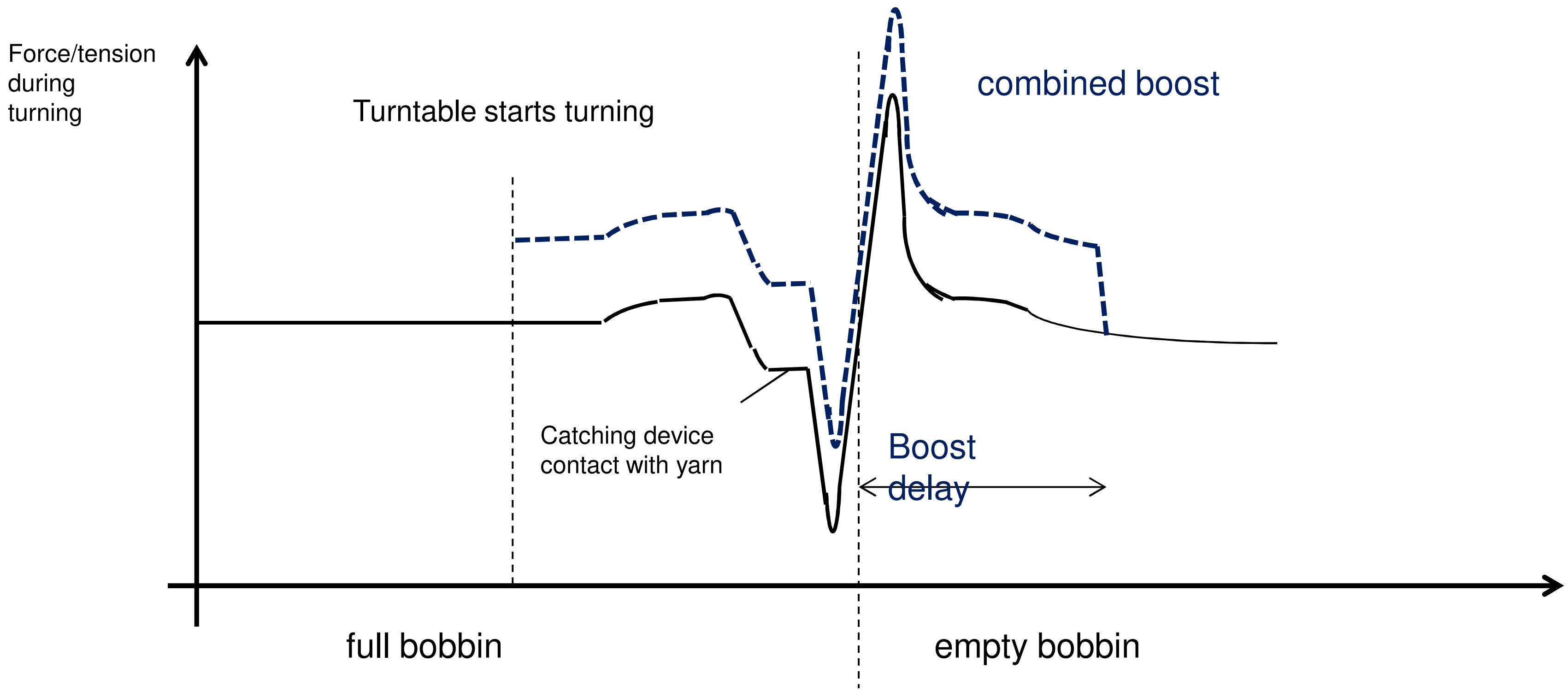
Combined boost		
boost speed	+0	m/min
boost delay	3.0	s



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Recommendations for boost settings

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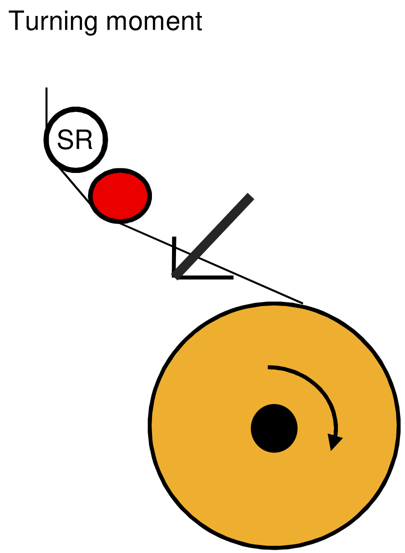

- Recommendation without use of „combined boost“:
  - Full boost: 0 …. 10 m/min
  - Empty boost: 0 …. 5 m/min
  - **Full boost higher than empty!**

- Recommendation with use of „combined boost“:
  - Full boost: 0 m/min
  - Empty boost: 0 m/min
  - Combined boost: +5..+10 m/min
  - Boost delay: 2..4 sec

Overview of all winder parameter

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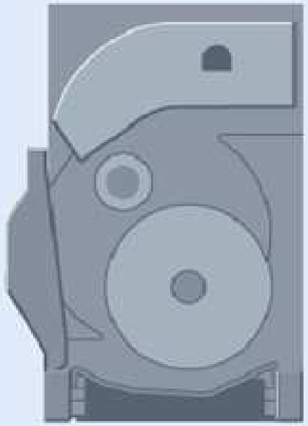

Setpoint

Winding speed	2900	m/min
Doffing diameter	260	mm
Doffing time	3600	s

Wobble Parameter

		☐	☑	☐	
Wobble freq.	0.7	1.0	0.7	0.5	Hz
Wobble ampl.	0.2	0.1	0.2	0.3	°

Boost

Boost full	+0	m/min
Boost empty	+0	m/min
Boost threading	+0	m/min
Tube diameter	79.4	mm

Combined boost

boost speed	+0	m/min
boost delay	3.0	s

Dispersion angle

Start	10.0 °	
Angle / Diameter 1	12.0 °	110 mm
Angle / Diameter 2	14.5 °	150 mm
Angle / Diameter 3	15.0 °	170 mm
Doffing angle	12.0 °	

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textile measurements

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Most important textile measurements

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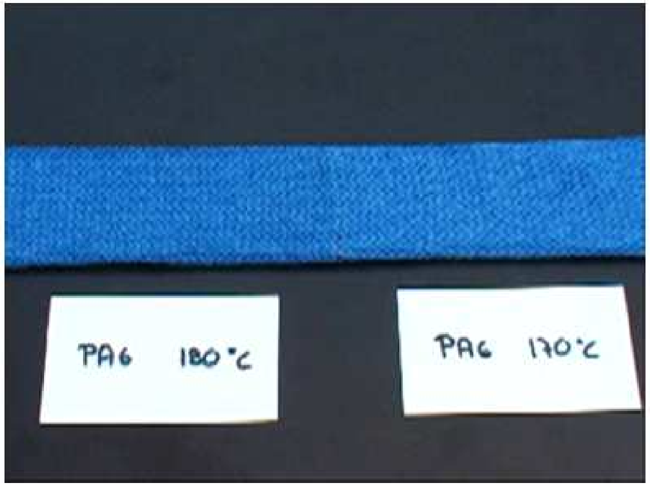
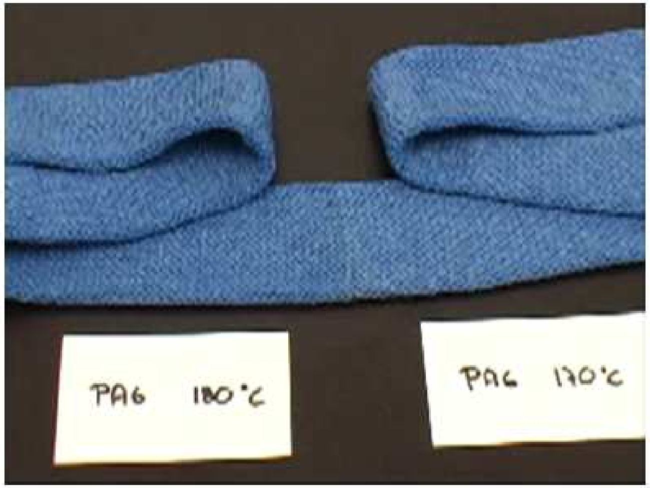
PP

- Titer / Tenacity / elongation values
- Cross section
- Crimp / shrinkage
- O.P.U.
- Tanglenode count
- Colour metric measuring system
- Card wraps





Additional for PA6 / PA6.6 / PET

- Chips humidity
- Tenacity curve !
- KWH
- Dye take up test with acid dye (degradation; crytallinity) or metal complex (crystallinity) with knitting socks + change ins knitting size
- Fibre cross section
- TiO2-content by ashing (usually R&D institutes)

NEUMAG does provide measurement standards

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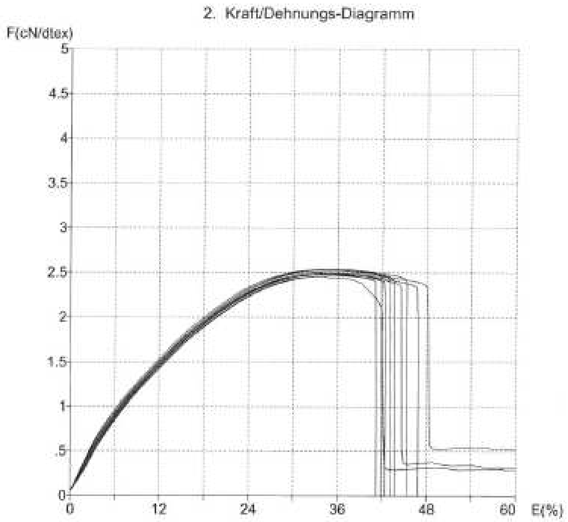
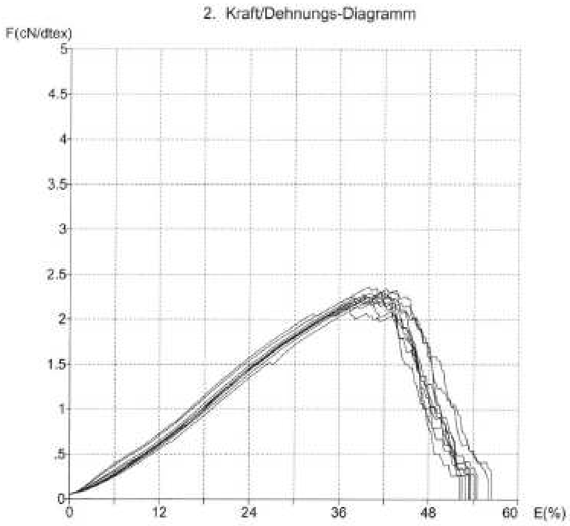
Most important textile measurements

- PP changes its inner, morphological structure after initial fibre formation little. It is very inert (does not dye), so most important is its crimp /shrinkage values, colour, titer, mechanical stenght and the O.P.U.
- PET and PA6/PA6.6 change its morphological and mechanical structure strongly with spinning conditions. This is especially true for PA6. Therefore mechanical properties are a first indication of different dye take up – but not exclusivly.

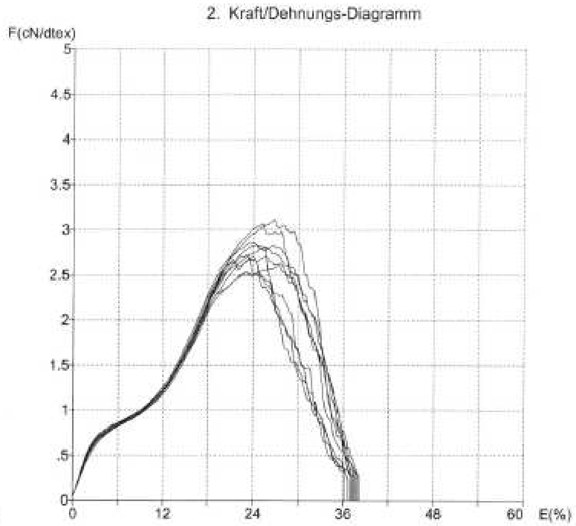
Typical tenacity/elongation curves



PP-BCF



PA6-BCF



PET-BCF

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Textile measurements

Acceptable variations in textile measurements are depending on the product/application:

- monocolor
- tricolor
- Automotive straight set
- heat set
- direct tuft BCF
- weaving

➢ own limits need to be tested (important: measure at same time distances after production)

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Determination of Resin Humidity

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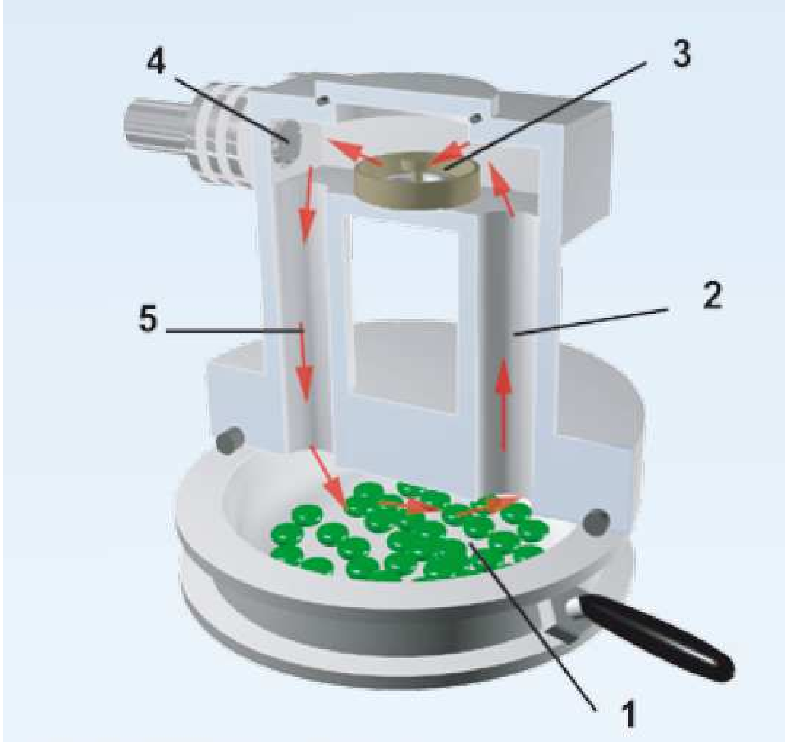
- Water in the resin leads to hydrolytic degradation of the molecule chains in the melt.

- Measuring principle: Chemical reaction of evaporated water and detection of the reaction product.
  $CaH_2 + 2\ H_2O \rightarrow Ca(OH)_2 + 2H_2$



Reactor principle in a cutaway view

1. The test material is heated in the sample tray, water evaporates
2. The hot humid gas ascends
3. The reagent exchanges water by hydrogen
4. The sensor measures the concentration of hydrogen
5. The cooled gas descends and can absorb water again

With courtesy of
Aboni GmbH, Germany

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Tenacity + Elongation: Statimat

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- <u>Measuring principle</u>: A yarn section under certain preload will be loaded under constant rate of deformation speed until it breaks (CRE-principle).

- Evaluation:
  - Tenacity [cN/dtex] or [g/den]
  - Elongation at F_H [%]
  - Elongation at break [%]

- DIN EN ISO 2062, Neumag TM 41

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Crimp – Measurement Texturmat

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1. Heat the yarn magazine in hot air for 5 minutes for developing the crimp.
   No pretension on the strands!
   PP – 90 °C
   PA6 – 120 °C
   PET – 120 °C

2. After cooling, determination of the strand lengths under various specified pretensions and automatic calculation of crimp contraction and crimp stability.

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Thank you.