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Soft-Coating

Finishing of Textiles under the Aspect of Economy and Ecology

Leader in Innovation

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Current daily hit words

Dwindling resources
The sirens sound

International Energy Agency sounds alarm

Growing risk of supply crisis

World running out of oil

Energy hunger meets shortage of energy

Shortage of energy – fossil fuels coming to an end

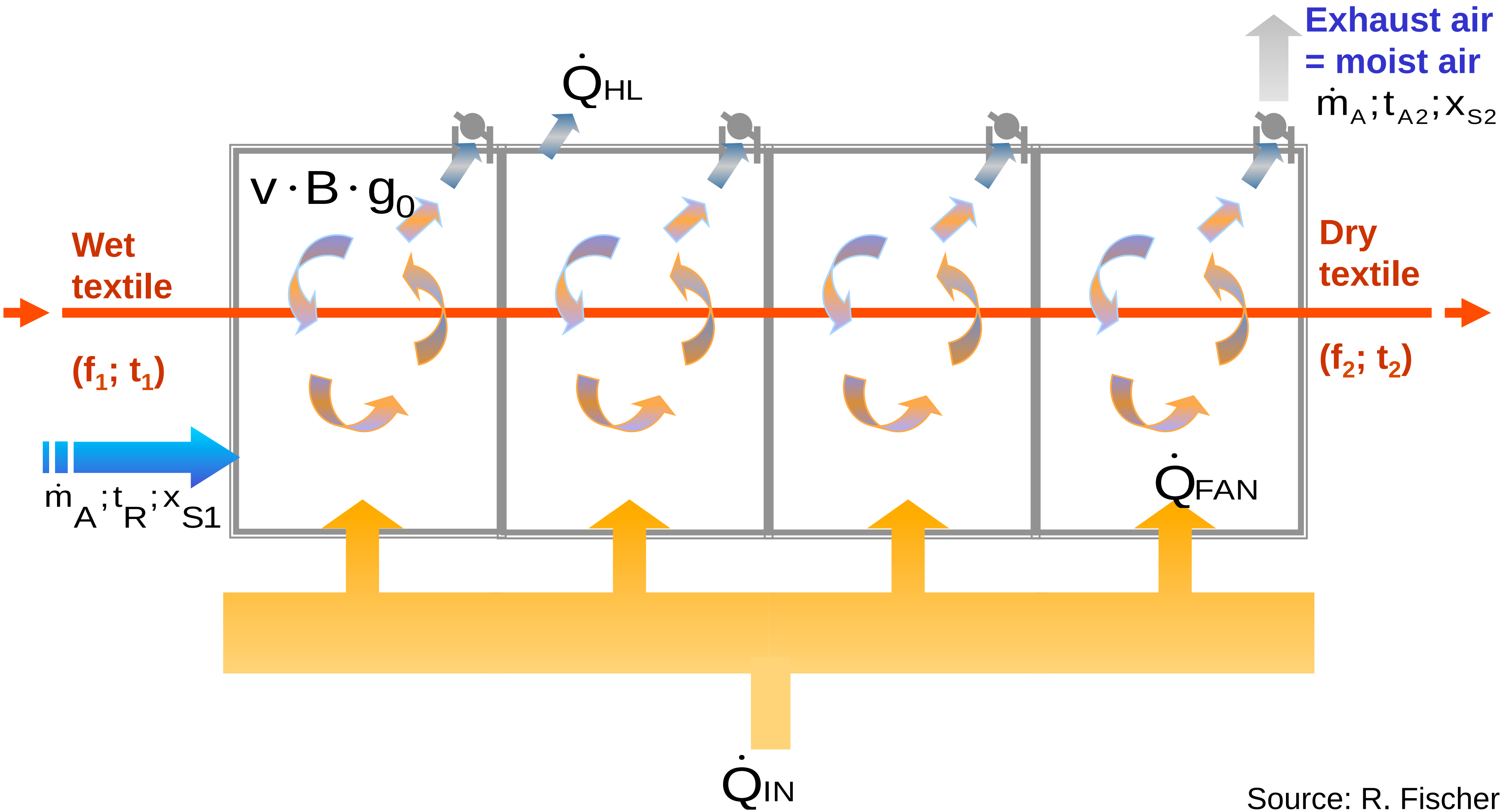
Energy costs – rising trend

Battles for resources

Parameters for energy consumption and costs of stenter processes

- Initial moisture content
- Residual moisture content
- Drying temperature
- Relative steam content of the ambient air

The classic drying process (stenter)



Source: R. Fischer

Calculation of the energy requirement
Drying process (stenter)

$$\dot{Q}_{IN} = \dot{Q}_{PRO} + \dot{Q}_{FA} + \dot{Q}_{HL} - \dot{Q}_{FAN}$$

$\dot{Q}_{PRO}$ = Heat flow for the actual drying process with energy requirement for heating up textile and water, for evaporation of the water and for superheating the resulting steam to drying temperature

$\dot{Q}_{FA}$ = Heat flow for heating up the fresh air to drying temperature

$\dot{Q}_{HL}$ = Heat loss flow, e.g. radiation via dryer walls and stenter chain

$\dot{Q}_{FAN}$ = Heat of friction of the fan blades, benefits the process (does not have to be provided by heating)

Process heat flow

$$\dot{Q}_{PRO} = \dot{Q}_T + \dot{Q}_{H_2O} + \dot{Q}_{Evap} + \dot{Q}_{SH}$$

$$\dot{Q}_T = \dot{m}_T \cdot C_T \cdot (t_2 - t_1)$$ Heating up the textile

$$\dot{Q}_{H_2O} = \dot{m}_{H_2O} \cdot C_{H_2O} \cdot (t_{wb} - t_1)$$ Heating up the water in the textile

$$\dot{Q}_{Evap} = \dot{m}_{H_2O} \cdot \Delta h_v$$ Evaporation of the water (Δh_v = 2260 kJ/kg)

$$\dot{Q}_{SH} = \dot{m}_{H_2O} \cdot C_{p,S} \cdot (t_{Noz} - t_{wb})$$ Superheating of the steam ($C_{p,S}$ = 2.0 kJ/kg • K)

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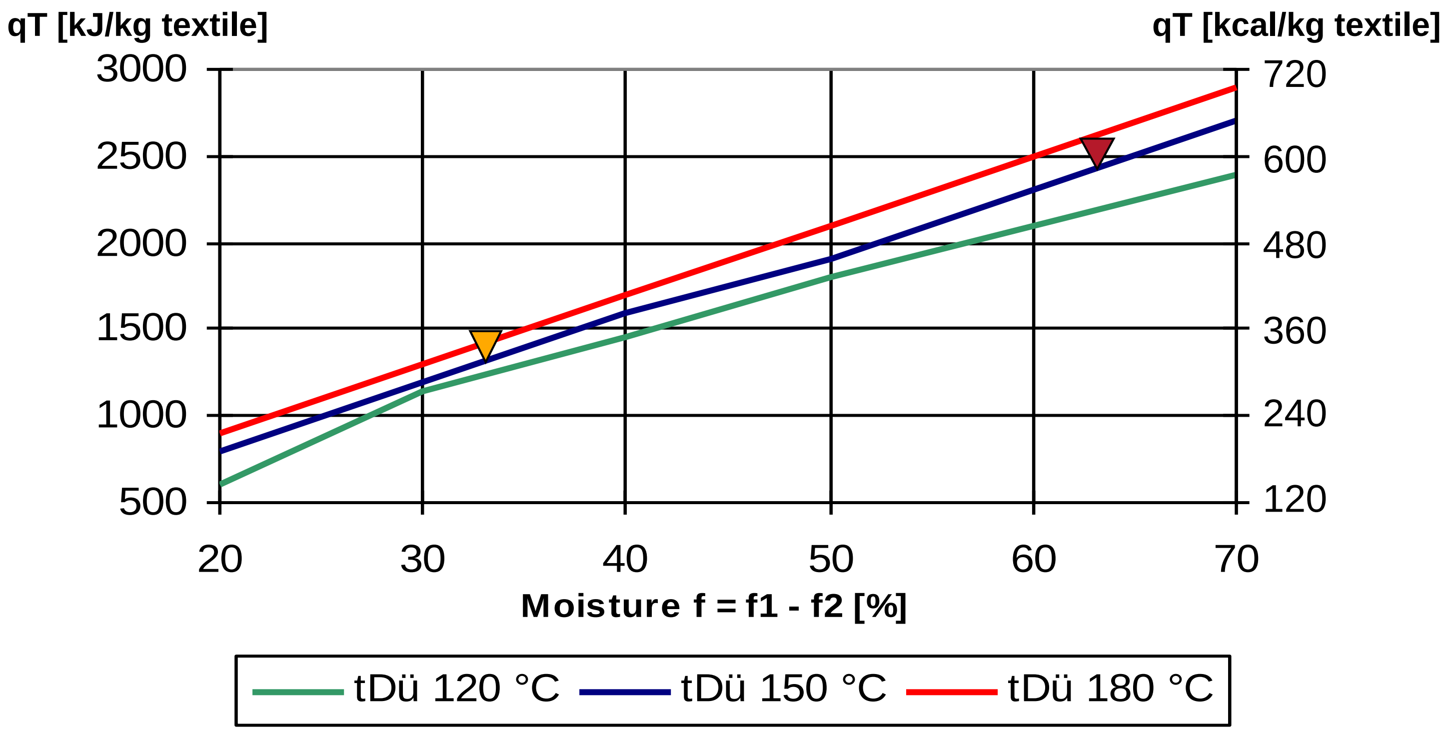
Specific energy consumption per kg textile for the drying process on the stenter as a function of the water volume to be evaporated (parameter is the drying temperature)

- 100% Co, 1.5 m, t_{Noz} = 150°C, x_S = 15 vol.%



- Example 1 pick-up = 70%, residual moisture = 8% q_T 2400 kJ/kg textile
- Example 2 pick-up = 40%, residual moisture = 8% q_T 1250 kJ/kg textile

Hourly energy consumption during the drying process

$$\dot{Q}_{IN} = \frac{60}{3600} \cdot q_T \cdot v \cdot B \cdot g_0$$

$$\dot{Q}_{IN\ 1)} = \frac{60}{3600} \cdot 2400 \cdot 80 \cdot 1{,}5 \cdot 0{,}2 = 960\ kW$$

$$\dot{Q}_{IN\ 2)} = \frac{60}{3600} \cdot 1250 \cdot 80 \cdot 1{,}5 \cdot 0{,}2 = 500\ kW$$

Savings with 40% f_1 Δ 460 kW

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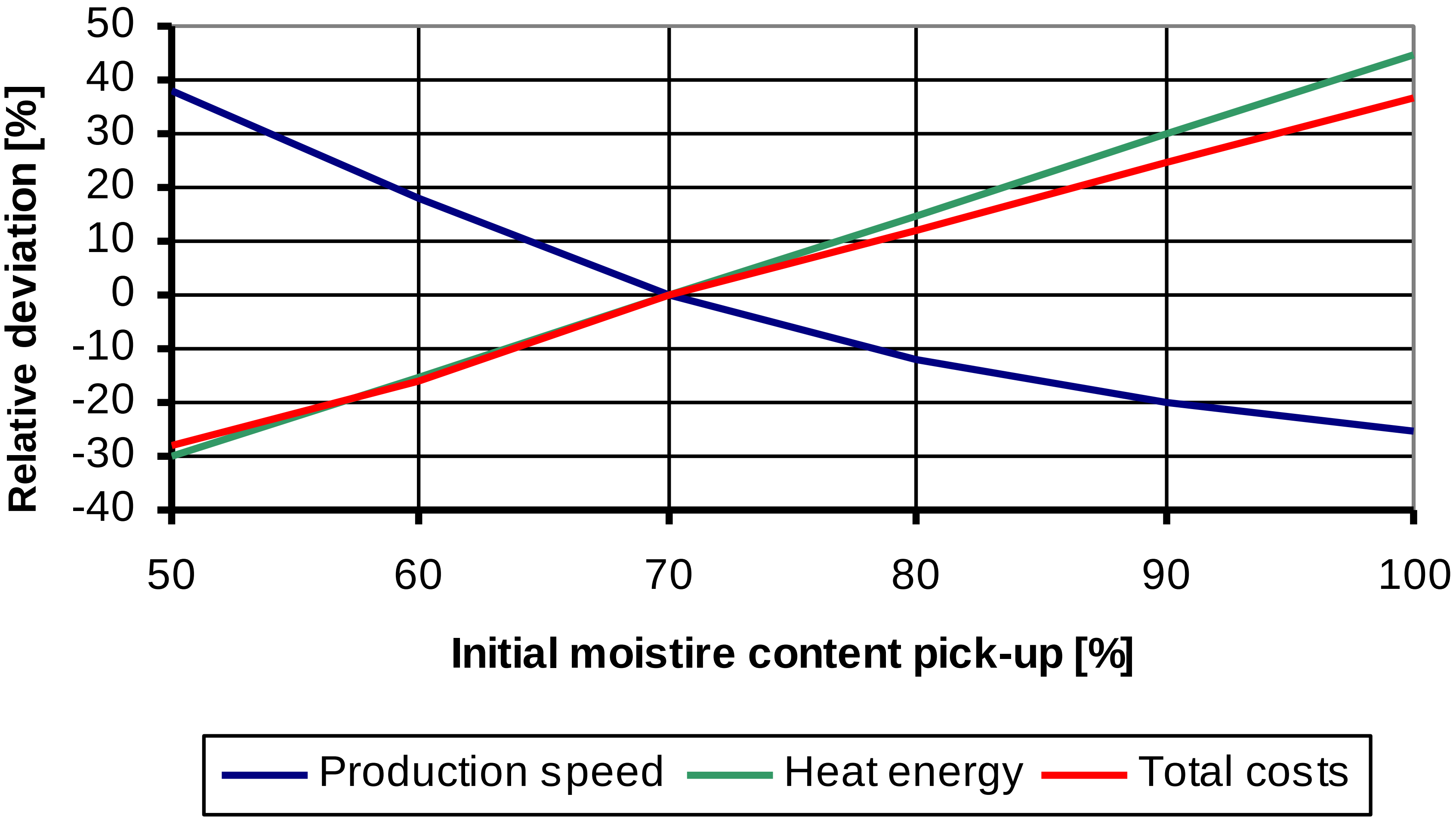
Influence of initial moisture content on the drying process



Possibilities for reducing drying costs

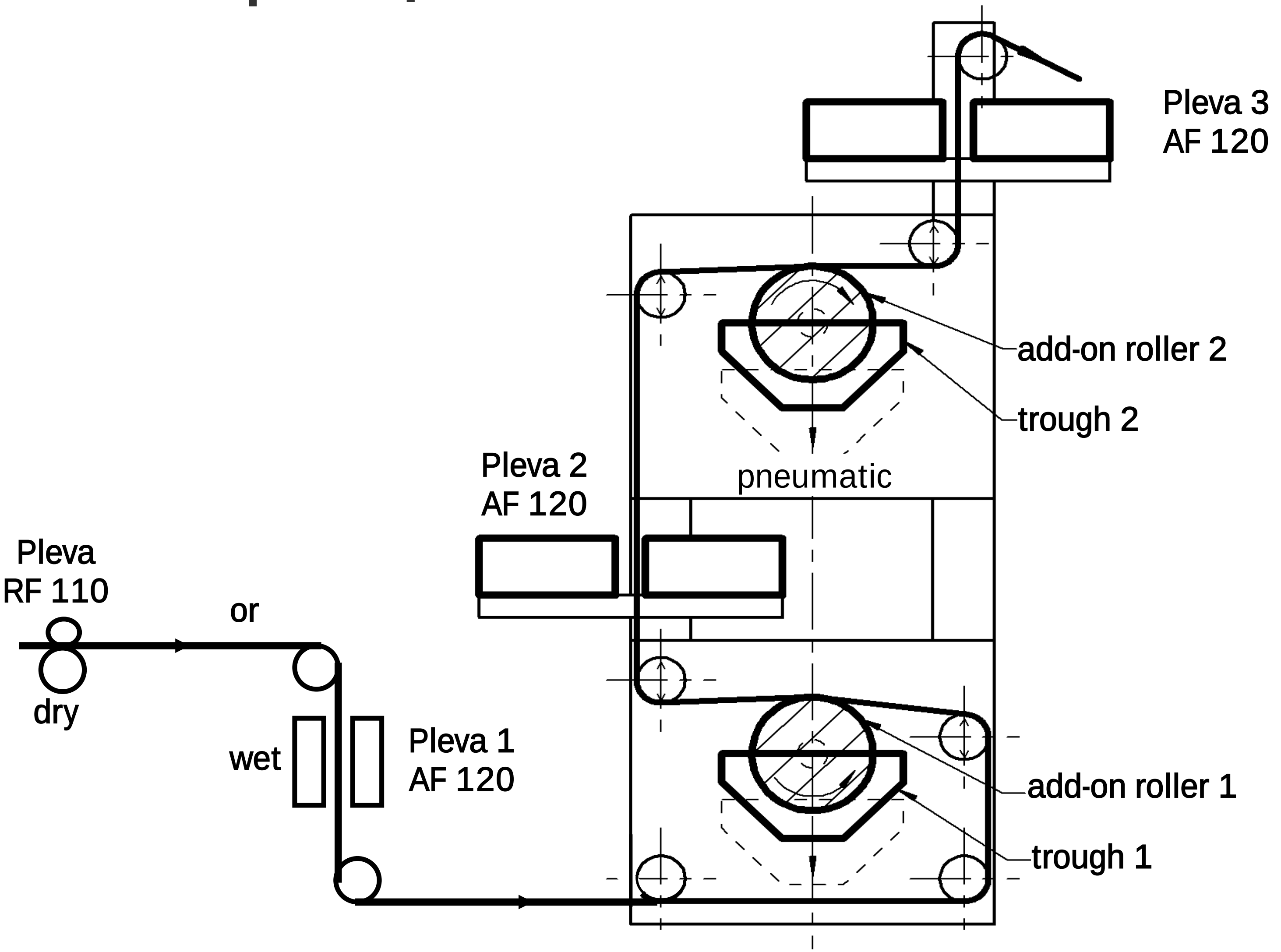
- **Selection of a suitable dryer**
  Energy-saving motors, reduction in air volumes, good α value
- **Selection of the right process for the dryer**
  Only drying, drying and curing
- **Dryer monitoring**
  Exhaust air, chamber climate, circulating air volume, temperature, automatic filter cleaning
- **Fabric monitoring**
  Initial moisture, fabric temperature, residual moisture
- **Heat recovery**
- **Reduce water volume**
  Select a suitable application method

Liquor application possibilities

- Padding
- Suction
- Foam application
- Spraying
- Coating
- Add-on application
- Soft-coating

Monforts soft-coating® range

Technical principle



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Add-on possibilities

- 1 fabric side 1 recipe
- 2 fabric sides 1 recipe
- 2 fabric sides 2 recipes

- (wet-in-dry)
- (wet-in-wet)
- (1 passage through the machine)

Example 1 Trouser fabric, 100% Co, 250 g/m², 1.52 m wide
(Range: 7F stenter + curing hotflue)

- Step 1: Drying on the stenter
- Step 2: Curing on the hotflue

} Stain release process

1.	Initial moisture:	70 %					
	Residual moisture:	8 %	Heat energy:	632	kW w/o HR	47 m/min
	Temperature:	130 °C	Electrical energy:	119	kW	
	Fan speed:	1450 rpm				
2.	Initial moisture:	40 %				
	Residual moisture:	8 %	Heat energy:	614	kW w/o HR	83 m/min
	Temperature:	130 °C	Electrical energy:	121	kW	
	Fan speed:	1450 rpm				
3.	Initial moisture:	40 %				
	Residual moisture:	8 %	Heat energy:	366	kW w/o HR	47 m/min
	Temperature:	110 °C	Electrical energy:	30	kW	
	Fan speed:	900 rpm				

Savings at constant V [m/min]:

Heat energy: 42 %
Electrical energy: 75 %

Example 2 Hydrophobing to reduce the penetration depth

Material: 100% glassfibre, 550 g/m², W = 1.80 m

Dryer: Montex 7F stenter, NW = 220 cm

I	Initial moisture Residual moisture Temperature Fan speed	50% (padder) 1% 130/150°C 1450 rpm	Heat energy w. HR. Electrical energy	835 kW 115 kW	32 m/min
II	Initial moisture Residual moisture Temperature Fan speed	15% (one-sided) 1% 130/150°C 1450 rpm	Heat energy w. HR. Electrical energy	967 kW 120 kW	107 m/min (possible)
III	Initial moisture Residual moisture Temperature Fan speed	15% (one-sided) 1% 110/100°C 600 rpm	Heat energy w. HR. Electrical energy	295 kW 17 kW	32 m/min

Summary:

- With constant production speed
  65% less heat energy and 85% less electrical energy

Example 3 Hydrophobing and UV protection

Material: 100% PES, 185 g/m², W = 1.60 m
1. Dryer: Montex 7F stenter, NW = 220 cm
2. Curing: Thermex hotflue

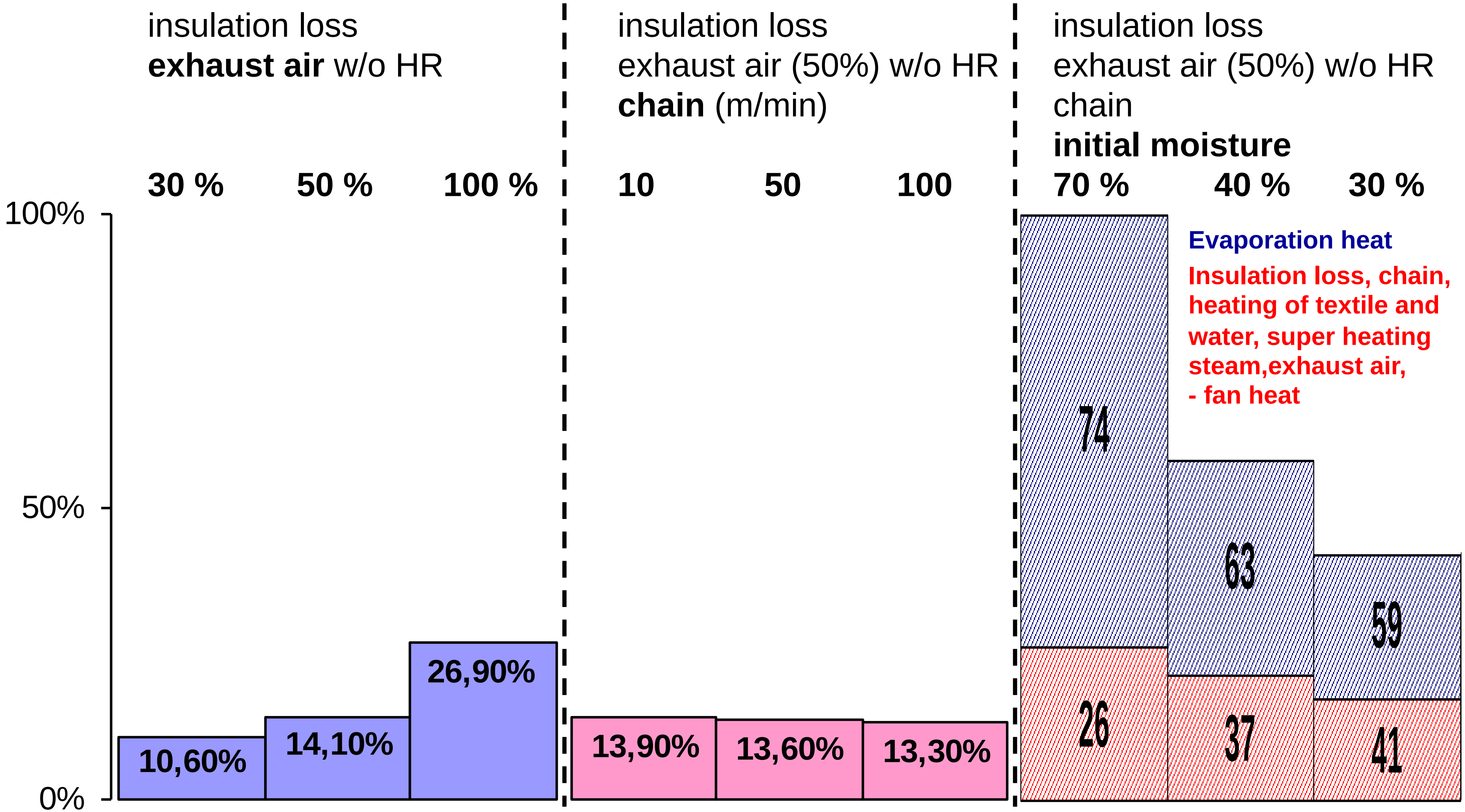
I	Initial moisture Residual moisture Temperature Fan speed	70% (padder) 2% 130/150°C 1450 rpm	Heat energy w.HR. Electrical energy	843 kW 122 kW	80 m/min
II	Initial moisture Residual moisture Temperature Fan speed	25% (soft-coating, single-sided) 2% 130/150°C 1450 rpm	Heat energy w.HR. Electrical energy	943 kW 132 kW	224 m/min (theoretically possible)
III	Initial moisture Residual moisture Temperature Fan speed	25% (soft-coating, single-sided) 2% 110/100°C 600 rpm	Heat energy w.HR. Electrical energy	428 kW 22 kW	97 m/min

Summary:

- With reduced range setting
Higher production speed 97 m/min and thereby
49% less heat energy and 82% less electrical energy

Energy consumption (gas) depending on insulation loss, quantity of exhaust air, chain and initial moisture

Montex 7F, 100 % Co, 250 g/m², 152 m width, V = 47 m/min



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Monforts soft-coating®

- economical ⇒ saving energy
- ecological ⇒ reducing treatment of waste water

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Example 4a) Terry cloth, 450 g/m², 2.10 m wide, 30 m/min (1701 kg fabric/h)

A. "Customer" process

1.	Continuous dyeing and washing			
2.	1st squeezing	pick-up	=	93 %
3.	Wet-in-wet	pick-up	=	112 %
	(4% softener application)	$G_{softener}$	=	68 kg/h
4.	Air passage			
5.	2nd squeezing	pick-up	=	90 %
	(remaining softener 2.4%)	$G_{softener}$	=	40,82 kg/h
	(loss of softener 1.6%)	$G_{softener}$	=	27,22 kg/h
		$G_{softener}$	=	120 t/year (4400 h/year)
6.	Drying			

Summary:

- with 1.50 EUR/kg = 180,000 EUR/year product down the drain
- Sewage pollution!

Example 4b) Terry cloth, 450 g/m², 2.10 m wide, 30 m/min (1701 kg fabric/h)

B. New “customer“ process
Minimum application on wet fabric

1.	Continuous dyeing and washing			
2.	1st squeezing	pick-up	=	93 %
3.	Minimum application 2 x 3% (2.4% softener)	pick-up	=	99 %
4.	Air passage	not required		
5.	2nd squeezing	not required		
6.	Drying	pick-up	=	99 %
		Additional drying costs 35,402 EUR/year		

Summary:

- No loss of softener, no waste water pollution.
- 180,000 EUR/year savings
  - 35,400 EUR/year additional drying costs

  144,600 EUR/year savings

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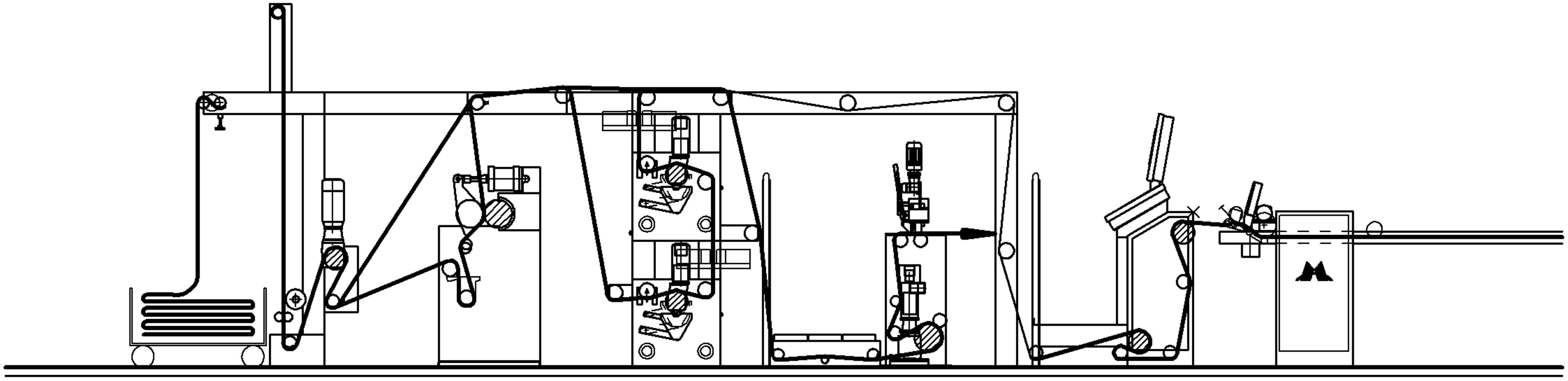
Range layout with coating and padder



Inlet section | Padder | Soft-coating (minimum application) | Coating | Stenter

Recommendation

- Electrically modernise "old" dryers,
  e.g. by the use of:
  - Frequency controllers
  - Energy-saving motors
  - Measuring equipment
- Reconcile economy and ecology
  - Reduce waste water pollution,
  - Use affordable technology to reduce energy and costs
- Energy efficiency is a step in the right direction.
- Use our resources conservatively,
  because our children's children will also need energy.

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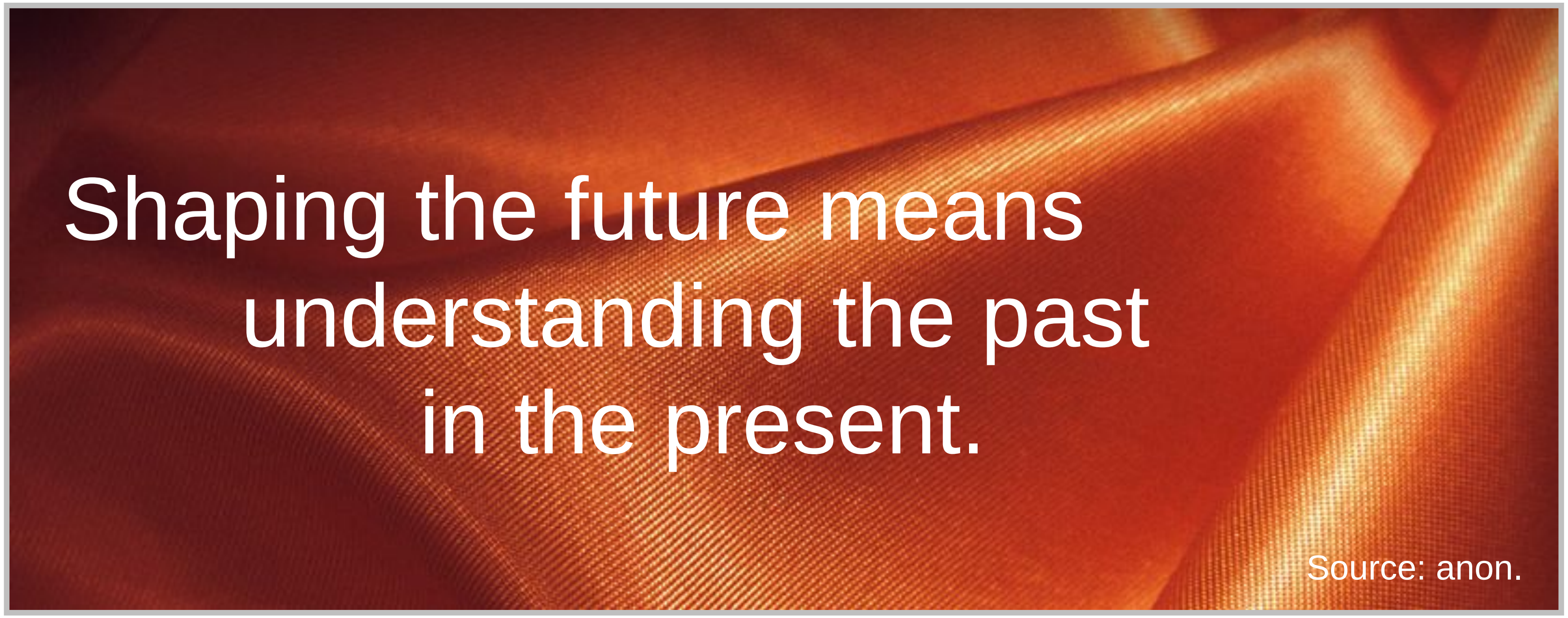

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Thank you!

Dipl.-Ing. Kurt van Wersch

Symbols used in formulae

atro	Absolutely dry (water content =0)	
B	Width of the textile web	[m]
C_{H2O}	Specific thermal capacity of water	[4.2 kJ/kg K]
C_{PS}	Specific thermal capacity of steam	[2.0 kJ/kg K]
C_T	Specific thermal capacity of textile	[1.4 kJ/kg K]
f_1	Initial moisture content (ingoing moisture)	[% w/w]
f_2	Residual moisture content (outgoing moisture)	[% w/w]
g_0	Specific weight of fabric web, referred to atro	[kg/m²]
$G_{softener}$	Softener consumption	[kg/h]
Δh_v	Specific evaporation heat of water	[2260 kJ/kg]
$\dot{m}_{H_2O}$	Mass flow of water	[kg/h]
$\dot{m}_A$	Mass of fresh air	[kg/h]
$\dot{m}_T$	Mass flow of textile	[kg/h]
w HR	With heat recovery	
w/o HR	Without heat recovery	
q_T	Specific energy consumption per kg textile	[kJ/kg textile]
$\dot{Q}_{FA}$	Heat flow to heat up the fresh air	[kW, kJ/h, kcal/h]
$\dot{Q}_{H_2O}$	Heat flow to heat up the water	[kW, kJ/h, kcal/h]

Symbols used in formulae

$\dot{Q}_{PRO}$	Heat flow for the whole process	[kW, kJ/h, kcal/h]
$\dot{Q}_{T}$	Heat flow to heat up the textile	[kW, kJ/h, kcal/h]
$\dot{Q}_{Fan}$	Frictional heat flow of the fan blades	[kW, kJ/h, kcal/h]
$\dot{Q}_{Evap}$	Heat flow to evaporate the water	[kW, kJ/h, kcal/h]
$\dot{Q}_{HL}$	Heat flow loss	[kW, kJ/h, kcal/h]
$\dot{Q}_{SH}$	Heat flow to superheat the steam	[kW, kJ/h, kcal/h]
$\dot{Q}_{IN}$	Heat flow input	[kW, kJ/h, kcal/h]
t_1	Inlet temperature of the textile fabric web	[°C]
t_2	Outlet temperature of the textile fabric web	[°C]
t_{Noz}	Nozzle outlet temperature	[°C]
t_{wb}	Wet bulb temperature	[°C]
t_{A2}	Temperature exhaust air	[°C]
t_R	Room temperature	[°C]
v	Production speed	[m/min]
x_{S1}	Steam content of fresh air	[Vol%]
X_{S2}	Steam content of exhaust air	[Vol%]