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Uncertainty of measurement of tumble dryers standard EN61121

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What do you have to expect...

- Target of thesis
- Presentation of experiments
 - Methods
 - Results
- Conclusion
- Open discussion



Proceeding

- Guessing about uncertainty of this standard
 - Extracting Factors of influence
 - Selecting the probably most important 
 - Planning and executing of tests
 - Analysing and interpretation of results
- Reduce uncertainties of measurements
respectively consideration of continuative tests



		Influence				Comment	Method of analysis
		A-TA	K-TA	time	humidity		
conditioning	Weighting	m	m	s	m	Conditioning: dry and wet direction	Calculation
	Temp. & rel. Humidity	m	m	s	m		Calculation & Tests
	Hysteresis	m	m	s	m		Calculation & Tests
Final moisture	Tolerances	m	m	m	m		Calculation & Tests
	Quality of water	m	m	m	m		Tests
Correction of energy	Depending of moisture	m	m	m	m		Calculation & Tests
	Abluftausgleich	s	-	-	-		
Climate (Laboratory)	climate	s	g	-	-		Calculation & Tests
	Rücksaugen	s	g	-	-		Calculation & Tests
Condensing rate	teilw. Abluftbetrieb	-	-	-	-	depend on dryers, irrelevant	--
	Kondensatverlust	-	-	-	-	depend on dryers, irrelevant	--
amount of venting air (A-TA)	Installation (vention system)	m	-	-	-	error of installation	Tests
	difference of pressure	m	-	-	-	conduct of exit air	Tests
Amount of cooling air (K-TA)	placement	-	m	-	-	Influence: amount of cooling air	Tests
age and kind of textiles		g	g	g	g	Influence: loss of humidity	4 Tests

15/05/2008



		Influence				Comment	Method of analysis
		A-TA	K-TA	time	humidity		
preparation of textiles	loading	g	g	-	-	Influence: loss of humidity	Tests
	Wetting	g	g	-	-	Influence: loss of humidity	Calculation & Tests
	Preparation	g	g	-	-	Influence: loss of humidity	Testes
tolerances of measurement	Energy consumption	m	m	-	-		Calculation
	Weight	g	g	-	-		Calculation
	Temperature	s	g	-	-		Tests
	rel. Humidity	s	g	-	-		Tests
	amount of air	m	-	-	-	calculation of exit air	Tests
Power loss	line voltage	g	g	-	-	influence of specific duration	Calculation
	loss of power	g	g	-	-	Direct influence on energy consumption, loss of power may be measured	Calculation
Preparation of tests	Temperature of dryers	g	g			direct influence of energy consumption	Tests
	Temperature of textiles	g	g			direct influence of energy consumption	Tests





Overview of tests

- **Conditioning**
- Loading of drum
- Wetting
- Temperature of tumble dryers
- Ambient conditions
- Evenness of drying



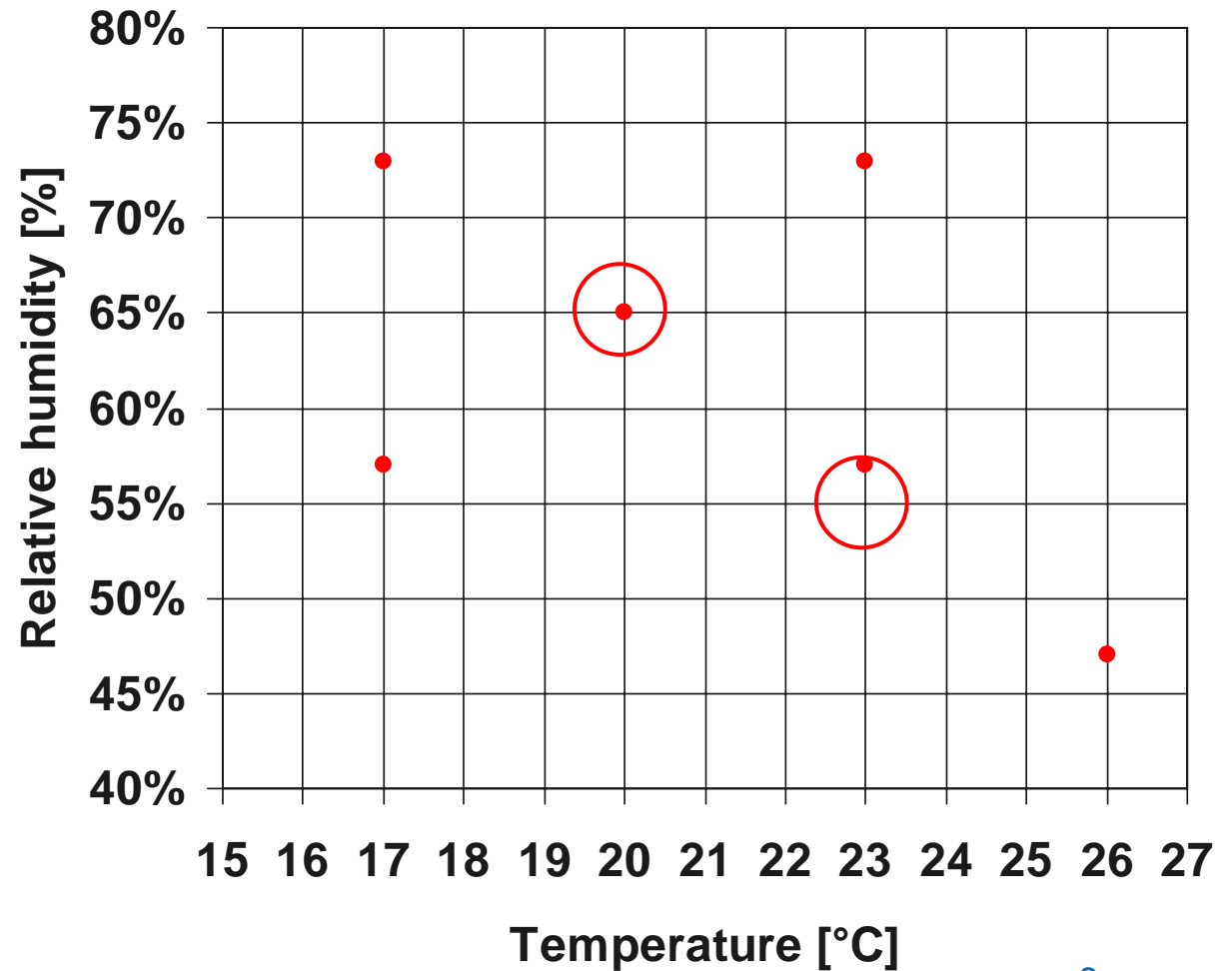
Conditioning tests

- Influence on conditioned weight
 - temperature and relative humidity conditions
 - ages of the textiles
 - Hysterese effect



Climate conditions

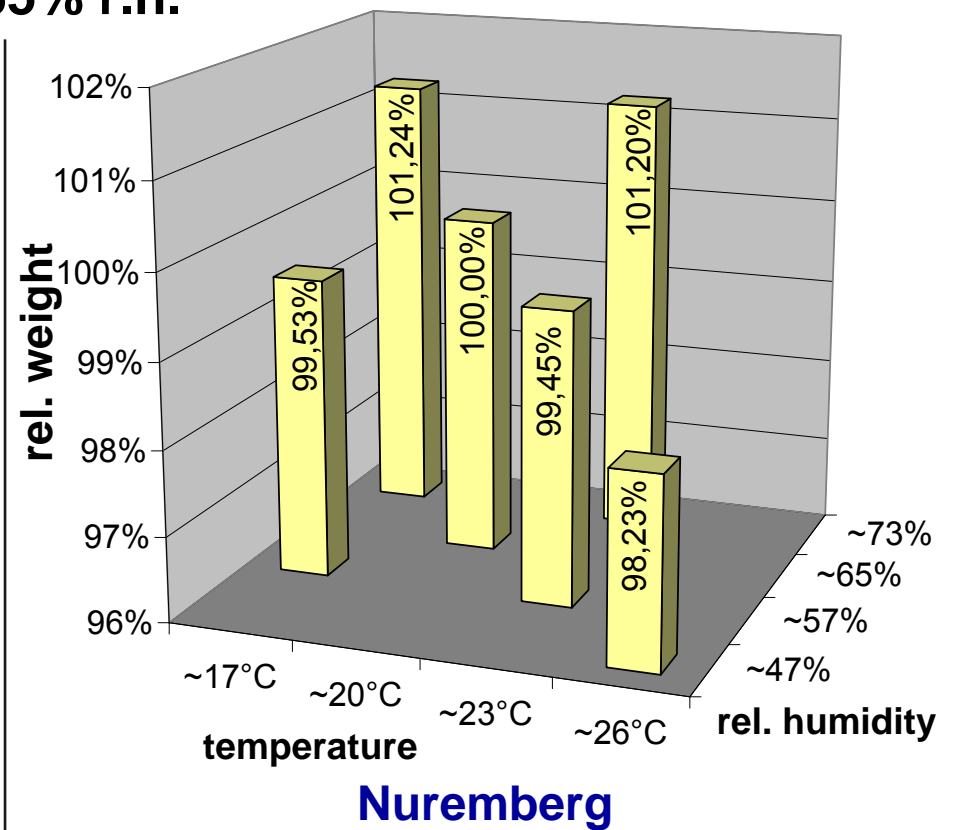
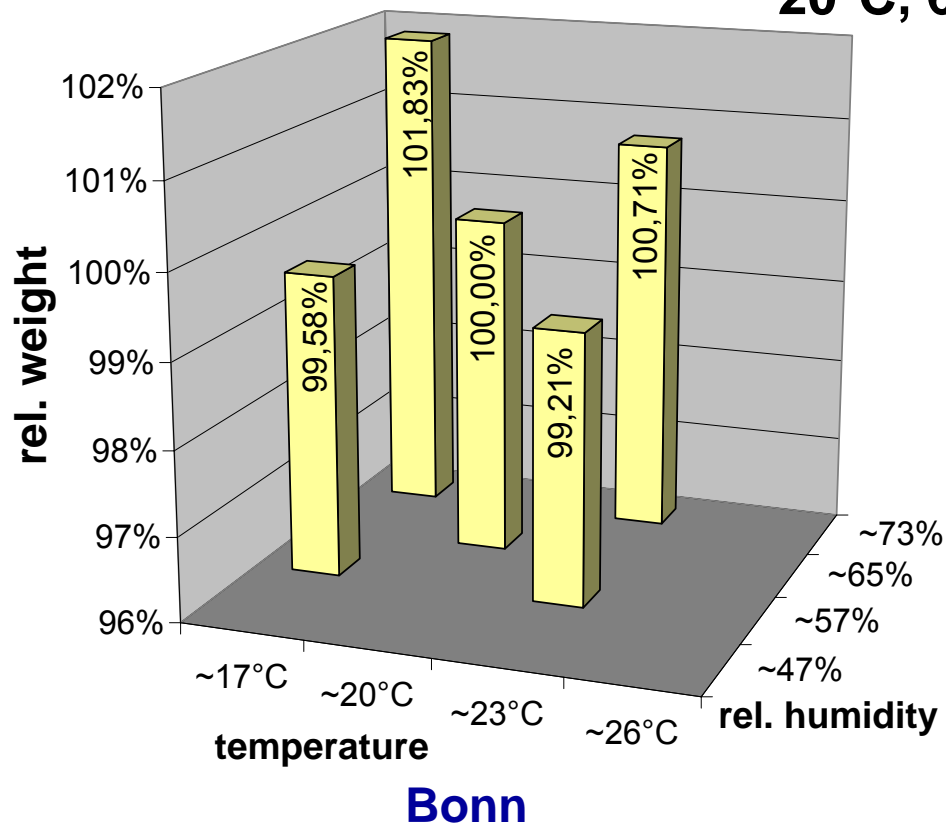
Executing of tests considering the range of the tolerances and the uncertainty of measurement device





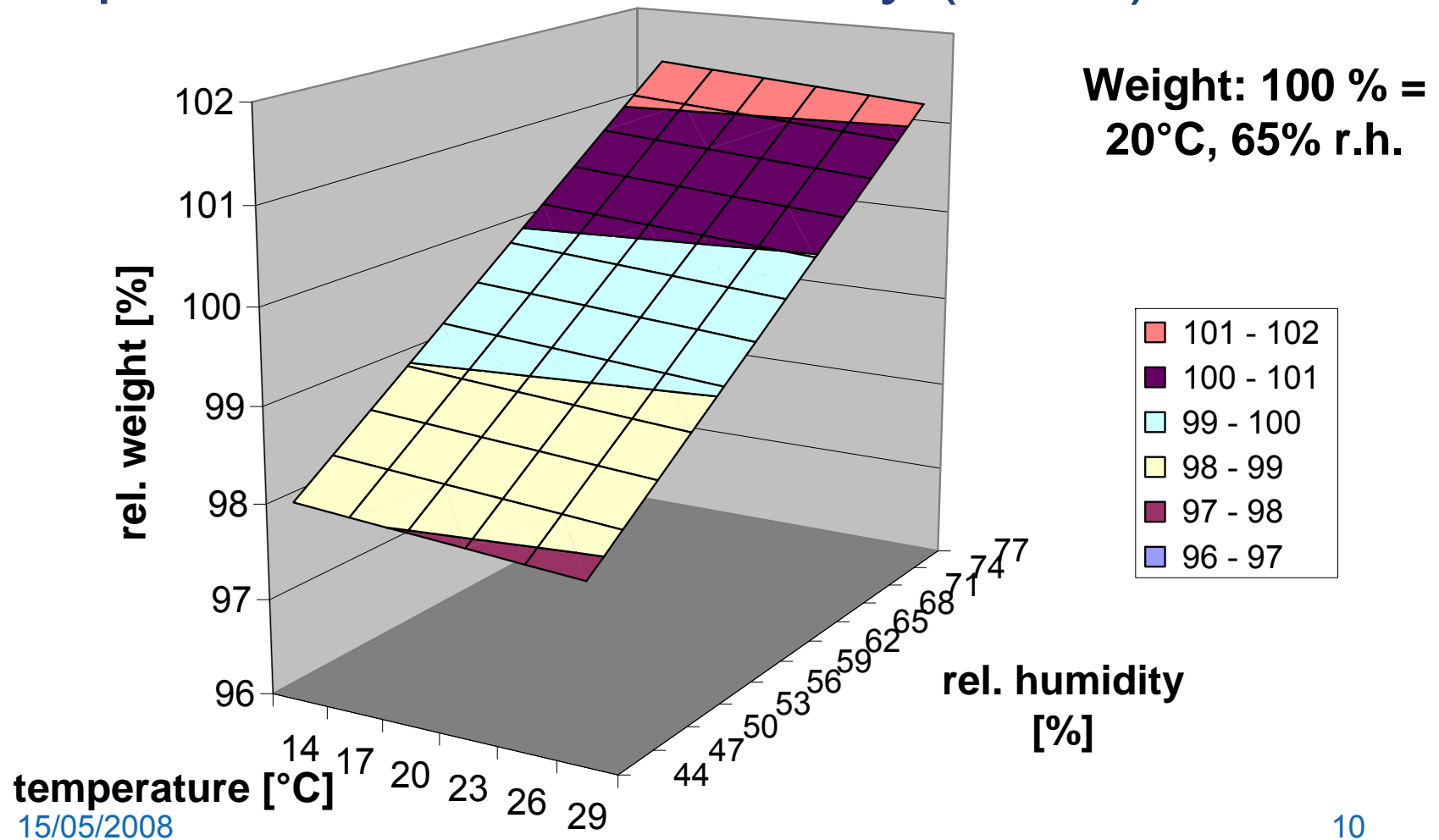
Results of different ambient conditions

Weight: 100 % =
20°C, 65% r.h.





Regression: Weight depending on temperature and rel. humidity (Bonn)





Weight depending on temperature and rel. humidity (corrected)

■ Error in conditioned weight:

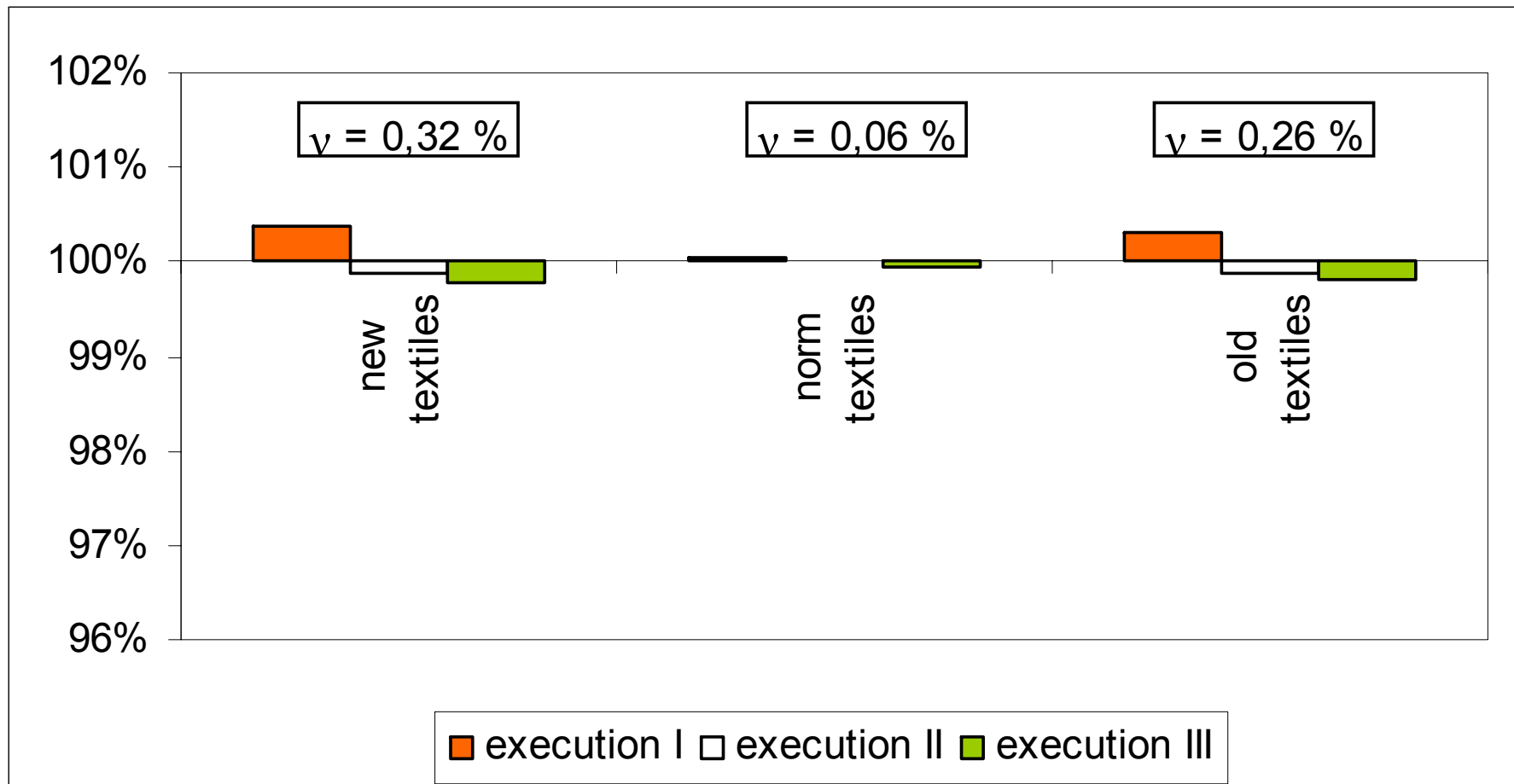
- At 18 °C, 60 %: - 0.48 %
- At 22 °C, 70 %: + 0.48 %

- At 23 °C, 55 %: - 1.05 %
- At 25 °C, 50 %: - 1.58 %

Compared to 20 °C, 65%

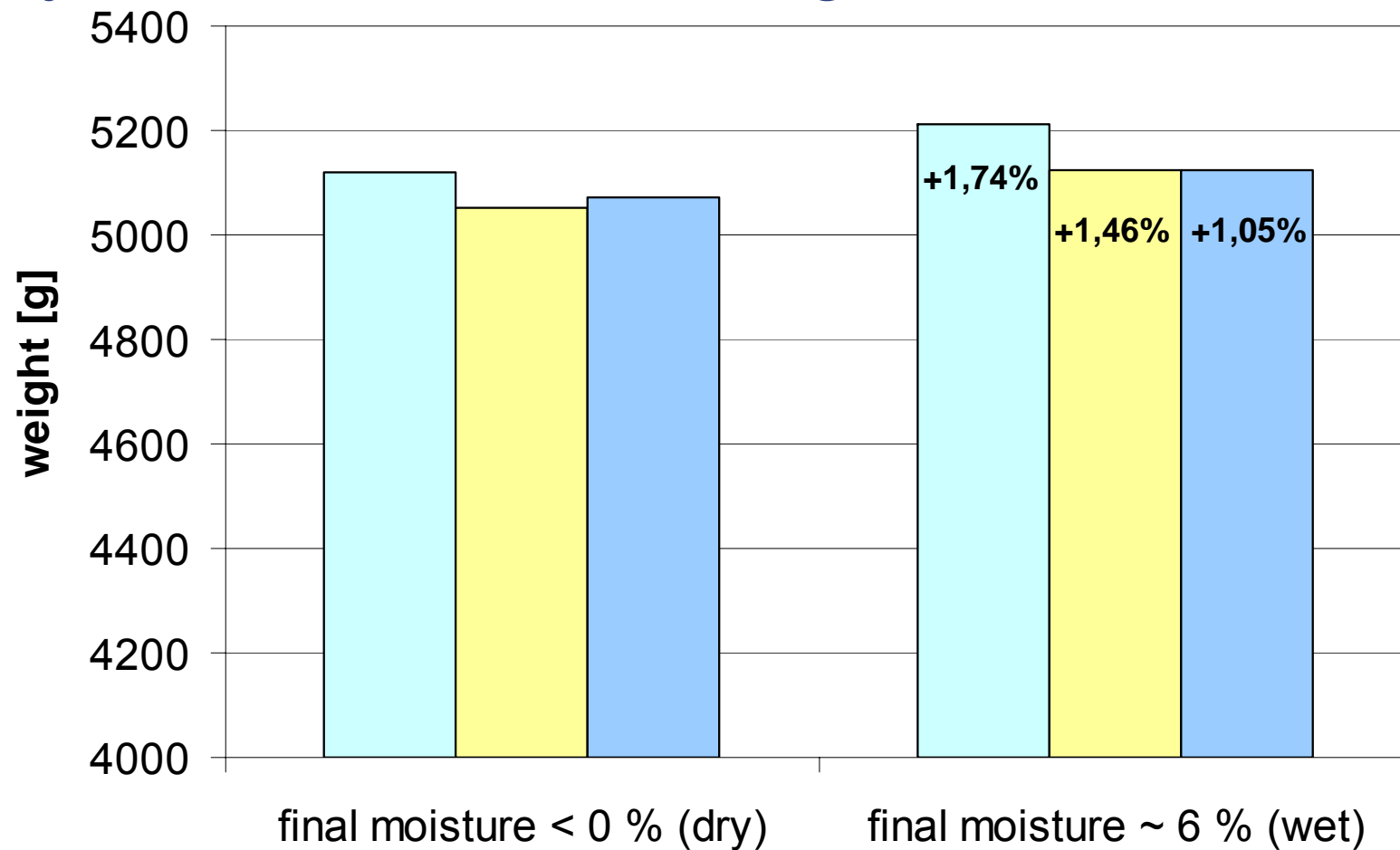


Influence of age of textile





Hysteresis of conditioning



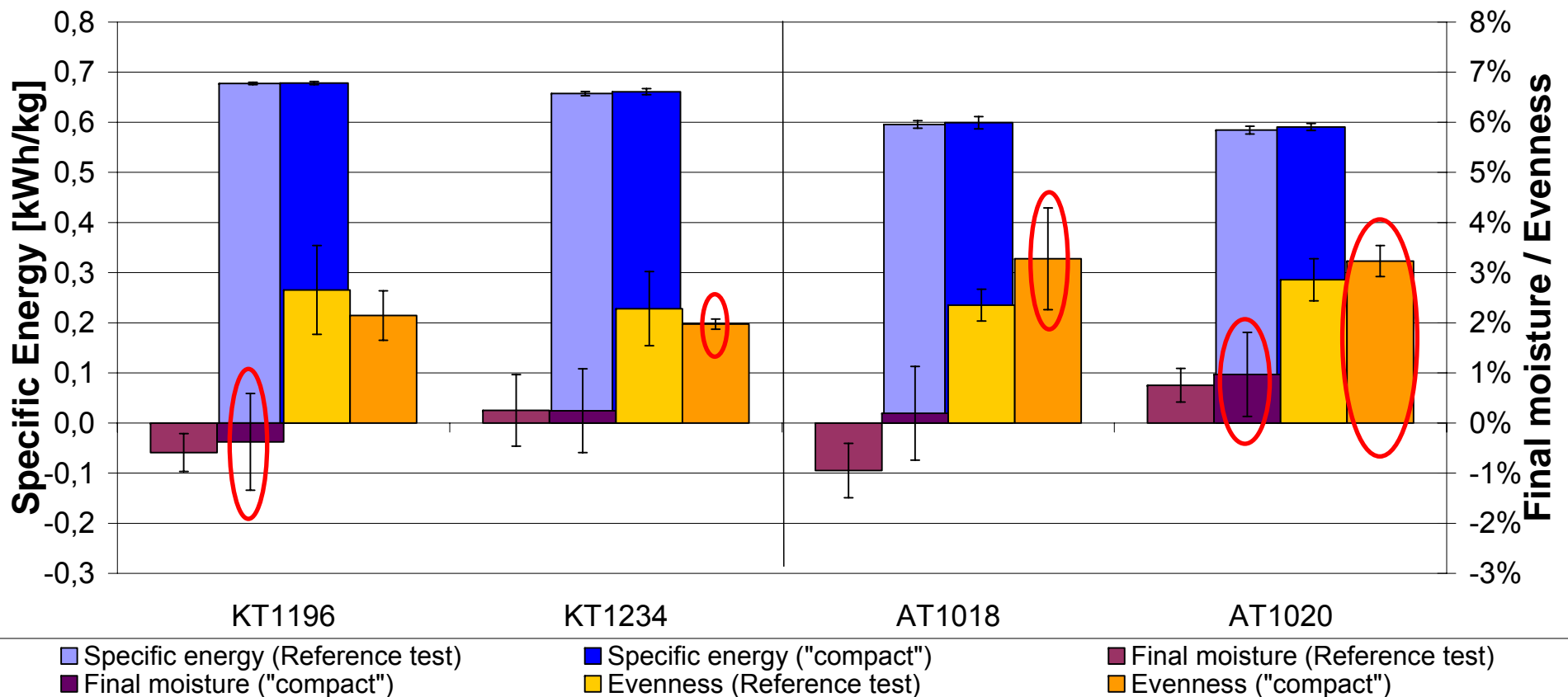


Loading of tumble dryer

- Loosened loading
- Compact loading
- Loading with normative positions (close to standard of washing machines)

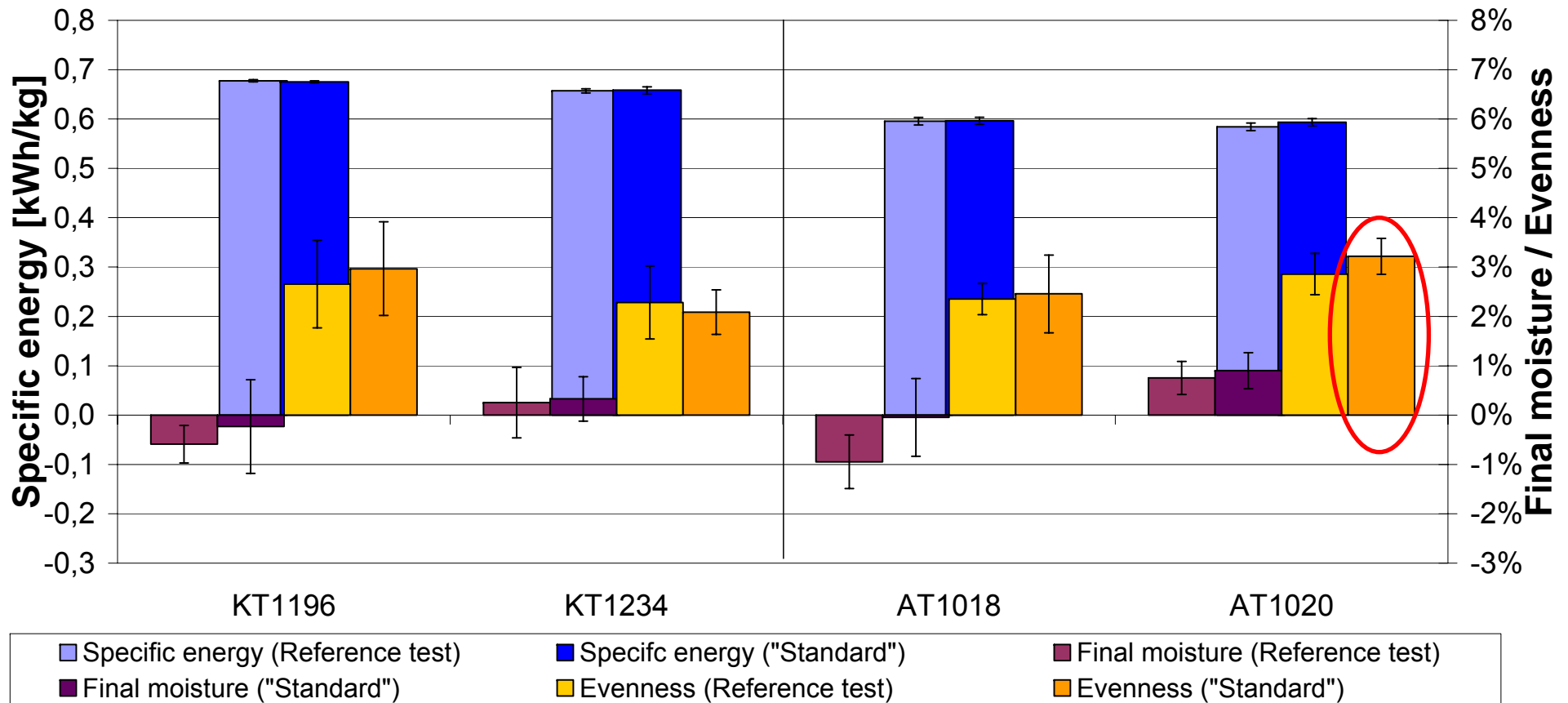


Compact loading





Normative Position





Results of loading

- Hardly no significant differences between loosened loading and loading with well defined positions
- Significant differences between compact and loosened loading
 - No loading scheme needed
 - Normative advice to loosen textiles before loading

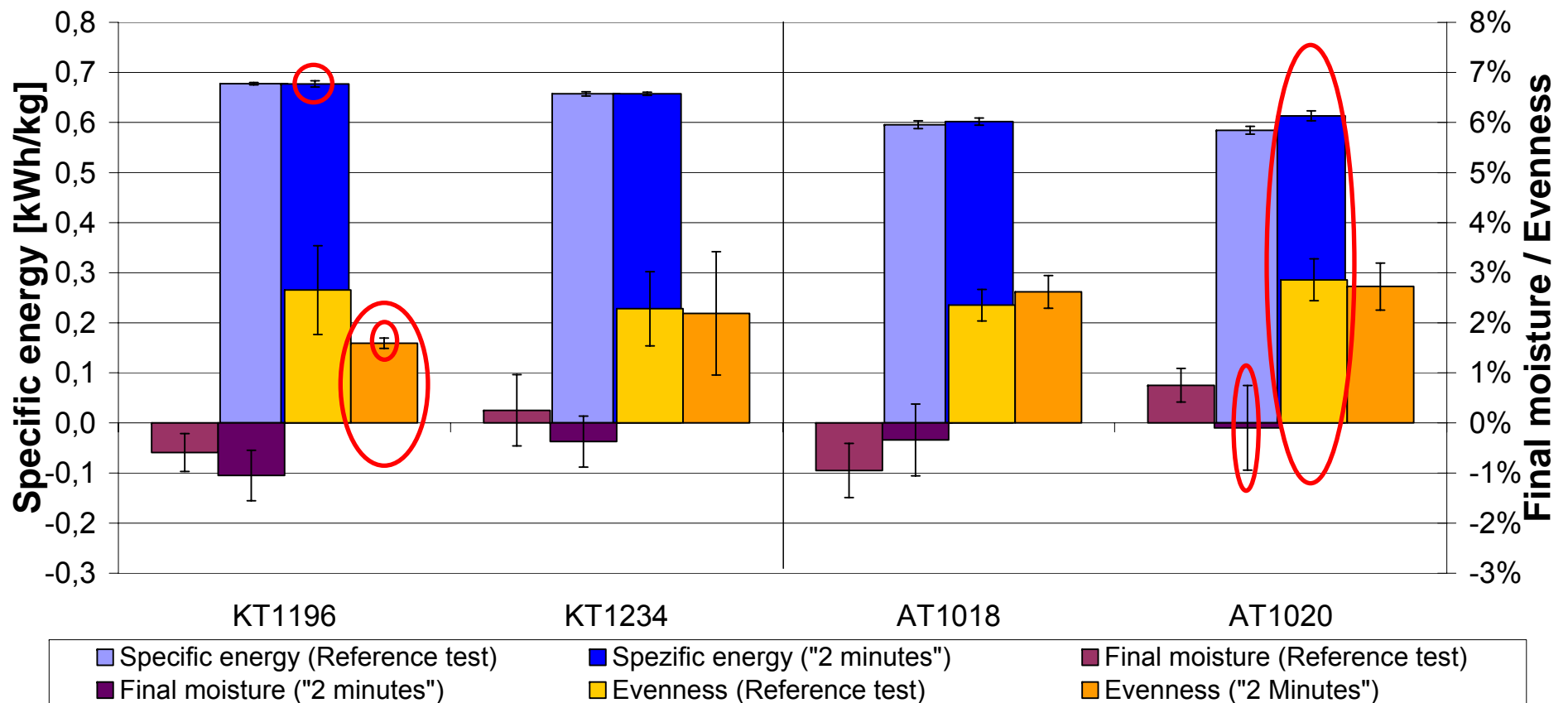


Wetting of textiles

- Wetting like advice in standard
- Wetting during two minutes
- Wetting during the night
- Wetting by dousing textiles to 60 % final moisture

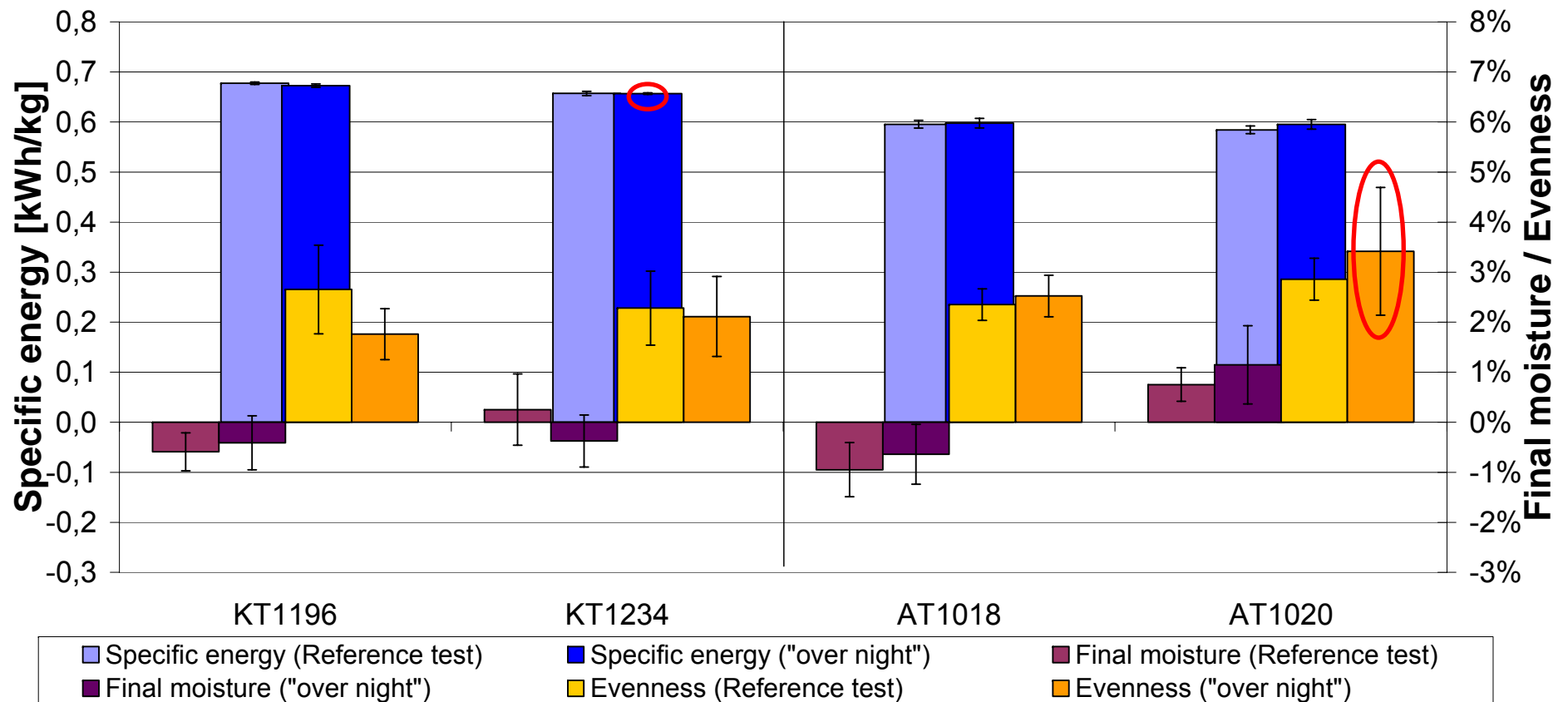


Wetting during 2 minutes



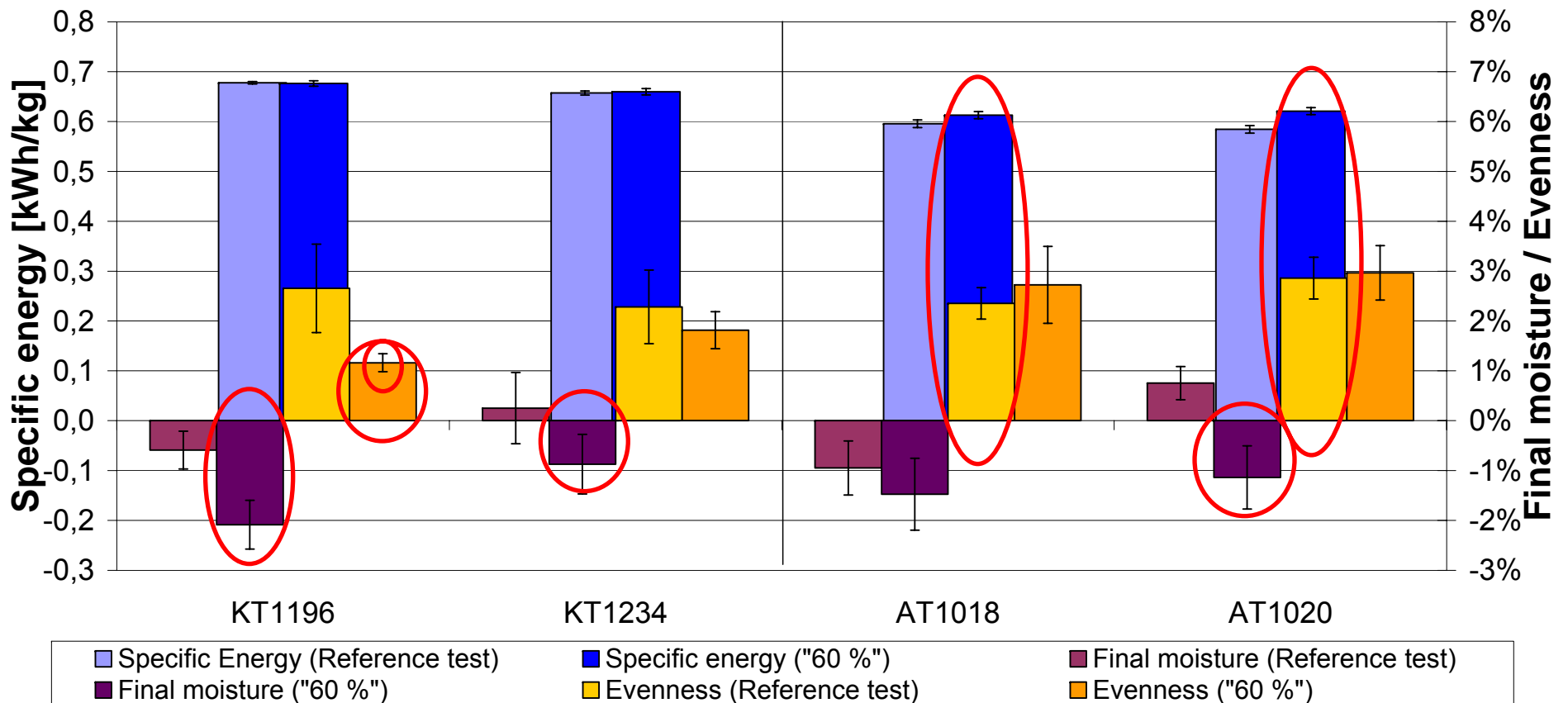


Wetting during the night





Wetting by dousing textiles to 60 % final moisture





Results of wetting

- Hardly no significant differences between wetting during two minutes respectively during the night and standard wetting
 - Significant differences between wetting by dousing and standard wetting
- Reduction of advised wetting time and water volume (continuative tests are necessary)

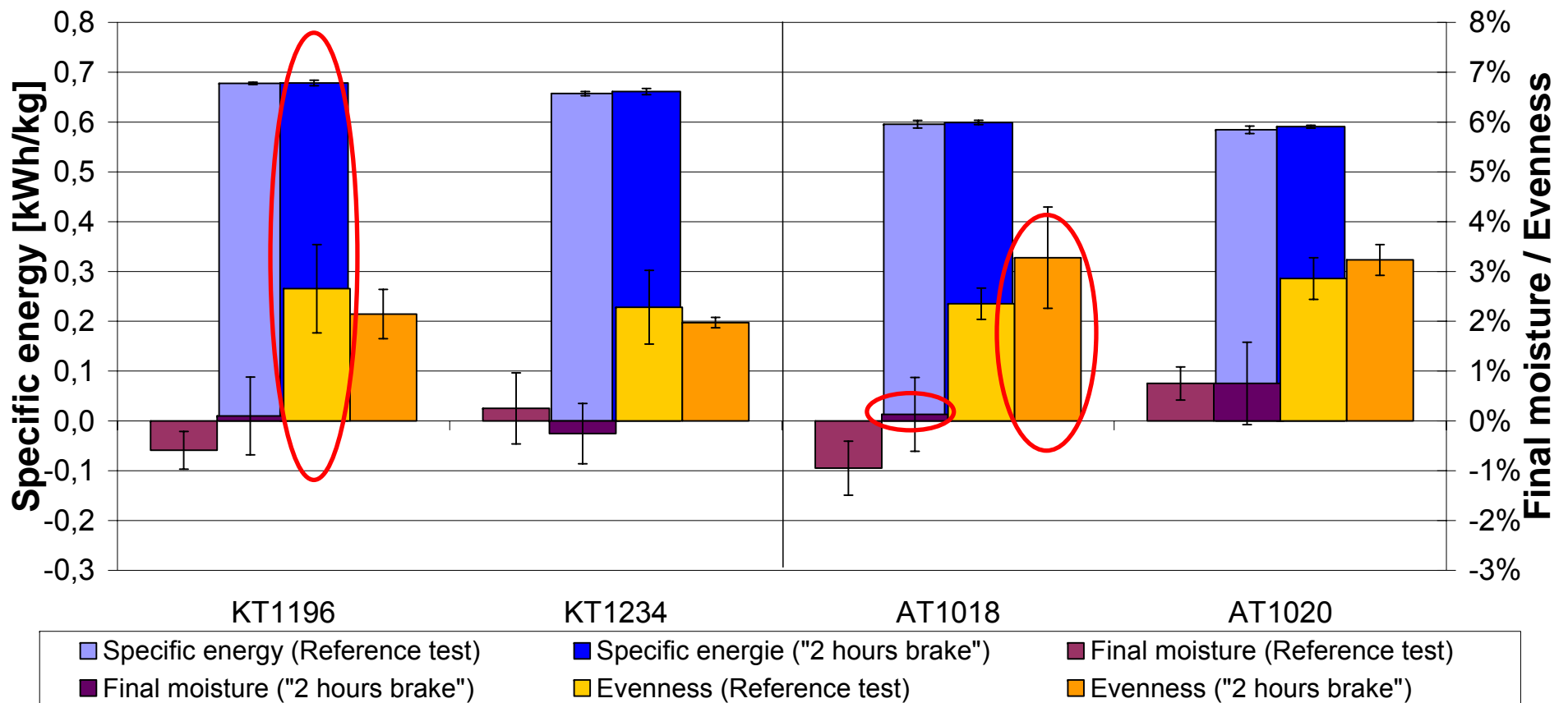


Temperature of dryers

- Time between test executions: 12 hours
- Time between test executions: 2 hours
- Time between test executions: 2 hours +
cooling by ventilator

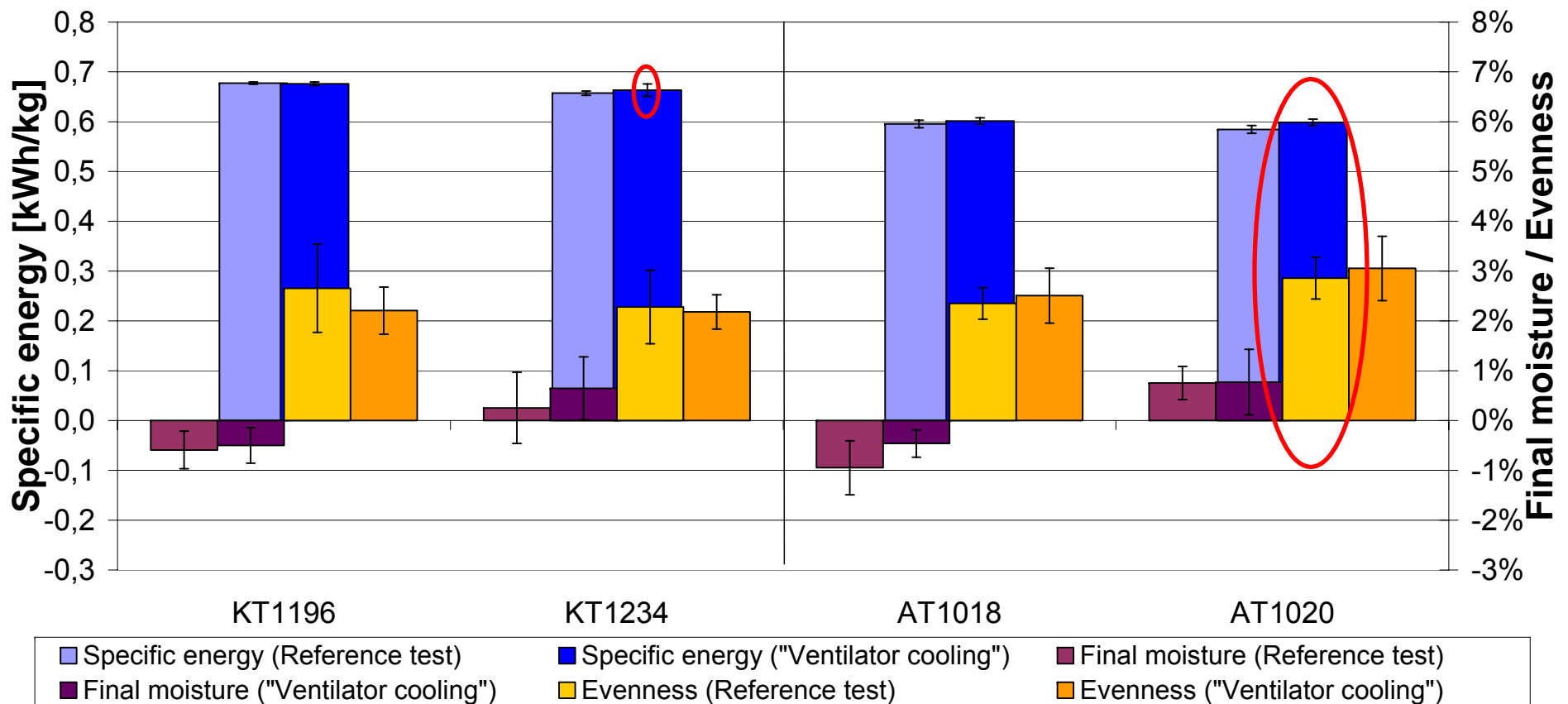


Brake: 2 hours





Brake: 2 hours with ventilator





Results of temperature of dryers

- Hardly no significant differences of cooling during two hours (using ventilator) and twelve hours
- Reduction of advised cooling time respectively cooling method (continuative tests)

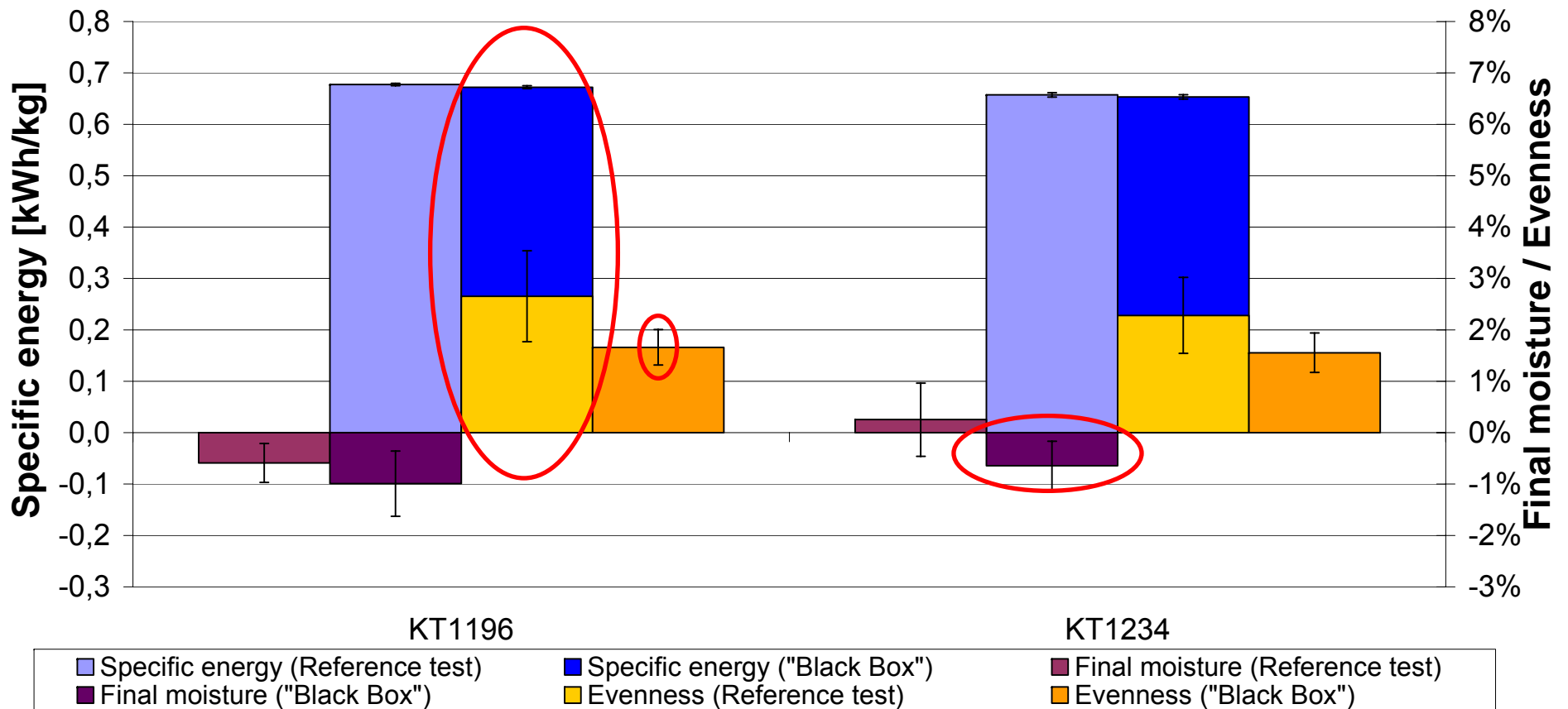


Ambient conditions

- Using a black box (only for condenser tumble dryer) covering the dryer
- Dryers are cooled by a ventilator during the test

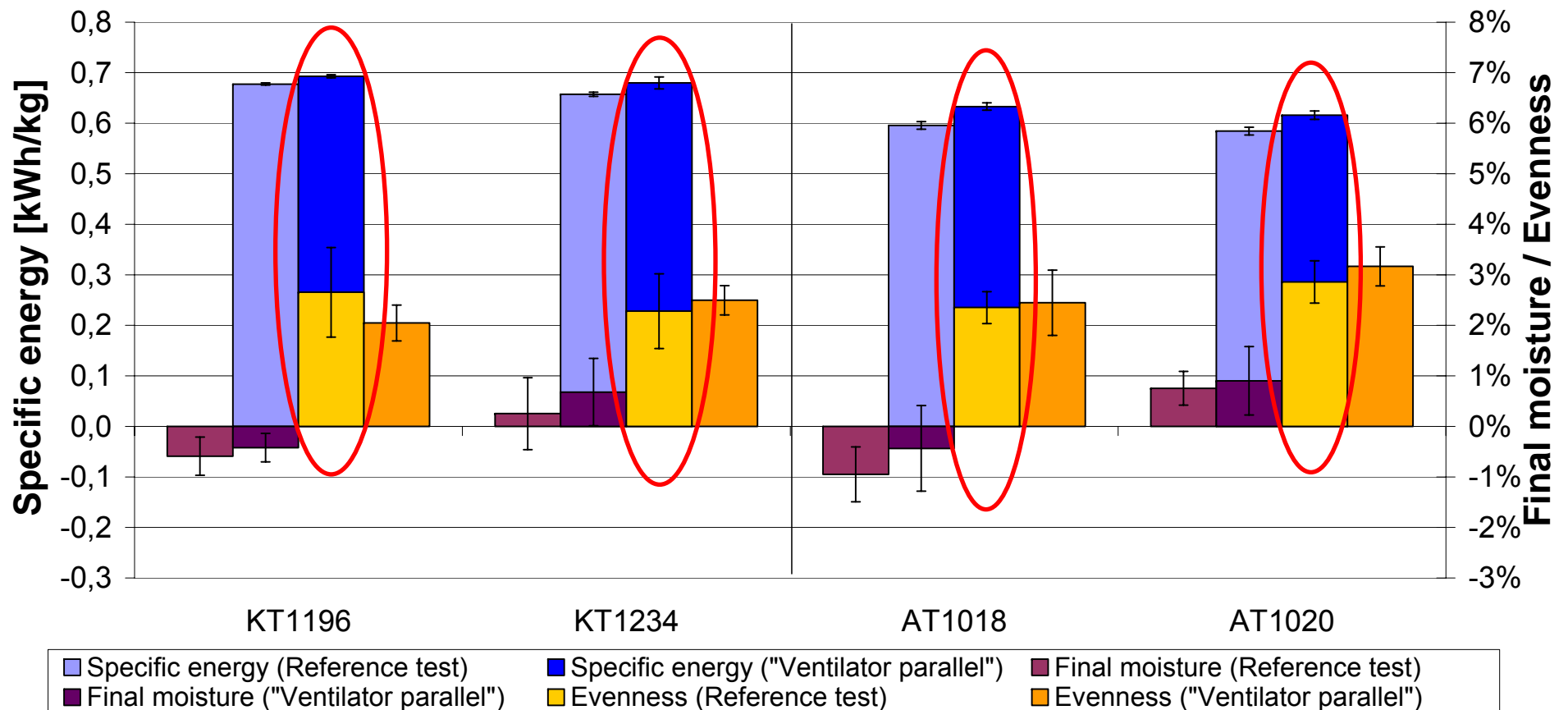


Black Box





Ventilator during drying process





Results of ambient conditions

- Some significant differences (specific energy) between using a black box and tests without it
 - Significant higher temperature in the lint filters
 - Many significant differences between cooling by a ventilator during the tests and significant lower temperatures in the lint filters
- Create ambient conditions for standard (continuative tests)



Evenness of drying

- No recommendation in EN 61121
- Possibility to use a plastic bag after drying (working praxis in some laboratories)



Results: Method of evenness

			\bar{x}	s
KT₁₂₃₄	without bag	Difference [g]	-29,7	6,0
		Difference [%]	-0,49%	0,10%
	with bag	Difference [g]	-22,4	2,1
		Difference [%]	-0,37%	0,03%
AT₁₀₂₀	without bag	Difference [g]	-15,9	16,5
		Difference [%]	-0,27%	0,28%
	with bag	Difference [g]	-11,5	4,4
		Difference [%]	-0,19%	0,07%



Conclusion

- The thesis gives advises for continuative tests and probable recommendations adding in the standard which have to be proved by other tests
 - Reduction of advised wetting time and water volume
 - Reduction of advised cooling time respectively cooling method
 - Create ambient conditions for standard (continuative tests)
 - No loading scheme necessary
 - Normative advice: loosen textiles before loading

It can be used as basic for other experiments.



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Thank you for your attention!

Are there any questions to discuss?

