# Sustainability in commercial laundering processes

Module 5

**Water and Energy Recycling**

Chapter 6

# Energy Recycling in Dryers

# Learning targets

- This chapter will provide you with a basic analysis and understanding of the laundry drying process
- This chapter will explain the differences and the relations between mechanical dewatering and thermal drying of laundry
- This chapter will provide you with best practices to optimize the mechanical dewatering of laundry
- This chapter will provide you with best practices to optimize the thermal drying of laundry
- The importance of a proper end-point determination will be enlightened in this chapter

## Content



- Introduction
- Analysis of drying process
- Energy-efficient dewatering
- Energy-efficient drying
- End-point determination
- Conclusions

# Introduction I



- General data regarding the energy consumption of the different processes in laundry processing in MJ of energy per kg of dry textile:

  - Washing open-end : 2,7 MJ/kg
  - Washing CBW : 1,8 MJ/kg
  - Tumble drying (Gas) : 2,7 MJ/kg
  - Tumble drying (Steam) : 4,7 MJ/kg
  - Ironing (Steam) : 4,5 MJ/kg
  - Tunnel Finisher (Gas) : 2,5 MJ/kg
  - Tunnel Finisher (Steam) : 3,0 MJ/kg

# Introduction II

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- Energy consumption of the drying process appears to be the major part of the total energy consumption of the laundry process

- These data also make clear that a major reduction of the energy consumption is possible by the replacement of steam heated drying equipment with gas heated drying equipment (as discussed in chapter 7)

# Analysis of Drying Process I

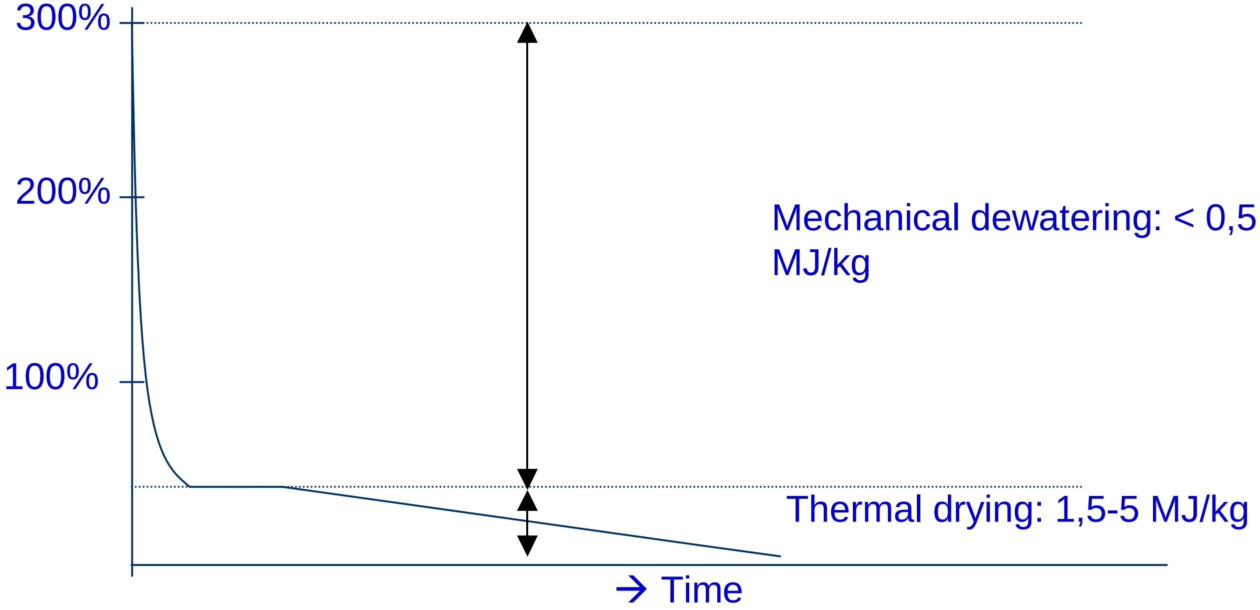


- The purpose of drying is to remove **excess (not all)** water from the textile products
  - ‘Dry’ cotton in standard conditions in equilibrium with the atmosphere still contains 6-8% water!
  - Drying to a lower water content has no use, as the dried textile will regain water from the atmosphere until equilibrium water content is reached

- Drying of laundry is a 2-stage process
  - Stage 1, mechanical dewatering
  - Stage 2, thermal drying

# Analysis of Drying Process II

- Energy consumption in the 2 stages of the drying process (residual moisture in mass % as a function of time)



# Analysis of drying process III



From this graph can be concluded:

- Mechanical dewatering
  - Fast, low level of energy consumption
- Thermal drying
  - Slow, high level of energy consumption

Conclusion :

- Optimization of the dewatering step is a very effective way to minimize the total energy consumption of the drying process

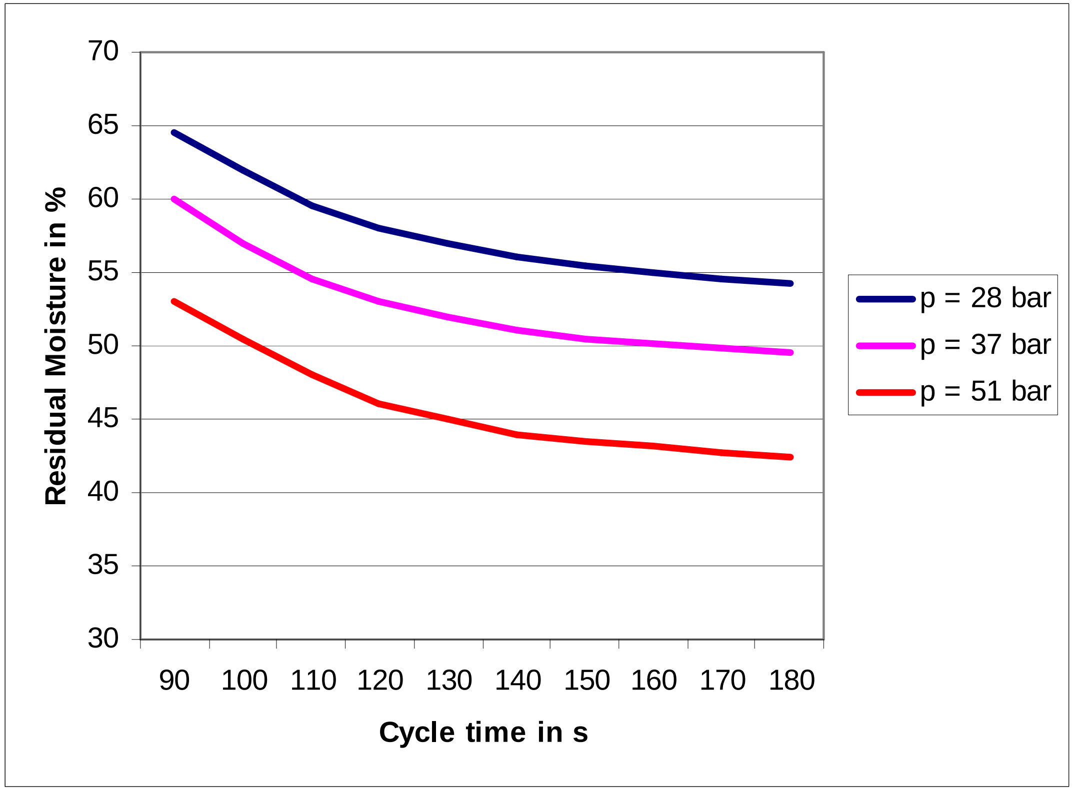
# Energy-efficient dewatering I



- The further analysis of the drying process will be limited to the efficient use of the dewatering press, the analysis of the centrifuge process will be comparable
- Processing variables of the dewatering press
  - Pressing time
  - Temperature of the rinsing water
  - Pressure
  - Textile product
- Processing variables of the centrifuge
  - Centrifuge time
  - Temperature of the rinsing water
  - Centrifuge Speed
  - Textile product
  - Machine load

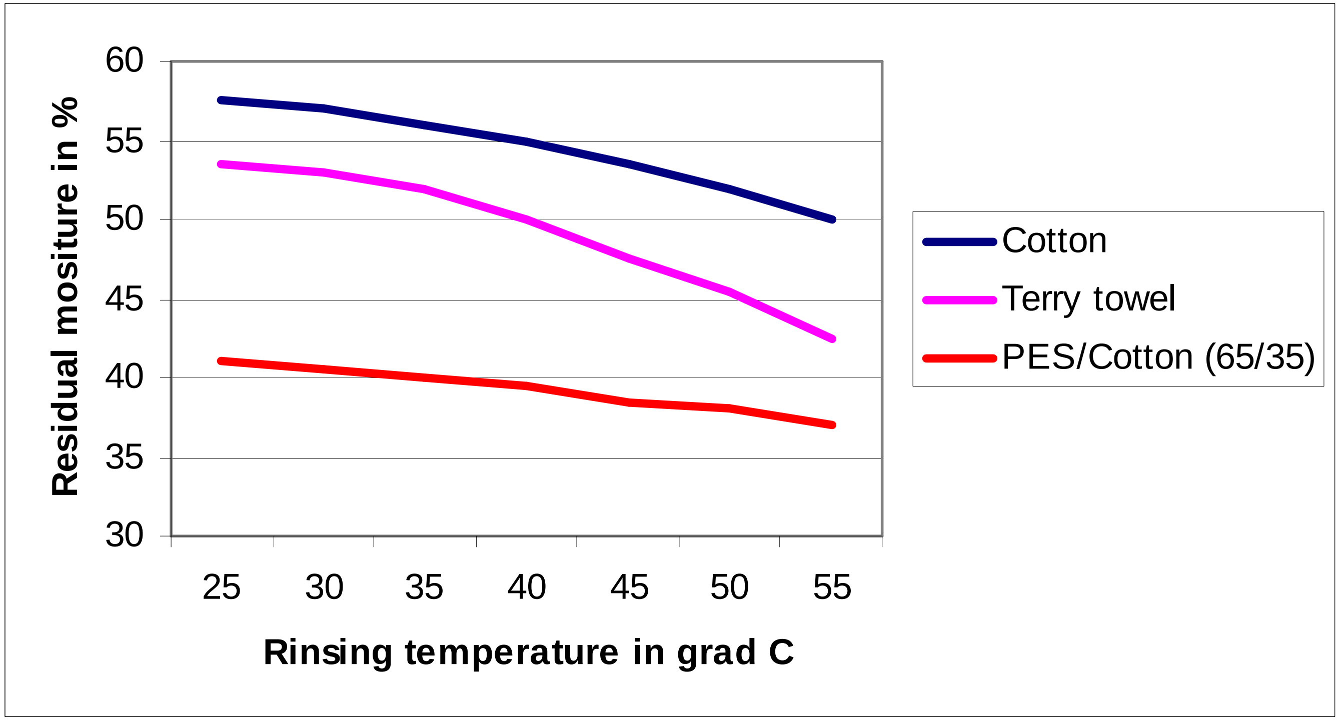
# Energy-efficient dewatering II

- Residual moisture (in mass %) as a function of pressing cycle time and pressure p



# Energy-efficient dewatering III

- Residual moisture (in mass %) as a function of the temperature of the rinsing water and the textile material



# Energy- efficient dewatering IV

From these graphs the following conclusions can be drawn:

Optimizing of the dewatering process is possible by :

- Applying maximum pressure, however the maximum pressure is not only a machine parameter, but also depends on the laundry type
- Using sufficient pressure time; however, extended pressure times have hardly any extra effect on residual moisture
  - Account for the time used to build up pressure
- Using high rinsing water temperatures, limitations of rinsing water temperature are connected to the applied washing process, the membrane of the press and the laundry type

# Energy-efficient drying I

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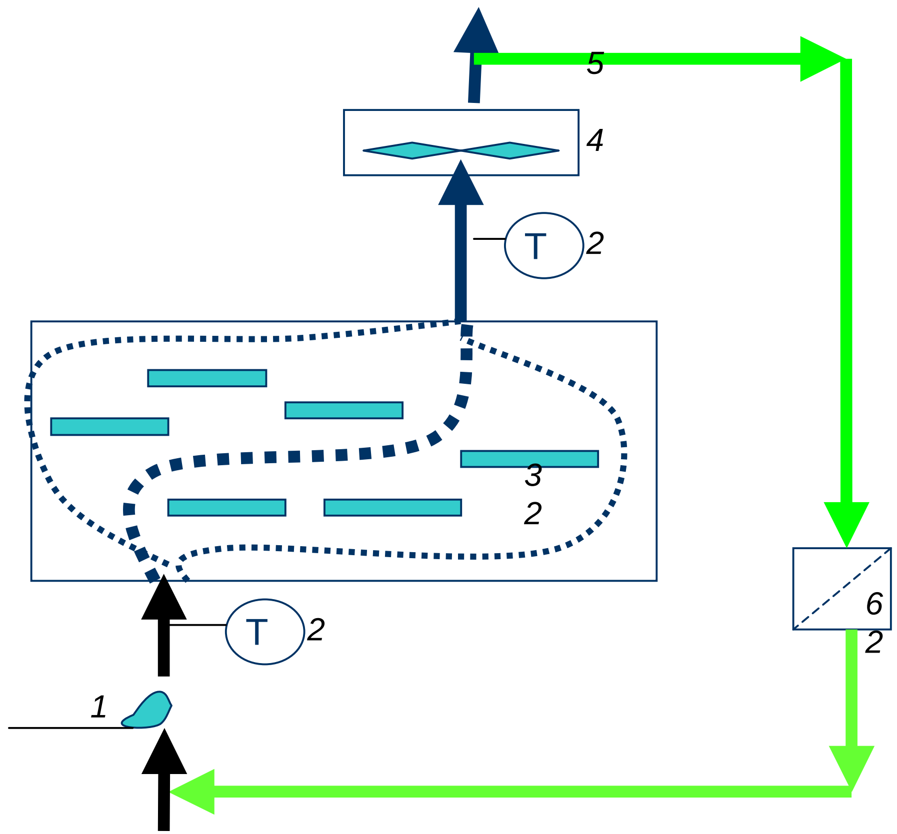
- Thermal drying is the removal of excess water by vaporisation, the heat required for vaporisation is transferred from hot air.
- The hot air can either be heated by steam of gas. From the point of energy consumption gas heated dryers are preferred.
- The content of the module will be limited to tumble dryers

# Energy-efficient drying II



Schematic view of a tumble dryer with recirculation of air:

1 = gas burner
2 = temperature control
3 = moving textile
4 = fan
5 = air recirculation
6 = filter



# Energy-efficient drying III

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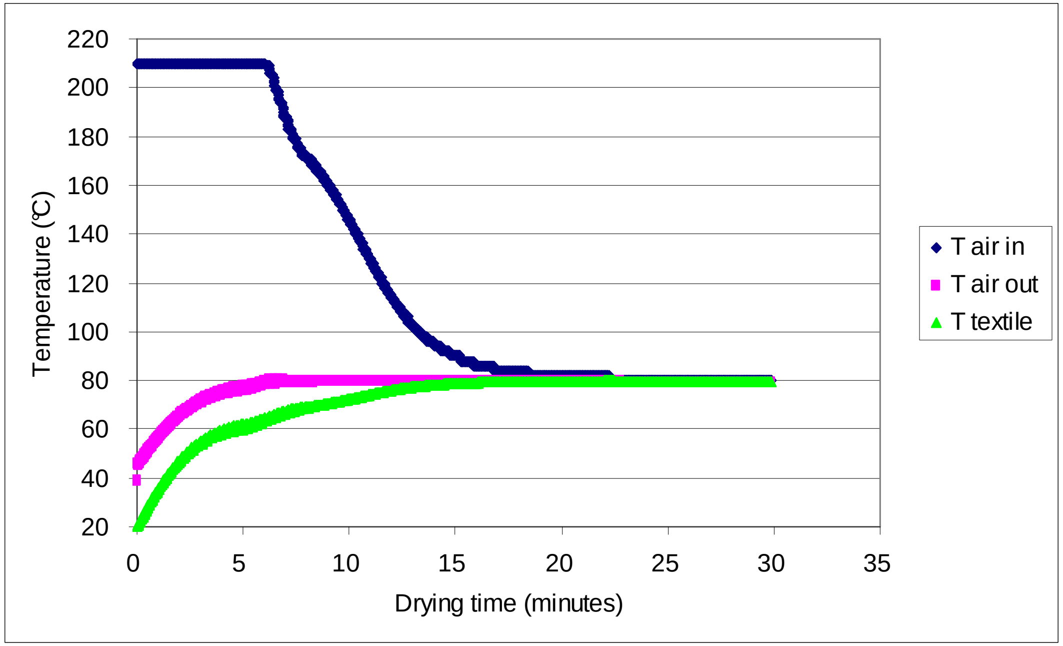
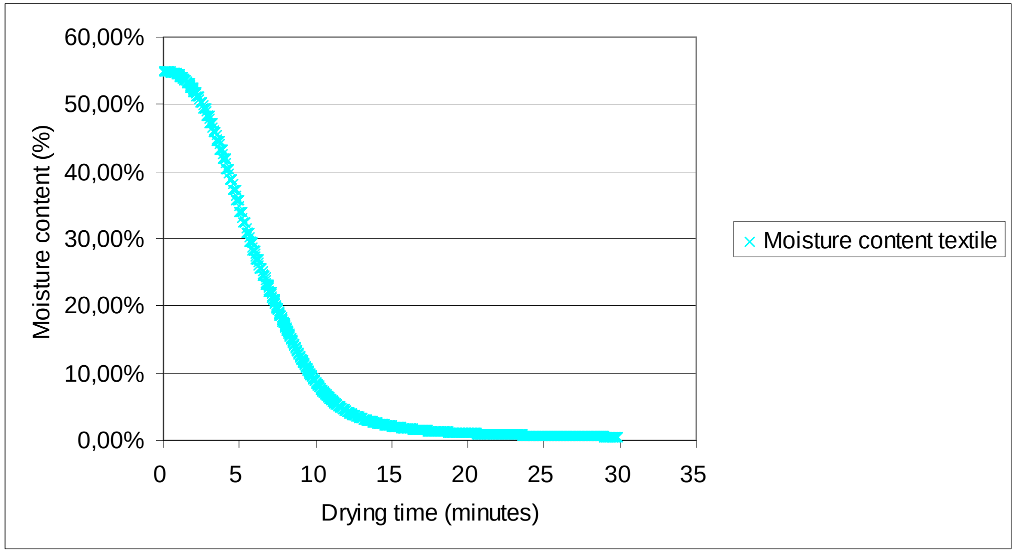
- Schematic representation of the temperatures of the incoming and outgoing air and textile temperature during the course of a typical drying process in a tumble dryer, note the low temperature of the textile at the beginning of the drying process



# Energy-efficient drying IV

- Schematic representation of the moisture content of the textile during the course of the same drying process



# Energy-efficient drying V



- Reducing energy consumption of drying process is possible by :
  - Air recirculation directly from the start of the process is recommendable to recycle hot air within the process
  - Fast heating-up of the process by a high temperature of the in-going air at the beginning of the process will shorten drying times and minimize energy consumption. Textile temperature is still low in this part of the drying process (see graph), so no textile damage will occur
  - Optimal textile movement in the drum by adapting drum movement to load to ensure optimal heat transfer
  - Optimal loading of the drum, avoid overloading but fill the machine to the optimum load
  - Optimal end-point determination to avoid both still wet laundry as a result of too short drying and over-drying by extended drying
  - Frequent cleaning of filter to enable optimal air recirculation

# End point determination I



- Drying process too short :
  - Laundry still wet
    - Extra drying step necessary which will increase the energy consumption lead to extra handling and labour costs and an unnecessary loss of production time

- Drying process too long
  - Laundry over-dried
    - Waste of drying energy
    - Unnecessary wear of laundry
    - Problems in the finishing department
  - Loss of production time

# End point determination II

- Several end point determination methods are available on the market:

  - Methods based on air temperature control
    - Temperature of the ingoing and out-coming air
    - Temperature difference between the ingoing and out-coming air
  - Fixed drying time per article
  - IR measurement of laundry temperature

- All methods are in principle well suitable for the end-point determination at a constant load of the dryer

- Problems arise when the machine load is varied, often leading to laundry coming out of the dryer which is still wet

# Conclusions



- Energy consumption of the drying process can be optimized by:

  - The application of gas-heated equipment
  - Optimization of mechanical dewatering
  - Optimal machine loading for the thermal drying process
  - Recirculation of hot air in the thermal drying process
  - Optimal end-point determination in the thermal drying process to avoid over-drying and a too short drying process