

Sustainability in commercial laundering processes

Module 1 Usage of water

Chapter 2

Use of water for washing

- Types of water supply in laundries

- General effects on water consumption
 - liquor ratio/total liquor
 - rinsing
 - types of washing machines
 - types of textiles

- Usage of water in tunnel washers
 - bath flow principle
 - counter current flow
 - bath exchange
 - re-use of water

Learning targets

After finishing this chapter, you will

- know and be able to refer the different types of water supply in laundries
- know influencing factors on water consumption
- know the effects of washing liquor and liquor ratio on washing process
- know how to calculate the liquor ratio
- be acquainted with application of water flow in tunnel washers
- have taken note of the possibility of water re-use in washer extractors

- **Municipal supply**
 - fresh water prepared by community (general supply)

- **Self supply by usage of**
 - fresh water taken from wells, springs, rivers and rain water
mainly has to be pre-treated before application in laundry

Types of water supply

municipal supply

■ Advantages

- simple
- without risks
- no special treatment necessary
- Last point deleted

■ Disadvantages

- expensive
(costs for supply and for discharge in municipal sewage system)
- only economical if fresh water and effluent water charges are at a low level

Types of water supply

self supply



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■ Advantages

- lower price or free of charge
- usage without treatment in non hygienic sensible processes only (washing of wiping cloths, mats)
- often economical if high fresh water costs are high

■ Disadvantages

- risks in presence of heavy metals, germs or other hazardous substances
- treatment often necessary
- therefore special facilities/devices are needed (wells, tanks, pipe systems, analytical installations to control water quality, treatment facilities)

General effects on water consumption

- **Washing machine**
(washer extractor/batch washer, tunnel washer, see module 3)
 - design of wash programliquor ratio (chart no. 9) affects mechanical action (water flow through textiles, swimming, falling) during washing and rinse phase
- **Textile** (wool, silk, cotton, PES, blended fabric)
 - water uptake of load depends on type of fibre, textile construction and age of textile
 - water uptake affects liquor ratio
(liquor ratio: see water demand for different laundry, chart no.12)
 - lint generation caused by low water level
- **Type and amount of soil**
- **Application** (of textiles)
 - e.g. textiles for medical use and clean room garments need good rinse efficiency → high water consumption as consequence

- Rinsing needs highest amount of water during wash process

- Fresh water is used for rinse step (independent of machine type)

- Reasons
 - Rinse determines kind and amount of residuals on laundry
 - Residuals may cause different problems, e.g.
 - skin irritation
 - unacceptable appearance of laundry
 - ironing problems at mangles

- **Liquor ratio**

$$\textit{Liquor ratio} = \frac{\text{water volume in drum [l]}}{\text{dry load [kg]}}$$

- **Example:**

10 kg cotton load need 40 l of water.

Liquor ratio is 40 l/10 kg = 4 l/kg

the commonly used notation is 1:4

- Liquor ratio depends on kind of washing machine and textile
- Common liquor ratio of 5 l/kg shows good wash performance

Liquor ratio determines

- Movement of load
- Water flow through and along textiles
- Swimming of load
- Falling intensity of load
- Heating up rate
- Concentration of detergent
- Intensity of soil removal and textile damage
- Rinsing efficiency
- Consumption of water and electricity

Bound liquor, examples



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Examples for bound liquor per kg dry textile

| Kind of textile | Bound liquor per kg dry textile in l/kg |
|-----------------|---|
| Cotton | 2,5 |
| Terry materials | 4 |
| Blended fabric | 1,5-2 |

Total liquor, examples



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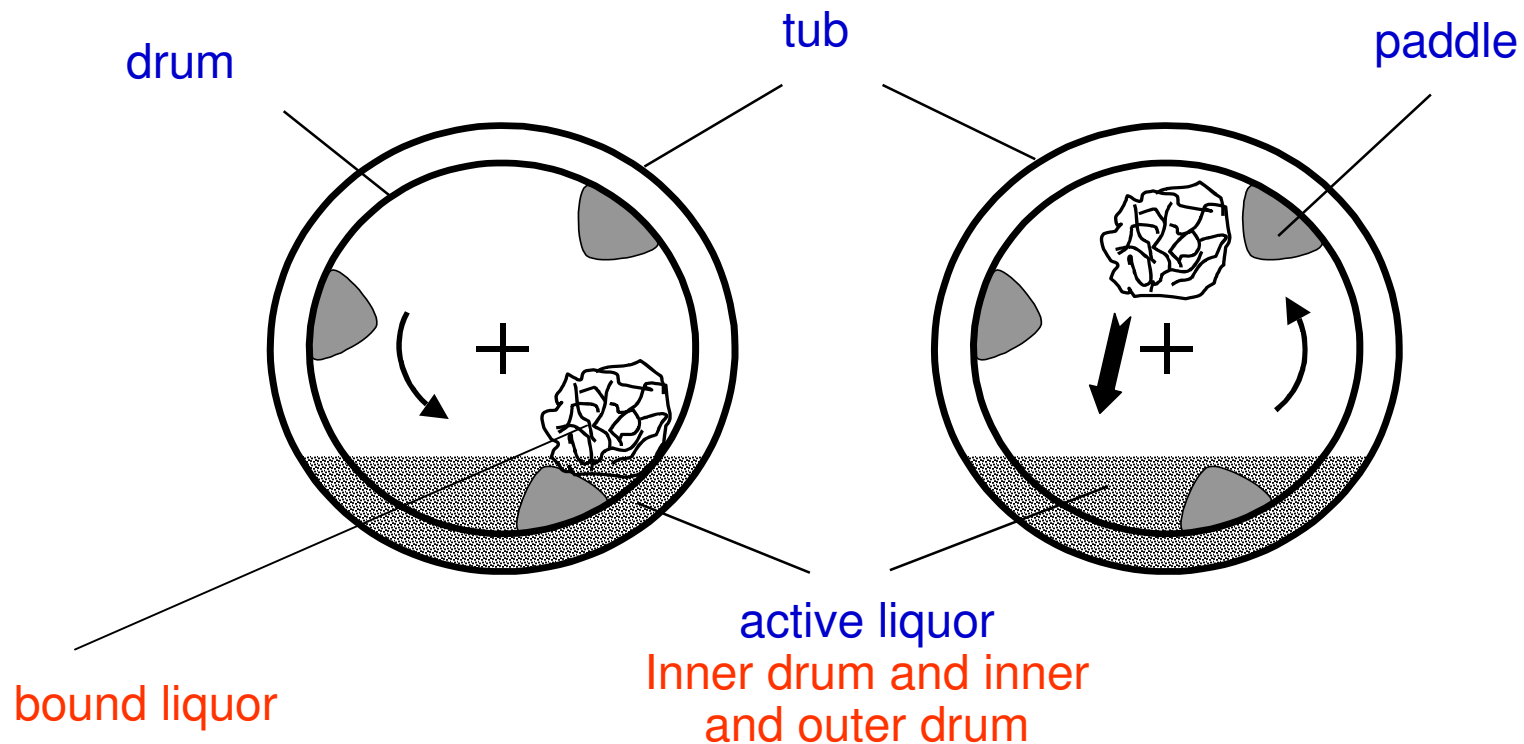
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Examples for total liquor

| Kind of textile | Active liquor in l/kg (wash liquor in drum) | Total liquor in l/kg (wash liquor in drum and space between drum and tub) |
|-------------------------------|--|--|
| Cotton | 2 – 3 | 3 - 5 |
| Blended fabrics, easy care | 3 – 5 | 5 – 8 |
| Sensitive materials | 15 – 20 | 15 – 30 |

Washing liquor: definitions

Total liquor = bound liquor (by textile) + active liquor



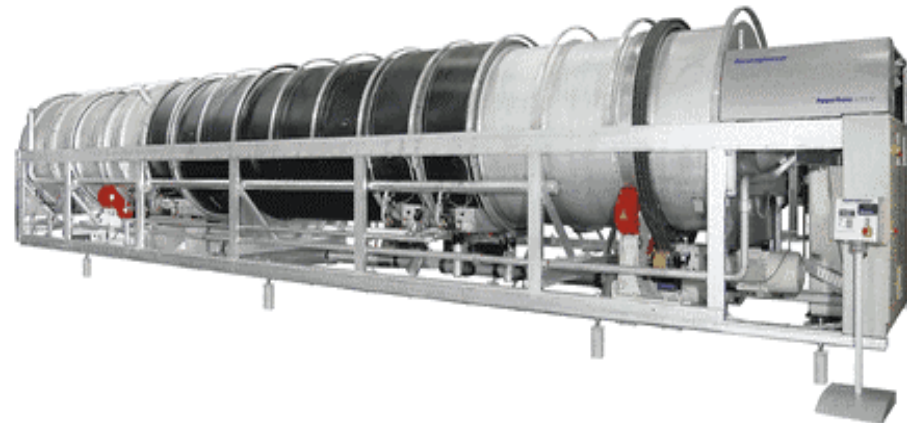
Common water consumptions

... in a washer extractor



20 – 30 l/kg dry textile

... in a tunnel washer



4 - 10 l/kg dry textile

Fresh water demand for washing

Fresh water inlet for conventional washing program:

| | |
|-----------|------------------|
| Pre wash | e.g. 250 l |
| Main wash | 180 l |
| rinses | 600 l (3X 200 l) |
| total | 1030 l |

⇒ specific water consumption if values are related to 50 kg load size (water consumption/kg dry textile)

$$1030 \text{ l} / 50 \text{ kg} = 20,6 \text{ l/kg}$$

... for different kind of textiles

| Kind of textile | Water consumption in l/kg |
|---------------------------------|---------------------------|
| OP theatre, clean room garments | 10 to 20 |
| Dark garments | 8 to 25 |
| White garments | 7 to 12 |
| Mats | 5 to 10 |
| Terry towels | 4,5 to 10 |
| Hotel linen | 4 to 10 |

Usage of water in tunnel washers

bath flow principle

- **Copy-paste from chart 20:**
- Continuous bath flow is applied
 - Using counter current flow
 - Using standing bath (water flow in parallel to load transportation)
- In a tunnel washer
 - Continuous flow of water into compartments during wash and rinse
- In a washer extractor
 - Only at start of wash step water is running into drum

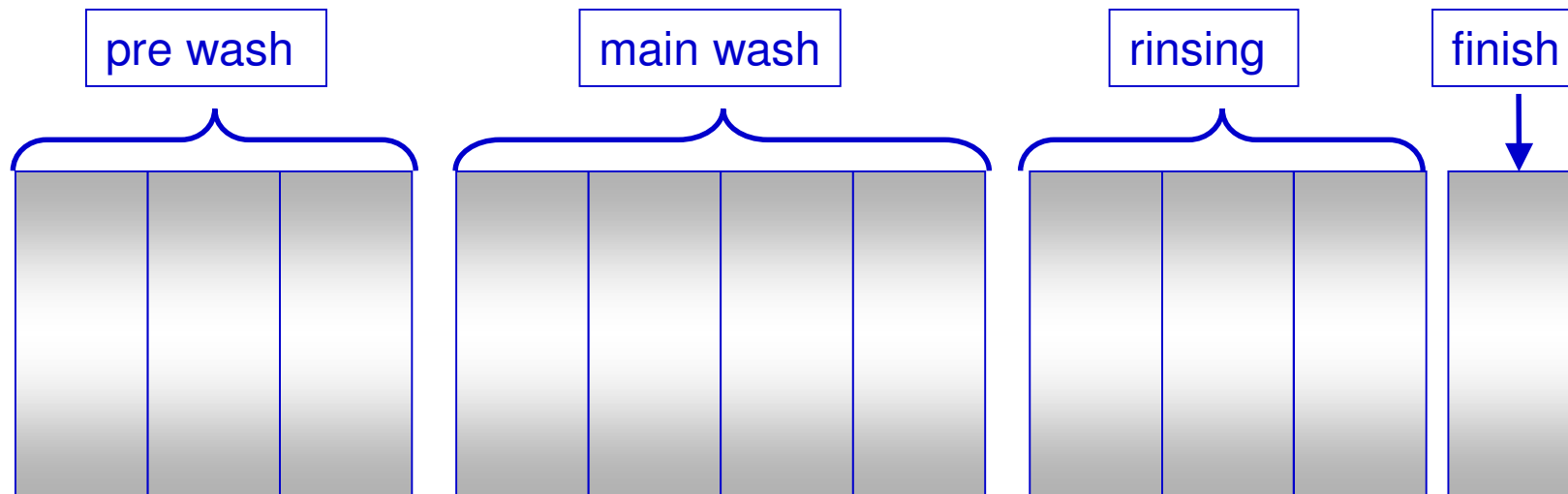
- Tunnel washers are divided into the following zones according to a common wash program, also see module 2 and 3
 - Pre wash
 - Main wash
 - Rinse
 - Finishing (e.g. softener, starch)

- Different ways of water application exist in total tunnel washer or separated zones (see module 2 and 3)
 - Counter current flow
 - Standing bath
 - Bath exchange

Usage of water in tunnel washers

principle

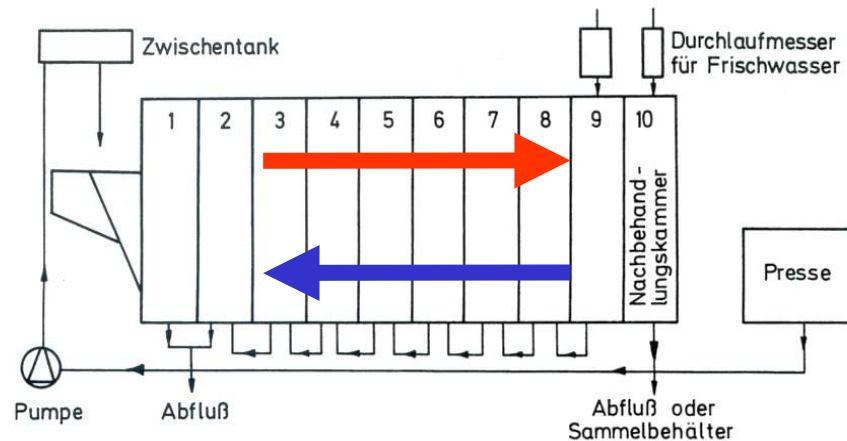
- Load is transported stepwise from compartment to compartment
 - ⇒ Tunnel consists of compartments
 - ⇒ Single compartments are combined to zones



Usage of water in tunnel washers

counter flow

- Copy-pasted from chart 22
- Counter flow means
 - Water used in the last compartment (e.g. number 10) is reused in compartment 9
 - Water used in compartment 9 is reused in compartment 8
 - Water used in compartment 8 is reused in compartment 7
 - And so on...



⇒ It is therefore a process with low water consumption

Usage of water in tunnel washers

counter flow



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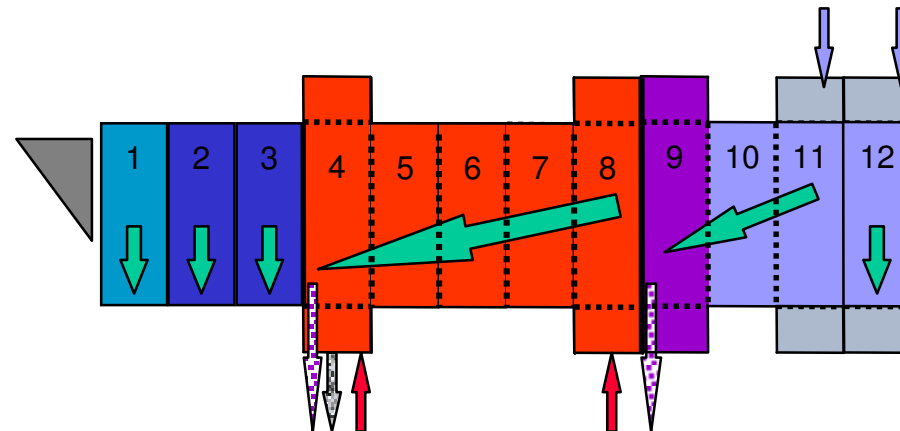
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- copy-paste from chart 23
- Problematically:
 - Concentration of detergent in wash liquor is continuously diluted
 - It is not possible to apply different water levels (liquor ratios) in compartments within one zone
 - Hence no more application of one counter flow in relation to the whole tunnel washer

Usage of water in tunnel washers

counter flow

- **2 counter flows**
- Once in rinse, once in main wash



- pre wash: in parallel to laundry
- re-use of 2/3rds of extracted water in pre wash
- use of 1/3rd of rinse in main wash

Usage of water in tunnel washers

counter flow

- Fresh water is used for rinse (compartment 11)
- Rinse water is drained in compartment 9
- Part (1/3) of the rinse water is used for main wash in compartment 8
- 2/3rds of rinse water is used for pre wash in compartment 1
- Main wash water is drained in compartment 4 into sewage
- Pre wash water is transferred from compartment 1 in parallel to load
- Water from rinse zone (compartment 9) and press water (mechanical extraction in press or centrifuge) is transferred into pre wash (compartment 1)
 - if this is not sufficient: fresh water supply

- Continuous bath flow application
 - In counter current flow
 - Water flow parallel to load transportation

- Flow means
 - Continuous flow of water into compartment during the whole wash or rinse step

 - ⇒ Contrary to common washing in a washer extractor
 - only at the start of the wash step water is running into the drum

- Bath exchange means
 - **Start of the wash duration:** in a single compartment or a zone water is added
 - **End of wash duration:** water in compartment is drained
 - **Fresh water feed**
 - If drained water is not re-used, bath exchange is more expensive than counter current flow

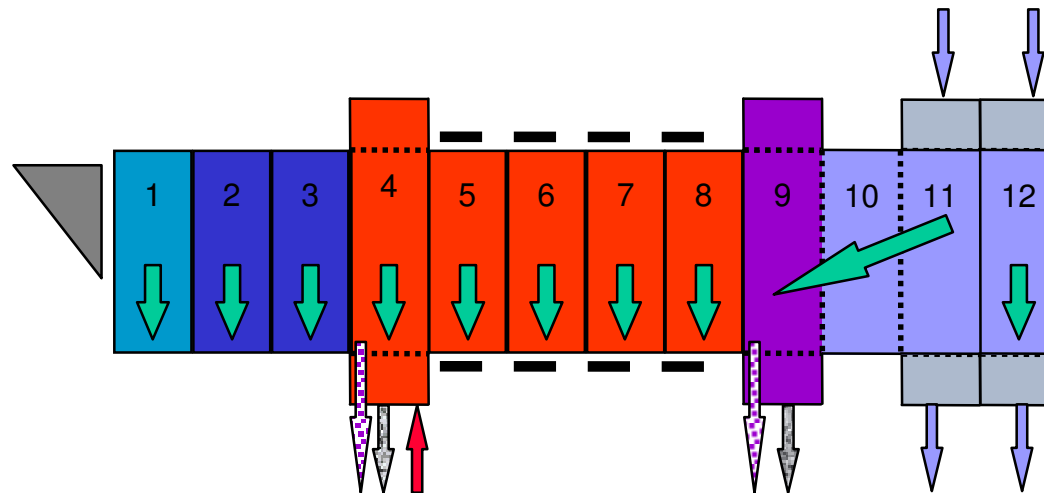
- **Bath exchange**
 - To remove soil load (end of wash/beginning of main wash)
 - To drain alkalinity (end of main wash/beginning of rinse)

- **Applying bath exchange,**
 - water is drained and
 - water has to be renewed
 - if no re-use of drained water, it is more expensive than counter current flow
 - no exchange of water between neighbouring compartments
 - therefore possibility of washing different types of laundry within one zone
 - no transfer of lints and/or dye pigments from coloured laundry to white/light laundry
 - example:
 - compartment 5: blue garments
 - compartment 6: white garments
 - compartment 7: green linen

Counter current flow with bath exchange

Combination example

Rinse (compartment 11 to 9): counter current flow), at the **start of rinse** in compartment 9 part of the water is drained (bath exchange)



At the start of **main wash** in compartment 4 part of the water is drained (bath exchange)

- Part of rinse water is used for main wash in compartment 4 and remains in compartment 4 during the whole main wash
- see module 2 and/or 3

- Washer extractor
 - last rinse for pre-/main wash (explained in module 2 and 3)
 - Need of devices/tanks to collect water

- Tunnel washer
 - counter flow, re-use of press water
 - See chart 17-20 and module 2/3

- Whole laundry
 - „cascade system“
 - drain water from hotel laundry is used for garments (garage overalls), drain water from garments laundry is used for mat washing
 - Application of rinsing water of hygienic sensible laundry in pre- and main wash of hygienic non-sensitive laundry
 - (see module 3)

Water recycling

- Is only economical if fresh water and/ or effluent water charges are at high level
- Need of additional complex facilities and expensive equipment (different tanks, pipe system, heating/cooling facilities, pumps, installed devices for controlling of water quality, etc.)
- Risky if water contains special ingredients
 - heavy metals, germs or other hazardous substances
 - see module 6