Distillation and evaporation in general

- Distillation/evaporation processes:
  - Separate or undilute solutions (mixtures) based on the different volatilities of the components

- Limit of atmospheric operation:
  - thermal sensitivity, decomposition under boiling temperature

- Solution:
  - different kinds of vacuum distillation
“Evolution steps” of vacuum distillers, evaporators

- **Batch vacuum distillation**
  - Distillation below 1 mbar
  - Low temperature: gentle handling (max. 250 °C)
  - No thermal decomposition

- **Falling film evaporator**
  - Vertical, polished evaporator surface
  - Internal cooler
  - Roller wiper
  - Expensive technique

- **Wiped film evaporators**
“Evolution steps” of vacuum distillers, evaporators

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- Wiped film evaporators

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Roller-wiper system

- Vertical and horizontal mixing
- Very thin film (<1 mm)
  - Optimal heat transfer
- Low mechanical gear (lightweight)
- Material
  - Fiber-glass reinforced PTFE
  - Graphite
- Self-cleaning ability

Heating, cooling

- Use of preheater
- Heat recovery?
- External steam-heated coat (Thermal sheet)
- Heated pumps and product outlets
The condenser

- Main part of vacuum formation (regulation)
- Condensation just above melting temperature
- Theoretical optimum not feasible
- Problem of freezing product: multiple parallel evaporators
- Leakage

Vacuum system

- Only to evacuate non condensable gases
- Generally consists of Roots-blowers and diffusion pumps
Scale up process steps:

**Laboratory**
- After computer simulation
- Borosilicate glass
- Visual observation
- Feasibility studies
- 0.02 m² evaporator surface
- 0.1-0.8 kg/h feed rate
- Computer aided

**Pilot**
- Stainless steel
- 0.06 m² evaporator surface
- Feed rate: 3-9 kg/h
- Often took over by manufacturer

**Industrial:**
- Residence time: maximum 20 s
- Evaporator surface: 50 m²
- 11.6 m high 2 m diameter
- 5000 kg/h capacity
Scale up - Laboratory

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- Stainless steel
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**Industrial:**
- Residence time: maximum 20 s
- Evaporator surface: 50 m²
- 11.6 m high 2 m diameter
- 5000 kg/h capacity
Scale up – big industrial

- Residence time: maximum 20 s
- Evaporator surface: 0,3-50 m²
- 11,6 m high 2 m diameter
- 30-5000 kg/h capacity
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<th>Film evaporator</th>
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<td>Pressure (Pa)</td>
<td>$10^5$</td>
<td>$10^3$</td>
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<td>Residence time (s)</td>
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<td>3000</td>
<td>25</td>
<td>10</td>
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