

# EVAPORATING EQUIPMENT OF NPP

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# Purpose of evaporating unit

1. Production of additional water
2. Generation of steam (for 1-circuit NPP):
  1. For turbine sealing;
  2. For ejecting units;
  3. For heating steam into special water treatment system;
3. For special water treatment of:
  1. Blowdown water of the first circuit;
  2. Radioactive water of stand-by reservoirs;
  3. Excess water;
  4. Water for sanitary purposes.

# Principle of action

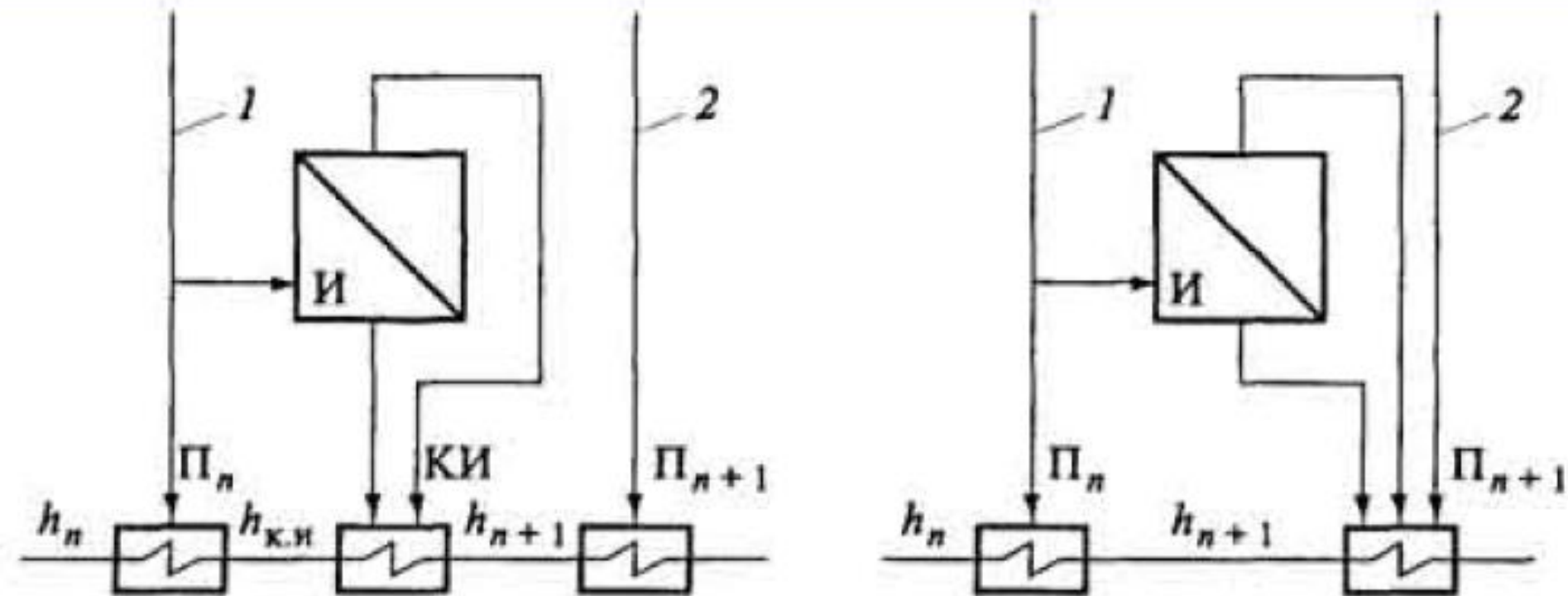
- The deaeration principle is applied during exploitation of evaporating unit: the impurities (even radioactive) don't dissolve into liquid phase.
- As the result the main purpose of evaporation is following:
  - **REMOVAL OF SOLID RADIOACTIVE AND NON-RADIOACTIVE IMPURITIES FROM WATER.**
- The following schemes are used:
  - One-stage;
  - Multi-stage.

# One-stage evaporator

- One-stage evaporators are heated by low-pressure steam.
- Such scheme is applied for:
  - Cleansing of radioactive blowdown water;
  - Treatment of water of stand-by reservoirs;
  - Processing water for sanitary purposes;
  - Deactivating of other radioactive water.
- Condensate of secondary water is accumulated into special tanks and applied for NPP purposes.

# Schemes of one-stage evaporator integration into NPP

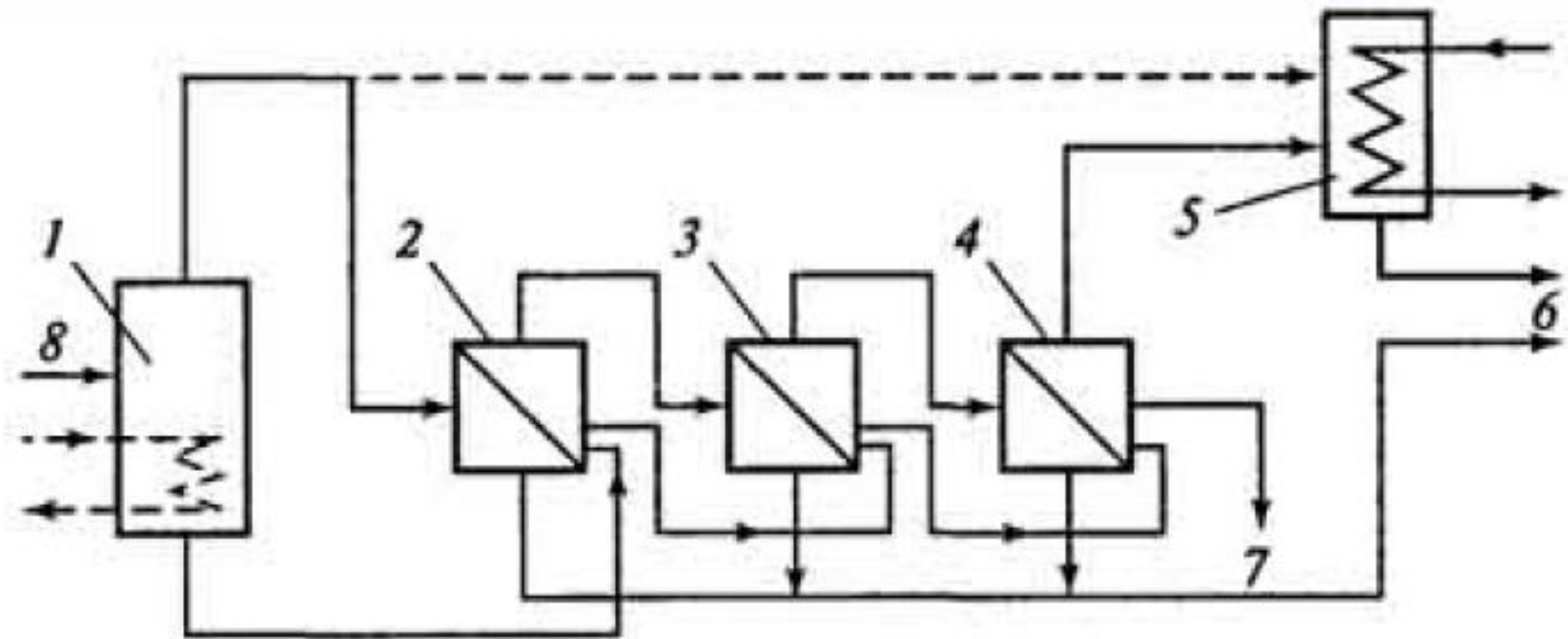
- Schemes of one-stage evaporator:
  - With separate regenerative heater;
  - With combined previous regenerative heater.



# Multi-stage evaporator

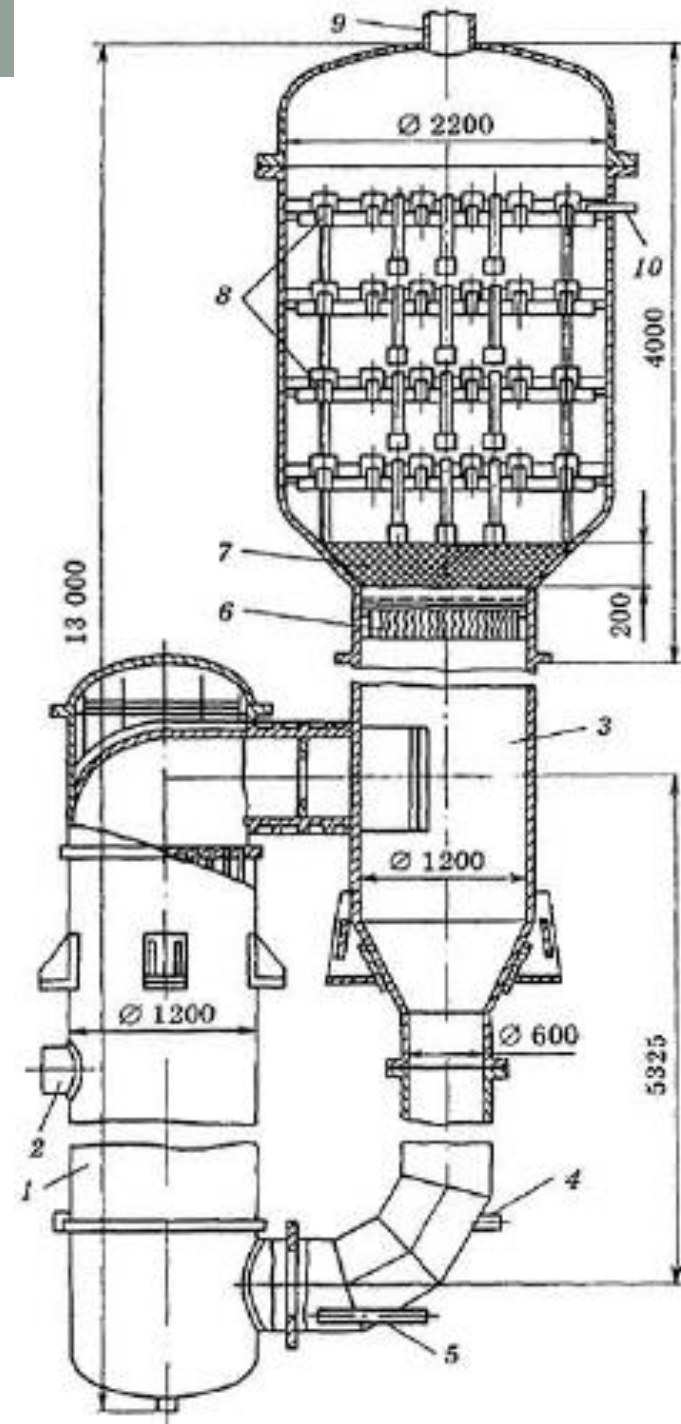
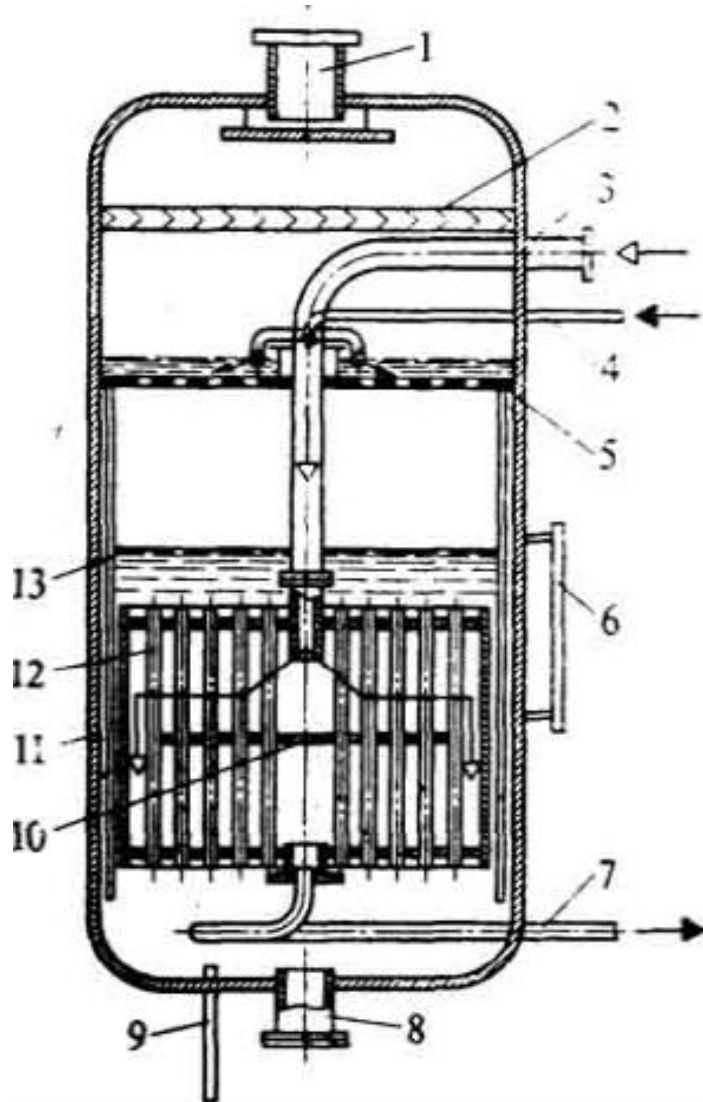
- The most usual application is treatment of blowdown water from steam generator. The main reason: high enthalpy of blowdown water from steam generator.
- Multi-stage evaporator scheme is realized as follows:
  - Blowdown water is directed into expander then – into evaporator;
  - Steam from expander is used as the heating steam into the first stage of evaporating unit;
  - Blowdown water of the last stage is directed into aux evaporator;
  - Residual water is utilized into hermetic reservoir and to chemical treatment.

# Scheme of evaporating unit for regeneration of blowdown water





# Construction of evaporating unit



# Calculation of evaporating unit

- The purpose of evaporating unit calculation:

- Defining heating steam flow rate:

This stage is realized using thermal balance equation of evaporator:

$$D \cdot (h'' - h_{in}) = D_{hs} (h_i - h')$$

- Defining needed percentage of blowdown:

This stage is realized using material balance equation of evaporator:

$$p = \frac{C_{fw}}{(C_c - C_{fw})} \cdot 100\%$$

$C_c$  - concentration of impurities into removed blowdown;

$C_{fw}$  - concentration of impurities into feed water.

$C_c = 40000-60000$  mg/kg – allows to obtain feed water and steam with high quality.