III. Water Treatment
Topic III. 2. Coagulants and Flocculants. Coagulation Processes: Kinds and Application

Coagulants

- Aluminium sulphate - $Al_2(SO_4)_3.18H_2O$
- Iron sulphate - $FeSO_4.\ 7H_2O$
- Iron chloride - $FeCl_3$

Flocculants

- Activated silicon acid (ASA) - Na_2SiO_3
- Polyacrylammid (PAA)
- Other synthetic polymers

Dozes of Coagulants and Flocculants

Doze of Coagulants - D_c

$$D_c = 4\sqrt{C} \text{ , mg/l}$$

where *C* is water colour grade, *grad* (*Pt-Co* scale)

Doze of the Alkalinity Regulation Reagent - D_A

$$D_A = k(\frac{D_c}{E} - A + 1) \text{ , mg/l}$$

where *E* is equivalent mass of the dry reagent, *mg-eq/l*

A - alkalinity, *mg-eq/l*

Dozes of Coagulants and Flocculants

Dozes of Coagulants

Suspended solids *mg/l*	Doze of coagulant *mg/l*
up to 100	25 - 35
101 - 200	30 - 45
201 - 400	40 - 60
401 - 600	45 - 70
601 - 800	55 - 80
801 - 1000	60 - 90
1001 - 1400	65 - 105
1401 - 1800	75 - 115
2801 - 2200	80 - 125
2201 - 2500	90 - 130

Dozes of Coagulants and Flocculants

Dozes of Flocculants

a) Before settlers or clarifiers

Suspended solids *mg/l*	Dozes of floculant PAA *mg/l*
1000 - 500	1,0 - 0,2
500 - 100	0,5 - 0,25
100 - 10	0,8 - 0,4
10	2,0 - 1,0

b) Before high rate send filters

50	0,01 - 0,1

c) Before contact (send) clarifiers

150	0,2 - 0,6

Coagulation Processes

Hydrolysis and Flocs Formation

$$Al_2(SO_4)_3 \leftrightarrow 2Al^{+3} + 3SO_4^{-2}$$

$$Al^{+3} + H_2O \leftrightarrow Al(OH)^{+2} + H^+$$

$$H^+ + HCO_3^- \leftrightarrow H_2CO_3 \leftrightarrow H_2O + CO_2$$

Technological Processes with Coagulation

- Diffuse coagulation (flocs, suspended in the water volume)
- Contact coagulation (on the pollutants suspended particles)
- Adsorption (on the send particles)

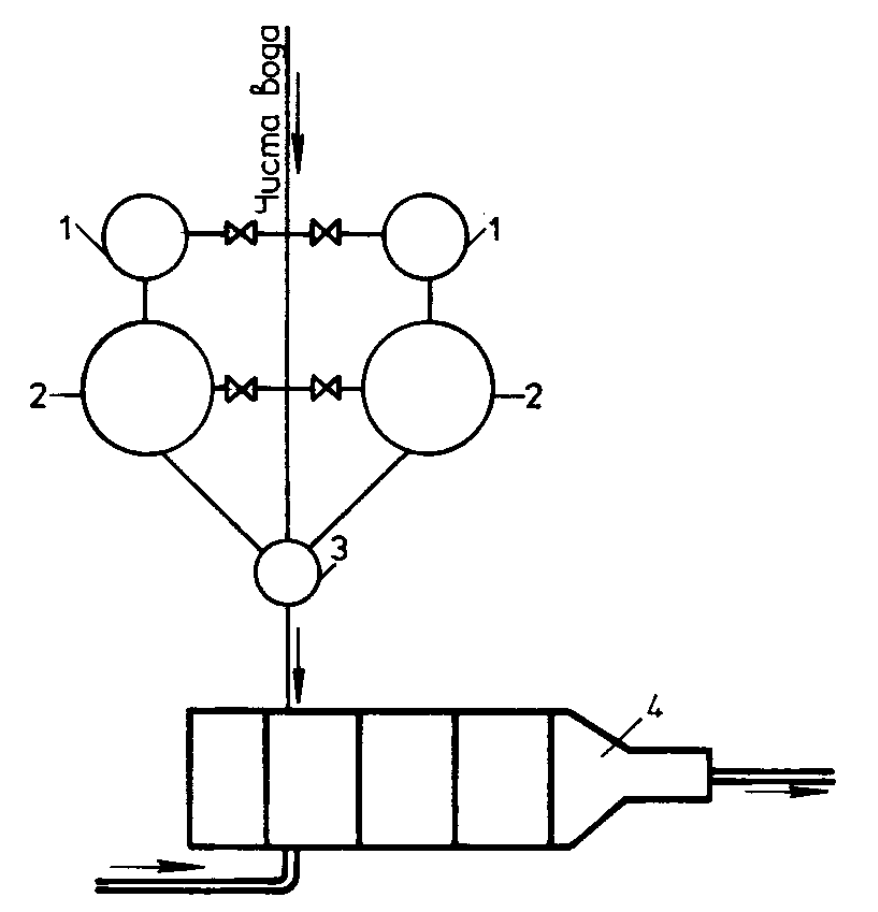
Technological Units with Coagulation

- Settlers
- High rate send filters
- Contact (send) clarifiers
- Upflow sludge blanket clarifiers

Reagents Management Units

- For reagents keeping
  - As dry substances
  - As concentrated solutions
- For reagents solution preparing
- For reagents dozing
  - Dry reagents dozing
  - Reagents solutions dozing
- For reagents and water mixing
  - Eddy type
  - With baffles
  - With propellers
  - With aeration

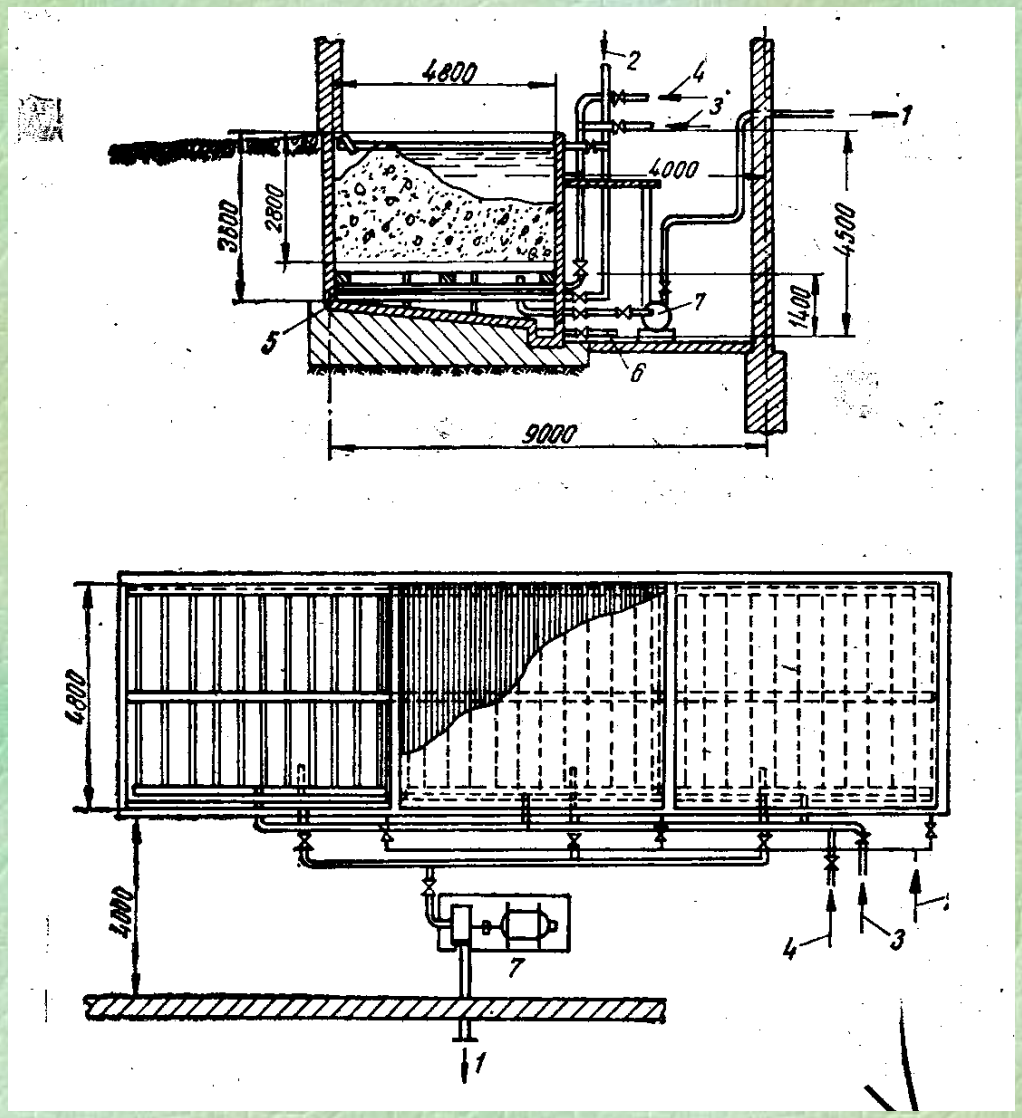
Reagents Management Units



General Reagents Management Scheme

1 - vessels for concentrated reagents solution (for reagents keeping); 2 - Vessels for diluted (working) reagents solution; 3 - dozing facility; 4 - mixing chamber

Reagents Management Units



Facility for Concentrated Reagent Solution Preparing and Keeping

1 - solution of aluminium sulphate

2 - air

3 - water

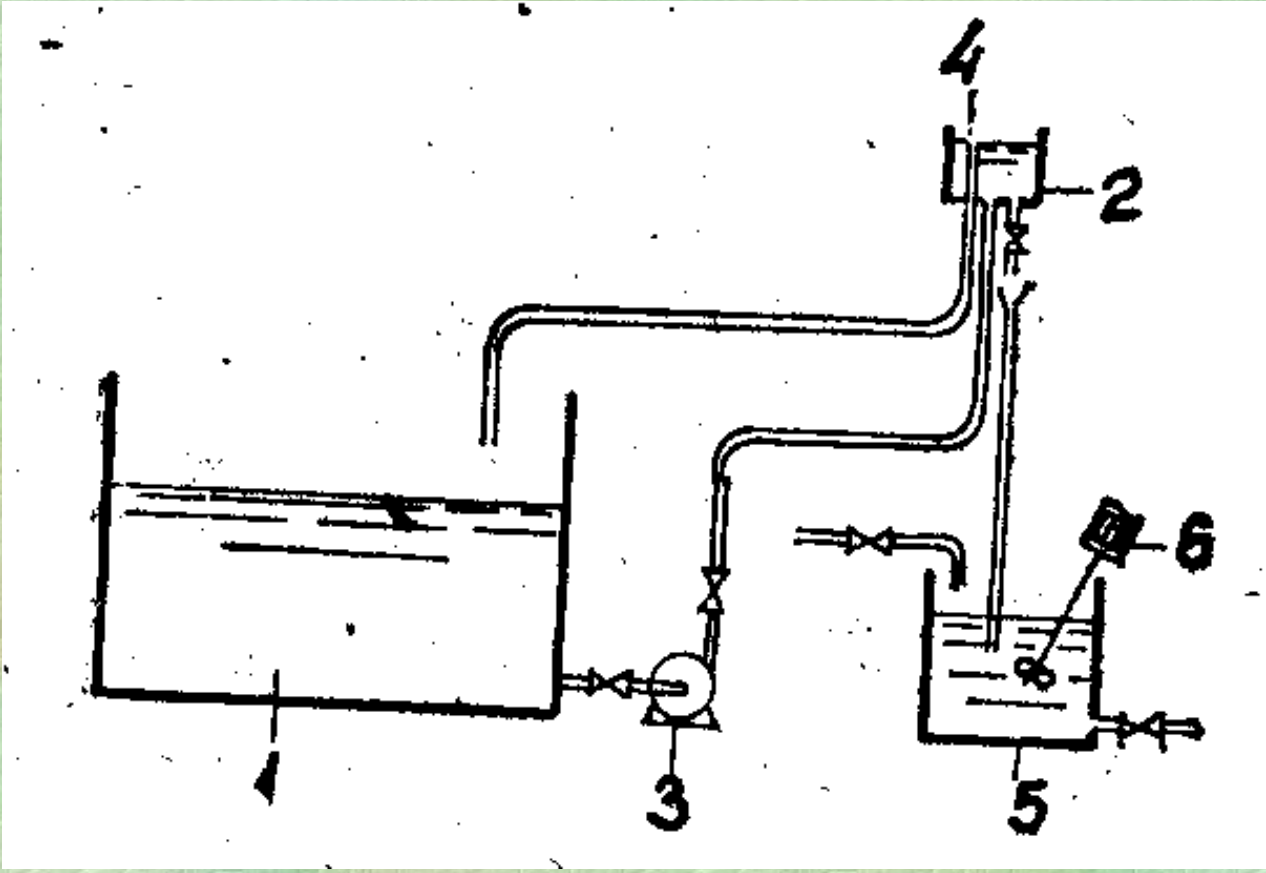
4 - steam

5 - washout water

6 - sediments (sludge)

7 - acid-proved pump

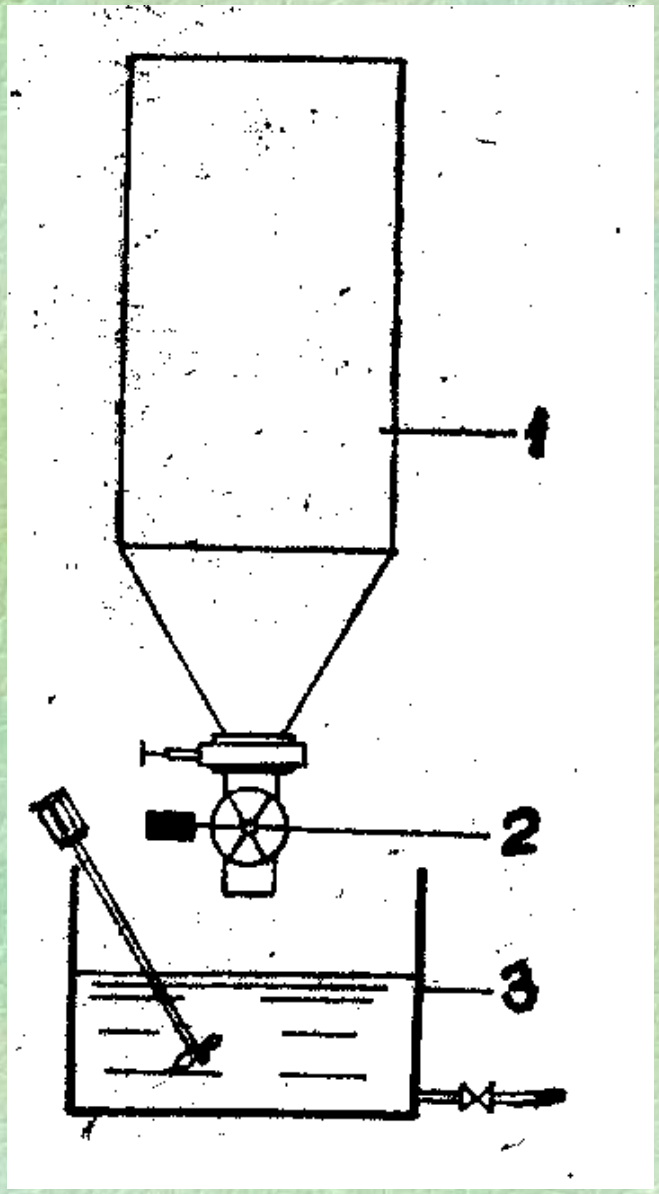
Reagents Management Units



Preparing of Diluted (Working) Reagent Solution from Concentrated Reagent Solution

1 - reservoir for concentrated reagent solution; 2 - dozing vessel; 3 - pump; 4 - overflow pipe; 5 - mixing chamber; 6 - propeller mixer

Reagents Management Units



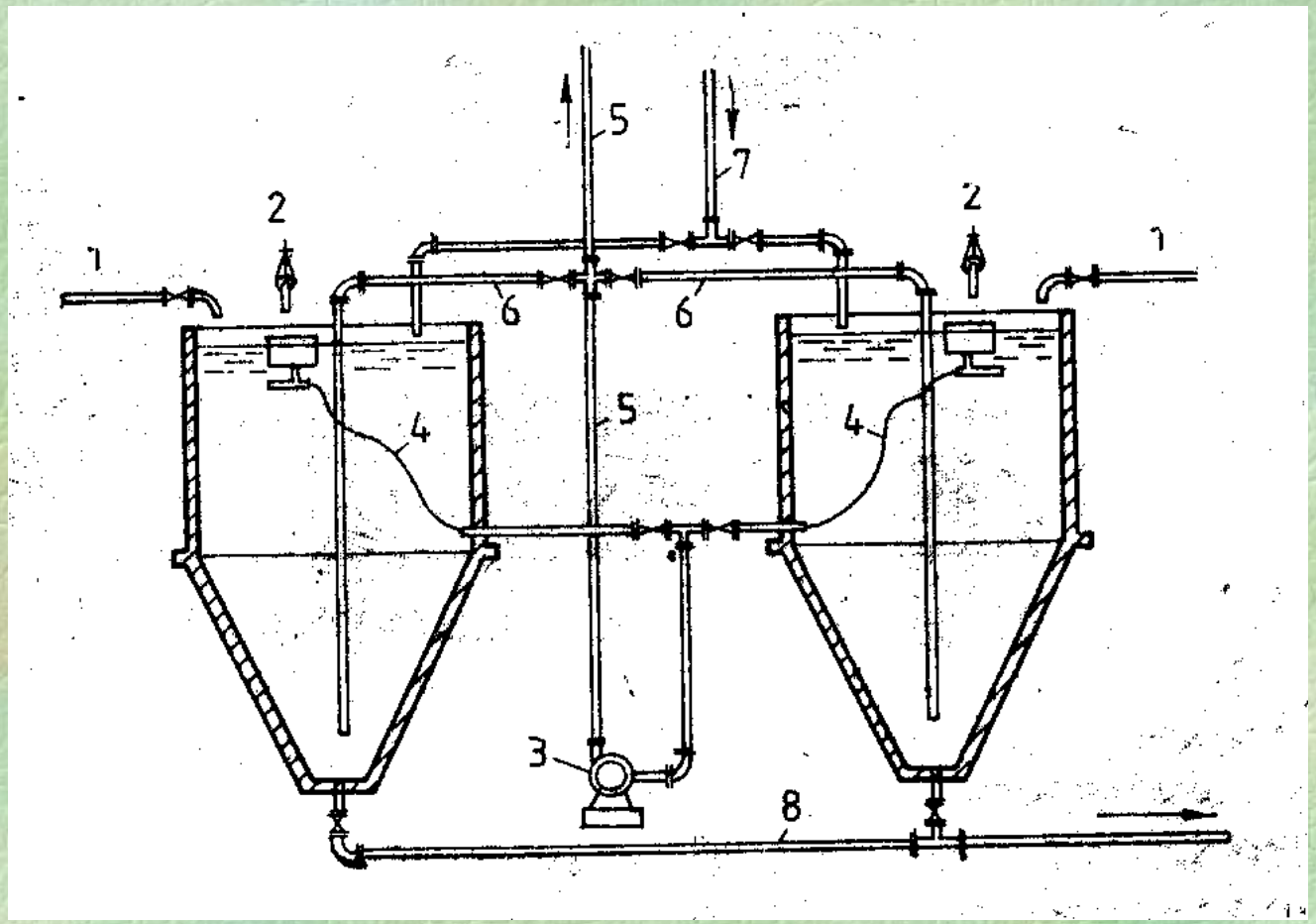
Preparing of Diluted (Working) Reagent Solution from Dry Reagent (Powder)

1 - silo for reagent (powder) keeping

2 - dozing device

3 - reservoir for diluted reagent solution

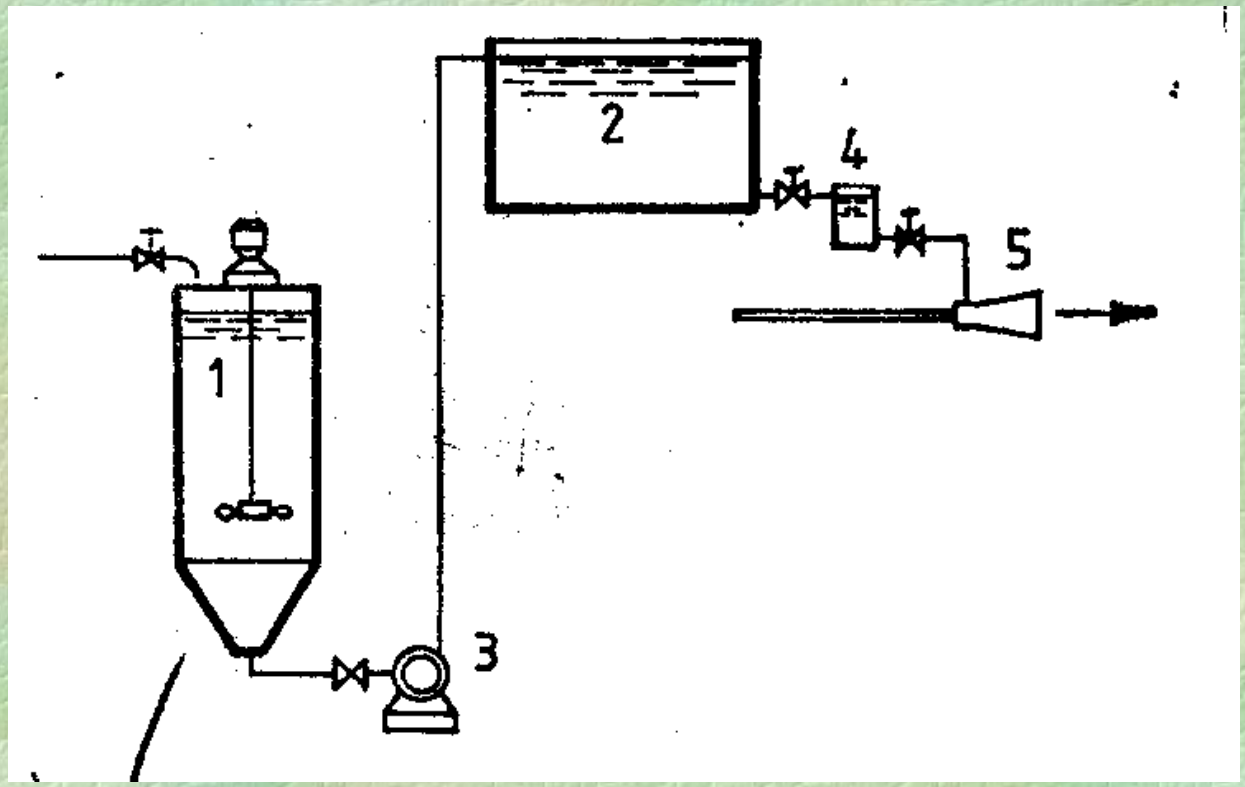
Reagents Management Units



Vessels for Diluted Lime Solution Preparing

1 - pipe delivering concentrated lime solution; 2 - delivering dilution water ; 3 - pump for mixing and solution transportation; 4 - flexible hoses; 5 - pipe to the dozing device; 6 - pipe for solution circulation (mixing); 7 - excess solution back-flow pipe; 8 - drainage pipe

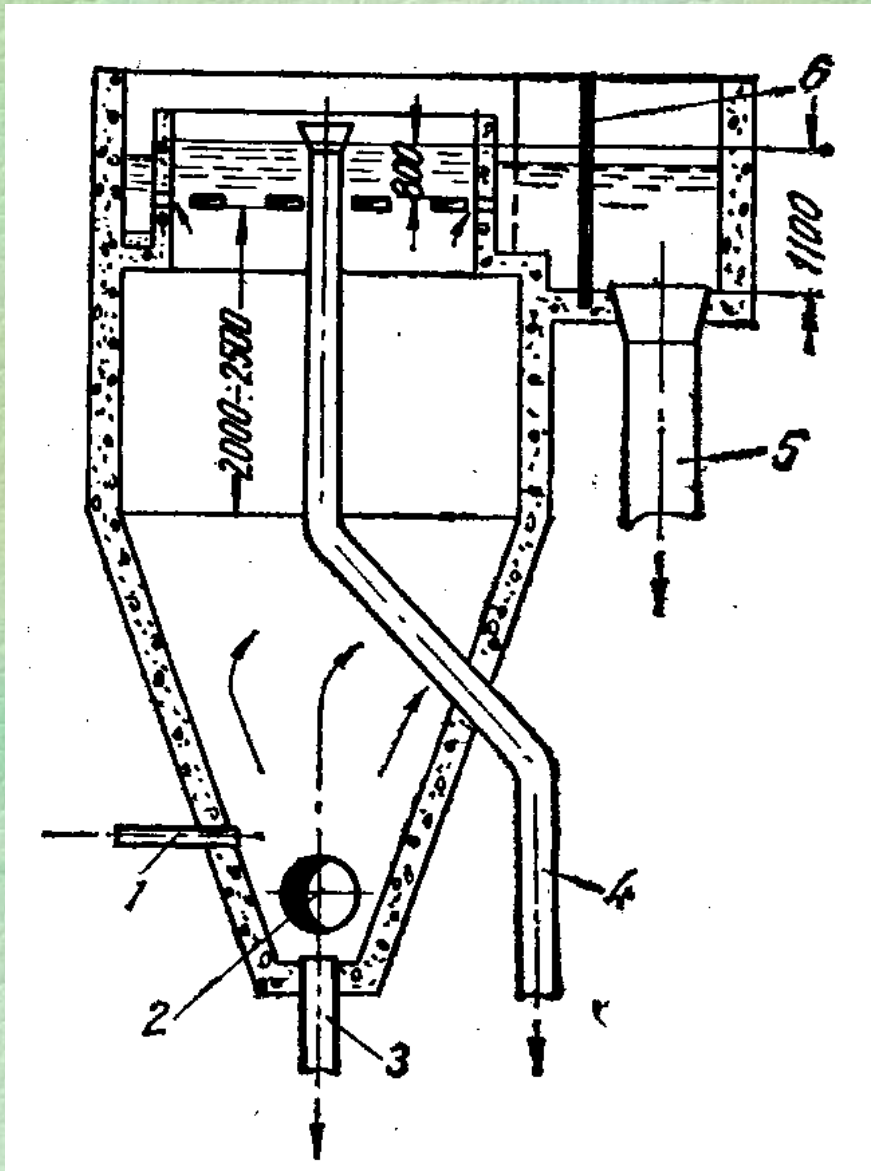
Reagents Management Units



Scheme of Facilities for Preparation of Polyacrylammid (PAA) solution

1 - vessel for PAA solution preparation; 2 - intermediate reservoir; 3 - pump; 4 - dozing device; 5 - mixing ejector

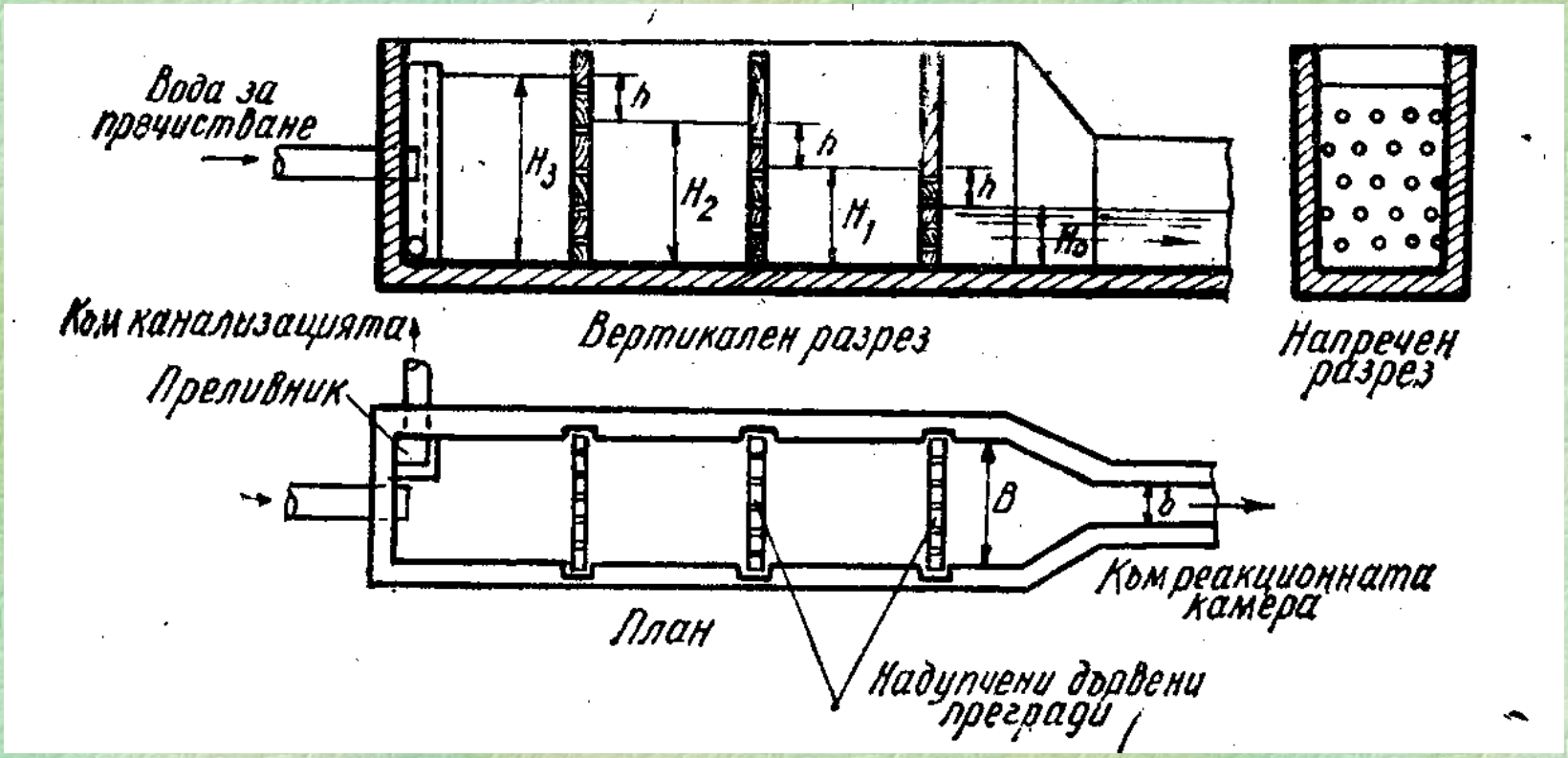
Reagents Management Units



Vertical Eddy Type Mixing Chamber

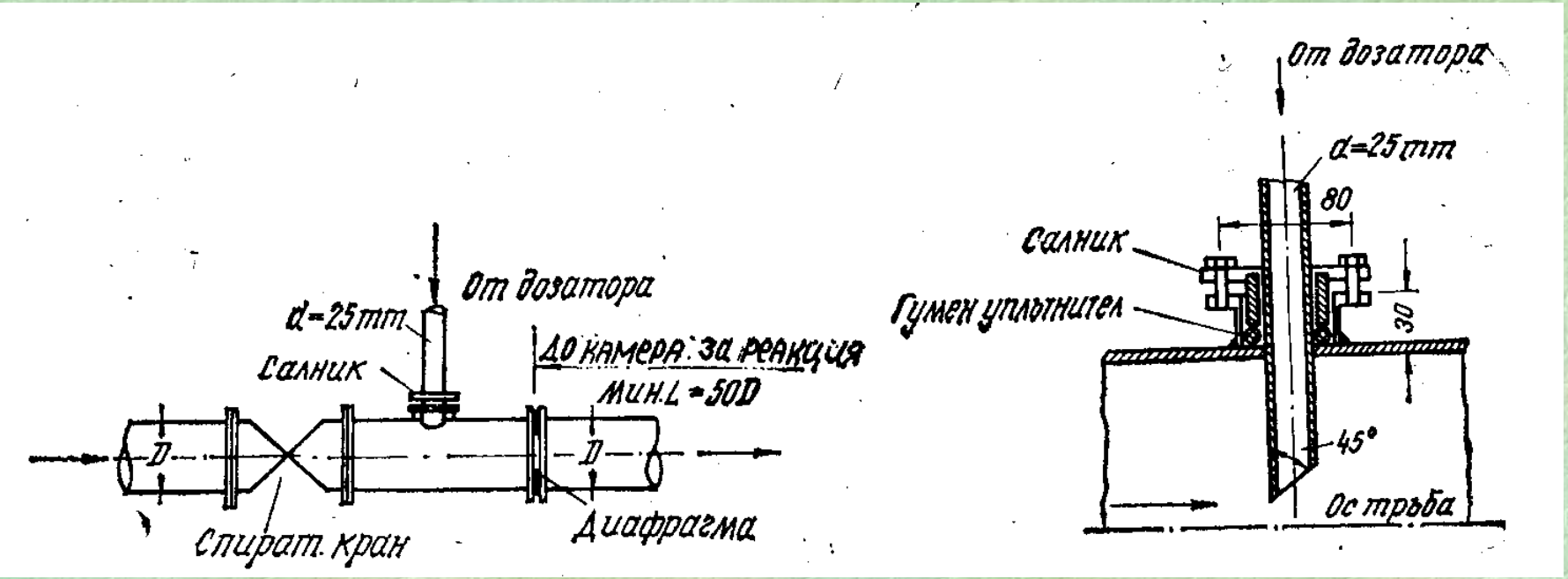
1 - reagent inflow pipe
2 - coarse water
3 - sludge withdrawing pipe;
4 - overflow pipe
5 - treated water feeding pipe
6 - rack

Reagents Management Units



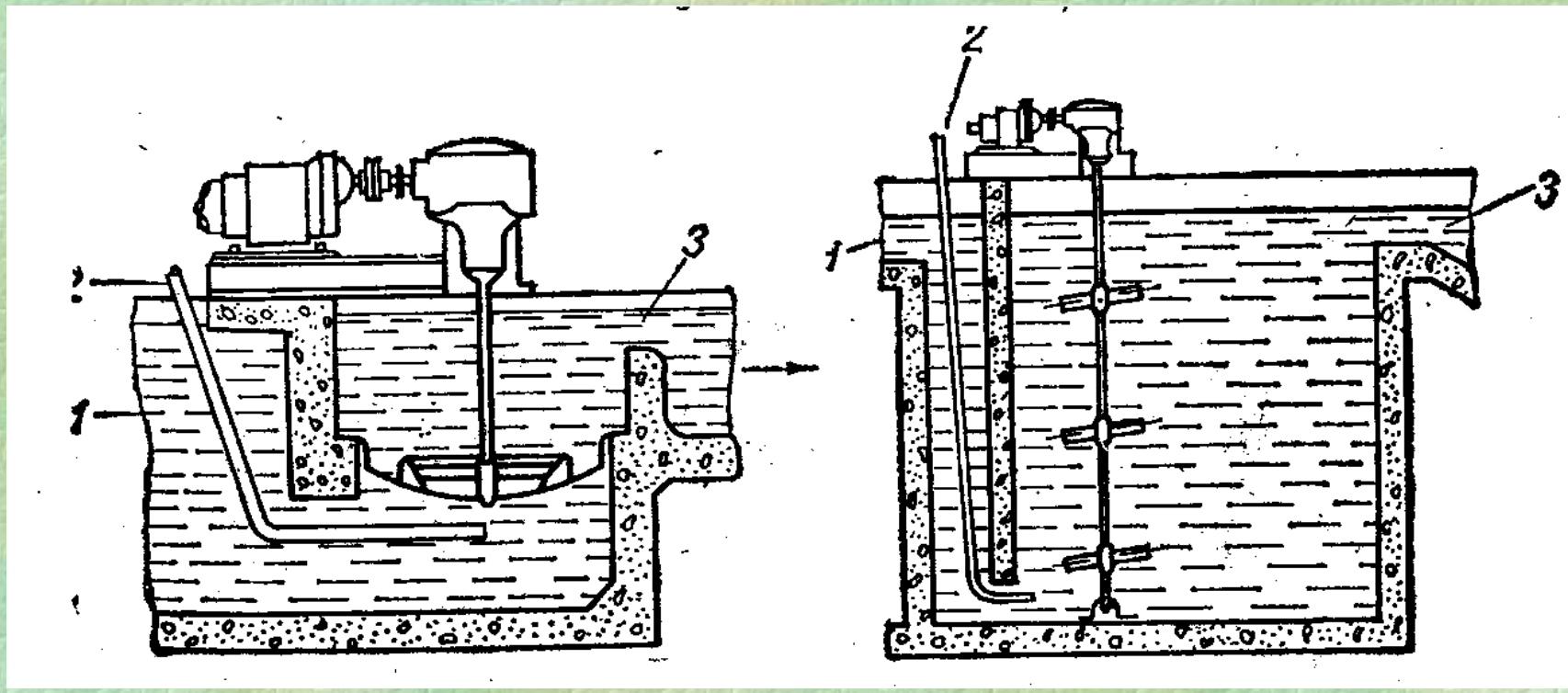
Mixing Chamber with Perforated Baffles

Reagents Management Units



Diaphragm Dozing Device

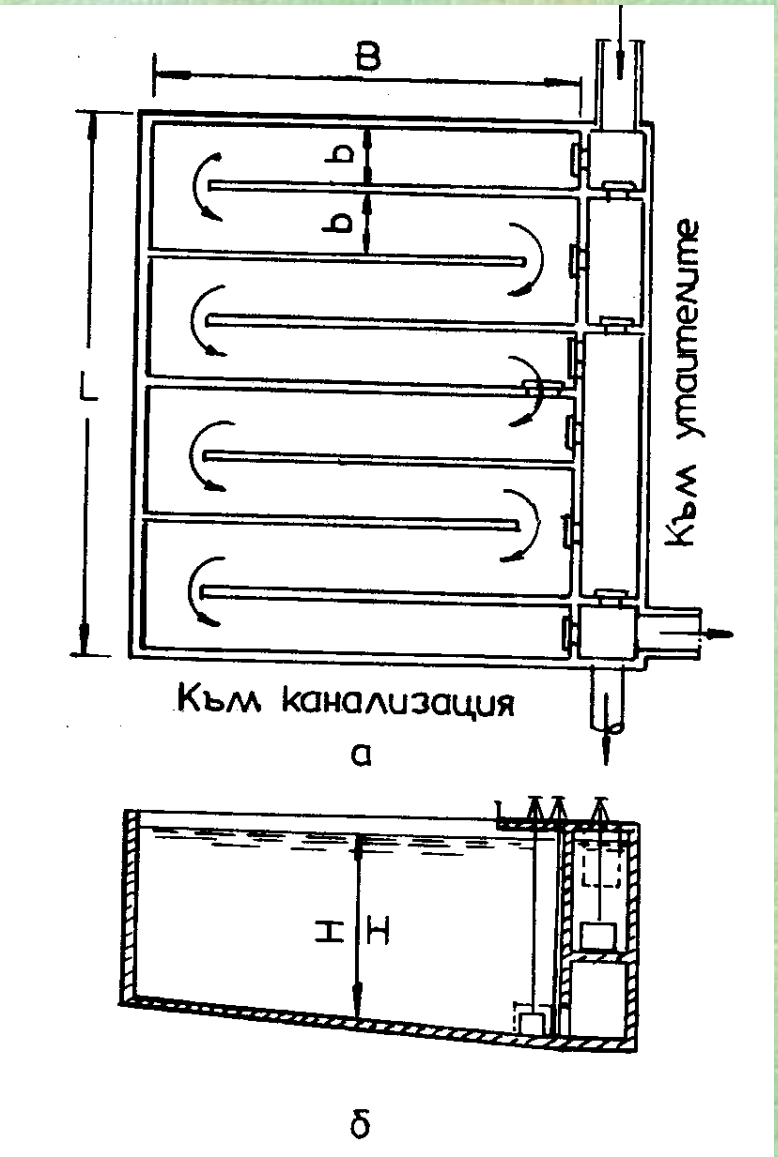
Reagents Management Units



Mixing Chamber with Mechanical Agitators

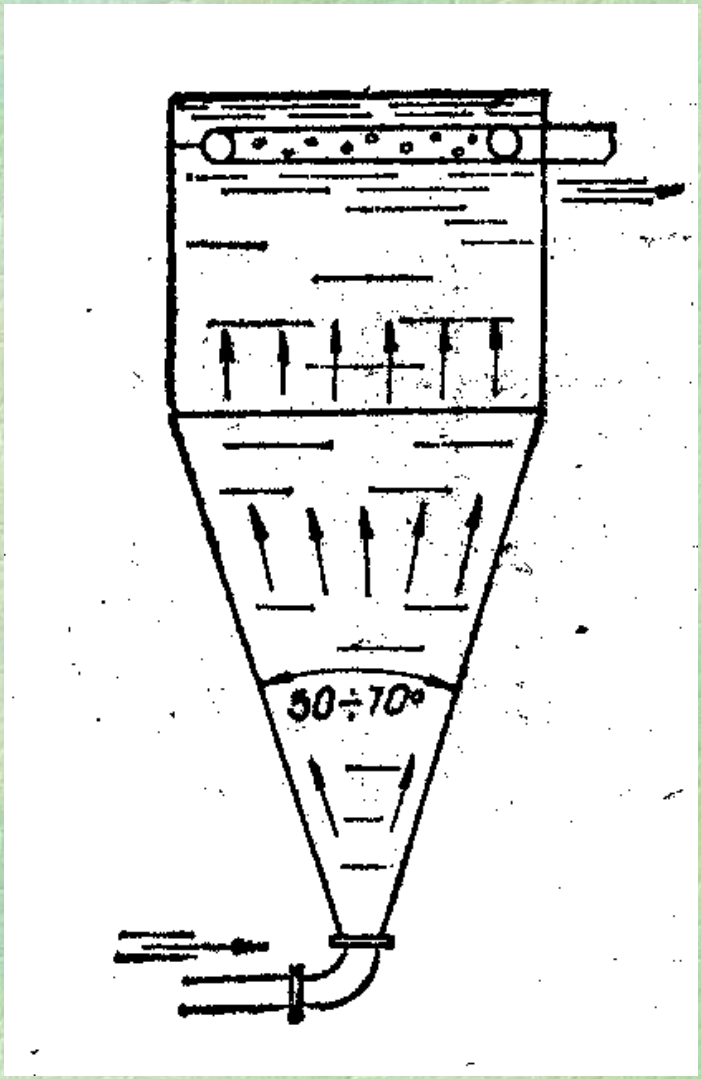
1 - coarse water; 2 - reagent; 3 - water/reagent mixture

Reagents Management Units



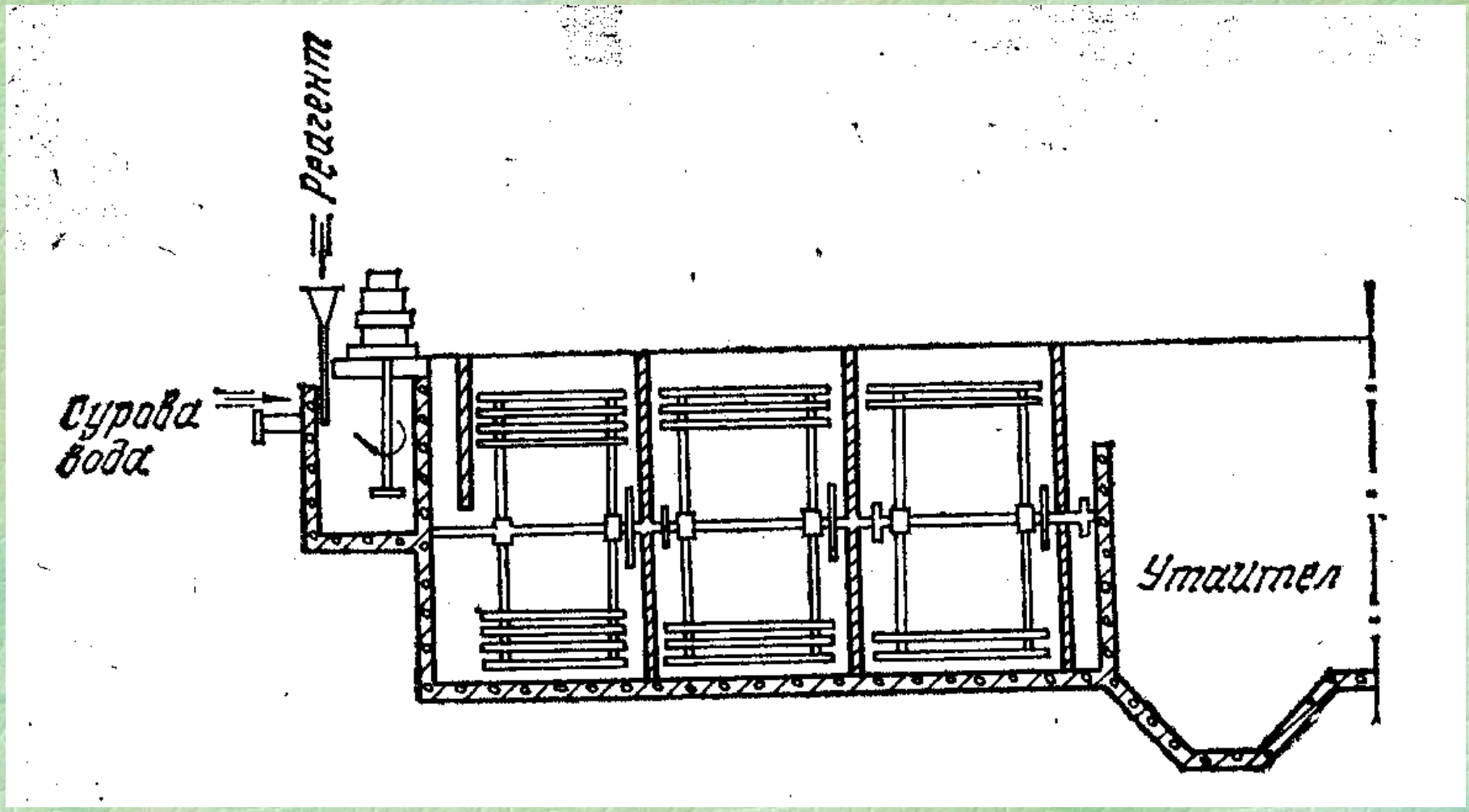
Horizontal Reaction (Flocculation) Chamber with Baffles

Reagents Management Units



Vertical Reaction (Flocculation) Chamber of Eddy Type

Reagents Management Units



Reaction (Flocculation) Chamber with Mechanical Agitation