



ENVE 301

Environmental Engineering Unit Operations

CHAPTER: 11

High rate settlers

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HIGH RATE SETTLERS

→ High rate settlers

parallel-plate settlers

tube settlers

increase the available area for solids settling

→ In a detention time of less than 20min they have settling efficiency comparable to that of a settling tank with a minimum 2 hr detention time.



→ Existing clarifiers can be upgraded to higher loading rates by the installation of a tube module or lamella.

Tube settlers

- Water to be clarified passes upward through the tubes
- As settling occurs the solids are collected on the bottom of the tubes
- Tubes are inclined at an angle of 45° to 60° , which is steep enough to cause the settled sludge to slide down the tubes
- The sludge falls from the tubes to the bottom of the clarifier where it is removed by sludge rakes
- Tube cross section → square or rectangular
- Higher overflow rates (three to six times as those used for conventional settling) can be used to achieve same degree of treatment with conventional settlers
- Laminar flow is necessary for efficient settling

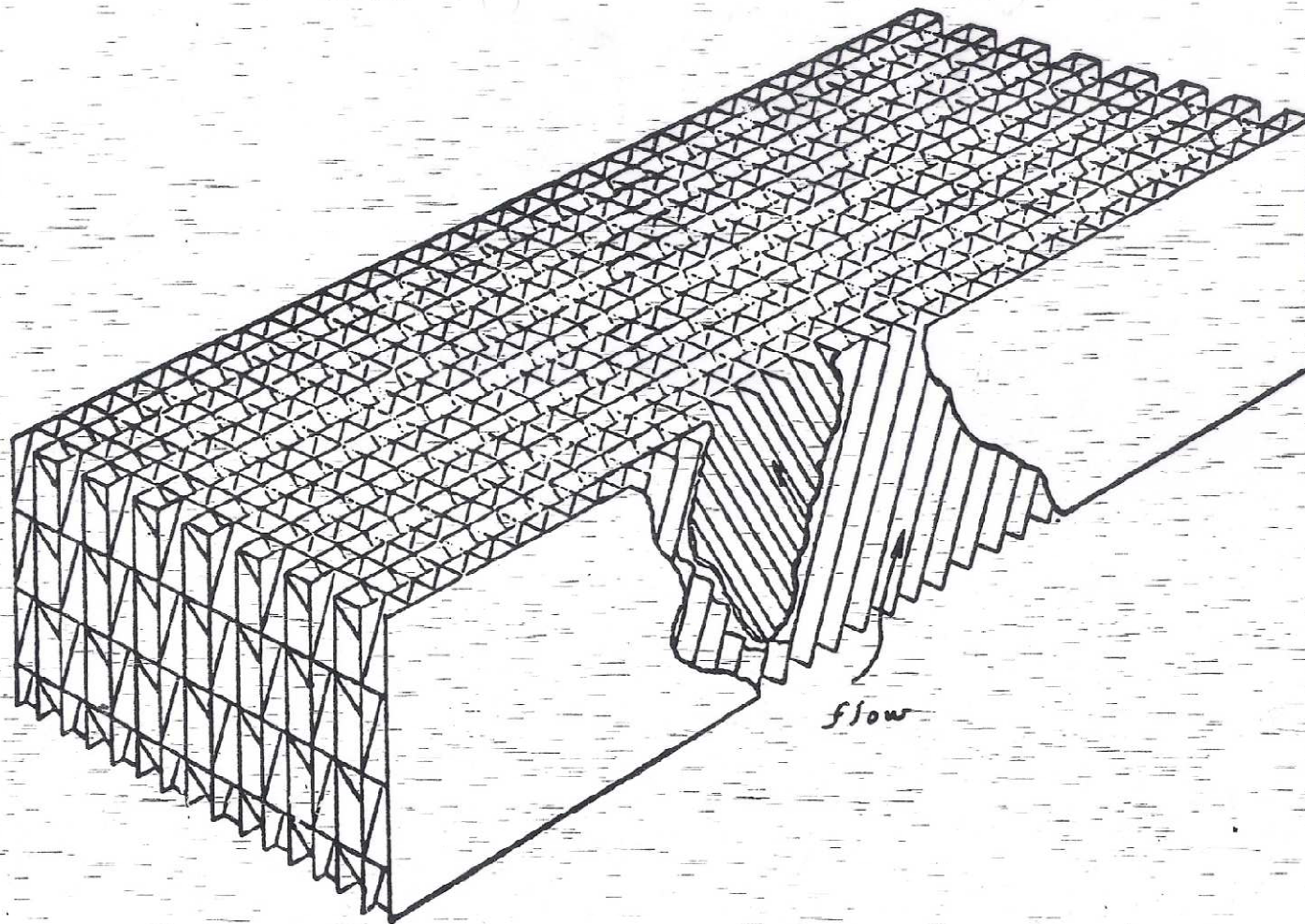


FIGURE 7-8
MODULE OF STEEPLY INCLINED TUBES
(Courtesy Neptune Microfloc, Inc.)

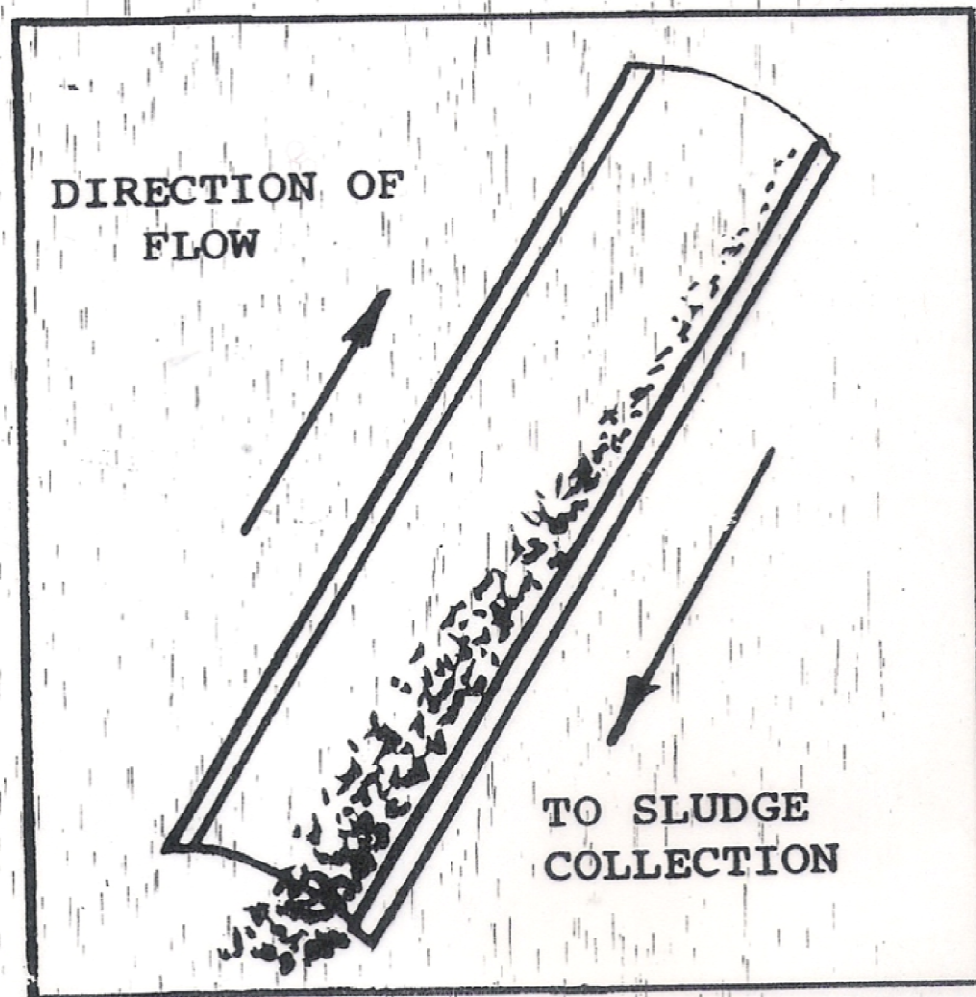


FIGURE 7-11
TUBE SETTLERS – FLOW PATTERN

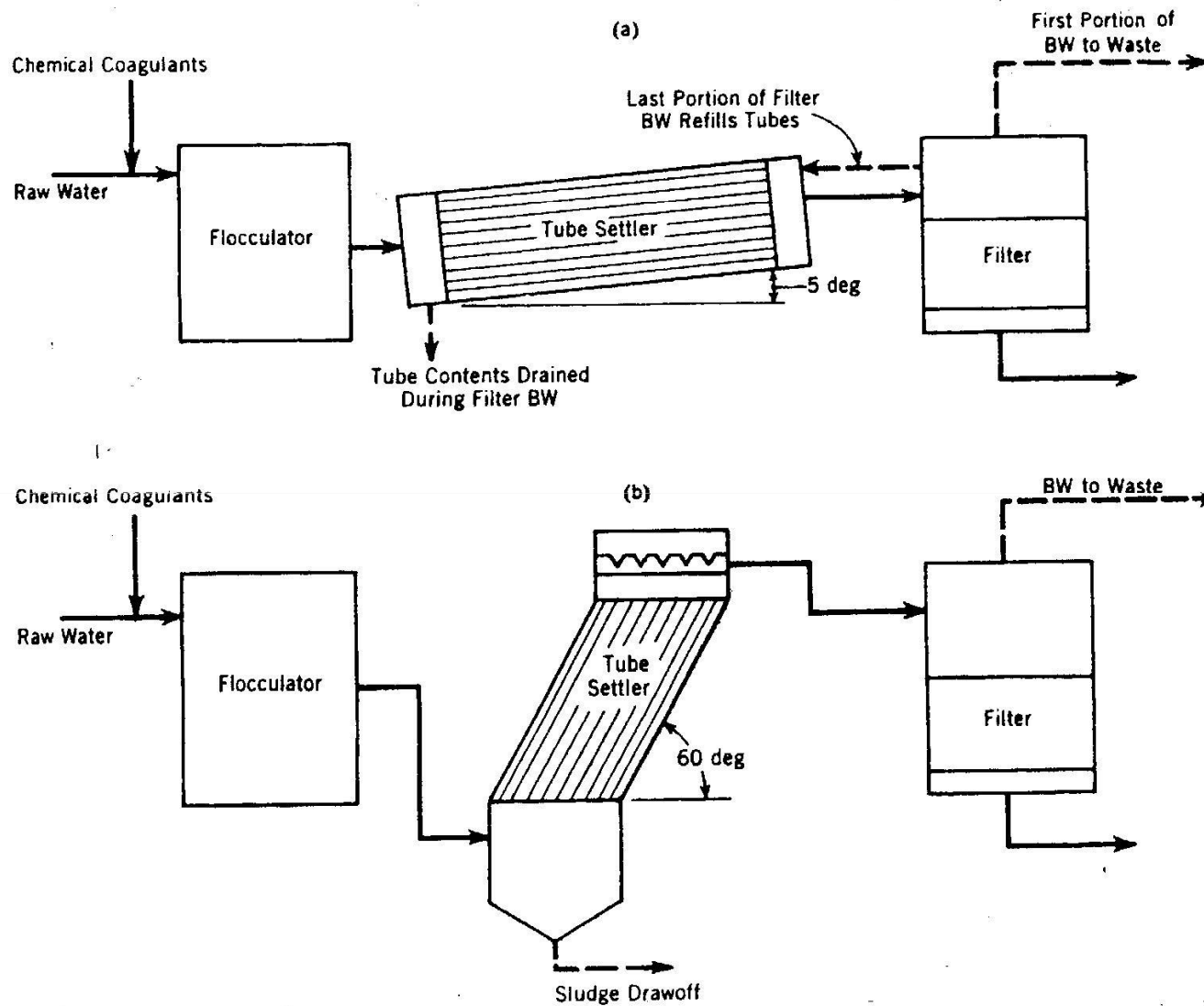


Figure 3-16 Basic tube settler configurations. (a) Horizontal tube settler; (b) steeply inclined tube settler. After Culp et al., 1968. Reproduced with permission from the American Water Works Association.

Lamella Separators

- Similar to the inclined-tube settlers except that inclined plates are used to form the settling compartments
- sludge and water flow is cocurrent (same direction)
- Flow entering a lamella separator flows downward between the plates depositing the sludge as it travels
- In a horizontal flow tank , the front one-quarter length of the basin is generally free from settler modules to allow for better inlet flow conditions.

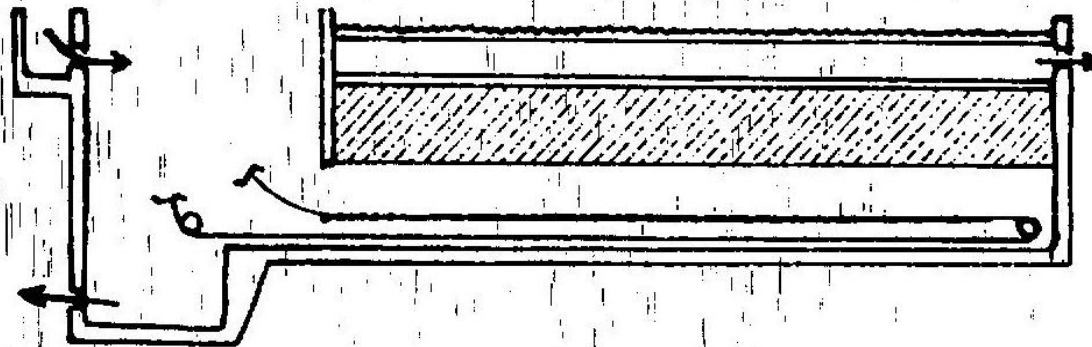
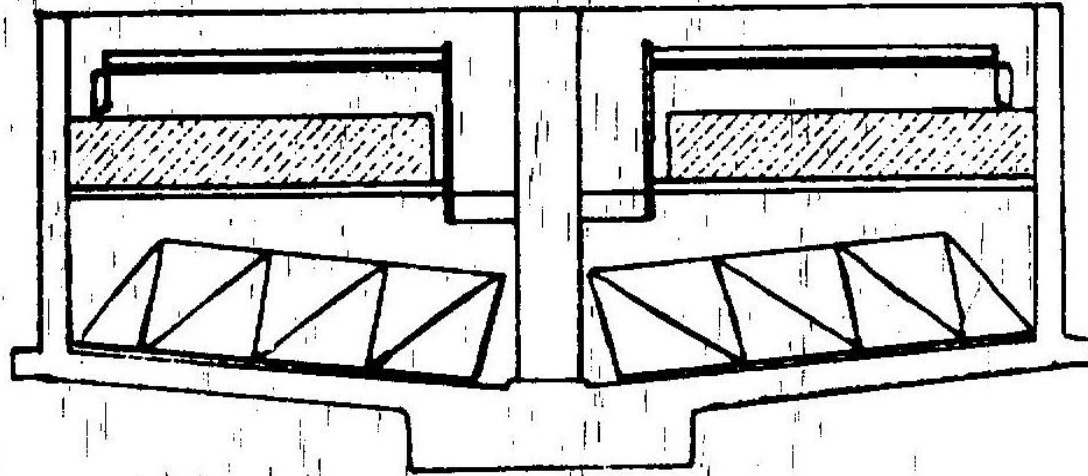
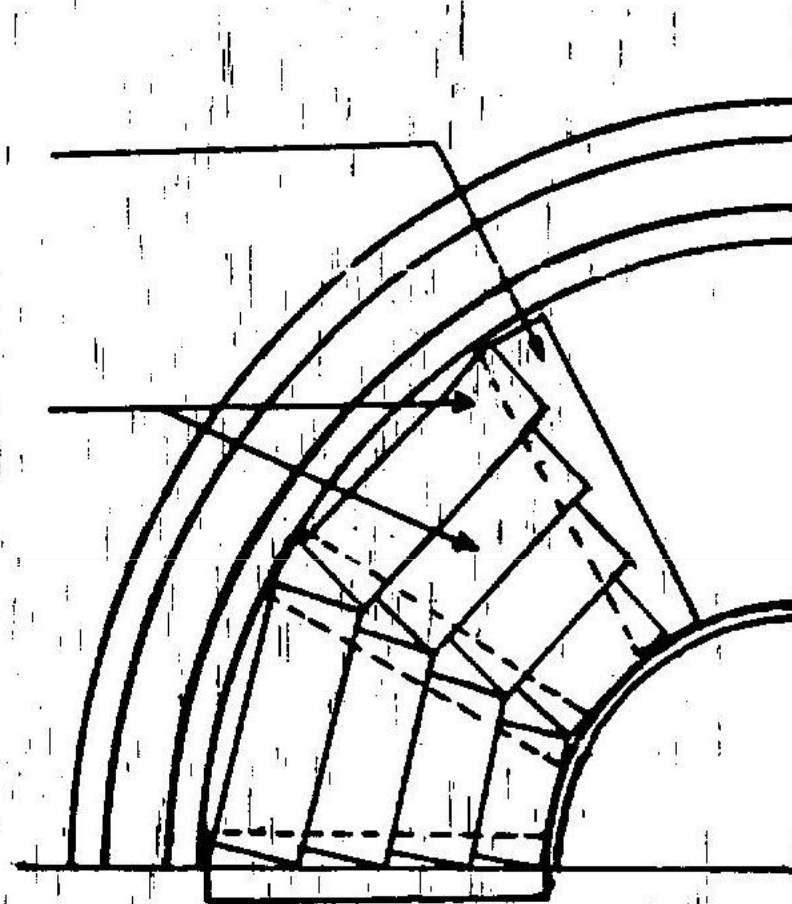


FIGURE 7-9
TUBE SETTLERS IN EXISTING CLARIFIER

SUPPORT MODULE

**TUBE SETTLER
MODULES**



**FIGURE 7-10
PLAN VIEW OF MODIFIED CLARIFIER**

Upflow Clarifiers (Solid Contact Units)

This units combine flocculation & sedimentation into a structural single unit

Upflow solid contact clarifier combine:

- Mixing
 - Coagulation
 - Flocculation
 - Liquid-solid separation
 - Sludge removal
- } into a single unit process

Types of upflow clarifiers :

- Solids – contact
- Sludge blanket type

Solids – Contact Clarifier

- Raw water is drawn into the primary mixing zone where initial coagulation & flocculation take place
- Secondary mixing zone is used to produce a large number of particle collisions so that smaller particles are entrained in the larger floc
- Water passes out of the inverted cone into the settling zone, where solids settle to the bottom and clarified water flows over the weir

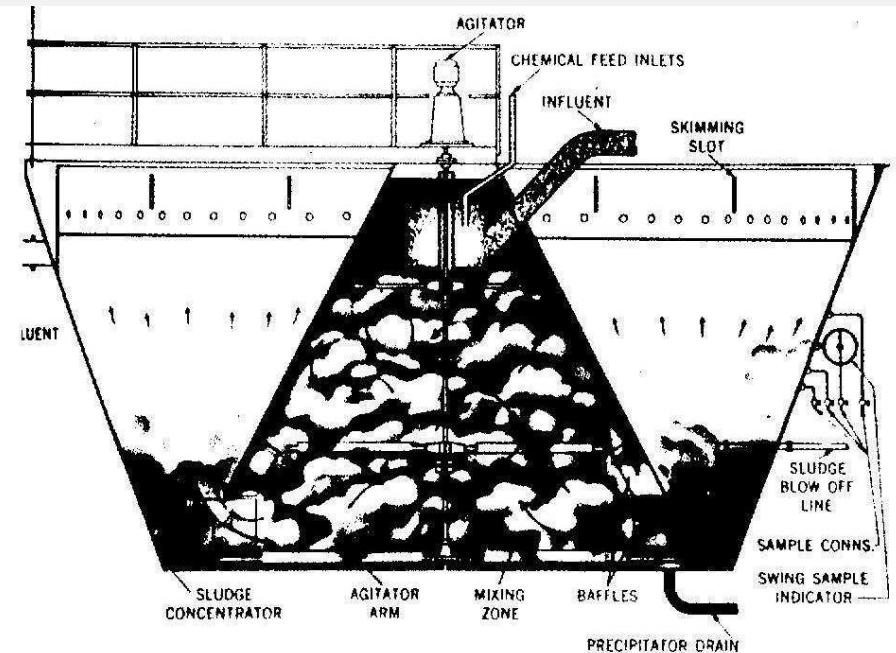


FIGURE 9-10
Suspended solids contact clarifier. (Courtesy Permutit Co., Inc.)

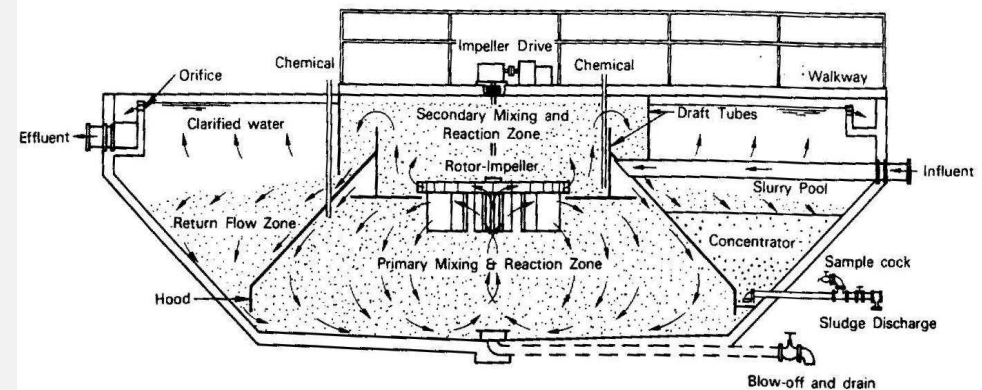


FIGURE 9-11
Suspended solids contact clarifier. (Courtesy Infilco-DeGremont, Inc.)

SLUDGE-BLANKET CLARIFIER

Inverted cone within the clarifier;

→ Produces an increasing cross-sectional area from the bottom of the clarifier to the top.

→ Upward velocity of water decreases as it approaches to the top.

At some point;

the upward velocity of water exactly balances the downward velocity of a solid particle

→ PARTICLE IS SUSPENDED

Heavier particles suspended closer to the bottom

As the water containing flocculated solids passes up through this blanket, the particles are absorbed onto the layer floc

Floc size increases and drops it down to a lower level
It eventually falls to the bottom of the clarifier.

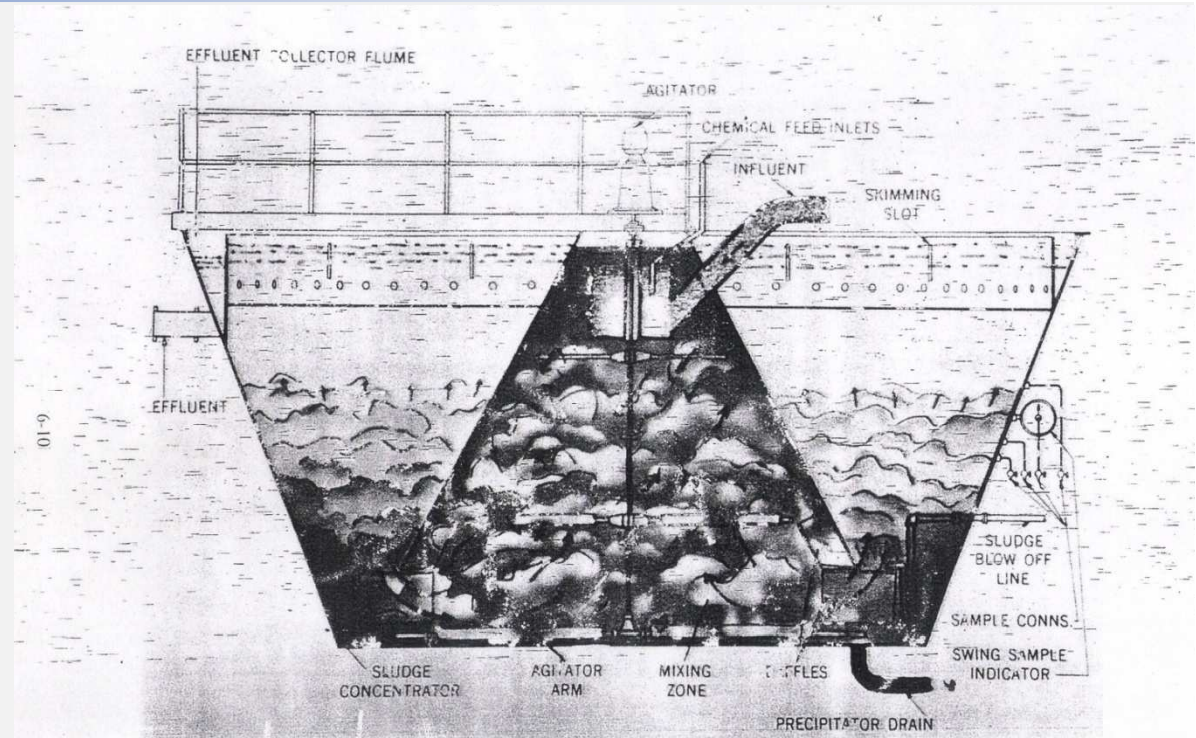


FIGURE 6-5
SOLIDS CONTACT CLARIFIER WITH SLUDGE BLANKET FILTRATION
(Courtesy of the Permutit Co.)