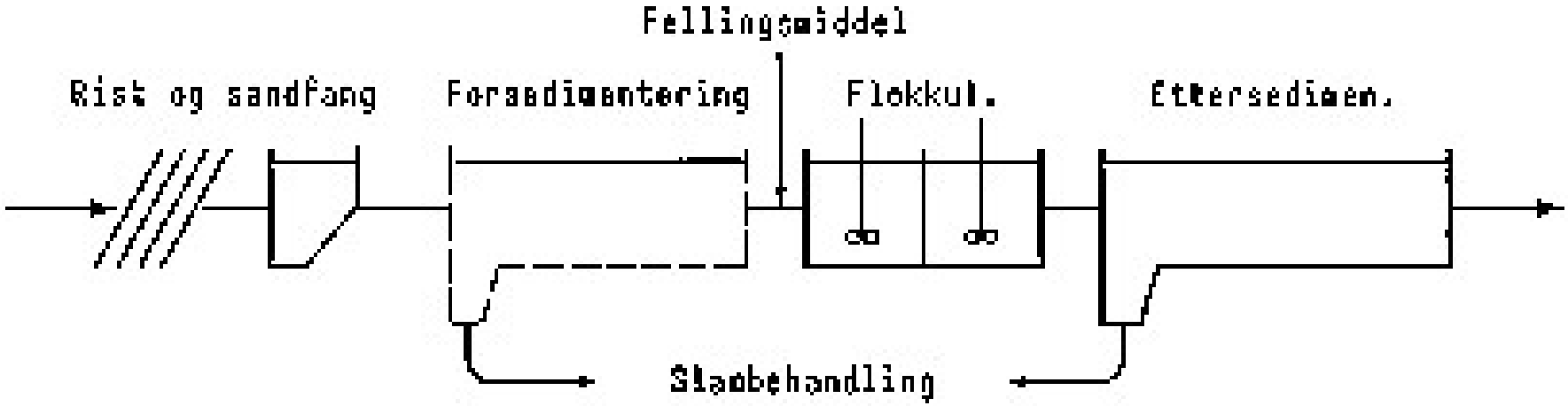
INTRODUCTION TO INNOVATIVE PHYSICAL/CHEMICAL TREATMENT METHODS

Hallvard Ødegaard

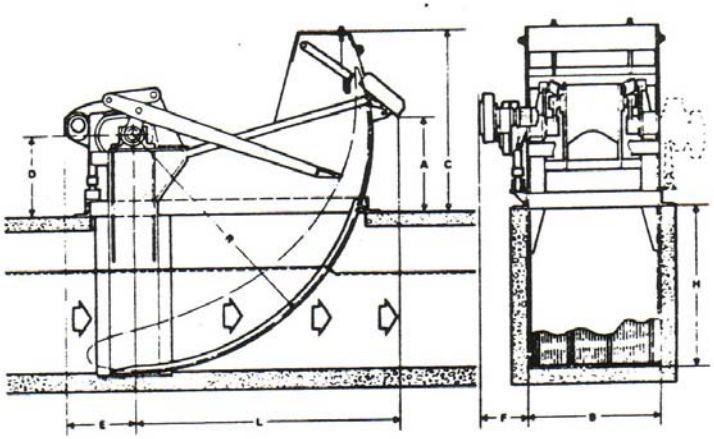
CHEMICAL TREATMENT PLANTS IN NORWAY



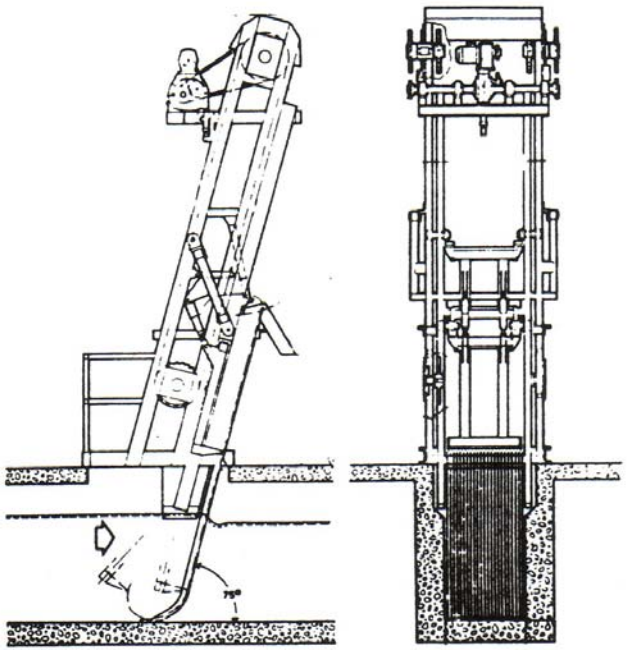
Without primary settling tank : Primary precipitation
With primary setling tank : Secondary precipitation plants

PRETREATMENT IN SCREENS

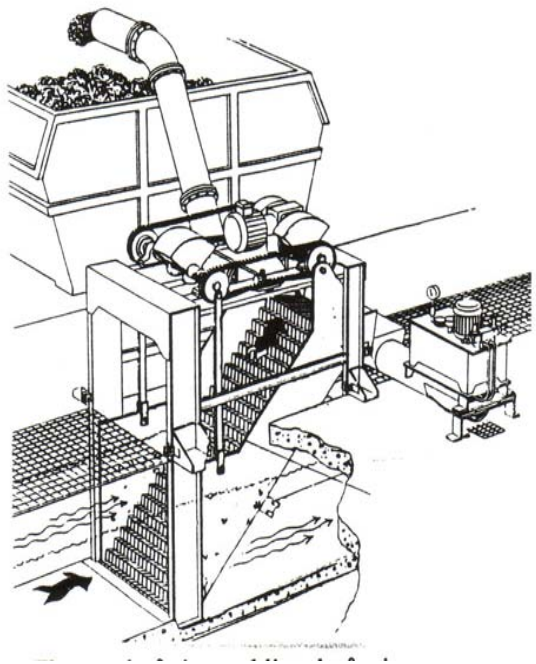
Maskinrenset buerist



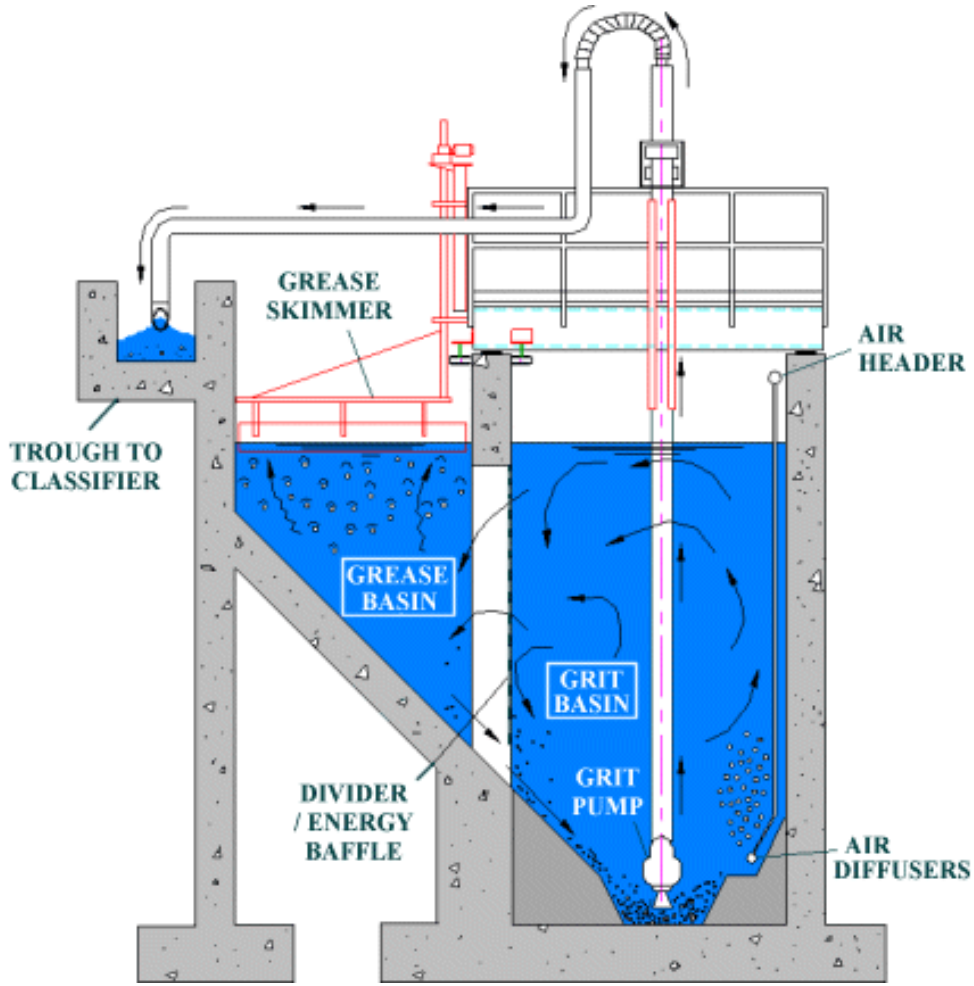
Maskinrenset planrist



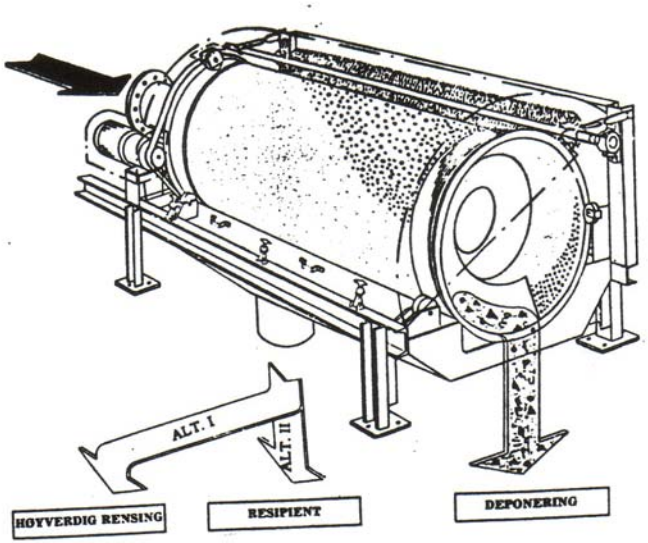
Step-screen



PRE-TREATMENT BY GRIT AND FAT REMOVAL

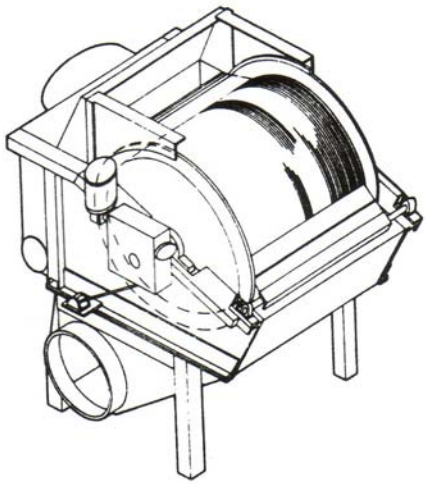


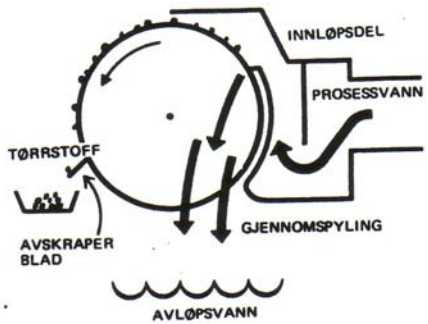
PRETREATMENT BY SIEVING



Sieve opening: 0,5-1,5 mm

The primary treatment requirement:
BOD > 20 %
SS > 50 %



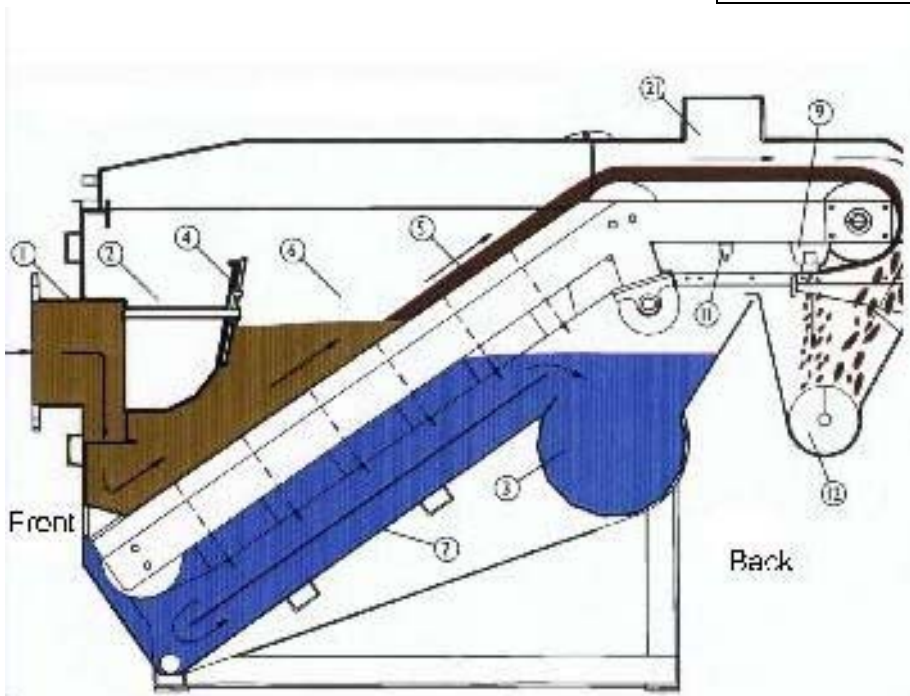


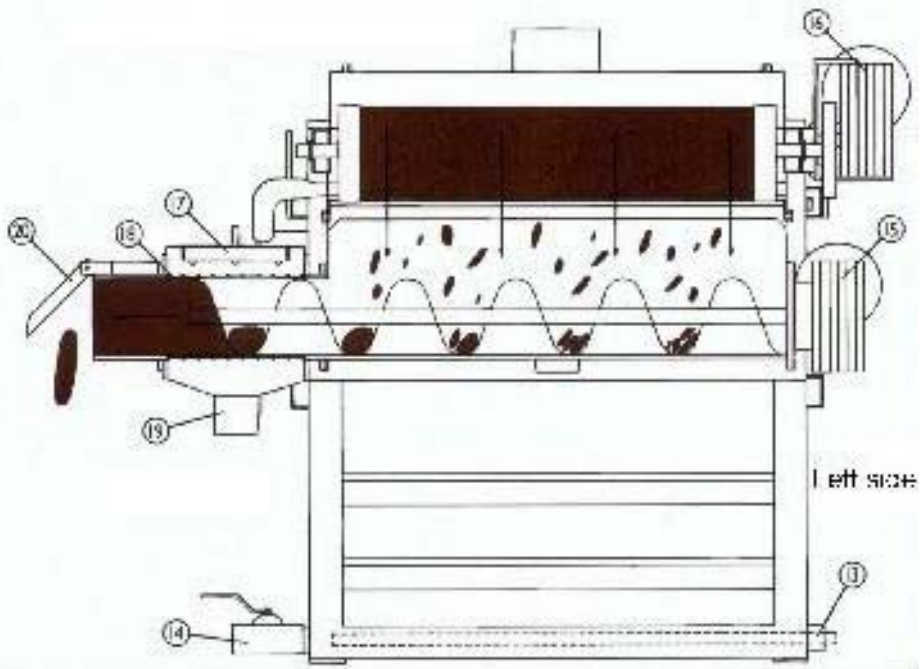
Sieve opening ≤ 0,3 mm required

Salsnes Filter
(0,3 mm sieve opening)

TS sludge : 23 %

Parameter	Salsnes Filter 0,3 mm silåpning Midl.renseeffekt, % Namsos RA	Sedimentering, 2- 2,5 m/h Renseeffekt, %
Suspendert stoff	59	45-55
Total COD	45	30-40
Total BOD_5	36	25-35





PRIMARY TREATMENT BY SETTLING

- Seldom used alone –
  - too low efficiency
  - too big area reuired (typical design load: $v_f = Q_{dim}/A_{overflate} = 2$ m/h)
- New innovative primary treatment alternatives are asked for
  - Coarse media filtration

WASTEWATER PRECIPITATION

At the addition of a metal-salt two precipitations take place:

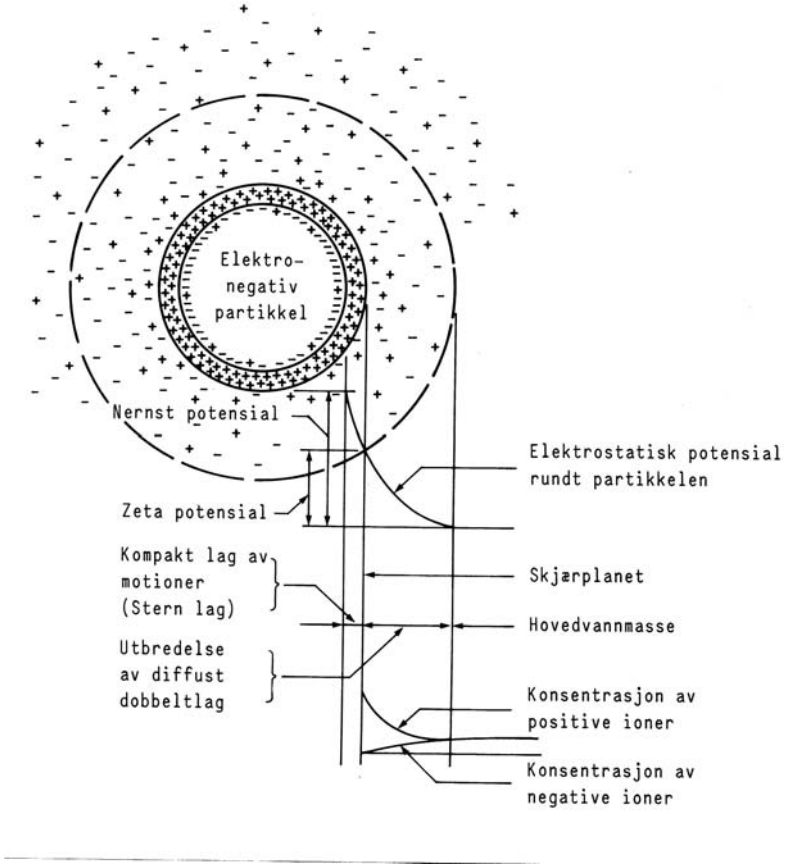
- Phosphate-precipitation : $Al^{3+} + PO_4^{3-} \rightarrow AlPO_4$
- Hydroxide-precipitation : $Al^{3+} + 3\ OH^- \rightarrow Al(OH)_3$

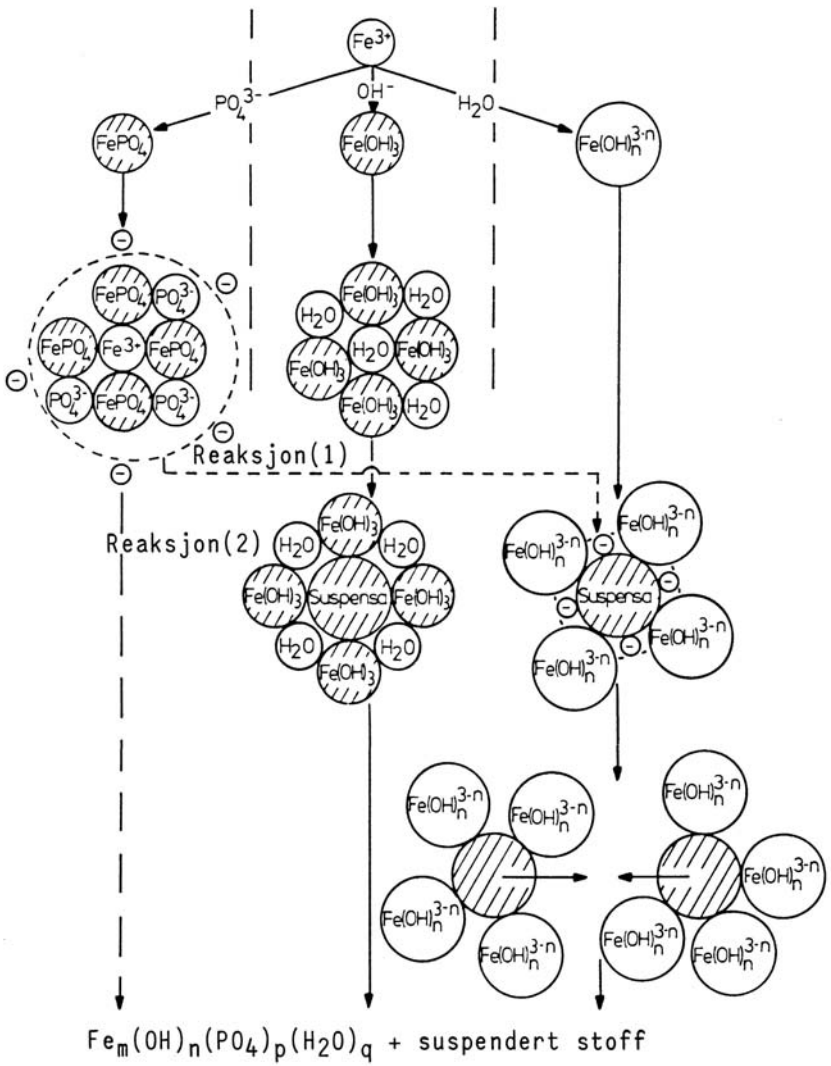
The precipitated floc consists of an aggregate of coagulated suspended solids/colloifs and $Me_m(OH)_n(PO_4)_p(H_2O)$

TYPICAL OPTIMAL pH-RANGES

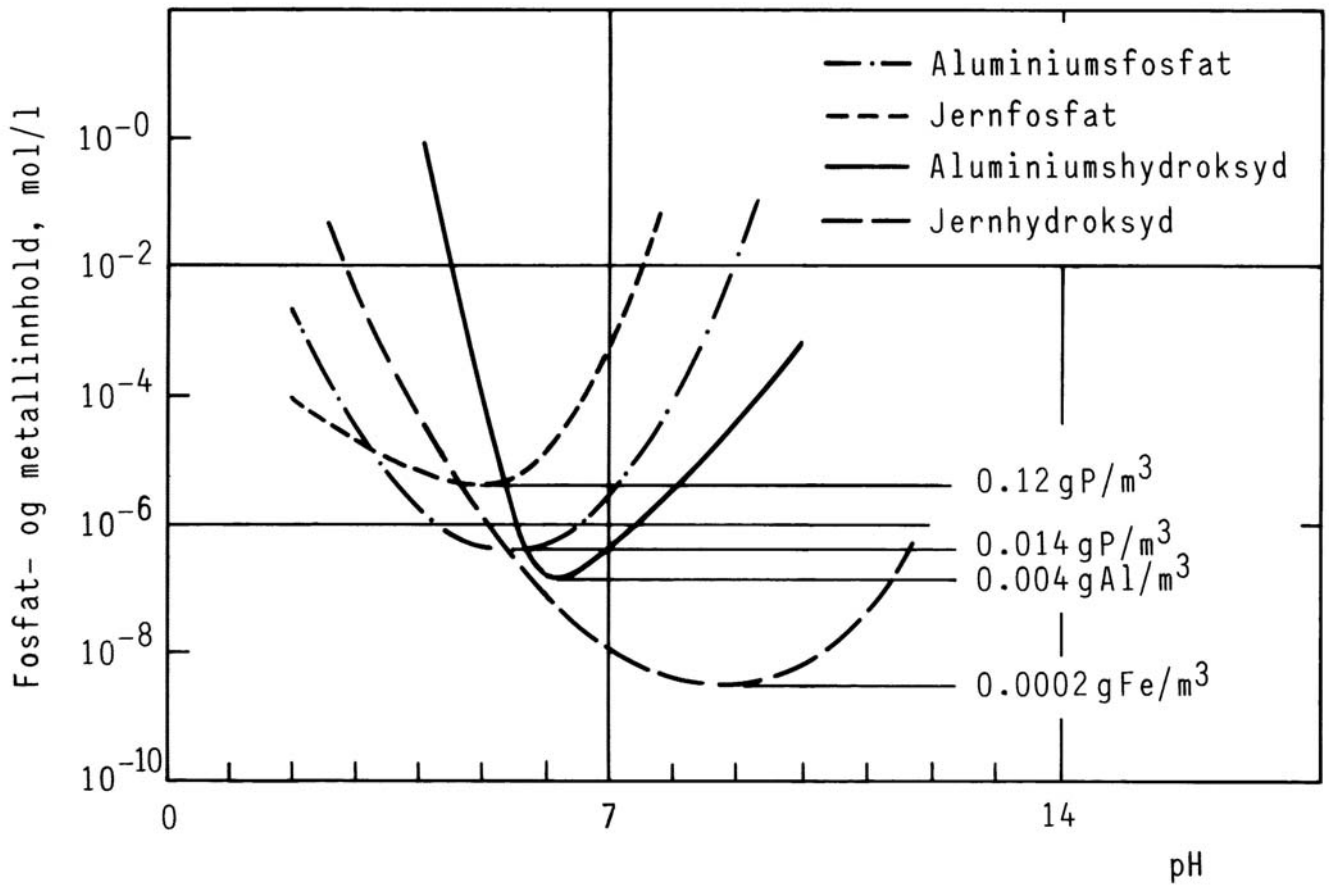
Precipitant	Commercial name	Precipitation.pH
$Al_2(SO_4/Cl_3)_3$	AVR	5,5-6,5
$Al_2(SO_4)_3$	ALG	5,5-6,5
$Al_m(OH)_n^{(3m-n)+}$	PAX	6,5-7,0
$Fe_2(Cl_3/SO_4)_3$	JKL	5,0-6,0
$Ca(OH)_2$	Lime	11,0-12,0

COAGULATION/ PRECIPITATION MECHANISMS

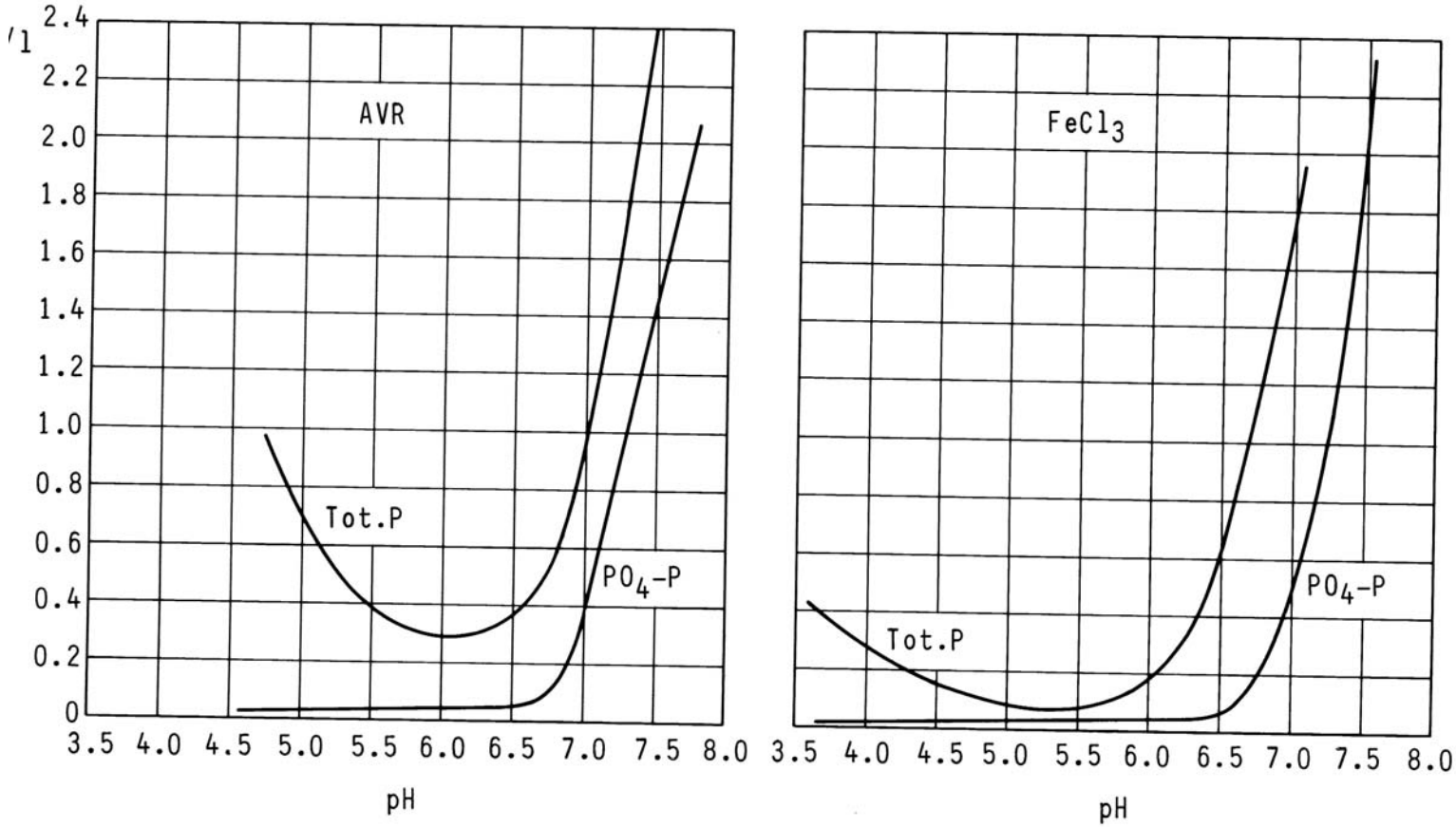




SOLUBILITY DIAGRAMS FOR PHOSPHATE AND HYDROXIDE



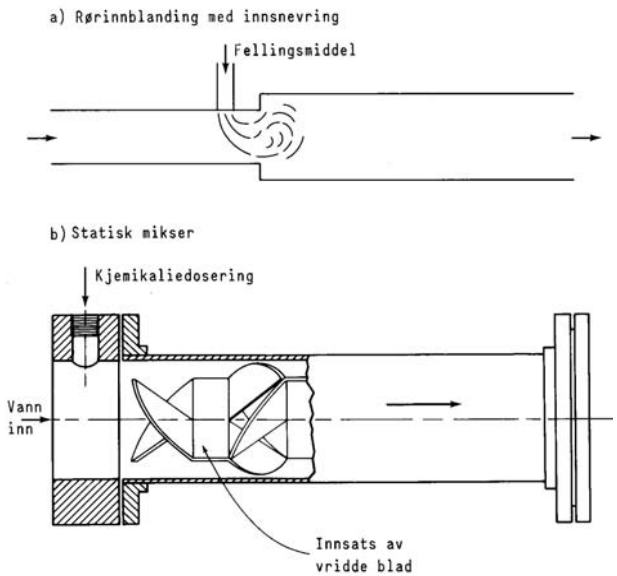
INFLUENCE OF pH ON PHOSPHATE PRECIPITATION

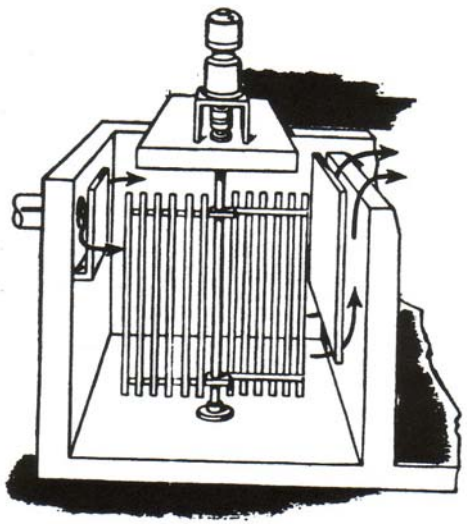


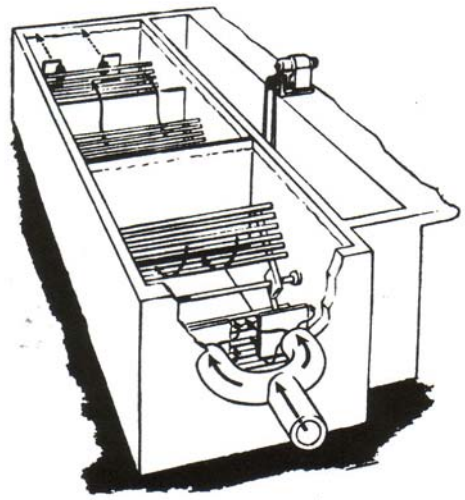
MIXING AND FLOCCULATION

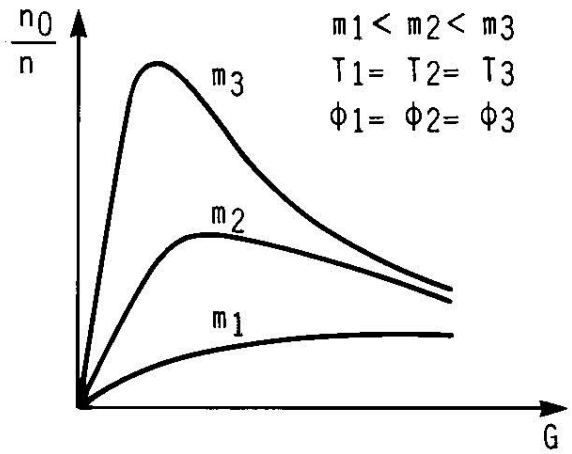
In-line, plug flow mixing is best

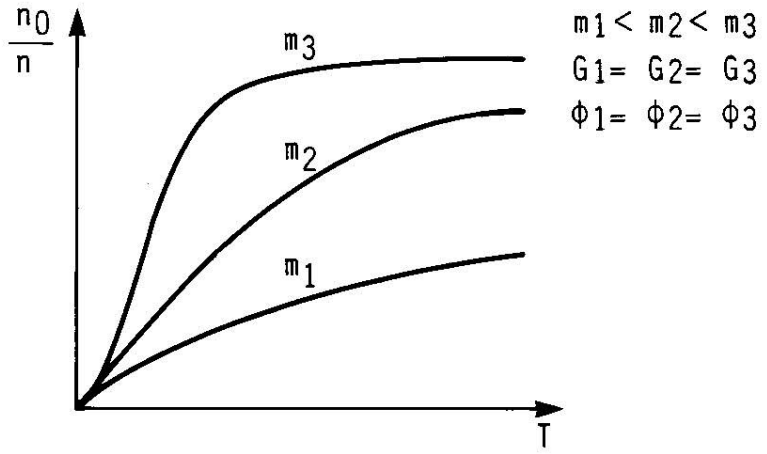
Paddle-type flocculation is normally used
Residence time: 20-30 min, 2-4 chamers











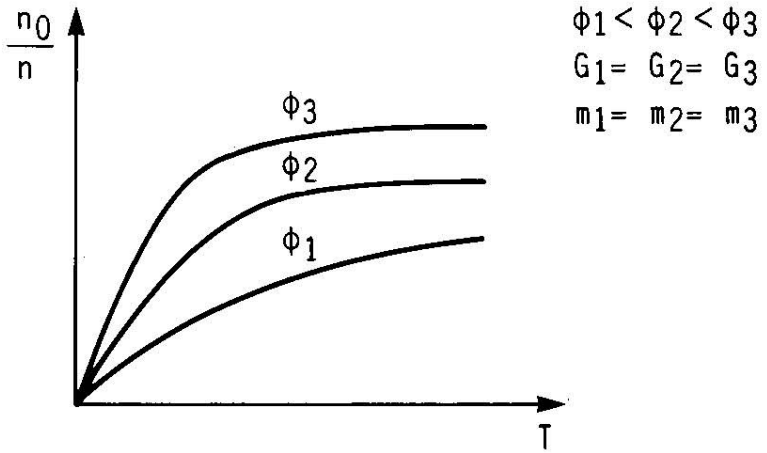
$\frac{n_0}{n}$ = Flokkuleringsgrad

G = Turbulent hastighetsgradient

T = Oppholdstid

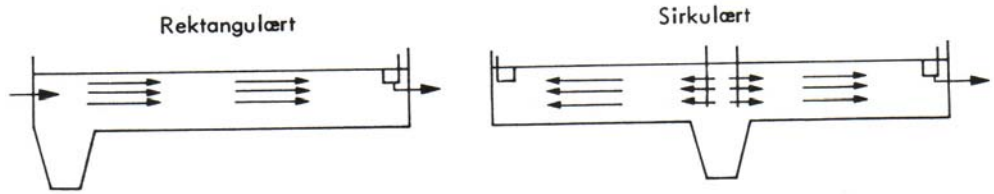
m = Antall totalomrørte reaktorer i serie

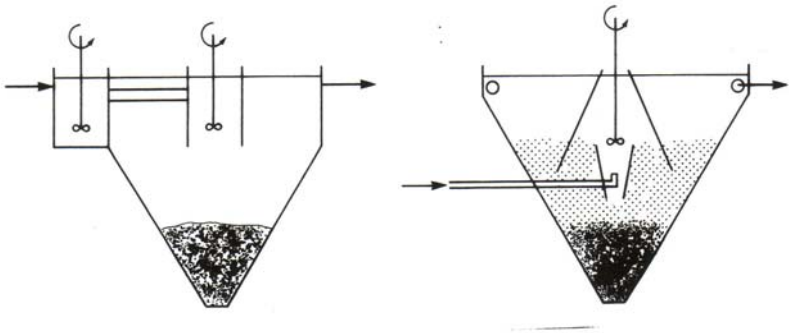
Φ = Fnokkvolum-fraksjon

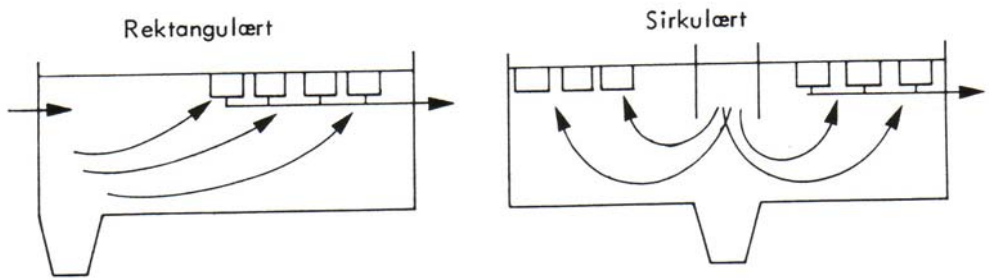


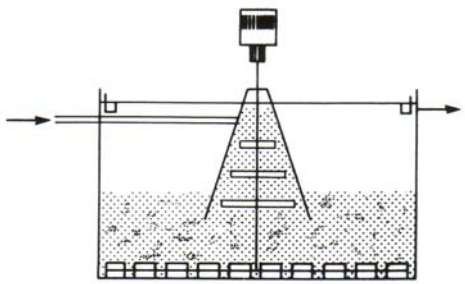
THE PARAMETERS INFLUENCING FLOCCULATION

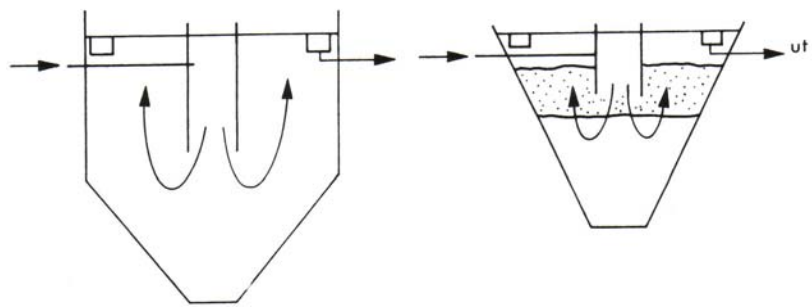
DIFFERENT DESIGNS OF SETTLING TANKS











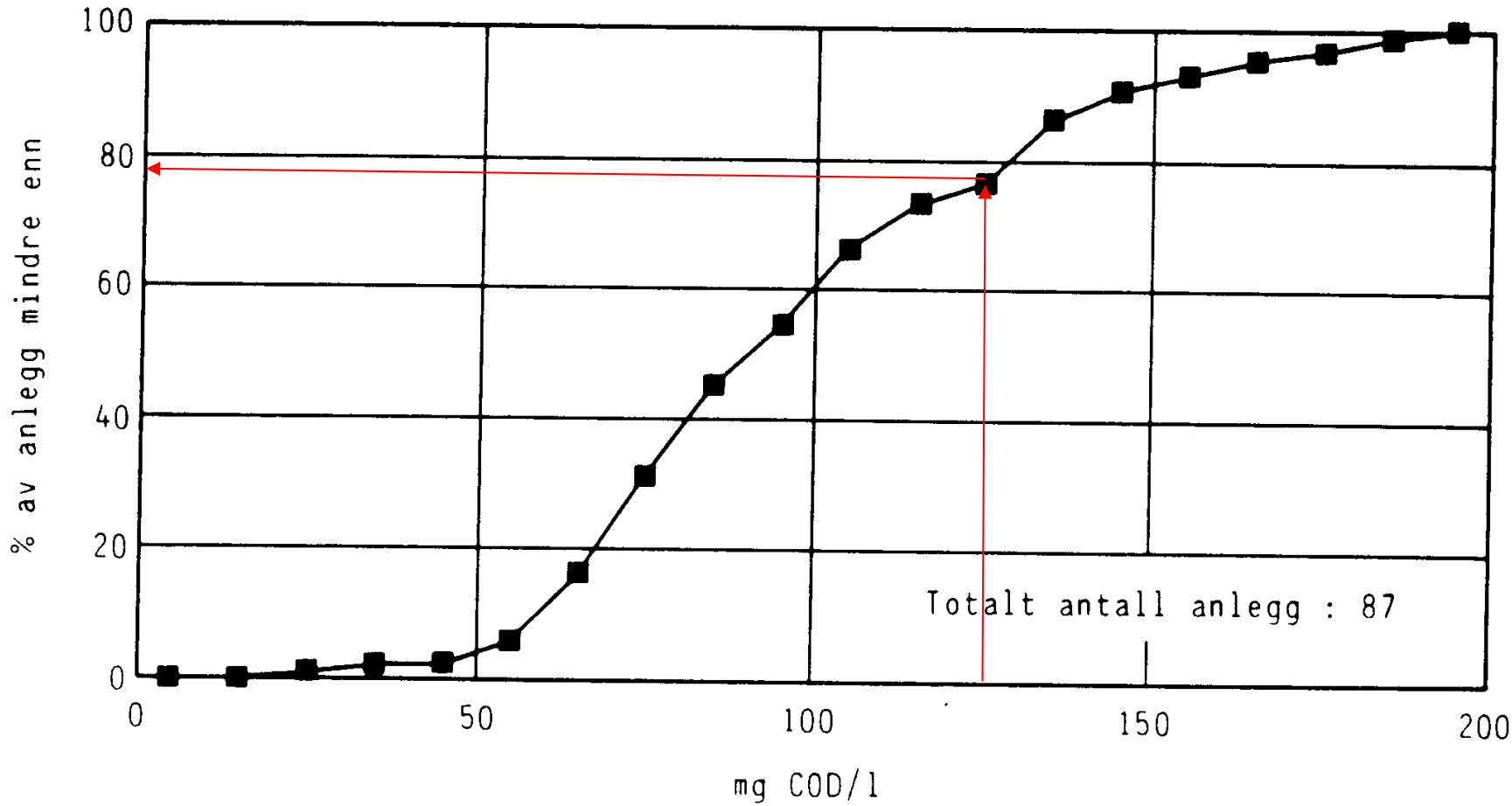
Vertikalstrømningsbasseng

Slamteppebasseng

AVERAGE TREATMENT RESULTS IN NORWEGIAN PRIMARY PRECIPITATION PLANTS

Parameter	Average inlet conc. (mg/l)	Average outlet conc. (mg/l)	Average treatment eff. (%)
SS (mg/l)			
Small plants	226 ± 150	22,3 ± 16,6	90,1
Large plants	233 ± 171	17,3 ± 10,0	92,5
BOD_7 (mg/l)			
Large plants	187 ± 143	25,4 ± 11,7	86,4
COD (mg/l)			
Small plants	494 ± 90	121 ± 72	75,5
Large plants	505 ± 243	108 ± 40	78,6
Tot P (mg/l)			
Small plants	5,33 ± 2,26	0,50 ± 0,46	90,6
Large plants	5,40 ± 3,01	0,28 ± 0,14	94,8

DISTRIBUTION OF COD-REDUCTION IN 87 PLANTS

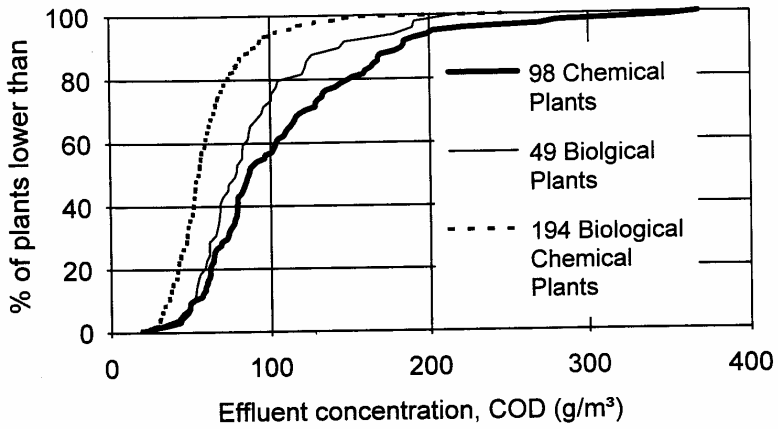


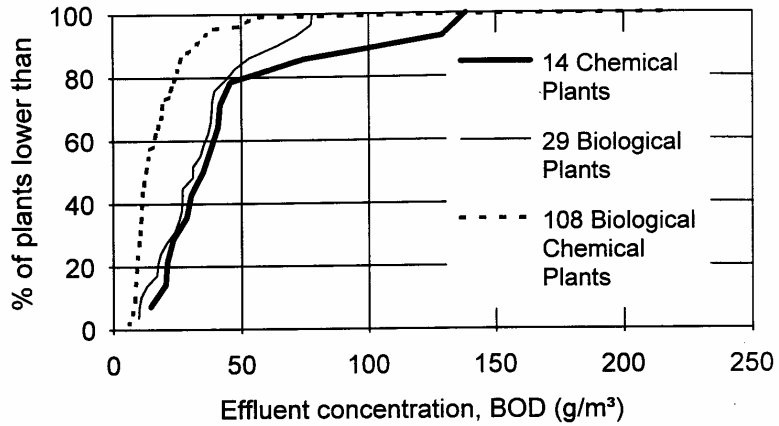
INFLUENCE ON TREATMENTRESULT BY PLANT SIZE

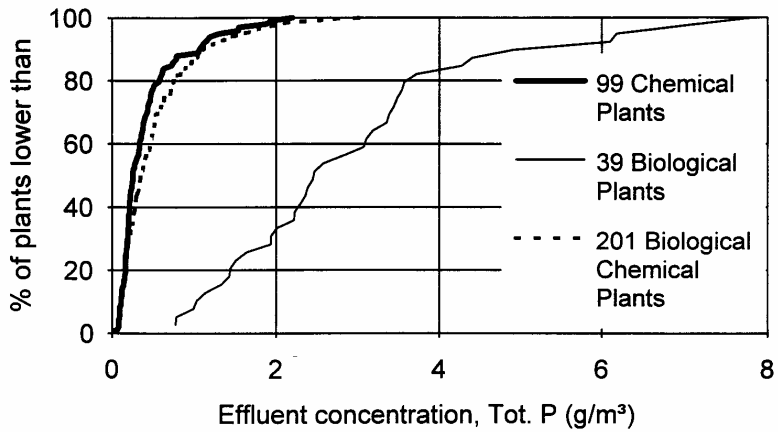
Anleggsstørr. i tusen pe	N[1)]	COD Effl.(mg/l)	%
< 2	22	114 ± 37	74.6
2 – 10	45	106 ± 40	75.6
10 – 50	15	101 ± 36	75.6
> 50	5	72 ± 12	74.1

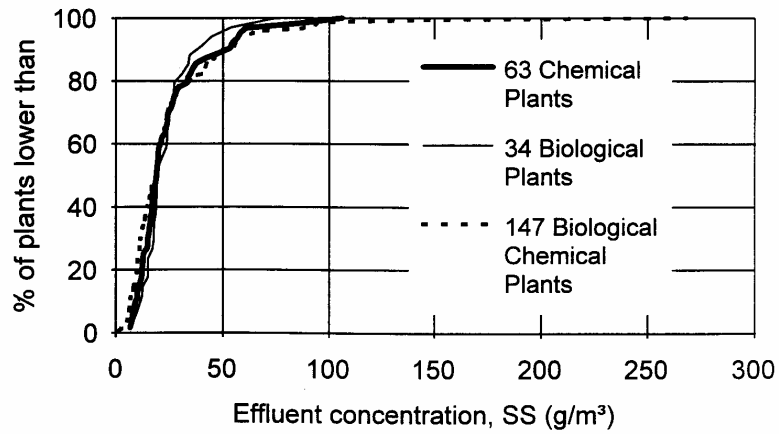
[1)] Antall anlegg

EXPERIENCES FROM ALL SMALL PLANTS

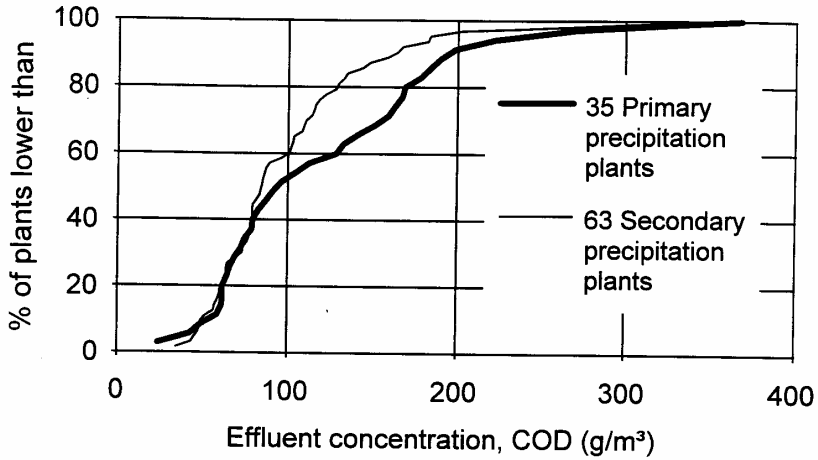


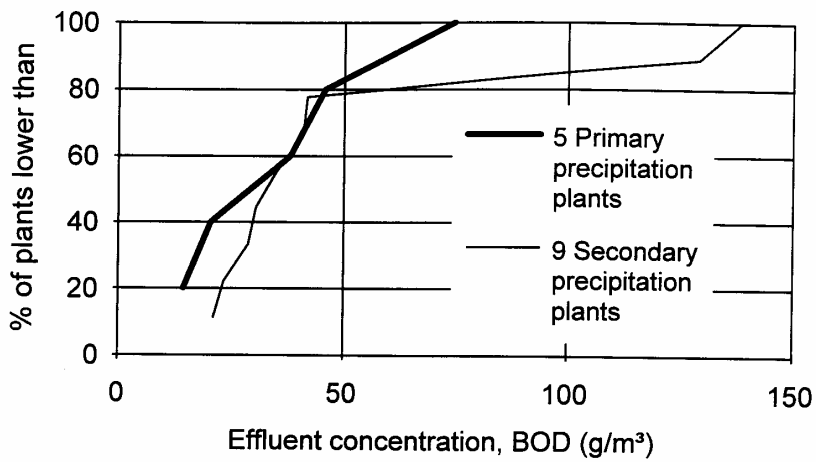


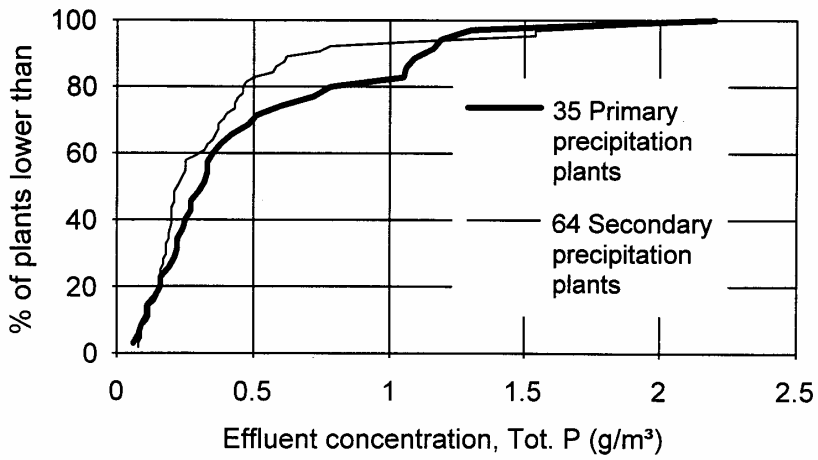


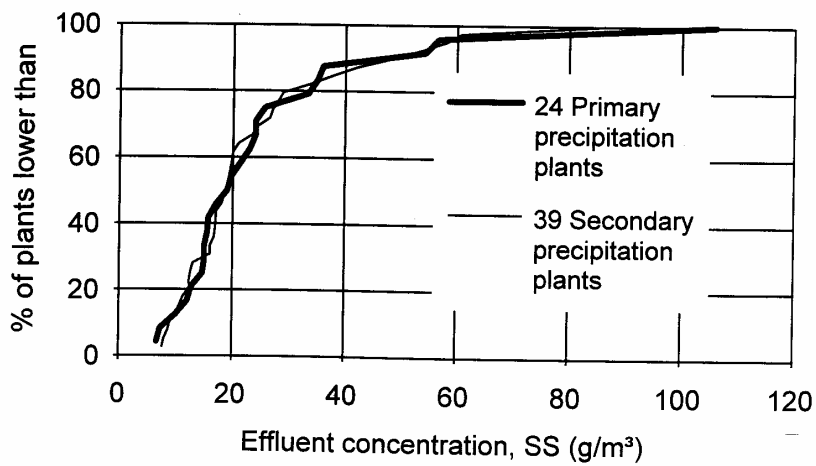


EXPERIENCES SMALL CHEMICAL PLANTS

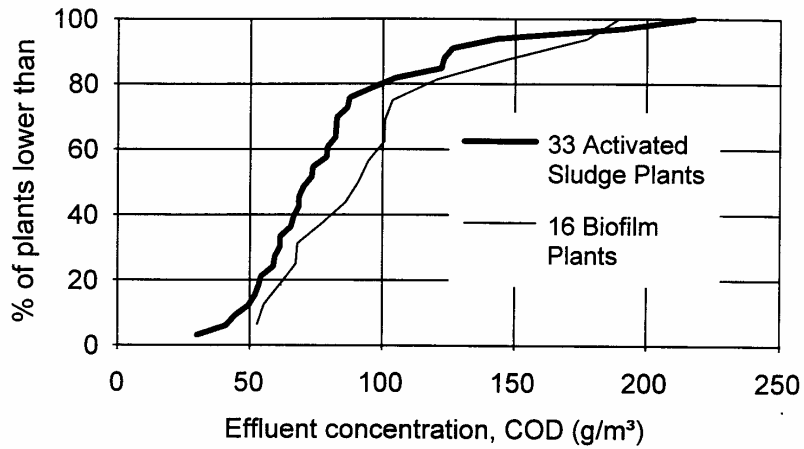


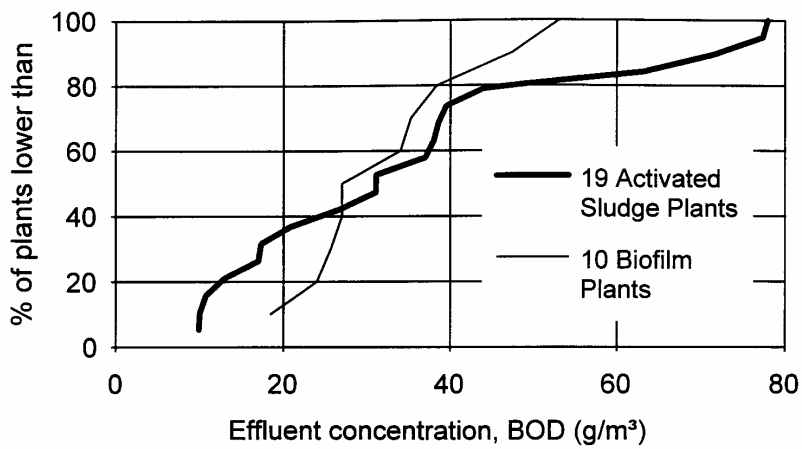


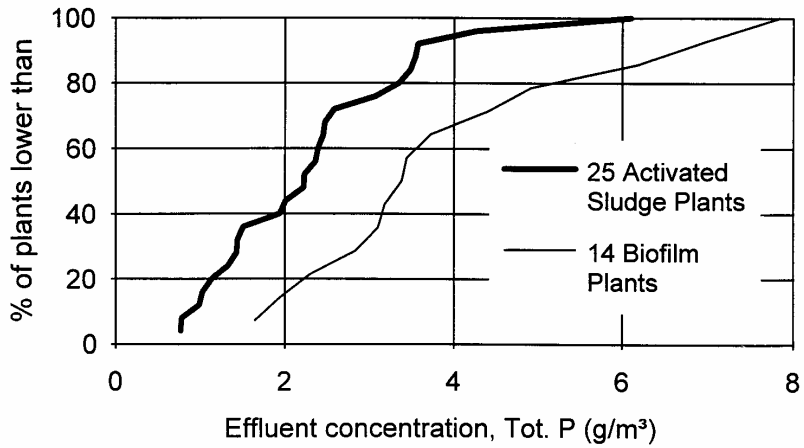


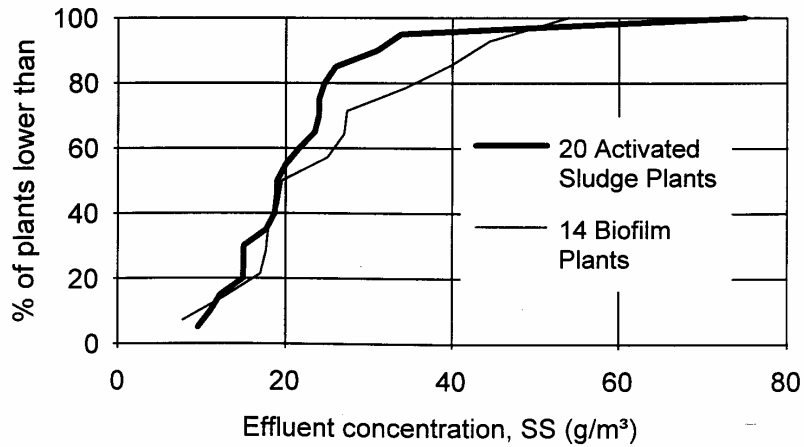


EXPERIENCES SMALL BIOLOGICAL PLANTS

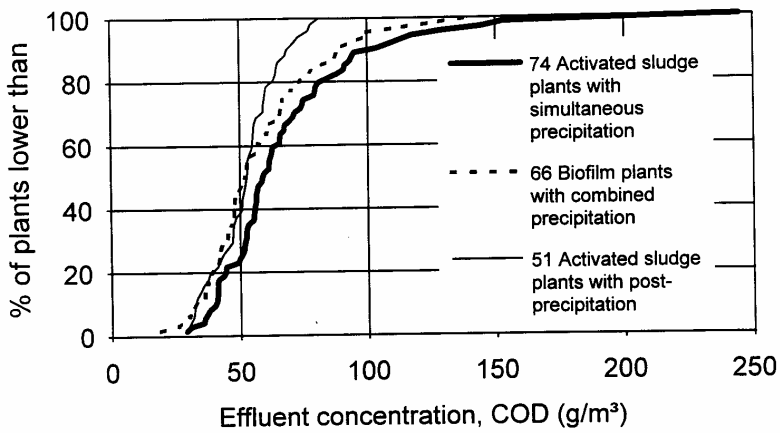


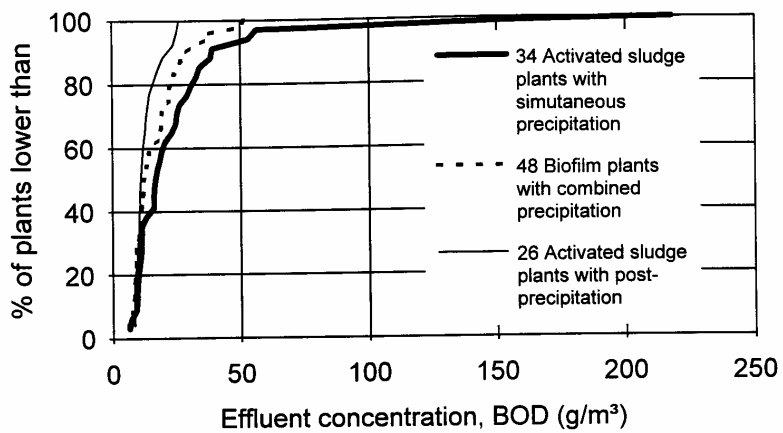


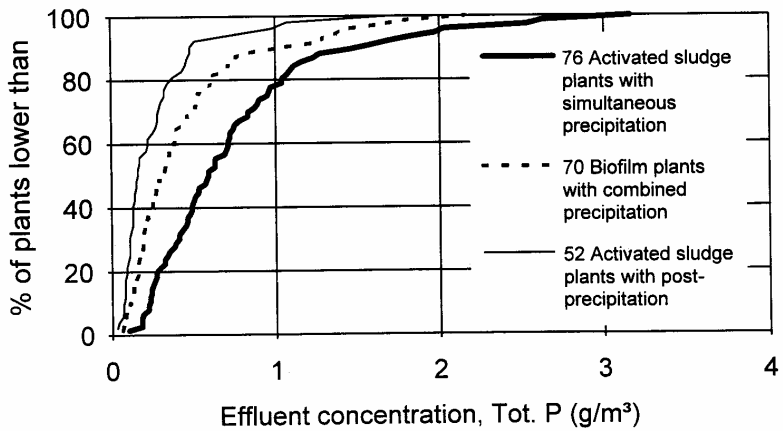


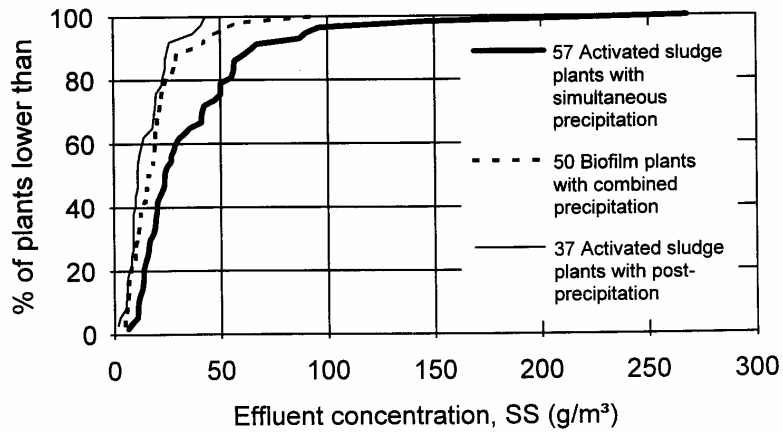


EXPERIENCES BIOLOGICAL/CHEMICAL PLANTS









Frequency plots for effluent concentration in small waste-water treatment plants in Norway operating after various treatment methods

Reference:

Ødegaard, H. og Skrøvseth, A.F.: "An evaluation of performance and process stability of different processes for small wastewater treatment plants". Wat. Sci. Tech. Vol. 35, No 6, 1997, 119-127.