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REGIONAL AFRICA

REGIONAL AFRICA LEATHER AND FOOTWEAR INDUSTRY SCHEME

US/RAF/92/200/11-06

MISSION REPORT (*)

to ETHIOPIA - July 1993

WALLIA TANNERY

Based on the work of

Mr. G. Clonfero, tannery effluent treatment expert

Backstopping officer: Aurelia Calabrò
Agro-Based Industries Branch

* *This report has been reproduced without formal editing*

ABSTRACT

This paper is prepared by Mr. G. Clonfero, UNIDO Tannery Effluent Treatment Expert during a two-week mission in Ethiopia for the project US/RAF/92/210.

The purpose of the mission was:

1. Nalbandian Tannery

   To prepare a design for the effluent treatment plant with appropriate fluxgrams, equipment specifications and cost estimates. The design includes sludge handling and disposal.

2. Ethiopian Pickling and Tanning

   To prepare a design for the effluent treatment plant (both primary and secondary including the treatment of sludge) with appropriate fluxgrams; to assist in the design and/or adaptation of the civil works for the plant and to prepare specifications for the equipment required with cost estimates.

3. Dire and Wallia Tanneries

   To improve the efficiency of the existing systems (including the handling of sludge of tanneries with similar problems.

The expert visited twice all the above listed tanneries with Mr. Seyoum Hailu, National Expert.

During the visits all the data of the proposals have been explained and discussed; the available data have been controlled directly in the tanneries, so that the necessary corrections have been made.

The expert believes that the managers of the tanneries have well understood the proposed technical solutions. The actual problem is represented by the fact they do not know which further action UNIDO will take. It is obvious that until they will know clearly if a UNIDO assistance for the necessary "hardware" will come true, they will not take any decision about the problems. Therefore, it is important that UNIDO shows the intentions about the future development of the project.

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WALLIA TANNERY

ETHIOPIA

1. FACTORY'S DATA AND OTHER INFORMATION

- Tannery capacity: 250 bovine hides, dry 5-7 kg/pc
  and
  2,000 sheep skins, wet-salted 1.3-1.4 kg/pc
  or
  2,000 goat skins, dry 0.5 kg/pc

  In total 7,000-8.000 kg/day green weight.

- Production: current
  wet-blue
  future
  also crust

- Process: conventional hair pulping system (lime and sodium sulphide) and chrome tanning. Sheep skins only: hair removal by painting.

- Work time: 6 days p/er week, 1 shift (8 hrs) per day.

- Water consumption: 50 m^3/day (factory's data), i.e. 6-7 l/kg of green weight. Also considering the current wet-blue production this figure seems underestimated. 100 m^3/day is a more realistic figure.

- Industrial waters: discharged into the same gully. At the present the beamhouse and tanning effluent are not separated.

- Rain water: separately discharged.

- Tannery location: rural area, distance from residential area 10 km ca.

- Recipient body: Akaki river.

- Limits for discharge: at the moment, no definitive standards exist. A new Minister for Natural Resources and Environmental Protection has been constituted in Ethiopia on October 1992: a more defined regulation is expected in short times.

2. BRIEF DESCRIPTION OF THE PROPOSED INTERVENTIONS

2.1 SEPARATION OF THE EFFLUENTS

The effluents from the beamhouse and tanning departments must be collected into two different channels. Few simple interventions inside the factory are sufficient for realizing this separation. The separation of the chrome containing liquor is mandatory if a chrome pretreatment will be installed (see paragraph 2.3).

2.2 SCREENING

Current situation:
a proper removal of coarse solids is not done.

Proposed intervention:
installation of two bar screens (one for each discharge gully).

Dimension of the concrete pit for the screen installation:
- width 50 cm,
- length 100 cm,
- same depth of the inlet channel.

Characteristics of the screen (see annexed sketch)
- bar screen to be manually cleaned (rake),
- slope 60° on the horizontal,
- spacing between bars 10 mm,
- capacity 50 m^3/h ca.

The screens can be locally realized using smooth steel bars (8-10 mm diameter) for building. The bars must be cut (the total length must be calculated on the base of the channel depth), curved at an extremity as a walking stick (r = 10 cm ca.) and electro-welded at the extremities to two steel plate or angular profiles.

Example:
installation of the screen in a pit of 50 cm width and 100 cm depth. The steel bars have a section (diameter) of 10 mm and they will spaced of 10 mm.
Total number of bars (500 : 20) = 25 pieces.
Total length (L) of the original bar piece (before bending):

L = 1.155 H + 30 cm H = channel depth 100 cm

L = 145.5 cm.

Part to be curved 30 cm ca.

2.3 PRETREATMENT OF CHROME WASTES:

Note : *the separate pre-treatment of the Chrome liquors was proposed as optional. At the moment a specific regulation does not exist in Ethiopia, but. it may be imposed in future because of the trend in East African countries to request it and to make difficulties for the disposal of chrome containing sludges.*

Current situation:
no separation of the chrome effluents, all the waste waters are mixed in one gully.

Proposed intervention:
separation of the discharges and installation of a precipitation tank for chrome and two dewatering beds for the chrome hydroxide sludge.
Other not chrome containing wastes discharged by the tanning department can be eventually by-passed into the other discharge gully. To programme the chrome discharge not simultaneously with other tannery effluents seems a practical way.
Furthermore, being a pre-treatment and not a recovery, the separation can be carried out without an excessive care.
No big problems if few other wastes are mixed with the chrome one.

Precipitation

The chrome precipitation will be carried out in batch only when the precipitation tank is full.
The alkali, lime-milk, is manually added and the final pH (8-9) checked by means of paper indicator. The lime-milk will be extemporaneously prepared manually by the operator.
At this pH the trivalent chrome is quantitatively precipitated as hydroxide.
During this operation the liquor in the tank must be mixed (mechanical mixer or air injection).
Note: the compressed air may be taken from the same blower of the equalization tank (see this paragraph).

Sedimentation

Ultimated the precipitation, the mixing is stopped and the solids settled. The minimum period of quiet is four hrs ca. but an overnight sedimentation is recommendable.

Discharge of the supernatant

After sedimentation and thickening of solids, the operator manually opens the discharge valve that sends by gravity the supernatant (virtually "chrome free") into the equalization tank where it is mixed with the other effluents.
The discharge valve is connected with a flexible pipe that permits the operator to draw-off the supernatant without discharge the hydroxide sludge that remains into the precipitation tank.
Successively, other chrome precipitation cycles are carried out in a similar way. The operator must only take care that the chrome hydroxide does not exceed the supernatant discharge level.

Discharge and dewatering of the chrome sludge

When the sludge blanket in the precipitation tank reaches the level of 1 m ca., the sludge draw-off must be carried out.
This operation is done by means of a submersible pump installed into a pit at the tank bottom.
Note that the removal of the majority of solids is necessary, not a complete cleaning of the tank from sludge.
In any case, this simple system resulted fully reliable.
The sludge is pumped to the chrome sand beds for dewatering.
To fill the sand drying beds at a maximum height of 30-40 cm of fresh liquid sludge is recommended.

A wood plank or a concrete slab must be placed at the sludge inlet point of the bed for avoiding the excavation of the sand layer.
When the sludge is dry the residual cake must be removed and disposed of. This operation can be done with a folk.
Cleaned the bed from solids, the sand surface must be smoothed with a rake.

List of the necessary facilities

Chrome storage and precipitation tank (civil work)
Expected max. volume of the chrome wastes: 18 m^3/day (*) - total volume 30 m^3 (useful 25 m^3 ca.).
Indicative dimensions: 3.5 x 3.5 x 3 h metres (useful height 2.5 m ca.).
Minimum volume for the storage of the chrome hydroxide sludge (25 - 18) = 7 m^3 ca.
Completely underground construction (the tank must be fed by gravity) with 15-20 cm of external board (above the ground level) to avoid stones or other solids to enter.
At the tank bottom is installed an air distribution device.
(*) The expert has considered a total safety volume (tanning, retanning and wet-blue pressing waters) of 200% on the green processed weight; i.e. 9,000 x 2 = 18 m^3.

n.1 mixer for the mixing of the chrome precipitation tank (to be locally constructed or imported: Antico Olindo - Italprogetti or similar).
Materials:
- shaft and paddles in stainless steel AISI 304 or epoxy painted steel.
Characteristics :
- shaft length : 300 cm ca.;
- shaft speed : 300 r.p.m. ca.;
- installed power : 2.2 kW, 380 V 50 Hz 3 phases.

The motor is coupled with a vertical gear box, coaxial type with oil lubricated gears.
The mixer is complete with frame in hot galvanized steel for the installation on the concrete tank.

Indicative price: 3,000 U.S.$

n.1 submersible pump, for waste waters with high solid content (to be imported: Flygt D45 - ABS or similar).
Body and propeller in cast iron with rubber paint, shaft, studs and nuts in stainless steel AISI 420.
Characteristics :
- 1.1 kW motor 380 V 50 Hz 3 phases 2 poles insulated to F Class;

- vortex impeller with solid passing of 50 mm diameter;
- capacity 400 l/min. at 4 m head (max. head 12 m ca.).
- weight 30 kg ca.

The pump is equipped with the 90°curve, connection for the flexible pipe, base stand and strainer cable.

Indicative price: 1,100 U.S.$

Chrome sludge drying beds (civil work)

Number of beds: 2.
Surface dimensions: 4 x 8 m each.
Average height: 1 m.
The filtering surface is constituted of :
- cm 10-15 upper layer of sand 0.3 - 0.6 mm;
- cm 5-10 lower layer of crushed stone 15-20 mm.

Lateral walls 20 cm thick in blocks reinforced with steel bars 8 mm diam. placed every 50 cm and connected with the bottom r.c. plate and r.c. tie beam at summit level. The internal surface is finished with plastering.
The beds are constructed above the ground level and the filtration waters must be piped to the general treatment.

2.3 EQUALIZATION AND SULPHIDE OXIDATION FOLLOWED BY PRIMARY SEDIMENTATION:

Current situation:
A circular tank [upper diameter 17.5 m, lower diameter 12 m, total height 2.5 m (useful 2.0 m ca.); usable volume 350 m^3 ca.] has been installed.
The original design includes a mechanical mixing device installed on a central platform (presently the mixer is out-of-order). The solids should settle in the tank bottom and the supernatant go by gravity into a lower lagoon (625 m^2 ca. surface). After further settling into this lagoon the effluent is discharged into the Akaki river.
The cicular tank should be periodically cleaned from solids discharging them by a lower pipe with the aid of the overmentioned mixer.

In practice, the current situation is the following:

the mixer is out-of-order and the effluent and solids are directly discharged into the lagoon. This causes big proplems both in dewatering and cleaning from solids the lagoon.

Proposed intervention:
Use the existing tank as equalization and sulphide oxidation tank and install a proper primary sedimentation tank for the removal of solids.
At the beginning, neither $MnSO_4$ (catalyst of sulphide oxidation) nor chemical flocculation (Alum and Polyelectrolyte) are recommended: these chemical can be used in a second step (when and if necessary).

List of the necessary facilities

Equalization tank

Tank of 350 m^3 ca. useful capacity (existing civil work).
In order to avoid deposit of solids and oxidize sulphides, the tank must be equipped with a mixing/aeration device.
The existing platform in concrete must be eliminated.

n.2 Venturi ejectors consisting of a submersible pump coupled with a Venturi tube and (to be imported: Flygt Flo-Get 112-31 or similar).
Characteristics:
- 3.1 kW motor 380 V, 50 Hz 3 phases 4 poles insulated to F class;
- 1 ejectors Mod. 4812 100 mm diameter. length 1,000 mm with nozzles of 55 mm diameter and 3 m snorkel for the air suction;
- oxygen transfer 3.6 kg/h at standard conditions.

Materials:
- pump's mechanical face seals with tungsten carbide seal rings for continuous operation.
- Venturi tube and snorkel in stainless steel AISI 304, nozzle in plastic material.

Indicative price:10,000 U.S.$

or in alternative

n.1 floating aerator, high speed type,(to be imported: Fenwick, Italprogetti or similar).
Characteristics:
- propeller rotation 1450 per min.,
- motor 10 kW, 380 V, 50 Hx, 4 poles, protection IP 55.
- oxygen transfert 12 kg/h at standard conditions.

Materials:
- propeller and shaft in stainless steel AISI 304.
- floating support in fibre-glass or steel with corrosion proof protection (hot galvanization or two coats of epoxy paint).

Indicative price: 12,000 U.S.$

Note: as provisional alternative the existing mixer can be restored and used for avoiding the deposit of solids. In this case (no aeration) there will be no sulphide oxidation.

Primary sedimentation tank

Sedimentation tank type Dortmund (civil work):
square surface tank with pyramidal bottom sloped at 60°.
Internal dimensions:
- square tank 5 x 5 m
- vertical wall: height 2.0 m
- pyramidal part: height 4.2 m.

Total volume 85 m^3.
The tank is partially underground and installed at a level that the water can flow by gravity from the existing circular (equalization) tank. I.e. the level of the water in the tank must be 50-100 cm lower than that in the equalization tank.

n.1 series of accessories for 5 x 5 m square sedimentation tank in concrete, type Dortmund, (to be imported: Italprogetti or similar).
Consisting of:
- 2 m length influent well of 50 cm diameter in polypropylene;
- overflow weir for supernatant in stainless steel AISI 304;
- support frame in hot galvanized steel with walk-way and parapets according to accident-prevention standards;
- inlet and outlet pipes 100 mm diam. in hot galvanized steel to be imbedded in the tank walls;
- flexible connections in PVC 100 mm diam.;
- sludge draw-off pipe 80 mm diam. in hot galvanized steel to be embedded in the tank wall.

Indicative price: 3,400 U.S.$

Note: the primary sludge will be discharged by gravity into the existing lagoon.

2.4 TREATMENT AND DISPOSAL OF SLUDGE:

- expected mean production of sludge: 0.8 kg per kg of processed material green weight (considering that the hairs of the sheep skins are removed by painting).
- total sludge production: 640 kg/day ca. as dry matter (D.M.) i.e. 16 m^3/day ca. as liquid sludge at 4% of solids.

Current situation:
the solids are discharged into the lagoon with the above mentioned problems.

Proposed intervention:
The existing lagoon will be divided in smaller portions and used only for the sludge dewatering.
At the moment, because of the local economical situation, the expert does not believe realistic the recommendation of an expensive mechanical dewatering alternative for sludges.

Sludge disposal:

Lagoons of natural ground will be used for the sludge dewatering, they (tentatively) should have a max. liquid sludge height of 50 cm (to allow the complete drying in about 3 months of dry season).
The existing lagoon (625 m^2) seems insufficient, the total surface must be increased using the remaining area. At minimum two lagoons must be installed. During the lagoon feeding period, the supernatant water must be discharged trough an overflow to Akaki river. In this way a thickening of about 250% can be expected (i.e. an increase of the D.M. from 4 to 10% and a reduction of the volume of 2.5 : 1). When the max. thickening is obtained (the sludge blanket reaches the overflow), the sludge must be by-passed into the adjacent empty lagoon and the drying cycle of the filled lagoon starts.
The capacity of a lagoon must be equal to the volume of the sludge produced in 3 months ca. (to allow the sludge storage in the wet season). I.e. in the case of Wallia tannery (640 x 75) 48,000 kg of D.M. and (48 x 100 : 10) 480 m^3 of thickened sludge must be theoretically stored.
As an example, n.2 lagoons of 1,000 m^2 each with alternate cycles of feeding and cleaning every 6 months could be installed.

Note: a 2,000 m^2 area is not currently available at Wallia tannery. On the other hand this is the result of the expert's theoretical calculations. He suggests to start dividing in two parts the existing lagoon and to see what are the real performances of the existing system.

The theoretical approach to the times necessary for a natural dewatering of the sludges is always very difficult. It depends on several climatic factors and sludge characteristics, data that are difficult to be previously defined.

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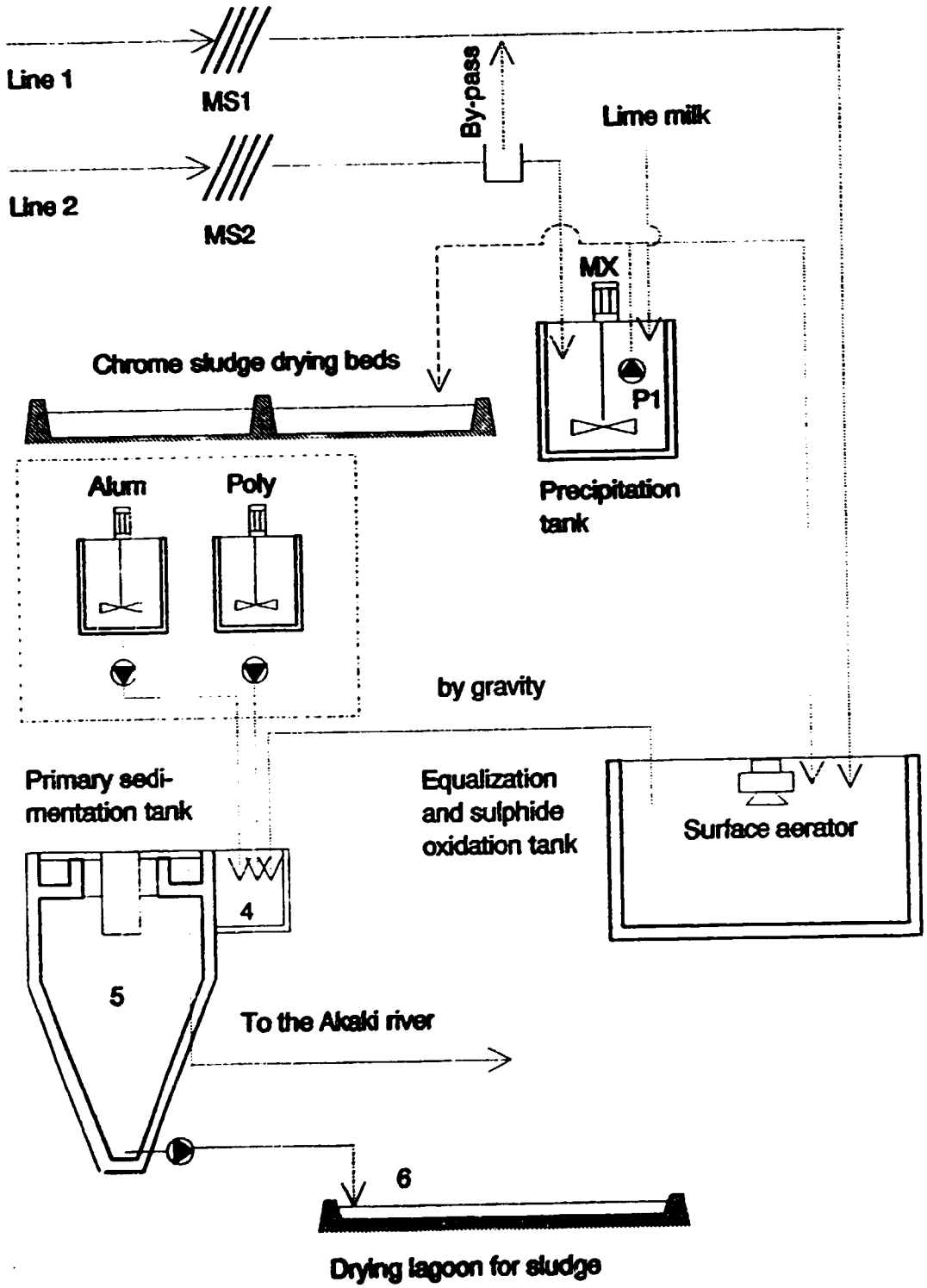
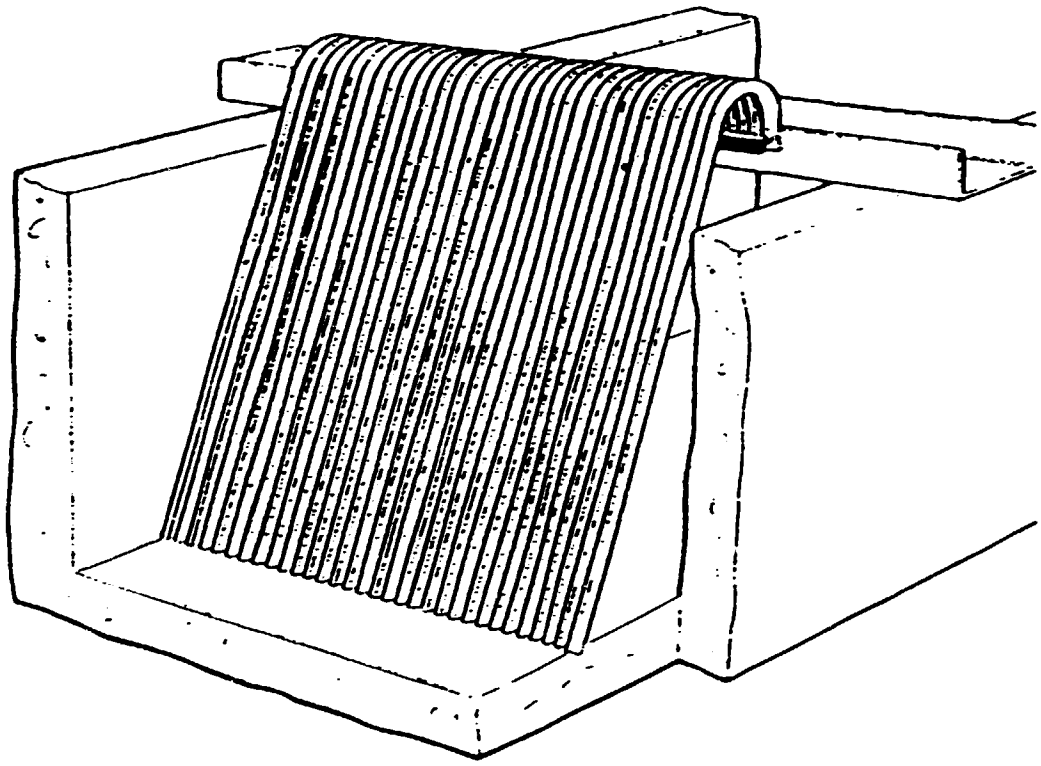
ANNEX 1

Proposed E.T.P. at
Wallia tannery - Ethiopia

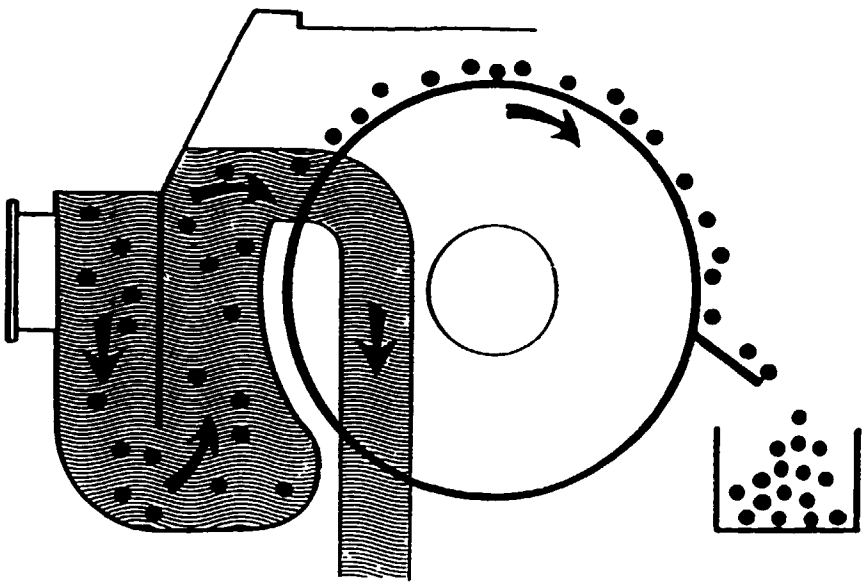


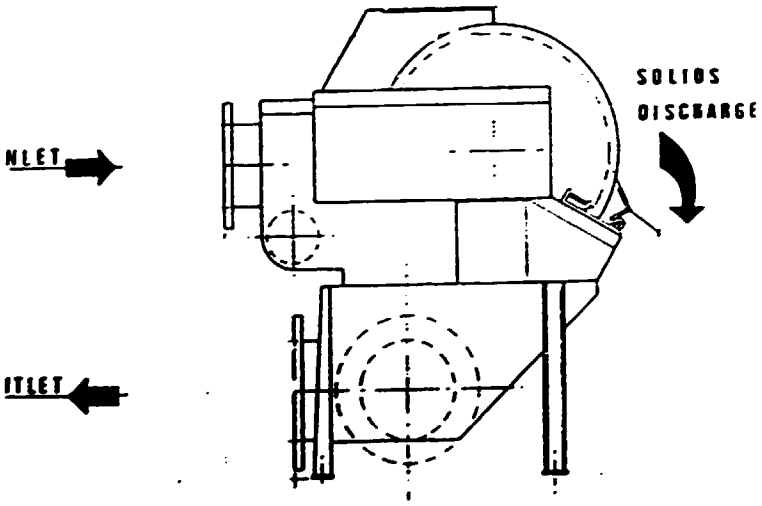
ANNEX 2

INDICATIVE PAMPHLET OF THE NECESSARY EQUIPMENTS

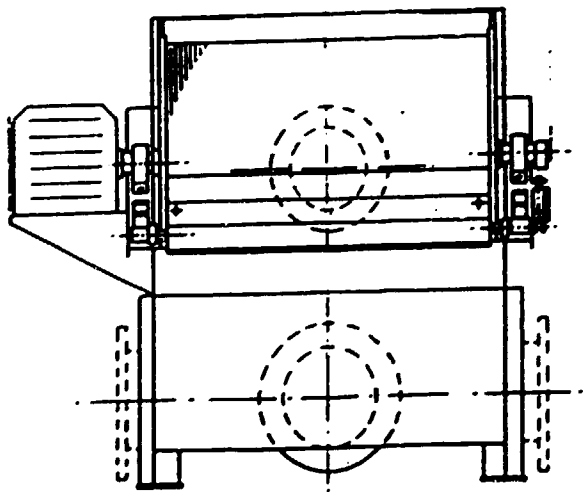


Simple manually raked screen. Flow is from left to right

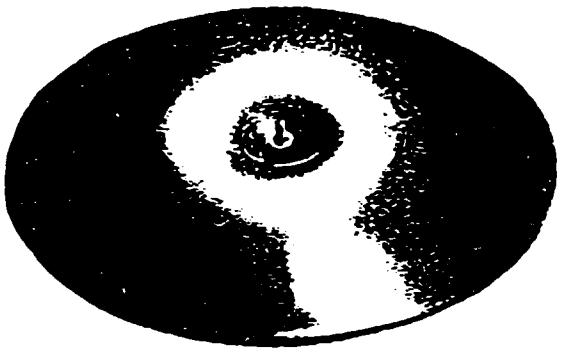


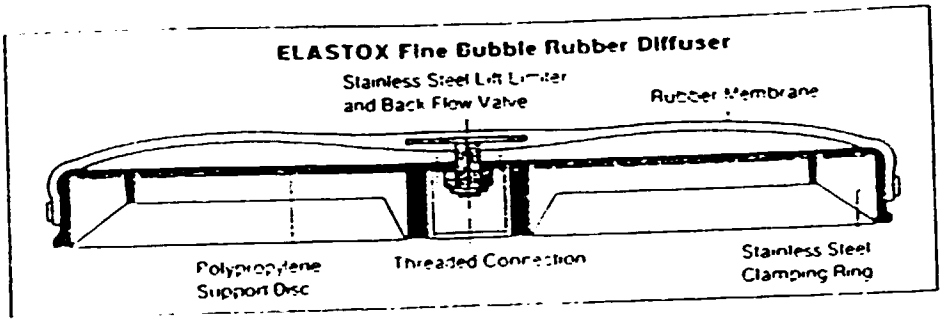


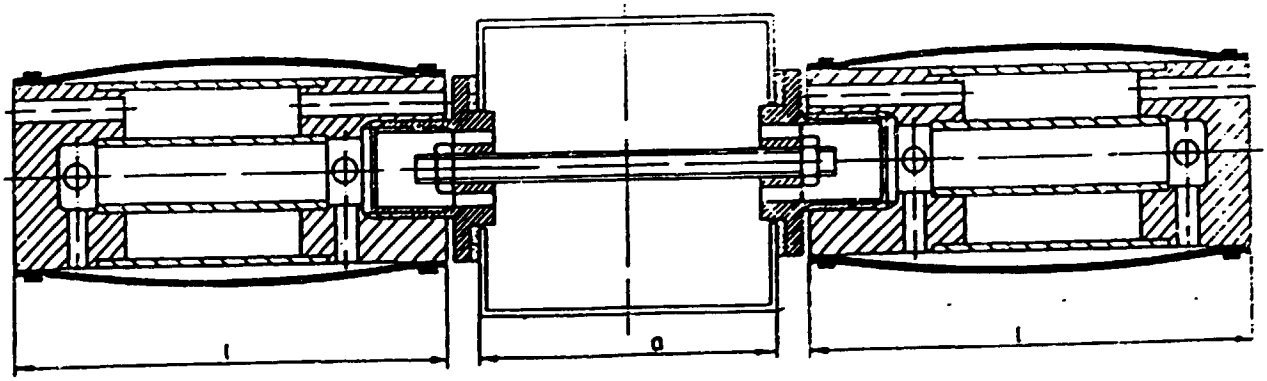
Rotating drum screen



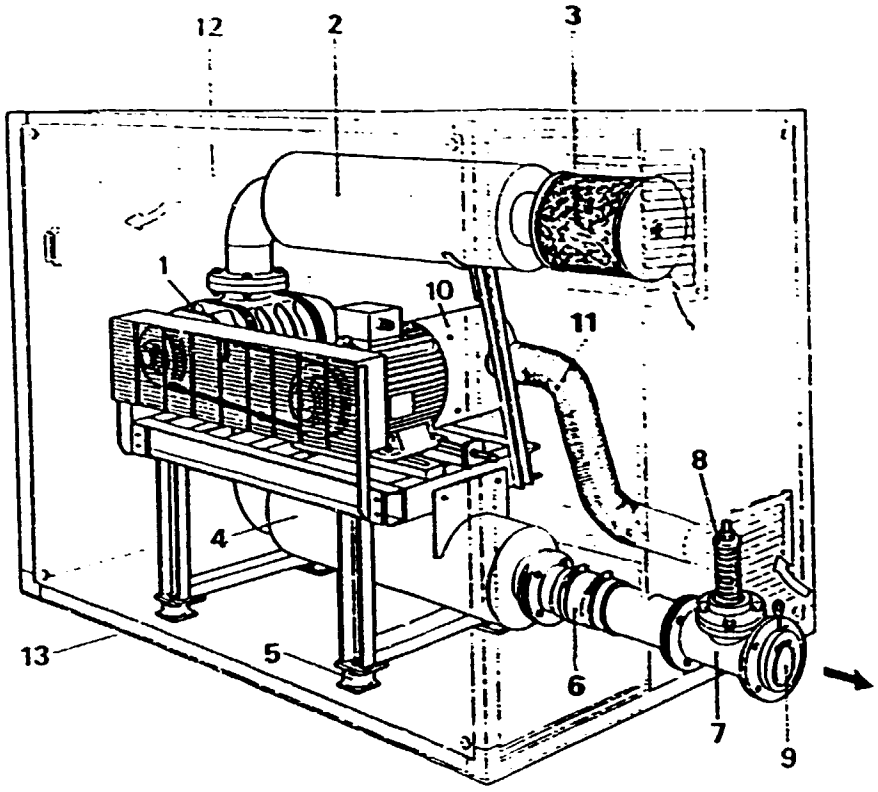
Fine bubble membrane diffusers







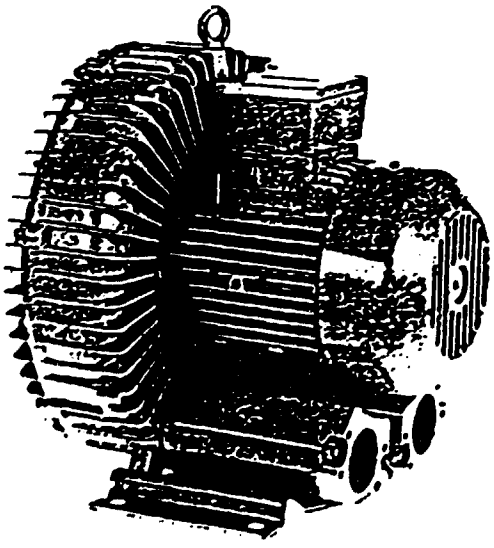
Membrane diaphragm diffuser

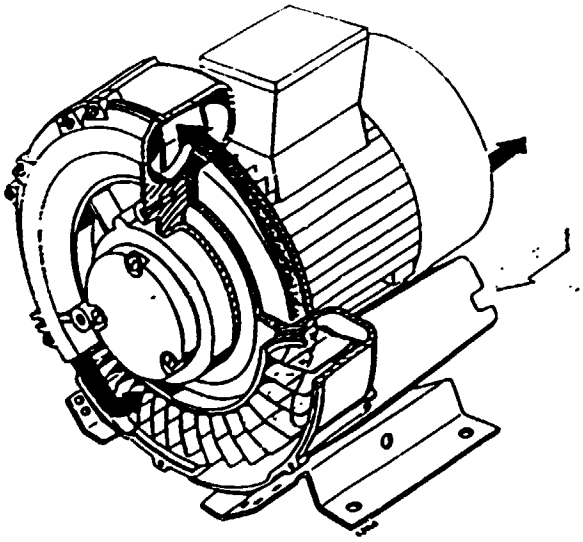


Pos.	DENOMINAZIONE
1	SOFFIATORE
2	SILENZIATORE ASPIRANTE
3	FILTRO
4	SILENZIATORE PREMENTE
5	SUPPORTI ANTIVIBRANTI
6	RACCORDO ELASTICO
7	RACCORDO A TRE VIE
8	VALVOLA DI SICUREZZA
9	VALVOLA DI RITEGNO A CLAPET
10	CALOTTA SPECIALE MOTORE
11	TUBO FLESSIBILE
12	USCITA ARIA VENTILAZIONE
13	TAMPONAMENTO CON MATERIALE ISOLANTE

Part. No.	PART DESCRIPTION
1	Blower
2	Suction silencer
3	Filter
4	Discharge silencer
5	Shock insulating feet
6	Rubber expansion joint
7	Three way connection
8	Safety valve
9	Non return valve
10	Outer motor cap
11	Flexible air duct
12	Air outlet
13	Plugging by insulating material

Blower





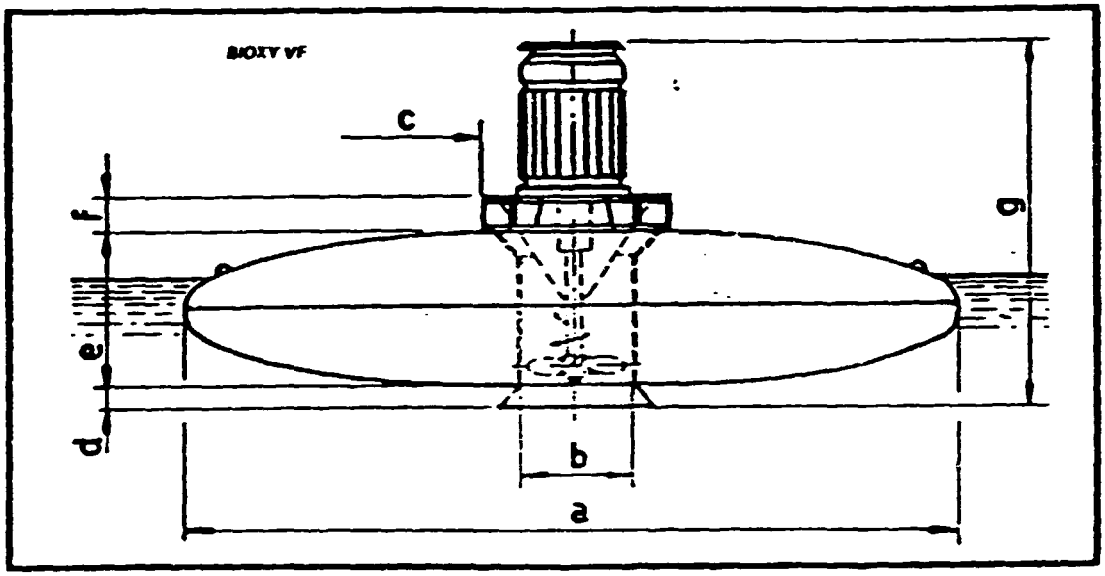
series

"BIOXY-VF"

FLOATING HIGH SPEED AERATORS

These machines have a " pancake " type of float that support it and the axial thrust generated by a marine shaped propellier running at high speed.

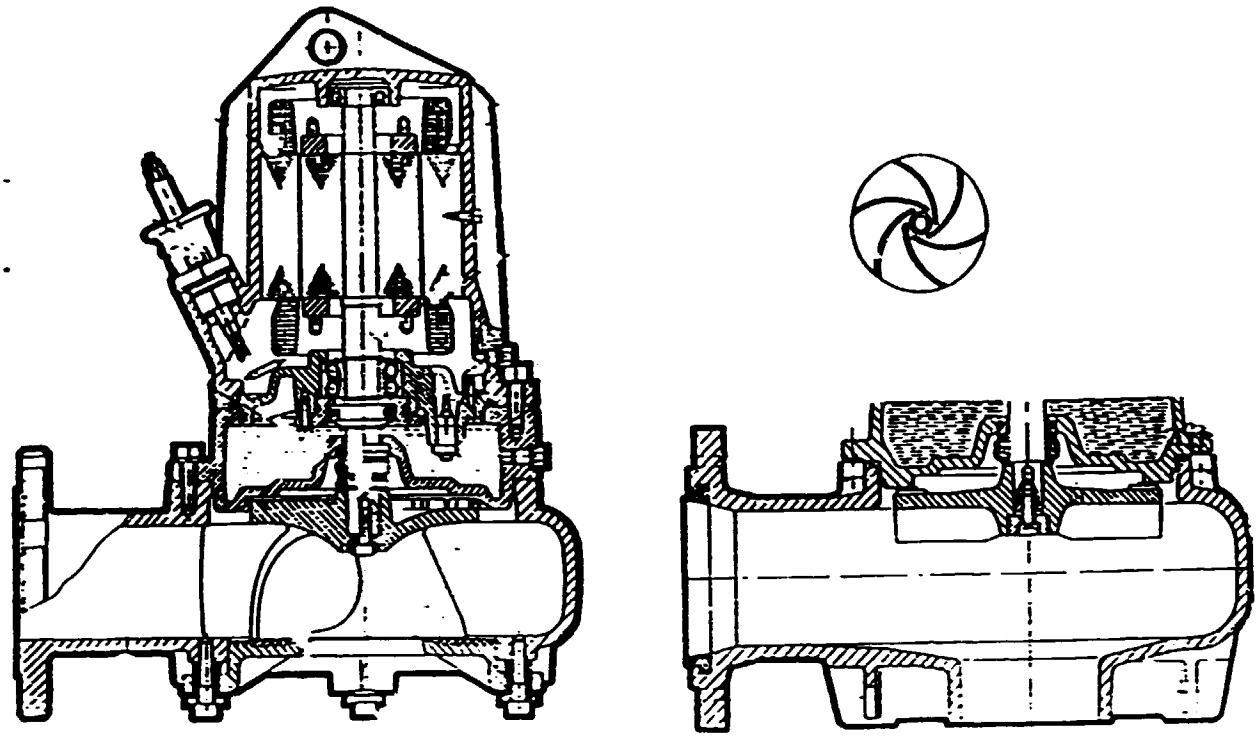
The floating high speed aerators can be manufactured in anticorrosive materials and stainless steels.
The construction of the aerators is such that it can follow the level of the liquid thereby maintaining a high oxygen transfer irrespective of the depth of the liquid.
Aerators developed from the " BIOXY-GA " low speed type.
The installation is extremely simple and does not require civil works or support bridge.



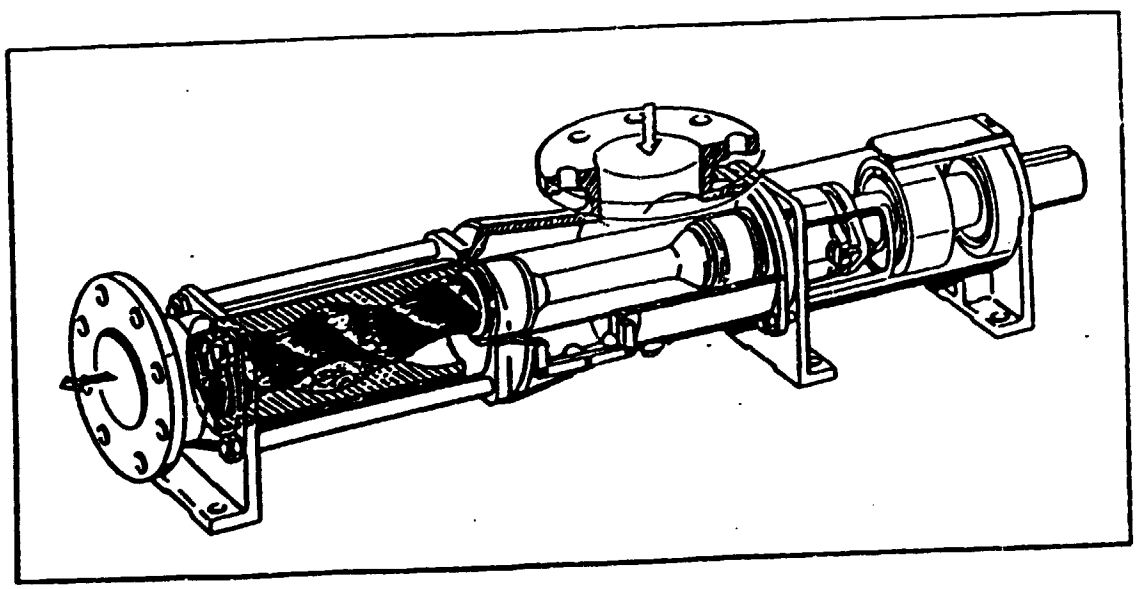
BIOXY TYPE	N° POLE MOTOR	PUMPING RATE m³/h	O_2 ABS. Kg.·C.	SHAFT Ø	"PANCAKE" FLOAT a	c	e	BAFFLE PLATE c	f	DIMENSIONS g	BIOXY TYPE
VF-1	2	680	5.2	40	1600	240	70	310	580	275	964	VF-1
VF-2	4	740	6.3	40	1600	240	70	310	500	275	964	VF-2
VF-3	5.5	850	8.4	60	1600	240	70	310	500	275	1003	VF-3
VF-4	7.5	980	9.8	50	1900	300	110	400	580	330	1204	VF-4
VF-5	11	1250	12.2	50	1900	300	110	400	580	330	1262	VF-5
VF-6	15	1450	17.3	50	1900	300	110	400	580	375	1372	VF-6
VF-7	20	1870	21.0	50	1900	300	110	400	580	375	1372	VF-7
VF-8	25	2280	26.5	60	2100	340	110	460	650	429	1529	VF-8
VF-9	30	2570	42.5	60	2100	340	110	460	650	429	1589	VF-9
VF-10	40	3520	57.6	70	2500	350	110	700	700	469	1935	VF-10
VF-11	ø 50	4250	72.4	70	2500	340	110	700	770	504	2056	VF-11
VF-12	ø 60	5150	87.7	70	2500	500	110	700	770	514	2284	VF-12
VF-13	ø 75	6520	112	70	2500	500	110	700	770	514	2284	VF-13
VF-14	ø 100	8560	144.7	80	3000	500	110	800	880	600	2485	VF-14
VF-15	ø 125	10.520	169	80	3000	500	110	800	880	770	2588	VF-15
VF-16	ø 150	12.100	198	80	3000	500	110	800	880	770	2588	VF-16

ø 6-pole motor

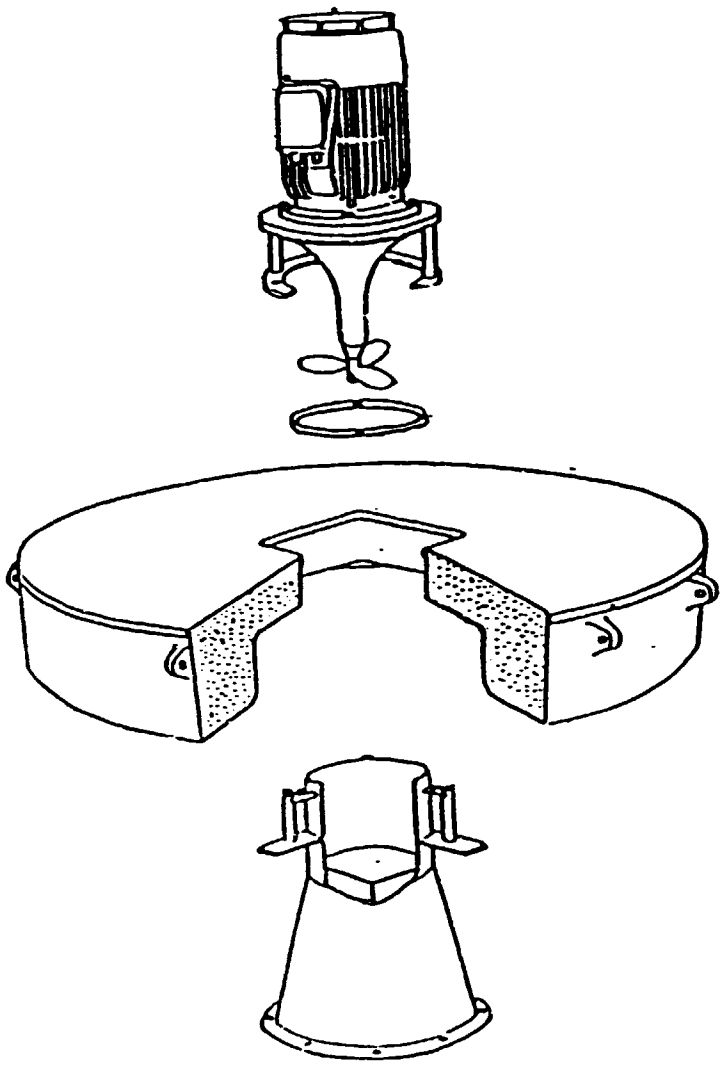
Surface aerator



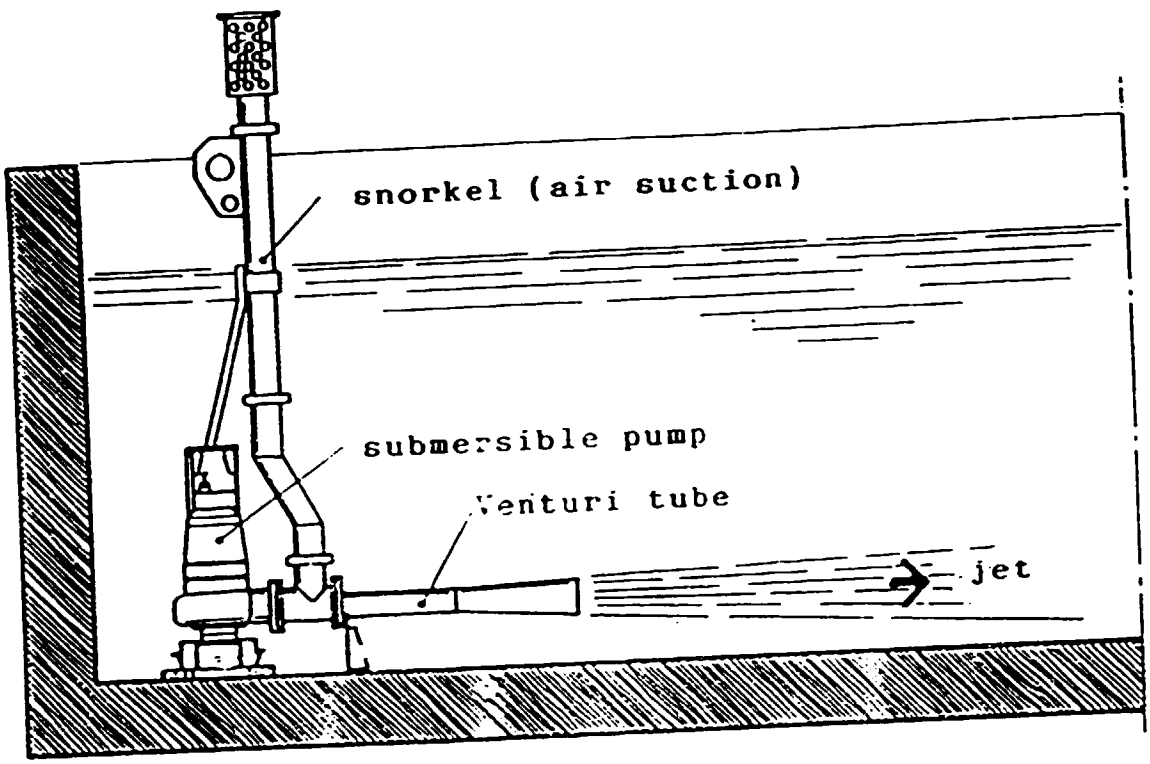
Submersible pumps

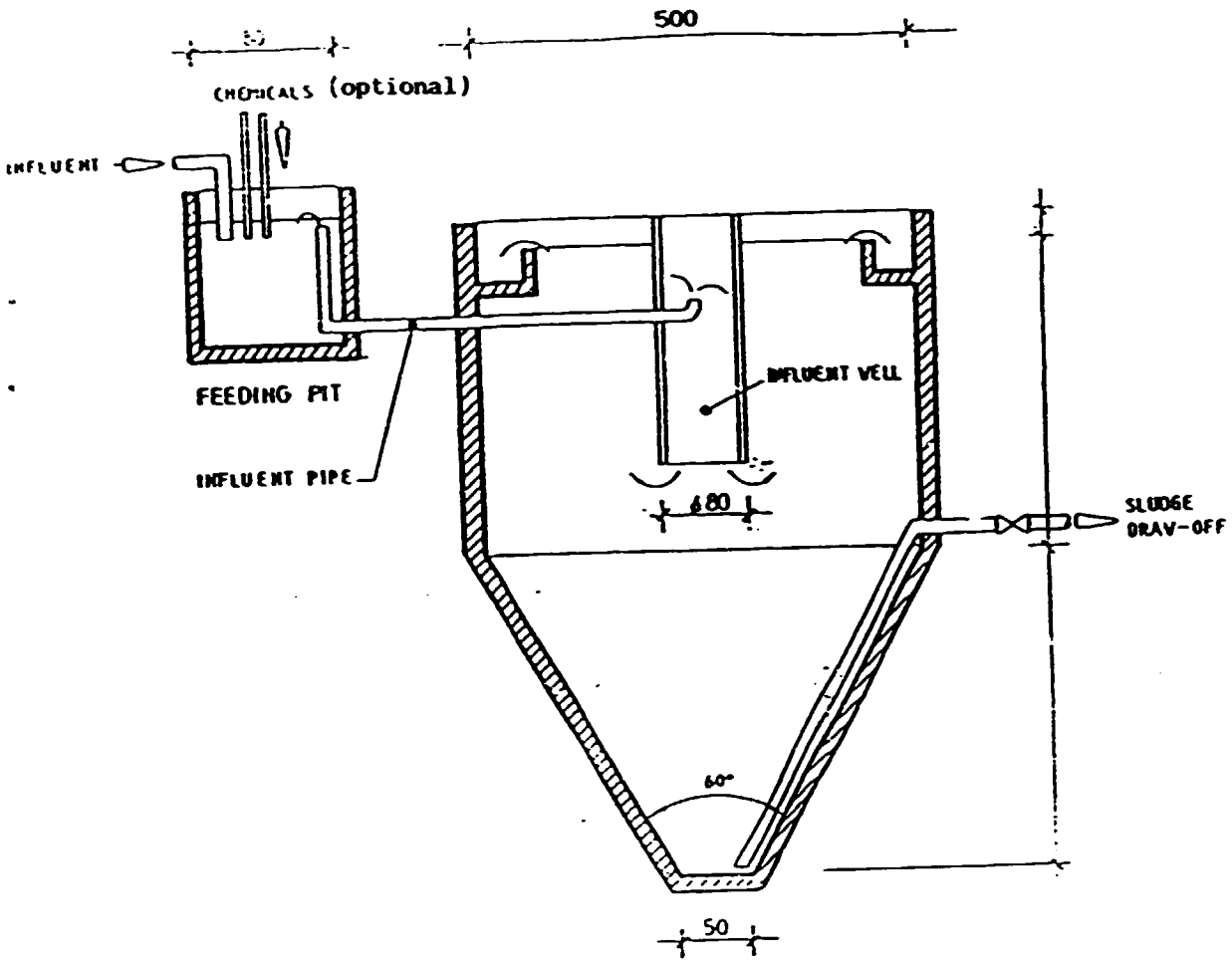


Screw pump

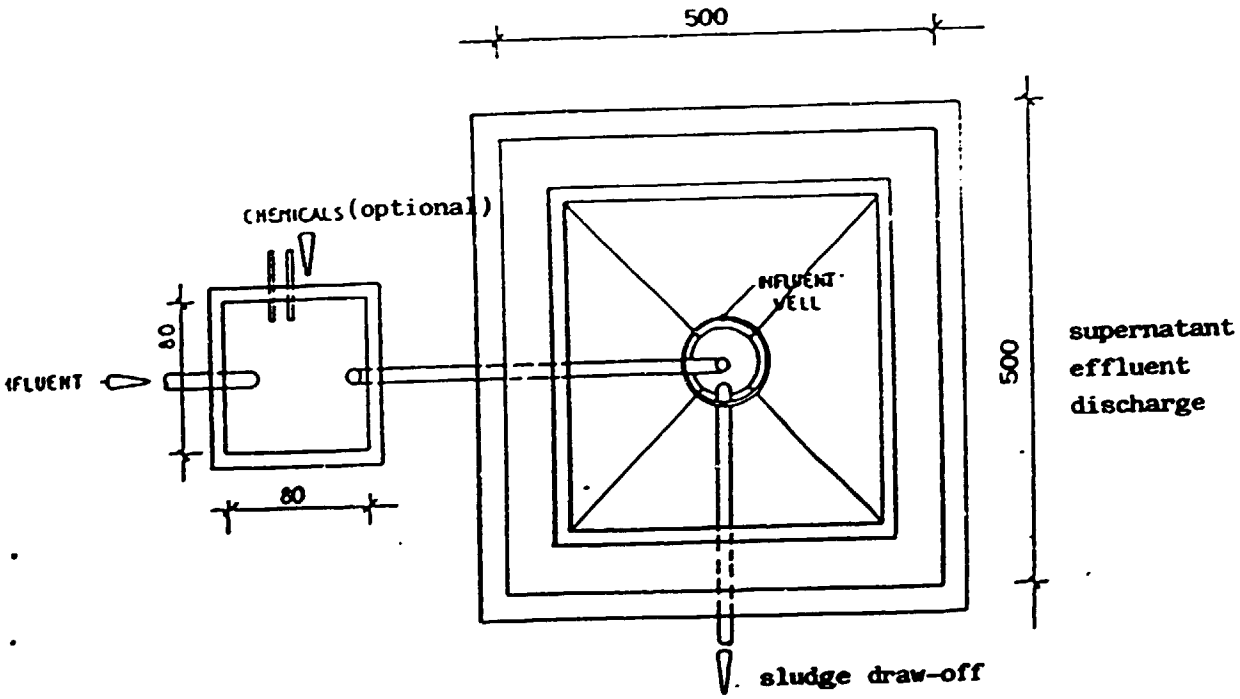


VENTURI EJECTOR (Assembly)

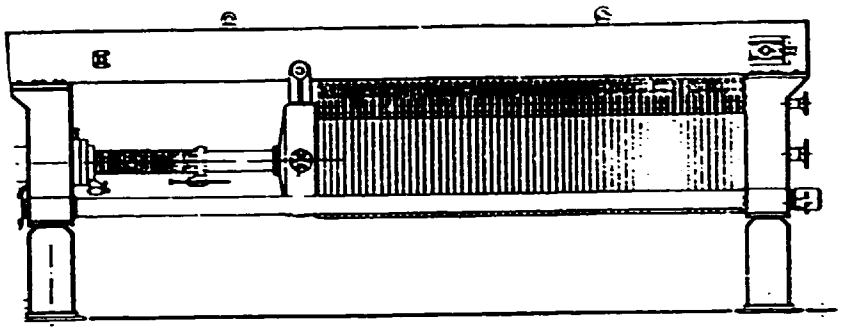


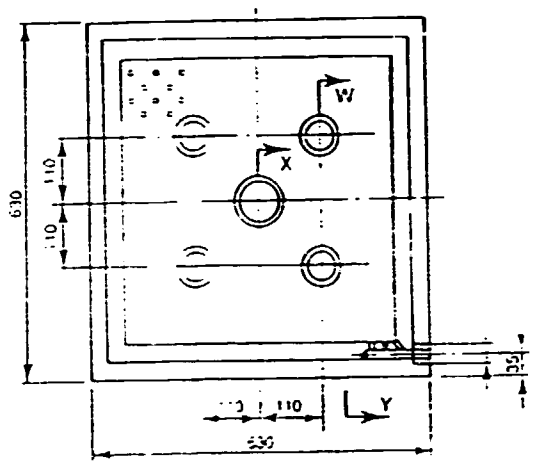


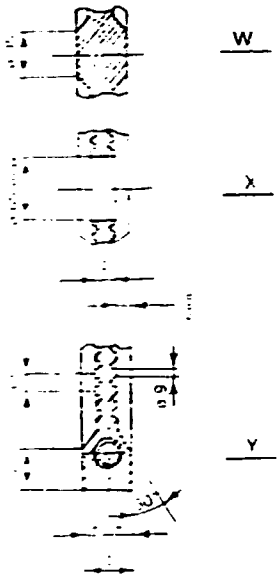
NOTE: NOT IN SCALE!



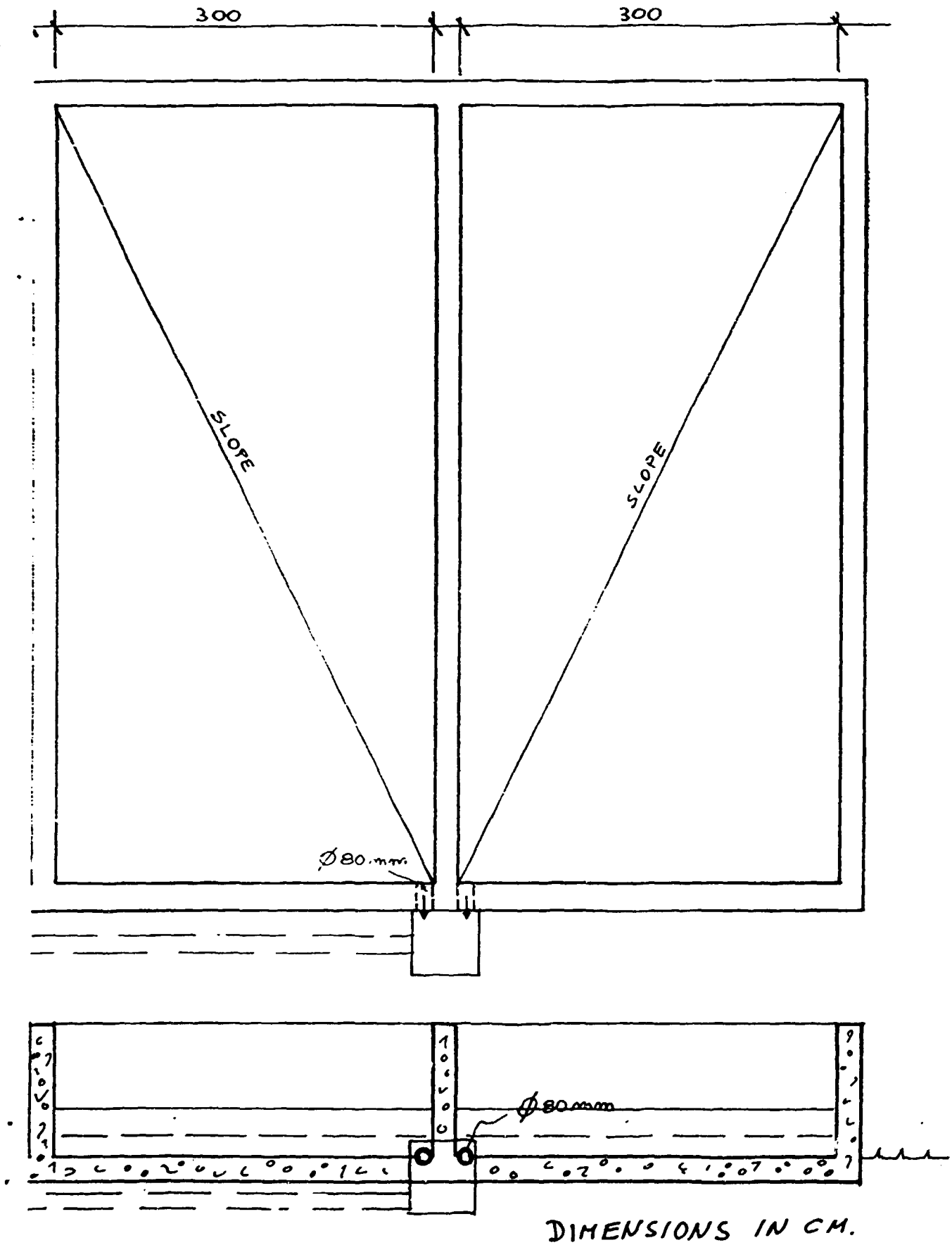
PRIMARY STATIC CLARIFIER
Pyramidal







Filter press with plate 630 x 630 mm



Sludge drying beds