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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

DIRE TANNERY

Based on the work of

Mr. G. Clonfero, tannery effluent treatment expert

Backstopping officer: Aurelia Calabrò
Agro-Based Industries Branch

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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/92/20C.

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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DIR TANNERY

ETHIOPIA

1. FACTORY'S DATA AND OTHER INFORMATION

- Tannery capacity: 2,000 sheep skins, wet-salted 1.1 kg/pc or dry 0.7 kg/pc
3,000 goat skins, dry 0.5 kg/pc
200 bovine hides, dry 5.5 kg/pc (occasionally)
In total 8,000-9.000 kg/day green weight.
- Production: current
hides (sides) and goats wet-blue for export
sheep pickled for export

future
crust for export
finished for local market only.
- Process: conventional hair pulping system (lime and sodium sulphide) and chrome tanning.
- Work time: 6 (sometime 7) days per week, 1 shift (8 hrs) per day and night-watchman.
- Water consumption: 100 m³/day (factory's data), i.e. 11-12.5 l/kg of green weight.
- Industrial waters: discharged into two separate gullies (wastes from beamhouse and tanning departments respectively).
- Rain water: separately discharged.
- Tannery location: close to a residential area. The more urgent problem is the neighbours claim against the bad smell.

- Recipient body: small stream discharging after some kilometres into the 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 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 m³/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 be spaced of 10 mm.

Total number of bars (500 : 20) = 25 pieces.

Total length (L) of the original bar piece (before bending):

$$L = 1.155 H + 30 \text{ cm} \quad H = \text{channel depth } 100 \text{ cm}$$

$$L = 145.5 \text{ cm.}$$

Part to be curved 30 cm ca.

2.2 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:

the inside separation of the chrome department is already realized but the effluents are successively mixed outside the factory.

Proposed intervention:

installation of a separate 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 fork.

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: $18 \text{ m}^3/\text{day}$ (*)

- total volume 30 m^3 (useful 25 m^3 ca.).

Indicative dimensions: $3.5 \times 3.5 \times 3$ 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 $15-20 \text{ cm}$ 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. $9,000 \times 2 = 18 \text{ m}^3$.

n.1 mixer for the mixing of the chrome precipitation tank (to be imported: Antico Olindo - Italprogetti or similar).

Materials:

- shaft and paddles in stainless steel AISI 304.

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: $3,000 \text{ U.S.}\$$

or in alternative

n. 1 air distribution device to be connected with the air blower of the equalization tank (to be imported: Nokia - Italprogetti - Flygt or similar).

Consisting of 16 non-clog membrane diffusers and ancillary equipment (pipes, flow-regulating valve, clamps and fittings).

Characteristics:

- non-clog medium-fine bubble diffusers
- capacity $4 - 6 \text{ Nm}^3/\text{h}$ of air per diffuser.

Materials:

- diffuser support in polypropylene,
- membrane in synthetic rubber EPDM,
- clamps and fittings in polypropylene,
- piping in PVC (submerged parts).

Indicative price $1,100 \text{ U.S.}\$$

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)

Note: if properly operated the dewatering of the chrome sludge by sand beds will not cause problems of bad smell. Due to their small surface, if necessary some lime powder can be sometime manually distributed on the top the sludge surface for minimizing eventual odours.

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 tank in stone blocks and concrete (dimensions 9.5 x 8.4 x 4.0 m) has been installed but not still used.

The original intention was to use it for the sedimentation of the solids before the effluent discharge.

In the expert's opinion, the original idea is not at all reliable:

- i. difficulty in cleaning from solids such a large tank;
- ii. increased risk of bad smell production during the cleaning operations.

Proposed intervention:

Use the existing tank as equalization 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 250 m³ ca. useful capacity (existing civil work). In order to avoid deposit of solids and oxidize sulphides, the tank must be equipped with an air blower and an air distribution device.

n. 1 air blower, rotary vane type (to be imported: Robuschi RB41 or similar)

Characteristics:

- body and vanes in cast iron;
- capacity 400 Nm³/h at 4 m head;
- speed 2,850 r.p.m.;
- motor 8 kW, 380 V, 50 Hz, 4 poles, protection IP 55;

The blower is complete of:

- manometer,
- in-let air filter,
- suction and discharge silencers,
- non return valve;
- safety valve;
- flexible anti-vibration connection and shock insulating rubber feet.

Indicative price: 4,000 U.S.\$

n. 1 air distribution device to installed at the bottom of the equalization tank (to be imported: Nokia - Italprogetti - Flygt or similar).

Consisting of 100 non-clog membrane diffusers and ancillary equipment (pipes, flow-regulating valve, clamps and fittings).

Characteristics:

- non-clog medium-fine bubble diffusers
- capacity 4 - 6 Nm³/h of air per diffuser.

Materials:

- diffuser support in polypropylene,
- membrane in synthetic rubber EPDM,
- clamps and fittings in polypropylene,
- piping in PVC (submerged parts).

Indicative price: 6,700 U.S.\$

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 m³.

The tank is partially underground and installed at a level that the water can flow by gravity from the existing equalization tank. I.e. the level of the water in the tank must be 50 cm ca. 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.\$

n.1 helicoidal pump, screw pump type Mohno; (to be imported: Allweiler SEP 100 or similar).

Materials:

- body in cast iron,
- rotor in hard chromium plated steel,
- stator in synthetic rubber.

The pump is coupled through a speed reducer to a 2.2 kW, 380 V, 50 Hz, 3-phases motor protection IP 55.

Other characteristics :

- rotor speed 300 r.p.m. ca.;
- capacity 4 m³/h at 20 m head.

The pump is installed on a frame in hot galvanized steel.

Indicative price: 4,150 U.S.\$

Note: the primary sludge may be discharged also by gravity (manually opening the discharge valve at the bottom) but because of the position of the primary sedimentation tank, a pump is necessary in order to lift up the sludge to the tannery level. A sludge storage tank must be located in a position that can be easily reached by the tank-truck.

2.4 TREATMENT AND DISPOSAL OF SLUDGE:

- expected production of sludge: 0.1 kg per kg of processed material green weight.
- total sludge production: 800 kg/day ca. as dry matter (D.M.) i.e. 20 m³/day ca. as liquid sludge at 4% of solids.

Current situation:

the sludge are discharged into the stream. They tried to use a sludge lagooning but were forced to stop because of the bad smell causing the claims of the neighbours.

Proposed intervention:

In the local situation the expert does not see other alternatives that the transport and disposal of the liquid sludge in a different area in which their dewatering in lagoons can be done without problems or the installation of an expensive mechanical dewatering system.

Sludge transport and disposal:

a. disposal onto soil as liquid product

- assuming a tank-truck of 10 m³ capacity: 2 travels ca. per day are necessary.

If 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). At minimum two lagoons must be installed. During the lagoon feeding period, the supernatant water must be discharged trough an overflow. During the feeding period the supernatant water must be discharged trough an overflow, 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 Dire tannery (800 x 75) 60,000 kg of D.M. and (60 x 100 : 10) 600 m³ of thickened sludge must be theoretically stored.

As an example, n.2 lagoons of 1,200 m² with alternate cycles of feeding and cleaning every 6 months could be installed.

The result of the expert's theoretical calculations must be taken with care. He suggests to start this system with smaller lagoons (also for facilitating the cleaning operations and transport of the solids to the final disposal) and to see what are the real performances of the 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.

b. mechanical dewatering

- final dry content in the dewatered cake: 35% (adopted)
- daily cake production: 2,300 kg (800 x 100 : 35) i.e.
1,900 litres ca. (sp. weight

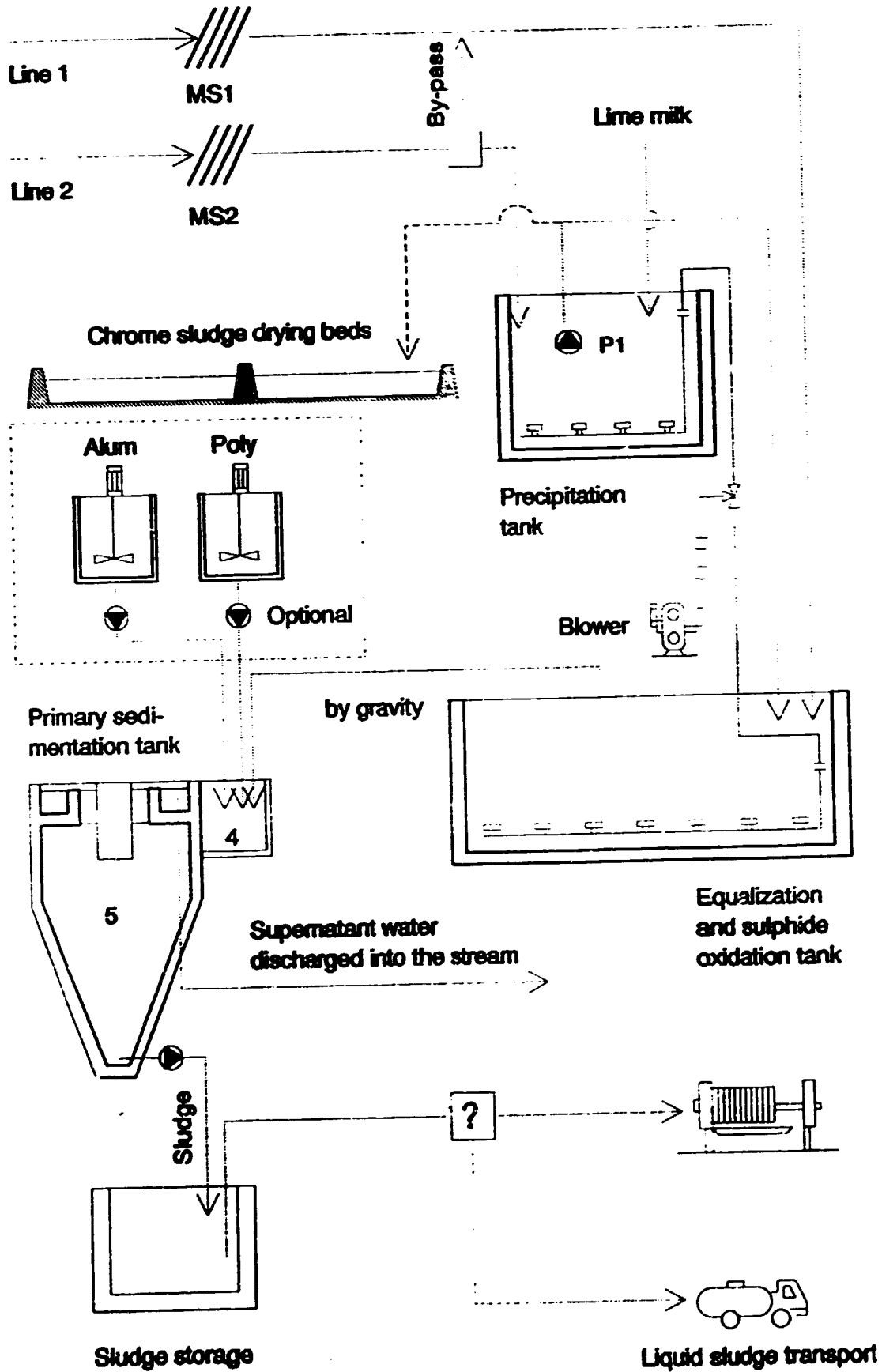
1.2).

- number of filtration: 2 per day (adopted).
- volume of the filter press: 950 litres (1,900 : 2).

Indicatively, a filter press with 50-60 plates 800 x 800 mm is required.

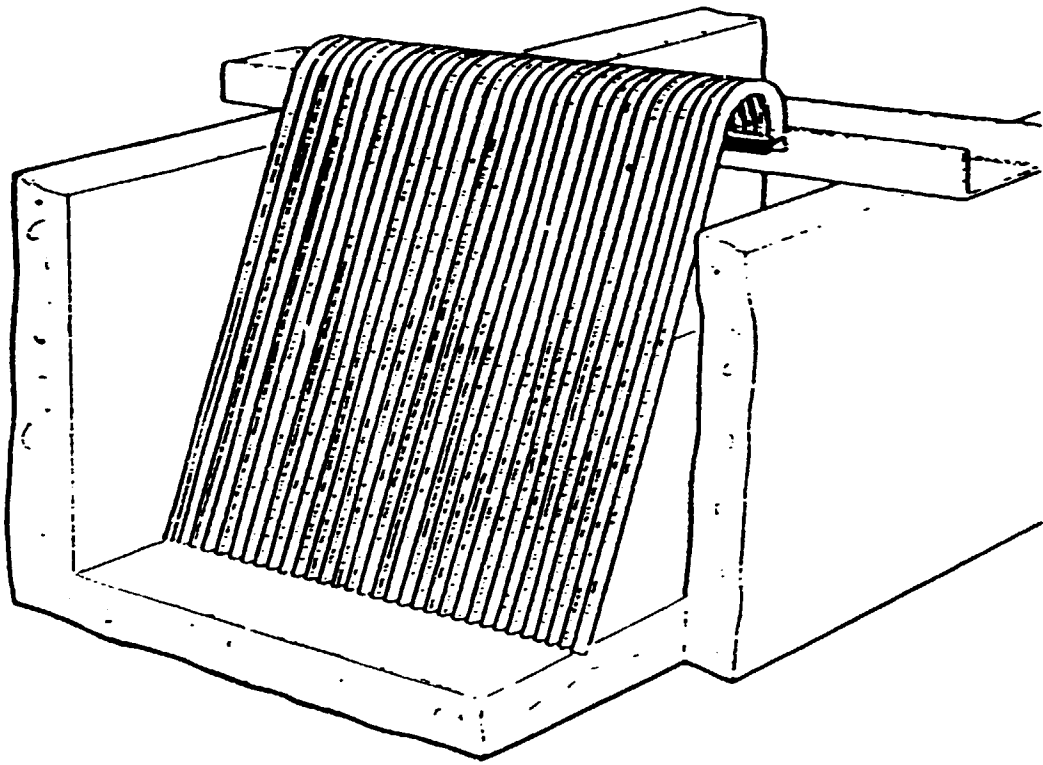
The price of such an equipment (including the feeding pump and the control board) is about 70,000 U.S.\$ in the manual plate displacement version.

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

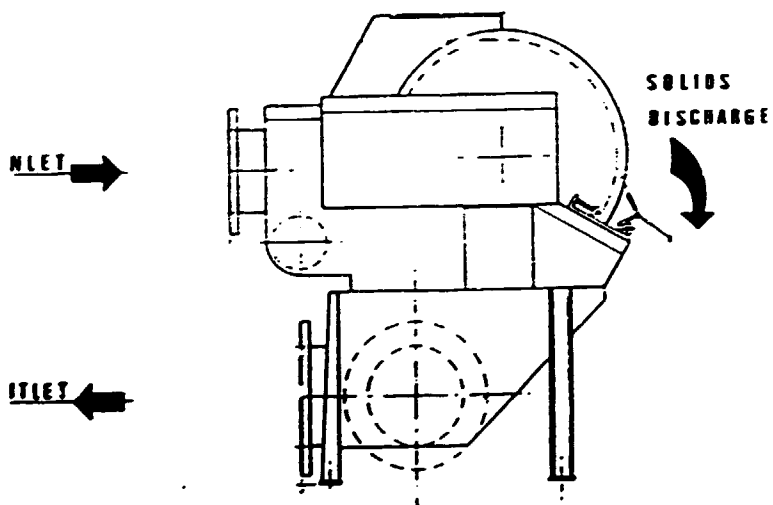
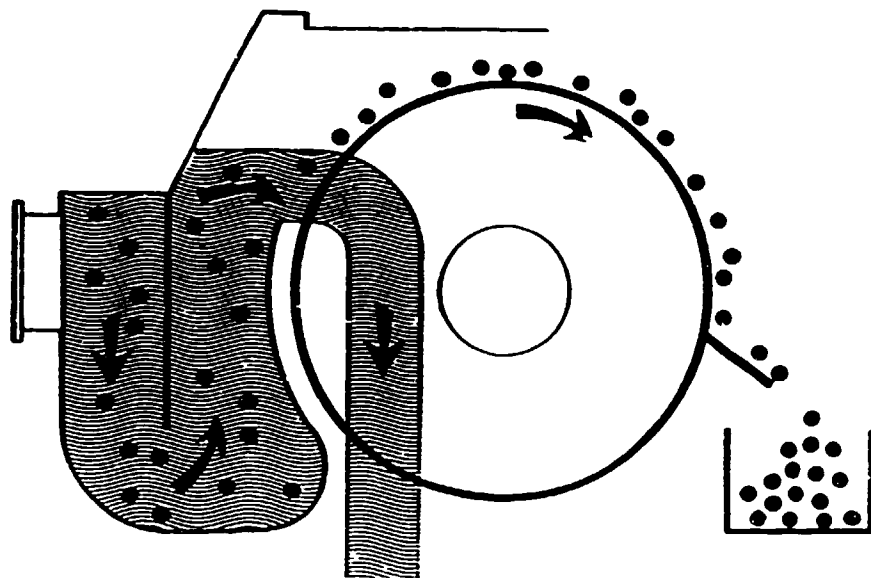


ANNEX 2

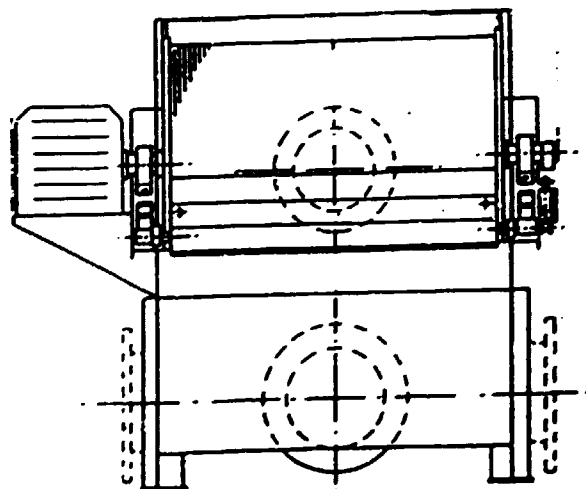
INDICATIVE PAMPHLET OF THE
NECESSARY EQUIPMENTS



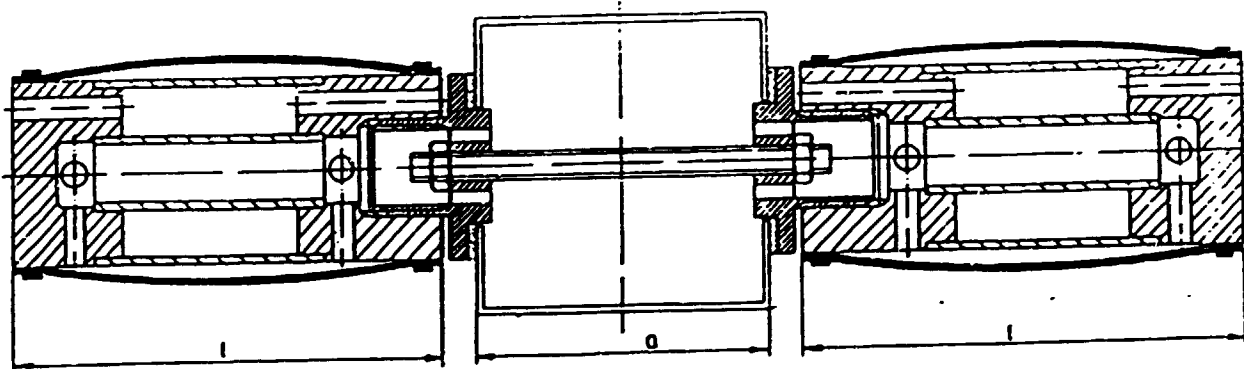
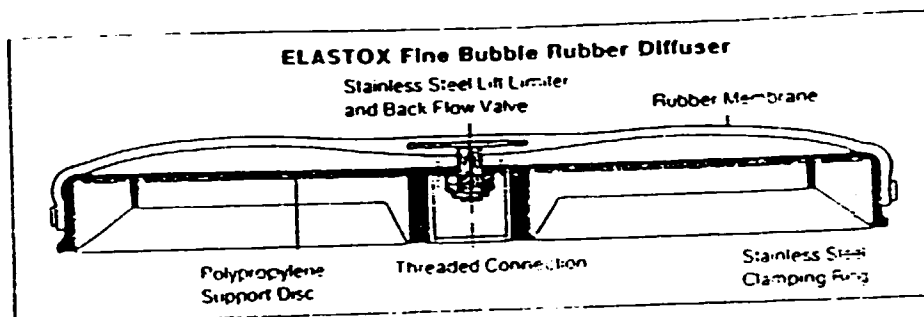
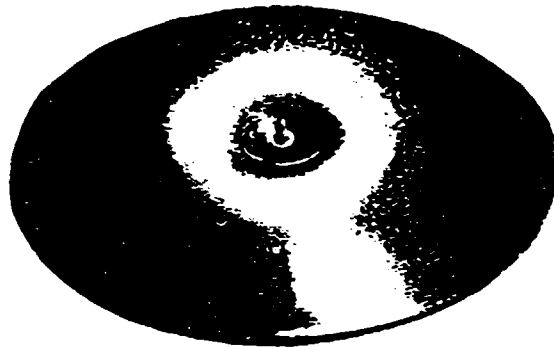
Simple manually raked screen. Flow is from left to right



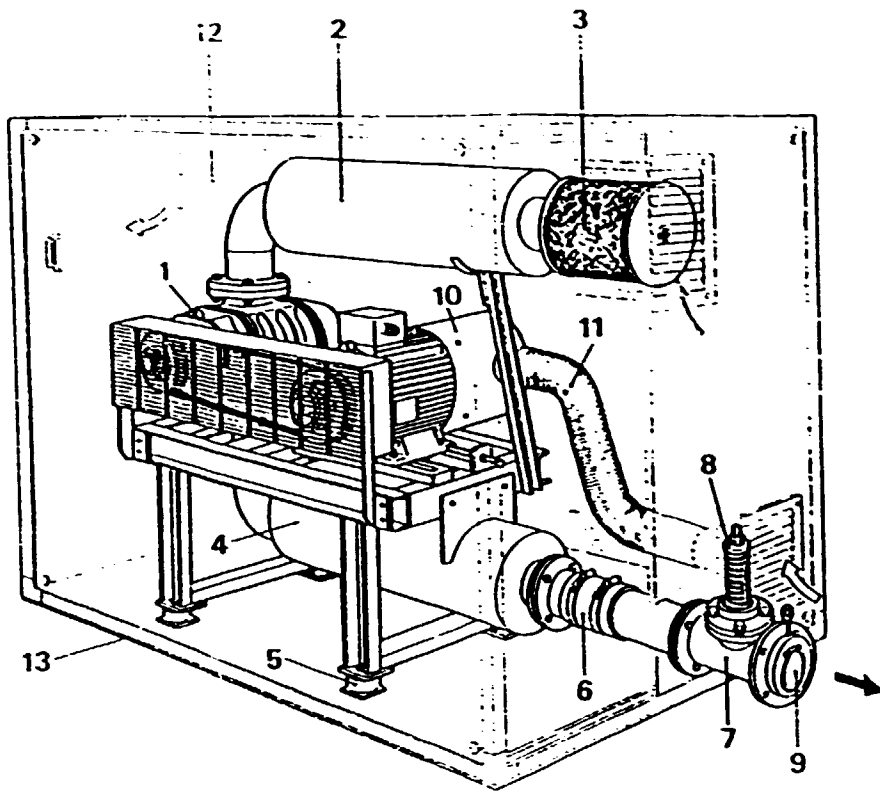
Rotating drum screen



Fine bubble membrane diffusers



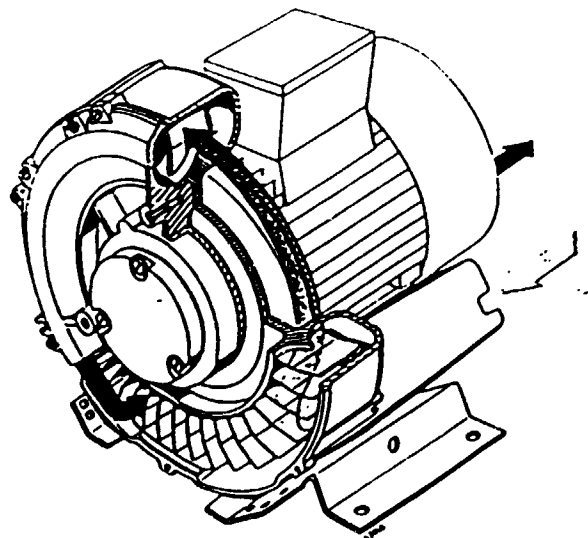
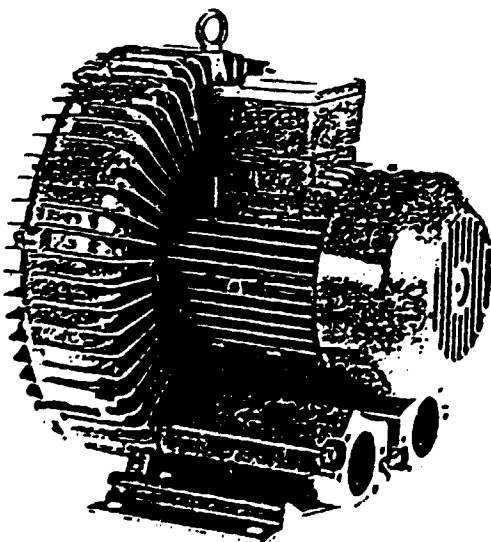
Membrane diaphragm diffuser



Pos.	DENOMINAZIONE
1	SOFFIATORE
2	SILENZIAIORE ASPIRANTE
3	FILTRO
4	SILENZIAIORE PRELENTE
5	SUPPORTI ANTIMBRANTI
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 pipe
12	Air outlet
13	Plugging by insulating material

Blower



series

"BIOXY-VF"

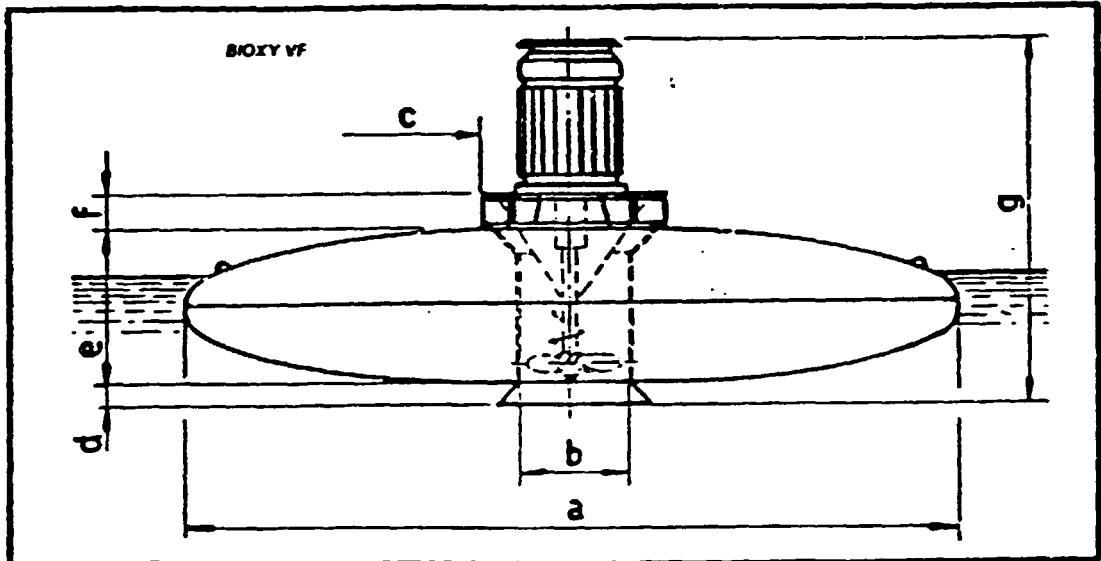
FLOATING HIGH SPEED AERATORS

These machines have a "pancake" type of float that support it and the axial thrust generated by a marine shaped propeller 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.

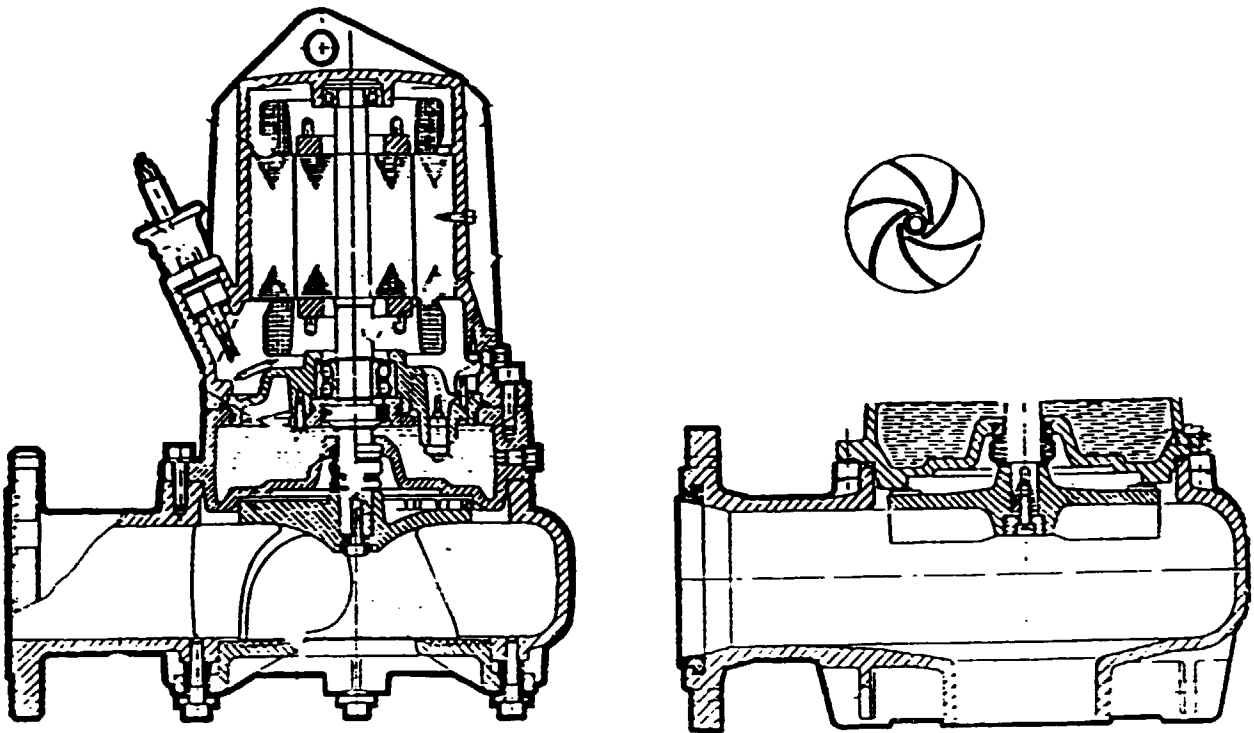
The installation is extremely simple and does not require civil works or support bridge.



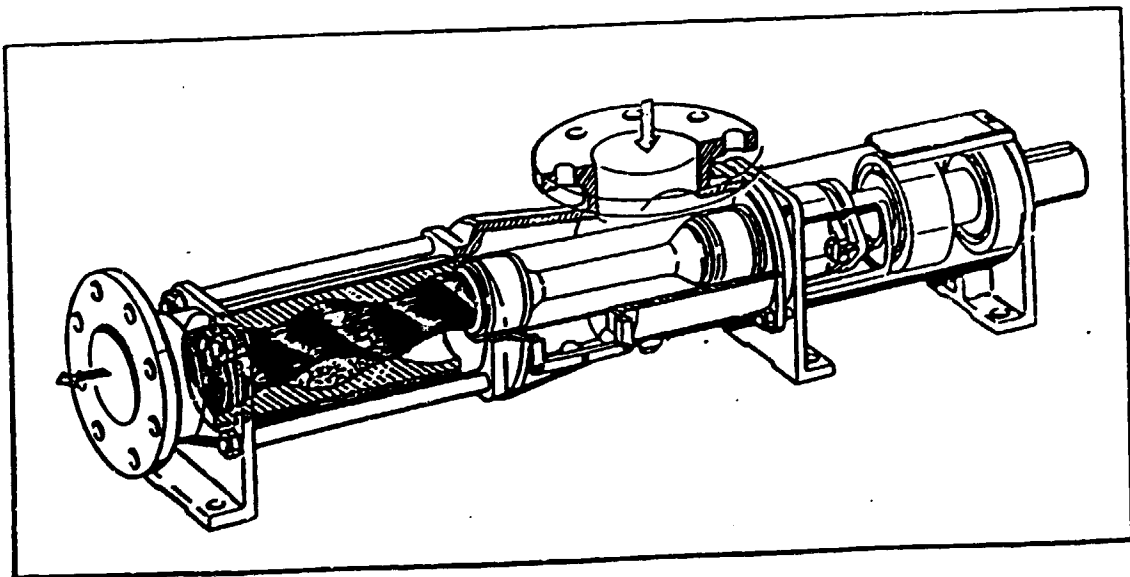
BIOXY TYPE	POLE MOTOR	POLE RATE m ² /hr	O ₂ ABS. Kg.-O ₂	SHAFT Ø	"PANCAKE" FLOAT			BATTLE PLATE	DIMENSIONS		BIOXY TYPE	
	HP				Ø	Ø	Ø	Ø	Ø	Ø		
VF-1	3	682	5.2	40	1600	240	75	310	580	275	964	VF-1
VF-2	4	750	5.5	40	1600	240	75	310	500	275	964	VF-2
VF-3	5.5	850	6.4	60	1600	240	75	310	500	275	1063	VF-3
VF-4	7.5	980	7.8	50	1900	300	110	400	580	330	1204	VF-4
VF-5	10	1250	9.2	50	1900	300	110	400	580	330	1262	VF-5
VF-6	15	1450	12.8	50	1900	300	110	400	580	375	1372	VF-6
VF-7	20	1870	17.8	50	1900	300	110	400	580	375	1372	VF-7
VF-8	25	2200	26.3	60	2100	340	110	660	650	429	1529	VF-8
VF-9	30	2520	42.5	60	2100	340	110	660	650	429	1589	VF-9
VF-10	40	3320	57.6	70	2500	350	110	780	700	469	1935	VF-10
VF-11	50	4250	78.6	70	2500	360	110	700	770	508	2056	VF-11
VF-12	60	4850	87.7	70	2500	360	110	700	770	516	2286	VF-12
VF-13	75	5620	112	70	2500	360	110	700	770	516	2286	VF-13
VF-14	100	7560	147	80	3000	380	110	880	880	610	2605	VF-14
VF-15	125	8320	161	80	3000	380	110	880	880	720	2588	VF-15
VF-16	150	9300	183	80	3000	380	110	880	880	720	2511	VF-16

Ø 6-pole motor

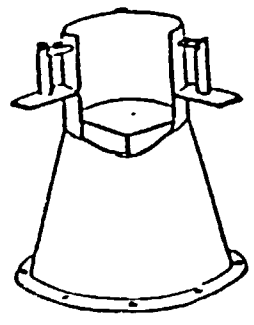
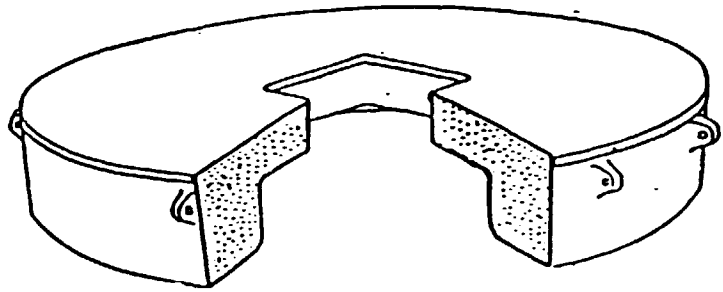
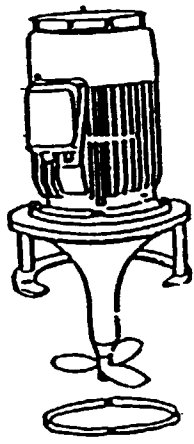
Surface aerator



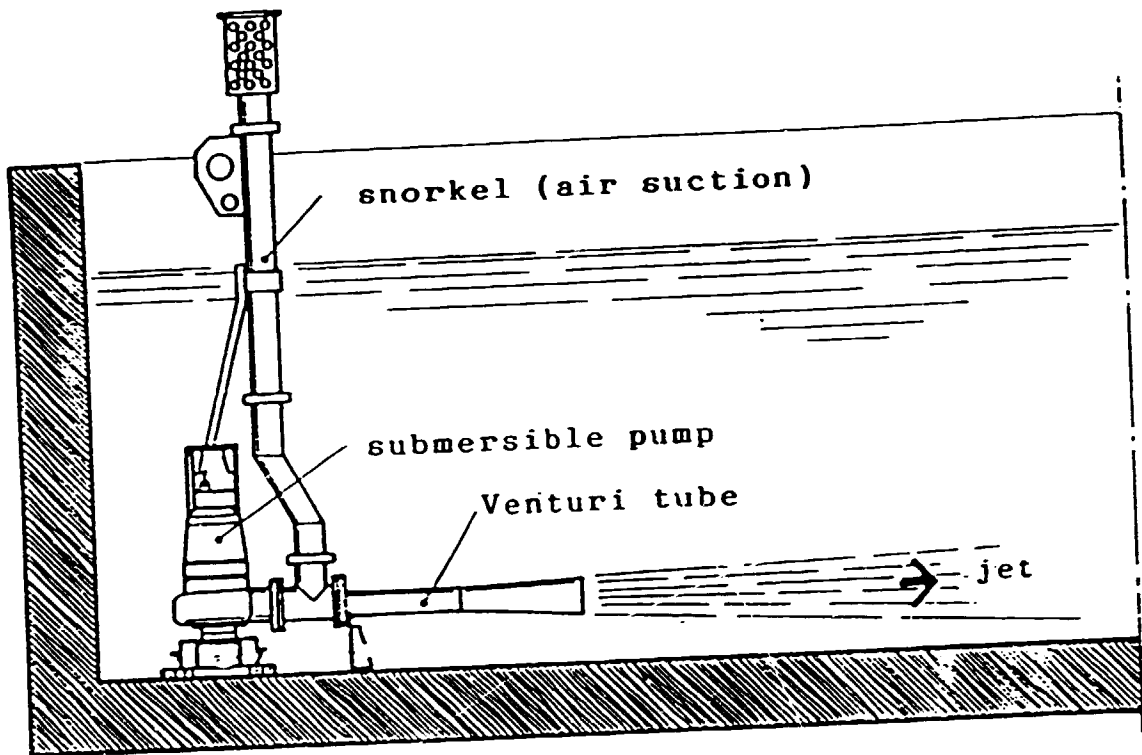
Submersible pumps

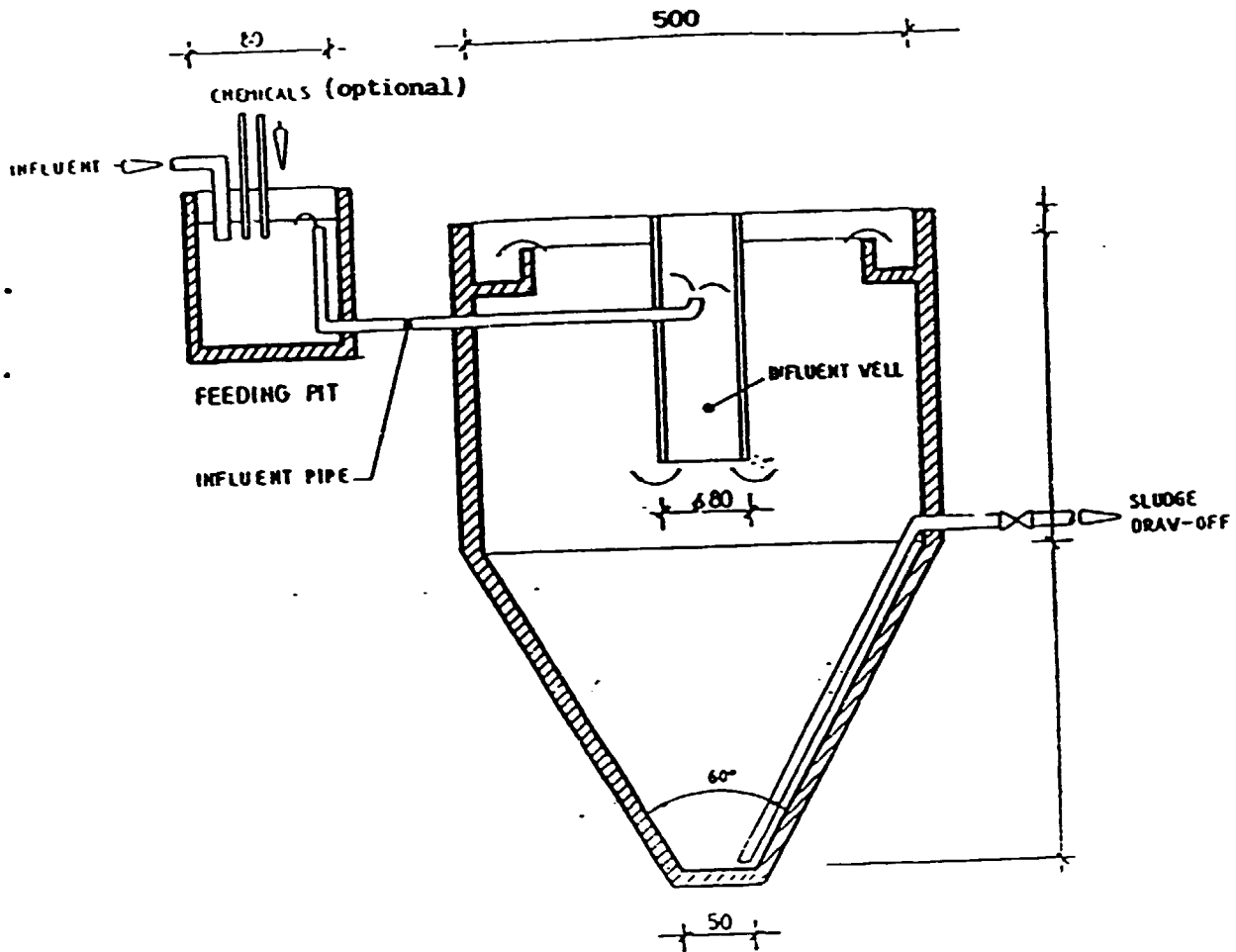


Screw pump

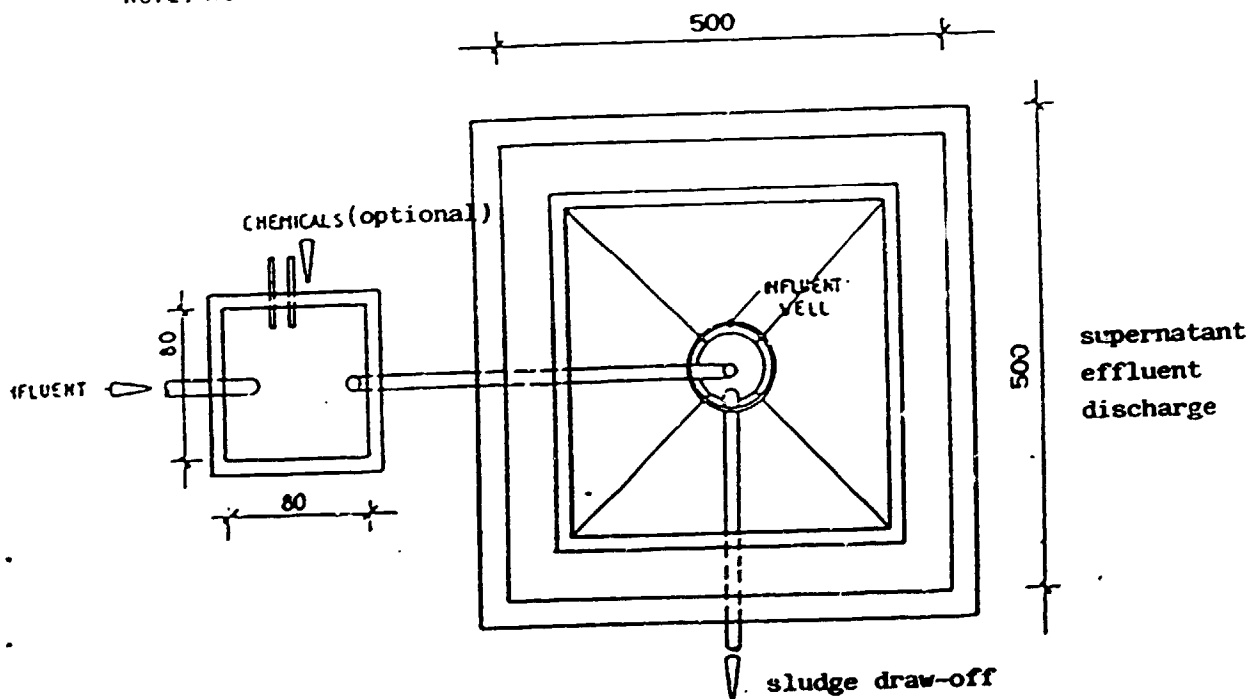


VENTURI EJECTOR (Assembly)

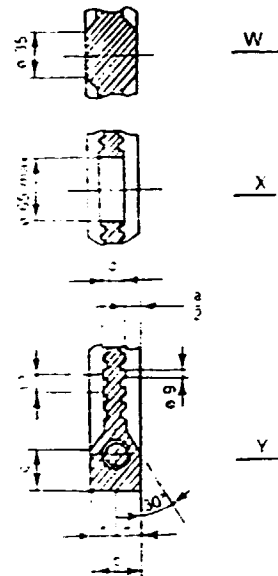
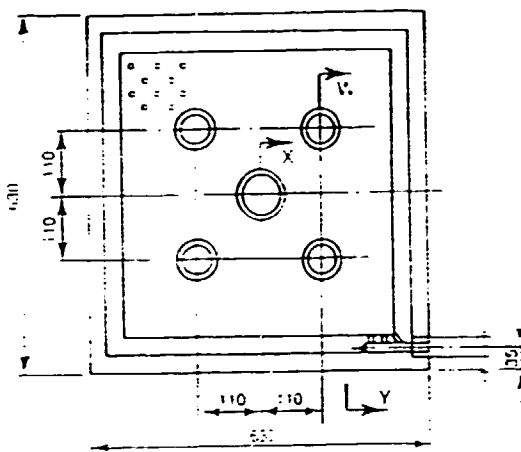
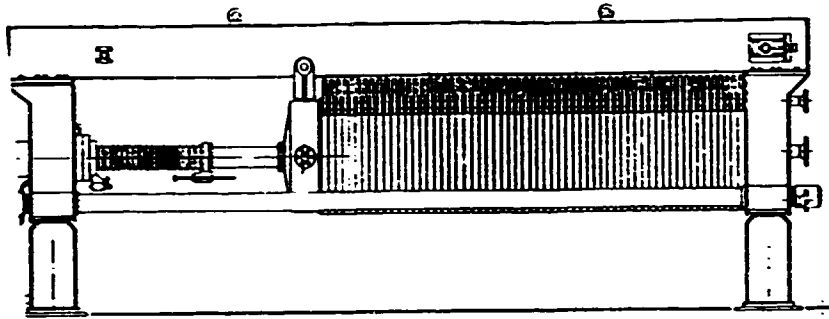




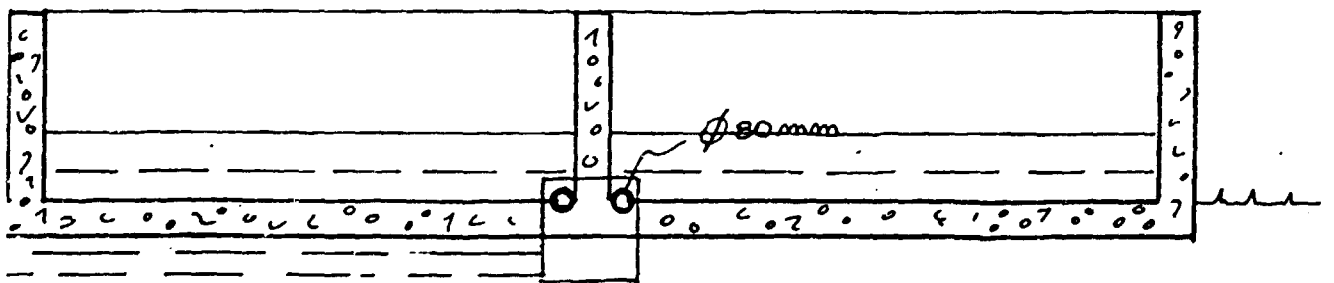
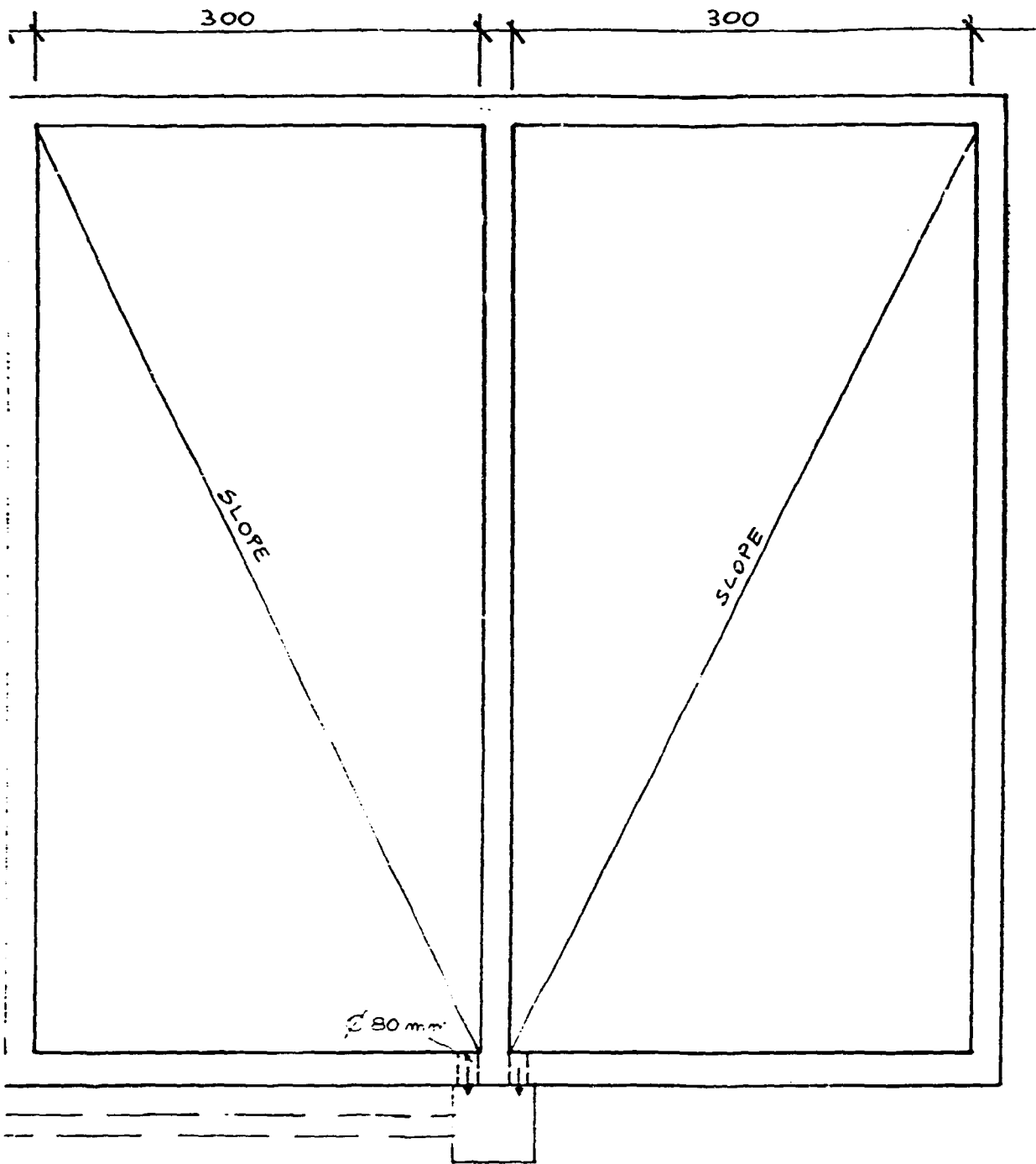
NOTE: NOT IN SCALE!



PRIMARY STATIC CLARIFIER
Pyramidal



Filter press with plate 630 x 630 mm



DIMENSIONS IN CM.

Sludge drying beds