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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

ETHIOPIAN PICKLING & TANNING 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/92/200.

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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ETHIOPIAN

PICKLING & TANNING T A N N E R Y

Addis Ababa - ETHIOPIA

1. FACTORY'S DATA

1.2. Max. daily capacity : 8,000 skins

1.3. Raw material
- goat skins : 3,000 pcs/day (dry: 0.5 kg/pc)
- sheep skins : 5,000 pcs/day (wet-salted: 1.3 kg/pc)

1.4. Final product
- goat skins : wet-blue (current) (*);
- sheep skins : pickled (current) (*);

(*) in future also crust and part finished for local market.

1.5. Information about the process (main phases)

1.5.1. Liming

- sheep skins (painting unhairing)
- goat skins (pulping unhairing in drums)

Total consumption of chemicals for liming (8,000 pcs/day)

$Ca(OH)_2$	880 kg/day
Na_2S (60%)	230 kg/day
NaHS (72%)	168 kg/day

- goat skins (pulp unhairing in drum 3x3 m at axis = 5,000 litres)

1.5.2. Tanning (goats)

Water 150% on pelt weight;
Cr sulphate 6% on pelt weight;
(normal chrome sulphate 25% Cr_2O_3
or self-basifying chrome 21% Cr_2O_3)

1.5.3. Chrome content in the spent tanning liquors (from factory's analysis): 2-4 g/l as Cr_2O_3.

1.6. Total volume of effluent: 500 m^3 per day (estimated by the factory)

1.7. Other information

1.7.1. Work time	1 shift (8 hrs) 6 days per week.
1.7.2. Final discharge	Akaki river
1.7.3. Rain periods	July/August/September (heavy rains) February/March/April (short rains).

2. INPUT DATA

2.1.	Quantity of processed material	10,500 kg/day ca. (green weight).
2.2.	Water consumption (adopted)	40 l per kg of skins (green weight).
2.3.	Effluent volume	420 (say 500) m^3/day.
2.4.	Discharge hours per day	10 ca.
2.5.	Mean discharge flow	50 m^3/h
2.6.	Peak factor (adopted)	2.5
2.7.	Peak flow	125 m^3/h (i.e. 2,000 l/min ca.)
2.8.	Hours of treatment (plant's operation) per day (adopted)	20 per day
2.9.	Mean treatment flow	25 m^3/h
2.10.	Expected sludge production	0.15 kg D.M. per kg of raw material (green weight)
2.11.	Total sludge production	1,570 kg D.M. per day (i.e. 40 m^3/day of liquid sludge at 4% of solids)

Note: D.M. means Dry Matter.

3. LEGISLATION

At the moment no specific standards exist in Ethiopia for the discharge of tannery or other industrial effluents into surface waters or sewer. In the general opinion, the future legislation will adopt discharge standards similar to those existing in Europe and other developed Countries.

4. PROCESS DESCRIPTION (see also the annexed flow-sheet)

Forwards

The here proposed treatment is based on the following assumptions:

i. rains waters must be separately collected and discharged.
ii. sanitary waters from the factory will undergo a pre-treatment into septic tanks before to be eventually piped to the plant (to the biological phase if installed).
iii. the production process does not foresee the use of organic solvent in the skin degreasing cycles.
iv. the pre-treatment of the trivalent Chrome has not been indicated here; it will be eventually installed in a second phase (if required by the Ethiopian environmental Authorises). Because of the difficulty in separating the Chrome containing waters (the various discharges are mixed in the same gully inside the factory) and the small quantity of the discharged Chrome the pre-treatment of these wastes does not seem strictly necessary.
v. near the tannery there is a pipe-line connected with the municipal sewage treatment plant of Kaliti.
There are chances that, after a suitable pre-treatment, the tannery effluent will be accepted into the Kaliti plant for the final biological treatment.
This could be a good opportunity of avoiding the individual secondary treatment or, at least, delaying its implementation.
vi. In our opinion, the primary and sludge dewatering treatments must be always installed first. The secondary phase can be better
The biological treatment has been here indicated only for information: if necessary, this part of the plant may be implemented in a future phase.

4.1. Storage and redistribution of the spent unhairing liquors

The spent liming, washing and fleshing liquors are collected in a separate gully and, after screening, are sent by gravity in an underground storage tank with a capacity equal to the daily volume of discharge. (An existing tank can be used for this scope).
In order to screen most of the hair, a self-cleaning brushed screen has been installed; in fact the partially pulped hair remaining in the concentrate lime/sulphide liquor are, in time, further dissolved increasing the BOD and COD of the effluent. Furthermore, this material floating or settling can form coarse aggregates with the risk of clogging the pumps and pipes. A submersible Venturi ejector assures the mixing to avoid solid deposits and the oxidation of part of sulphides. At this step, due to the high concentration of the sulphide in the liquors, a dosage of $MnSO_4$ is unnecessary (the sulphide oxidation will completed in the equalization tank) but it can be manually given if on-plant tests will show a better performance.
These wastes are then pumped to the equalization tank and mixed with the other tannery effluents.

4.2. Primary treatment

The effluents from the tannery are screened (brushed screen) and sent by gravity into the equalization and sulphide oxidation tank. The equalization is necessary to realize a good mixing (homogenization) of the various streams and to eliminate the flow-peaks (hydraulic equalization) of the factory in order to obtain an uniform and constant effluent to treat. In order to avoid sedimentation of solids, this basin is mixed through injection of suppressed air (blower and air diffusers). The injected air enables the oxidation of sulphide too; this process is catalysed by the addition of Manganese II salts. A submersible pump re-distributes the daily treated mixed liquor to the further treatment phases in a period of 20 hrs ca.
The successive coagulation and flocculation process is done adding Alum and Polyelectrolyte. This treatment with chemicals enables both a reduction of the organic load sent to the biological phase and an increase of the settleability of the suspended solids. The flocculated effluent flows by gravity into the primary sedimentation tank where the most of solids contained in the effluent settles as sludge and the clear supernatant is piped to the biological treatment.

4.3. Secondary treatment (optional)

The biological treatment is an extended aeration that is realized in three successive steps:
- aeration (BOD-removal through bio-absorption/flocculation of the soluble/suspended organic matter)
- sedimentation (physical treatment necessary in order to separate the biological sludge from the treated water)
- biological sludge recycle (the settled sludge is continuously re-pumped into the aeration tank to maintain the bacterial mass necessary to the process.

The aeration tank is designed for 48 hrs retention time and the oxygen necessary to the process is supplied by air blowers and diffusers. The secondary sedimentation is realized into a circular tank fitted with rotary bridge mechanism for sludge-scraping.
A submersible pump recycles the settled sludge to the aeration tank. Periodically, the excess of sludge is discharged through a by-pass-valve into the equalization basin.

4.4. Sludge Treatment

All the produced sludge is extracted from the primary sedimentation tank. The sludge is drawn-off from the bottom of the tank and pumped (submersible pump) to the dewatering station (filter press or sand beds) after a previous conditioning with chemicals (lime-milk until pH = 10). The sludge cake is sent to the final disposal (land-fill or burial) and the filtration waters piped back to the general treatment.

5. CALCULATIONS

5.2. SPENT LIMING WASTES STORAGE AND RE-PUMPING

5.2.1. Volume of discharge

The adopted volume is 50 m^3/day ca. (20 m^3 liming, 20 m^3 first washing and 10 m^3 fleshing and floor washing after the painting). This volume is quite cautionary.

5.2.2. Rate of discharge

The discharge peak flow (a 3 x 3 m. drum discharged in 15 min) is 5 x 60/15 = 20 m^3/h.

5.2.3. Screening

A brushed screen, with minimum capacity of 50 m^3/h of liming wastes, has been adopted.
Note: a brushed screen is more efficient than a bar screen in removing the hair. This represents the advantage to have less hair in the spent liming baths and, so, less solids and BOD/COD in the effluent sent to the treatment plant.

5.2.4. Storage

A tank with a useful volume of 50 m^3 ca. has been adopted.

5.2.5. Mixing

A minimal specific power of 40 Watt/m^3 has been adopted for mixing and avoiding the deposit of solids.
Total required power (50 x 40/1,000) = 2 kW.
A 2.2 kW submersible Venturi ejector has been adopted.
Note: the adopted ejector will furnish 2 kg/h of oxygen at standard conditions; let the oxygen transfer efficiency in the real operating conditions be 70%, i.e. 2 x 0.7 = 1.4 kg/h.
This oxygen will be able to oxidize 1.4 kg/h ca. of S^{2-} and must be considered in the calculation of the total oxygen necessary for sulphide oxidation (see ahead).

5.2.6. Re-pumping

The same working period inside the factory, i.e. 10 hrs/day, will be utilized as re-pumping period. Capacity of the pump 50 : 10 = 5 m^3/h.
Note: a submersible pump operated by a programmed timer has been adopted for the re-pumping.

5.3. GENERAL EFFLUENT TREATMENT

a. PRIMARY TREATMENT

5.3.1. Total volume

The daily effluent volume to be treated is 500 m^3.

5.3.2. Peak flow

Working period inside the factory = 10 hrs per day.
The mean volume of the general effluent is 450 m^3/day (500 - 50 of lime waste).
The average discharge flow is 450 : 10 = 45 m^3/h.
Peak factor = 2.5 (adopted).
Peak flow (45 x 2.5) = 112.5 m^3/h.

5.3.3. Screening

A brushed screen with minimum capacity of 150 m^3/h of tannery effluent has been adopted.

5.3.4. Equalization and sulphide oxidation

a. Hydraulic equalization and wastes homogenization

The hydraulic equalization necessary during the first phase of the plant's installation is minimal: in fact the mean discharge period from the factory is 10 hrs/day; i.e. the mean influent flow is 50 m^3/h ca. and the out-let flow 550 : 20 = 27.5 m^3/h.
The difference (50 - 27.5) x 10 hrs is 225 m^3.
Due to the fact that a separation and dosage of the concentrated liming wastes have been adopted, the volume necessary for the homogenization of the various effluents can be reduced from the 24 hrs retention time that is generally adopted in the design of tannery effluent treatment plants. A tank with a total volume of 350 m^3 has been here adopted. The retention time (350/550 x 24) is ca. 15 hrs. In practice, 100 m^3 ca. will be the minimal water volume in the tank for the effluent homogenization and the remaining 250 m^3 will be used for absorbing the tannery's flow-peaks.

5.3.5 Quantity of air for the mixing and avoiding deposit of solids

is 2 Nm^3/h per m^3 of tank volume (adopted).
The total necessary air is (2 x 350) 700 Nm^3/h.

5.3.5. Sulphide oxidation

Calculation of the oxygen required for the oxidation of sulphide.
The daily consumption is 230 kg of Na_2S (60%) and 168 kg of NaHS (72%). This amount is equivalent to 125.7 kg/day of S^{2-}.
[230 x 0.60 x 32/78 = 56.6 kg and 168 x 0.72 x 32/56 = 69.1 kg of S^{2-}] where 32 = a.w. S^{2-} and 78 and 56 m.w. of Na_2S and NaHS respectively.
Let 80% of this quantity be discharged with the spent liquors, i.e. 125.7 x 0.80 = 100 kg/day of S^{2-}. 14 kg/day of S^{2-} (1,4 x 10 hrs) are oxidised in the liming storage tank, therefore 100 - 14 = 86 kg of S^{2-} must be treated in the equalisation tank at the rate of 86 : 15 = 5.7 kg/h.

The installed air injection is able to supply a total of 700 Nm^3 of air per hour. Considering an oxygen transfer efficiency of 15% at the real operational conditions, (700 x 0.28 x 0.15) 29.4 kg/h of oxygen are supplied. The aeration equipment results over-abundant; on the other hand reducing the air rate will increase the risk of solid deposits.

5.3.6. Dosage of catalyst

Manganese sulphate, the catalyst of the sulphide oxidation reaction will be dosed in 20 mg/l quantities only if strictly necessary. The average consumption is 500 x 20/1,000 = 10 kg/day of industrial product (80% ca. of $MnSO_4$) or 10 x 0.80 x 54.94/151.94 = 2.9 kg of Mn^{2+} per day. The $MnSO_4$ is dosed in solution at 5%, i.e. 10 x 100/5 = 200 l/day, with a dosing pump of 20 l/h ca. capacity.

5.3.7. Lifting

The total volume of effluents to be daily pumped is about 550 m^3/day: 500 m^3 waste waters from the tannery + 50 m^3 ca. of waters from the sludge filtration that are recycled to the equalization tank.
Hours of treatment per day = 20 (adopted).
Treatment flow 550 : 20 = 27.5 m^3/h.
A submersible pump, min. capacity 500 l/min at 5 m, has been adopted; the flow will be regulated by means of a by-pass valve.

5.3.8. Flocculation

Minimum retention time = 5 min. (adopted).
Volume of flocculation tank 27.5 : 60 x 5 = 2.3 m^3.
A tank of dimensions 1.2 x 1.2 x 2 H metres has been adopted.
A mechanical mixer is unnecessary: the same influent flow will assure the mixture of the influent with the chemicals.

5.3.9. Dosage of chemicals

Note: the amount of chemicals to be dosed can be varied according to the required efficiency during the plant commissioning. The quantities here indicated are the mean values generally used in similar plants.
Alum, industrial $Al_2(SO_4)_3.18\ H_2O$, average dosage = 300 mg/l;
550 x 300/1,000 = 165 kg/day or 1,650 litres solution at 10%.
Polyelectrlyte, anionic powder, average dosage = 1 mg/l;
0.55 kg/day or 550 litres of solution at 0.1%.
Two dosing pumps, capacity 0-100 l/h, adopted.

5.3.10. Primary sedimentation

Minimal retention time = 2 hrs (adopted).
Maximum surface loading 1 m^3/m^2 per hour.(adopted).
A static sedimentation tank (type Dortmund) of 5 x 5 metres has been adopted (for shape and dimensions see the paragraph "civil works"); surface 25 m^2 and volume 75 m^3.
Retention time (75 : 27.5) = 2.7 hrs.
Surface loading (27.5 : 25) = 1.1 m^3/m^2 per hour.

b. SECONDARY TREATMENT

Note: a primary treatment alone will hardly comply with the general standards for the discharge into surface waters.
A properly operating primary treatment can produce a final tannery effluent with the following realistic characteristics (*):

- pH	:	7 - 9
- BOD_5	:	500 - 800 mg/l
- COD	:	1,000 - 1,500 mg/l
- Oil & grease	:	traces
- Phenols	:	very variable (depending on the production process)
- Chromium tot.	<	1.0 mg/l
- Suspended Solids	<	100 mg/l

(*) main parameters

The reduction of the residual BOD, COD and phenols can be obtained only via biological treatment: to increase the dosage of chemicals in the flocculation process will result only in a massive increase in sludge production.

5.3.11. Biological treatment
The process adopted for the secondary treatment is an "extended aeration":
- retention time in the aeration tank: 48 hrs (adopted)
- volume of the aeration tank (500 x 2): 1,000 m^3 (*)
- F/M ratio < 0.1 kg of BOD_5/kg of MLVSS in the oxidation tank (adopted).

(*) The internal recycles have not been considered.

Note:
F = organic loading, kg BOD_5 of the influent per day.
M = mass of Mixed Liquor Volatile Suspended Solids (MLVSS) in the aeration tank (quantity of active biological sludge).

F = 500 x 1 = 500 kg of BOD_5/day (*)

M = 500 : 0.1 = 5,000 kg of MLVSS

MLVSS (5,000 : 1,000) = 5,000 mg/l.

(*) an influent BOD of 1,000 mg/l has been considered.

5.3.12. Oxygen requirement (O.R.)

$$O.R. = \frac{(a \times F) + (b \times M)}{24}$$

where:
O.R. = total oxygen requirement per hour.
a = coefficient related to O_2 requirement for synthesis.
F = organic load, kg BOD/day

b = coefficient related to O_2 requirement for endogenous sludge respiration.

Replacing the project's data and assuming:

a = 0.8 and b = 0.15 (experimental data)

$$O.R. = \frac{(0.8 \times 500) + (0.15 \times 5{,}000)}{24} = 48 \text{ kg/h ca.}$$

Let the oxygen transfer efficiency of the installed air diffusers be 15% at the operational conditions:
48 x 100 : 15 = 320 kg/h of O_2 must be furnished or
320,000 : 280 = 1,143 Nm^3 of air per hour.

5.3.13 Secondary sedimentation
- superficial load = 0.5 m^3/m^2 of tank surface per hour (adopted);
- influent flow 27.5 m^3/h;
- total necessary surface = 27.5 : 0.5 = 55 m^2.

A circular tank of 9 metres of diameter has been suggested (S= 63.6 m^2) .

5.3.14. Sludge recycle
- recycle rate = 100% (adopted);
- capacity of the recycling pump = 27.5 m^3/h.

5.5. SLUDGE TREATMENT

5.5.1. Production of sludge (primary & secondary)

Assumed a sludge production of 0.15 kg of dry matter per kg of processed hides or skins (green weight): a daily production of 10,500 x 0.15 = 1,575 kg of sludge dry matter or (1,575 x 100 : 4) 39,375 litres (say 40 m^3) of liquid sludge with a 4% dry content is expected.

5.5.2. Sludge dewatering station

Alternative 1: Filter press

Assuming a final sludge cake at 35% of D.M., (1,575 x 100 : 35) 5,250 kg of dewatered sludge per day or (5,250 : 1,2) = 3,750 litres. Adopting 3 filtration cycles per day, a filter with a minimum capacity of (3,750 : 4) = 940 litres ca. is necessary.

Alternative 2: Sand beds

Calculation of the drying beds.
Assuming a mean drying time of 3 weeks (i.e. 18 work days) the total quantity of sludge produced in this period is 1,575 x 18 = 28,350 kg of D.M. (dry matter).
Let the dry content in the de-watered sludge be 20%, a total of 28,350 x 100/20 = 141,750 kg or 142 m^3 of residue will result.
Limiting the final height of the sludge layer to 0.25 m for a good drying of the cake bottom (142 : 0.25) 568 m^2 of bed surface are required.
Eight 6 x 13 metres beds total surface = 624 m^2 have been proposed: seven beds (546 m^2) in operation and one bed in cleaning and maintenance.
In principle each bed must receive 100 m^3 ca of liquid sludge or 100,000 x 4/100 = 4,000 kg of D.M. (the feeding period of each bed results 3 days ca. and the filtration/evaporation period 18 days).
The residual layer, de-watered at 20% of dry content, is 4,000/1,000 x 100/20 = 20 m^3 with an average height of 20/78 = 0.25 m.
This means that every three days ca. one bed must be cleaned and 20 tons of de-watered sludge transported to the final disposal.

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6. LIST OF THE NECESSARY EQUIPMENT

6.1. SEPARATION AND STORAGE OF THE SPENT LIME LIQUORS AND PRIMARY TREATMENT

6.1.1. n.2 bar screens, sloped 60°, in steel, manually cleaned.
Characteristics:
- bar diameter : 10 mm ;
- spacing between bars : 10 mm ;
- width : 50 cm ;
- length : 70 cm ;
- capacity : 50 m^3/h.

Equipped with cleaning rake.

To be locally realized

6.1.2. n.1 brushed screen, type Parkwood (Idrascreen, Italprogetti or similar).
Filtering panel, support frame and carters in stainless steel AISI 304, rotating brushes in polypropylene and nylon.
Characteristics:
- 1 kW motor 380 V, 50 Hz 3 phases insulated IP 55;
- filtering surface 1.3 m ca.;
- diameter of holes 3 mm;
- capacity 100 m^3/h of tannery waste water;
- n.3 brushed spaced at 120°.

Price: 7,500 U.S.$

6.1.3. n.1 Venturi ejector Consisting of a submersible pump (Flygt CS 3085 MT 432 and an ejector Mod. 4812 or similar).
Characteristics:
- 2.2 kW motor 380 V, 50 Hz 3 phases 4 poles insulated to F class;
- 1 ejector Mod. 4812 100 mm diameter. length 1,000 mm with nozzle of 55 mm diameter and 3 m snorkel for the air suction;
- oxygen transfer 2 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.

Total Price: 4,100 U.S.$

6.1.4. n.1 **submersible pump**, for waste water with high solid content (Flygt, ABS or similar).
Body and propeller in cast iron with rubber paint, shaft, studs and nuts in stainless steel.
Characteristics:
- 2.2 kW motor 380 V, 50 Hz, 3 phases, 4 poles, insulated to F Class;
- vortex impeller with solid passing of 50 mm diameter;
- capacity 900 l/min. at 4 m head.

The pumps is equipped with a hose connection, base stand and strainer.

Price: 3,000 U.S.$

6.1.5. n.1 **rotary vane blower** (Robuschi or similar) able to supply oil-free air, rotors and body in spheroidal cast iron, driving through belt/pulley coupling to 13 kW motor 380 V, 50 Hz, threephase, protection IP 55.
Technical specifications:
- capacity = 650 Nm^3/h of air at 0.4 Bars;
- max. head = 0.5 Bars.

The blower is equipped with:
- suction filter,
- suction and discharge silencers,
- non return valve;
- safety valve;
- flexible anti-vibration connection and shock insulating feet.

Price: 7,500 U.S.$

6.1.6. n.1 **air distribution device** (Italprogetti or similar) consisting of:
- 130 non-clog air diffusers (medium/small bubbles) with cone-shaped base in polypropylene and flexible perforated EPDM membrane for the air escape in fine bubbles.
  Oxygen transfer efficiency 20% ca.;
- air distribution net-work in galvanized steel (out-side part) and in PVC (submerged part);
- air regulation valves;
- clamps for the device fixing at the walls of the tank in concrete.

Total Price: 9,300 U.S.$

6.1.7. n.1 **submersible pump** identical to that described at item 6.1.4.

Price: 3,000 U.S.$

6.1.8. OPTIONAL

n.3 Dosing groups for chemicals ($MnSO_4$, Alum and Polyelectrolyte) (OBL Dosapro Italprogetti or similar) consisting of:

- 3 reservoirs, in acid proof material, for the dissolution of chemicals.
Capacity 1,200 litres.
Complete of support for the installation of the mixer and the dosing pump.

- 3 mixers for the dissolution; shaft and paddles in stainless steel AISI 304.
Characteristics:
1.1 kW motor, 380 V, 50 Hz, 3 phases, protection IP 55;
vertical speed reducer, coaxial type with oil lubricated gears;
shaft speed 200 r.p.m. ca.

- 3 dosing pumps body in PVC, plunger in ceramic and no-return valves in stainless steel AISI 316.
Characteristics:
0.3 kW, motor 380 V, 50 Hz 3 phases protection IP 55;
capacity variable from 0 to 100 l/h;
maximum working head 2.5 bars.

Total Price: 7,500 U.S.$

6.1.9. n.1 series of accessories for 5 metres square sedimentation tank in concrete, type Dortmund, consisting of:
- 2 m length influent well of 50 cm diameter in poly-propylene;
- 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 diameter in stainless steel AISI 304 to be imbedded in the tank walls;
- sludge draw-off pipe 80 mm diameter. in stainless steel to be embedded in the tank wall.

Price: 3,000 U.S.$

6.1.10. n.1 control board for the operating and control of the electrical equipment of the E.T.P.
The control board is designed in accordance with the standards of the European Electricity Committee.
The board is made for the installation under a covered area.

Price: 11,000 U.S.$

Sub total 6.1. **56,900 U.S.$**

INDICATIVE PRICE OF THE HYDRAULIC AND ELECTRIC CONNECTION FOR THE PRIMARY TREATMENT
(this material can be locally purchased)

6.1.11. -- piping:
pipes, valves and fittings for the hydraulic connections of the primary treatment.
The materials (PVC, steel, polythene, etc.) and the sizes are different according to the characteristics of the piped product and the required flow or head.

Total Price: 8,000 U.S.$

6.1.12. -- electrical wiring:
cables of different sections and accessories for the connection and/or control of the electrical equipment of the E.T.P. including installation/clamping devices with the exclusion of the main line from the tannery's power station to the control board.

Total Price: 6,000 U.S.$

6.2. BIOLOGICAL TREATMENT

6.2.1. n.? rotary vane blowers and accessories, identical to that described at item 6.1.4.

Price: 15,000 U.S.$

6.2.2. n.1 air distribution device (Italprogetti or similar) consisting of:
- n. 260 membrane non-clog air diffusers(fine/medium bubbles), support in polypropylene and flexible membrane in EPDM; oxygen transfer efficiency = 20% ca.;
- air distribution net work, pipes, connections, etc. in galvanized steel (outside) and PVC (submerged parts);
- air regulation valves ;
- clamps for fixing at the tank walls.

Total Price: 18,600 U.S.$

6.2.3. n.1 sludge scraping device (Italprogetti or similar) for 9 metres diameter circular secondary sedimentation tank.
Technical specifications:
central driver of 0.5 kW, 380 V, 50 Hz, 4 poles, three phases, protection IP 55, with two speed reducer; peripheral speed 2.5 m/min. ca.
Electrowelded structure in hot galvanized steel.

Equipped with:
- over-flow weir type Thomson and scum-baffle in stainless steel AISI 304;
- surface scum-blade scraper and scum-troug in stainless steel AISI 304;
- bottom sludge scraper in hot galvanized steel and rubber blades;
- central influent well in hot galvanized steel;
- flanged inlet and outlet connection and sludge draw-off pipe in Fe 37.

Price: 16,000 U.S.$

6.2.4. n.1 helicoidal pump (Allweiler, CSF or similar) (eccentric screw type), pump body in cast iron, screw in hard chromium plated steel and stator in synthetic rubber. Coupled by belt and pulley to motor of 1.1 kW, 380 V, 50 Hz, protection IP 55. Rotor speed 400 r.p.m. Capacity 4.5 m3/h ca. at 40 m head.

Price: 4,100 U.S.$

6.2.5. n.1 control board realized in plastic material for the operation and control of the effluent treatment plant. The board is designed according with the standards of the European Electricity Committee. The board is executed for the installation under a cover area.

Price: 3,000 U.S.$

Sub total 6.2. 56,700 U.S.$

INDICATIVE PRICE OF THE HYDRAULIC AND ELECTRIC CONNECTION FOR THE SECONDARY TREATMENT
(this material can be locally purchased)

6.2.6. -- piping:
pipes, valves and fittings for the hydraulic connections of the secondary treatment.
The materials (PVC, steel, polythene, etc.) and the sizes are different according to the characteristics of the piped product and the required flow or head.

Total Price: 2,000 U.S.$

6.2.7. -- electrical wiring:
cables of different sections and accessories for the connection and/or control of the electrical equipment of the E.T.P. including installation/clamping devices with the exclusion of the main line from the tannery's power station to the control board.

Total Price: 1,500 U.S.$

6.3. SLUDGE TREATMENT

Sludge dewatering: alternative with plate filterpress

6.3.1. n.1 submersible mixer (Flygt or similar)
body and propeller in cast iron with chloric rubber paint; shaft, screws, studs and nuts in stainless steel; o-rings in
nitrile rubber.
Characteristics:
motor 2.5 kW, 380 V, 50 Hz, threephases, insulation to Class F, 4 poles coupled with a spur gear with helical teeth;
propeller speed = 1,400 rpm ca.
Blades propeller with 300 mm diameter.
The mixer is supplied with installation/lifting system consisted of:
lifting david, guide holder sets(upper and lower) and 4 m guide bar 100 x 100 mm in galvanized steel.

Price: 6,000 U.S.$

6.3.2. n.1 lime milk preparation and dosage unit, (Italprogetti, Antico Olindo or similar), consisting of:
- n.1 mixer, shaft and paddles in stainless steel AISI 304, motor of 1.2 kW, 380 V, 50 Hz, 4 poles, threephases, protection IP 55;
  vertical gear box coaxial type with oil lubricated gears, shaft speed = 400 rpm ca.,
  support frame in hot galvanized steel for the installation on a 5 m^3 concrete tank.
- n.1 centrifugal pump, body and propeller in stainless steel AISI 304, capacity = 50 l/minute, 0.5 kW motor, 380 V, 50 Hz, 4 poles, threephases, protection IP 55, installed on a support frame in galvanized steel.

Price: 3,500 U.S.$

6.3.3. n.1 filter press (Diefenbach, Italprogetti or similar) for the sludge de-watering.
Materials:
- steel frame with corrosion proof painting,
- plates and filtering clothes in polypropylene.

Characteristics:
- Plates dimensions 800 x 800 mm.
- Filter frame max. capacity 80 plates.
- Number of installed plates 80
- Filtering surface 80 m^2 ca.
- Volume of the cake 1,200 litres ca.
- Dryness of cake 30-35%.
- Hydraulic closure of the filtering plates by oil-power and double-acting plunger.
- Installed power of the hydraulic closure 5.5 kW ca.
- Manual displacement of the plates.

Filter complete of:

- Pump for the feeding of the filter, capacity 5.5 m^3/h, motor with speed reducer 5.5 kW, 380 V, 50 Hz, three phase, protection IP 55;
- Belt conveyor for the cake transport, length 9 m. ca., motor 1.1 kW, 380 V, 50 Hz, IP 55.
- General control panel for the operation and control of the sludge treatment station. The board is executed for the installation under a cover area.

Total Price: 60,000 U.S.$

6.3.4. n.1 control board realized in plastic material for the operation and control of the sludge treatment. The board is designed according with the standards of the European Electricity Committee. The board is executed for the installation under a cover area.

Price: 1,000 U.S.$

Sub total 6.3. (filter press) 70,500 U.S.$

INDICATIVE PRICE OF THE HYDRAULIC AND ELECTRIC CONNECTION FOR THE SECONDARY TREATMENT
(this material can be locally purchased)

6.3.5. -- piping:
pipes, valves and fittings for the hydraulic connections of the sludge treatment.
The materials (PVC, steel, polythene, etc.) and the sizes are different according to the characteristics of the piped product and the required flow or head.

Total Price: 2,000 U.S.$

6.3.6. -- electrical wiring:
cables of different sections and accessories for the connection and/or control of the electrical equipment of the E.T.P. including installation/clamping devices with the exclusion of the main line from the tannery's power station to the control board.

Total Price: 800 U.S.$

SUMMARY OF COSTS (Main equipment only)		
SULPHIDE STORAGE & PRIMARY TREATMENT	56,900	U.S.$
SECONDARY (BIOLOGICAL) TREATMENT	56,700	U.S.$
SLUDGE TREATMENT (Alternative A: FILTER PRESS)	70,500	U.S.$

7. SPARE AND CONSUMPTION PARTS

Indicative price (see Note) for the spare and consumption parts for two years of the plant's operation:

7.1. General treatment: . . . . . 10,000 U.S.$

7.2. Biological treatment:. . . . . 8,000 U.S.$

7.3. Sludge treatment (with filter press only): . . . . . 5,000 U.S.$

Note: the type and quantity of spare parts will be defined by ITALPROGETTI on the base of its experience in similar plants, taking into account also the local peculiar situation.

8. PLANT COMMISSIONING & TRAINING

8.1. Supervision during plant installation:

n.1 technician for 30 days: 12,000= U.S.$

Travel expenses (2 international trips), board and lodging at the charge of the recipient Company.

8.2. Plant start-up and training of the local personnel:

n.1 technician for 20 days: 8,000= U.S.$

Travel expenses (two international trips), etc. at the charge of the recipient Company.

9. COSTS FOR THE PLANT'S OPERATION

(on the basis of 500 m^3 effluent per day)

- General effluent treatment

a) Sulphide Separation & Primary Treatment

Consumption of chemicals:

.. Alum	150 kg/day
.. Polyelectrolyte (powder)	0.5 kg/day
.. Manganese Sulphate	10 kg/day
Energy consumption:	350 kWh/day ca.

b) Secondary treatment
Consumption of chemicals:
.. Sodium Threephosphate (eventual) 5 - 10 kg/day
Energy consumption: 500 kWh/day ca.

-Sludge treatment

Consumption of chemicals:
(alternative with filterpress)
.. Lime 150 - 200 kg/day
Energy consumption: 150 kWh/day ca.

- Labour
n.2 persons during the day + night-watchman.

Note: the consumptions (both of chemicals and energy) here indicated represent the average figures encountered in similar plants.

10. CIVIL WORKS (Indicative dimensions)

Prior to the starting of the civil works the site must be cleared. All shrubs, trunks, grass and other vegetable matter must be removed and disposed of.

10.1. SEPARATION AND STORAGE OF THE SPENT LIME LIQUORS

10.1.1. Pit for the installation of the brushed screen:
lateral walls in block bedded with cement mortar and bottom in lean concrete with plastering of internal surface.
Internal dimensions: cm 125 x 190 x 70 H.
The pit is 30 cm above and 40 cm ca. below ground level.

10.1.2. Storage tank:
Tank built underground with a 20 cm external board, capacity 50 m^3.
For this service an existing tank can be used.

10.2. GENERAL EFFLUENT TREATMENT

A. PRIMARY TREATMENT

10.2.1. Equalization tank:
with lateral and bottom walls in reinforced concrete 30 cm thick.
Internal dimensions:
- width 800 cm,
- length 1,500 cm,
- height 350 cm (useful 300 cm).

Useful volume: 350 m^3
Underground tank that must be fed by gravity.

10.2.2. Flocculation tank:
in reinforced concrete 30 cm thick.
Internal dimensions: 120 x 120 x 200 H cm.
Useful volume = 2 m^3.

10.2.3. Primary sedimentation tank:
square tank 500 x 500 cm with pyramidal bottom sloped at 60°, walls in reinforced concrete 30 cm thick.
Internal dimensions:
- height of the vertical walls 200 cm;
- height of the pyramidal part 300 cm.

Two holes 25 x 25 cm must be foreseen for the in-let and out-let pipes of 200 mm diameter and a connection pit 40 x 40 x 110 H cm to the general effluents equalization tank.
Tank partially underground.

B. SECONDARY TREATMENT

10.2.4. Aeration tank:
with lateral and bottom walls in reinforced concrete 40 cm thick.
Internal dimensions:
- width 1,000 cm,
- length 3,500 cm,
- height 400 cm (useful 350 cm).

Useful volume: 1,200 m^3 ca.
Partially underground tank: 150 cm above and 250 cm below the ground level.

10.2.5. Secondary sedimentation tank
circular tank of 9 metres diameter in reinforced concrete.
Complete of bridge in reinforced concrete for the installation of the sludge scraping device and pit for the sludge recycle pump.
Other dimensions:
- height of vertical wall = 2.6 m (2.3 m useful);
- useful volume = 150 m^3 ca.

Thank partially underground.

10.3. SLUDGE TREATMENT AND COMMON FACILITIES

Alternative A: filter-press

10.3.1. Tank for the preparation of lime-milk:
in reinforced concrete.
Dimensions: 200 x 200 x 150 H cm.
Volume 5 m^3
Tank partially underground.

10.3.2. Tank for the sludge conditioning:
in reinforced concrete.
Dimensions: 200 x 500 x 300 H cm.

10.3.3. Covered area:
for the installation of the filter press.
Dimensions: cm 300 x 850 x 400 H.

Alternative B: Sand beds

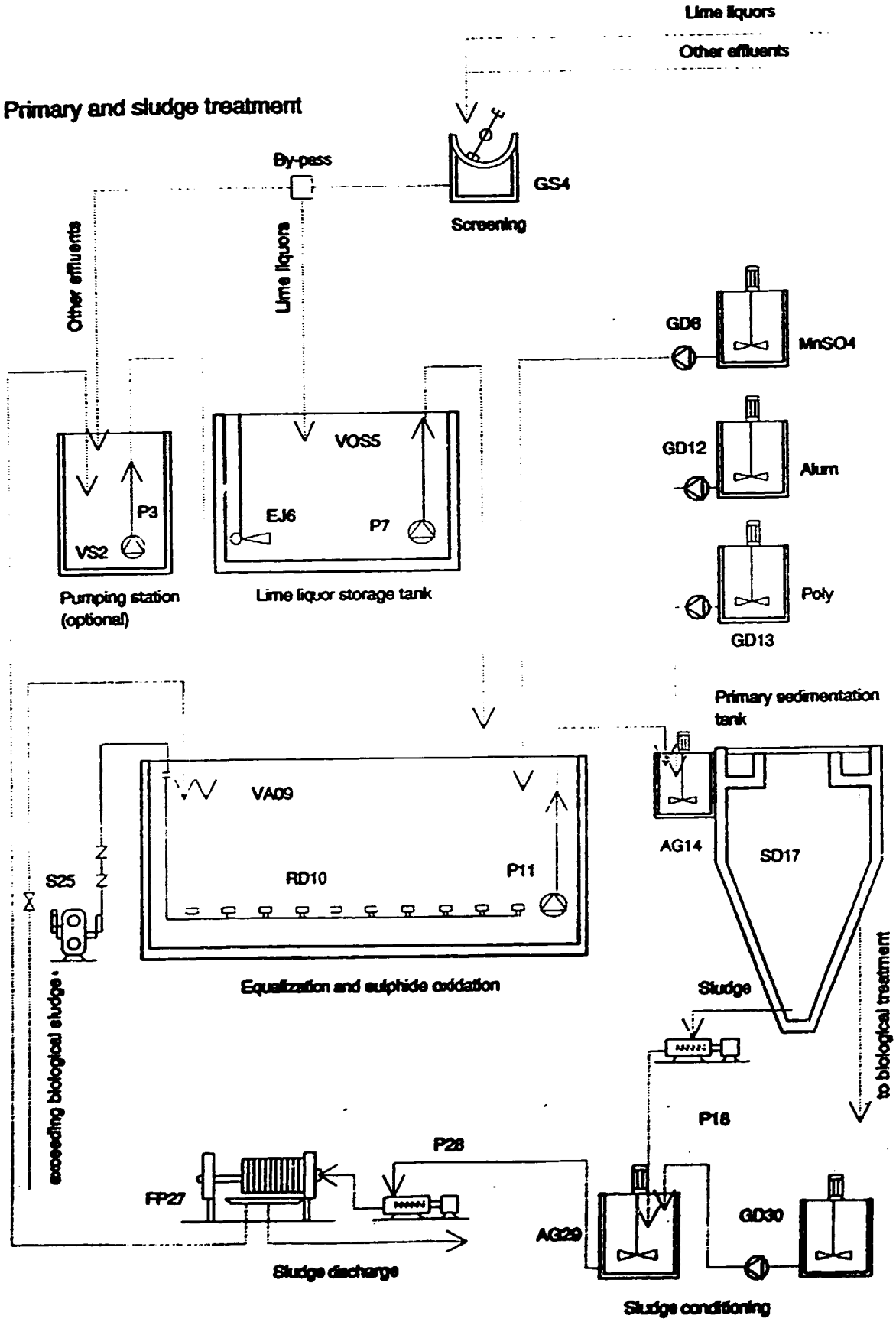
10.3.4. Sludge drying beds:
Internal dimensions: cm 600 x 1,300 (78 m2 surface) with a average vertical height of 125 cm (lateral walls).
Number of beds: 10.
Lateral walls 20 cm thick in blocks reinforced with steel bars 8 mm diameter placed every 60 cm and connected with the bottom r.c. plate and r.c. tie beam at summit level. The internal surface is finished with plastering.
The filtering surface is constituted of:
- cm 10 upper layer of sand 0.3 - 0.6 mm;
- cm 10 middle layer of crushed stone 15 - 20 mm;
- cm 5 lower layer (average height) of crushed stone 40 - 80 mm.

10.3.5. Covered area:
for the installation of the general control panel of the electric equipment of the plant and the dosing units, and for the storage of the chemicals used in the effluent treatment.
A portion of cm 500 x 200 is closed with lateral walls in blocks bedded with cement mortar (control board room) the remaining is open.
Dimensions: cm 500 x 1,000 x 400 H.

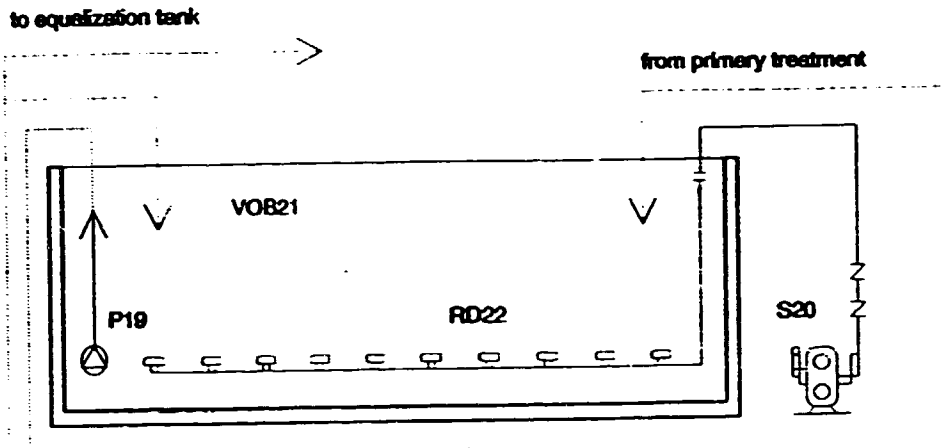
ANNEX 1

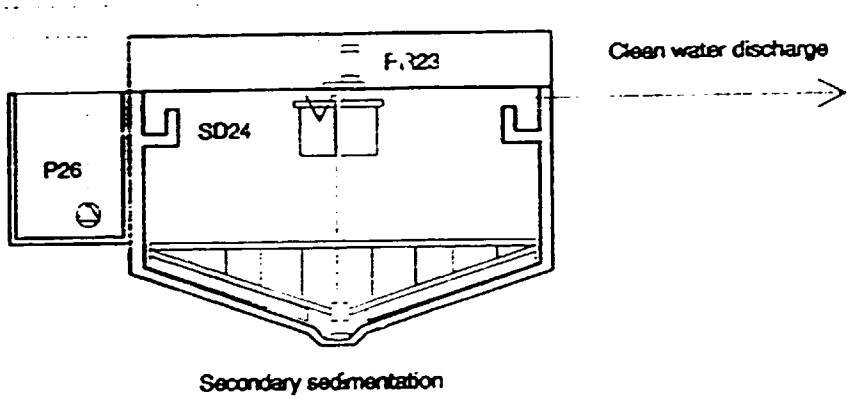
Proposed E.T.P. at

Ethiopian Pickling tannery - Ethiopia



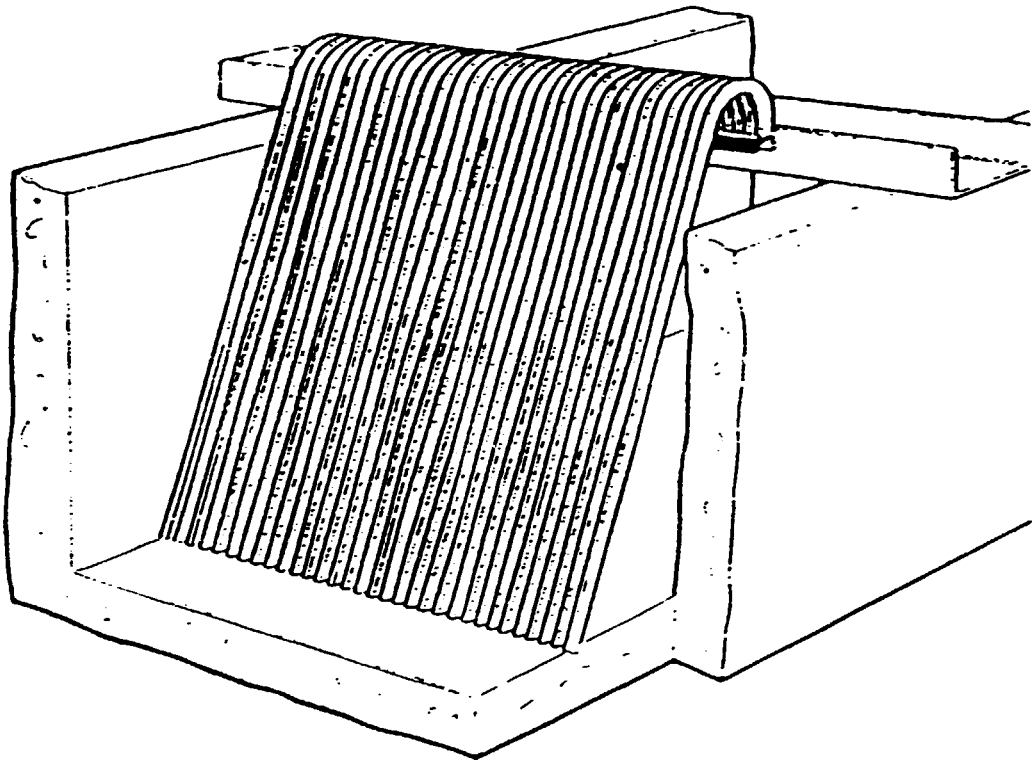
Biological treatment



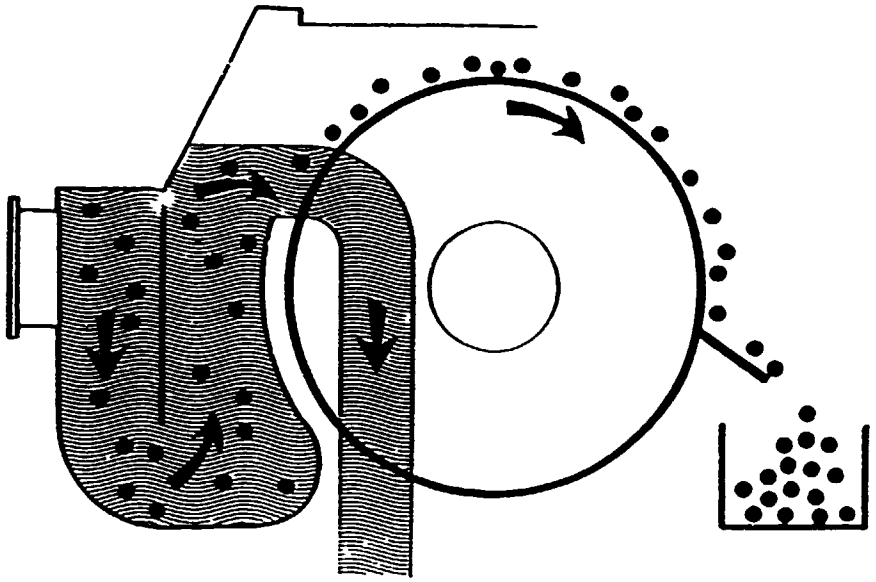


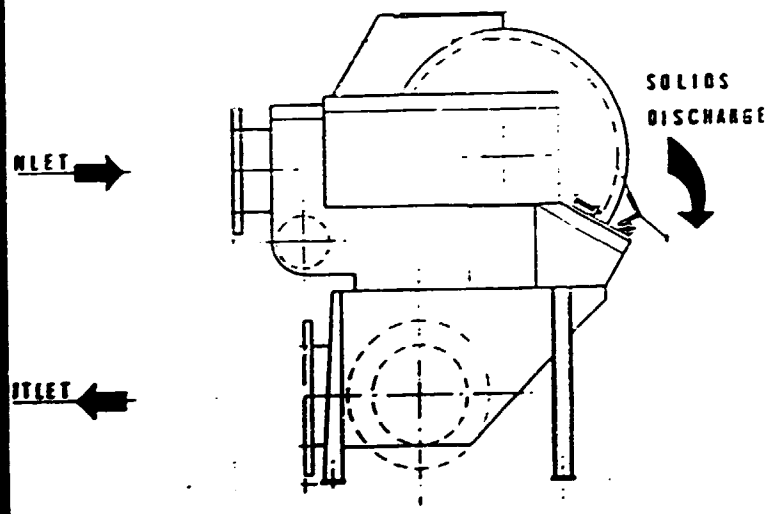
ANNEX 2

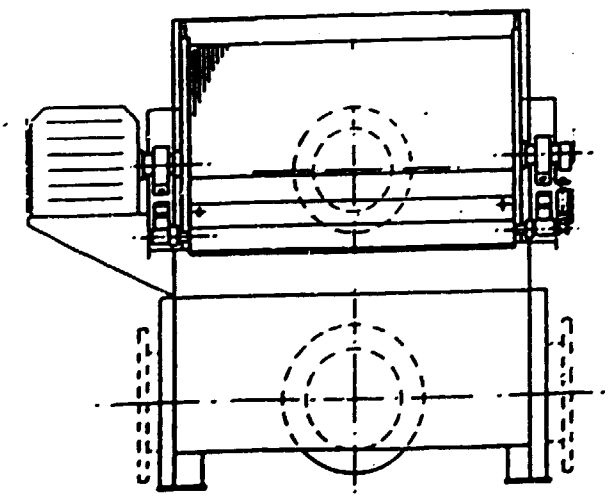
INDICATIVE PAMPHLET OF THE NECESSARY EQUIPMENTS



Simple manually raked screen. Flow is from left to right

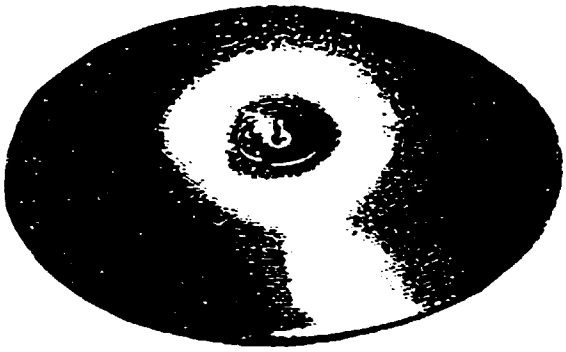


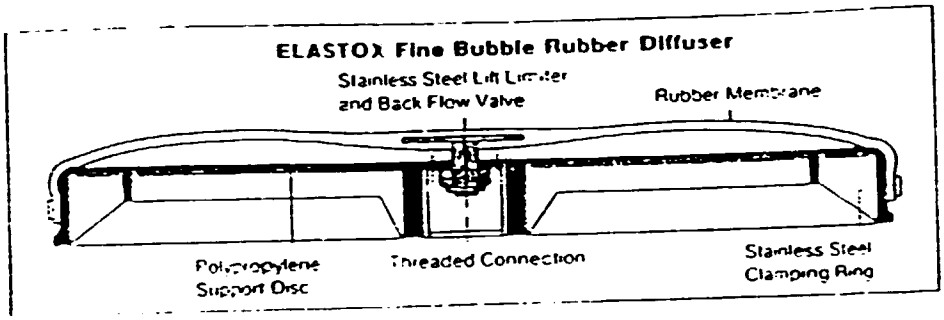


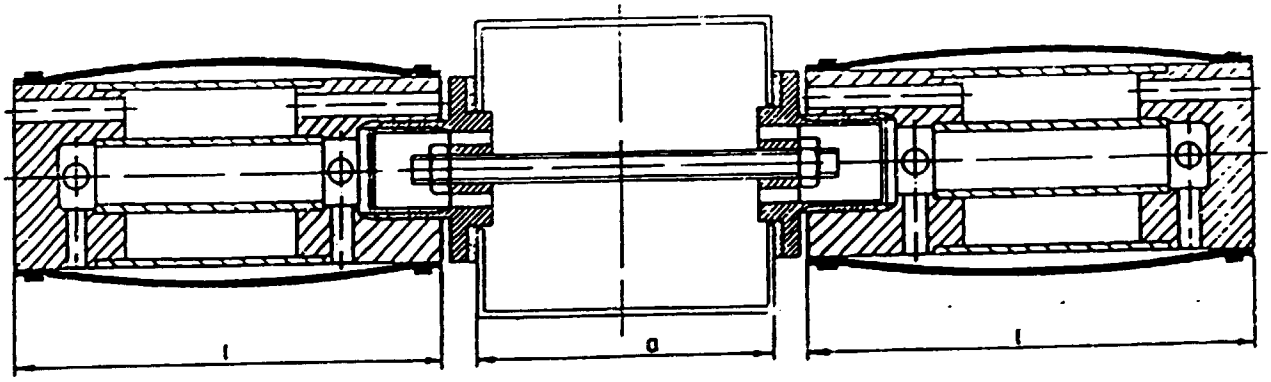


Rotating drum screen

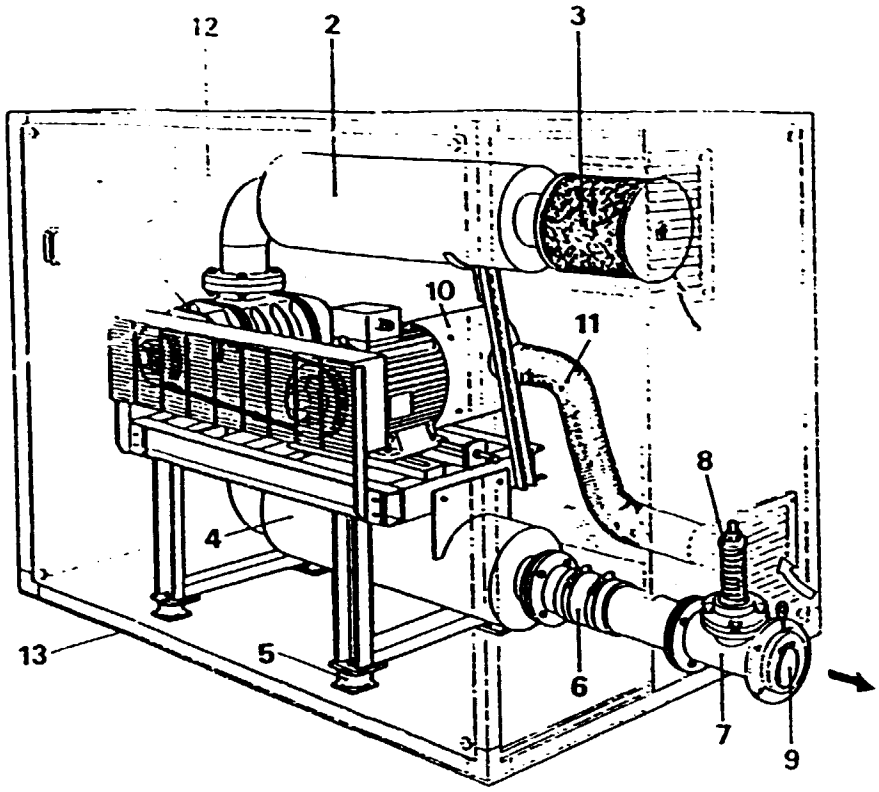
Fine bubble membrane diffusers







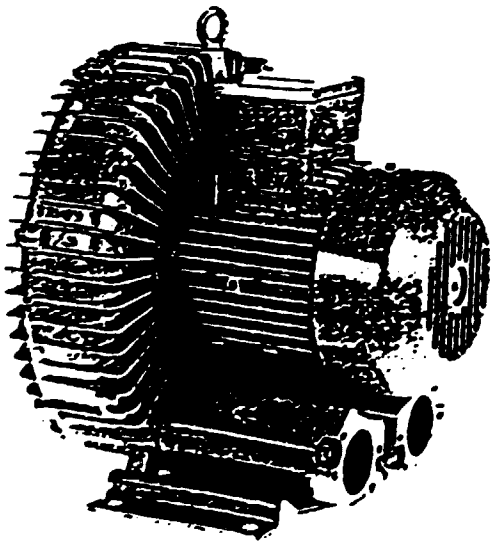
Membrane diaphragm diffuser

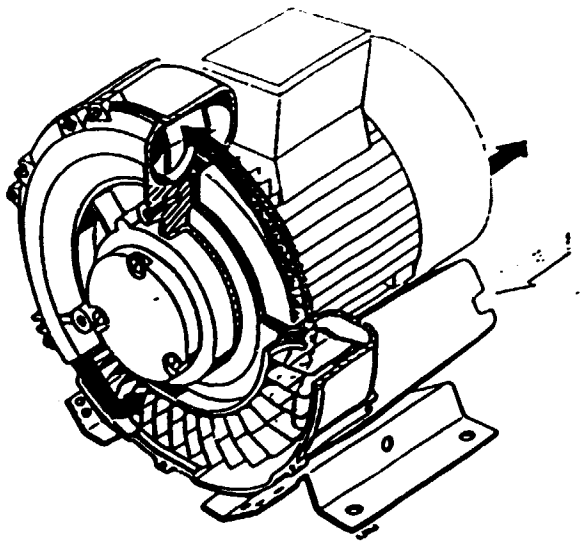


Pos.	DENOMINAZIONE
1	SOFFIATORE
2	SILENZIATORE ASPIRANTE
3	FILTRO
4	SILENZIATORE PREMENTE
5	SUPPORTI ANTIVIBRANTI
6	RACCORDO ELASTICO
7	RACCORDO A TRE VIE
8	VALVOLA DI SICUREZZA
9	VALVOLA DI RITEGNO A CLAPET
10	CALOTTA SPECIALE MOTORE
11	TUBO FLESSIBILE
12	USCITA ARIA VENTILAZIONE
13	TAMPONAMENTO CON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

Blower





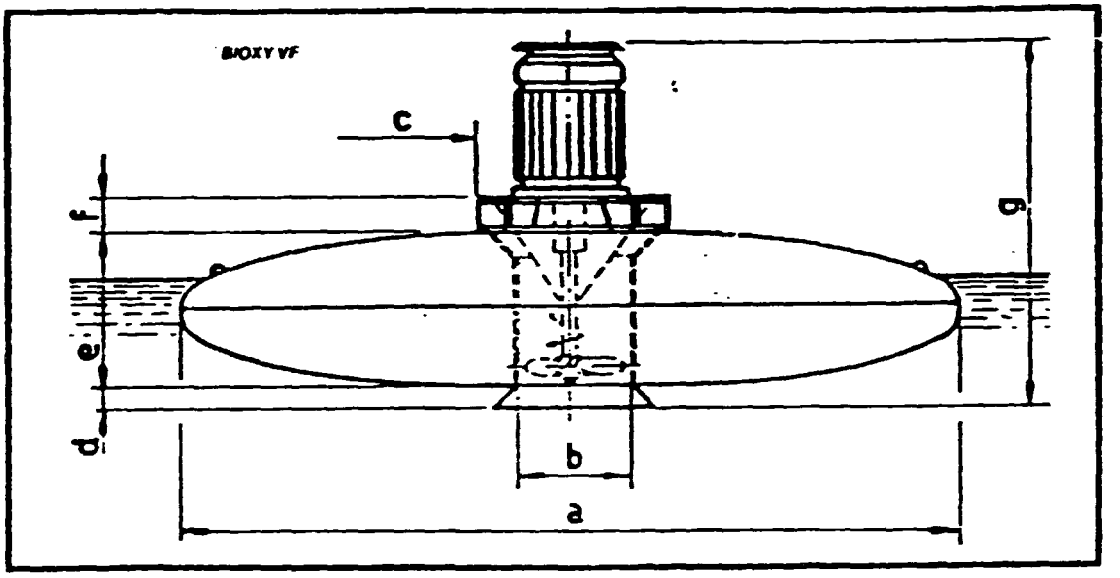
series

"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.

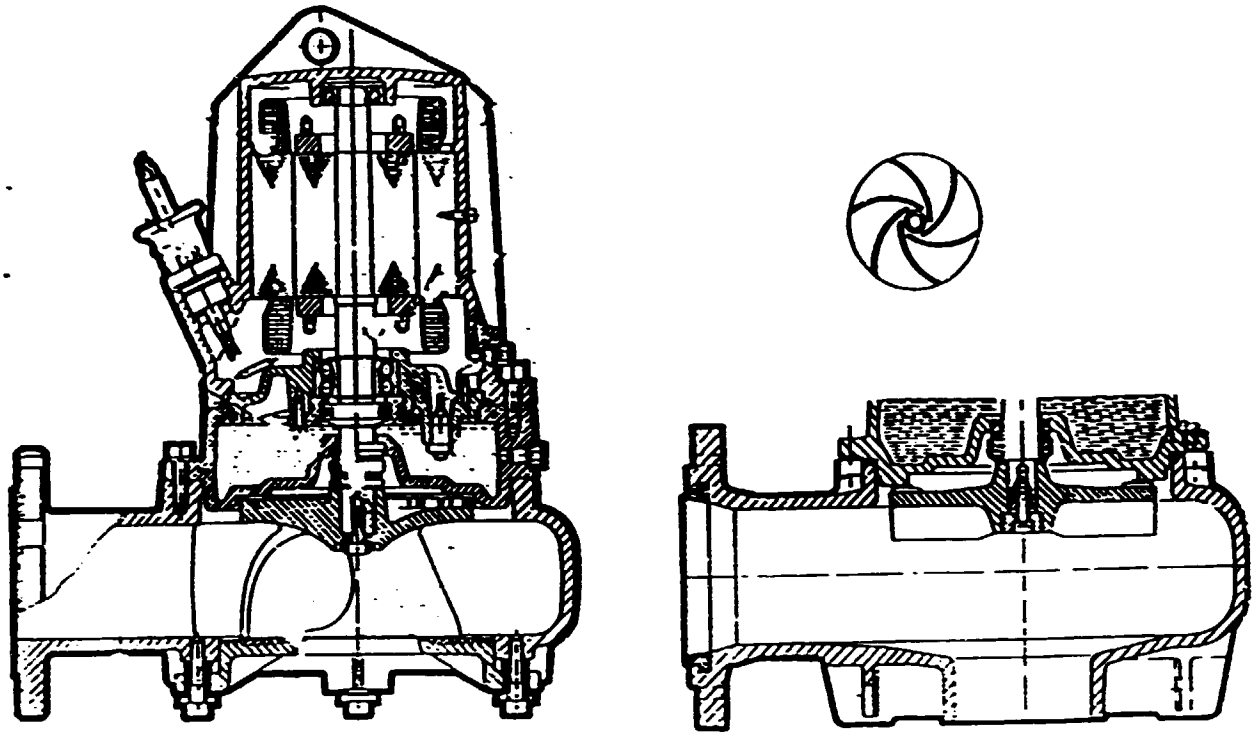
The floating high speed aerators can be manufactured in anticorrosive materials and stainless steels.
The construction of the aerators is such that it can follow the level of the liquid thereby maintaining a high oxygen transfer irrespective of the depth of the liquid.
Aerators developed from the " BIOXY-GA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



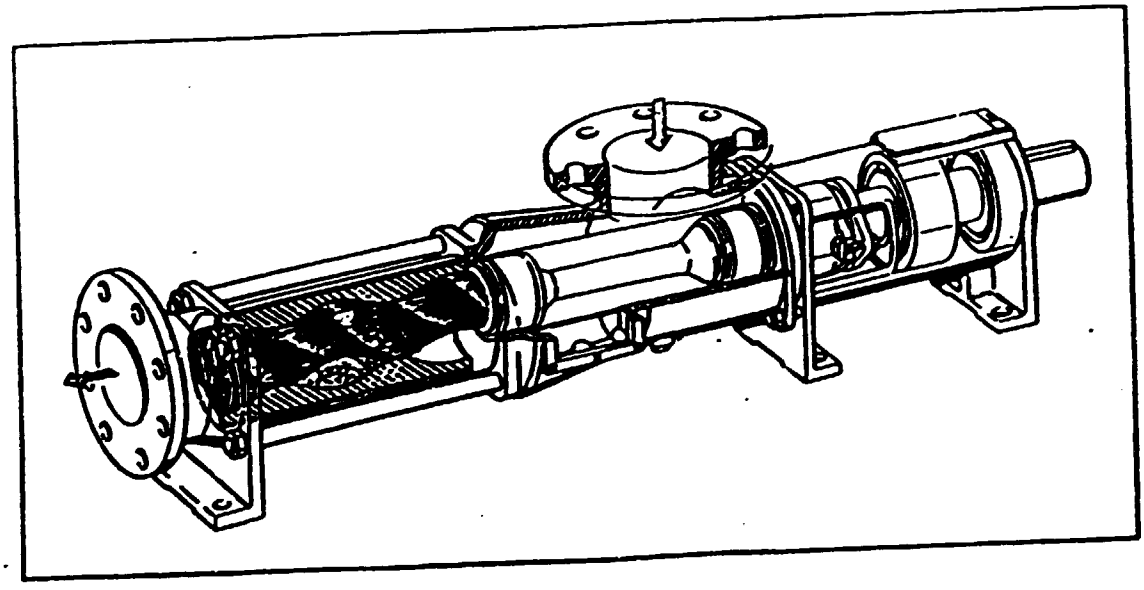
BIOXY TYPE	4-POLE PUMPING MOTOR kW	RATE m³/h	O_2 kg/h	SHAFT ø	"PANCAKE" FLOAT ø a	ø c	e	ø	BAFFLE PLATE ø c	f	DIMENSIONS b	BIOXY TYPE
VF-1	3	650	5,2	40	1600	740	75	310	580	275	964	VF-1
VF-2	4	750	6,5	40	1600	740	75	310	500	275	964	VF-2
VF-3	5,5	850	8,4	40	1600	740	75	310	500	275	1003	VF-3
VF-4	7,5	980	11,6	50	1900	880	110	400	580	330	1204	VF-4
VF-5	11	1250	15,2	50	1900	880	110	400	580	330	1262	VF-5
VF-6	15	1450	22,8	50	1900	880	110	400	580	375	1372	VF-6
VF-7	22	1870	27,3	50	1900	880	110	400	580	375	1372	VF-7
VF-8	25	2200	36,5	60	2100	940	110	460	650	420	1529	VF-8
VF-9	30	2570	42,5	60	2100	940	110	460	650	420	1589	VF-9
VF-10	40	3520	57,5	70	2500	1050	110	700	700	460	1935	VF-10
VF-11	ø 50	4250	72,6	70	2500	1050	110	700	770	500	2056	VF-11
VF-12	ø 60	4850	87,7	70	2500	1050	110	700	770	510	2284	VF-12
VF-13	ø 75	5620	112	70	2500	1050	110	700	770	510	2284	VF-13
VF-14	ø 100	8560	140,7	80	3000	1250	110	800	880	600	2608	VF-14
VF-15	ø 125	10520	175	80	3000	1250	110	800	880	720	2608	VF-15
VF-16	ø 150	12300	205	80	3000	1250	110	800	880	720	2608	VF-16

ø 6-pole motor

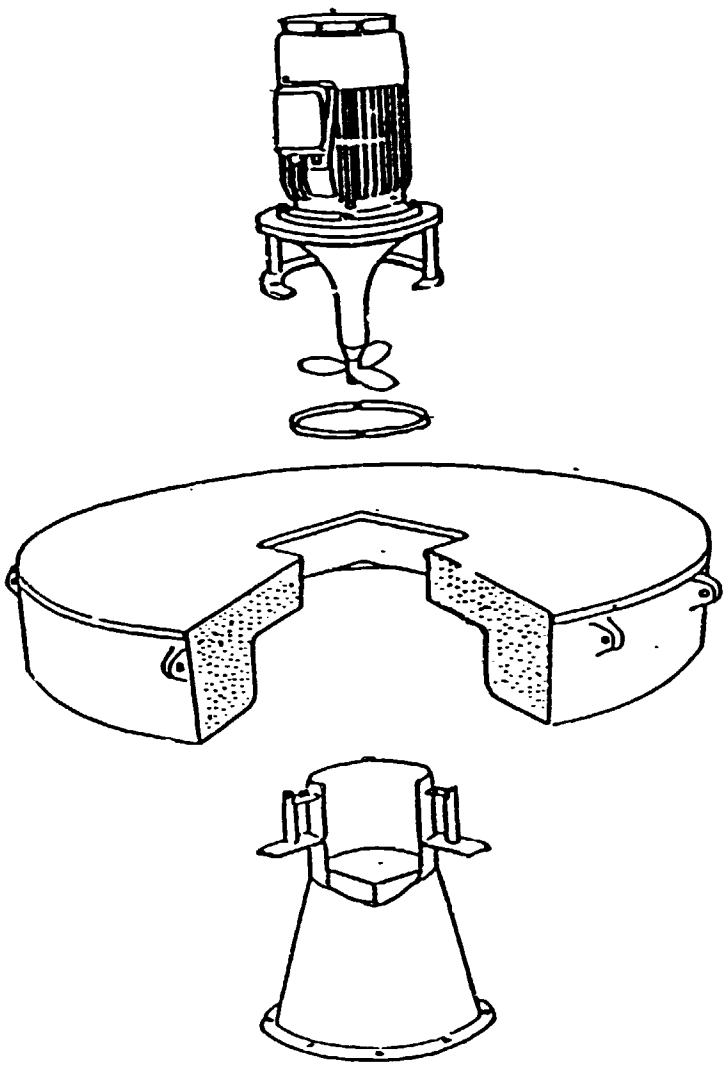
Surface aerator



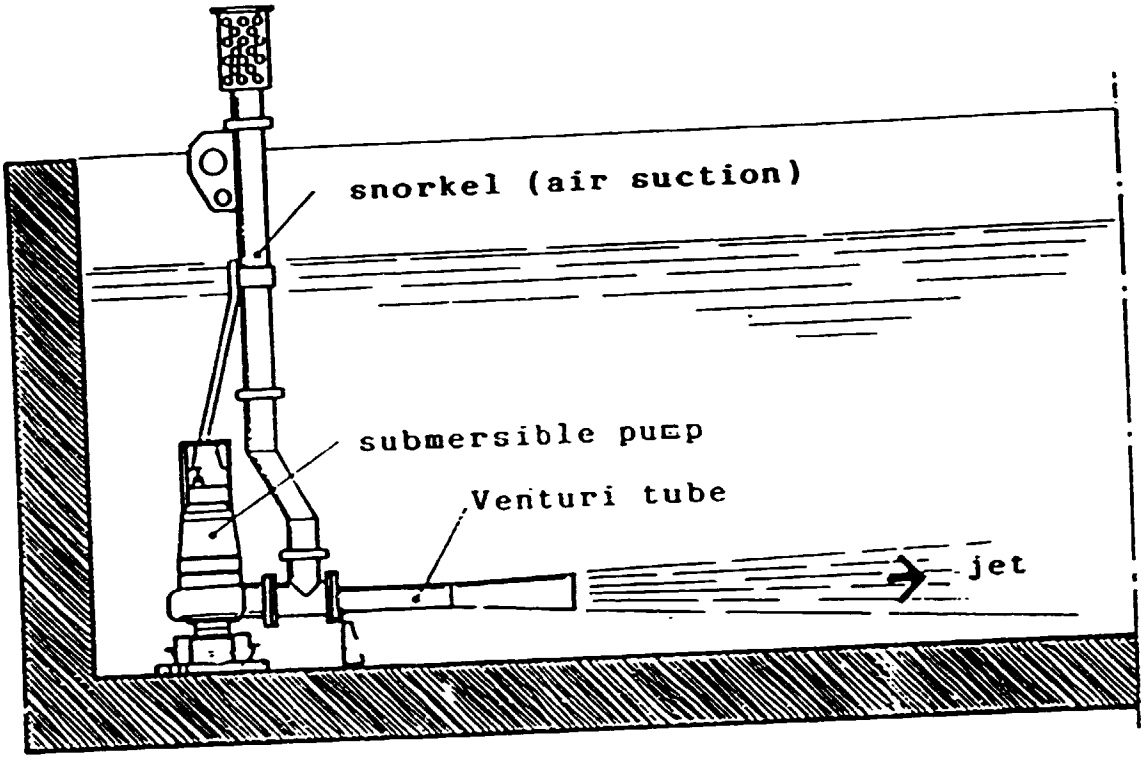
Submersible pumps

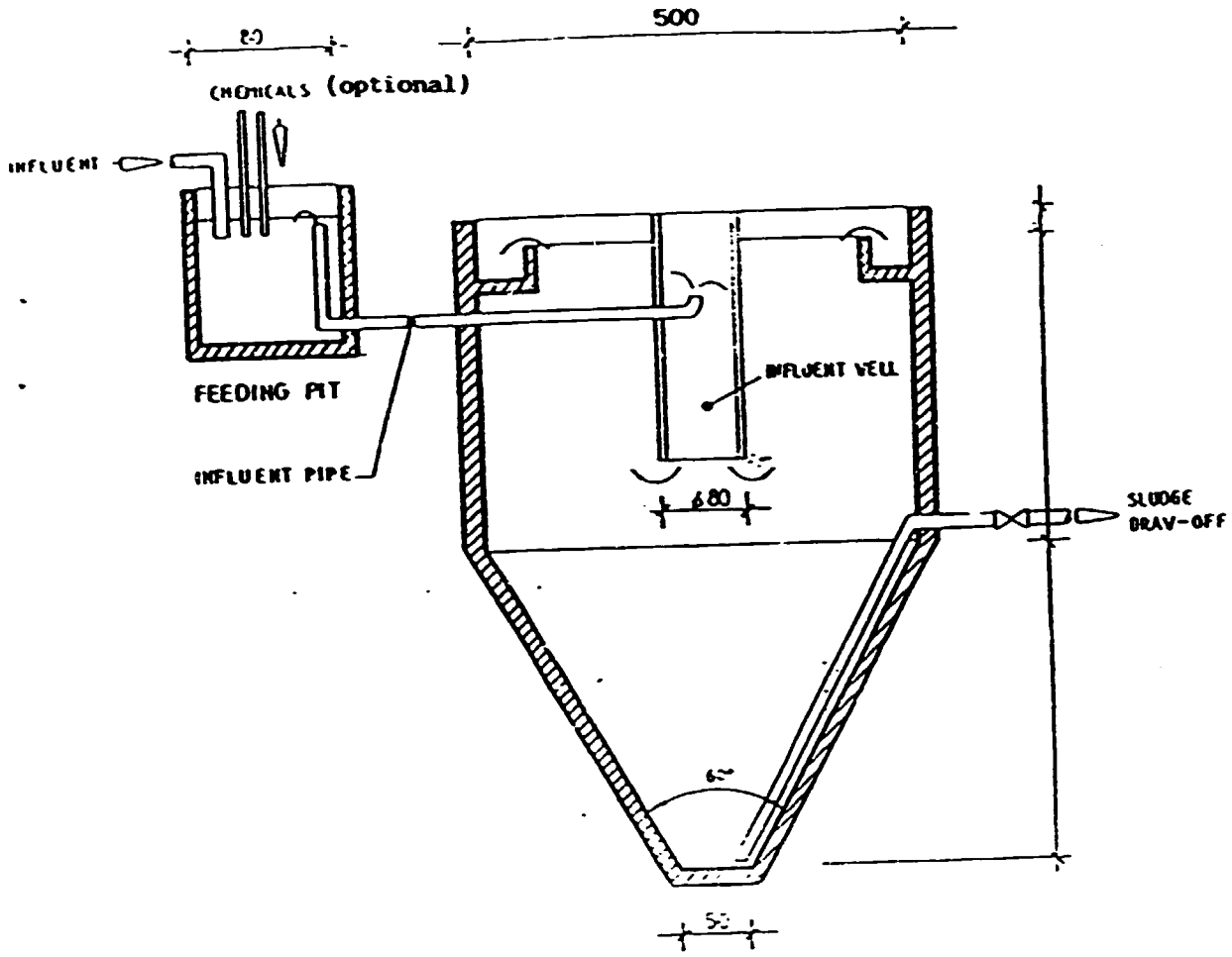


Screw pump

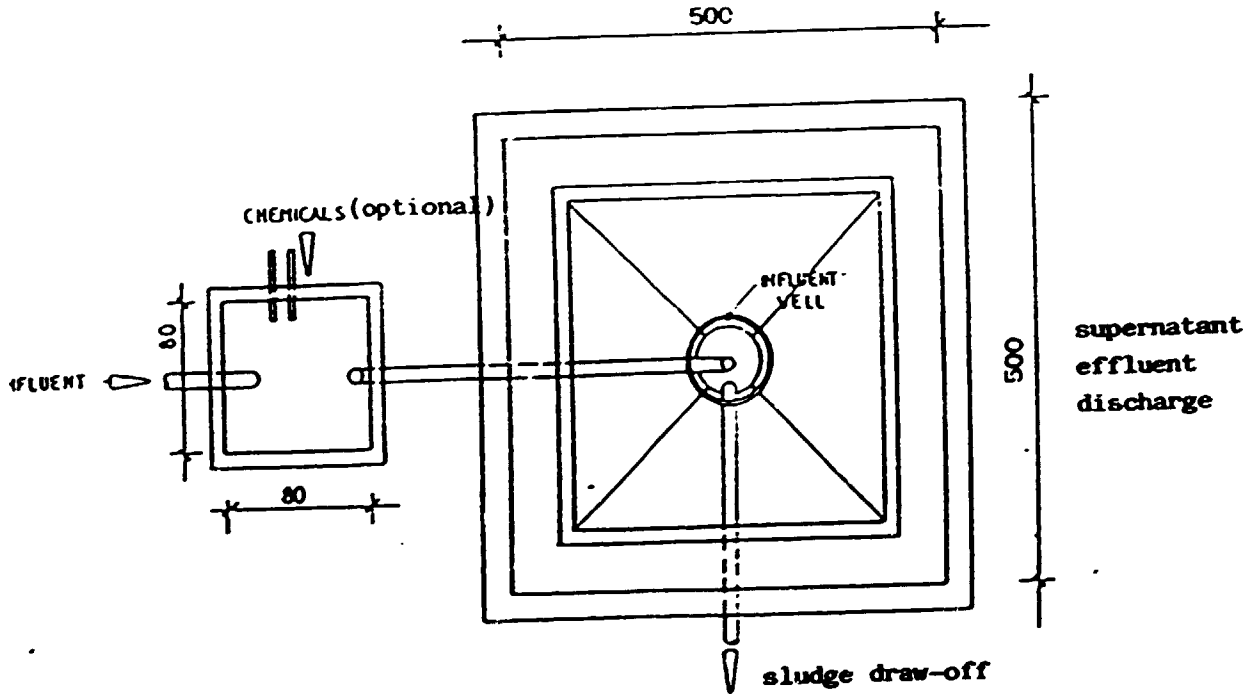


VENTURI EJECTOR (Assembly)

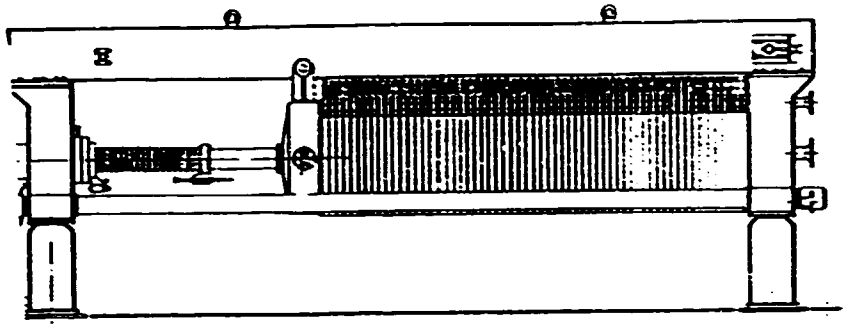


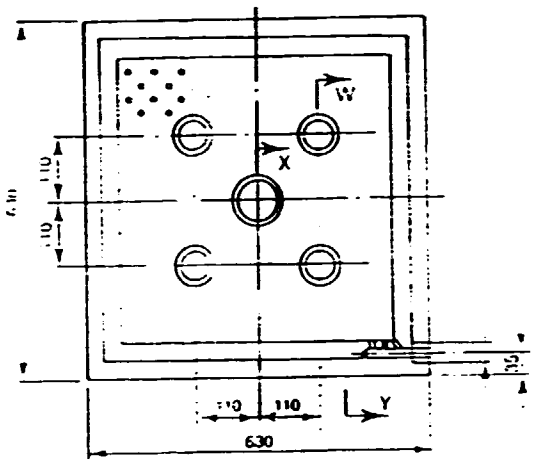


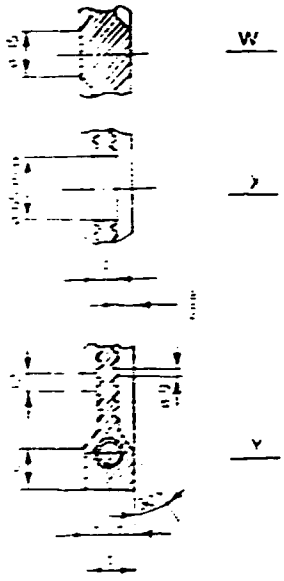
NOTE: NOT IN SCALE!



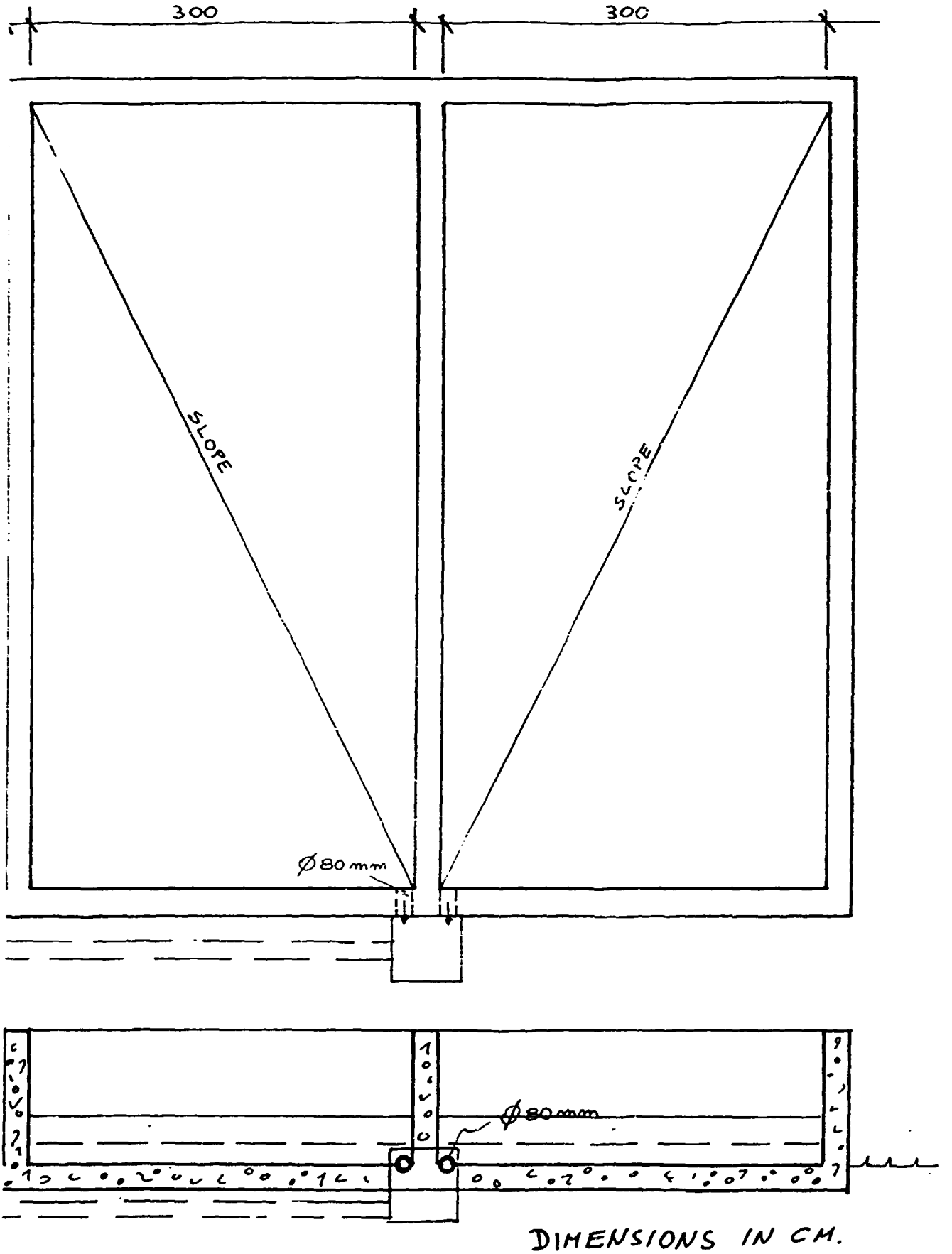
PRIMARY STATIC CLARIFIER
Pyramidal







Filter press with plate 630 x 630 mm



Sludge drying beds