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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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ASSISTANCE IN WATER AND WASTEWATER TREATMENT IN THE FOOD INDUSTRY IN THE SYRIAN ARAB REPUBLIC

PART 2

OIL AND SOAP MANUFACTURING COMPANY DAMASCUS – JEREMANA

FINAL REPORT

ZAGREB, JULY 1989.

Ordering Party: UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Waagramerstrasse 5
A-1220 VIENNA
AUSTRIA

The Contractor: "RINEX-TEH PROJEKT"
Fiorello la Guardia 13
51000 RIJEKA
YUGOSLAVIA

Contractors Personel:

SRDJAN SELANEC	- Team Leader
RADOVAN GORJANOVIC	- Effluent Treatment Specialist
ZORAN GOLOB	- Food Technologist
PETAR BRUSIC	- Civil Engineer
TOMISLAV KNEZEVIC	- Mechanical Engineer
MIRJANA TURCIN	- Droughtsman
LJILJANA VENIER	- Typist
MAJA SELANEC	- Editor

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PART 2

ARABIC OIL AND SOAP MANUFACTURING COMPANY

1. GENERAL DATA

The Edible Oil and Soap Factory is situated in Damascus, in the part of the city called Jaramana.

The two basic technological processes in the factory are edible oil manufacturing, and soap manufacturing which form a logical operational circle of turning the waste by-products from oil production into useful product (soap).

The factory was built around 1955. 165 workers are employed there at the moment and they have to work in triple (3) shifts through 280-290 days/year. The production is very irregular because of the problems with row material supplies.

The daily oil production reaches the amount of 8 to 9 tons, while the quantity of produced soap is between 15 and 20 tons/day. The working lines depend partly on the supply of raw materials, and due to some problems in connection with them, it is difficult to decide exactly on the steady yearly amount of the produced goods.

Basically, the approximate amounts are: 2700-2800 t/year of oil and 200-2500 t/year of soap. Some by-products are obtained as well, approx. 50 t/day of cake obtained after pressing the oil (used as a stock-feed), raw cotton (approx. 5 t/day) and the so called "soap stock", approx. 5 t/day, used as a raw material in soap manufacturing.

2. DESCRIPTION OF THE PRODUCTION PROCESSES

2.1. OIL PRODUCTION

(See Block Flow Diagram, Fig. 1.1.)

The raw material in oil manufacturing is cotton seed. The first step in the production cycle is the removal of seed from the cotton lint. The lint is packed into bales and used as the raw material in cotton processing while the separated seeds are transported to the grinding machine. Following the grinding, the substance is cooked by means of steam and then filtered through a filter press to separate the fluid phase. The by-product called a filter cake is packed and used as stock-feed.

The filtrate (mixture of oil and water) is then finely sieved and later brought to the reaction tank where acidity is adjusted by adding NaOH solution. The mixture must be constantly mixed.

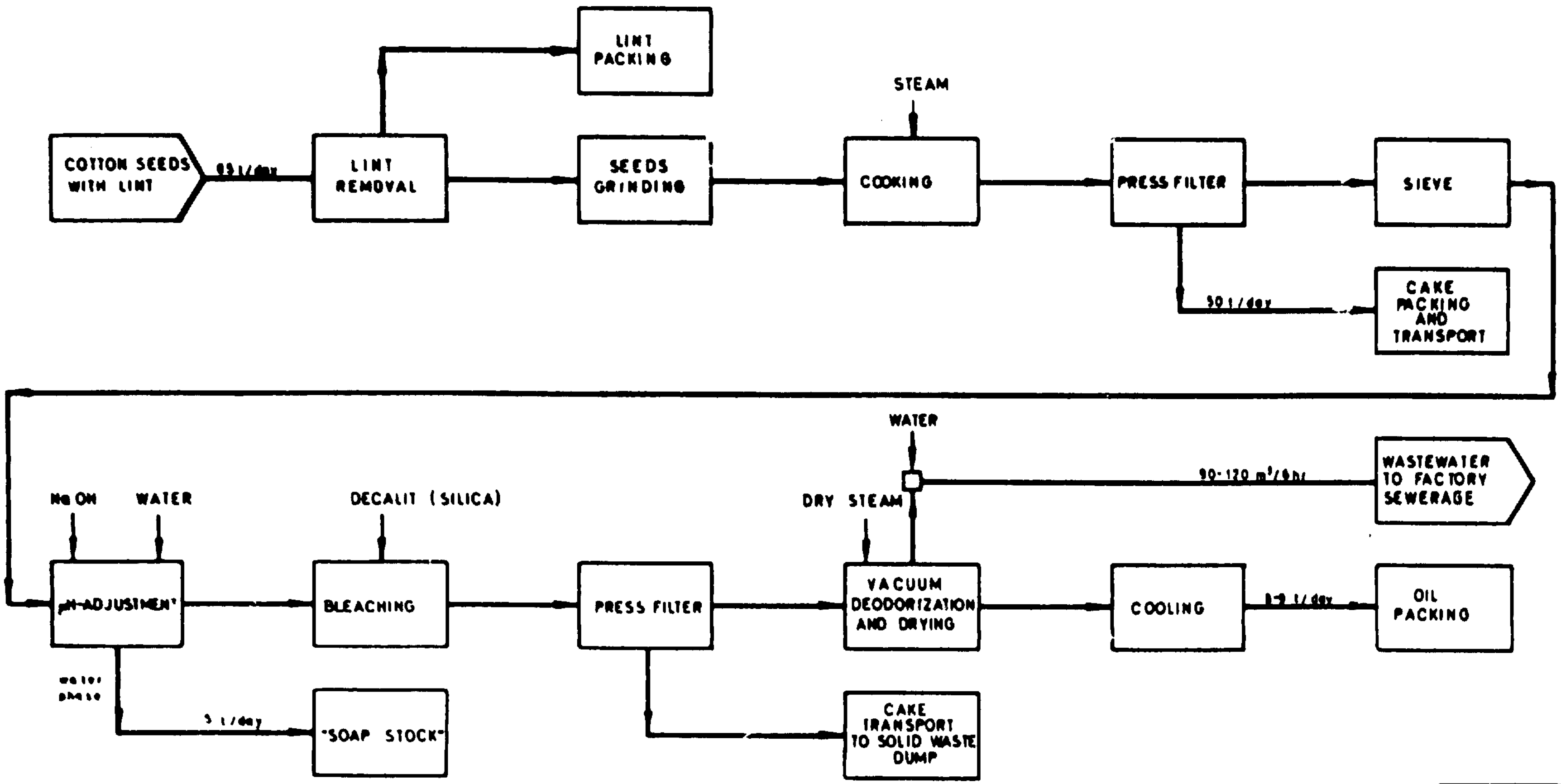


FIG. 1.1. BLOCK FLOW DIAGRAM OF OIL PRODUCTION
Oil and Soap Factory

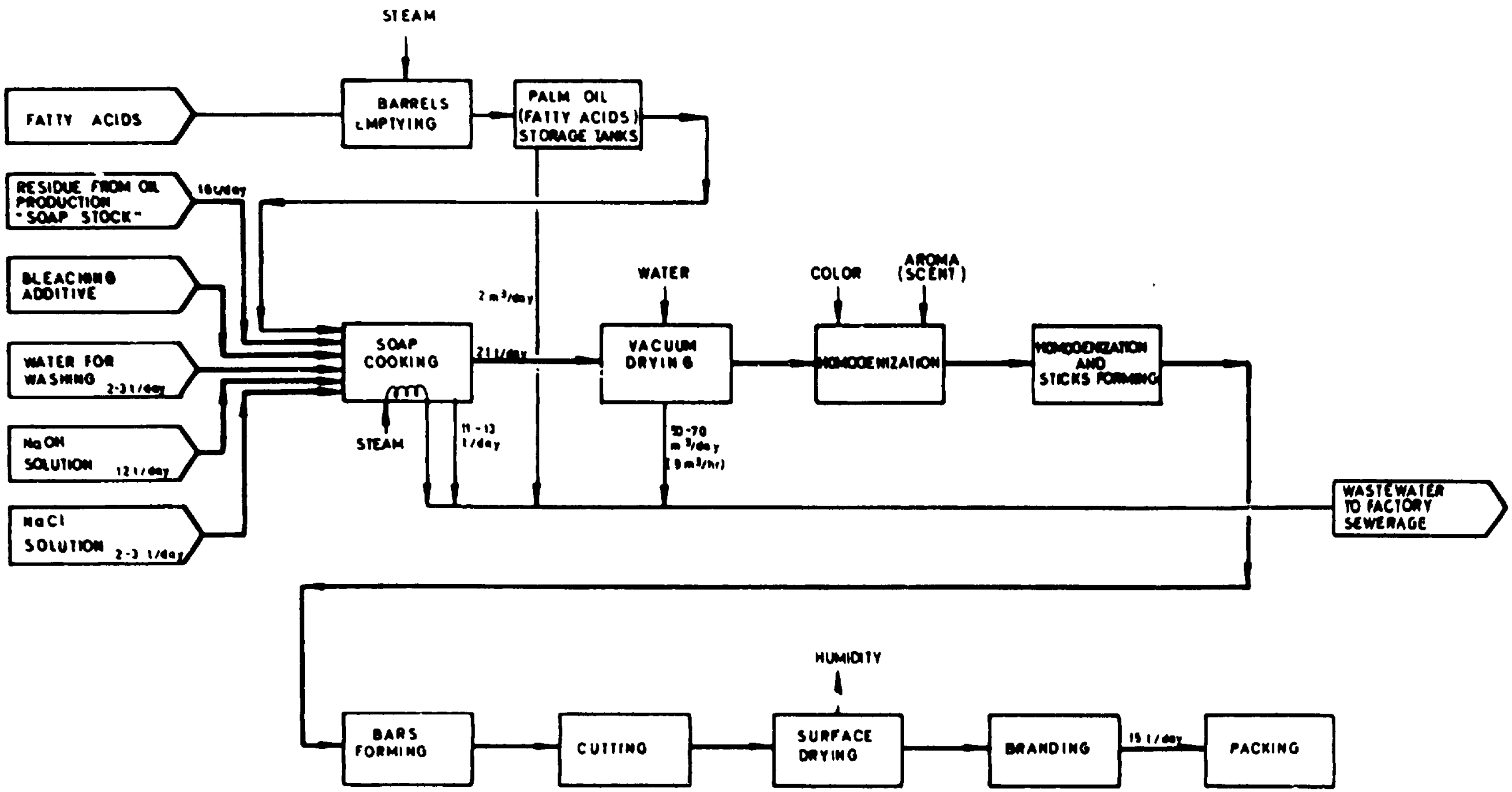


FIG. 1.2. BLOCK FLOW DIAGRAM OF SOAP PRODUCTION
Oil and Soap Factory

Following the pH adjustment, two phases are separated: the upper layer consists of raw oil, while water is formed at the bottom. The water layer (so called "soap stock") is drained and stored in a storage tank to be used in soap production.

The adsorbtion additive (decalit) is used for bleaching raw oil. The additive is later on removed from oil by filtering through the filter press with cloth and then disposed of.

The odour must be removed as well. It is done in a deodorizer under vacuum, generated by a barometric consender. The barometric condenser effluent is in fact the only waste water in oil manufacturing.

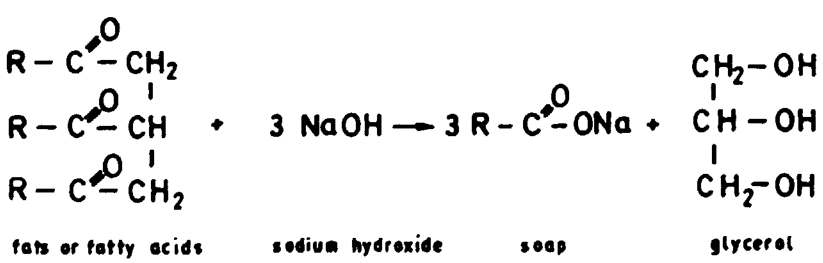
Hot, purified oil is cooled down and packed.

2.2. SOAP MANUFACTURING PROCESS

(See Block Flow Diagram, Fig. 1.2.)

The basic raw materials in soap manufacturing are so called soap stock (from the oil manufacturing line) and/or fatty acids (mostly palm oil) and sodium hydroxide.

In principle soap manufacturing process is a so called "batch kettle" process where fatty acids are acted upon by the alkali, and direct results are fatty acid salts, (sopas) while glycerol is a by-product.



In practice "soap stock" is used instead of one of fatty acids so the by-production of glycerol is very poor and most of it is held inside the final product.

Fatty acids are transported to the factory in iron barrels and emptied by means of steam. In this way they can be softened and transferred by a pump into storage tanks. There are three storage tanks, the volume of each being 15 cu m. The tanks are warmed up and approx. 2 cu m of waste waters are removed from the bottom per day.

Soap manufacturing is performed in kettles. There are six such kettles (35 cu m each), all equipped with steam pipe heaters and mixers. 16 tons of soap stock and/or fatty acids approx. and 12 tons of 20-25 % NaOH solution are added to the kettle and mixed and cooked for three hours. After letting it at rest (1 day), the water layer from the bottom is drained to the sewerage and a NaCl solution is added to soap. After mixing the water layer is drained again (after 1 day) and soap is rinsed with clean water. NaOH is added practically in stoichiometric amount, so it is not necessary to use a lot of NaCl-solution and water. That way glycerol is held inside the final product.

Water is removed and soap can undergo further processes (approx. 21 t/tank).

The total quantity of the water layer removed from the tank is approx. 8-11 cu m/day, per tank. One tank per day is usual in the process of manufacturing.

The humidity of the soap fabricated in such a way reaches 30 % and it must undergo vacuum drying to reduce humidity to 18 %. Colour and fragrance are than mixed into the soap and the soap compound is then cast into bars. Finally the bars are cut, dried up on the surface, branded and packed.

The humidity of the final product is 14 %. 15 t/day of soap is manufactured.

3. WATER SUPPLY, TREATMENT AND DISTRIBUTION

(See the Simplified Process Flow Diagram, Fig. 1.3.)

3.1. GENERAL DESCRIPTION

Water is supplied from two wells situated within the factory limits, Water is pumped by pumps of 6 l/sec each (P1 and P2).

Water is used for:

1) Technological processes
2) Steam production
3) Sanitary needs (only for cleaning toilets, since its quality does not correspond to drinking water standards)

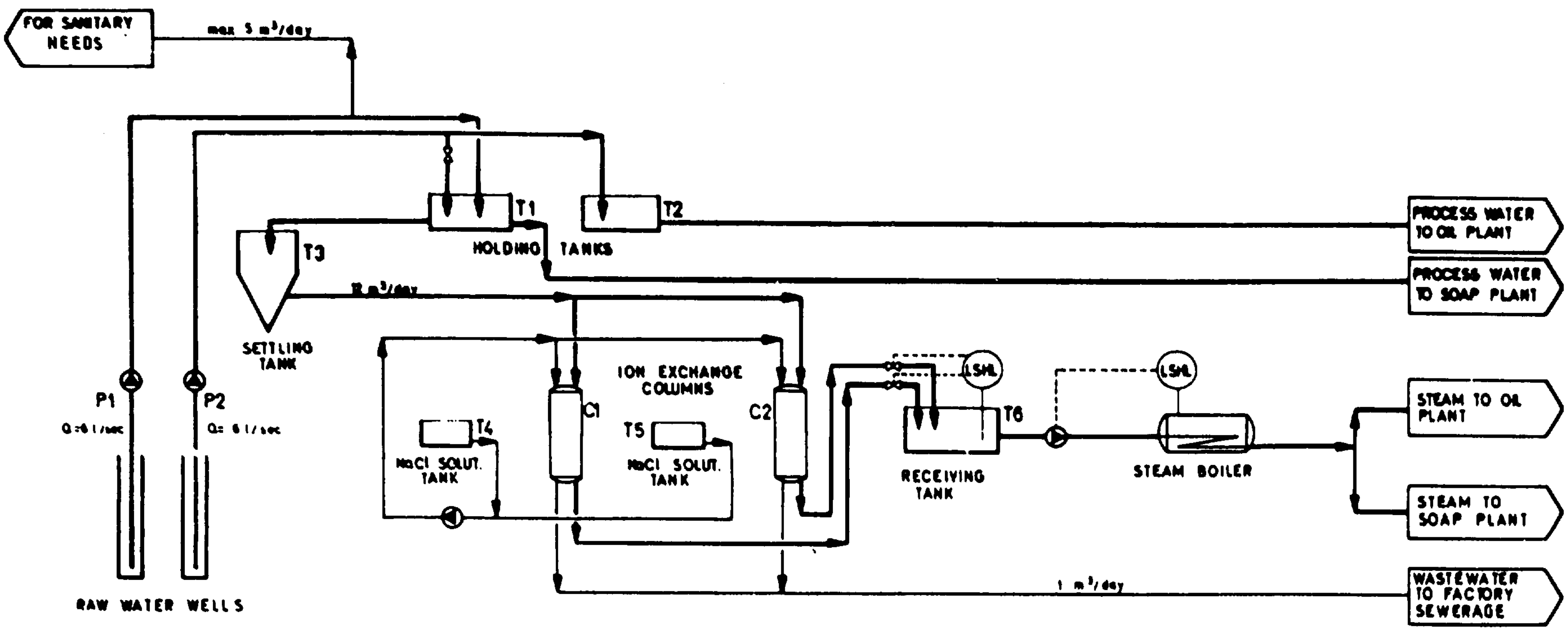


FIG. 1.3. SIMPLIFIED PROCESS FLOW DIAGRAM OF WATER TREATMENT AND DISTRIBUTION (existing)
Oil and Soap Factory

Water for steam production is softened in ion exchange columns C1 or C2 (neutral ionic resin type ROHM & HAAS IR 120). The water required daily is 12 cu m. The total hardness of raw water is 25 o dH and it is reduced to max. 1-3 o dH in ion exchange columns, and as such is pumped into a steam boiler. There are two columns, the working one and a stand-by column. The ion exchange column must be regenerated once a day, and 10-12 % of NaCl solution is used as a regeneration substance (the amount being approx. 450 l/regeneration). Following the regeneration, the column is rinsed for half an hour, the water amount being 0,5-0,7 cu m. The total effluent is 1 cu m/regeneration, and per day respectively.

Following the treatment, the water is pumped into the receiving tank T6 and into a steam boiler whose maximum capacity is 8000 kg of steam/hr and the working pressure of 10 bars.

4. WASTE WATER FLOWS AND CHARACTERISTICS

4.1. GENERAL DESCRIPTION

The whole factory is situated on the area of 20500 sq m consisting of the:
- administration building
- soap factory
- oil factory
- boiler house
- storages for row materials
- storages for products
- work shops
- fuel storages and ıks etc.

The area of 13000 sq m is occupied by covered buildings and the rest is mostly a paved manipulation area with small green interspaces.

All the wastewaters are collected by a combined sewerage system and discharged without any treatment into the municipal sewer of Jerremana whose final recipient is the river Acraba. For the time being the settlement of Jerremana does not have a waste water treatment plant.
The main sources of process effluents are shown in the Production Block Flow Diagrams Fig. 1.1. and 1.2. and the Water Treatment and Distribution Process Diagram Fig. 1.3. The drainage system of effluents and their quantities are shown in the Block Flow Diagram Fig. 1.4. Unfortunately the lay-outs and the geodetical data about the sewerage were not available.

4.2. EFFLUENT QUALITIES AND QUANTITIES

During our visit to the site we organized sampling and laboratory analyses for all the effluents but unfortunately we have not received the results. Anyhow, in Table 1.1. we shall try to summarize the main characteristics on the basis of our investigation and experience.

- Oil production processes produce no liquid wastes due to the fact that "soap-stock" iz used for soap production and that dry cleanup is practisized. The only effluent is relatively clean but high volume barometric condenser water from the deodorizer.

- Soap production processes produce several effluents which have discontinuons flows, pH and organic contents throughout a day and from day to day.

  a) Leaks, spills and drainages from palm oil transport and storage contain high concentrations of oil.

  b) Spent lyes after soap cooking which contain NaOH, oil, glicerol, NaCl and dirt.

  c) Barometric condenser water which contains very low concentrations of organic matters.

- Regeneration of ion exchangers produces a small amount of waste water which contains a little amount of inorganic matter.

- Sanitary effluents result from the sanitary needs of 165 workers employed in 3 shifts.

- Occasional rain will periodically cause greater amounts of wastewater which will contain different matters washed off the manipulation areas such as:

  - cotton seeds
  - vegetable and mineral oils
  - sand and grit.

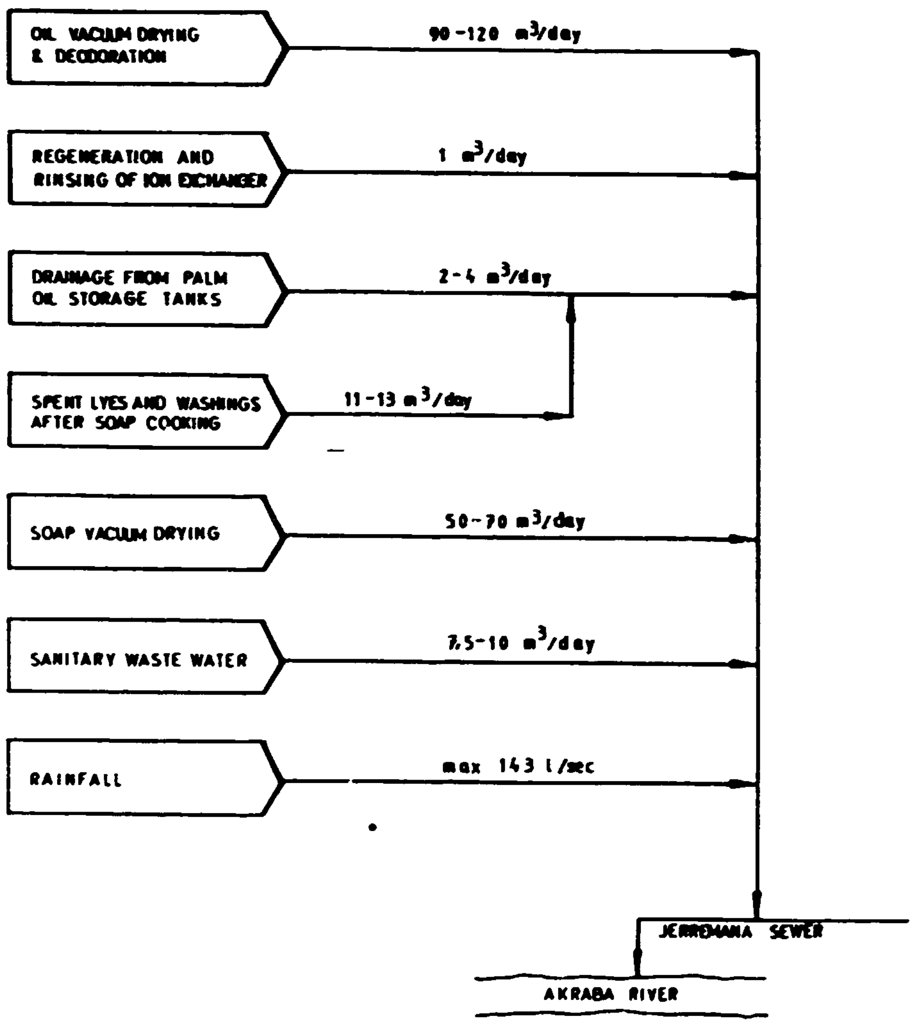


FIG. 1.4. BLOCK FLOW DIAGRAM OF THE DREINAGE SYSTEM
Oil and Soap Factory

TABLE 1.1.

CHARACTERISTICS OF THE EFFLUENTS FROM OIL AND SOAP FACTORY

SOURCE	QUANTITY		OIL AND GREASE	SUSPENDED SOLIDS	BOD_5	COD	pH	NOTE
	m^3/d	max l/sec	mg/l	mg/l	mg/l	mg/l		
1./ PROCESS EFFLUENTS								
OIL DEODORIZATION	90 - 120	5.5	50	—	50	150	7	
ION EXSCHANGERS	1		8	60	—	—		
PALM OIL STORAGE	2 - 4	1	3000 - 5000	3000 - 5000	1000 - 2000	30 000 - 50 000	6.5 - 7.5	
SPENT LYES AFTER SOAP COOKING	11 - 13	2	1000 - 1200	4000 - 4700	6000 - 8000	10 000 - 12 000	8 - 12	
SOAP VACUUM DRYING	50 - 70	2.5	75 - 110	1000 - 1500	600 - 900	1000 - 1500	7	
2./ SANITARY	7.5 - 10	1	—	330 - 450	220 - 300	330 - 450	7	
TOTAL DRY WEATHER EFFLUENTS	161 - 218	12	150 - 500	650 - 1750	700 - 1800	1480 - 4000	8 - 9	DISCONTINUOUS FLOWS (24 - 45 m^3/h) CAUSE VARIATIONS IN THE CONCENTRATIONS OF POLLUTANTS
RAINFALL		143						FLOW AND POLLUTION DEPEND OF RAIN INTENSITY WICH IS MAX. 130 l/s · ha

5. WATER TREATMENT RECOMMENDATIONS

5.1. GENERAL OBSERVATIONS

According to the SNS Standard No. 45/1973. water used in food industry must have physical, chemical and bacteriological properties of drinking water, which is not the case here.

On the other hand there is a hygienic aspect because water is also used in administrative buildings and in the kinderganten - for sanitary reasons.

In our opinion water should be disinfected before distribution.
We suggest the NaOCl solution with 5 % of available chlorine as a disinfectant. The reasons for it are as follows:

- the NaOCl solution is easy to obtain,
- chlorine as a disinfectant is allowed to be used according to Syrian laws
- simple equipment operation and maintainance
- low investments

Two different systems for disinfection and water distribution have been suggested in the following text.

Boiler water is softened in the ion exchanger. Resin regeneration is performed once a day which seems too frequent regarding the low water consumption (12 cu m/day). According to that observation, and on the request of the technical management, a rough checking of the ion exchanger performance is done in Chapter 5.4.

5.2. DISINFECTION OF WATER WHICH RETAINS THE EXISTING WATER DISTRIBUTION SYSTEM - ALTERNATIVE A

5.2.1. Description

(See Simplified Flow Diagram on Fig. 1.5.)

In this alternative the holding tanks of raw industrial water are kept on the roof of the factory buildings, keeping their function.

To obtain this, several new objects and some equipment should be necessary:

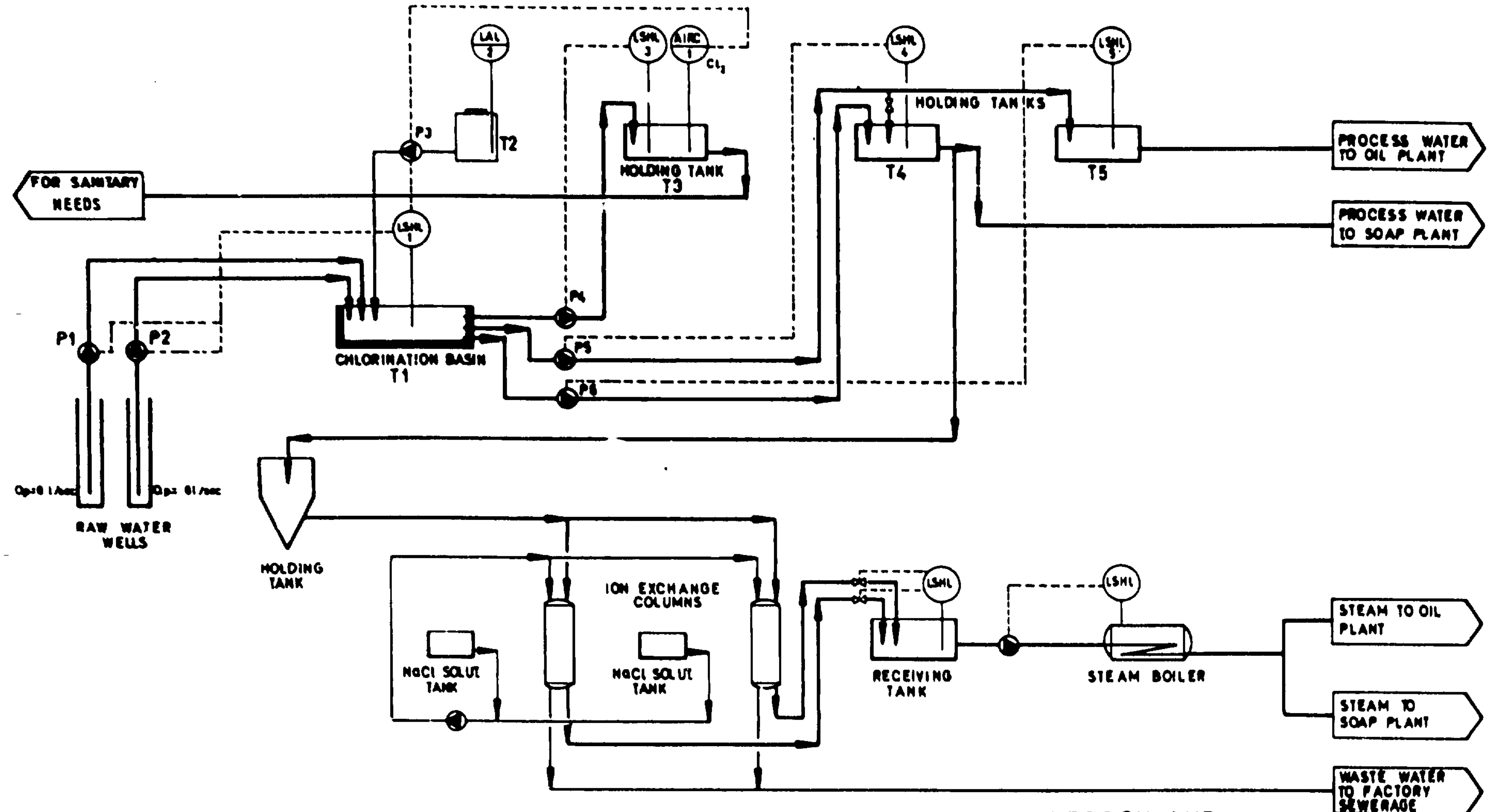


FIG. 1.5. SIMPLIFIED PROCESS FLOW DIAGRAM OF WATER DISINFECTION AND DISTRIBUTION (recommendation) — ALTERNATIVE "A"
Oil and Soap Factory

- a concrete tank for chlorination,
- a holding water tank for sanitary needs on the administrative buiding,
- three centrifugal pumps and
- a dosing pump for the NaOCl solution should be installed.

The well pumps P1 and P2 should be switched on/off depending upon the level of water in the chlorination basin T1 (LSHL 1). The same signal would be used for switching on the dosing pump of the NaOCl solution (P3).

The sanitary water holding tank (T3) should be equipped by an automatic analyser of residual chlorine (AIRC 1 - Cl2). Its function is to strengthen or weaken the function of the dosing pump electro motor and respectively the dose of the NaOCl solution. It has been settled that the chlorination time is 30 minutes.

From the chlorination basin, water is pumped (P5 and P6) to the holding tanks T4 and T5. There are two such tanks while the third one is to be installed. Every tank should be supplied by water with separate pumps. Switching on/off the pump is regulated by separate level switches installed in the tanks (LSHL 3, 4 and 5).

5.2.2. Calculations, Specifications and Dimensions

Chlorination Basin T-1

Concrete tank of netto dimensions:

Length: 4 m
Width: 3 m
Depth: 2 m
Volume: 24 cu m

- Retention time:

$$R = \frac{24}{12 \times 3,6} = 0,55 \text{ hr}$$

$$0,55 \times 60 = 33 \text{ min}$$

- the NaOCl solution necessity:

The obtainable NaOCl solution has 5 % of the available chlorine. The chlorinator equipment has to be gauged to maximum 5 ppm of chlorine. What follows is that the maximum daily use of NaOCl solution would be:

Quantity of water: Q = approx 200 cu m/day
Dosing concentration: max. 5 mg/l
Available chlorine: 5 %

Dosing of the NaOCl solution:

Max. inflow of raw water: 12 l/sec (43200 l/hr)

Dosing concentration of Cl2: 5 mg/l (0,005 g/l)

43200 x 0,005 = 216 g/hr (0,216 kg/hr)

Since the solution contains 5 % of Cl2, the approximate value is:

$$\frac{0{,}216}{0{,}05} = 4{,}3 \text{ l/hr}$$

NaOCl solution dosing equipment with accessories consists of: One dosing pump (P 3), a pump suction line system, a back pressure valve, a PVC chemical tank (T2), a signal horn for low level alarm (LAL-2) and a signal lamp-alarm, a manual stirrer, measurement and recording of chlorine residual (AIRC Cl2 - 1).

The Dosing Pump P3

Q = 0-7 l/hr
N = 0,06 kW

The Polyester Dosing Tank T2

V = 100 l

The Holding Tank T3 for Sanitary Water

An isolated polyester tank (volume 1000 l) placed on the administrative building roof, at least 3 to 4 m above the highest discharge point.

1 pc

A Centrifugal Pump P4

Used for pumping water from T1 into the sanitary water holding tank T3.

Q = 3 l/sec (11 cu m/hr)
H = 17 mw
n = 1450 min -1
N = 2,2 kW

1 pc

A Centrifugal Pump P5 & P6

Q = 6 l/sec (22 cu m/hr)
H = 20 mw
n = 2900 min -1
N = 3 kW

2 pcs

- Level regulation equipment, 5 sets.

- An automatic chlorine analyser.

1 set

5.3. DISINFECTION OF WATER AND NEW WATER DISTRIBUTION SYSTEM - ALTERNATIVE B

5.3.1. Description

(See Simplified Process Flow Diagram on Fig. 1.6.)

This alternative assumes water supply of the whole factory from one source - water reservoir T1.

The tank should be installed near the well pump P1. The tank should be elevated on to a steel construction 12 m high, in order to get the total level of water aoout 15 m from the ground. In that case the preassure will be about 1,5 bars.

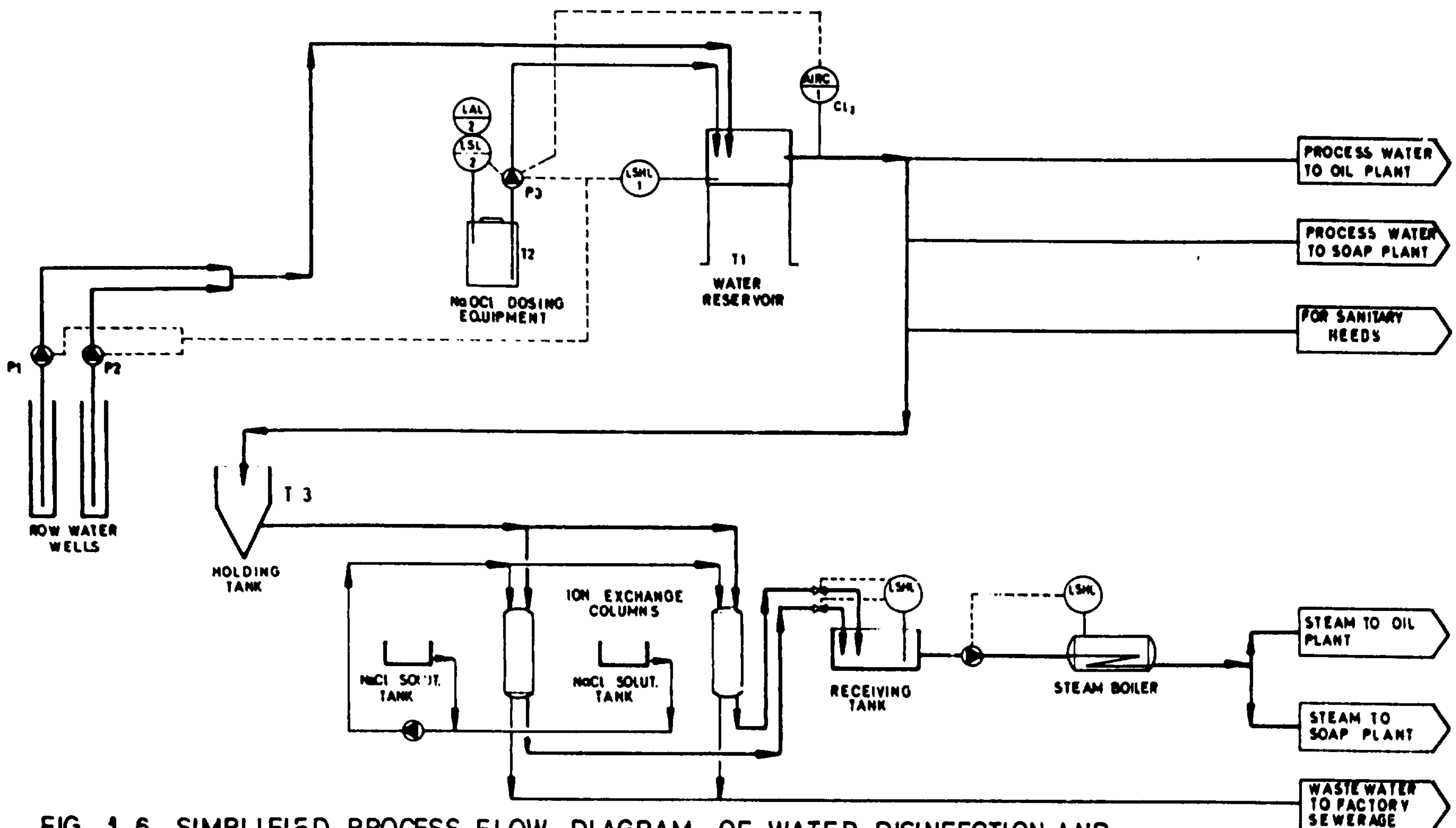


FIG. 1.6. SIMPLIFIED PROCESS FLOW DIAGRAM OF WATER DISINFECTION AND DISTRIBUTION (recommendation) - ALTERNATIVE "B"
Oil and Soap Factory

From the tank, water will be distributed by gravity. The volume of the tank is about 100 cu m, which means the quantity of water required for half a day.

The water disinfection would be carried out by the same equipment described in Chapter 5.2.2., while the NaOCl solution would be dosed in the holding tank.

The automatic analyzer of residual chlorine (used to regulate dosing of NaOCl in water) would be installed at the tank outlet (AIRC-1 Cl2).

The well pumps P 1 and P 2 will operate in accordance with the water level in the tank (LSHL 1).

On the other hand dosing of the NaOCl solution would be also conditioned by functioning of well pumps P1 and P2.

5.3.2. Specifications and Dimensions

- NaOCl solution dosing equipment with all accessories - same like in 5.2.2.

  1 complete

- Water reservoir T 1

  Steel tank, inside protected with epoxy-coat, standing on steel-construction height 12 m.

  0 6 m
  h 4 m
  V 113 cu m

  1 pc

5.4. BOILER-FEED WATER TREATMENT UNIT

Data obtained in the factory:

- Ion resin - ROHM & HAAS, IR 120 (neutral exchange).

- Two ion exchangers exist: the working one and the stand by. The dimensions of the exchangers are as follows - diameter 800 mm, height 1800 mm. The volume comes out to be 0,9 cu m. The volume of the ionic resin is about 50 % of the column volume (450 l).
- The softening water line is in operation for several hours per day.
- Water is regenerated every day with 50 kg of NaCl (in 450 l of water). About 0,5 - 0,7 cu m per regeneration of rinsing water is used.
- The working preassure of the steam b· iler is 10 bars.

REMARKS: A complete analysis of basic parameters has not been carried out, and only from time to time some quick methods are used to check water hardness (the test pills manufacturer is unknown). Water flows directly to the ion exchange without being previously treated chemically (water is not filtered).

Theoretically, the total exchange capacity of the ionic mass used, is 50 g of CaO/l.

The frequency control of ionic resin regeneration is as follows:

$$V = \frac{10\ TH \times Q \times t}{Kk}$$

V = ionic mass volume, l
TH = total hardness of raw water. o dH
Q = raw water inflow, m3/hr
t = time between two regenerations, hr
K = useful capacity of ionic mass, g CaO/l

V = 450 l
TH = 25 o dH
Q = 12 cu m/day (15 cu m/hr during 8 hr/day)
K = 30 g CaO/l (assumtion)

$$t = \frac{Vm \times Kk}{10\ THQ} = \frac{450 \times 30}{10 \times 25 \times 1,5} = 36\ hr$$

The solution of the regeneration substance (NaCl) must have the concentration of 10 w/w %, while the wolume of the needed solution is at least 1,5 volume of the ionic mass (1,5 x 450 = 680 l). The useful volume of the vessel for NaCl solution preparation is 500 l.

The qyantity of the needed regeneration substance is (on condition that ion exchange is 36 hr on):

Th = 25 o dH
t = 36 hr
Q = 1,5 cu m

NaCl = 70 x TH x t x Q

NaCl = 70 x 25 x 36 x 1,5

NaCl = 94500 g NaCl/regeneration

It means that approx. 95 kg NaCl dry is needed for a single regeneration of the ionic resin.

It can be concluded from the above mentioned that on conditions of max. loading of raw water by total hardness of 25 o gH and max. flow of water up to 12 cu m/day, the ion exchange line can work without regeneration for 4,5 days (36 hr/8 hr = 4,5).

Ion resin should be regenerated by dissolving 100 kg of NaCl in 1000 l of water. It practically means that the regeneration will be carried out with two volumes of the vessel for preparation of NaCl solution (2 x 500 l), and each time 50 kg of NaCl will be dissolved.

The obtained results lead to the following facts:

1. Too frequent regeneration (one time per day)

2. If the hardness control points to the fact that regeneration should be carried out daily, the reasons for that should be looked for in the following:

   - ionic mass volume of the column is lower than 450 l
   - useful capacity of the ionic mass is lower than 30 g CaO/l
   - combination of both reasons mentioned above.

   In our opinion the useful capacity of the ionic mass has been decreased. This decrease occurs from several reasons, and the most frequent are:

- mechanical impurity of raw water (direct inflow to ion exchange without previous physical and chemical treatment)
- old and wasted ionic mass
- probable presence of iron in raw well water.

CONCLUSIONS: The contents of raw and treated water should be constantly analysed.

In our opinion, physical and chemical treatment of raw water should be developed. In this way a possible blocking of ionic resin by mechanical or coloid impurities would be prevented. To obtain this a dosing station for Al-sulphate and polyelectrolite should be installed together with a pressure sand filter, while the existing cylindric holding tank (T-3) should be rebuilt into a settling tank.

5.5. BILL OF QUANTITIES AND COST ESTIMATIONS

5.5.1. Water Disinfection and Distribution

ALTERNATIVE A

5.5.1.1. Equipment Cost

- NaOCl solution dosing equipment with accessories consist of: dosing pump (P 3), pump suction line system, back pressure valve, PVC chemical tank (T 2), signal horn for low level alarm (LAL-2) and signal lamp-alarm, manual stirrer, measurement and recording of Chlorine residual (AIRC Cl2 - 1).		
	1 complete	3850 USD
- Holding Tank for Sanitary Water T 3		
	1 pc	1100 USD
- A Centrifugal Pump P 4		
	1 pc	550 USD
- A Centrifugal Pump P5 & P6		
	2 pcs	1400 USD
- Level regulation equipment (LSHL 1,3,4 and 5)		
	4 sets	700 USD
- Piping, fitting, valves and accessories		
	lump sum	1600 USD
- Mounting		
	man hours 72	550 USD
TOTAL (5.5.1.1.):		9750 USD

5.5.1.2. Civill works

Chlorination basin

Civil works include: excavation of the surface layer, depositing of gravel screed, casting of the concrete base screed, casting of the basin, filling up of the area on the site.

Total (5.5.1.2.):	4320 USD
TOTAL ALTERNATIVE A:	13970 USD

5.5.2. Water Disinfection and Distribution - ALTERNATIVE B

5.5.2.1. Equipment and Civil works

- NaOCl solution dosing equipment with accessories consist of: dosing pump (P 3), pump suction line system, back preessure valve, PVC chemical tank (T 2), signal horn for low level alarm (LAL-2) and signal lamp-alarm, manual stirrer, measurement and recording of Chlorine residual (AIRC Cl2 - 1).

  1 complete 4.650 USD

- Water reservair T 1 (mounted) 49.550 USD

TOTAL ALTERNATIVE B: 54.200 USD

5.6. RUNNING COSTS

Basically, running costs (CR) consist of the following:

- maintenance costs (CM)
- energy costs (CE)
- costs for Chemicals (CC)
- labour costs (CL)
- depreciation costs (charges) (CA)

Maintenance costs (CM) are usually about 1,5 % of capital costs.

Energy costs (CE) consist of electric power and steam costs. Labour costs (CL) are applied according to the number of employed as well as the costs that are to be ensured for each employee.

Depreciation costs (CA) are applied with 6,7 % per annum of capital costs (based on the 15 year period exploitation).

NOTE: Running ccosts are computed only through newly suggested equipment. Working days per annum 285.

5.6.1. Water disinfection and distribution - ALTERNATIVE A

- Maintenance costs (CM)

  13970 USD x 0,015 = 210 USD/year

- Chemical costs (CC)

  NaOCl Solution (13 % Cl2)

  1,9 kg/day x 285 day/year = 545 kg/year

- Energy costs (CE)

  P-3: 0,06 kWx3 hr/dayx285 day/year=51,3 kW hr/year

  P-4: 2,2 kW x 1 hr/day x 285 day/year=627,0 kWhr/year

  P-5: 3,0 kWx11 hr/dayx285 day/year= 9405,0 kW hr/year

  P-6: 3,0 kWx7 hr/dayx285 day/year = 5985,0 kW hr/year

  TOTAL: 16068,3 kw hr/year

  CE = 16068,3 kW hr/year

- Costs for Chemicals (CC)

  NaOCl solution (13 % Cl2)

  1,9 kg/day x 285 day/year = 541,5 kg/year

- Labour costs (CL)

  No need for additional labour.

  CL = 0

- Depreciation costs (CA)

  CA = 13 970 USD x 0,067 = 936 USD/year

5.6.2. Water disinfection and distribution - ALTERNATIVE B

- Maintenance costs (CM)

  54200 USD x 0,015 = 813 USD/year

- Chemical costs (CC)

  NaOCl solution (13 % Cl2)

  1,9 kg/day x 285 day/year = 545 kg/year

- Electric power costs, Energy Costs (CE)

  P3: 0,06 kWx3 hr/dayx285 day/year = 51,3 kW hr/year

  CE = 51,3 kW hr/year

- Labour costs (CL)

  No need for additional labour.

  CL = 0

- Depreciation costs (CA)

  CA = 54200 USD x 0,067 = 3631 USD/year

6. RECOMANDATIONS FOR WASTEWATER TREATMENT AND DISPOSAL

6.1. GENERAL POSSIBILITIES

Comparing the qualites of effluents from the "Oil & Soap Factory" (Tab. 1.1.) with the standards from Chapter 2.2. it is obvious that they cannot be discharged into the municipal sewerage and certainly not into the river without treatment.

The main concern are high concentrations of free oil and grease which cause clogging of drains and prevent final, usually biological, treatment of waste water prior to their discharge into the river.

A high pH value of spent lyes can cause problems too, but after dilution with barometric condenser waters, pH between 8-9,5 can be expected.
The rest of emulsified oil and grease as well as other dissolved and suspended organic matters are readily degradable and can be handed in conventional iological treatment plants.

The quantity and pollution of waste water can be reduced by: - In-Plant Modifications
- Pretreatment On-Site and
- Final treatment On-Site or on Municipal Treatment Plant.

The justification for in-plant modification and a certain degree of on-site treatment should be the comparison of their marginal costs with charges for municipal treatment.

6.1.1. In-Plant Modifications

In case the factory management wishes to reduce the water use and the pollutant discharge, there appear to be some in-plant modifications which could prove beneficial. This approach will be to the advantage of industry when it is faced with the necessity of final wastewater treating prior to discharge or when there is no sufficient quantity of fresh water. Arabic Oil & Soap Factory is not in such a situation now but we shall list some modifications for possible future needs or in case GOFI meets similar problems in some other factories.

6.1.1.1. Reuse of Spent Lyes

In the case that one day high quality soap is produced from oil and fatty acids spent lye will contain 7-8 % of glycerol which can be recovered in a separate system. The spent lye can then be transported by gravity or by a pump to one of the six kettles and then neutralized by HCl. Insoluble forms of soap can then be precipitated by alum, and drained from the kettle. The cleaned-up glycerine solution can be fed to an evaporator operated under partial vacuum generated by a barometric condenser. As glycerine is concentrated to 80 % by weight, salt comes out of the solution and is removed by filtration.

Alternatively, the spent lye can be recycled into the kettle to start a new batch.

6.1.1.2. Recirculation of Barrometric Condenser Waters

The conversion of once-through barometric condenser systems to recirculating systems with a cooling device and subseqment treatment of lower volume of continuons blowdown will be costly and may increase the level of air pollution.

Alternatively, the treatment of once-through condensing system effluent may compete on cost-benefit basis, specialy if enough water free of charge is available.

6.1.1.3. Oil and Grease Recovery

The drainage from palm oil storage and transport has to be collected in oil and grease traps settled in the storage room. Recovered oil and grease can be steam softened and transported by the existing pump to tanks enabling waste water discharge with no fear of clogging.

6.1.2. On-Site Pretreatment

In case of in-plant modifications pH will be between 7 and 8, concentrations of oil and grease will be less than 50 mg/l and suspended solids less than 300 mg/l.

This will not prevent final biological treatment and the effluent can be easily discharged to municipal treatment. Otherwise a pretreatment of effluents by aerated oil and a grease flotator will be necessary, as well as neutralization of final effluent.

6.1.3. Final Treatment

The final treatment of the total effluent prior to discharge into the river is an absolute necessity, since common standards require the following values:

Oil and grease: < 10 mg/l
BOD5: < 30 mg O2/l
COD: < 100 mg O2/l
Susp. solids: < 60 mg/l

To reach those standards by an on-site biological plant it would be necessary to build a two-step plant, which needs a lot of space and high investments.

Consequently, the final treatment should be on the municipal plant because of a much lower investment and running costs and because of the lack of space inside the factory.

6.2. TEHNICAL DESCRIPTIONS AND CALCULATIONS

6.2.1. Oil and Grease Recovery

(See Process Flow Diagram, Fig. 1.7.)

Raw material for the production of soap, palm oil, and fatty-acids is transported to the factory in barrels. Fatty acids are softened and emptied from the barrels by steam into the pump pit and transported to storage tanks. In the storage tanks the water layer is separated by gravity and periodically drained into the sewer which collects all the spillages as well. Drainage and spillages contain very high concentrations of oil and grease which cause cloggings in the sewer. To prevent that it is advisable to install a fat and oil trap into the storage room and to recover oil and grease as much as possible.

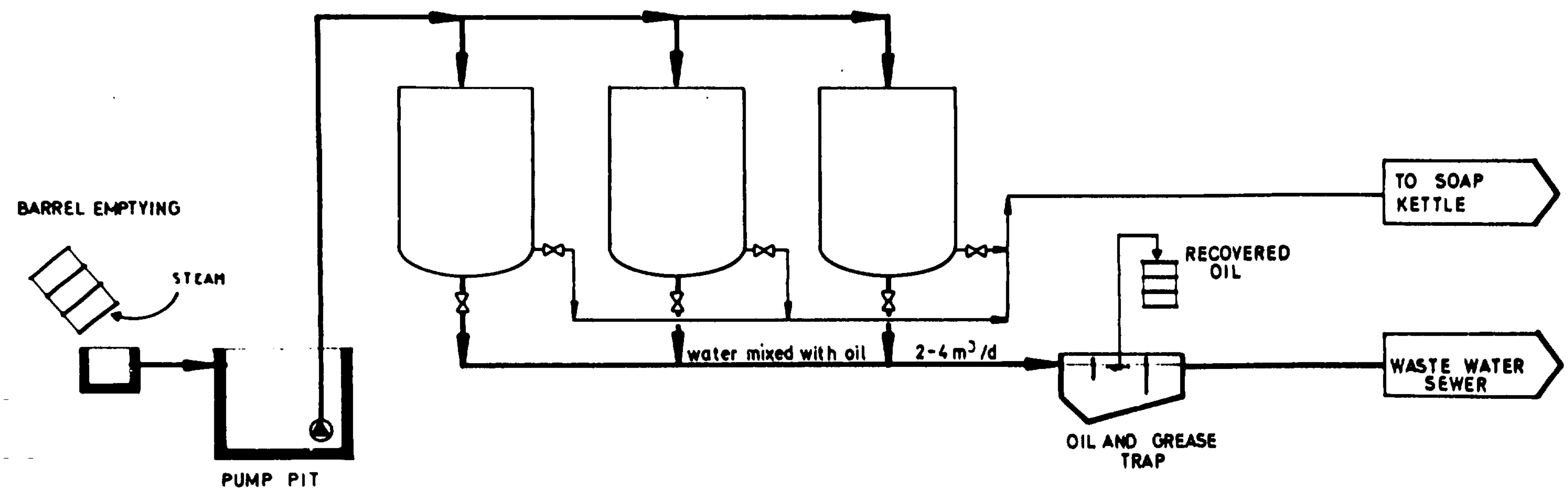


FIG. 1.7. OIL AND GREASE RECOVERY FROM THE DRAINAGE OF PALM OIL STORAGE (recommendation)
Oil and Soap Factory

The cheapest and the most effective way to do this will be a simple grease trap with a partition before the outlet, to enable the outlet of the purified water from the bottom. Separated oil and grease can be skimmed into the barrels and returned to the pump pit e.g. storage tanks.

- Oil and Grease Trap

  Oil and grease trap can be constructed as a concrete tank or can be prefabricated of epoxside coated steel plates.

  Its dimensions are as follows:

  lenght: 1900 mm
  widtht: 1085 mm
  depth: 1400 mm
  weight: 6,1 kN
  inlet and outlet: 0 = 150 mm

6.2.2. On Site Pretreatment

In case that spent lye as well as wasted oil and grease are not reused, it would be necessary to prevent clogging and contamination of the municipal sewer by an air-flotation tank. The tank will dilute alkaline shocks from the soap production and remove oil, grease, soap and other suspended materials from waste water. If necessary final effluent can be neutralized by automatic addition of HCl.

(See: Process Flow Diagram Fig. 1.8.)

The total waste water flow from the factory area will be collected by the internal sewerage and pass through the bar rack into the aerated tank.

Bar Rack (R-01)

The main sewer pipe should enter the rack channel with a downward slope floor. The bar rack will be manually cleaned, so it can be settled under an adequate angle, and a perforated drainage plate should be provided at the top of the rack where the rakings may be temporarily stored.

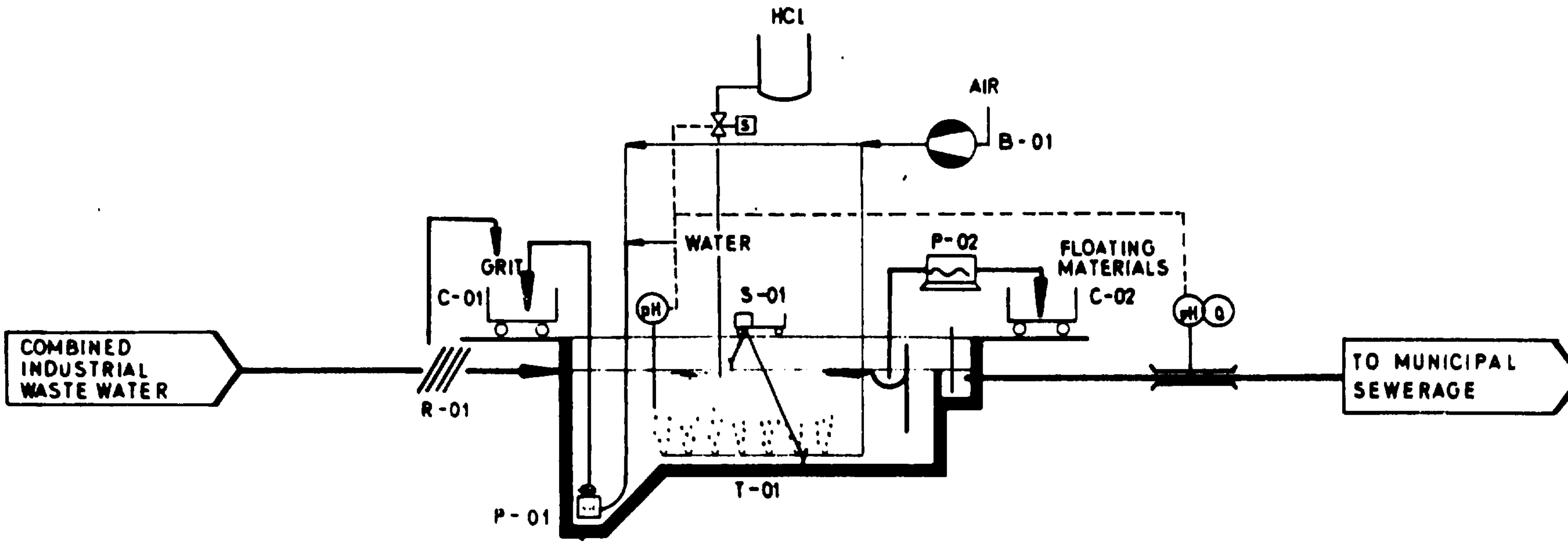


FIG 1.8. PROCESS FLOW DIAGRAM OF THE ON-SITE WASTE WATER PRETREATMENT (recommendation)
Oil and Soap Factory

- channel width: 0,6 m
- bars: 65 mm x 10 mm
- clearance between bars: 20 mm
- angle: 60 o
- plate perforations: 25 mm
- space between plate perforations: 25 mm

- Air-Flotation Tank (T-01)

The concrete tank is divided by a slotted partion on the aerated part and the part for collection of floating materials.

Oposite the partiton, a perforated air pipe is settled at the bottom.

Settling materials are collected at the bottom of the aerated part and are scraped by the same moving bridge which scrapes the floating particles in the opposite direction. The settled sludge is evacuated from the bottom pit by an air-lift pump and the floating material is skimmed from the surface into the scum pit. The floating materials (mostly grease) are pumped out by the Moyno-pump and can be returned to the soap production or dumped together with the sludge.

- Tank Lenght: 7,5 m
- Tank Width: 1,9 m
- Tank Depth (water): 1,9 m

- Scraper Bridge (S-01)

Velded steel construction consisting of:

- automatic electromotor drive mechanism: N=1,1 kW
- 4 weels
- 4 roller quides
- grit scraper
- scum skimmer
- foatpath with pipe-quard railing
- switchboard
- scraper lifting device.

- Air Lift Pump (P-01)

Q = 6-14 l/sec
P = 1 bar = 100 k Pa
Air quantity: 15-150 N cu m/n
Air pressure: 0,4-0,5 bars = 50 kPa
Clean water quantity: 18 cu m/h
Clean water pressure: 2 bars = 200 kPa

- Blower (B-01)

Necessary air quantities:

- aeration: 40 N cu m/h
- pump: 15-150 N cu m/h

max: 190 N cu m/h = 3,16 N cu m/min.

Blower capacity:

Q = 4,9 N cu m/min
P = 0,5 bars = 50 kPa
N = 7,5 kW

- Sludge Pump (P-2)

Q = 11,3 cu m/hr
N = 2,2 kW
H = 14 m = 1,4 bars = 140 kPa

- pH Regulation

1 set

- End Control

Flow: 0 - 150 l/s
pH: indication
recording

1 set

6.2.3. Final Treatmant

The final treatment has to be performed on the municipal biological treatment plant. To design the municipal plant, the hydraulic and organic load from the Oil and Soap factory should be taken in consideration. The organic load will be decreased, by in-plant modifications and/or pretreatment, in amount of 20-30 % of the total load.

In regards to that, one has to calculate the municipal treatment plant with the following loadings from the factory:

- Hydraulic Load:

  Dry weather flow: 161-218 cu m/d
  Maximum dry weather flow: 12 l/sec
  Maximum rainy weather flow (10 min.): 155 l/sec

- Organic Load:

  Total load: 220-250 kg BOD5/day
  Modification and Pretreatment effect:
  - 20-30 % removal of BOD5 load
  Organic load on municipal plant:
  - 165-190 kg BOD5/day which will correspond to : approx. 3300 population equivalents.

6.3. BILL OF QUANTITIES AND COST ESTIMATIONS

6.3.1. Equipment Cost

6.3.1.1. Oil and Grease Recovery

- Oil and Grease Trap

lenght	1900 mm
width	1085 mm
depth	1400 mm
weight	6,1 kN

1 pc 400 USD

6.3.1.2. On Site Pretreatment

- Bar Rack (R-01)

bars 65 mm x 10 mm
clearance between bars 20 mm
angle 60 o

1 pc 135 USD

- Scraper Bridge (S-01)

Velded steel construction consisting of:

- automatic electromotor drive mechanism:
  N = 1,1 kW
- 4 weels
- 4 roller quides
- grit scraper
- scum skimmer
- foatpath with pipe-quard railing
- switchboard
- scraper lifting device.

1 set 7.300 USD

- Air Lift Pump (P-01)

  Q = 6 - 14 l/sec
  P = 1 bar = 100 k Pa
  Air quantity: 15- 150 N cu m/hr
  Air pressure: 0,4 - 0,5 bars = 50 kPa
  Clean water quantity: 18 cu m/hr
  Clean water pressure: 2 bars = 200 kPa

  1 set 2.200 USD

- Blower (B-01)

  Q = 4,9 N cu m/min
  P = 0,5 bars = 50 kPa
  N = 7,5 kW

  1 pC 5.700 USD

- Sludge Pump (P-02)

  Q = 11,3 m/hr
  N = 2,2 kW
  H = 14 m = 1,4 bars = 140 kPa

  1 pc 3.600 USD

- pH Regulation

  1 set 3.100 USD

- Flow and pH End Control

  1 set 4.470 USD

- Pipes and fittings

  lump sum 2.000 USD

- Electrics and automatics

  lump sum 2.500 USD

- Mounting (432 man-hours) 3.240 USD

Total (6.3.1.): 34.245 USD

6.3.2. Civil Works Cost

6.3.2.1. Oil and Grease Recovery

1. Escavation, pouring of concrete, and erection of shafts for a concrete pit of the grease separator The lay out pit measures are: 2,20 m x 1,25 m, depth: 2,10 m.

   Piece 1 x 16.500 SP = 16.500 SP

   Total (6.3.2.1.): 750 USD (1 USD = 22 SP)

6.3.2.2. On Site Pretreatment

1. Excavation of the surface layer, 30 cm

   12 x 6 x 0,30 = 21,60 m3

   m3 21,60 x 32 (SP) = 692 SP

2. Soil Excavation of the first, second, third and fourth category. It has been represented by 35,35, 15 and 15 %. The total quantity is:

   10 x 4 x 3 = 120 m3

   1. ctg m3 42 x 50 = 2100 SP

   2. ctg m3 42 x 57 = 2394 SP

   3. ctg m3 18 x 76 = 1368 SP

   4. ctg m3 18 x137 = 2466 SP

3. Depositing of the gravel screed, 15 cm thick beneath the concrete base of the flotation basin

   9 x 2,50 = 22,50

   m2 22,50 x 70 = 1575 SP

4. Casting of the flotation basin by MB-30 concrete with addition of waterimpermeability admixtures.

Casting should be carried out in smooth oil formwork with vibration. Interruptions of casting and dilatations should be ensured by dilatation lines (Water Stop Couplings). Double formwork is included in the unit price.

(750 x 2 + 2,00 x 2) x 3 x 0,30 +

+ 7,50 x 2,50 x 0,40 = 24

m3 24,60 x 2000 = 49.200 SP

5. Casting of the levelling stratum with the MB 10 concrete, 10 cm thick

(2,20 x 1,25 + 7,50 x 2,50) x 0,10 = 2,15 m3

m3 2,15 x 1000 = 2.150 SP

6. Filling up of the flotation basin area with the excavation material.

120 + 21,60 - 8 x 2,50 x 3 = 81,60

m3 81,60 x 50 = 3.264 SP

7. Carting off the excavation material

8 x 2,50 x 3 x 1,25 + 81,60 x 0,05 = 79,08

m3 79,08 x 50 = 3.954 SP

8. Reinforcing of the concrete basin with rebbed bars according to static calculations and drawing of bending.

24,60 x 80 = 1968 kg

kg 1968 x 10,50 = 20.664 SP

9. Supplying and erection of the steel enclosure around the basin

m´ 20 x 120 = 2.400 SP

Total (6.3.2.): 92.227 SP
eq. 4.192 USD

RECAPITULATION:

1. Oil and Grease recovery: 1.050 USD

2. On-Site Pretreatment: 38.437 USD

6.4. RUNNING COSTS

Basically, running costs (CR) consist of the following:

- maintenance costs (CM)
- energy costs (CE)
- costs for Chemicals (CC)
- labour costs (CL)
- depreciation costs (charges) (CA)

Maintenance costs (CM) are usually about 1,5 % of capital costs.

Energy costs (CE) consist of electric power and steam costs. Labour costs (CL) are applied according to the number of employed as well as the costs that are to be ensured for each employee.

Depreciation costs (CA) are applied with 6,7 % per year of capital costs (based on the 15 year period exploitation).

NOTE: Running ccosts are computed only through newly suggested equipment. Working days per year 285.

- Maintenance Costs (CM)

CM = 39.487 USD x 0,015 = 592 USD/year

- Chemical Costs (CC)

- Energy Costs (CE)

B-01: 7,5 kWx24 hr/day x 285 day/year=51300 kW hr/day

B-02: 2,2 kW x 1 hr/day x 285 day/year= 627 kW hr/year

TOTAL: 51 927 kw hr/year

CE = 51927 kW hr/year

- Labour Costs (CL)

Working period (1 man) 2 hr/day

- Depreciation Costs (CA)

CA = 39 487 USD x 0,067 = 2.646 USD/year

7. GENERAL CONCLUSIONS AND SUGGESTIONS

7. GENERAL CONCLUSIONS AND SUGGESTIONS

The main problems regarding water-pollution control in Oil & Soap Man. Co arise from the fact that undisinfected water is not sutable for the use in food industry and that the effluent (heavily polluted by alkaline, oils and fats) is not treated prior to the discharge into the recipient.

Considering the problems with the existing production and the fact that the future plans are not defined yet, only general suggestions for water and waste-water treatment have been given. Final decisions and a detailed design will depend on the future plans which have to be taken in consideration:

1. Installation of proper water treatment and supplying system, according to the standards for food industry. Although more expensive, we would suggest Alternative B which will ensure:

   - sufficient amount of water
   - constant quality and flow, and
   - possibility to connect the surrounding municipality to the system.

2. Possible in-plant modifications for decreasing of water consumption and pollution.

3. Installation of an on-site wastewater pretreatment plant according to the required standards for industrial effluents which can be connected to the municipal treatment plant.

   During our Second Field Mission we visited similar factories in Alepo which have even greater problems, and our suggestion is for GOFI to use more sutable technological and economical ways of waste water treatment than already used in "Al Nairab Fact. - Alepo".

8. DRAWINGS

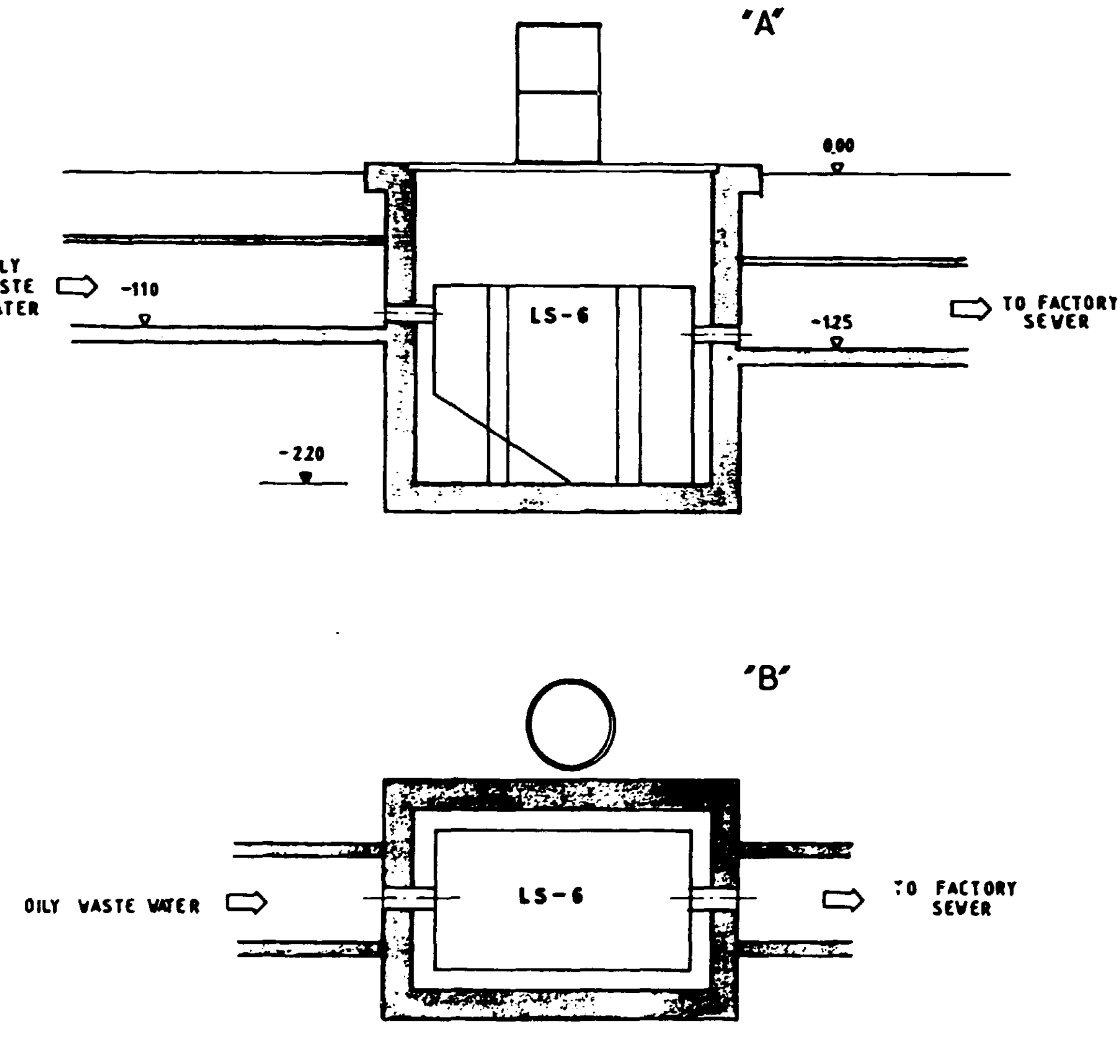
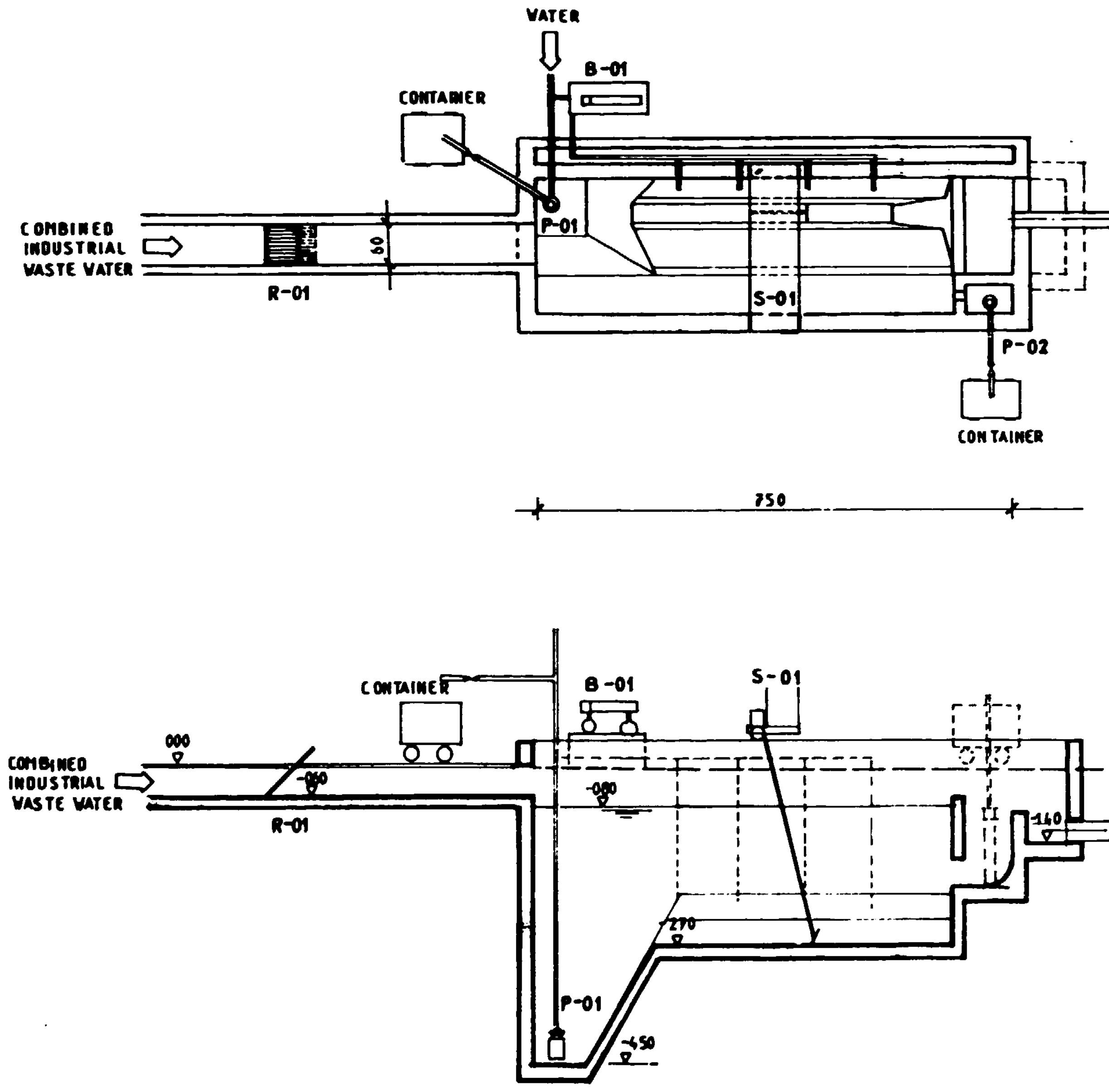


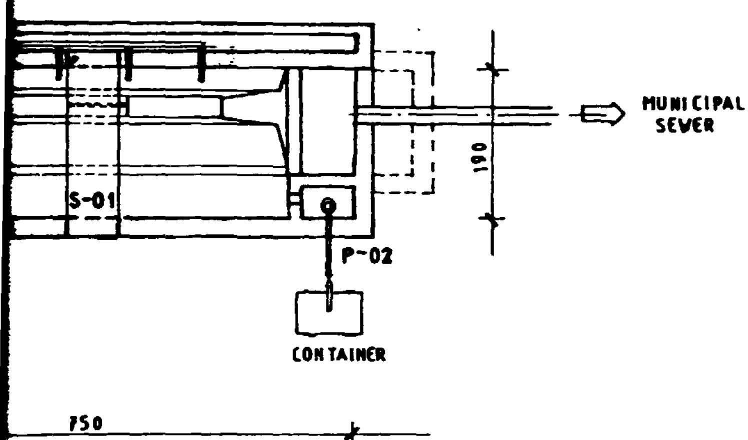
FIG 1.9. FAT TRAP FOR OIL AND GREASE RECOVERY
Plan (A) and Cross-sectional (B) View
Oil and Soap Factory



SECTION 1

FIG. 1.10 CO
Pl
Oil

"A"



SECTION 2

"B"

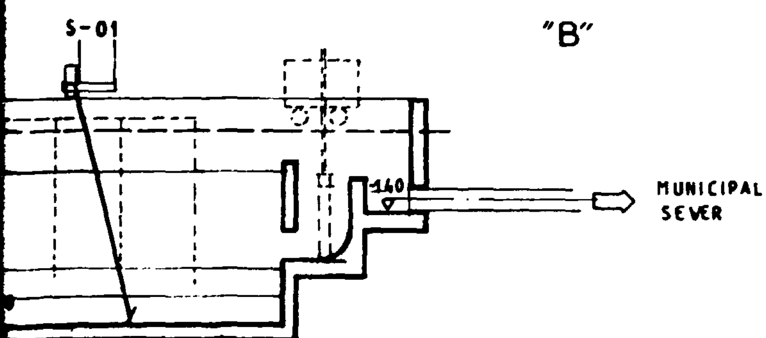
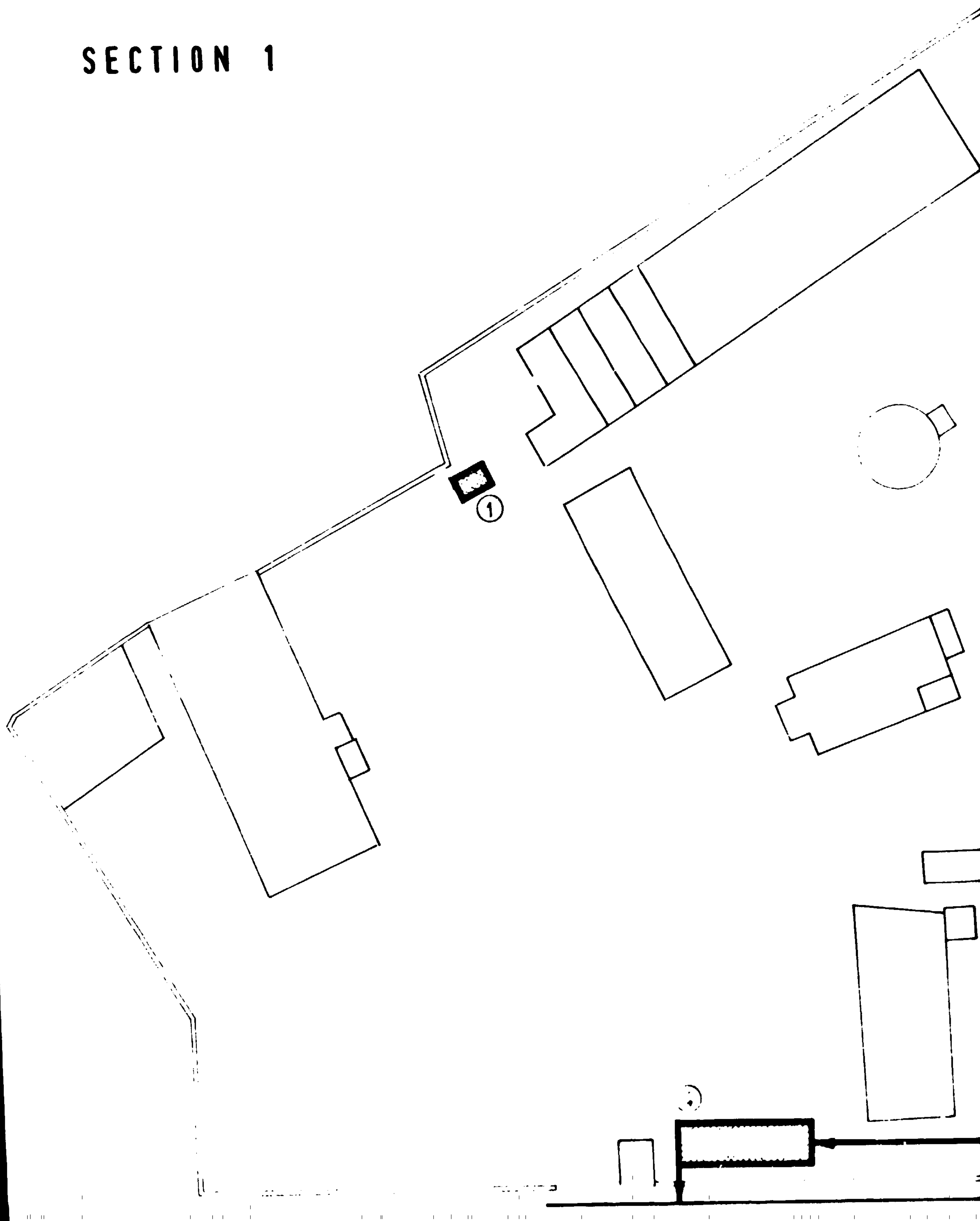
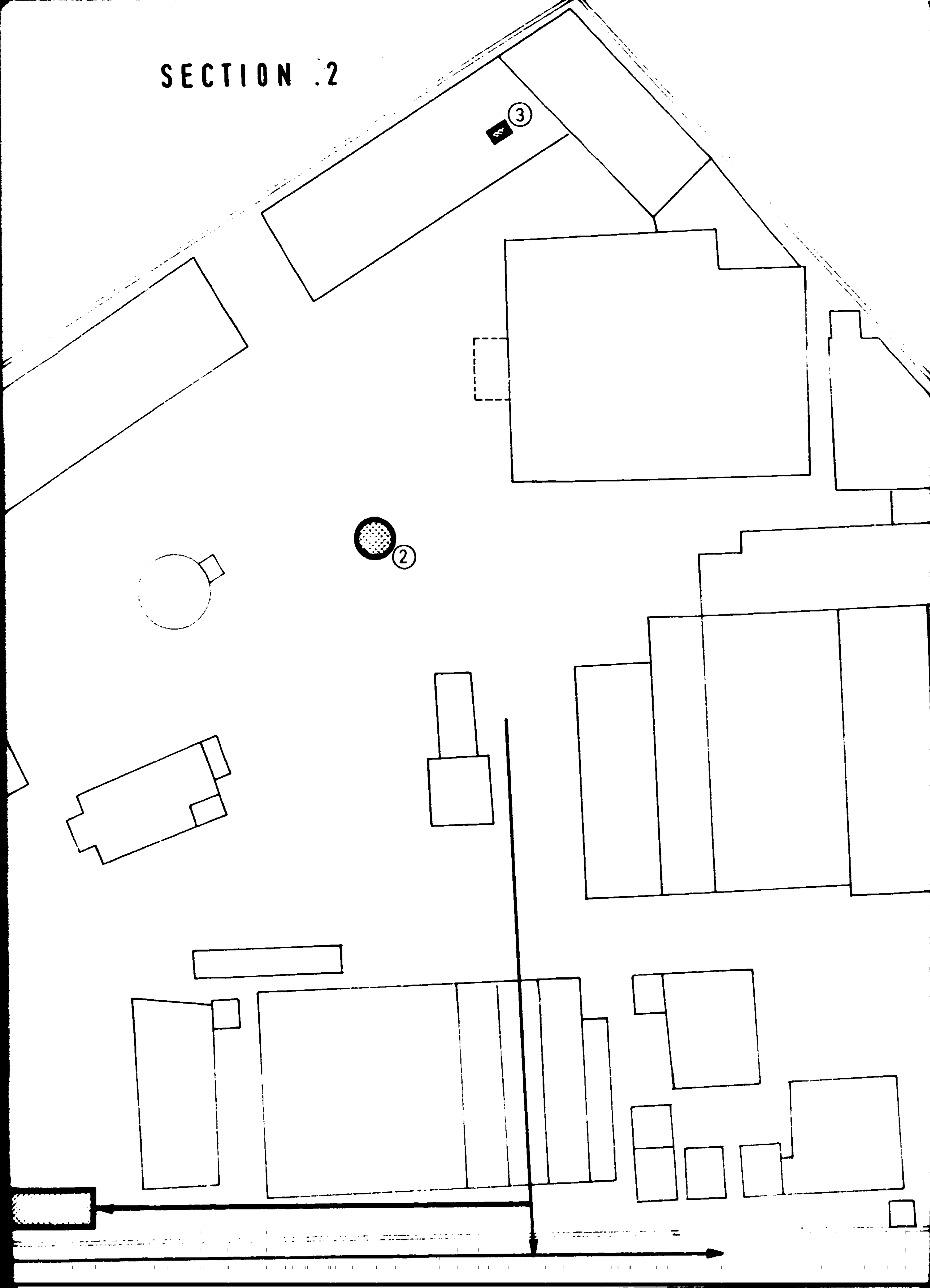


FIG. 1.10 COMBINED WASTE WATER ON SITE PRETREATMENT
Plan(A) and Cross-sectional (B) View
Oil and Soap Factory

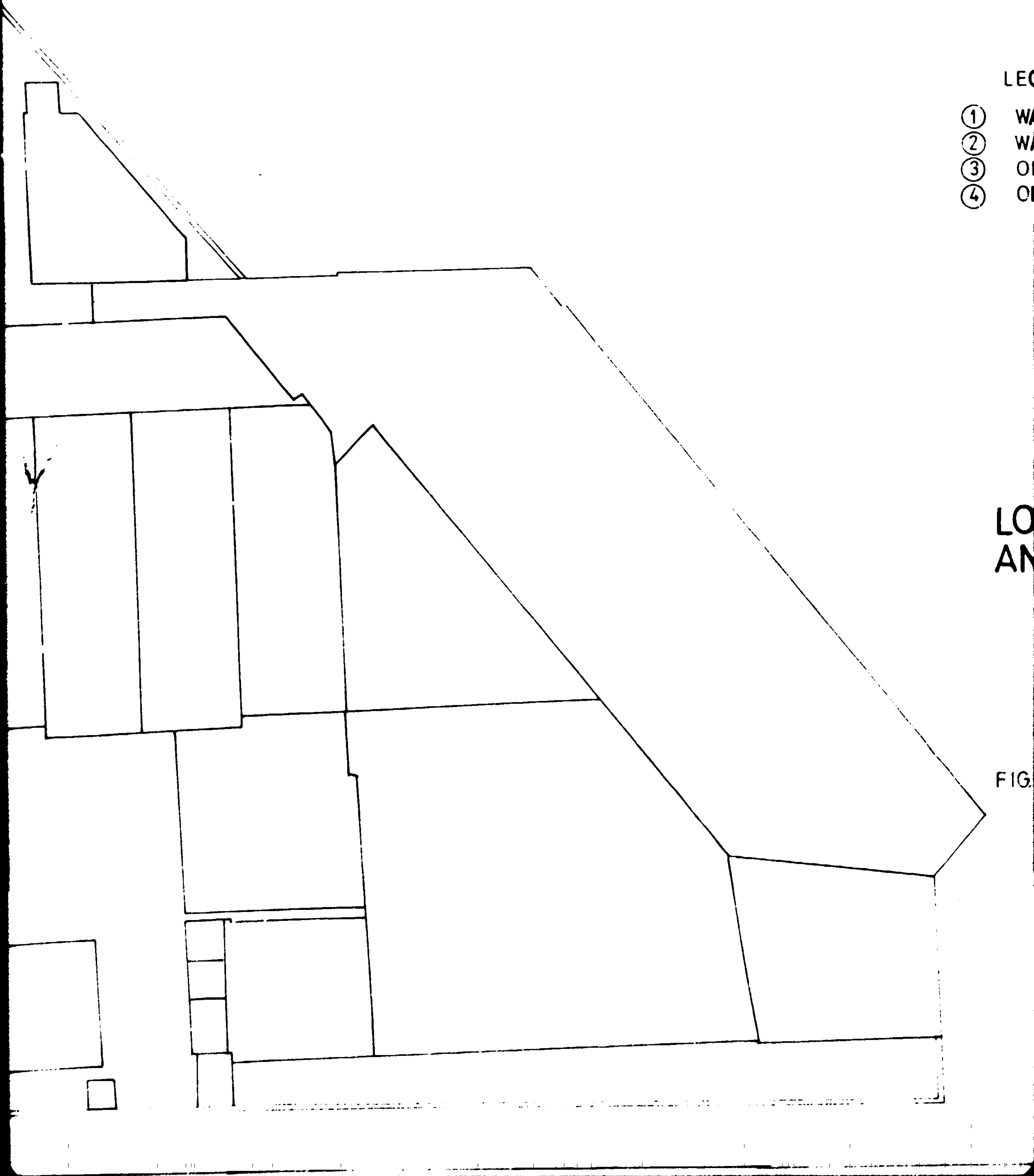
SECTION 1



SECTION 2



SECTION 3



SECTION 4

LEGEND:

① WATER DISINFECTION – Alternative A
② WATER DISINFECTION – Alternative B
③ OIL AND GREASE RECOVERY
④ ON SITE PRETREATMENT OF WASTEWATER

LOCATIONS OF THE WATER AND WASTEWATER TREATMENT UNITS

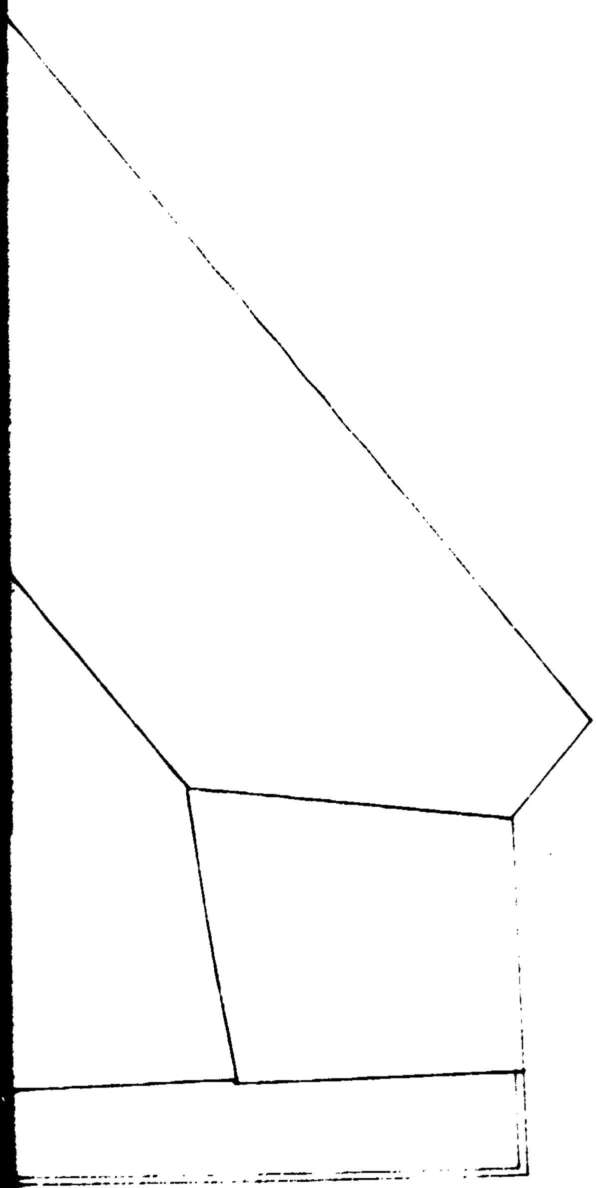


FIG. 1.11. OIL AND SOAP FACTORY LAY OUT SCALE 1:500