J.4 Characteristics of coffee waste water treatment in Cristales basin

J.4.1 Meteorological conditions

There are good conditions for waste water treatments mainly by biological method in the area. Annual rainfall is 2,000mm/year, which is not convenient for drying surplus sludges by winds, but there are not so many troubles as a whole.

J.4.2 Geographical conditions

The topography of the area is an undulating canyon. There are few plains in the area, therefore waste water treatment facilities are likely to be located on steep slopes. This is convenient for using gravity difference for waste water, however, some devices for arrangement of facilities according to slope conditions will be necessary for farmers, which is not a uniform design applied to facilities on flat planes.

J.4.3 Characteristics of farms

Intensive collection of waste water is not unsuitable and very difficult in this area from technical point of view, because farms are apart from each other more than kilometer order. Coffee producers are said to have temperature of independence and they must overcome many difficulties in order to solve pressing problems such as installation of waste water treatment facilities and intensive treatment of coffee fruits.

J.4.4 Characteristics of waste water

Amount of waste water of farms is different from each other and even in the same farm amount of daily waste water fluctuate delicately.
In general, amount of coffee waste water per one kg of coffee from a big farm possessing an intensive processing factory and having a contract for processing on commission is almost five times as much as that from a small or middle scale farm. Quality of every one of waste water is with low pH and with high concentration of suspended solids and organic matters. When such waste water is percolated into soil, the soil loses permeability and is acidified by organic matters contained in the water, and as a result the land becomes a barren.
Anti acid and anti corrosive materials are required for waste water treatment facilities, and durability of concrete structures used in such facilities is shorter than those used in general structures.

J.4.5 Waste water treatment technique

There were many suggestions, studies and seminars on waste water treatment techniques since several decades ago, however, effective and acceptable methods have never been found yet. Although several pilot plants for coffee waste water treatment were constructed, there is no clear result obtained, which suggests that there are some problems with the plants.
It is clear that coffee farmers in the area can not afford construction cost of waste water treatment facilities devised in Japan, U.S.A. and in Europe, which is the common problem of many agricultural processing.

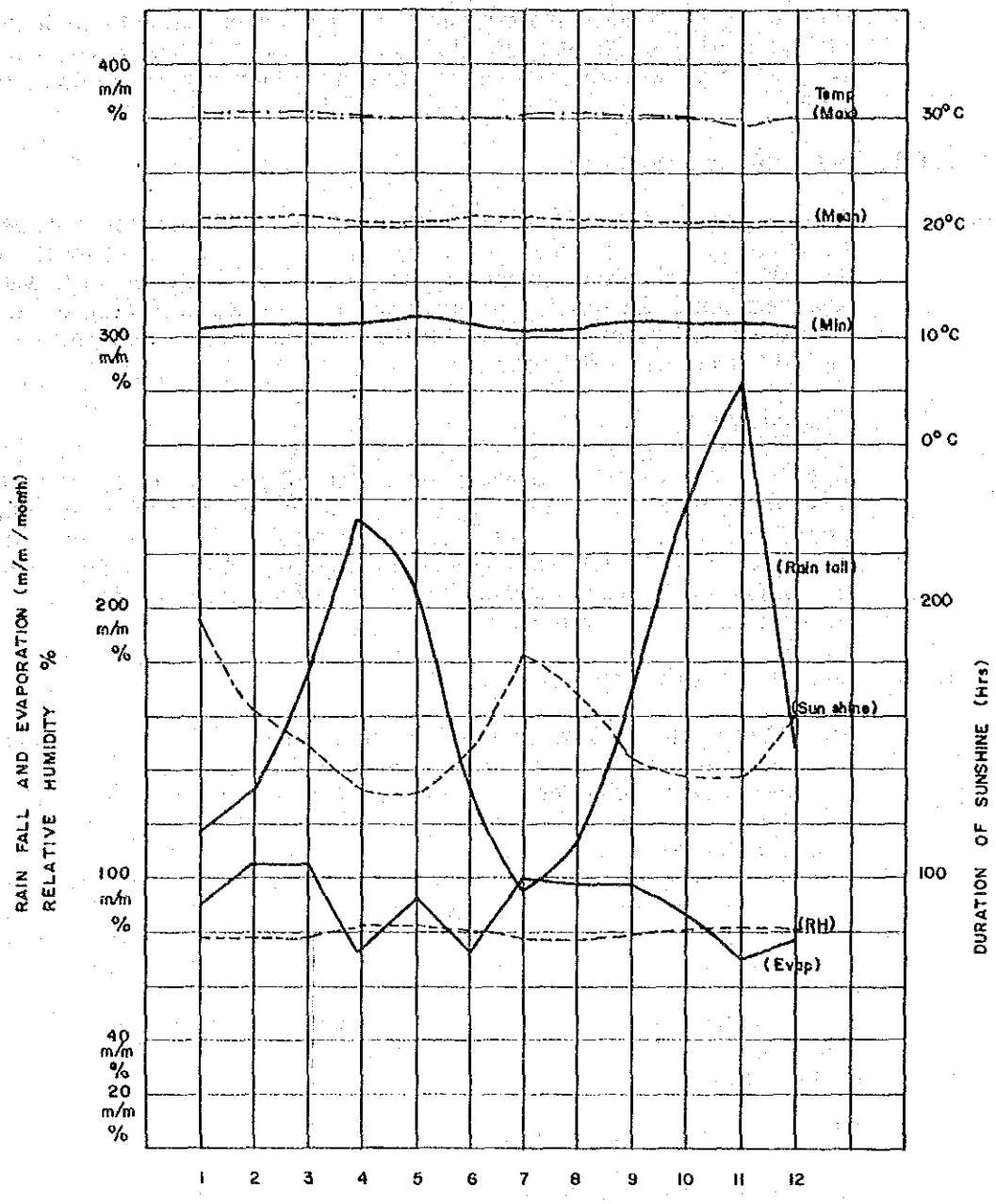


Fig. J.4.1.1 Climate Condition at El EDEN

J.5 Technology of Coffee waste water treatment

J.5.1 Neutralization

J.5.1 1 Neutralizing chemicals

1) Sodium Hydroxide

a) Chemical formula	NaOH M.W. = 40
b) Figure	Liquid and Solid
c) Characteristics	
Concentration	1) 25% and 45% liquid in market 2) 95 - 98% solid in market 3) Possible measuring concentration by meter 4) Dissolved in the water freely
Reaction	Rapid and strongly basic.
Handling	Strongly attack to the skin and eye, thus, it's not suitable for coffee farms.
d) Neutralization	
Required facilities for dosing	Storage and dissolving vessel 1) Dosing pump 2) pH meter and controller 3) Agitator for mixing with water and NaoH 4) Electrical device for the above 5) The initial cost will be assumed about 3,500US dollar.
e) Price	The most expensive among alkaline. 0.7 U$/kg in Colombia.

2) Calcium oxide

a) Chemical formula	CaO
b) Characteristics	
Specific gravity	2.3 - 3.4
Appearance	White powder
Quality	Ca 0 % = 80 or more as JIS II grade
Production	Made from lime stone
Characteristics	Strongly basic and attack to skin and eye thus it's relatively difficult applying to coffee farms.
c) Neutralization	
Required facilities	1) Storage or dissolving vessel 2) Table feeder or dosing pump 3) Agitator for mixing with water and CaO 4) Electrical devices for the above 5) Increasing sludge volume in the waste water 6) pH meter and controller
Difficulties	CaO dosing system has some problems such as dissolving, piping system and maintenance.
Price	0.07 U$/kg in Colombia

3) Calcium Hydroxide

a) Chemical formula — $Ca(OH)_2$
b) Figure — Powder or slurry
c) Characteristics — Roughly similar as Calcium oxide.
d) Price — 0.085 U$/kg in Colombia

4) Sodium bicarbonate

a) Chemical formula — $NaHCO_3$
b) Figure — White powder
c) Characteristics — Weak base
Dissolved in the water freely
Easy handling
d) Price — 0.65 U$/kg in Colombia
e) Difficulty — Difficult to get in Colombia

5) Lime stone

a) Chemical formula — $CaCO_3 + MgCO_3$
b) Chemical component

Example of typical chemical component

Ignition Loss	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
42.14	1.97	0.78	0.50	53.44	0.89

c) Figure — White rock
d) Characteristics — Weak base
Density — 2.7 - 3.0g/cm3
e) Neutralization
Reactor — Slow and not exceed pH7
Sludge volume — Increase
Facilities — Reaction tank only
Handling — Easy and safe
f) Production
Easy to get in Colombia
g) Price — 0.0278U$/kg in Colombia

J.5.1.2 The comparison of each alkaline

Table J.5.1.2.1 Comparison table

Alkaline	Description					Remark
	Character	Handling	Reaction	Safety	Price (U$)	
NaoH	Strong	Difficult	Quick	Danger	0.7	
CaO	Strong	Difficult	Quick	Danger	0.07	
$Ca(OH)_2$	Strong	Difficult	Quick	Danger	0.085	
Lime-stone	Strong	Easy	Very slow	Safe	0.0278	
Na_2CO_3	Strong	Difficult	Quick	Danger	0.6	
$NaHCO_3$	Weak	Easy	Quick	Safe	0.65	

J.5.1.3 Cost comparison

Neutralizing agents costs were compared in the case of 5 Ha farm in the Cristales.

1) Conditions

a) Farm's scale 5 Ha
b) Annual waste water volume 270m³/5Ha/year
c) Neutralizing agent
Required amount and cost

NaOH	1.8kg/m³	0.7U$/kg
CaO	2.8kg/m³	0.07U$/kg
Lime stone	5.25kg/m³	0.027U$/kg

d) Annual net profit of 5 Ha farm

Per Ha of Cuturra	1,014 U$/Ha/year
For 5 Ha farm	5,072 U$/5Ha/year

e) Cost of neutralization

NaOH	340.2 U$/year
CaO	52.9 U$/year
Lime stone	38.3 U$/year

2) Discussion

The ratio of neutralizing agent cost against 5 Ha coffee farm's annual net profit from Coffee production are mentioned as below.

NaOH	6.7%
CaO	1.04%
Lime stone	0.75%

Additionally, the initial cost of neutralizing facility should be considered.

J.5.1.4 Selection of neutralizing agent

1) Parameter

a) Cost
b) Handling
c) Safety
d) Cost of dosing system
e) Necessity of strict pH control
f) Reaction speed
g) Affection to biological treatment
h) Purchasing

2) Comparison table

Table J.5.1.4 Comparison table of alkaline

Parameter	a	b	c	d	e	f	g	h	Total
NaOH	N	N	N	N	N	EY	Y	Y	4
CaO	Y	N	N	N	N	Y	N	Y	3
$Ca(OH)_2$	Y	N	N	N	N	Y	N	Y	3
Lime-stone	EY	Y	Y	Y	Y	N	N	Y	7
$NaHCO_3$	N	Y	Y	N	Y	EY	Y	N	6
Na_2CO_3	N	N	N	N	N	EY	Y	N	3

Y = Yes = point 1 EY = Excellent = point 2
N = No = point 0

Good quality of lime stone should be studied as an excellent neutralizing agent.

J.5.2 Comparison between Anaerobic and Aerobic treatment

J.5.2.1 General difference of Anaerobic and Aerobic treatment

1) Aerobic biological treatment

a) Necessity of oxygen supplement and it's power	Increase initial cost
b) Power consumption covers greater parts of running cost .	Increase running cost
c) Great deal of excess sludge generation	Increase initial and running cost
d) Effective to low organic substance contents water especially	To be achieved good treated water
e) Necessity of skilled operator	Increase running cost
f) Possible to keep oxygen contents condition	
g) Ineffective under the low temperature (10°C or less) condition	
h) Even no waste water period necessity of oxygen supplement to biomas reactor	Otherwise aerobic biomass destroy easily

2) Anaerobic biological treatment

a) Possible high rate treatment	Decrease initial cost
b) Few routine maintenance	Decrease running cost
c) Unneccesity of oxygen supplement	No power consumption
d) A small amount of excess sludge generation	Decrease initial cost
e) Relatively slow reaction	Increase initial cost
f) Unneccessity of aclimi period in case of to get seeding sludge	

g) Effective to high organic substances contents water — Decrease initial cost

J.5.2.2 Discussion

For completion of coffee waste water treatment anaerobic bio mass and aerobic biomass should be applied as a primary and secondary treatment, so that treats economical and effectively.
Chemical treatment is out of discussion due to its uneconomical reasons.

J.5.3 Anaerobic biomass treatment

J.5.3.1 Selection of anaerobic biomass reactor as the primary treatment

Newly designed high rate anaerobic biomass reactor AACF will be applied to the pilot plants.

J.5.3.2 Anaerobic biomass reactors

12 (twelve) typical anaerobic biomass reactors are introduced in the main report.

Table J.5.3.1 Various anaerobic bio mass reactors

PFD	Plug flow digester	Sludge bed
CMD	Completely mixed digester	Suspended
ACD	Anaerobic contact digester	Suspended
DAFD	Down flow anaerobic film digester	Bio-film
UAFD	Up flow anaerobic film digester	Bio-film
FBR	Fluidized bed reactor	Bio-film
USBR	Up flow sludge bed reactor	Sludge bed
UASB	Up flow anaerobic sludge blanket	Suspended
ARC	Anaerobic rotating contactor	Bio-film
AL	Anaerobic lagoon	Lagoon
MCB	Micro carrier bed	Sludge bed
AACF	Agglomerated anaerobic sludge and bio film	Suspended + Bio film

J.5.3.3 Parameter for selection

1) Parameter for selection

a) Low H.R.T and high CODcr removal ratio
b) Few consumables
c) Simple mechanical structure and few movable devices
d) No using special material
e) No anaerobic sludge wash out into the treated water
f) Low running cost
g) Easy restarting of reactor after stopped running

h) High CODcr removal efficiency to high organic matter content waste water
i) High CODcr removal efficiency to low organic matter content waste water
j) Operational difficulty
k) Difficulty to system control
l) Tolerance to cold climate
m) Tolerance to the toxic substances
n) Durability to organic substances
o) Durability to solid loading
p) Small required space for the reactor installation
q) Easy construction works
r) Low initial cost

2) Evaluation of anaerobic bio mass reactors

Table J.5.3.3 Comparison of various kinds of anaerobic bio mass reactor

Reactor / Parameter	PED	CMD	ACD	DAFD	UAFD	FBB	USBR	UASB	ARC	AL	MCB	AACF
a	N	Y	Y	Y	Y	Y	Y	yy	Y	N	yy	yy
b	Y	Y	N	Y	Y	Y	Y	Y	N	yy	N	Y
c	Y	N	N	Y	Y	N	Y	Y	N	yy	Y	Y
d	Y	N	N	Y	Y	N	Y	Y	N	Y	N	N
e	N	N	N	Y	Y	Y	N	N	N	Y	Y	yy
f	N	N	N	Y	Y	N	Y	Y	Y	Y	Y	yy
g	N	N	yy	Y	Y	Y	N	N	Y	Y	N	yy
h	N	Y	Y	N	N	N	Y	Y	Y	N	Y	Y
i	N	N	Y	Y	Y	Y	N	N	Y	Y	Y	Y
j	Y	N	N	yy	yy	N	Y	Y	Y	Y	Y	Y
k	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y	Y
l	N	N	Y	yy	yy	Y	Y	Y	Y	Y	Y	Y
m	N	N	Y	yy	yy	Y	N	N	Y	N	N	Y
n	N	Y	Y	N	N	Y	Y	Y	N	N	Y	Y
o	Y	Y	N	N	N	N	N	N	Y	N	N	N
p	N	N	N	N	N	N	Y	Y	N	N	Y	Y
q	Y	N	N	N	N	N	Y	Y	N	Y	Y	Y
r	N	N	N	N	N	N	Y	Y	N	N	Y	Y
	7	5	8	14	15	8	13	13	10	13	14	20

3) Discussion

a) Group-PED, CHD & ACD which got poor evaluation required a long time H.R.T and high initial cost.

b) DAT, UAFD, ARC & FBB are a group which is classified anaerobic bio film type and they are not suitable for the treatment high organic substance content and suspended solid. Especially ARC is weak for rotating parts and it's module.

c) AL is an excellent waste water treatment method but it's necessary wide land space.

d) USBR has an advantage to loading shock but rather difficult to operation.

e) MCB & UASB are necessary to long time self-immobilization period, usually for 3 - 6 months. On the other hand, the self-immobilized anaerobic sludge can not get easily in Colombia.

f) AASF new type anaerobic bio mass reactor which has the functions, agglomerated anaerobic sludge zone and anaerobic bio film, is excellent for handling and treated water quality.

AACF should be recommended as an suitable type of anaerobic biomass reactor for Cristales coffee farms.

J.5.4 Aerobic bio mass treatment

J.5.4.1 Aerobic bio reactor as secondary treatment

An anaerobic bio mass treated water of coffee waste water sill has high organic substance in it.
The characteristics of this water area.

1) Demand of dissolved oxygen in the water is shown 0 mg/l normally
2) The treated water has an offensive odor
3) Still high organic substance content water

Generally when the organic substance in the waste water is become low content, the anaerobic bio mass reactor. Also reduces it's purification efficiency.
On the other hand, technology of aerobic bio mass treatment are widely developed and can treat until CODcr to 10mg/l order in the low organic substance content of waste water.

J.5.4.2 A comparison of non-attached bio mass and fixed bio mass film contactor

1) Aerobic biological treatment is roughly divided into 2 types. They are non-attached bio-mass method such as activated sludge treatment and fixed bio mass film method.

Table J.5.4.2 Comparison of Non-attached bio mass and Fixed biomass film contactor

	Non-attached bio mass reactor	Fixed bio mass film contactor
Oxygen Supplement	Air generator such as an blower turbine aerator etc.	Free water surface or Air generator
Type of micro organisms	Activated sludge suspension	Fixed bio mass film on the surface of carrier
Characteristics of micro organism	Simple narrow food linkage	Various, big food-linkage
Characteristics of sludge	Biggest sludge volume of bio logical treatment	Few sludge volume
Organic substance loading	No flexibility	Flexibility
Treated water quality	Good but sometimes has problem "Bulking"	Good
Durability against raw water quality	Weak	Flexible
N & P removal	Possible	Possible effectively
Adjustment of M.L.S.S	Necessary returning sludge	Unnecessary
Scale up of facilities	Easy	Easy
Odor and noise of facilities	Noisy and emission of peculiar odor	Color Emission of peculiar odor
Handling	Necessary skilled operator	Easy
Operational cost	High	Low

2) Discussion

The aerobic bio mass film reactor is more excellent comparison with the non-attached bio mass reactor.

Merit

a) Unnecessary of returning sludge
b) Unnecessary of MLSS adjustment
c) Few excess sludge generation
d) To have durability against raw water quality change and raising an efficiency to select suitable bio mass carrier
e) Low running cost
f) Good starting after stop running

Demerit

a) A bit high initial cost
b) Necessary periodical back wash cleaning

3) As a result of discussion the aerobic biomass film reactor is recommendable to coffee farms in the Cristales.

J.5.4.3 A comparison of various aerobic biomass film contactor

1) Classification of aerobic bio mass film contactors

a) Trickling filter (Proto type of bio mass film)
- 1) Standard type trickling filter
- 2) High rate trickling filter

b) Fixed film contactor dipping type
- 1) Up flow outside aeration
- 2) Down flow outside aeration
- 3) Up flow inside aeration
- 4) Down flow inside aeration

c) Fluidized bed
- 1) Up flow outside aeration
- 2) Down flow outside aeration

d) Rotating dise contactor

2) Discussion

a) Trickling filter should not allow stopping water sprinkle and often generates offensive odor and the fly.

b) Dipping type fixed film contactor is packed various carriers - plastic ring, porous materials.

Special module etc in the water tank and supplied air from bottom by air diffusers.
The structure is very simple and easily possible cleaning inside carriers. Mainly, demand of dissolved oxygen detection is only required for handling as routine work.

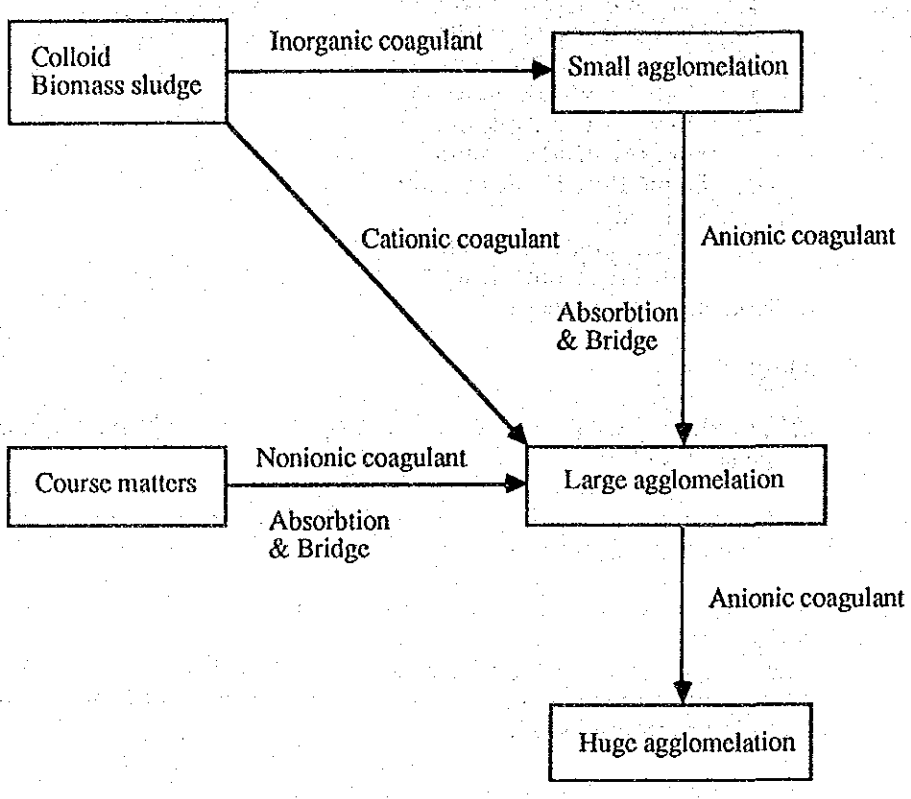
c) Fluidized bed is under developing at present time.

d) As one of the most compact and simple handling reactor, rotating disc contactor will be introduced but this reactor sometimes get fatal damages such as break down of main rotating shaft by unexpected excess weight of bio mass film, leaving out of module from the its frames.
Once the accident occur, it will be taken long time waste period for the repairing.

After considering all the factors, fixed bio-mass film contactor should be recommended to the coffee farms in the Cristales.

J.5.5 Agglomeration of digested sludge

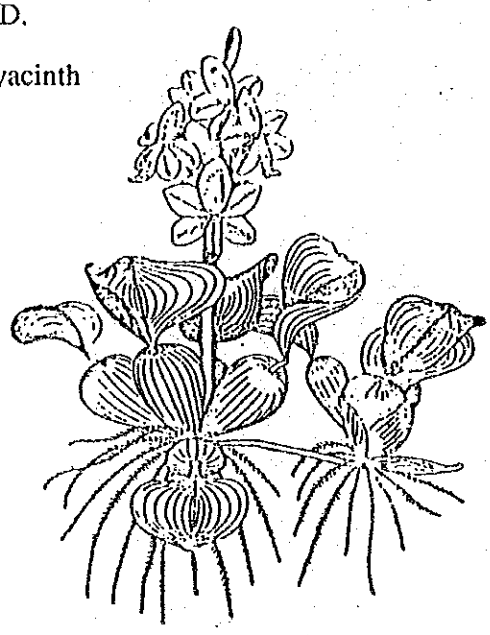
Fig J.5.5 Agglomeration of bio-sludge with coagulant



J.5.6 Aquatic plant stabilization pond

As an economic treatment method, water hyacinth will be applied to polishing of aerobic bio mass treated water.
It is well known that water hyacinth consumes dissolved phosphate and nitrogen as resource of nourishment and reduces organic substances expressed BOD and COD.

Fig J.5.6 Water Hyacinth



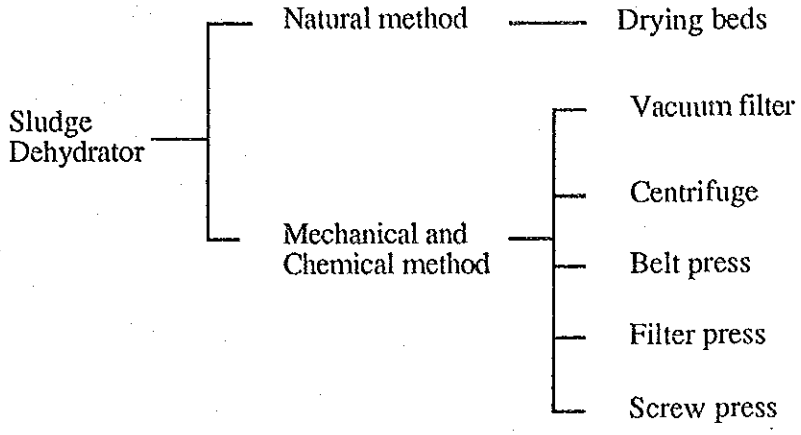
Water hyacinth, Eichhornia
(Phylum Spermatophyta, 22cm)

J.5.7 Dewatering

J.5.7.1 Method of dewatering

Sludge dewatering methods are roughly classified into 2 ways, they are natural and mechanical dewatering.

Table J.5.7.1 Kinds of dehydrator



J.5.7.2 Comparison of various dehydrators

	Natural	Mechanical & Chemical
Structure	Simple-sand bed	Complex in structure
Maintenance	Supplement of consumed sand	Mechanical damage and consumption
Initial cost	Low	High
Handling	Easy	High technique and complex
Electrical power	None	Necessary
Chemical aid	None	Necessary organic or Inorganic coagula
Dewatering speed	Very slow	Rapid
Cleaning water	None	Some are necessary
Cake collection	Man power	Belt conveyer
Location	Out door	In door

J.5.7.3 Selection of dehydrator

As a result of the comparison of 2 kinds dewatering systems, the sludge drying beds should be recommended as an suitable method for local condition.
Because, the sludge drying bed has several advantages to the cost, handling, and maintenance, especially the climate in Cristales is more favorable to drying bed system than the mechanical.

J.5.7.4 Treatment of the dewatering cake

To consider the facilities cost, and fuel, the treatment by a trash burner-inciralator, the utilization for fertilizer to the farms should be recommendable as an profitable in this area.

J.6 Labo-scale experimental results on coffee waste water

J.6.1 Neutralization

J.6.1.1 Neutralization by limestone with air bubbling

1) Condition

Crushed limestone	10-20mmø	440g
Coffee water	Volume	200ml
	CODcr	4,680mg/l
	pH	3.95
	Water temperature	24°C

2) pH variation by broken test

Table J.6.1.1 Neutralization by lime stone with air

1990 8/29 Time	Reaction Time Hr	pH	CODcr	DO	Remark
9 : 00	0	3.95	4,680	0.0	Start
9 : 30	0.5	4.78	(2,480)		
11 : 00	2.0	6.00			
12 : 00	3.0	6.04			
14 : 45	5.75	5.27		3.5	
15 : 30	6.5	5.91	2,730		
16 : 00	7.0	–	(1,820)		
17 : 00	8.0	6.12	2,590		Finish
			(1,750)		

( ) value shows analysis result of filtered samples by filter paper.

3) Result

The reaction time pH raising until value 6 required 2.5 hours.
CODcr value also reduced about 45% after naturalization.

J.6.1.2 Neutralization by limestone with air bubbling in laboratory scale

The possibility of practical equipment was confirmed by limestone packed in transparent plastic cylinder with air bubbling in long time laboratory scale examination continuously.

Fig J.6.1.1 shows the device of neutralization in laboratory.

1) Conditions

Size of reaction column	50mmø x 500mmH
Volume	980ml
Limestone	
Bed height	300mmH
Volume	500gr
Crushed stone size	5-20mmø
Air pump	
Waste water quality	Fermentation waste
pH	3.63 – 4.76
CODcr	2,000 – 13.950 mg/l
Samples from	La Aurora
	Pisararda
	El Rocio
	Sebastopol
Period of trial	900hrs continuously
	1990.8.15 - 10.22
Retention time	4.3hrs - 8.6 hrs
Flow rate	1.4 l - 2.8l/day

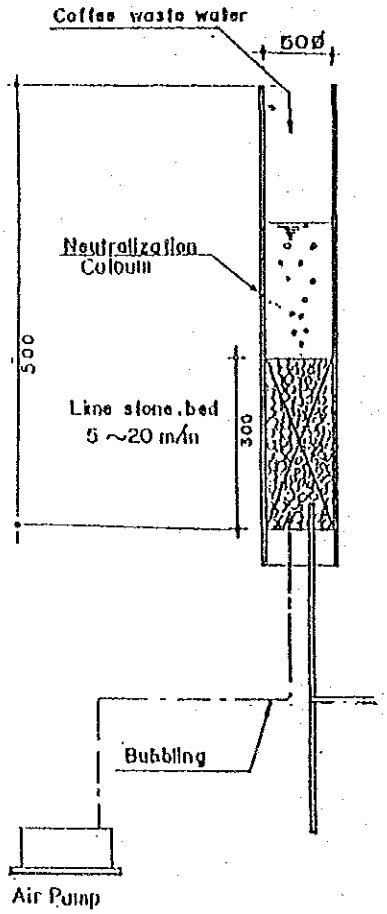


Fig J.6.1.1 Neutralization device in Laboratory

2) pH variation

Table J.6.1.2 Continuous laboratory examination of neutralization by limestone and air

Date / Fecha		Raw Water / Aqua Cruda	Neutralization / Neutralizac.
8/	15	3.6	
	16	4.75	
	17	3.7	
	23	3.7	6.0
	25	3.7	5.75
	27	3.6	5.7
	28	3.7	6.1
	29	4.0	6.0
	30	4.25	6.3
	31	4.6	7.0
9/	3	4.3	6.35
	4	4.3	6.1
	5	4.4	6.6
	6	4.35	6.4
	7	4.3	6.3
	10	4.56	5.74
	11	4.63	6.48
	12	4.67	6.12
	13	3.43	6.50
	18	3.73	5.84
	19	3.28	5.27
	20	3.22	5.34
	21	3.14	5.41
	24	3.17	5.50
	25	3.20	5.74
	26	3.63	6.03
	27	4.30	5.90
	28	3.38	6.15
10/	1	3.28	5.80
	2	3.11	5.58
	3	3.08	5.95
	10	3.57	6.00
	11	3.58	6.15
	12	3.40	6.21
	16	3.30	6.00
	17	3.31	6.24
	18	3.25	5.90
	19	3.26	6.15
	22	3.18	6.19

3) Result

pH value was adjusted about 6 at outlet of the reaction column.
During the trial, consumed limestone was supplied suitably.
Due to the clogging of 6 mmø out let tube, the limestone bed was washed 4 times, during trial period, by clean water.

Neutralization of the coffee waste water by limestone and air bubbling is prospective for the application of practical scale pilot plant.
For the lime stone application for raw coffee waste water periodical limestone bed cleaning is necessary, the frequency presupposes once per two weeks in case of continuous operation.

J.6.1.3 Limestone consumption

An expected lime stone consumption of raw coffee waste water naturalization was carried out in laboratory.

1) Condition

Waste water pH value	3.5
pH value after neutralizing	6.0
Waste water volume	200ml x 25 5,000ml
Initial limestone weight	400g
Final limestone weight	373.5g
Consumed limestone weight	26.25g
Another condition	Air bubbling
Waste water foam	El Rocio Sebastopol
Consumption	5.25kg/m^3 waste water

J.6.1.4 Discussions

The further study is necessary on limestone application from the view of technical and economical side.

1) Effective size of limestone
2) Effective structure of reaction vessel
3) Economical method of air bubbling
4) Variation of pH and decarbonation by air bubbling
5) Chemical composition and variation of organie acid after neutralizing
6) Effective cleaning method of generated sludge b neutralization

Fig J.6.1.2 – J.6.1.8 show several interesting results of neutralization test in laboratory.

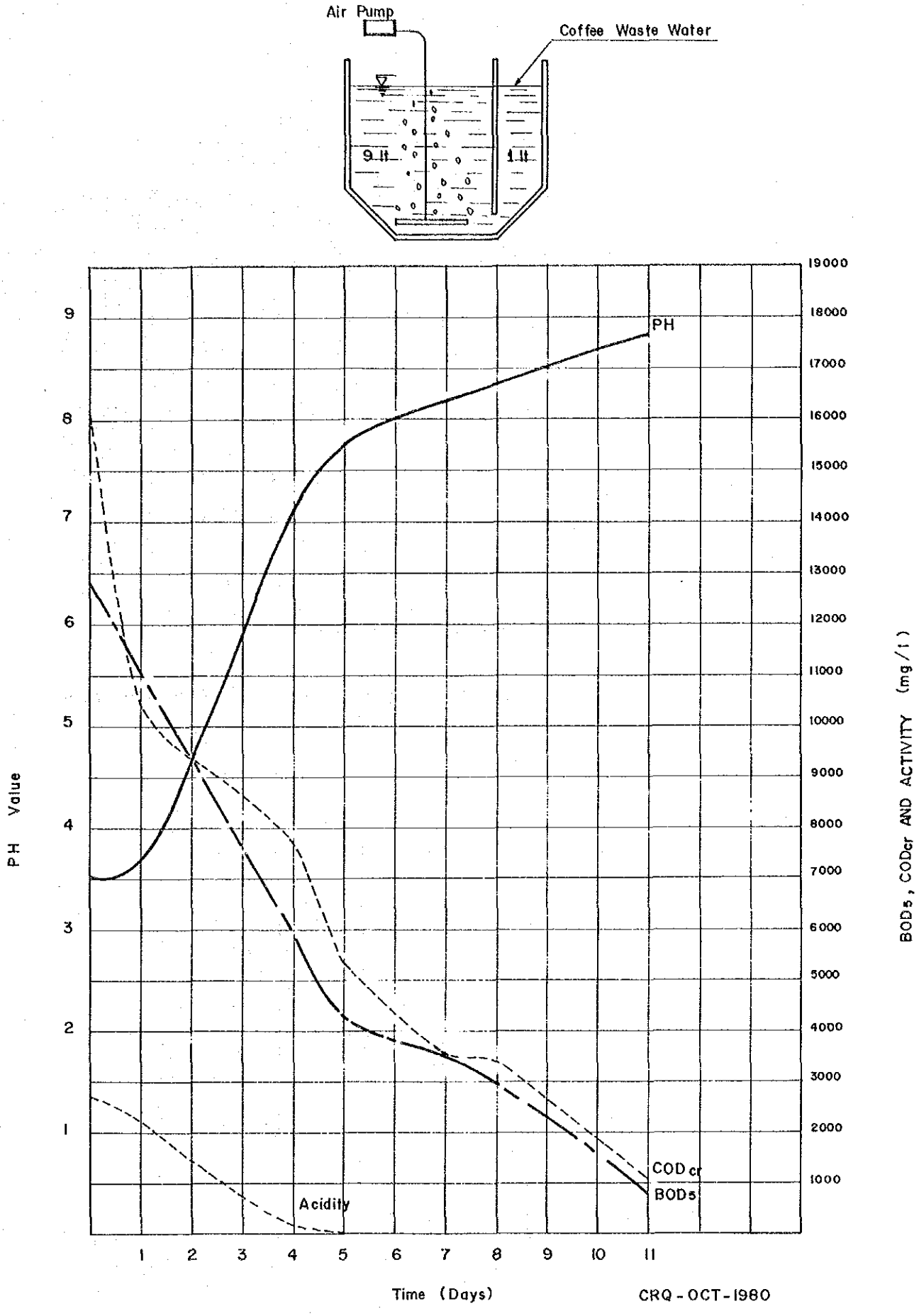


Fig. J.6.1.2 Quality Deterioration by Simple Aearation

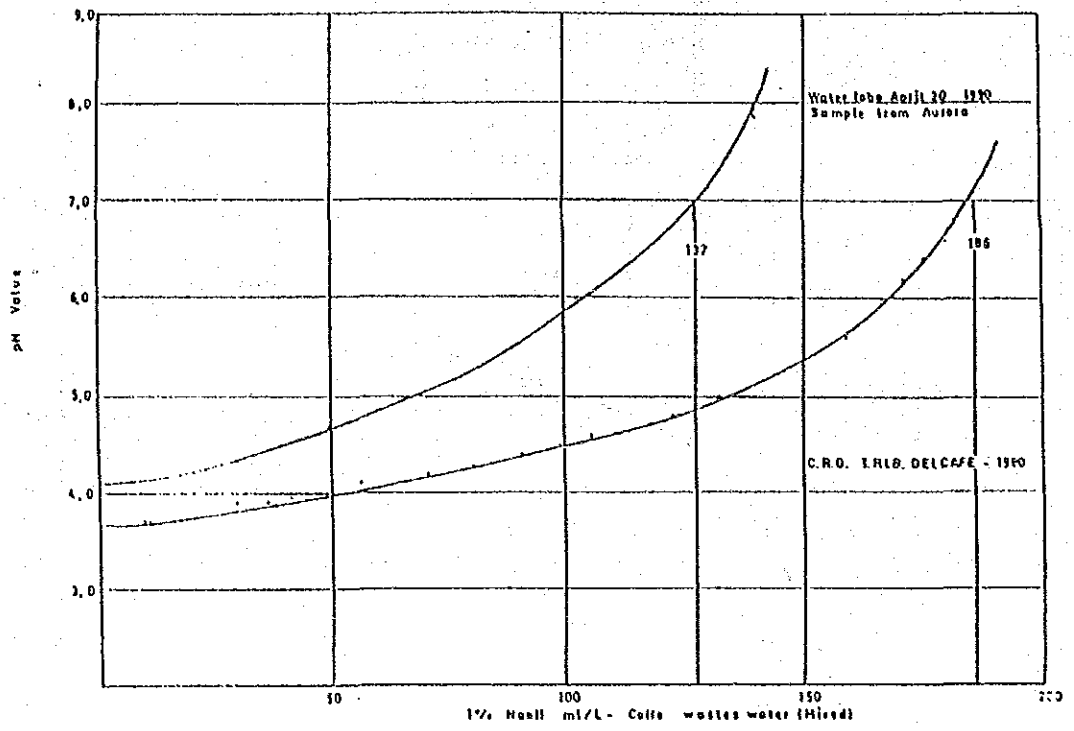


Fig. J.6.1.3 Neutralization Curve for Coffee Waste Water (Mixed) by NaOH

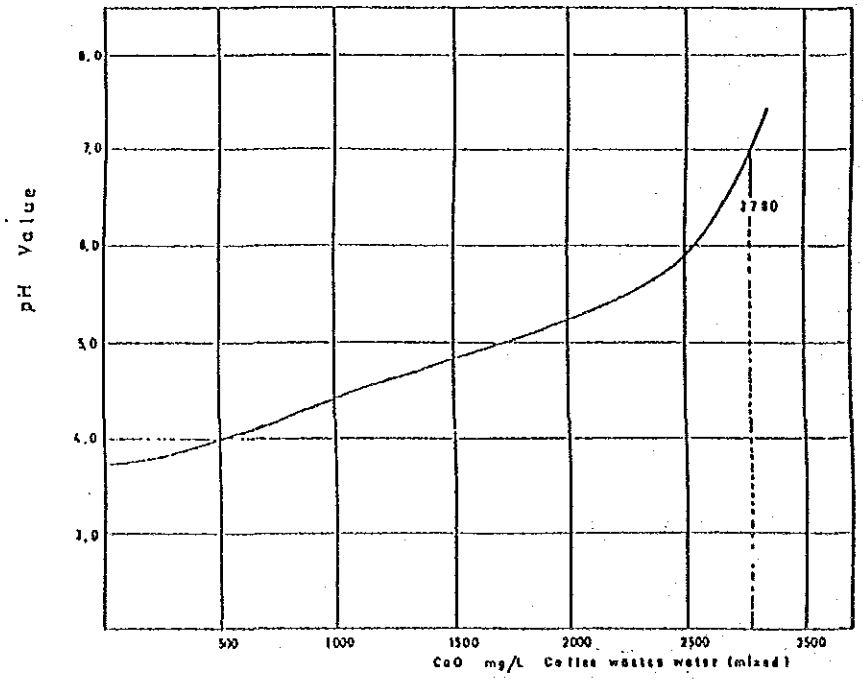


Fig. J.6.1.4 Neutralization Curve for Coffee Waste Water (Mixed) by CaO

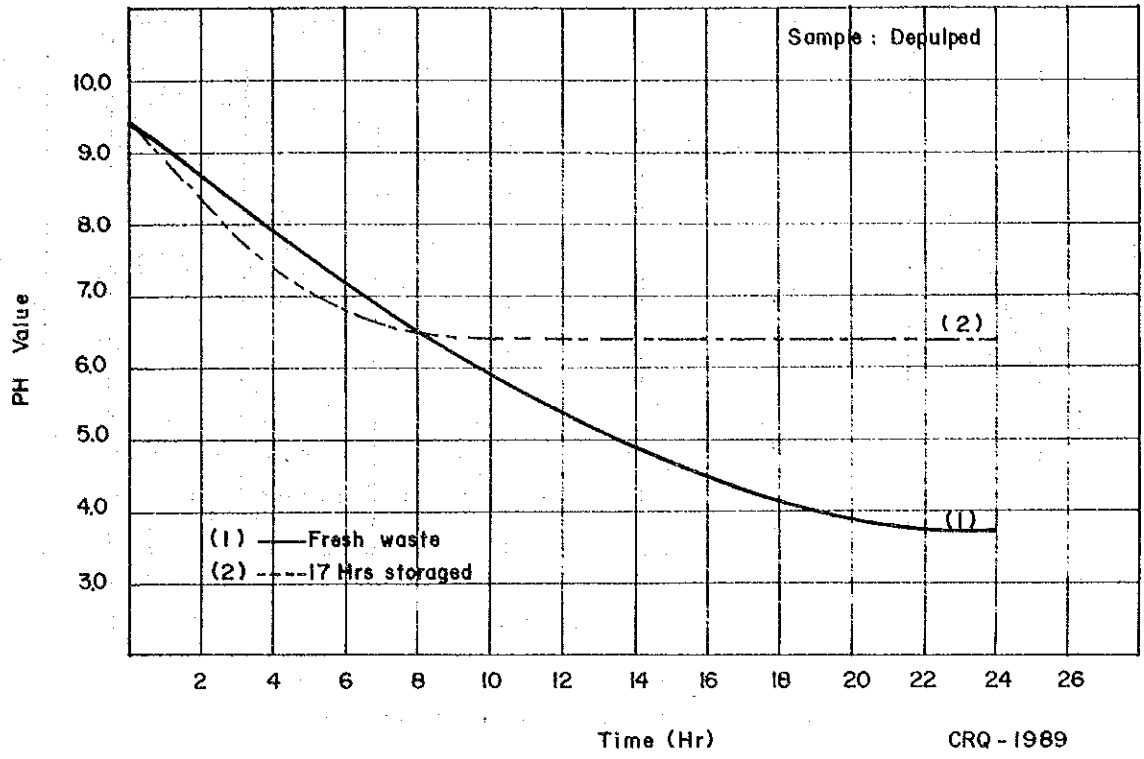


Fig. J.6.1.5 pH Variation after Neutralization(I)

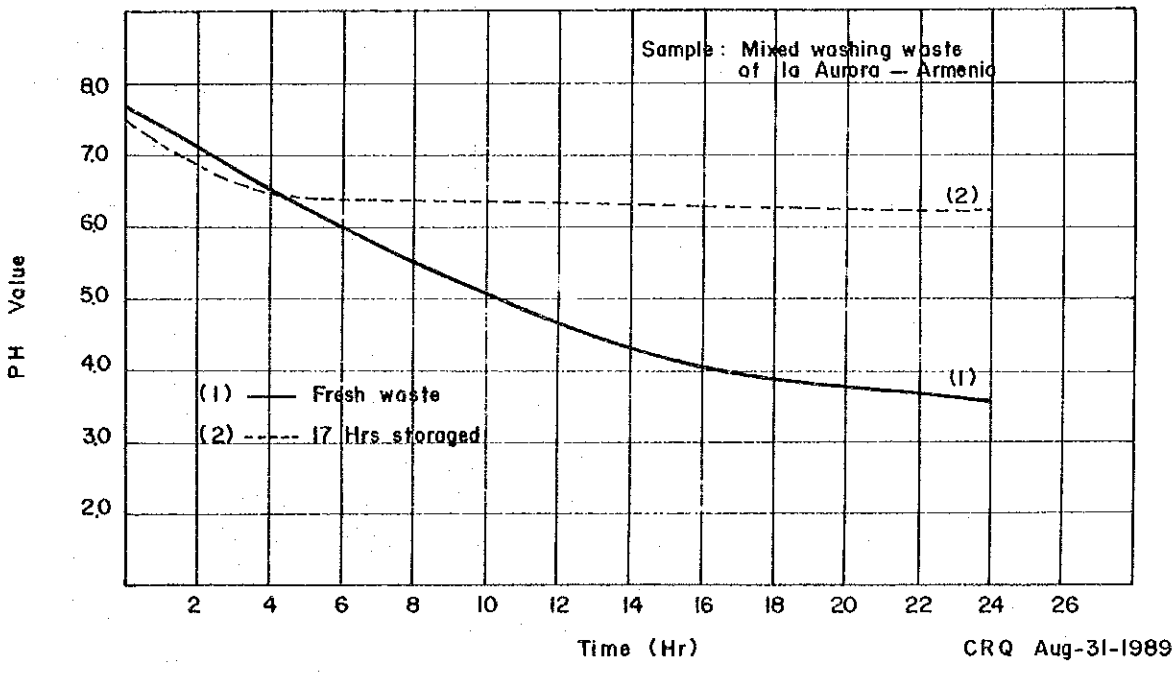


Fig. J.6.1.6 pH Variation after Neutralization(II)

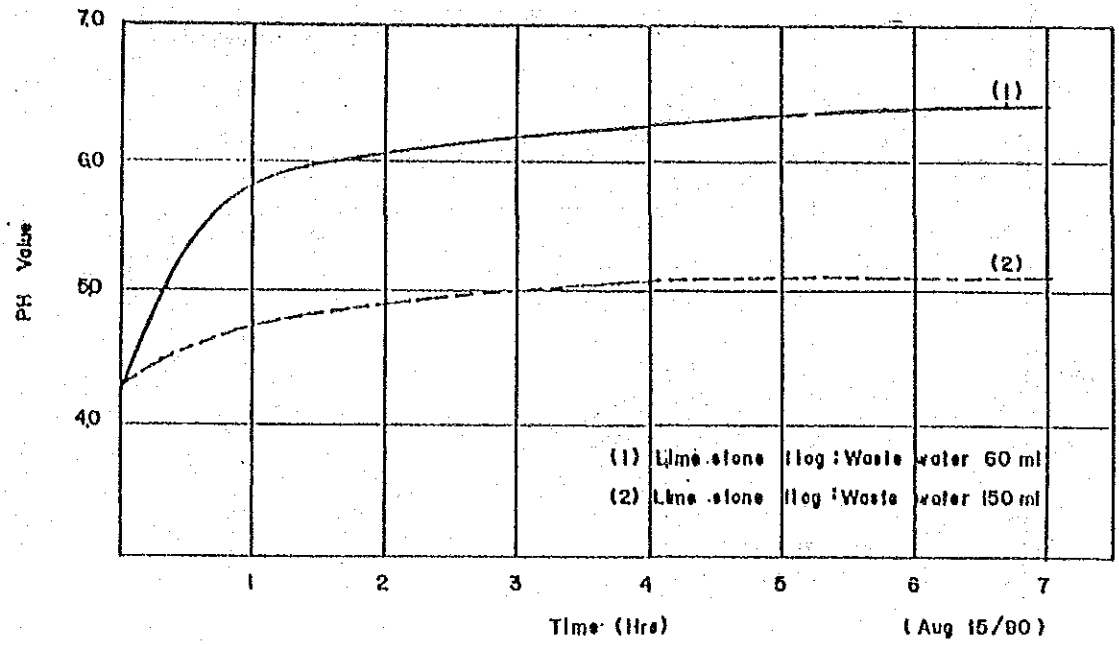


Fig. J.6.1.7 pH Variation by Lime Stone

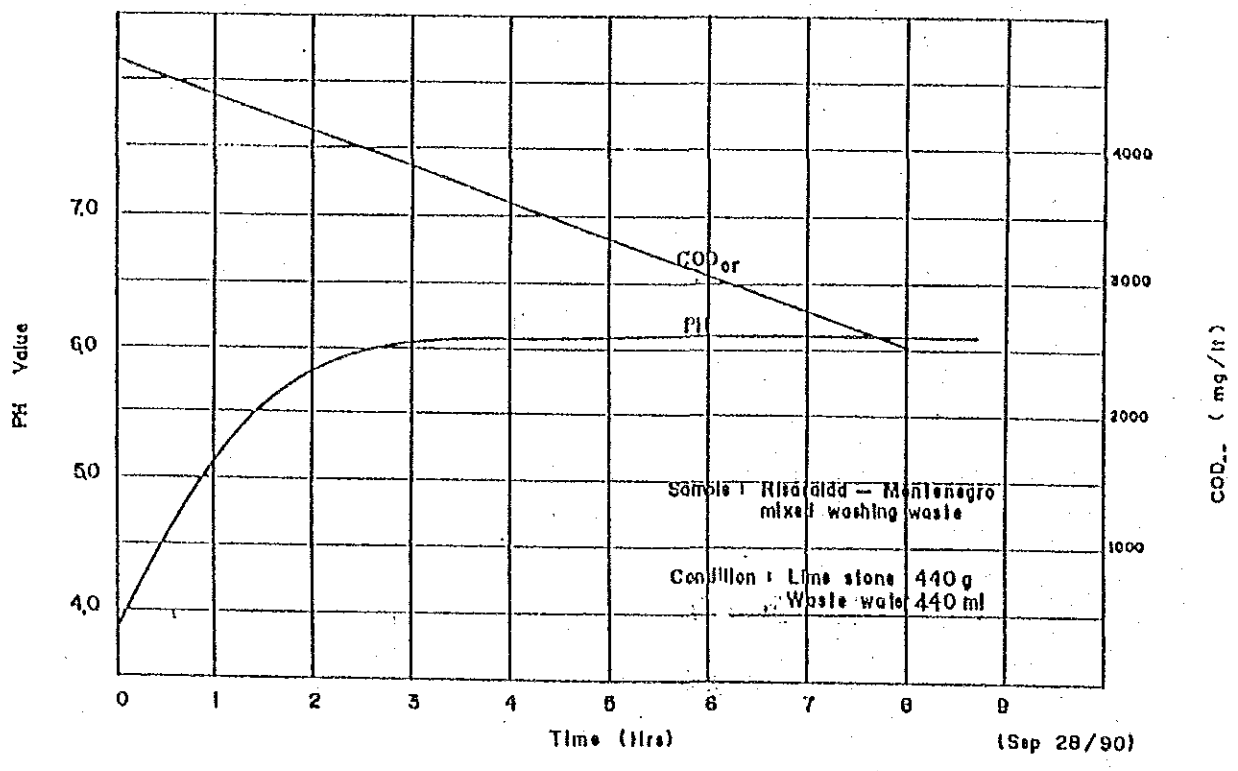


Fig. J.6.1.8 pH and CODcr Variation by Lime Stone with Air

J.6.2 Anaerobic bioreactor treatment

J.6.2.1 High organic substance content of coffee waste water. As an high rate removal examination on high organic substance content in the neutralized coffee processing waste water was done using agglomerated anaerobic bio sludge. The waste water to be treated was supplied by gravity for 41 days continuously.

J.6.2.2 Condition I

1) Test period	1990.5.25-7.4 41 days
2) Waste water sample	Small scale central processing Aurora
3) Seed sludge	from Coffee waste water pilot treatment plant at Aurora
4) Size of test column	50mmø x 400mmH 785ml
5) Anaerobic bed	Volume 500ml Height 250mmH
6) Anaerobic filter	Material steel wire and plastic net Height 50mmH
7) Quantity of waste water	2,000ml/day
8) H.R.T	9.4 Hrs
9 Temperature	Room 25°C-27°C

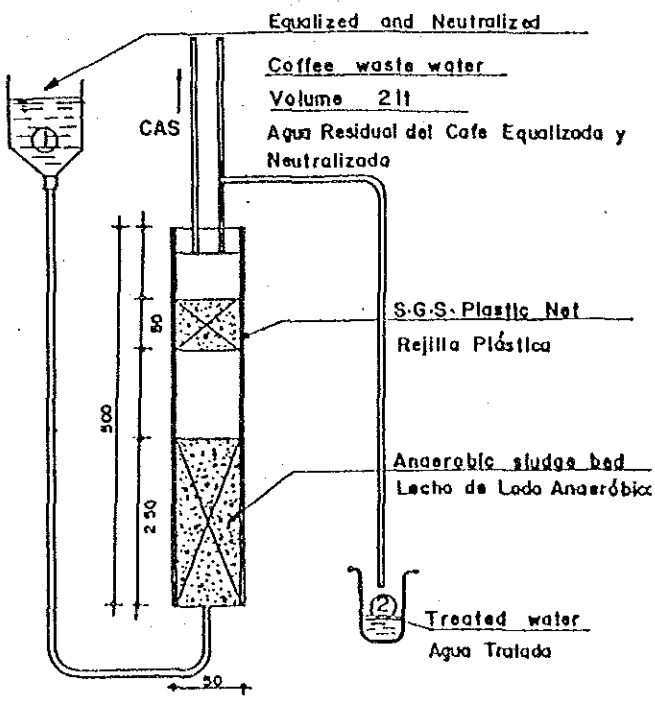


Fig. J.6.2.1 Anaerobic Biomass Device I

10) Result

a) Transparency and color unit have not improved remarkably.
b) Color unit in the treated water was guessed coming from steel made bio filter module.
c) Some offensive odor in the treated water was also guessed coming from some chemical reaction between treated water and steel made bio filter module.
d) CODcr removal ratio was the range from 32 to 78% deleted the highest and the lowest removal ratios and the CODcr removal between neutralized waste water with anaerobic treated water will be expected about 50%.
e) During the trial, active gas generation was confirmed.

11) Discussion

a) Steel should not be applied to anaerobic system.
b) It is necessary another examination to improve CODcr removal ratio.
c) Due to the no extreme capacity dropping of biomass reaction during the test period, the result will be prospective to apply for the practical scale pilot plant.

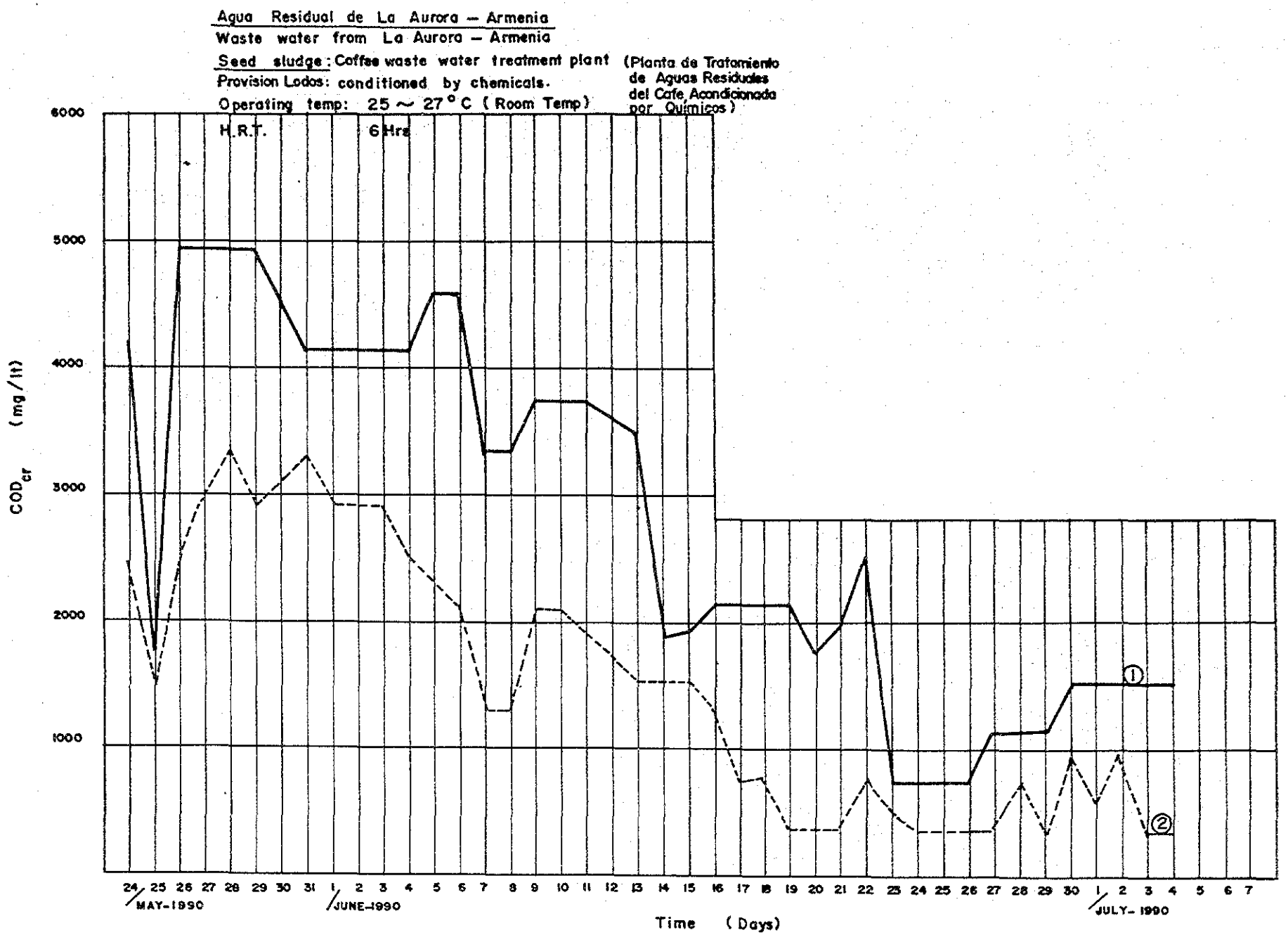


Fig. J.6.2.2 Result of Anaerobic Mass Test

Table J.6.2.1 Result of Anaerobic reactor column test

Analysis Reult												
		Temp. Temperature		Transparency Tranparencia		Coleur Color		pH PH		Coder Demanda Quiqeno		Coder Rata de Remoción
		inlet ENT.	outlet SLD.	inlet ENT.	outlet SLD.	inlet ENT.	outlet SLD.	inlet ENT.	outlet SLD.	inlet ENT.	outlet SLD.	%
5	25									4,200	2,450	41.7
	26									1,250	145	17.1
	27									4,940	2,510	49.2
	28									4,940	2,930	41.0
	29									4,940	3,350	32.6
	30	19								4,940	2,930	41.0
	31									2,510		
6	1	23.5	4.8	4.0	3.2	60	20	7.8	7.2	4,180	3,350	19.8
	2		22.5	4.0	3.5	30	75	7.19	7.43	4,180	2,930	29.9
	3	22.5	23	3.0	3.0	30	75	7.25	7.21	4,180	2,930	29.9
	4	22	22	3.0	4.0	30	50	-	7.46	4.180	2.930	29.9
	5	22	22	4.5	7.0	30	50	-	7.41	4,180	2,510	40.0
	6	22	22	4.2	-	50	60	8.14	-	4,600	-	
	7	24		4.2	5.7	50	58	7.6		4,600	2,090	54.6
	8	26.5	25	4.5	6.2	85	50	288	7.35	3,340	1,260	62.3
	9	-	24	5.5	6.2	200	125	7.20	7.45	3.340	1,260	62.3
	10	25	24	6.5	6.1	200	35	7.40	7.53	3,768	2,090	44.0
	11	26	26	6.5	6.3	200	40	7.40	7.57	3,765	2,090	44.0
	12	24		6.5	4.2	175		7.40		3,765		
	13	24		10.45	4.2	175		8.23	7.18	1,670		
	14	22	23	7.2	4.9	175	175	7.25	6.8	3,510	1,560	55.0
	15	23	26	4.0	4.0	200	150	8.5	7.6	1,670		
	16	26	27	4.0	3.8	200	75	8.64	7.0	1,950	1,560	20.0
	17	20	27	4.0	5.7	175	75	8.2	7.5	2,150	1,120	46.0
	18	20	27	4.0	6.2	175	25	8.2	7.3	2,150	780	64.0
	19	-	25	4.0	5.9	100	50	8.2	7.23	2,150	780	64.0
	20	21	25	5.3	8.0	50	50	8.2	7.25	2,150	390	82.0
	21	26	25	5.3	80	50	50	8.2	7.72	1,760	390	78.0

Table J.6.2.1 Result of Anaerobic reactor column test (continued)

Analysis Reult												
		Temp. Temperature		Transparency Tranparencia		Coleur Color		pH PH		Coder Demanda Quiqeno		Coder Rata de Remoción
		inlet ENT.	outlet SLD.	inlet ENT.	outlet SLD.	inlet ENT.	outlet SLD.	inlet ENT.	outlet SLD.	inlet ENT.	outlet SLD.	%
6	22	25	24	4.2	9.3	100	50	7.45	7.82	1,950	390	80.0
	23	25	26	22	6.0	100	50	7.86	7.56	2,540	780	69.0
	24	25	26	11	6.0	100	75	8.80	7.74	780	435	44.0
	25	25	26	11	6.0	100	100	8.80	7.86	780	390	50.0
	26	25	26	11	4.0	100	75	8.80	7.90	780	380	50.0
	27	24	26	11	-	100	50	8.80	7.90	1,170	390	67.0
	28	24	26	18.9	4.0	75	50	8.35	7.90	1,170	390	67.0
	29	24	28	13.9	4.5	75	50	8.35	7.69	1,170	750	36.0
	30	25	27		4.5	50	75	7.48	7.80	1,170	370	68.0
7	1	27	26	9.2	5.5	50	75	8.30	7.80	1,490	930	38.0
	2	27	22	9.2	6.0	50	75	8.30	7.80	1,490	560	62.0
	3	27	25	9.2	8.4	50	75	8.30	7.90	1,490	930	38.0
	4	25	26	5.0	6.4	100	75	8.30	7.00	1,490	370	75.0
	5	25	23	5.2	6.0	100	50	7.00	7.43	745	370	50.0
	6	25		7.8		125		-	2.73		745	

J.6.2.3 Anaerobic bioreactor treatment II

As another effective removal examination of organic substances in the neutralized coffee waste water by lime stone was done using agglomerated anaerobic bio sludge.
The water to be treated was supplied by a small size volumetric pump connected with the neutralization column in series, and hundred for 65 days continuously.

Condition II

1)	Test period	1990.8.19-10.25 65 days
2)	Waste water samples from	
	a) La Aurora	Small scale central factor
	b) Pisaralda	Large scale central factory
	c) El Rocio	8 Ha farm
	d) Sebastopol	25 Ha farm
3)	Seed sludge	From Coffee waste water pilot treatment plant at La Aurora
4)	Size of test column	75mmø x 500mmH 2,200ml
5)	Anaerobic bed	
		Volume 1,100ml
		Height 250mmH
6)	Anaerobic filter	Material
		Height 50mmH
7)	Quantity of waste water	1,440ml - 2,880ml/day
8)	H.R.T	36Hrs - 18.3Hrs
9)	Temperature	Room temp
10)	Result	

a) Active gas generation was confirmed through the trial.
b) There was no offensive orlorr in the treated water and improved appearance.
c) CODcr removal ratio was the range between 51% to 95% deleted the highest and the lowest removal ratios.

11) Discussion

a) 75% or more high CODcr removal ratio will be expected.
b) No extreme capacity drop of bioreactor during 65 days test period.
c) After successful engineering accomplishment such as structure, piping system, and waste water distribution etc. The system agglomerated anaerobic sludge bioreactor was confirmed to apply for the practical scale pilot plant.

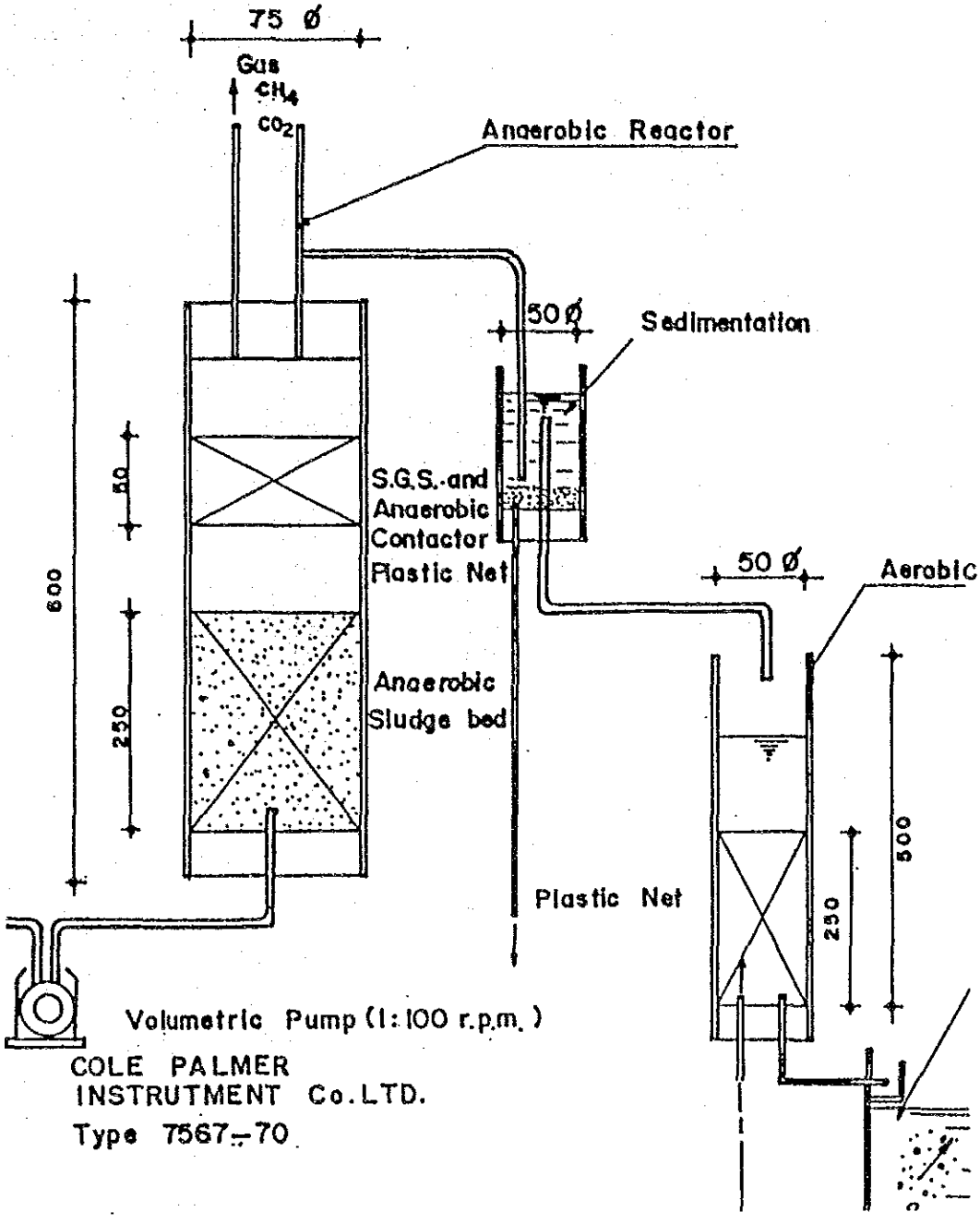


Fig. J.6.2.3 Anaerobic Biomass Device II

Table J.6.2.2 Anaerobic biomas test II

Date		Raw waste	Anaerobic Outlet CODcr	Removal Ratio %	Remark
1990					
8	19	7,480			Pisaralda
	23	6,360			
	24	7,590	3,670	51.6	
	25	6,540	3,320	49.2	
	27	4,680	1,950	58.3	
		(2,480)	(1,560)	(37.1)	
	28	4,500	1,960	56.4	
	29	8,625	2,140	75.2	
		(2,290)	(960)	(58.1)	
	30	7,980	1,740	78.2	
		(2,480)	(730)	(70.1)	
	31	3,330	1,400	57.9	
		(1,660)	(1,030)	(38.0)	
9	5	3,620	1,030	71.5	
		(2,290)	(370)	(83.8)	
	6	3,350	920	72.5	
		(2,465)	(550)	(77.6)	
	11	2,000	1,200	40.0	Sebastopol
		(1,850)	(910)	(50.1)	
	12	3,240	1,490	54.0	
		(2,070)	(360)	(82.6)	
	17	12,700	960	92.4	
		(11,500)	(285)	(97.5)	
	18	11,605	1,030	91.1	
		(11,140)	(390)	(96.5)	
	19	12,100	4,485	62.9	
		(8,470)	(3,560)	(58.0)	
	20	13,950	5,700	59.1	
		(9,300)	(5,270)	(43.3)	
	21	12,650	6,150	51.4	
		(10,630)	(5,350)	(49.6)	
	24	10,910	3,845	64.7	
		(19,510)	(2,730)	(86.0)	
	25	13,280	3,700	72.1	
		(9,230)	(2,800)	(69.7)	
	26	10,910	2,940	73.1	
		(8,570)	(2,380)	(72.2)	
10	1	10,440	2,090	80.0	
		(7,605)	(2,010)	(73.5)	
	2	10,810	3,620	65.5	
		(7,870)	(2,910)	(63.0)	
	5	8,930	3,310	62.9	
		(8,210)	(3,240)	(60.5)	
	8	11,810	940	92.0	
		(6,980)	(650)	(90.6)	

Date	Raw waste	Anaerobic Outlet CODcr	Removal Ratio %	Remark
10	8,460	1,360	83.9	Aurora
	(5,160)	(1,050)	(79.6)	
11	6,600	740	88.7	
	(6,170)	(500)	(91.8)	
16	9,640	1,610	83.2	
	(3,820)	(1,220)	(68.0)	
18	8,410	1,840	78.1	
	(8,180)	(1,150)	(85.9)	
22	7,370	2,180	80.0	
23	12,030	2,560	78.7	Sebastopol
	(9,700)	(1,800)	(81.4)	
25	6,320	1,650	73.8	
	(4,290)	(1,500)	(65.0)	

J.6.3 Aerobic bioreactor treatment

J.6.3.1 The trial of aerobic biocontactor I

As an effective removal examination of organic substances in the anaerobic bio reactor's treated water was done using aerobic bio contactor. Water to be treated was fed by gravity continuously for 65 days.

J.6.3.2 Condition

1) Test period		1990.8.19 - 10.25
2) Size of test column		50mmø x 350mmH 687ml
3) Aerobic bed	Material	Colombian made mineral carbon
	Bed height	250mmH 490ml
4) Quantity of waste water		1,440ml/day - 2,880ml/day
5) H.R.T		11.4 - 5.73Hrs
6) CODcr loading		5.24 kg - 10.5kg/m^3
7) Air source		Air pump
8) Temperature		Room Temperature

Table J.6.3.3 The result of aerobic treatment

Date		Raw waste water CODcr	Anaerobic outlet CODcr	Aerobic outlet DO mg/l	Aerobic outlet CODcr	Removal ratio	
						VS Ana	VS Aero
8	19	7,480			1,890		74.7
	24	7,590	3,670		2,620	28.6	70.2
	25	6,540	3,320				
	27	4,680	1,950		1,820	6.7	61.1
		(2,480)	(1,560)		(1,490)	(4.5)	(40.0)
	28	4,500	1,960		1,120	42.8	75.1
	29	8,625	2,140		890	58.4	89.6
		(2,290)	(960)		(700)	(27.0)	(69.4)
	30	7,980	1,740	0.1	1,220	29.8	84.7
		(2,480)	(730)		(850)		(65.7)
	31	3,330	1,400		520	62.8	84.3
		(1,660)	(1,030)		(370)	(64.1)	(77.7)
9	5	3,620	1,030		295	71.3	91.8
		(2,290)	(370)		(150)	(59.4)	(93.4)
	6	3,350	920		330	64.1	90.2
		(2,465)	(550)		(150)	(72.7)	(93.9)
	11	2,000	1,200		690	42.5	65.5
		(1,850)	(910)		(470)	(48.3)	(74.6)
	12	3,240	1,490	2.8	545	63.4	83.1
		(2,070)	(360)		(330)	(8.3)	(84.0)
	17	12,700	960	1.8	750	21.8	94.1
		(11,500)	(285)		(210)	(26.3)	(98.2)
	18	11,605	1,030	1.7	530	48.5	95.4
		(11,140)	(390)		(390)	(0)	(96.5)
	19	12,100	4,485		3,060	31.7	74.7
		(8,470)	(3,560)		(1,920)	(46.0)	(77.3)
	20	13,950	5,700	0.1	1,780	68.8	87.2
		(9,800)	(5,270)		(290)	(94.5)	(96.9)
	21	12,650	6,150	0.7	3,770	38.7	70.2
		(10,630)	(5,350)		(3,430)	(35.9)	(67.7)

Date		Raw waste water CODcr	Anaerobic outlet CODcr	Aerobic outlet DO mg/l	Aerobic outlet CODcr	Removal ratio	
						VS Ana	VS Aero
9	24	10,910	3,845	0.0	1,750	54.5	83.9
		(9,510)	(2,730)		(1,430)	(47.6)	(84.9)
	25	13,280	3,700	0.5	1,330	64.1	89.9
		(9,230)	(2,800)		(840)	(64.6)	(90.8)
	26	10,910	2,940	0.3	900	69.4	91.7
		(8,530)	(2,380)		(790)	(66.8)	(90.7)
10	1	10,440	2,090	0.3	450	78.4	95.7
		(7,605)	(2,010)		(430)	(78.6)	(94.3)
	2	10,810	3,620	0.8	1,680	53.6	84.5
		(7,870)	(2,910)		(1,230)	(57.7)	(84.3)
	5	8,930	3,310	0.0	2,520	23.8	71.8
		(8,210)	(3,240)		(2,480)	(23.5)	(69.8)
	8	11,810	940	0.1	540	31.9	95.4
		(6,980)	(650)		(290)	(55.3)	(95.8)
	10	8,400	1,360	0.0	350	74.3	95.8
		(5,160)	(1,050)		(190)	(81.9)	(96.3)
	11	6,600	740	0.0	500	32.4	92.4
		(6,170)	(500)		(300)	(40.0)	(95.1)
	16	9,640	1,610	0.0	990	38.5	89.7
		(3,820)	(1,220)		(360)	(70.5)	(90.5)
	18	8,410	1,840	0.0	840	54.3	90.0
		(8,180)	(1,150)		(290)	(74.8)	(96.4)
	22	7,370	2,180		440	79.8	94.0
		(5,870)	(1,180)		(360)	(69.5)	(93.8)
	23	12,030	2,560		550	78.5	95.4
		(9,700)	(1,800)		(520)	(71.1)	(94.6)
	25	6,320	1,650		1,280	22.4	79.7
		(4,290)	(1,500)		(1,130)	(24.7)	(74.7)

As results of aerobic bio contactors treatment

1) Glowing of micro organisms were confirmed for a week after starting.
2) Demand of dissolved oxygen in the treated water has reduced in the later half of trial.
3) The CODcr removal ratio was the range from 32 to 82% deleted the highest and the lowest rations, and the CODcr removal between anaerobic treated water with aerobic treated water will be expected 50% or more.

J.6.3.4 Discussion

The further studies are necessary on the aerobic bio contactor from view of technical side. They are

1) Effective size of mineral carbon.
2) Required air volume.
3) Required H.R.T

J.6.4 Stabilization pond experiment

J.6.4.1 Procedure

1)	Period of experiment	1990.8.19 - 10.25 65 days
2)	Size of pond	340mm x 250mm x 250mm
3)	Aquatic plant	Water Hyacinth 160g
4)	H.R.T	7 - 14 days
5)	Air supplement	Air pump
6)	Water temperature	Room

J.6.4.2 Discussion

CODcr removal ratio will be expected in the range 50 - 80%.

Several interesting experimental results in C.R.Q laboratory show in Fig J.6.4 and J.6.4.2.

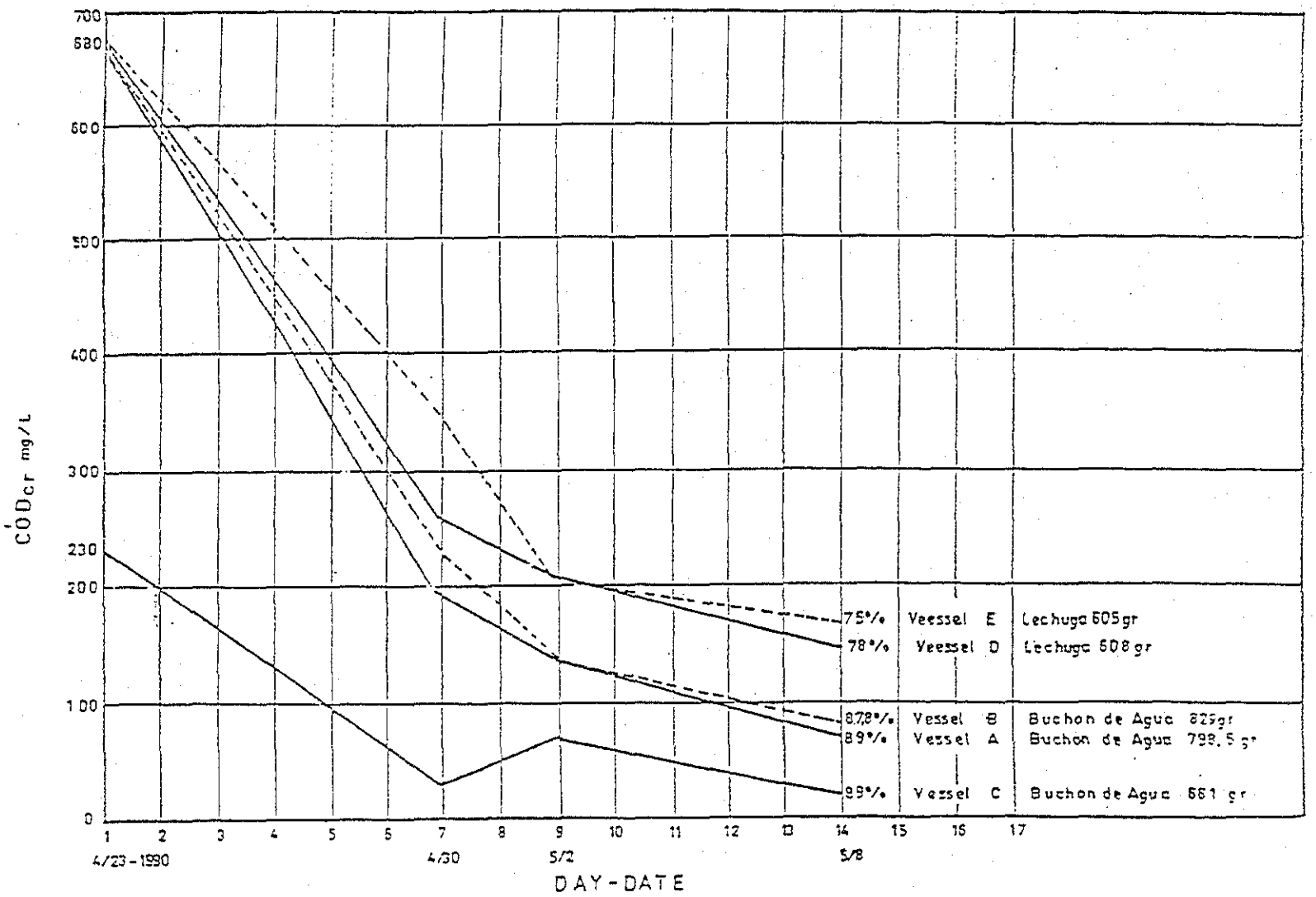


Fig. J.6.4.1 Removal Test for Organic Substances in Coffee Waste Water by Water Grasses

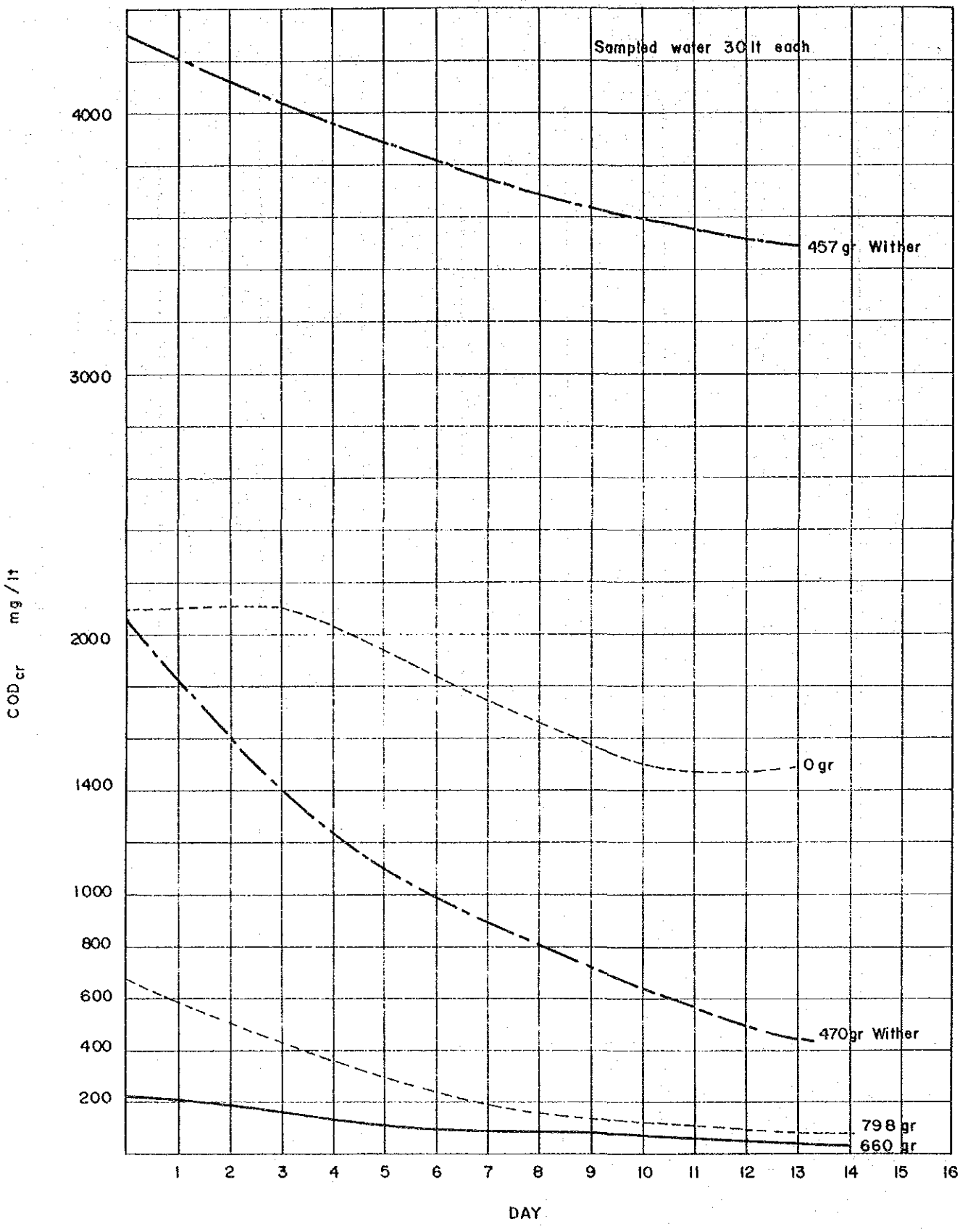


Fig. J.6.4.2 CODcr Removal by Aquatic Plant

J.6.5 The results of labo scale experiment

J.6.5.1 Outline of labo-scale experiment

Fig J.6.5.1 shows a series flow diagram of labo-scale examination.
The system consisted of Aerated lime stone neutralization and equalization-AACF Anaerobic biomass reacotor – Aerobic contact filter – Aquatic plant stabilization pond and tested for 65 days conteniously.

J.6.5.2 Experimental results

Table J.6.5.1 shows DO variation.
Table J.6.5.2 shows pH variation.
Table J.6.5.3 shows results of CODcr removal.
Table J.6.5.4 shows results of CODcr value.

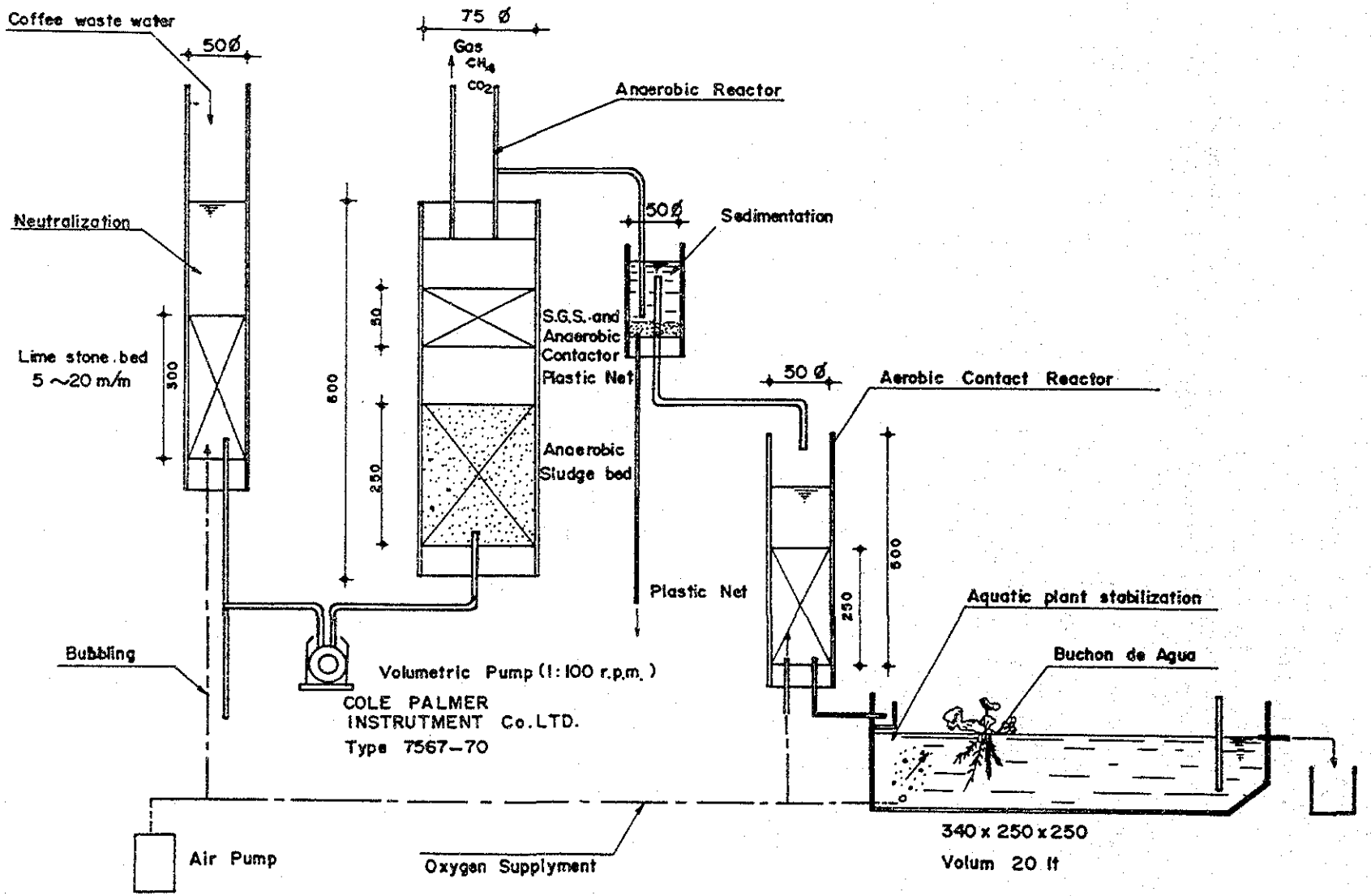


Fig. J.6.5.1 Labo-scale Examination Devices
for Coffee Waste Water Treatment

Table J.6.5.1 DO disolved oxigen variation

Date		Raw water	Neutralization	Anaerobic	Aerobic	Pond	Removal (%)
8	23	0.3		0.5			
	25	0.3					
	27	0.3				0.1	
	28	0.2				0.2	
	30	0.0	0.0		0.1	0.0	
9	3	0.0			0.1		
	4	0.4	0.1	1.5	2.4	0.2	
	12	0.3	0.1	0.5	2.8	2.8	
	17	0.7	0.0	0.7	1.8	2.5	
	18	0.5	0.0	0.6	1.7	1.9	
	20	0.0	0.2	0.1	0.1	0.2	
	21	0.0	0.2	0.1	0.7	0.0	
	24	0.0	0.0	0.0	0.0	0.0	
	25	0.0	0.0	0.2	0.5	3.3	
	26	0.0	0.0	0.1	0.3	2.4	
	27	0.0	0.0	0.2	0.4	3.8	
	28	0.0	0.0	0.0	0.2	3.6	
10	1	0.0	0.0	0.0	0.3	5.9	
	2	0.0	0.1	0.2	0.8	6.0	
	3	0.0	0.0	0.0	0.5	3.6	
	4	0.0	0.0	0.0	0.6	3.5	
	5	0.0	0.0	0.2	0.0	5.5	
	8	0.0	0.2	0.2	0.1	6.0	
	9	0.0	0.2	0.2	0.0	6.0	
	10	0.0	0.0	0.2	0.0	4.9	
	11	0.0	0.0	0.2	0.0	5.2	
	12	0.0	0.0	0.1	0.0	5.0	
	16	0.0	0.0	0.0	0.0	5.7	
	17	0.0	0.0	0.0	0.0	6.7	
	18	0.0	0.0	0.2	0.0	6.6	
	19	0.0	0.0	0.2	0.0	4.5	
	20	0.0	0.0	0.2	0.0	7.0	

Table J.6.5.2 pH variation

Date		Raw water	Neutralization	Anaerobic	Acrobic	Pond	Removal (%)
8	15	3.6					
	16	4.75					
	17	3.7					
	23	3.7	6.0				
	25	3.7	5.75				
	27	3.6	5.7	6.75			
	28	3.7	6.1	6.25			
	29	4.0	6.0	6.6			
	30	4.25	6.3	6.25	7.6	7.8	
	31	4.6	7.0	6.7	7.4	7.5	
9	3	4.3	6.35	7.3	7.45	7.45	
	4	4.3	6.1	7.05	7.15	7.45	
	5	4.4	6.6	7.45	8.1	7.35	
	6	4.35	6.4	7.55	7.85	7.85	
	7	4.3	6.3	7.6	8.8	7.8	
	10	4.56	5.74	5.59	8.19	8.06	
	11	4.63	6.48	7.76	8.30	8.11	
	12	4.67	6.12	7.45	8.26	8.08	
	17	3.43	6.50	7.21	7.31	8.34	
	18	3.73	5.84	6.90	8.34	8.01	
	19	3.28	5.27	6.32	7.44	8.20	
	20	3.22	5.34	6.34	7.26	8.03	
	21	3.14	5.41	6.58	7.41	8.07	
	24	3.17	5.50	6.67	7.25	8.00	
	25	3.20	5.74	6.87	7.12	7.98	
	26	3.63	6.03	7.00	7.32	8.00	
	27	4.30	5.90	7.01	7.05	8.06	
	28	3.38	6.15	6.95	7.58	8.13	
10	1	3.28	5.80	6.95	7.84	8.35	
	2	3.11	5.58	6.00	7.35	8.23	
	3	3.08	5.95	6.84	7.42	8.35	
	10	3.57	6.00	7.15	7.69	8.42	

Table J.6.5.2 pH variation (continued)

Date		Raw water	Neutralization	Anaerobic	Aerobic	Pond	Removal (%)
10	11	3.58	6.15	6.92	7.60	8.36	
	12	3.40	6.12	7.01	7.09	8.32	
	16	3.30	6.00	7.08	7.17	8.41	
	17	3.31	6.29	6.98	7.59	8.61	
	18	3.25	5.90	7.06	7.35	8.51	
	19	3.26	6.15	7.05	7.77	8.59	
	22	3.18	6.19	7.17	8.04	8.55	

Table J.6.5.3 Result of CODcr removal test

Date		Raw water	Neutralization	Anaerobic	Aerobic	Pond	Removal (%)
8	19	7,480			1,890		
	23	6,360					
	24	7,590	4,964	3,670	2,620		
	25	6,540	6,430	3,320			1,441/day
	27	4,680	7,190	1,950	1,820		2,880/day
		2,480	1,610	1,560	1,490		
	28	4,500	3,420	1,960	1,120		
					720		
	29	8,625	4,170	2,140	890		
		(2,290)	(2,180)	(960)	(700)		
	30	7,980	5,430	1,740	1,220	1,370	
		(2,480)	(2,220)	(730)	(850)	1,370	
	31	3,330	2,660	1,400	520	1,034	
		(1,660)	(810)	(1,030)	(370)	(660)	
9	5	3,620	2,880	1,030	295	440	
		(2,290)	(1,220)	(370)	(150)	(295)	
	6	3,350	3,050	920	330	480	85.5
		(2,465)	(1,070)	(550)	(150)	(400)	
	11	2,000	4,330	1,200	690	470	76.5
		(1,850)	(1,270)	(910)	(470)	(406)	
	12	3,240	5,560	1,490	545	400	87.6
		(2,070)	(1,490)	(360)	(330)	(180)	
	17	12,700	7,230	960	750	640	95.0
		(11,500)	(1,890)	(285)	(210)	(140)	
	18	11,605	11,710	1,030	530	360	97.0
		(11,140)	(915)	(390)	(390)	(320)	
	19	12,100	12,100	4,485	3,060	710	
		(8,470)	(7,300)	(3,560)	(1,920)	(360)	
	20	13,950	9,825	5,700	1,780	315	97.7
		(9,300)	(7,260)	(5,270)	(280)	(260)	(98.4)
	21	12,650	12,510	6,150	3,770	460	
		(10,630)	(9,340)	(5,350)	(3,430)	(380)	

Table J.6.5.3 Result of CODcr removal test (continued)

Date		Raw water	Neutralization	Anaerobic	Aerobic	Pond	Removal (%)
9	24	10,910	9,370	3,845	1,750	1,330	
		19,510	8,215	2,730	1,430	700	
	25	13,280	11,610	3,700	1,330	590	
		(9,230)	(7,240)	(2,800)	(840)	(570)	
	26	10,910	12,030	2,940	900	430	
		(8,570)	(5,380)	(2,380)	(790)	(400)	
10	1	10,440	8,350	2,090	450	180	
		(7,605)	(7,230)	(2,010)	(430)	(180)	
	2	10,810	11,560	3,620	1,680	930	
		(7,870)	(7,790)	(2,910)	(1,730)	(270)	
		8,930	10,080	3,310	2,520	720	
		8,210	7,990	3,240	2,480	310	
	8	11,810	8,790	940	540	260	
		(6,980)	(5,580)	(650)	(290)	(240)	
	10	8,460	8,150	1,360	350	270	
		(5,160)	(3,140)	(1,050)	(190)	(160)	
	11	6,600	5,660	740	500	160	
		(6,170)	(4,070)	(500)	(300)	(150)	
	16	9,640	10,400	1,610	990	120	
		(3,820)	(3,750)	(1,220)	(360)	(90)	
	18	8,410	8,410	1,840	840	140	
		(8,180)	(5,200)	(1,150)	(290)	(110)	
	22	7,370	6,620	2,180	440	140	
		(5,870)	(4,850)	(1,180)	(360)	(120)	
	23	12,030	9,780	2,560	550	110	
		(9,700)	(7,970)	(1,800)	(520)	(90)	
	25	6,320	6,470	1,650	1,280	195	
		(4,290)	(3,380)	(1,500)	(1,130)	(150)	

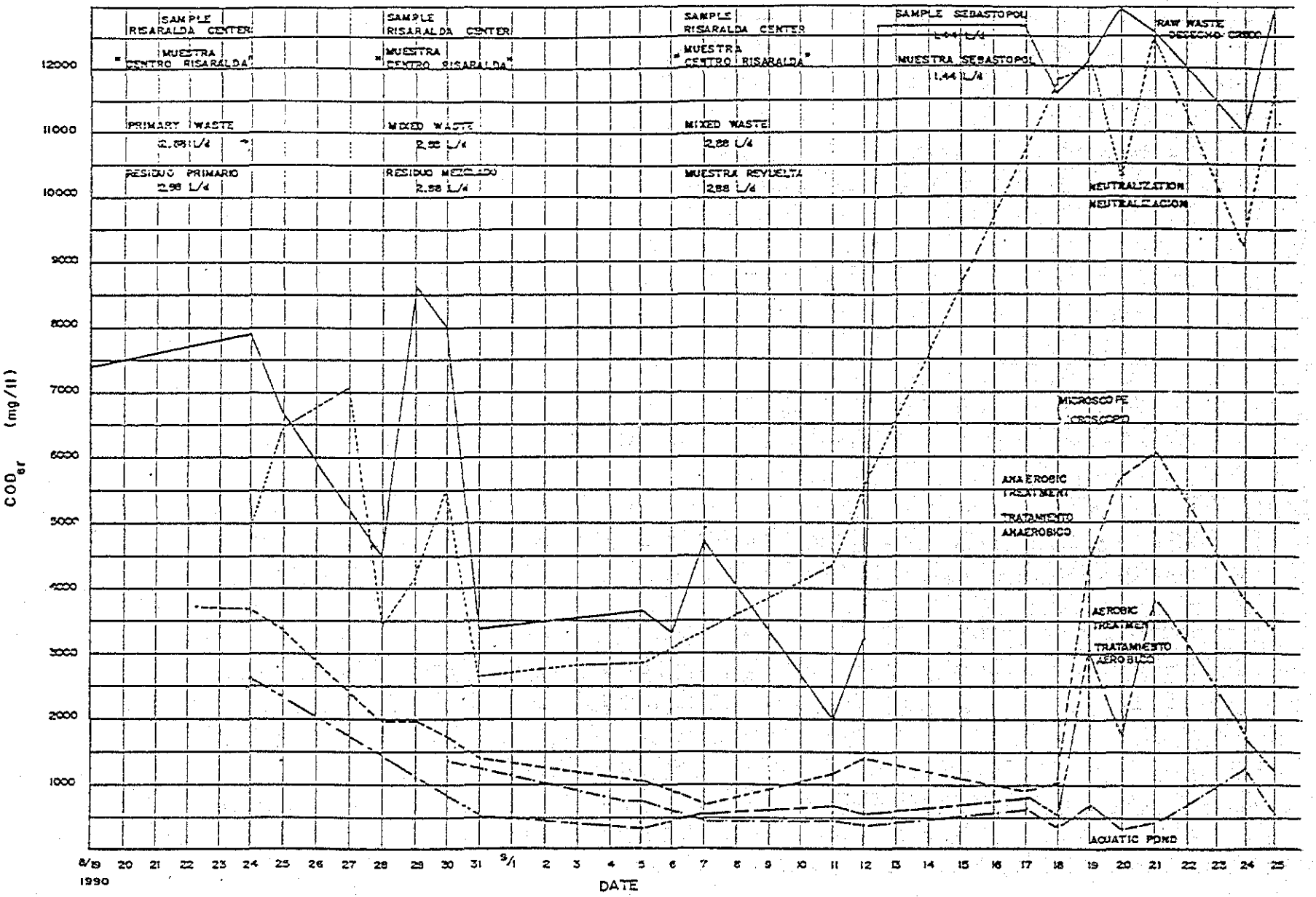


Fig. J.6.5.2(1) The result of CODcr Removal in Labo-Examination

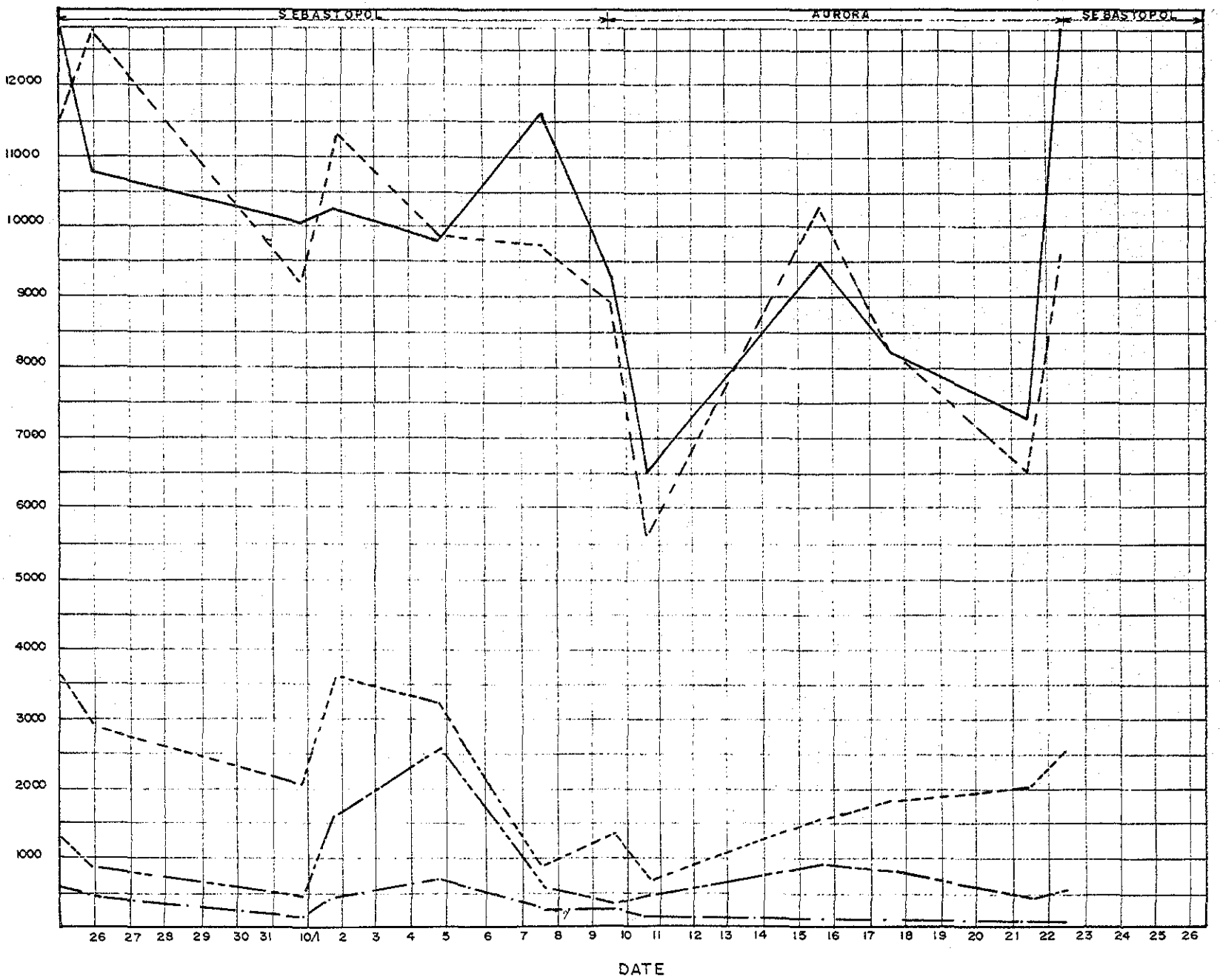


Fig. J.6.5.2(2) The result of CODcr Removal in Labo-Examination

J.7 Pilot plan of coffee waste water treatment

J.7.1 Selection of pilot area

J.7.1.1 River contamination in Quindio

The most wide-broaden agricultural water pollutant in the Quindio in the last decade is the waste water discharges from the wet processing of coffee during the two (2) harvesting seasons.

According to the result of water quality examinations during past several years, six (6) water sheds are injured striking contamination by high contents organic substances from the coffee processing effluents.

They are:

	BOD Loading
Rio Vieja	11.8%
Rio Santo Domingo	10.3%
Quebrada Cristales	10.2%
Rio Espejo	9.8%
Rio Quindio	9.7%
Rio Lejos	9.2%

J.7.1.2 The basin high effect of contaminant reduction

From the view point of reducing a water contamination level, the rivers which are required a cutting down ratio over 90% are Q. Cristales, Q. Buenavista, Rio Robre and Rio Barragan.

J.7.1.3 Decision of pilot area

The Cristales is adjoined at south west of Armenia, as well as a main coffee production are in Quindio. And a high potential area of river water quality improvement.
The Cristales area should be recommended as a pilot area for water quality conservation.

J.7.2 Condition of the Cristales area

The Christales water solved consist of 18 (eighteen) small streams. They are divided by 2 (two) administratives - Armenia and La Tebaida.

J.7.2.1 Streams belong to Armenia

Q - Christales	Length	34.5 km
Q - Erlin		6.5 km
Q - Germania		6.0 km
Q - Los Angers		7.5 km
Q - Chispero (including Q. Tatabras)		20.3 km
Q - Portogal		6.8 km
Q - Malmato		6.0 km
Q - Betica		1.5 km
Q - Christalito		4.5 km
9 streams		

J.7.2.2 Streams belong to La-Tebaida

Q - Paraneglo	8.2 km
Q - Argentina	9.0 km
Q - Las Tabras	3.0 km
Q - Venesia	6.0 km
Q - Julia	4.8 km
Q - Oriente	2.2 km
Q - Jaramilla	3.5 km
Q - La Popa	6.0 km
Q - Pontonto	3.0 km
9 streams	

J.7.2.3 Characteristics of Cristales

1) Coffee production

7.095 ha of coffee cultivation area in the Cristales is equivalent to 75.4% of the total area, 9,400 ha.
The composition of coffee farms are as follow.

30 Ha or more	55 Farms	Total	4,100 Ha
30 - 5 Ha	330 Farms	Total	2,000 Ha
5 Ha or less	285 Farms	Total	995 Ha
		G. Total	7,095 Ha

2) Characteristics of Armenia area

a) The Cristales starts to flow in Castilla and gets water from (nine) small streams. It also gets the sewer of Castilla which has about 4,400 people and finally flow to the Rio Vieja at Pisamal.
Beside, Castilla sewer, there are 2 (two) recreation parks on the Q-Cristales, they discharge their guest wastes through septie tanks.
As another human waste source, El Caimo which has about 330 people is situated near Q-Tatabras. Indeed an effect of the Castilla sewer gives contamination to main flow of Cristales at an alto area, however Q-Cristales has good enough water quantity and good slope and shallow water depth. Those condition fits for the self-purification of the river. That's the reason why at Diamante which is located 10 km far from Castella, the Q-Christales becomes rather clean in none coffee harvest seasons.

b) There are about 400 farms scattered in Cristales basin in Armenia. The topography of this area also has a sharp slope but many farms are located on the road and with an easy access from Armenia.

3) Characteristic of La-Tebaida area

a) The Quebrada Jaramilla starts to flow in La-Tebaida and gets water from 9 (nine) small streams. It also gets the sewer of La-Tebaida and finally flows to the Cristales.
Besides that Tebaida has one of the biggest central coffee processing factory which discharges a huge amount of coffee waste water to sewer piping net work directly.

b) Considerable number of farm mainly in Paranegro area entrust the processing of coffee the central factory in Tebaida.

c) There are about 235 farms which are scattered in 4,300 ha, due to the topography even the small jeep can not reach to several farms.

d) The topography of this area, farms are situated at an altitude about 1,100m, but there is sharp slope which impedes the access to the stream at an altitude, about 900m.
In some places no body can reach to the river.

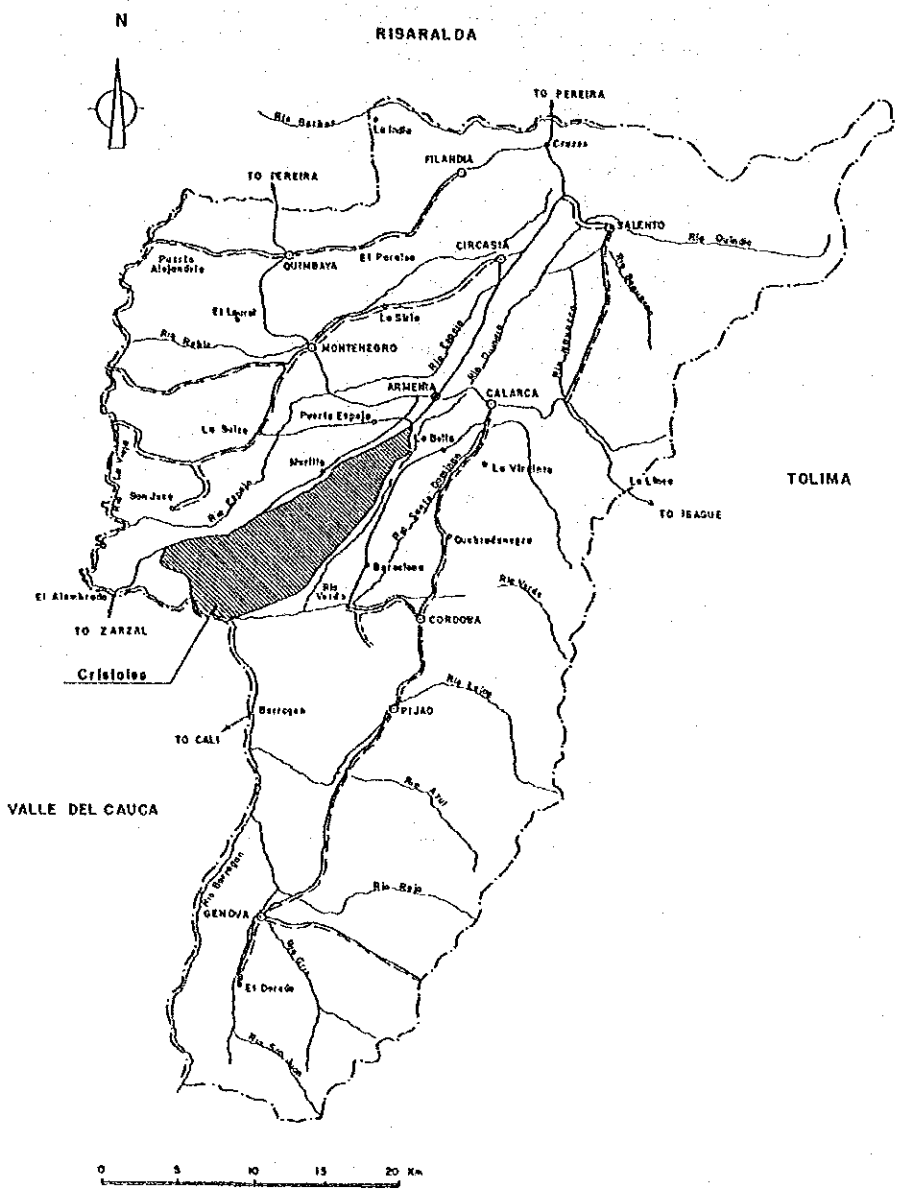


Fig. J.7.2.1 Location Map of Cristales Area

J.7.3 Selection of the potential area for coffee waste

J.7.3.1 Parameter for selection

1) To get good coffee harvest area which has about 700 ha cultivated area
2) High ratio coffee production farms and processing by own factory
3) To obtain good enough area for the plant
4) To have good topographical condition (lay of the land) for waste water treatment
5) To have possibility of establishing economical piping network for waste water collection
6) To obtain clean water and power easily
7) Convenience for construction, maintenance and inspection
8) Easy access to the river for effluent
9) Easy access from Armenia (for CRQ & constrictor)
10) Good indentification of farm's awareness (Fund and environmental)

J.7.3.2 Evaluation

Table J.7.3.2 Evaluation of potential area

Name of Area	Cultivation (Ha)	Production Miels @	Distance from Armenia (km)	Evaluation										Yes Total
				1	2	3	4	5	6	7	8	9	10	
Q. Crist Arto	820	132.0	6	Y	Y	Y	Y	N	Y	N	Y	Y	-	7
Q. Crist Media	1,475	205.3	12	Y	N	N	Y	Y	Y	N	Y	Y	-	6
Q. Erlin	225	27.8	3	N	Y	Y	Y	N	Y	N	Y	Y	-	6
Q. Los Angels	360	59.1	3	N	Y	Y	Y	N	Y	N	Y	Y	-	6
Q. Germania	465	89.2	6	N	Y	Y	Y	N	Y	N	Y	Y	-	6
Q. Malmato	280	32.5	8	N	Y	N	Y	N	Y	Y	Y	Y	-	6
Q. Betica	145	26.2	7	N	Y	Y	Y	N	Y	N	Y	Y	-	6
Q. Chrispero	1,020	196.5	12	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	9
Q. Portugal	300	56.0	18	N	Y	Y	Y	N	Y	Y	Y	N	-	6
Q. Jarramilla	320	39.0	20	N	N	Y	N	N	Y	N	N	N	-	2
Q. La Popa	560	34.0	20	N	N	N	N	N	Y	N	N	N	-	1
Q. Argentina	560	86.9	17	N	Y	Y	N	N	Y	N	N	N	-	3
Q. Palo Negro	750	116.0	18	N	Y	Y	Y	Y	Y	N	N	Y	-	6
Acro puerto	55	6.9	12	N	N	Y	Y	Y	Y	Y	N	N	-	5
Q. Cantaro	525	71.3	19	N	N	N	N	N	Y	N	N	N	-	1
Q. La Jalia	600	67.6	15	Y	N	N	N	N	Y	N	N	N	-	2
Q. Oriento	345	38.9	16	N	N	N	N	N	Y	N	N	N	-	1
Q. Quindio	380	36.2	10	N	N	N	Y	Y	Y	Y	N	Y	-	4
Q. Las Tables	200	39.6	13	N	Y	Y	N	N	Y	N	N	N	-	3
Total	9,385	1,361.0												

Yes = yes No = no

J.7.4 Selection of pilot area

J.7.4.1 Comparison of the Cristales Alto Basin and the Chispero Basin

According to the results of the comparison, the Cristales basin or the Chispero basin should be selected as the pilot area.

	The Cristales Alto	The Chispero Alto
Distance from Armenia	1 - 12 km	8 - 16 km
Required time to get	5 - 20 min.	20 - 25 min.
Altitude	1,200 - 1,400 m	1,200 - 1,280 m
Topographical	Sharp undulation and rugged	Gently sloping

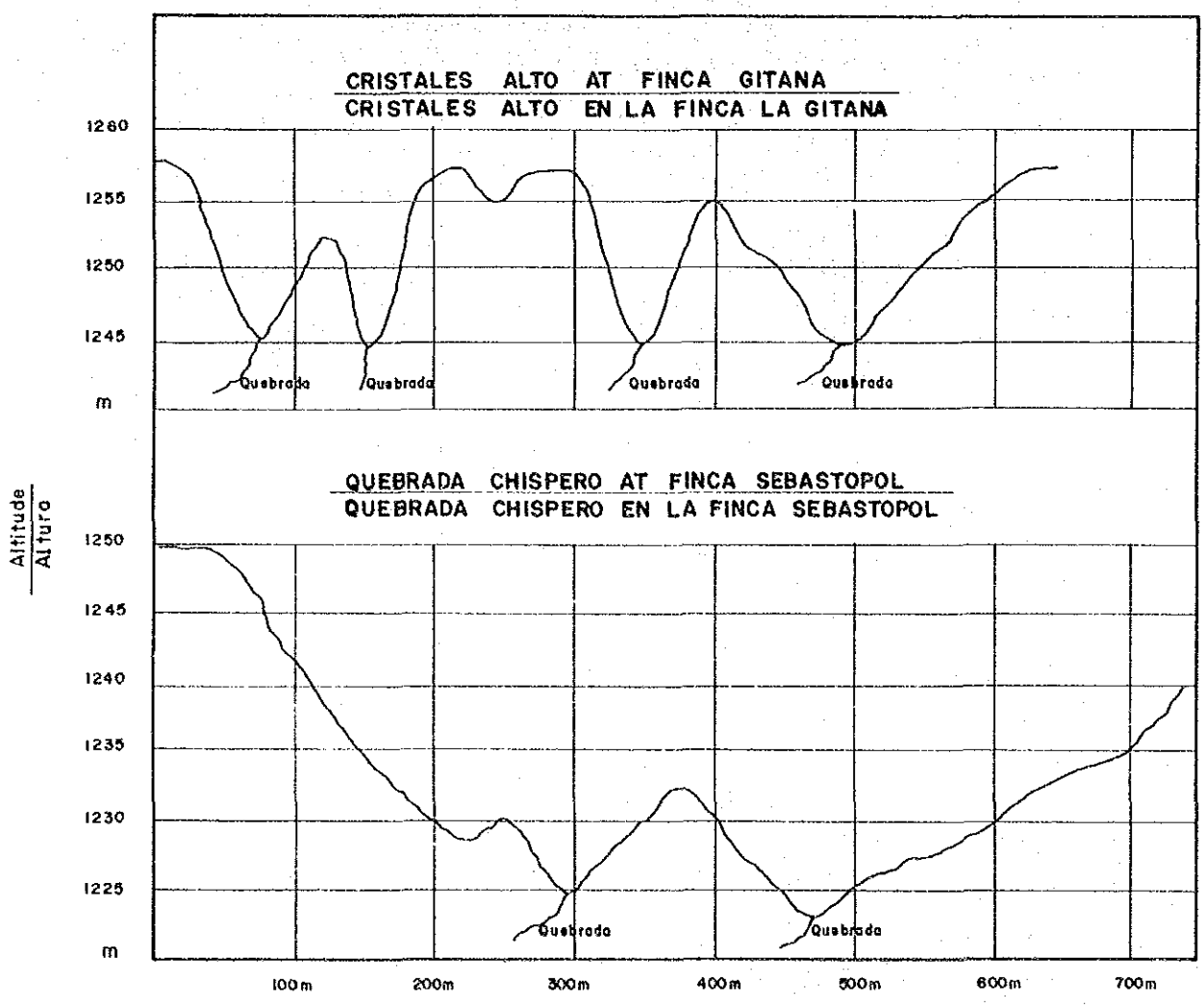


Fig J.7.4.1 Comparison of Schematic Topographic Conditions

Composition of farm	Cultivation	Number	Number
	100 Ha or more	1	1
	- 50 Ha	-	3
	- 30 Ha	3	5
	- 20 Ha	2	3
	- 10 Ha	5	8
	- 5 Ha	9	8
	- 1 Ha	13	15
	Others	-	4
	Total	33	52
Coffee cultivation	Total :	820 Ha	1,067 Ha
		8.7% Cristales	11.3% Cristales
	Coffee area :	574 Ha	859 Ha
	:	8.1% of Cristales	12.1% of Cristales
	Ratio of coffee area	70%	area 80.5%
Infrastructure	Good condition of power and water supply Narrow 3-4m wide road without pavement, Possible driving only small jeep car,		Good condition of power and water supply 6-8m wide road without pavement, Possible driving 10 ton truck car,
Stream	Rich and rapid water flow, Narrow 1m wide,		Rich water flow, Very narrow and joints at the point 17km down stream of the Cristales
The other contaminants	Living waste water from castella, population 4,400, and 2 big scale leisure facilities are discharged to upstream of the Cristales		No big village and facilities

J.7.4.2 Decision of the pilot area

As a result of the selection, Q. Chispero-Tatabra area should be recommended as an excellent pilot area for river water quality improvement. This area will be shown on Fig. J.7.4.2 & J.7.4.3.

Table J.7.4.1 COFFEE FARMS IN Q. CHISPERO

NOMBRE DE LA FINCA	FICHA No.	AREA CAFE		PRODUCCION		TOTAL
		Tradicional	Caturra	Tradicional 80 @/Ha	Caturra 190 @/Ha	Arrobas
1. El Triángulo	0072		3.26		619.4	619
2. Germania	0113		3.76		714.4	714
3. Lindaraja-2	0108		7.62		1,447.8	1,448
4. El Horizonte	0107	0.97	1.66	77.6	315.4	393
5. La esperanza	0066		5.0		950	950
6. La Marielita	0105		3.5		665	665
7. La Esmeraldita	0112	2.9		232		232
8. El Guazimo	0102					
9. Oalermo	0103	3.1	1.14	248	216.6	465
10. Morelia	0064	8.55	14.41	684	2,737.9	3,422
11. El Balcón	0688		12.3		2,337	2,337
12. San Enrique	0069					
13. Alejandría	0068	2.51	7.48	200.8	1,421.2	1,622
14. La Palma	0695		14		2,660	2,660
15. El Rancho	0675		9.8		1,862	1,862
16. El Rocío	0747	1.68	7.70	134.4	1,463	1,597
17. Siuza Chiquita	0062		10		1,900	1,900
18. Montecarlo	0360					
19. Suiza	0361		38.86		7,383	7,383
20. La carmelita	0058					
21. La María	0056		23.73		4,508	4,509
22. El Prado	0059		15.62		2,968	2,968
23. Santa Lucía	0562		43.6		8,284	8,284
24. La Colonia	0076		43.54		8,272.6	8,273
25. La Primavera	0040		57.93		11,006.7	11,007
26. El Jordán	0073		18.6		3,534	3,534
27. La Pradera	0057		91.88		17,457	17,457
28. El Hatico	0565		9.5		1,805	1,805
29. El Brillante						
30. El Porvenir	0575		176		33,440	33,440
31. La Grecia			17.33		3,293	3,293
32. El Caimo	0746		5		950	950
33. Chía	0747		6.2		1,178	1,178
34. Sebastopal	0747		19.12		3,632	3,632

NOMBRE DE LA FINCA	FICHA No.	AREA CAFE		PRODUCCION		TOTAL
		Tradicional	Caturra	Tradicional 80 @/Ha	Caturra 190 @/Ha	Arrobas
35. El Convenio	0674		6.2		1,178	1,178
36. Las camelias	0642	1.26		100.8		101
37. Los Naranjos	0641					
38. El Porvenir			2.15		408.5	409
39. Mi Tesorito	0086		8		1,520	1,520
40. Galconda	0920		8.62		1,638	1,638
41. Sierra Leona	0932		3.93		747	747
42. San Antonio	0683		24		4,560	4,560
43. Lorena	0841					
44. Mi Refugio	0850					
45. El Ocaso	0921					
46. San diego	0052		19.25		3,657.5	3,658
47. La Esmeralda	0051		9.18		1,744.2	1,744
48. San Cayetano			11.74		2,231	2,231
49. Golconda Vieja			23.16		4,400	4,400
50. La Colina			24.58		4,670	4,670
51. La castellana			19.96		3,792	3,792
52. La Floresta			9.05		1,719.5	1,720
				1,677.6	159,286.7	160,967

Table J.7.4.2 COFFEE FARMS IN Q. CRISTALES ALTO

NOMBRE DE LA FINCA	AREA CAFE		PRODUCCION		TOTAL
	Tradicional	Caturra	Tradicional 80 @/Ha	Caturra 190 @/Ha	Arrobas
1. Los Angeles		27		5,130	5,130
2. La Bretaña		54.19		10,296	10,296
3. Balsora		21.5		4,085	4,085
4. Las Margaritas		12		2,280	2,280
5. El Zapata	1.2	2.1	96	399	495
6. El Guayabo	0.6	4	48	760	808
7. La Ribera		4.2		798	798
8. La Saporrita		3.8		722	722
9. El Recreo	3	2.09	240	397	637
10. La Cabaña	2.134		171		171
11. La cabañita	2.45		196		196
12. El Carmelo		3.8		722	722
13. El Vergel		1.33		253	253
14. La Esmeralda	0.85		68		68
15. La Esperanza		13.24		2,516	2,516
16. El Rin		38.26		7,269	7,269
17. La Herradura	10	5	800	950	1,750
18. La Esmeraldita		7.17		1,362	1,362
19. La esperanza	1.0	2.8	80	532	612
20. El Retiro		3		570	570
21. La Mesa	1.5	7	120	1,330	1,450
22. Villa Andrés (Crist.)	1	3.2	80	608	688
23. La Encanto	8.8		704		704
24. El Recreo	0.8	8.61	64	1,636	1,700
25. La Mariela	0.5	2	40	380	420
26. La Holanda		11.18		2,124	2,124
27. El Topacio	0.60	8.37	48	1,579	1,627
28. La Mesa		5.5		1,045	1,045
29. Villa Adriana		5		950	950
30. La Carmelita	2.86	2.98	229	566	795
31. Milán	8.97	6.31	717	1,199	1,916
32. La Mesita		4.0		760	760
33. El Cedrito		37		7,030	7,030
	46.264	306.63	3,701	58,248	61,949

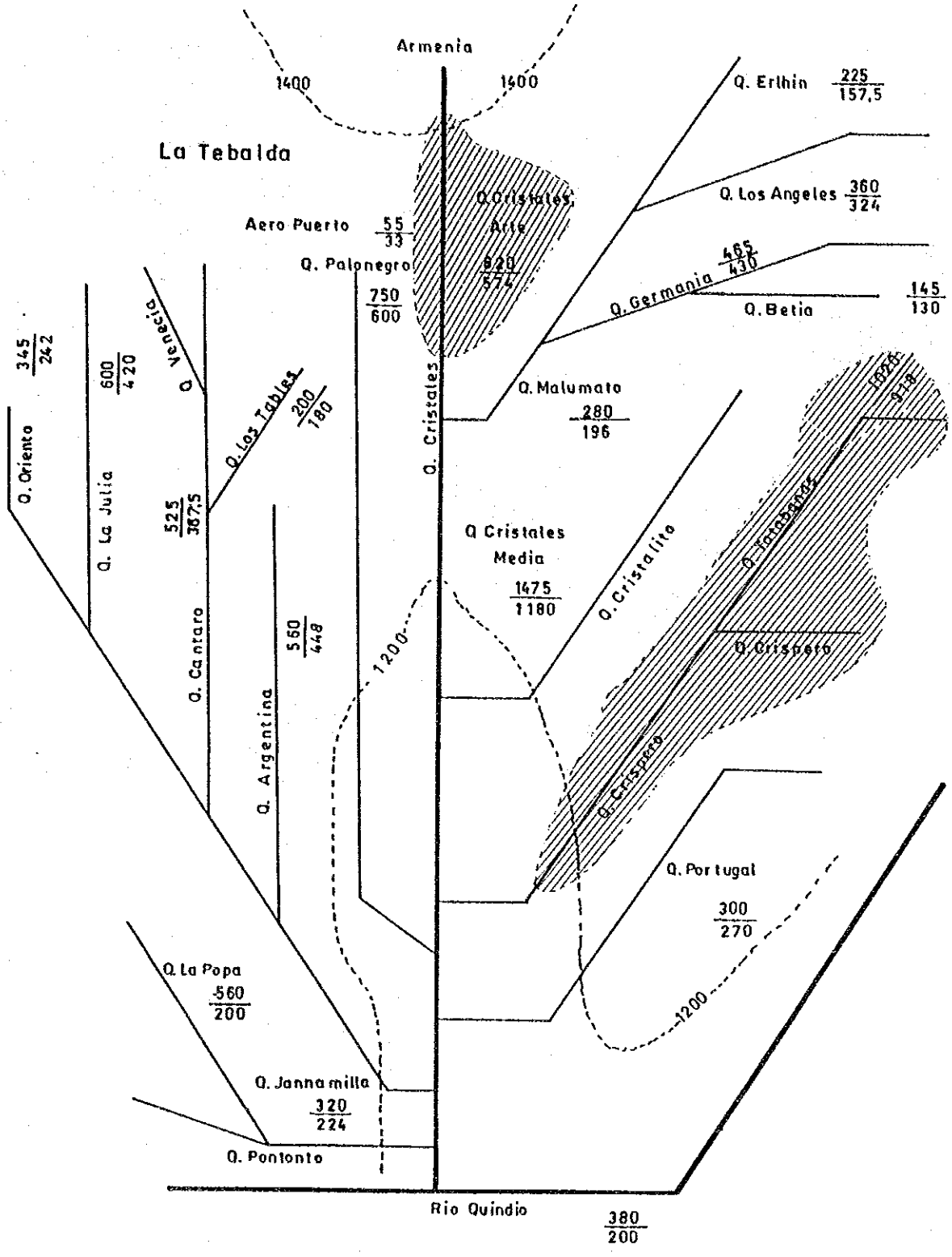


Fig J.7.4.2 Potential areas for pilot

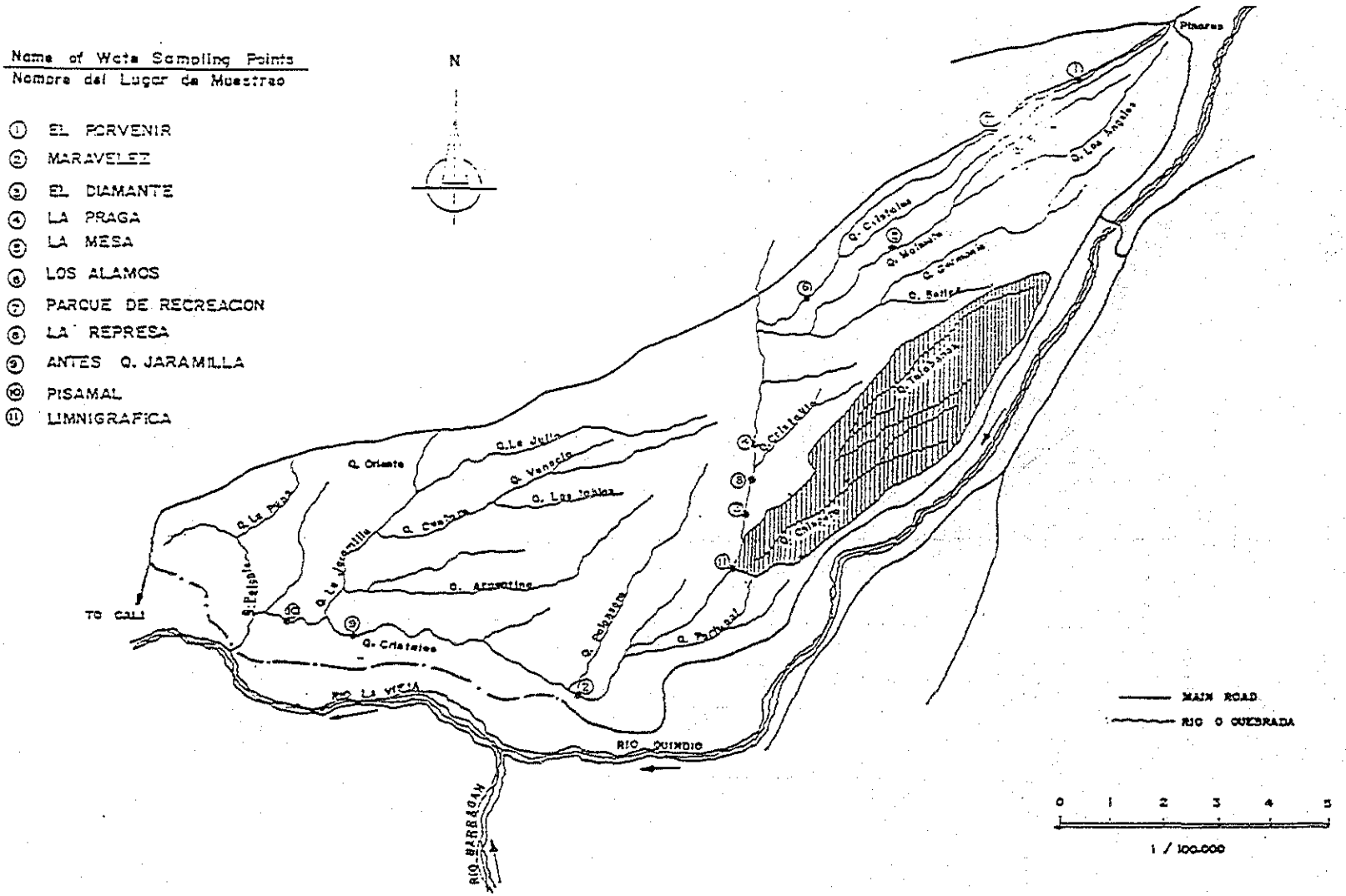


Fig. J.7.4.3 Location of Chispero Area

J.7.5 Selection of the pilot farms

J.7.5.1 Parameter of the selection

1) 1 (one) small size and 1 (one) medium size coffee farms
2) Locating on the stream without the other contaminants
3) In the Chispero basin
4) Easy understanding place of river water quality improvement and purification
5) Good road and traffic condition
6) To have the typical Cristales area's topographic conditions
7) Good identification of farm's awareness of pilot plant construction and maintenance

J.7.5.2 Decision of two (2) pilot farms

The required conditions of the candidates for two model plants ought to be satisfied by the items of J.7.6.1 and it is natural for the farms to select in the chispero Basin.

In addition to the above, the scale of the farm's location, the distance of between two farms, the effect of display and the preparation for accepting of farms were imposed as the selection of the site.

At first, the farms were restricted by means of (20-30 ha) and a small of (5-10 ha) scale but also were situated on the rise of small stream.

The result of the above studies, El Rocio and Sebastopl are satisfied by each condition.

The characteristics of two farms are:

	El Rocio	Sebastopol
Coffee cultivation	8 ha	25 ha
Altitude	1,253m a.s.l.	1,240m a.s.l
Topography	50mg gently slope to stream	15mg sharp and rugged slope to stream
Distance of each farm	350m	
Space	300m^2	600m^2
Location	Up stream of Chispero	Up stream of Chisipero
Acceptance	Positive understanding	Positive understanding

The contract for installation of coffee waste water treatments between 2 (two) farms and CRQ were completed on Oct. 1990.

J.7.6 The method of coffee waste water treatment in Chispero

It is necessary to compare the raw cost of several methods for coffee waste water treatment, especially between individual treatment by each farm's own system and the other centralized treatment systems.

J.7.6.1 The methods of coffee waste water treatment

1) Individual treatment by each farm's own plant
2) Centralized treatment

   a) Centralized collection of coffee cherry and processing by central factory with an incidental waste water treatment plant
   b) Waste water collection by piping net work
      - 1) on the road
      - 2) on the Quebrada
   c) Combination system of above mentioned methods

J.7.6.2 The attentions for treatment method selection

1) Farm's acceptance to central processing of coffee cherry.
2) Turning unemployed facility of farm's own present-coffee processing plant.
3) Money source to operational expense of waste water treatment.
4) Continuous maintenance of waste water collection piping net works.
5) Continuous maintenance of waste water collection by tank cars.
6) Technical adaptation of piping net work to high content suspended solid waste water.
7) Extension of existing road and newly construction.
8) Economical and efficiency of each treatment methods.

J.7.6.3 Waste water collection by tank car

To avoid a long piping net work, collection by tank car method should be investigated as another plan.

1) Characteristics of the tank collection

   a) Necessary to waste water storage tank for one day.
   b) Required small size tank can to fit road conditions.
   c) Necessary various expense.
      - 1) Construction of new waste water treatment plant
      - 2) Extension of existing road
      - 3) Employment of car drivers
      - 4) Treatment of car drivers in off season
      - 5) Car fuel and lubricant
      - 6) Car repairing and maintenance
      - 7) Car base facilities such as work shop oil supplier, cleaning and parking space etc.

2) Condition of waste water collection by car

a) Required cars number

A networking rate per one car	Collecting 4 times/day = 25 Ha equivalent
Coffee cultivation in Chispero	859 Ha
Required 2.5m^3 car	35

b) Car driver 40 persons

c) One day driving distance per car 50km
One day driving total distance 1,750km
Fuel consumption per car220 l

d) Water consumption car cleaning 17.5m^3

e) Required space for car base 1,000m^2

f) Administration building300m^2

g) Car work shop 30m^2

h) Car cleaning facilities 30m^2

3) Cost of waste water collecting car

Specification

Tank volume	2,500 l	1
Intake pump	10m^3/HR	1
3 ton truck (camionet)		1

Cost

Camioneta (Chevolet 300)	11,182,000
Moto bomba	250,000
Tanque	455,000
Adewacion	200,000
	C$ 12,087,000
	(US$ 22,000)

1990 - September

4) Initial and maintenance cost for Chispero area

a) Initial cost

35 Tank cars	423,045,000
Administration bed	30,000,000
Car work shop	45,000,000
Oil feeding system	3,000,000
Car cleaning system	5,000,000
Land for car base	10,000,000
	C$ 516,045,000
	(US$ 938,263)

b) Maintenance cost (a year)

	10 persons	36,000,000
Expense to drivers	40 persons	96,000,000
Lubricants		10,560,000
Maintenance material		25,800,000
Miscellaneous		3,000,000
		C$ 171,360,000
		(US$ 311,563)

J.7.6.4 Piping net work cost in round figure

A case installation along the road

1) Initial cost

a) Facilities and piping work

Piping material

75 mmø	12,400m	23,590,000
100 mmø	8,200m	23,200,000
150 mmø	7,600m	44,050,000
200 mmø	6,100m	50,400,000
250 mmø	1,550m	18,700,000
	35,850m	C$ 159,940,000

Joint pit

75 - 100m/m	100	3,700,000
150 - 200m/m	70	3,500,000
250m/m	10	700,000
	180	C$ 7,900,000

Booster pump station

Station	2	1,000,000
Booster pump	4	1,600,000
		C$ 2,600,000

Pumping facilities of each farms

Pump	52	10,400,000
Pump pit	52	1,040,000
		C$ 11,440,000

b) Installation and others

Escavation and reclaim

Piping	15,800m^3	14,220,000
Pit	500m^3	450,000
Station	100m^3	90,000
Reclaim		8,200,000
		C$ 22,960,000

Piping installation

Piping			10,800,000
Electrical work			1,500,000
		C$	12,300,000
Surveying, measurement & Designing	6 months		6,000,000
		C$	6,000,000
Miscellaneous expense			22,000,000
AIU	25%		61,285,000
		C$	83,285,000
	Total	C$	306,425,000
		(US$	557,136)
2) Annual maintenance cost	3%	C$	9,192,750
		(US$	16,714)

J.7.6.5 Piping net work cost in round figure

A case installation on Quebradas.
We may have some difficulties to installation work in this case due to the land and topographic conditions.

1) Initial cost

a) Facilities and piping work

Piping material

75mmø	17,700m		33,720,000
100mmø	11,900m		33,580,000
150mmø	4,900m		28,140,000
200mmø	3,800m		31,420,000
250mmø	3,900m		47,450,000
	42,300m	C$	174,310,000

Joint pit

75 - 100m/m	150		5,400,000
150 - 200m/m	50		2,500,000
250m/m	20		1,400,000
	220	C$	9,300,000

Booster pump station

Station	4		2,000,000
Booster pump	8		3,200,000
		C$	5,200,000

b) Installation & Reclaim

Escavation & reclaim

Piping	18,000m^3		16,200,000
Pit	300m^3		270,000
Station	200m^3		180,000
Reclaim			15,000,000
		C$	31,650,000

Piping installation

Piping			16,200,000
Electrical work			1,000,000
		C$	17,200,000
Surveying, measurement & designing	8 months		8,000,000
		C$	8,000,000
Miscellaneous expense			25,000,000
AIU	25%		67,665,000
		C$	92,665,000
	Total	C$	338,325,000
		(US$	615,136)
2) Maintenance cost (a year)	3%	C$	10,149,750
		(US$	18,454)

J.7.6.6 Centralized cherry collection

This system is necessary to

1) Dumping cars for cherry
2) Centralized coffee processing factory
3) Centralized waste water treatment plant

J.7.6.7 Individual treatment by each farms

1) 52 farms plant initial cost	C$377,000,000 (U$685,450)
2) Annual maintenance cost	C$7,550,000 (U$13,700)

J.7.7 System flow of pilot plants

Pilot plants are designed by 4 types according to the farms size.
Fig. J.7.7.1 – J.7.7.4 and Table J.7.7.1 – J.7.7.4 show the each system flow.

4 different types of coffee waste water pilot plants are

1) For HACIENDA or large scale farms
2) For 11 – 30 Ha scale farms
3) For 6 – 10 Ha scale farms
4) For 1 – 5 Ha scale farms

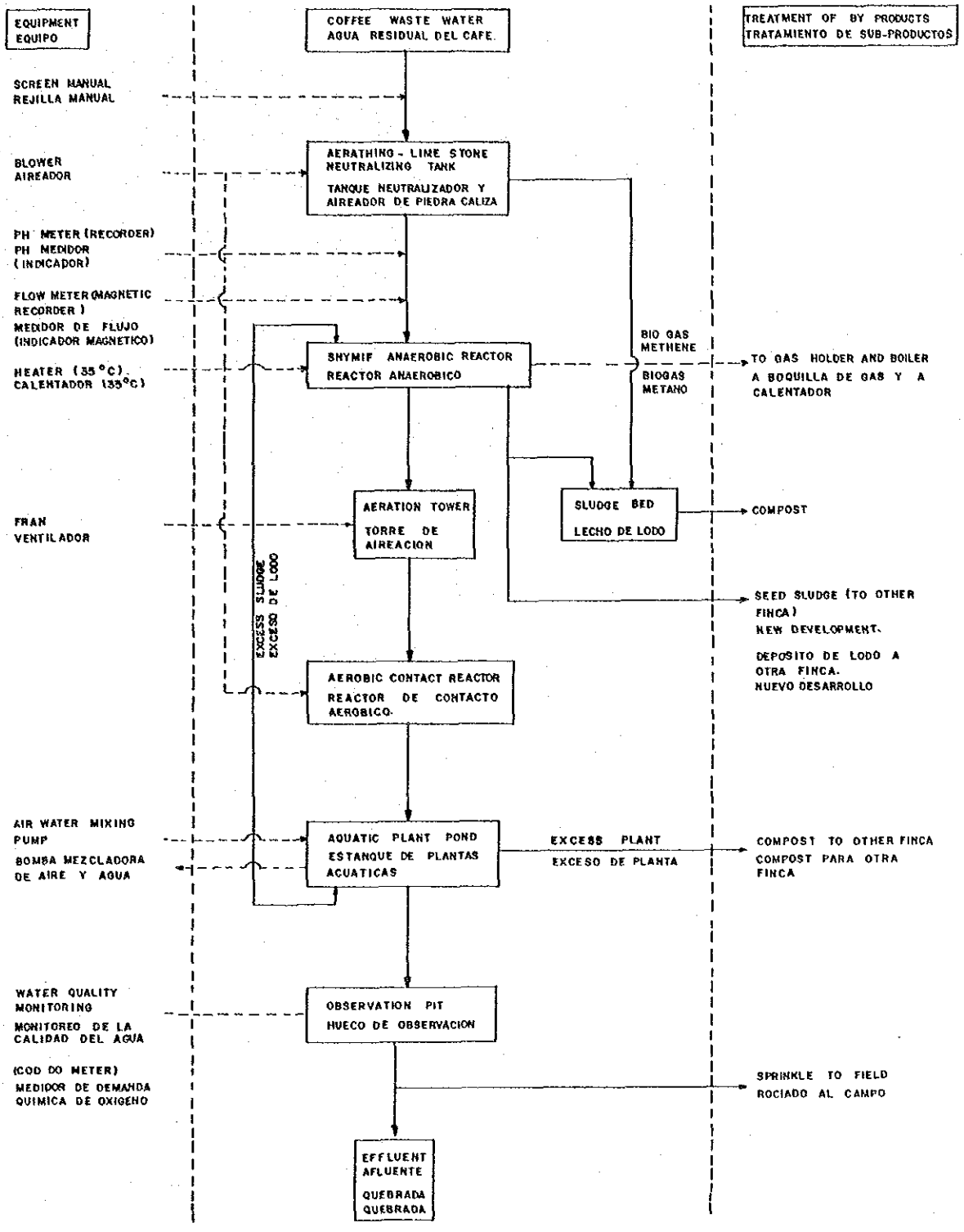


Fig. J.7.7.1 Schematic Flow of Coffee Waste Water Treatment for Hacienda

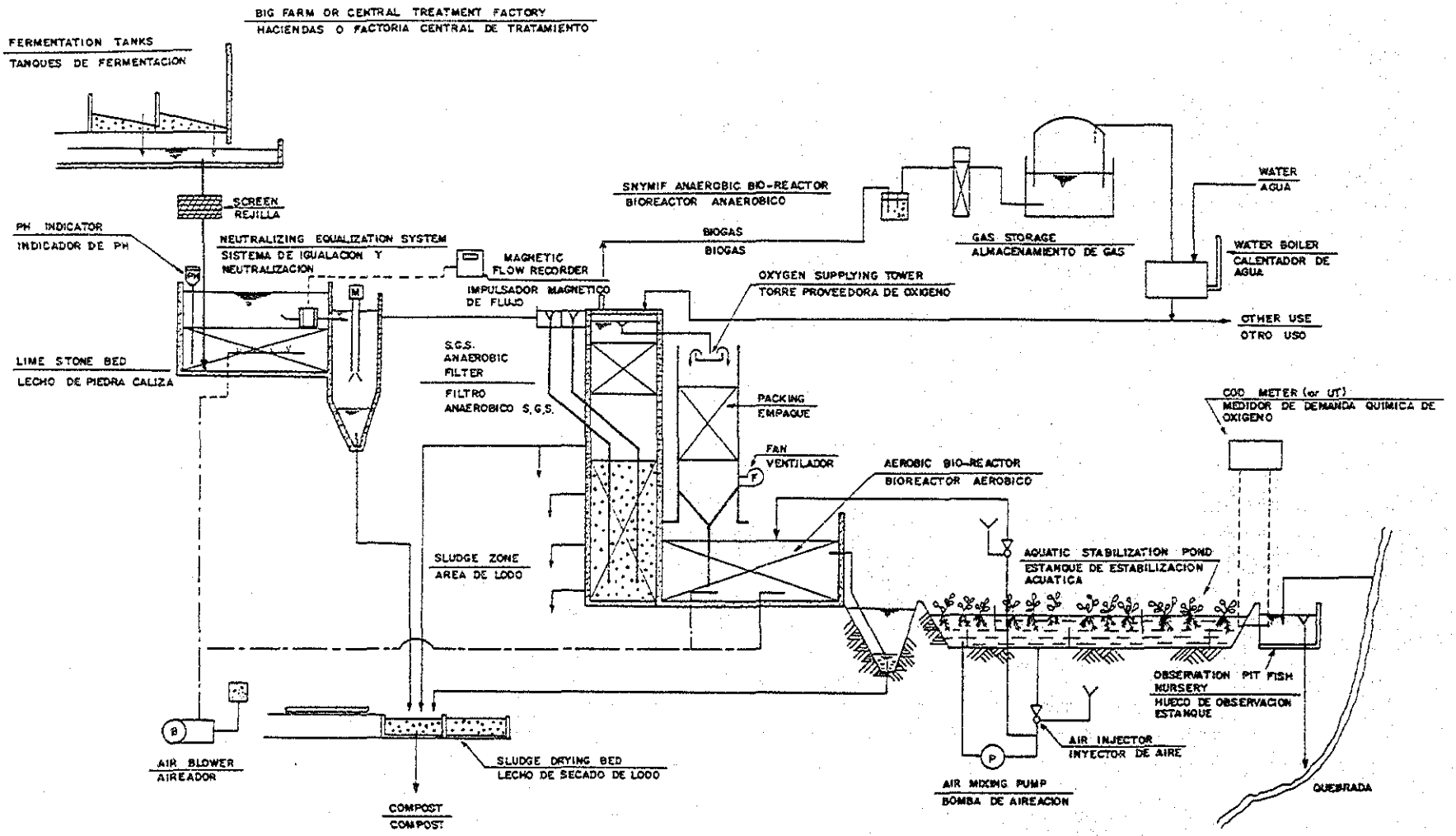


Fig. J.7.7.2 Coffee Waste Water Treatment Method for Hacienda

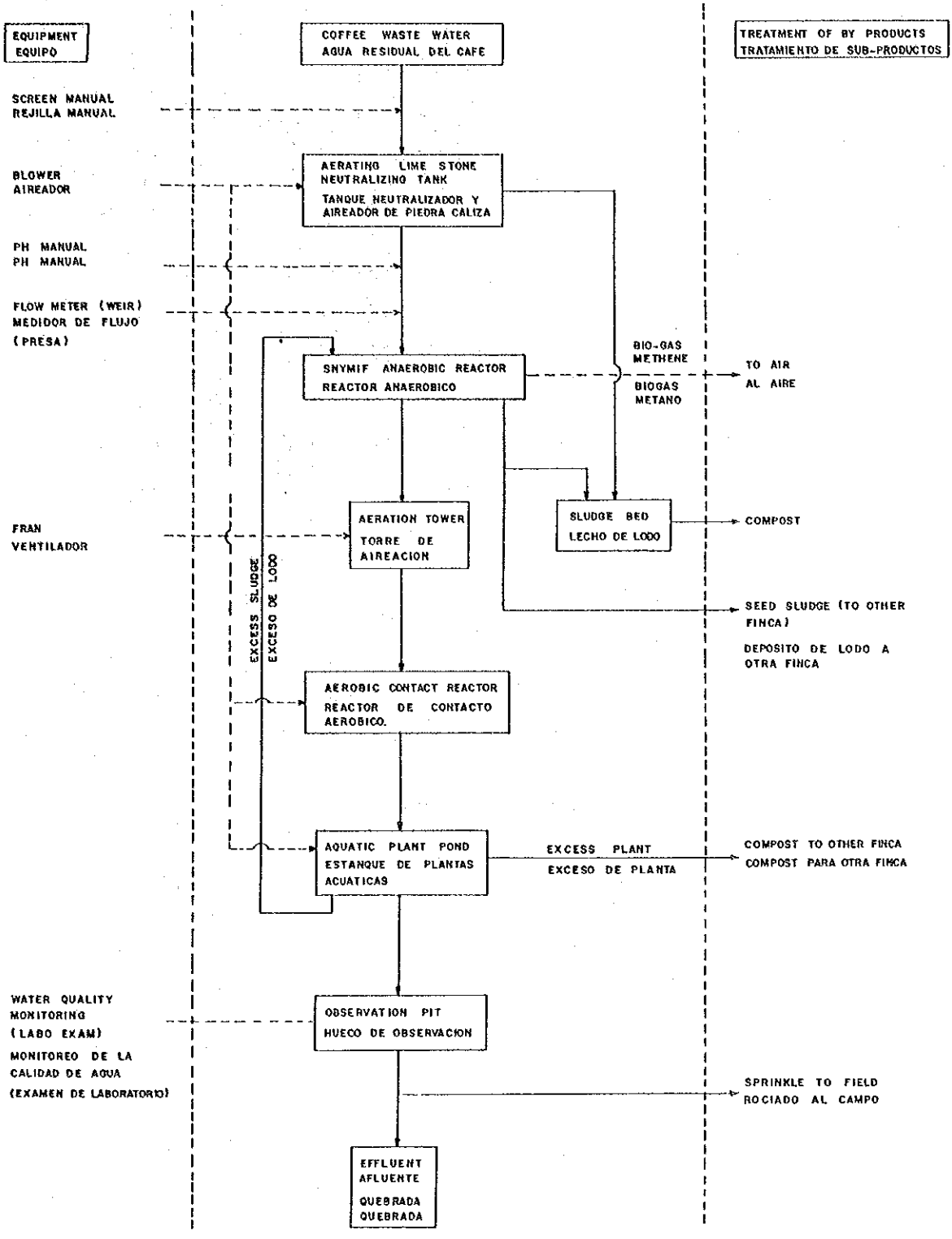


Fig. J.7.7.3 Schematic Flow of Coffee Waste Water Treatment for 20-30 ha Farm

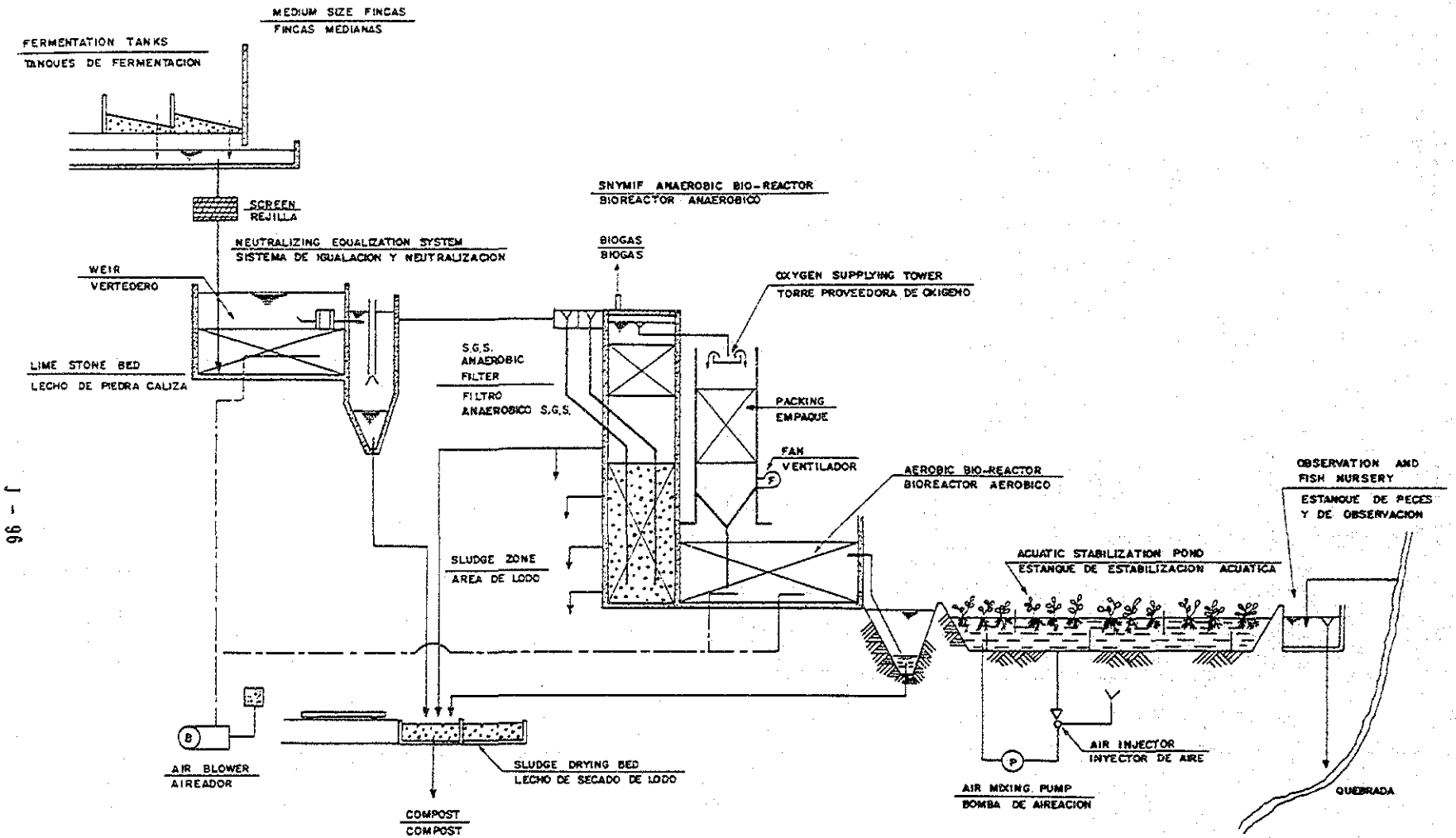


Fig. J.7.7.4 Coffee Waste Water Treatment Method for 20-30 ha Farm

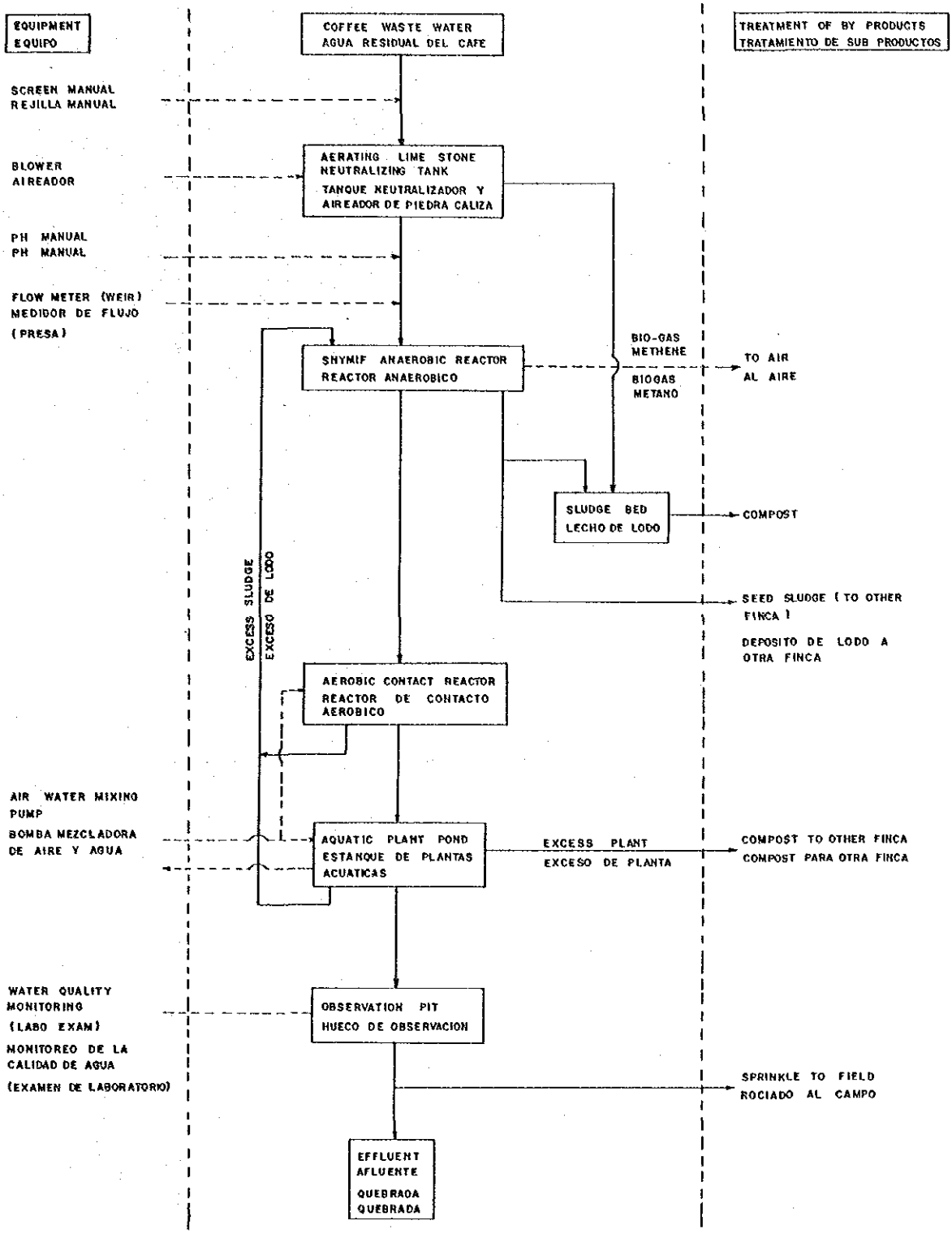


Fig. J.7.7.5 Schematic Flow of Coffee Waste Water Treatment for 6 - 10 ha Farm

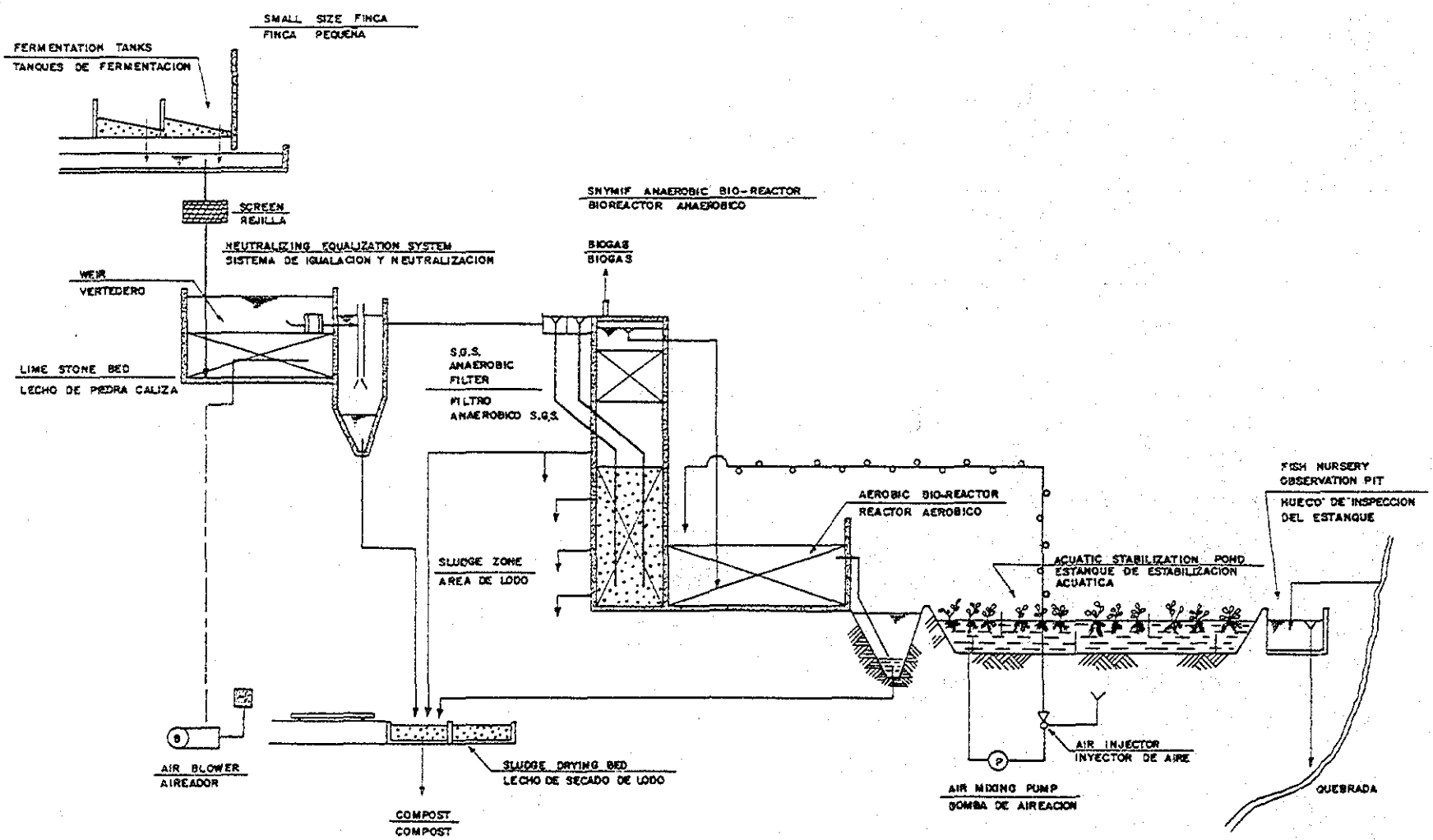


Fig. J.7.7.6 Coffee Waste Water Treatment Method for 6-10 ha Farm

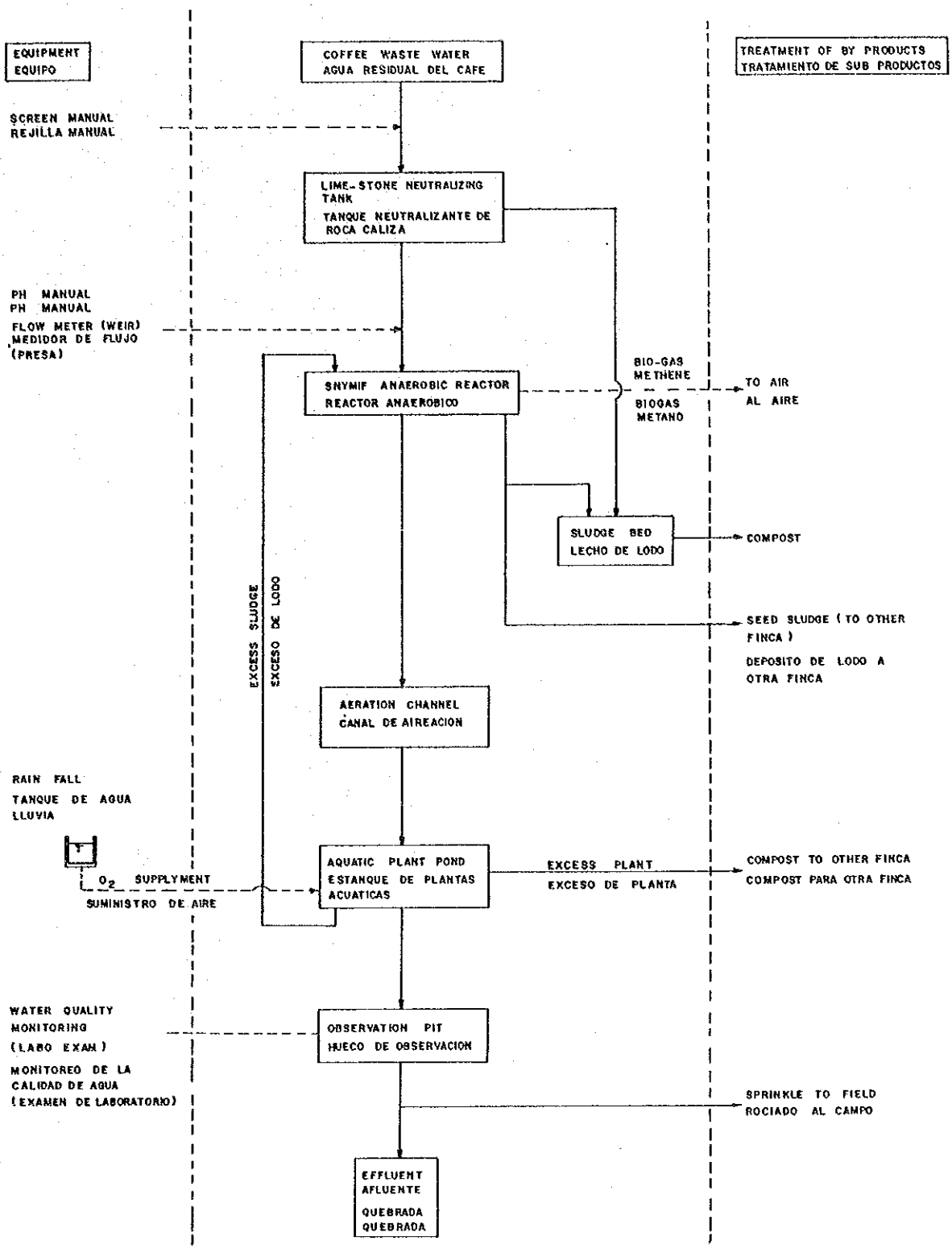


Fig. J.7.7.7 Schematic Flow of Coffee Waste Water Treatment for 1 - 5 ha Farm

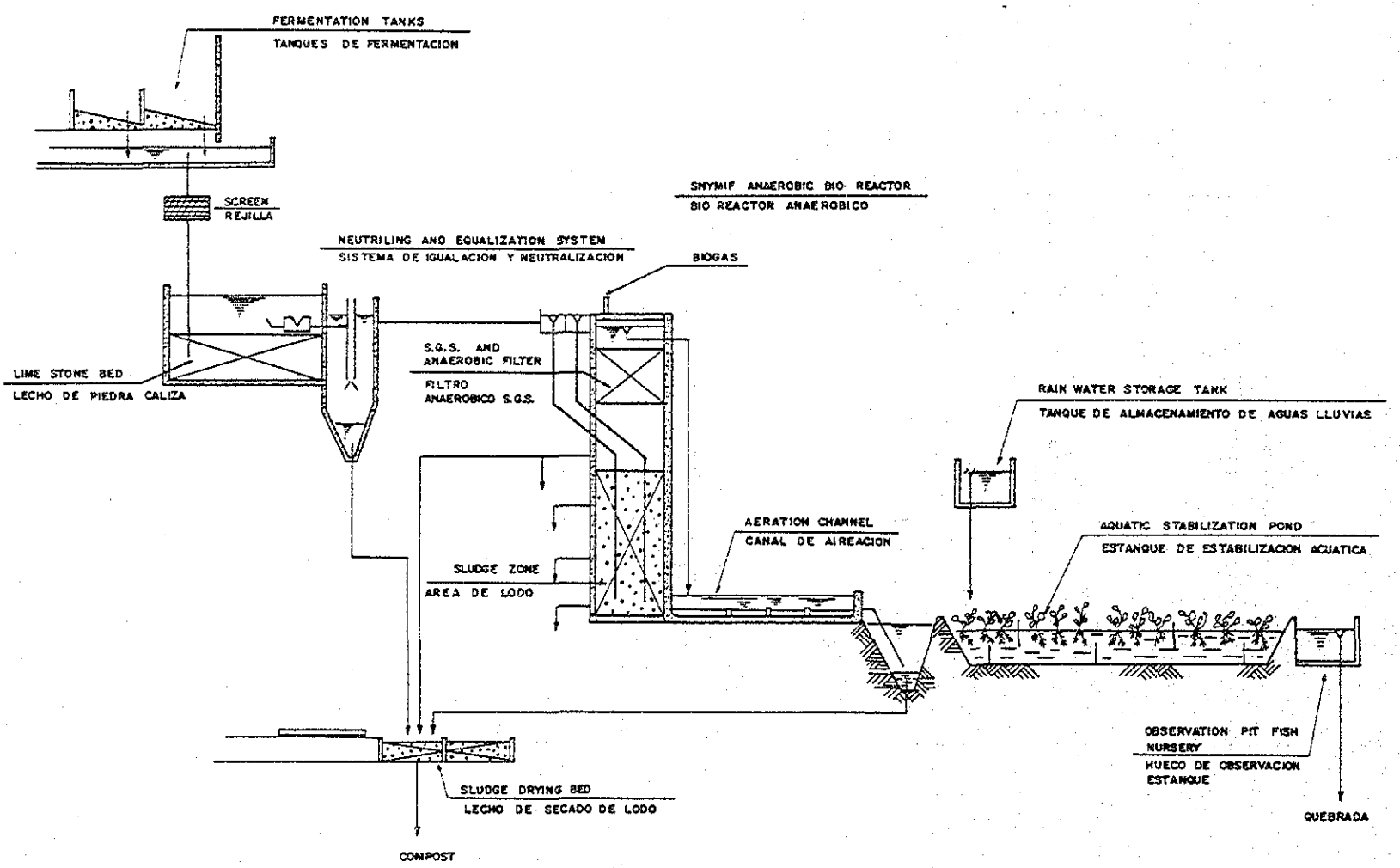


Fig. J.7.7.8 Coffee Waste Water Treatment Method for 1-5 ha Farm

J.8 MODEL PLANT FOR COFFEE WASTE WATER TREATMENT

J.8.1 General

J.8.2 Result of Test Operation

J.8.3 Technical Specification

J.8.3.1 Technical Specification for Model Plant for 25Ha Coffee Farm (SEBASTOPOL)

J.8.3.2 Technical Specification for Model Plant for 8Ha Coffee Farm (EL ROCIO)

J.8.3.3 Technical Specification for Construction Work

J.8.4 Operation Manual for Model Plant

J.8.1 General

In the coffee waste water model plants of El Rocio (8ha) and of Sebastopol (25ha), acceptance of waste water was started in the beginning of April due to the coffees' delay in maturing, which is considered to be attributed to abnormal weather. Results of water quality analyses for the two farms carried out four times respectively are as follows.

: The pH values of the raw water were around pH 4 and those of the treated water were above pH 7 always maintained neutral.

: The removal rate of chemical oxygen demand (CODcr) are shown below.

Sampling place of treated water	CODcr removal rate
Effluent part of anaerobic reactor	70 - 80%
Primary stabilization pond	more than 90%

Although a removal rate at an effluent part of the final stabilization pond (the tertiary pond) indicated more than 98%, this rate is only a reference, because this rate was affected by spring water used for leakage tests

: There is almost no difference between the water quality of upstream water in the discharged river and that of downstream.

J.8.1.1 Harvest of Coffee Cherries and Coffee Beans Production

(1) Harvest

The model plants were constructed at the sites with an elevation around 1,200m where usual travieza (sub-harvest season) is from March to May (3 months), however, maturation of coffee cherries managed to start at the beginning af April this year, and processing of coffee beans come to be carried out once on twice a week. Maturation of coffee beans is considered to be related with rainfall, and according to coffee farms travieza is from April to the end of June and they anticipated that the harvest of June may be the highest.

(2) Coffee beans production

Matured coffee cherries harvested in a day are pulped within the day and fermented in the fermentation tank for 5 - 6 days, which is the longest, in the process of coffee beans production during low harvest period. In order to avoid degradation of the beans during fermentation soak water for beans is changed to new fresh spring water every day.
During pulping, a few spring water added into the pulping machine is emitted as pulping waste water.
Fermented beans in the tank are conveyed by the third pouring water aiming at the second washing, cleaning and conveying at the same time to the drying process in the next day of when the fermentation tank is almost filled with pulped beans. By the three time use of water coffee processing waste water is generated, and the waste water is thick in the beginning and dilute in the end. Volume of coffee processing waste water in one processing does not depend on the harvest but on the capacity of the facility, on the other hand the frequency of processing depends on the harves.

J.8.1.2 Coffee Processing Waste Water

(1) Volume of waste water

As mentioned in J.8.1.1 (2) (Coffee beans production), there are three kinds of waste water as follows.

a) Small amount of waste water during pulping — Approx. 100 l/hr./pulping machine

b) Waste water exchanged with fresh water in the fermentation tank

	Capacity of fermentation tank/day
8 Ha farm, El Rocio	1.4m^3
25 Ha farm, Sebastopol	6.0m^3

c) Fermented beans washing waste water

8 Ha farm, El Rocio — 5.5m^3/washing

25 Ha farm, Sebastopol — 23.0m^3/washing

(2) Volume of waste water discharged from model plant farms

El Rocio — 5.5m^3/375kg-day beans/processing, 14.7 l/kg·dry beans

Sebastopol — 26.4m^3/1,000kg-day beans/processing, 26.4 l/kg·dry beans

Total volume of the treated waste water during test operation is as follows.

El Rocio — 45.5m^3/25 days

Sebastopol — 101.8m^3/25 days

(3) Quality of waste water

Quality of waste water during test operations is as follows.

- CODcr (mg/l)
  - El Rocio — 45,360 (Max.) - 8,950 (Min.)
  - Sebastopol — 23,630 (Max.) - 5,740 (Min.)
- pH
  - El Rocio — 3.58 - 4.30
  - Sebastopol — 3.62 - 3.86

J.8.1.3 Preparatory Works for Test Operation

(1) Seed sludge preparation

In order to accelerate the commencement of operation, seed sludge was obtained from an anaerobic lagoon of Zaragza at Cartago city in Valle department.
The sludge was chemically treated after taken from the lagoon, concentrated to water content of 93.5% and packed into anaerobic bio-reactors.

	Original volume of sludge	Volume after chemical treatment
El Rocio	$10m^3$	$2m^3$
Sebastopol	$28.5m^3$	$5.7m^3$

540g of polymer was used against diluted sludge of $38.5m^3$ in total for sludge preparation. This chemical treatment is performed only one time in principle.

(2) Aquatic plant

An aquatic plant, water hyacinth (Buchon de aqua), indigenous to South America was obtained from a swamp at Tapao in Quindio. 650kg of this plant without water was taken and put into the stabilization pond.

	Amount of water hyacinth
El Rocio	150kg
Sebastopol	500kg

The above amount of the plant is one third of the designed amount considering its rapid growth.

(3) Limestone for neutralization

Limestone with calcium carbonate content ratio of above 80% was obtained from mine at a suburb Cali city in Valle department.
Packing volume of the limestone to the neutralization tanks is as follows.

El Rocio	5.5 ton
Sebastopol	16.0 ton

Above quantities are for 2.5 years' use, derived from theoretical calculation, and limestone of 0.5 year's use for each plant was stored in bankers as spare.

J.8.2 Results of Test Operation

J.8.2.1 Test operation period

After an operation using normal water, the acceptance of waste water was started from April 1, 1991.
Test operation using actual waste water was done for 25 days, and treated water quality of the two farms was analyzed four times respectively from April 16, 1991. The total number of analyzed sample amounts to 75 and the total number of items of water quality analysis amounts to 372. Characteristics and surrounding conditions of this period were as follows.

- There was almost no harvest, and coffee processing was done only twice in El Rocio and once in Sebastopol.
- The last ten days of the latter half of March corresponded to Semana Santa (Holy week before Easter Sunday), therefore it was almost holiday in those days throughout the country including farms.
- Coffee processing was managed to be commenced early in April, however, as outstanding in Sebastopol, daily harvest was so small that all harvested coffee cherries in a week were processed in a lump at the end of a week.

J.8.2.2 Subjects of water quality analysis

The following ten kinds of water in and out of the treatment process of the model plant became the subjects of the water quality analysis.

1. Raw water	(Coffee processing waste water)
2. Effluent water from neutralized water	(Neutralized waste water)
3. Effluent water from anaerobic reactor	(Anaerobic reactor treatment water)
4. Effluent water from aerobic sedimentation tank	(Aerobic reactor treatment water)
5. Water of the first stabilization pond	(Stabilization pond influent water)
6. Water in the middle part of stabilization pond	(Stabilization pond inner water)
7. Effluent water from stabilization pond	(Stabilization pond treated water)
8. Upstream water of discharged river from discharging point (El Rocio)	
9. Upstream water of discharged river from discharging point (Sebastopol)	
10. Downstream water of discharged river from discharging point (El Rocio & Sebastopol)	

J.8.2.3 Items of water quality analysis

CODcr and pH, the main items, and following ten items in total became the subject of the water quality analysis.

1. CODcr
2. BOD_5
3. pH
4. Acidity
5. Alkalinity
6. Phosphorus
7. Ammonia nitrogen

8. Total solid
9. Suspended solid
10. Volatile suspended matter

J.8.2.4 Result of analysis

Result of water quality analysis on April 25, 1991 are shown below as examples. It is found that raw water with low pH is treated into neutral.

a) pH fluctuation in each unit on April 25, 1991

Farm / Sampling water	Sebastopol	El Rocio
Coffee processing waste water	3.82	3.73
Effluent water from neutralized water sedimentation pit	6.40	5.12
Effluent water from anaerobic reactor	6.02	5.48
Effluent water from aerobic sedimentation tank	7.15	6.75
Water of the first stabilization pond	7.48	7.14
Water in the middle part of stabilization pond	6.94	7.60
Effluent water from stabilization pond	6.90	8.49
Upstream water of discharged river from discharging point	6.85	6.50
Downstream water of discharged river from discharging point	6.95	6.95

b) CODcr removal ratio

Farm / Sampling water	Sebastopol		El Rocio	
	CODcr	Removal ratio [VS raw water (%)]	CODcr	Removal ratio [VS raw water (%)]
Coffee processing waste water	23,630		45,360	
Effluent water from neutralized water sedimentation pit	14,410		19,150	
Effluent water from anaerobic reactor	4,180	82.3	7,600	83.2
Effluent water from aerobic sedimentation tank	3,840	83.7	6,350	86.0
Water of the first stabilization pond	840	96.4	1,410	96.9
Water in the middle part of stabilization pond	420	98.2	990	97.8
Effluent water from stabilization pond	120		690	
Upstream water of discharged river from discharging point	18		72	
Downstream water of discharged river from discharging point	8		8	

J.8.2.5 Evaluation and Discussion

(1) The Evaluation based on the test operation is as follows.

Water quality comparison among

1) the water quality of a river around El Diamante during the harvesting season of coffee (October),
2) the water quality of a river around El Diamante during non-harvesting season of coffee and
3) the water quality of downstream water, about 50m downstream from the discharging point, of the river (upstream of Chispero river) accepting treated waste water from the model plants

are as shown in Table 6-1. According to this comparison it is considered that the water quality of Chispero river after accepting treated waste water from the model plants is almost the same as that of non-harvesting period.

Table 6-1 Comparison of Main Quality of Water

River / Item	El Diamante 15km from upstream of Cristales river		Chispero (after accepting treated waste water)
	Harvesting period	Non harvesting period	Harvesting period
pH	6.38	6.70	7.16
CODcr (mg/l)	125	20	10
Acidity (mg/l)	14		12
Alkalinity (mg/l)	36	28	40

(2) Discussion

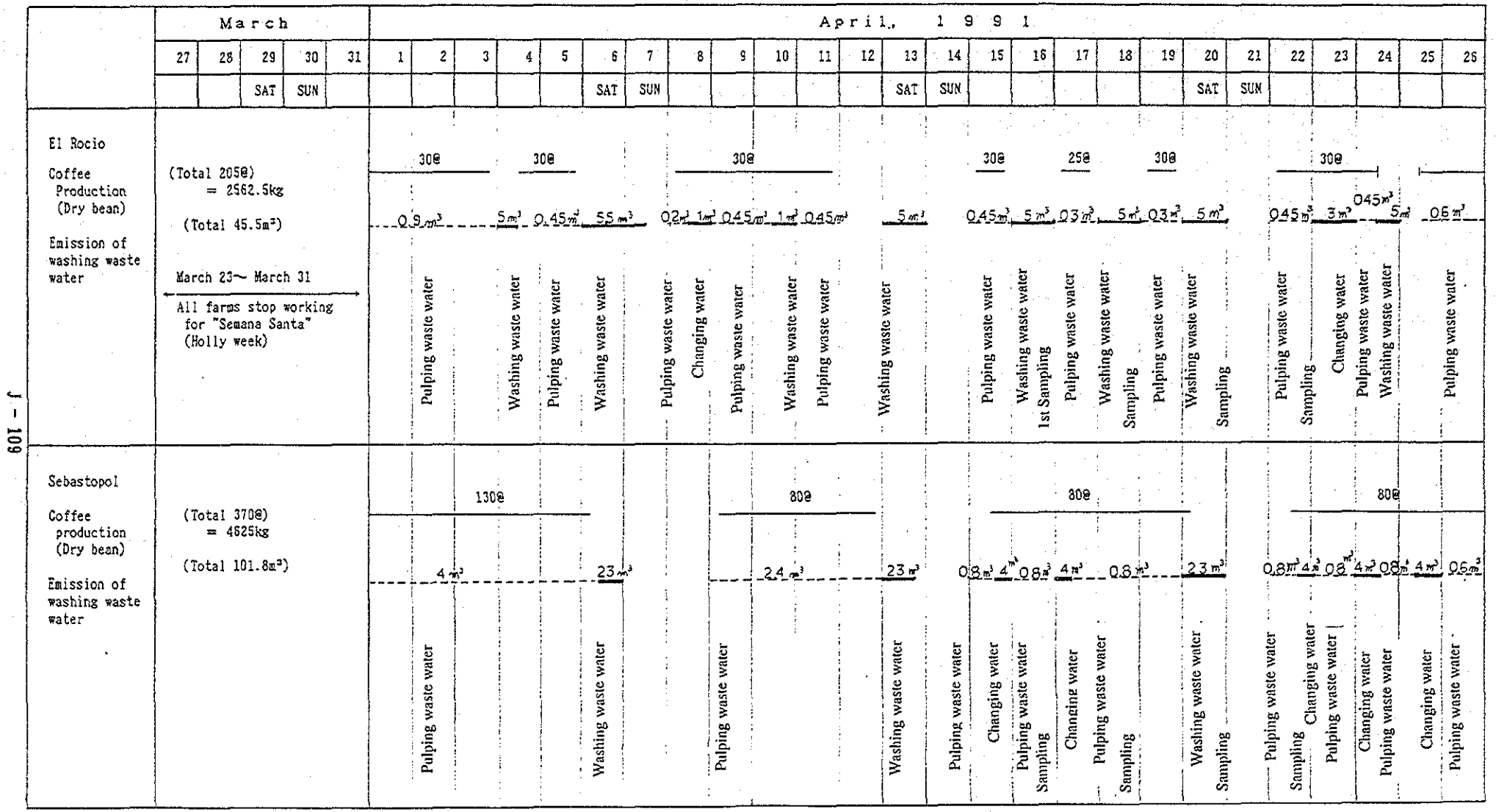
Based on the results obtained from 25 days of test operation the following discussions were performed.

- Coffee processing waste water was dense in the beginning and dilute in the end, however, CODcr values of waste water from the two pilot farms were thought to be considerably exceeding the anticipated average value of 10,000 mg/l as a result of accepting whole waste water.
- Neutralization tanks required periodical washing because of waste water with dense suspensoid, as expected.
- Verification test for the plants as biological treatment facilities requires observation throughout a year and a coping with changing conditions, which is highly expected to be carried out by CRQ's technical team who has succeeded the project.
- As to COD removal, the removal rate of aerobic reactor is low, and it will take another several weeks for aerobic organisms to be acclimated.
- Some attentions to be paid for designing coffee waste water treatment plant hereafter are as mentioned below, in relation to the scale of the waste water treatment facilities.
  - Coffee cultivation area and annual harvest of farms
  - Coffee processing facilities, especially capacity of fermentation tank
  - Method of coffee processing and of washing
  - Capacity of tank for washing

The above four items of coffee farms and their way of use are necessary to be studied individually.

- "SNIMIF", the adopted coffee waste water treatment facilities this time, mainly composed of high rate anaerobic bio-reactor has specially devised neutralization method, structure of anaerobic reactor and chemical treatment for seed sludge, structure of aerobic bio-reactor, stabilization pond, etc., and as to adoption of this method in the future, it is necessary for a decision waker to get some advice from the deviser of this method.

J.8.2.6 References (1) Discharging condition of coffee waste water from model plant farm



(2) Result of Analysis for Improved Quality of Waste Water by Model Plant EL ROCIO -(1)

FECHA: April 16 1991 HORA: OBSERVADOR: Jiménez

FINCA: EL ROCIO CAFE: BENEFICIADO: g Kg

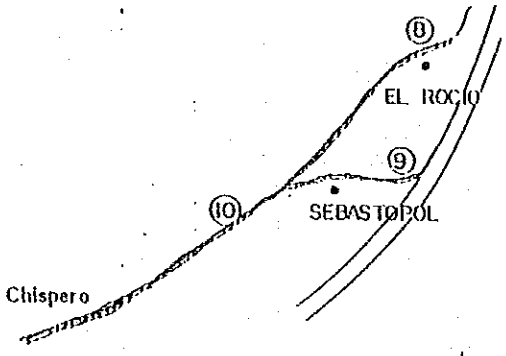
TIPO DE MUESTRA: CAUDAL: Lt/min M^3/Hora M^3/Dia

PARAMETROS

PUNTO		1	2	3	4	5	6	7	8	9	10	11
* DQO	mg/Lt	8950	8640	7370	5270	520		250	16			
+ DBOs	mg/Lt		5485	4920	4000	310		92				
* OXIGENO DISUELTO	mg/Lt											
* SOLIDOS TOTALES S.T.	mg/Lt		5910	5035	4930	795		280	75			
* SOLIDOS SUSPENDIDOS VOLATILES			765	575	105	130		65	15			
* SOLIDOS SUSPENDIDOS TOTALES			350	295	360	95		25	25			
* P.H.		4.30	5.20	5.14	5.74	8.27		10.03	6.20			
* ACIDEZ	mg/Lt		1230	1000	330				10			
* ALCALINIDAD	mg/Lt		235	920	1170	200		100	10			
+ NITROGENO AMONIACAL	mg/Lt		47.3	37.5	32.5	2.8		0.2	0.14			
+ NITROGENO KJELDAHL	mg/Lt											
+ FOSFORO TOTAL	mg/Lt		2.8	2.3	1.3	0.5		0.15	0.35			
+ COLIFORMES	NMP/100ml											
+ FECALES	NMP/100ml											

OBSERVACIONES: Los Parámetros Señalados con * se tomarán diariamente, los señalados con + se tomarán una vez por semana.

PUNTOS:
1- Aguas sin tratar
2- Agua Neutralizada y Sedimentada.
3- Salida del Sistema Anaeróbico.
4- Salida del Sistema de Aireación y Sedimentación.
5- Entrada a Laguna de Estabilización.
6- Interior de la Laguna.
7- Salida de la Laguna.
8, 9- Quebrada Arriba
10- Quebrada Abajo



OPINION:

(2) Result of Analysis for Improved Quality of Waste Water by Model Plant EL ROCIO -(2)

FECHA: April 18 1991 HORA: OBSERVADOR Jiménez

FINCA: EL ROCIO CAFE: BENEFICIADO: g Kg

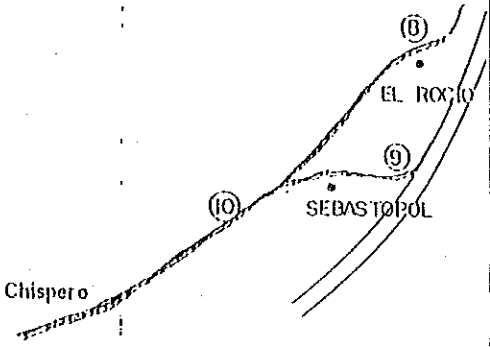
TIPO DE MUESTRA: CAUDAL: Lt/min M^3/Hora M^3/Dia

PARAMETROS

PUNTO		1	2	3	4	5	6	7	8	9	10	11
* DQO	mg/Lt	18800	18310	8790	7030	540	420	180				
+ DBOs	mg/Lt											
* OXIGENO DISUELTO	mg/Lt											
* SOLIDOS TOTALES S.T.	mg/Lt	9435	9010	4930	5245	725	610					
* SOLIDOS SUSPENDIDOS VOLATILES		2870	1745	350	305	80	150					
* SOLIDOS SUSPENDIDOS TOTALES		2985	1790	385	385	95	145					
* P.H.		3.60	4.50	5.05	5.78	8.04	8.51	9.75				
* ACIDEZ	mg/Lt	2130	1550	1350	400	100						
* ALCALINIDAD	mg/Lt			800	1420	250	200	90				
+ NITROGENO AMONIACAL	mg/Lt											
+ NITROGENO KJELDAHL	mg/Lt	230	182	91	63	7	5.6	2				
+ FOSFORO TOTAL	mg/Lt											
+ COLIFORMES	NMP/100ml											
+ FECALES	NMP/100ml											

OBSERVACIONES: Los Parámetros Señalados con * se tomarán diariamente, los señalados con + se tomarán una vez por semana.

PUNTOS:
1- Aguas sin tratar
2- Agua Neutralizado y Sedimentado.
3- Salida del Sistema Anaeróbico.
4- Salida del Sistema de Aireación y Sedimentación.
5- Entrada a Laguna de Estabilización.
6- Interior de la Laguna.
7- Salida de la Laguna.
8, 9- Quebrada Arriba
10- Quebrada Abajo



OPINION:

(2) Result of Analysis for Improved Quality of Waste Water by Model Plant EL ROCIO -(3)

FECHA: April 20 1991 HORA: OBSERVADOR: Jiménez

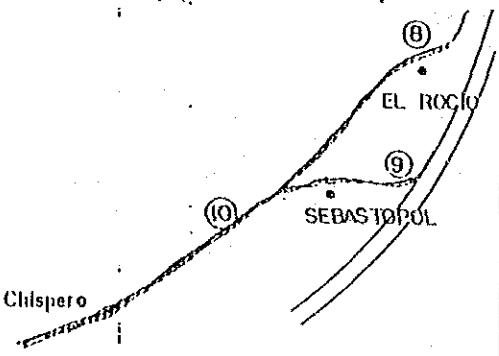
FINCA: EL ROCIO CAFE: BENEFICIADO: g Kg

TIPO DE MUESTRA: CAUDAL: Lt/min M^3/Hora M^3/Dia

PARAMETROS / PUNTO		1.	2	3	4	5.	6	7	8	9	10	11
* DQO	mg/Lt	18200	10900	11740	2200	2000	480	230				
† DBOs	mg/Lt											
* OXIGENO DISUELTO	mg/Lt											
* SOLIDOS TOTALES S.T.	mg/Lt											
* SOLIDOS SUSPENDIDOS VOLATILES												
* SOLIDOS SUSPENDIDOS TOTALES												
* P.H.		4.00	5.82	5.08	5.30	7.13	8.20	9.70				
* ACIDEZ	mg/Lt	445	600	1100	980	110	10					
* ALCALINIDAD	mg/Lt		2200	220	1000	260	220	100				
† NITROGENO AMONIACAL	mg/Lt											
† NITROGENO KJELDAHL	mg/Lt											
† FOSFORO TOTAL	mg/Lt											
† COLIFORMES	NMP/100ml											
† FECALES	NMP/100ml											

OBSERVACIONES: Los Parámetros Señalados con * se tomarán diariamente, los señalados con † se tomarán una vez por semana.

PUNTOS:
1- Aguas sin tratar
2- Agua Neutralizada y Sedimentada.
3- Salida del Sistema Anaeróbico.
4- Salida del Sistema de Aireación y Sedimentación.
5- Entrada a Laguna de Estabilización.
6- Interior de la Laguna.
7- Salida de la Laguna.
8, 9- Quebrada Arriba
10- Quebrada Abajo



OPINION:

(2) Result of Analysis for Improved Quality of Waste Water by Model Plant EL ROCIO -(4)

FECHA: April 23 1991 HORA: OBSERVADOR: Jiménez

FINCA: EL ROCIO CAFE: BENEFICIADO: g Kg

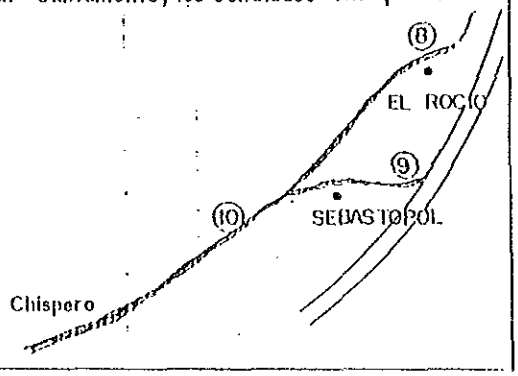
TIPO DE MUESTRA: CAUDAL: Lt/min M^3/Hora M^3/Dia

PARAMETROS

PUNTO		1	2	3	4	5	6	7	8	9	10	11
* DQO	mg/Lt	15360	19150	7600	6350	1410	990	690	12			
+ DBOs	mg/Lt											
* OXIGENO DISUELTO	mg/Lt											
* SOLIDOS TOTALES S.T.	mg/Lt											
* SOLIDOS SUSPENDIDOS VOLATILES												
* SOLIDOS SUSPENDIDOS TOTALES												
* P.H.		3.73	5.12	5.48	6.75	7.14	7.60	8.49	6.50			
* ACIDEZ	mg/Lt	2500	700	980	120	20	40		16			
* ALCALINIDAD	mg/Lt		1290	1560	1810	350	270	20	20			
+ NITROGENO AMONIACAL	mg/Lt											
+ NITROGENO KJELDAHL	mg/Lt											
+ FOSFORO TOTAL	mg/Lt											
+ COLIFORMES	NMP/100ml											
+ FECALES	NMP/100ml											

OBSERVACIONES: Los Parámetros Señalados con * se tomarán diariamente, los señalados con + se tomarán una vez por semana.

PUNTOS:
1- Aguas sin tratar
2- Agua Neutralizado y Sedimentado.
3- Salido del Sistema Anaeróbico.
4- Solido del Sistema de Aireación y Sedimentación.
5- Entrada a Laguna de Estabilización.
6- Interior de la Laguna.
7- Salida de la Laguna.
8, 9- Quebrada Arriba
10- Quebrada Abajo



OPINION:

(2) Result of Analysis for Improved Quality of Waste Water by Model Plant EL ROCIO -(5)

FECHA: April 25 1991 HORA: OBSERVADOR: Jiménez

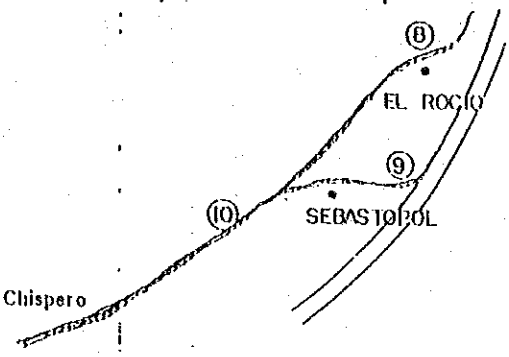
FINCA: EL ROCIO CAFE: BENEFICIADO: g Kg

TIPO DE MUESTRA: CAUDAL: Lt/min M^3/Hora M^3/Dia

PARAMETROS / PUNTO		1.	2	3	4	5.	6	7	8	9	10	11
* DQO	mg/Lt	26620	24220	13200	6080	590	560	360				
+ DBOs	mg/Lt											
* OXIGENO DISUELTO	mg/Lt											
* SOLIDOS TOTALES S.T.	mg/Lt											
* SOLIDOS SUSPENDIDOS VOLATILES												
* SOLIDOS SUSPENDIDOS TOTALES												
* P.H.		3.58	5.41	5.24	7.01	7.04	7.20	8.10				
* ACIDEZ	mg/Lt	2000	1800	1000	120	20	14	8				
* ALCALINIDAD	mg/Lt		2900	1530	580	280	270	210				
+ NITROGENO AMONIACAL	mg/Lt											
+ NITROGENO KJELDAHL	mg/Lt											
+ FOSFORO TOTAL	mg/Lt											
+ COLIFORMES	NMP/100ml											
+ FECALES	NMP/100ml											

OBSERVACIONES: Los Parámetros Señalados con * se tomarán diariamente, los señalados con + se tomarán una vez por semana.

PUNTOS:
1- Aguas sin tratar
2- Agua Neutralizada y Sedimentada.
3- Salida del Sistema Anaeróbico.
4- Salida del Sistema de Aireación y Sedimentación.
5- Entrada a Laguna de Estabilización.
6- Interior de la Laguna.
7- Salida de la Laguna.
8, 9- Quebrada Arriba
10- Quebrada Abajo



OPINION:

(2) Result of Analysis for Improved Quality of Waste Water by Model Plant SEBASTOPOL -(1)

FECHA: April 16 1991 HORA: OBSERVADOR: Fundación

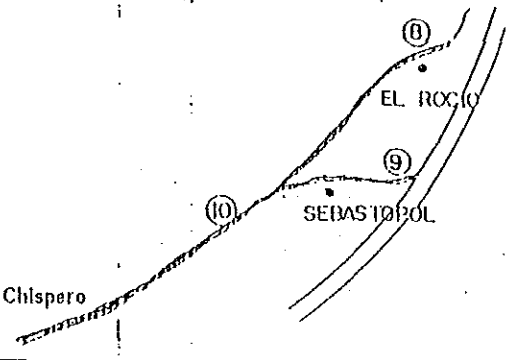
FINCA: SEBASTOPOL CAFE BENEFICIADO: g Kg

TIPO DE MUESTRA: CAUDAL: Lt/min M^3/Hora M^3/Dia

PARAMETROS / PUNTO		1	2	3	4	5	6	7	8	9	10	11
* DQO	mg/Lt	5740	5217	4700	3400	450	16	8				
+ DBOs	mg/Lt	3730	3110	2830	1810	257						
* OXIGENO DISUELTO	mg/Lt											
* SOLIDOS TOTALES S.T.	mg/Lt	4900	4090	4020	3050	700	130					
* SOLIDOS SUSPENDIDOS VOLATILES			1125	60	305	35						
* SOLIDOS SUSPENDIDOS TOTALES			1390	65	355	75						
* P.H.		3.85	6.30	5.80	7.01	7.54	6.29	8.82				
* ACIDEZ	mg/Lt		900	1000	910	250	30					
* ALCALINIDAD	mg/Lt		260	570	40	10	10	9				
+ NITROGENO AMONIACAL	mg/Lt		28	36.4	19.6	2.8	<0.1	<0.1				
+ NITROGENO KJELDAHL	mg/Lt											
+ FOSFORO TOTAL	mg/Lt		2.4	3.1	0.75	0.1	0.025	0.02				
+ COLIFORMES	NMP/100ml											
+ FECALES	NMP/100ml											

OBSERVACIONES: Los Parámetros Señalados con * se tomarán diariamente, los señalados con + se tomarán una vez por semana.

PUNTOS:
1- Aguas sin tratar
2- Agua Neutralizada y Sedimentada.
3- Salida del Sistema Anaeróbico.
4- Salida del Sistema de Aireación y Sedimentación.
5- Entrada a Laguna de Estabilización.
6- Interior de la Laguna.
7- Salida de la Laguna.
8, 9- Quebrada Arriba
10- Quebrada Abajo



OPINION:

(2) Result of Analysis for Improved Quality of Waste Water by Model Plant SEBASTOPOL -(2)

FECHA: April 18 1991 HORA: OBSERVADOR: Jiménez

FINCA: SEBASTOPOL CAFE BENEFICIADO: g Kg

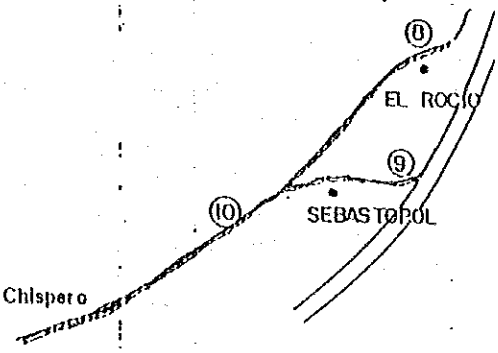
TIPO DE MUESTRA: CAUDAL: Lt/min M^3/Hora M^3/Dia

PARAMETROS

PUNTO		1	2	3	4	5	6	7	8	9	10	11
* DQO	mg/Lt	7820	7110	4170	3600	1350	230	180				
+ DBOs	mg/Lt											
* OXIGENO DISUELTO	mg/Lt											
* SOLIDOS TOTALES S.T.	mg/Lt	6890	5760	8030	3860							
* SOLIDOS SUSPENDIDOS VOLATILES				3845	64							
* SOLIDOS SUSPENDIDOS TOTALES				5510	130							
* PH		3.62	5.73	6.03	7.05	7.60	7.71	8.17				
* ACIDEZ	mg/Lt		750	100	60	20	10	4				
* ALCALINIDAD	mg/Lt		1400	1280	1290	690	200	110				
+ NITROGENO AMONIACAL	mg/Lt											
+ NITROGENO KJELDAHL	mg/Lt											
+ FOSFORO TOTAL	mg/Lt											
+ COLIFORMES	NMP/100ml											
+ FECALES	NMP/100ml											

OBSERVACIONES: Los Parámetros Señalados con * se tomarán diariamente, los señalados con + se tomarán una vez por semana.

PUNTOS:
1- Aguas sin tratar
2- Agua Neutralizada y Sedimentada.
3- Salida del Sistema Anaeróbico.
4- Salida del Sistema de Aireación y Sedimentación.
5- Entrada a Laguna de Estabilización.
6- Interior de la Laguna.
7- Salida de la Laguna.
8. 9- Quebrada Arriba
10- Quebrada Abajo



OPINION:

(2) Result of Analysis for Improved Quality of Waste Water by Model Plant SEBASTOPOL -(3)

FECHA: April 20 1991 HORA: OBSERVADOR: Fundación

FINCA: SEBASTOPOL CAFE: BENEFICIADO: g Kg

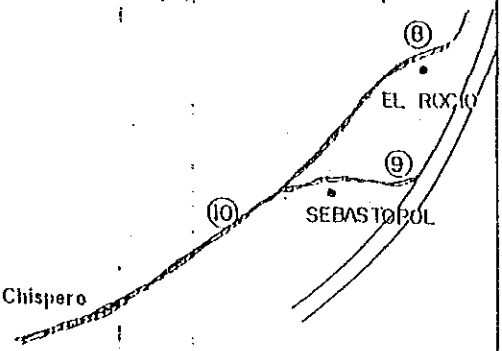
TIPO DE MUESTRA: CAUDAL: Lt/min M^3/Hora M^3/Dia

PARAMETROS

PUNTO		1	2	3	4	5	6	7	8	9	10	11
* DQO	mg/Lt	11220	10110	5090	3400	2050	240	110				
+ DBOs	mg/Lt											
* OXIGENO DISUELTO	mg/Lt											
* SOLIDOS TOTALES S.T.	mg/Lt											
* SOLIDOS SUSPENDIDOS VOLATILES												
* SOLIDOS SUSPENDIDOS TOTALES												
* P.H.		3.86	6.05	5.85	7.51	7.45	7.82	8.02				
* ACIDEZ	mg/Lt	670	580	420	80	60	30	20				
* ALCALINIDAD	mg/Lt	300	1480	1400		1180	200	160				
+ NITROGENO AMONIACAL	mg/Lt											
+ NITROGENO KJELDAHL	mg/Lt											
+ FOSFORO TOTAL	mg/Lt											
+ COLIFORMES	NMP/100ml											
+ FECALES	NMP/100ml											

OBSERVACIONES: Los Parámetros Señalados con * se tomarán diariamente, los señalados con + se tomarán una vez por semana.

PUNTOS:
1- Aguas sin tratar
2- Agua Neutralizada y Sedimentada.
3- Salida del Sistema Anaeróbico.
4- Salida del Sistema de Aireación y Sedimentación.
5- Entrada a Laguna de Estabilización.
6- Interior de la Laguna.
7- Salida de la Laguna.
8. 9- Quebrada Arriba
10- Quebrada Abajo



OPINION:

(2) Result of Analysis for Improved Quality of Waste Water by Model Plant SEBASTOPOL -(4)

FECHA: April 23 1991 HORA: OBSERVADOR: Fundam

FINCA: SEBASTOPOL CAFE: BENEFICIADO: g Kg

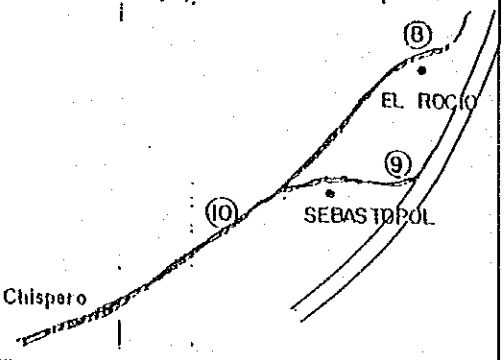
TIPO DE MUESTRA: CAUDAL: Lt/min M^3/Hora M^3/Dia

PARAMETROS

PUNTO		I	II	2	3	4	5	6	7	8	9	10	11
* DQO	mg/Lt	23680	14410	4180	384	840	240	120		18	8		
+ DBO5	mg/Lt												
* OXIGENO DISUELTO	mg/Lt												
* SOLIDOS TOTALES S.T.	mg/Lt												
* SOLIDOS SUSPENDIDOS VOLATILES													
* SOLIDOS SUSPENDIDOS TOTALES													
* P.H.		3.82	6.40	6.02	7.15	7.48	6.94	6.90		6.85	6.95		
* ACIDEZ	mg/Lt		140	290	50	10	14	10					
* ALCALINIDAD	mg/Lt		950	1340	1400	320	340	180		35	25		
+ NITROGENO AMONIACAL	mg/Lt												
+ NITROGENO KJELDAHL	mg/Lt												
+ FOSFORO TOTAL	mg/Lt												
+ COLIFORMES	NMP/100ml												
+ FECALES	NMP/100ml												

OBSERVACIONES: Los Parámetros Señalados con * se tomarán diariamente, los señalados con + se tomarán una vez por semana.

PUNTOS:
1- Aguas sin tratar
2- Agua Neutralizada y Sedimentada.
3- Salida del Sistema Anaeróbico.
4- Salida del Sistema de Aireación y Sedimentación.
5- Entrada a Laguna de Estabilización.
6- Interior de la Laguna.
7- Salida de la Laguna.
8, 9- Quebrada Arriba
10- Quebrada Abajo



OPINION:

(2) Result of Analysis for Improved Quality of Waste Water

by Model Plant SEBASTOPOL -(5)

FECHA: April 25 1991 HORA: OBSERVADOR: Jiménez

FINCA: SEBASTOPOL CAFE BENEFICIADO: g Kg

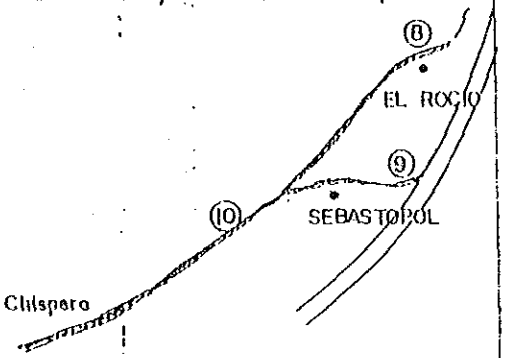
TIPO DE MUESTRA: CAUDAL: Lt/min M^3/Hora M^3/Dia

PARAMETROS

PUNTO		1	2	3	4	5	6	7	8	9	10	11
* DQO	mg/Lt	13600	12240	11300	3830	460	300	150		12	10	
+ DBOs	mg/Lt											
* OXIGENO DISUELTO	mg/Lt											
* SOLIDOS TOTALES S.T.	mg/Lt											
* SOLIDOS SUSPENDIDOS VOLATILES												
* SOLIDOS SUSPENDIDOS TOTALES												
* P.H.		3.67	5.90	5.92	7.30	7.20	7.10	7.47		6.08	7.16	
* ACIDEZ	mg/Lt		970	1005	70	48	32	20		48	12	
* ALCALINIDAD	mg/Lt									30	40	
+ NITROGENO AMONIACAL	mg/Lt											
+ NITROGENO KJELDAHL	mg/Lt											
+ FOSFORO TOTAL	mg/Lt											
+ COLIFORMES	NMP/100ml											
+ FECALES	NMP/100ml											

OBSERVACIONES: Los Parámetros Señalados con * se tomarán diariamente, los señalados con + se tomarán una vez por semana.

PUNTOS:
1- Aguas sin tratar
2- Agua Neutralizada y Sedimentada.
3- Salida del Sistema Anaeróbico.
4- Salida del Sistema de Aireación y Sedimentación.
5- Entrada a Laguna de Estabilización.
6- Interior de la Laguna.
7- Salida de la Laguna.
8. 9- Quebrada Arriba
10- Quebrada Abajo



OPINION:

martes, junio 18 de 1991 **LA PATRIA**

Gobierno japonés destaca planta piloto

FERNANDO ELIAS ACOSTA GONZÁLEZ
Redactor\LA PATRIA

Armenia

El gobierno del Japón representado en su embajador Chihiro Tsukada exteriorizó la satisfacción por la entrega de una planta piloto en la vereda El Caimo, jurisdicción de Armenia; destinada a establecer en toda su magnitud el problema de las "aguas mieles" del café y su posterior solución.

El diplomático quien estuvo acompañado de una comitiva que encabezó el director de la Corporación Autónoma Regional del Quindío (C.R.Q.), Julián Serna Giraldo; recordó que su gobierno ha concretado ayuda a este departamento de tiempo atrás, a través del Plan Maestro para el Desarrollo Agrícola Integral del Quindío y posteriormente con el Estudio de Factibilidad para ese mismo fin.

El señor Tsukada también aprovechó el acto de entrega en la finca Sebastopol, para destacar la positiva acogida y aprovechamiento que han tenido las ayudas de su país, a través de la C.R.Q.

El embajador se mostró confiado en que su gobierno continuará incrementando y estrechando las relaciones con las autoridades del departamento del Quindío.

FOTO ORLANDO QUICENO

Una comisión de funcionarios estatales y de la Corporación Autónoma Regional del Quindío (C.R.Q.) acompañó al embajador del Japón en Colombia, Chihiro Tsukada a conocer las investigaciones sobre purificación de aguas residuales del café, que se llevan a cabo en la vereda El Caimo de Armenia.

FOTO ORLANDO QUICENO

Con la presencia del embajador del Japón en Colombia, Chihiro Tsukada, se llevó a cabo el acto de inauguración de la planta de tratamiento de Aguas Mieles del café, en la finca Sebastopol, jurisdicción de El Caimo.

J.8.2.7 Recent operational results of coffee waste water treatment plant.

Result of pH variation at Sebastopol

The result of pH variation mentioned below shows desirable performance of each unit operation.
Low pH of coffee waste water rises steadly and reaches value 8.0 finally.

Sampling point (Sebastopol)	pH value
Raw waste water	3.5
Out let of neutralization tank	6.24
Inside of sedimentation pit	6.26
Out let of sedimentation pit	6.32
Anaerobic reactor	7.32
Aerobic reactor I	7.98
Aerobic reactor II	8.63
Inside of sedimentation pit	8.62
Primary part of stabilization pond	7.83
Middle part of stabilization pond	7.82
Final part of stabilization pond	7.65
Inside of inspection pond	8.0

Data from Sebastopol - C.R.Q. May 1991

Result of CODcr value removal at Sebastopol (I)

Sampling point	CODcr	Removal ratio VS waste water in the neutralization tank
Out let of neutralization tank	4475	
Out let of anaerobic reactor	2417	46%
Out let of aerobic reactor	1571	65%
Out let of stabilization pond	110	98%

Data from sebastopol C.R.Q. May 1991

Result of CODcr Value removal at Sebastopol (II)

Date		CODcr Value		Removal ratio
		Raw waste water	Treated water	VS raw waste
April	16	2920	29	99%
"	18	7110	213	97%
"	20	3470	104	97%
"	23	4410	529	88%
"	30	13350	400	97%
May	6	3200	1248	61%
"	9	3840	1344	65%
"	14	1840	1527	17%
"	21	3200	1440	55%

Data from Sebastopol C.R.Q. April - May

J.8.3 Technical Specification

J.8.3.1 Technical Specification for Model Plant for 25Ha Coffee Farm (SEBASTOPOL)

J.8.3.2 Technical Specification for Model Plant for 8Ha Coffee Farm (EL ROCIO)

J.8.3.3 Technical Specification for Construction Work

J.8.3.1 Technical Specification for Model Plant for 25Ha Coffee Farm (SEBASTOPOL)

1. General

The plant is designed for a coffee farm in Armenia, Quindio state of the Republic of Colombia considering circumstances of the said area.

Characteristics of the plant are as follows:

: Full system consists of facilities for neutralization, anaerobic treatment, aerobic treatment, stabilization pond and dehydration, including tertiary treatment.
: Lime-stone-aeration method is applied to the neutralization, which is expected to be safe and economical in its running cost for low-income farmers.
: Not conventional method as in the past but high technology of high speed treatment is applied to anaerobic reactor. The treatment is carried out by two steps, pre-agglomeration treated strong agglomerated anaerobic sludge zone and anaerobic contact filter in one reactor named "SNYMIF. The anaerobic contact filter also has a function to prevent the anaerobic sludge from being washed out by generated methane gas, as SGS (sludge-gas separator), newly divised anaerobic reactor.
: The aerobic treatment removes offensive smell, specific to anaerobic treatment water, releases no-oxygen condition and at the same time decomposes residual organic compounds furtherly. The contact filter to be applied is a method where organic compound load is higher than that in the conventional activated sludge process for suspending treatment, and can simplify handlings for the activated sludge to be returned. This facility shall be able to be used as an anaerobic filter and the usage, as an aerobic facility or anaerobic facility, is switched by the load accordingly.
: In the final treatment polishing and stabilization are carried out by an aquatic plants stabilization pond called as "Living filter".

By the above mentioned treatment the quality of the final treated water clears the standard for quality of waste water treatment authorized by the Ministry of Health of the Republic of Colombia, moreover, as to organic compound (CODcr), the target of the removal ratio is higher than 90 per cent which is higher than the standards.

Other remarkable characteristics of this plant is that materials to be applied to the facilities are designed to be obtained easily at the region as far as possible as mentioned below.

: Acid proof paint produced in Colombia is applied to protection of inner wall of concrete tanks.
: Raw lime-stone used as material for soil improvement produced in the suburbs of Cali City is used for the facility.
: Porous mineral carbon produced near around Quindio used for solid fuel is used for the contact filter media. - carbon mineral coke.
: Bamboo growing naturally in Quindio is applied to fence support, wall protection of the stabilization pond and to baffle wall.
: Abundant rainfall is used as miscellaneous purpose.
: Buchong de Agua, "Water hyacinth", growing naturally considered an original plant of South America is used as aquatic plant.
: Lime-stone, mineral carbon and bamboo are very cheap, which can save the initial cost quite a lot, and at the same time these materials are quite easy to obtain.

It is expected that by the installation of the pilot plant, economically and technically appropriate treatment method will be studied, new technological developments will be promoted and that bringing up engineers those who concern will be carried out.

Still more, at present there are several coffee processing waste water treatment pilot plants and sewage treatment pilot plants don't work effectively in this region.

According to data obtained, removal ratio of CODcr of those plants are around 50 per cent, which is not satisfactory.
It is necessary to study about the reasons of troubles of those plants in the next investigation. The main factors of trouble is attributed to anaerobic reactors as follows:

1) Acclimatization of anaerobic sludge being not enough
2) Anaerobic sludge being washed out, that is, mal-function of SGS
3) Shortage of know-how on aerobic treatment
4) Shortage of running and controling engineers' ability
5) Shortage of designers' engineering ability

2. Design Criteria

Designed quantity of waste water		
Maximum daily waste water	30 l/kg/Ha/Dry coffee bean	
Average daily waste water	22.5 l/kg/Ha/Dry coffee bean	
Annual days of coffee processing		
Maximum	200 Days	
Average	160 Days Small amount of processing, however, is continously carried out through out a year.	
Temperature		
Maximum	31.7°C	
Average	21.9°C	
Minimum	12.2°C	
Annual Rainfall		
Maximum	283 mm/month	
Average	168 mm/month	
Minimum	96 mm/month	
Insolation Duration		
Maximum	199 hrs./month	
Average	149 hrs./month	
Minimum	133 hrs./month	
Relative Humidity		
Maximum	82%	
Average	80%	
Minimum	73%	
Evaporation		
Maximum	105 mm/month	
Average	85.3 mm/month	
Minimum	70 mm/month	
Coffee Beans Production		
Maximum	18.31 kg/Day/Ha/ dry coffee bean	(Cosecha season)
Average	15.0 kg/Day/Ha Dry coffee bean	

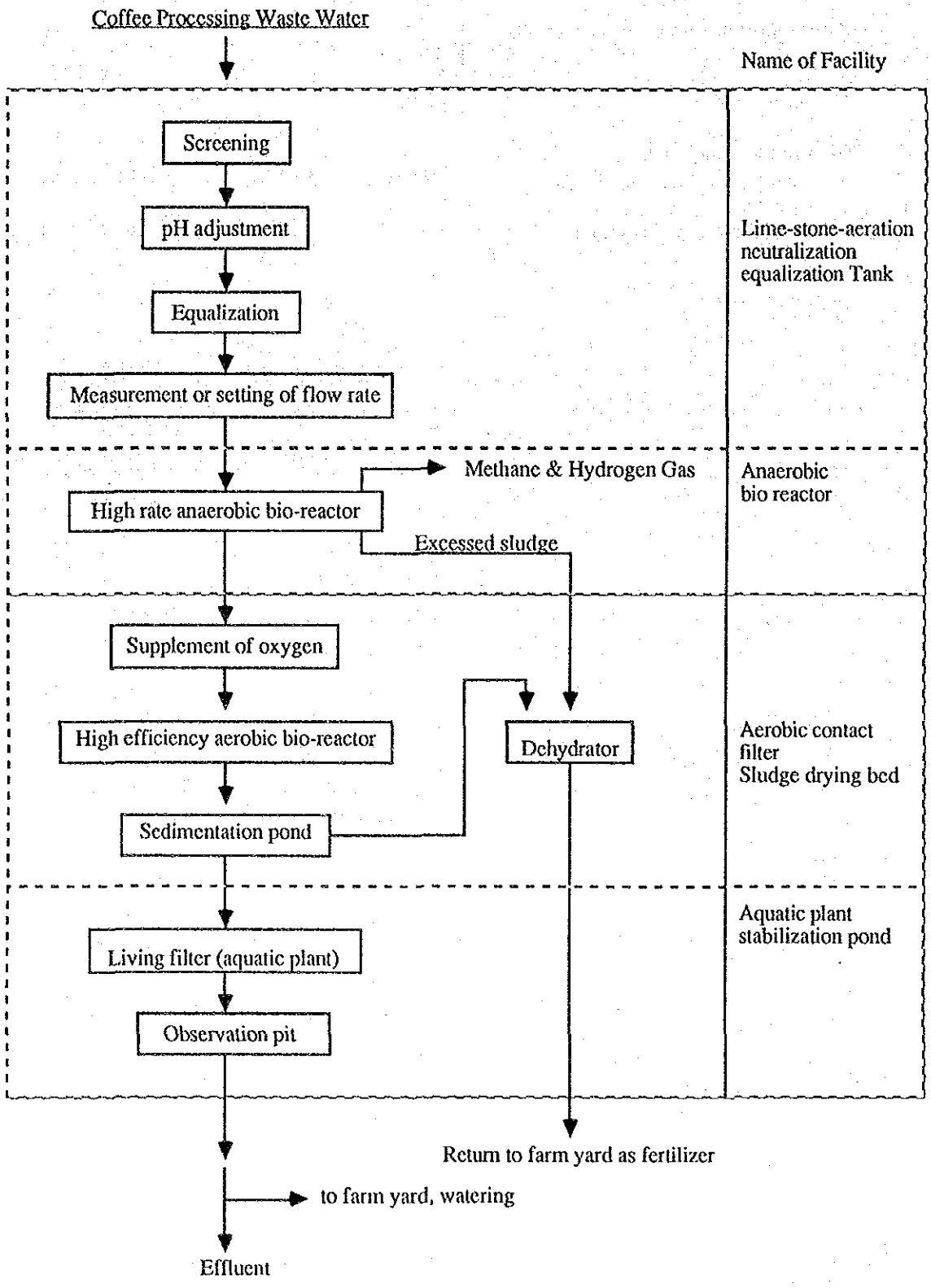
Water required for coffee processing	Potable Water	
Coffee cultivation	25 Ha	
Amount of waste water		
Daily maximum discharge	13.75m^3 (0.573m^3/hr)	(550 l/Ha/Day)
Daily average dioscharge	10.30m^3 (0.43m^3/hr)	(412 l/Ha/Day)

Quality of Waste Water

Item	Maximum	Average
Water Temperature	normal temperature	normal temperature (18-28°C)
Appearance	turbid yellowish brown	turbid yellowish brown
pH	3.5	4.0
Suspended Solid (SS)	3,000 mg/l	2,000 mg/l
Chemical Oxygen Demand (CODcr)	15,000 mg/l	10,000 mg/l
Biochemical Oxygen Demand (BOD_5)	10,000 mg/l	6,700 mg/l

Quality of Treated Water

Item	Standard of Colombia	Target Value
Appearance		slightly turbid light yellow
pH	5-9	5.8-8.6
Suspended Solid (SS)	400mg/l (80% removal)	30mg/l (98.5% removal)
CODcr	2,000 mg/l (80% removal)	less than 300 mg/l (97% removal)
BOD_5	1,340 mg/l (80% removal)	less than 200 mg/l (97% removal)



Flow of Coffee Processing Waste Water Treatment

Designed removal ratio and target of CODcr and SS

Treatment / Item	Waste water	Pre-treatment	Primary treatment	Secondary treatment	Tertiary treatment	Removal Ratio %
pH		5-6	5.8-8.6	5.8-8.6	5.8-8.6	
CODcr (mg/l)	10,000	-	2,500	600	300	
CODcr removal ratio			75%	75%	50%	97%
SS (mg/l)	2,000	-	-	200	30	
SS removal ratio				90%	85%	98.5%
Name of facility and remarks	Average value	Lime-stone neutrization aeration equalization	SNYMIF anaerobic reactor	Aerobic reactor	Aquatic plant stabilization pond	Standard of Colombia for BOD % SS, 80%

3. Specification of Equipment

Rain Water Storage Tank

Rain water is collected by rainfall collecting troughs of buildings around the site and stored in this tank of which water is used for washing precipitate in the neutralization tank as required. Excessed water is used for supplying oxygen to the aquatic plant stabilization pond.

Type	Concrete made, open rectangular type
Number of tank	1
Used frequency	Maximum 1 time/week
Capacity of tank	6.0 m^3
Size	3,000 mm (l) x 2,000 mm (w) x 1,000m (Effective depth of water)

Auxiliary equipments

Overflow pipe	PVC 2"	1 set
Rainwater outlet pipe	PVC 2"	1 set
Rain water outlet valve	Stop valve BC 2"	1 pc

Screen

There is no big solid in the waste water since screening is done in coffee beans producing process usually. The screen is installed at the inlet of neutralization tank and basket shaped with net of 10 mesh as a standard. Waste shall be removed manually.

Type	Plastic made, square basket type
Number of screen	1
Net size	10 mmø
Size	300 mm (l) x 300 mm (w) x 280 mm (H)

Lime stone-Aeration Neutralizing Tank

Tank used both for Lime-stone aeration Neutralization and for Equalization.

Coffee processing waste water is discharged ordinary within 2 or 3 hours through out one day process of coffee beans production. The density and flow rate of the waste water are changed with time as a matter of course. Usually the equalization tank for one day is necessary, after then treatment is carried out by fixed flow rate, however, considering minimization of the construction cost and simplification of the facility, the facility serves as equalization tank and neutralization tank at the same time.
3 or 4 hours are required for neutralization by use of alkali. After dosing alkali into the waste water, pH is adjusted to neutral, however, by decomposition of organic matter, pH becomes lower after that again. Usually, neutralization of inorganic matter is accomplished within few minuets level of time, however, it should be careful when neutralization for coffee processing waste water is performed. In this case for one day capacity of equalization tank functions effectively. The use of strong alkali, for example sodium hydroxide, calcium hydroxide etc., seems effective but when used by coffee farm following points becomes fatal disadvantages.

- Dangerously of over dosing of alkali and abnonnal pH.
- Chemical cost gives influence upon benefit of coffee production.
- Cost increase by installation of electrical pH meter for pH control.

Neutralizing reaction by lime-stone is moderate and its pH after reaction often comes to an end at about pH 5. Removing dissolved carbon dioxide in the neutralized waste water by air bubbling can make its pH up to about pH 6. This air bubbling is effective in removal of suspended solids which deposit on the surface of lime-stones, which disturb next neutralization and is effective also in removal of sludge retained among lime-stone. This is, of course one of the best method for equalization for coffee farm in Quindio.
Anaerobic treatments at pH 6 is testified to its effectiveness by lime-stone aeration water in 70 days' continuous labo-scale test, and is found no problems in the treatment.

Type	Lime-stone-aeration equalization method, concrete made acid proof coating inside (anti acid tile finishing)
Number of tank	1
Capacity of tank	Bigger than 20 m^3
Size	6,600 mm (l) x 3,000 mm (w) x 1,250 mm (Effective depth of water)
Lime-stone	Product in Colombia
Appearance	Like crushed stones, yellowish white lime-stone

Specification for packing

Size	Volume of Packing	Height of Packing
10 x 10mm	6 m^3	300 mmH
20 x 20mm	6 m^3	300 mmH
40 x 40mm	6 m^3	300 mmH
Total	18 m^3	900 mmH
Approximate Weight of Packing		21 Ton

Surplus materials after packing is stored as spare.

Slope of Bottom	Bigger than 1/100, to neutralized water outlet.	
Air diffusing		
Air volume	0.21 Nm^3/min (0.01 Nm^3/ m^3/min)	
Air pressure	Bigger than 1,000 mmAq	
Using condition	Continuous use	
Air generator (common use for aerobic reactor)		
Type	Turbo blower	1 unit
Motor	0.75kw-115V, outdoor type	
Capacity	1.31Nm^3/min	
Air diffusing pipe	Vinyl pipe	1 set
Size of pipe	1" - 3/4"	
Size of nozzle	4 m/m ø	
Auxiliary equipments		
Outlet pipe of neutralized water	Vinyl pipe	1 set
Outlet valve of neutralized water	Vinyl made ball valve 3"	1 pc
Weir for water flow rate Measurement	Mild steel plate made, trough type anti-corrosive coating	1 set
Volume of measurement	550 l/hour	
Size of trough	150 mm(w) x 100 mm(D)	
Neutralized water sedimentation pit		
Type	Concrete made, rectangular thickener	
Number of pit	1 pit	
Linear velocity	7 m/day	
Retention time	4.5 hours	
Angle of repose of sludge zone	60° or more	
Volume of pit	2.5 m^3	
Size of pit	1400mm x 1400mm x 1800mm(D) (Effective Depth)	
Feed well	Mild steel plate made, cylindrical, outlet with baffle plate, anti-corrosive coating	1 set
Size	300 mmø x 1000mmH	
Trough	Mild steel plate made, anti-corrosive coating	1 set
Size	75 mm (w) x 75 mm (D)	
Effluent pipe	Vinyl pipe 2"	1 set
Desludge pipe	Vinyl pipe 3"	1 set
Desludge valve	PVC made, ball value 3"	1 pc

Anaerobic Bio Reactor (SNYMIF)

SNYMIF anaerobic reactor is different from the conventional 30 days thermophilic digestion method in its high speed treatment of 1 or 3 days. UASB method the proto type of high speed anaerobic digester has following disadvantages.

1) It takes 3 - 6 months for acclimatization of sludge being granulated under careful running control, which is not appropriate for coffee farmers. And granulated sludge can not be obtained at present in Quindio.
2) Mechanism of separating gas from sludge is complicated and difficult, and sludge is seriously washed out with methane gas, therefore, the quality of treated water is degraded in fact.

As to the present method, pre-agglomerated sludge is charged into the reactor for the preparation of heavy sludge zone. Then anaerobic contact filter with crushed mineral carbon is installed above the sludge zone. These make polishing for waste water and stopping sludge carry over by gas generation possible. By these procedures treated water with expected quality is obtained in an early stage after starting running the facility and appropriate treatment of waste water influenced during harvesting period can be controlled.

Type	Up flow agglomerated anaerobic sludge zone, SGS, function anaerobic contact filter reinforced concrete made, rectangular type "SNYMIF"
Number of reactor	1
CODcr load of reactor	3.8kg-CODcr/cm^3/day
Agglomerated sludge	
Standard volume of sludge	13 m^3
Standard density of sludge	40,000 mg/l
Hydraulic detension time	60 hours
SGS mechanism	
Packing media	Mineral carbon coke (Product in Colombia)
Size	10 x 10mm and 40 x 40mm
Volume of packing	7 m^3 (4 m^3 + 3 m^3)
Height of packing	750 mm
Supporting base for packing media	Mild steel plate made, grating type, all antic corrosive coating
Size of reactor	3000mm x 3000mm x 4000mmD (Effective depth)

Neutralized water distributor		
Type	Weir distribution type, mild steel plate made, all anti corrosive coating (3 times)	
Number of distributor	1	
Number of distribution	4	
Distribution pipe	Vinyl pipe 3"	
Size	500mm (l) x 400mm (w) x 500mm(D)	
Sampling rack		1 set
Type	Concreat made	
Size of rack	500mm (l) x 400mm (w) x 300mm (D)	
Sampling valve	Vinyl made ball valve 2"	3 pcs.
Upper water collecting equipment		
Type	All around water collecting trought type, mild steel plate made, with baffle plate all anti-corrosive coating	
Size		
Water collecting part	100mm (w) x 100mm (D)	
Gathering part	400mm (w) x 400mm (D)	
Drain pipe	Vinyl pipe 2"	
Forced draft oxygen supplement tower		
Type	Forced draft aeration tower type, mild steel plate made, cylindrical, all anti corrosive coating	
Number of tower	1	
Linear velocity	3.8 m/hour	
Size of tower	300mm x 500mm x 1200mmH	
Packing media	Mineral carbon coke (product in Colombia)	
Size of packing media	300mm x 300mm	
Volume of packing	70 L	
Rack of packing media	Mild steel plate made, all anti corrosive coating	
Air blower		
Type	Sirocco fan	
Number of blower	1	
Air volume	0.3 NM3/min	
Air pressure	115 mmAq or more	
Motor	0.1kw - 115V, outdoor type	
Outlet pipe	Vinyl made, 2"	

Aerobic Contact Filter

Mineral carbon coke obtained the region is used as filter media. In the porous part, aerobic organic matter decomposing bacteria are maintained. The filter is divided into two ponds considering dispersion of load. As to this filter returning sludge is not required, therefore, returning pump facility is not necessary. Since activated sludge is maintained onto the filter, high loading becomes available compared with suspending activated sludge method, and at the same time volume of excessed activated sludge becomes small.
Possibility of bulking is small also. Main operation is air controlling, thus, operation is comparatively easy. The facility is high efficiency and can be used as anaerobic filter during off season and when the load is low.

Type	Aerobic contact filter media packing air diffusing method, concrete made type	
CODcr load of the reactor	1.56 kg CODcr/Reactor m^3/day	
Detention time (two ponds)	16 hours + 15 hours = 31 hours	
Aeration		
Air volume		
Primary	0.6 Nm^3/minute	
Secondary	0.5 Nm^3/minute	
Air pressure	1000 mm Aq or more	
Diffuser	Vinyl pipe, porous pipe	
Size of nozzle	4 mmø, zigzag arrangement	
Size of the reactor		
Primary pond	1600mm x 3000mm x 1800mmD ($8.64\ m^3$)	
Secondary pond	1500mm x 3000mm x 1800mmD ($8.1 m^3$)	
Packing media	Mineral carbon coke (Product in Colombia)	
Size	10mm x 10mm	
Volume of packing		
Primary pond	$8m^3$	
Secondary pond	$7.5m^3$	
Aerobic treated water sedimention pit		1 pit
Type	Concrete made, rectangular type thickener	
Linear velocity	28m/day	
Detention time	1 hour	
Angle of repose of sludge zone	60° or more	
Volume of pit	$0.6m^3$	
Size of pit	700 x 700mm x 1800mm (Effective depth)	
Feed well		
Type	Mild steel plate made, cylinder type, outlet with baffle plate, all anti corrosive coating	1
Size	100mmø x 1000mmH	

Auxiliary equipments		
Desludge pipe	Vinyl pipe 3"	1 set
Desludge valve	Bronze made, ball valve 3"	1 pc
Water collecting valve	Mild steel plate made, all anti corrosive painting	1 set
Size	75mm(w) x 75mm(D)	
Excessed sludge storage pit		1
Type	Concrete made, rectangular type	
Volume of pit	$3m^3$	
Size of pit	2500mm x 800mm x 1800mmD (Effective depth)	

Sludge drying bed

As to drying sludge, solar drying method is applied, therefore no power and no chemicals are required. Coffee harvest season is comparatively rainy season, so, drying bed with roof is applied. There are coffee beans drying facilities called "Elva" at the site, but its roof (shelter) should be closed when it rains, therefore, fixed roof is applied to the facility.

Type	Brick made, mortar finishing, rectangular type, with roof, winds drying		
Capacity	3000 l/bed x 3		
Water content of sludge	99%		
Water content of cake	85%, or less 1 week drying for 1 bed		
Number of bed	3		
Size of bed pit	2900mm x 6000mm x 1500mm (Effective depth)		
Slope of bottom	1/100 or more, outlet pipe-ward		
Packing media			
Name of packing media	Size	Packing Height	Volume
Gravel	10-20mmø	250mm	$4.3m^3$
Coarse sand	3-5mmø	250mm	$4.3m^3$
Sand	0.8-1mmø	250mm	$4.3m^3$
	Total	750mm	$12.9m^3$

Auxiliary equipments		
Scraper for cake		1 set
Wood made stop weir		6 sets
2" Drain pipe		3 sets
Shelter	$27m^2$ or more	1 set
Rainfall collecting trough		1 set

Aquatic Plant Stabilization Pond

Highly fertile water hyacinth is applied to this stabilization pond. It is well known that water hyacinth consumes dissolved phosphate and nitrogen as resource of nourishment and can reduce organic matters expressed in CODcr and BOD_5 also. In floating aquatic plant pond dissolved oxygen is consumed rapidly, therefore, some of rainfalls are added into the pond to cope with this. The retention time of the pond shall be 7 days. Water-air mixed solution aerated by air-jet at in-flow part is sprinkled from bell-mouth shaped jet cylinder, which supplies oxygen, and at the same time, considering good appearance. Sediment at the bottom is removed periodically by a spare submersible pump of sewer (once a season).

Type	Rectangular aeration pond	
Number of pond	1	
Retention time	7 days	
Required volume	$100m^3$ or more (including inspection pond)	
Water proofing	Plastic sheet and Si Ka-1	
Size of pond	20,000mm(l) x 6,000mm(w) x 900mm (Effective Depth)	
Stubilization pond part	95m3	
Inspection pond part	15m3	
Total	110m3	
Revetment of buffle wall	Bamboo, surface mortar coated	
Aquatic plant		
Name of plant	Water Hyacinth (Buchong de Agua)	
Amount of plant	1,500kg drip weight	
Inspection pond	$15m^3$	1 pond
Oxygen supplying cylinder		
Type	Mild steel plate made, bell-mouth topped type, all anti corrosive painting	1 set
Size	Bell mouth part 500mmø x Cylindrical port 300mmø x	
Pump	Submersible type for sewer with cable	1 set
Capacity	0.1 m^3/min x 10m Aq	
Motor	0.2kw - 115V	
Piping	3/4"	

4. Various Works

Civil work		1 set
Piling		
Excavation and surplus soil treatment		
Concrete and iron work		
Fence and gate	Mild steel plate made gates with locks Bamboo made pillar, barbed wire painted in light-green	2 sets
Gardening		
Tree planting		
Sod facing		
Maintenance road	Concrete	
Rain water collecting trough		
Clearance and land grading		
Mechanical works		1 set
Installation of rotating machine	Blower	
Machine erection	Feed well, trough, filter bench, distribution pit, air diffuser	
Piping works		1 set
VP	Socket joint	
Electrical works		1 set
Introduction of electrical Source	115V, 20m	
Motor starter	Breaker with push button & Knife switch	
Conduit & wiring		
Lighting		
Painting works		1 set
Painting out side of concrete tank in light-gray		
Naming		
Bamboo (fence etc.) surface in light-green		
Operation room		
Type	Concrete block or brick made, mortar finishing	
Required area	$24m^2$ or more	
Height of room	2.5m or more	
Equipments		
Motor starter	Motor breaker, electric source	1 set
Desk		1 set
Chair		1 set
Lighting		1 set
Desk for analysis		1 set
Sink		1 set

Outdoor lighting

Type	Self standing incandescent electric lamp	
Number of lighting	2 lightings	
Capacity	200W	
Height of pole	3m or more	
Pole painting	Navy blue	

Fence around the facilities and gate

Fences are installed so that person who does not concern the facilities and domestic animals may not enter the site.

Type	Bamboo made supporting pole with burbed wire	1 set
Scope of works	Around all the facilities, height 1m	
Gate	Mild steel plate made, with locks	2 set

Miscellaneous works

Charging lime-stone and Carbon	41.1m^3	1 set
Sampling and transporting seed sludge	13m^3	1 set
Adjustment and charging of seed sludge	13m^3	1 set
Sampling and transporting aquatic plant	1.5ton	1 set
Leakage test for tanks etc. and pipes		1 set
Attendance for inspection		1 set

Spare equipment

Submersible pump for sewer	0.2kw with cable 10m	1 unit

List for Valves and Instruments (Sebastopol)

Name of Instruments & Valves	Installing Place	Type	Size (B)	Material	Joint	Number
Outlet Valve of Rain Water	Outlet of rain water storage tank	Stop	2"	BC	Screw	1
Outlet Valve of Neutralized Water	Outlet of neutralization tank	Ball	3"	PVC	Socket	1
Sedimentation Pond of Neutralized Water						
Desludge Valve	Bottom of neutralization sedimentation pond	Ball	3"	PVC	Screw	1
Anaerobic Reactor	Anaerobic reactor sampling					
Sampling Valve	rack	Ball	2"	PVC	Socket	2
		Ball	1"	PVC	Socket	3
Aerobic Reactor Sedimentation Pit	Bottom of aerobic reactor	Ball	3"	PVC	Socket	1
Desludge Valve	sedimentation pit					
Air Valve	Intake part or neutralization tank	Stop	1"	BC	Screw	1
Air Valve	Aerobic tank	Stop	1"	BC	Screw	2
Air Valve	Outlet of blower	Stop	1"	BC	Screw	1
Blow Valve of Aerobic Reactor	Bottom of aerobic reactor	Ball	2"	PVC	Screw	2
Air Flow Meter	Intake part of aerobic tank	Rotor meter	1"	Acryle	Screw	1
Neutralized Water flow Meter	Outlet of neutralization tank	Weir	-	SS-anti corrosive painting	-	1
Pressure Gauge of Blower	Outlet of turbo blower	Bourdon	2"	BC	Screw	1