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TECHNICAL CONSULTATIONS FOR THE FOOD INDUSTRIES 1/

(IS/SYR/72/026/11-03/06)

Project Findings and Recommendations

Terminal report prepared for
the Government of the Syrian Arab Republic

by

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**Expert of the United Nations Industrial Development Organization
acting as Executing Agency for
the United Nations Development Programme**

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I SUMMARY

A. Purpose of the Project

The following shortcomings at the distillery plant at Home exist:-

1. The low daily capacity of the plant 6,000 - 6,500 litres of alcohol (calculated as 100%) instead of the nominal capacity of 9,000 litres.

2. The bad quality of certain raw molasses, specially those produced from the refining of raw sugars imported from Argentina and Brasil. The fermentation of such molasses is so badly performed that the "richesse" of the fermented mash does not exceed more than 3 - 4 per cent alcohol, resulting therefore in a low yield of alcohol and in a decrease of the plant's capacity.

3. The periodical incrustations (muds and calcium sulphate) which block up the first column of the distillation unit, reducing its flow gradually, and consequently reducing the capacity of the plant until complete shut down for cleaning.

B. Investigations and Results

The technique of the fermentation process, as it has been practised since seventeen years ago, presented certain anomalies:

1. No aeration was carried out during the preparation phase of the inoculum in spite of the vitality of such procedure for the propagation of yeast.

The air compressor (170 m^3/hr) and its connections have been restored and put into operation since 11 February 1975, during the propagation of the yeast inoculum.

Samples of aerated fermented mash and undisturbed fermented mash have been compared in the laboratory under the same conditions as those forother factors. In the plant, aeration during preparation of the inoculum has also been proceeded with during a certain period and comparison of the two procedures (with and without aeration) has resulted in favour of the aeration:

(a) An increase by 8 per cent of the production yield of alcohol.

(b) High count increase of yeast cells by more than 200 per cent.

(c) Increase of the capacity of the "cuverie" (vessels) by 15 per cent and consequently an increase in the daily capacity of the plant. The data of these experiences are detailed in this report. These experiences demonstrated the benefit of aeration during the yeast reproduction and its effect on the yield of alcohol.

2. The water available in the plant is artesian and not chlorinated. A sample sent to the central bacteriological laboratory at "Homs" for analysis revealed the pollution of this water (see annexed bulletin No. 2).

It was noted that the possibilities of supplying the plant with potable chlorinated water for the fermentation (100 m^3 daily) is not possible and thus chlorination of the available artesian water has been done by using the calcium hypochlorite.

The use of the hypochlorite is expensive and not quite efficient and specifications on an automatic chlorination station have been given for possible purchase.

3. Before the expert's arrival, the plant used the commercial bakers yeast 30 per cent (dry matter) as a seeding for inoculation. Such practice is improper for the following reasons:

(a) Pollution of the bakers yeast during manufacturing, packing, transport from Damascus to Homs and manual manipulations during seeding. This fact has been confirmed by microscopical tests.

(b) Besides, the bakers yeast is considered relatively old and over-reached in its logarithmic phase which means, therefore, that it is unable to reproduce abundantly decreasing its enzymatic effect. In this case, the bakers yeast cannot perform the work of an active strain and consequently secure a good yield of alcohol and efficient capacity of the plant.

(e) Also, the use of bakers yeast as seeding is very expensive. For this reason, since 7 March 1975, a strain of pure culture as a seeding has been used in a form of yeast cream in the bakers yeast factory near Damascus.

During the experiments with this pure culture seeding, aeration is practiced in the propagation vats as well as the chlorination of the available water by hypochlorite. The nutrient dose (ammonium di-phosphate and sulphate) consumed has been reduced to four kgs. per ton molasses instead of six kgs. formerly.

The results obtained are quite successful.

(i) Capacity of the fermentation vessels

The duration of the propagation has notably been reduced. The capacity of vessels has increased by 40 - 50 per cent. In the main fermentors, the increase in the capacity is 35 per cent.

(ii) Alcohol yield and daily capacity of the plant

As already mentioned, a new strain was introduced on 7 March 1975 and was replaced by a second one on 26 March 1975. During this period of twenty consecutive days, the strain continued to give acceptable yields, in spite of some little lactobacillus streptococci which was left in the fermentors from the previous period.

4. Experiment on inoculation of the plant by using a seeding of "saccharomyces cervicea" from the brewery of Aleppo

The strain was reproduced in the laboratory and then transferred to the plant through the pure culture vessel, (200 litres), and propagator tanks, until finally to the main fermentors. The duration of the experiment was unfortunately brief (4 days) because of re-inoculation by the "Vogelbusch" strain before the end of mission. The results which were obtained seemed to be satisfactory.

5. <u>Experiment with inoculation of the plant using a seeding of anaerobic saccharomyces cervicea from "Vogelbusch" Vienna</u>

From the "Vogelbusch" (Vienna), three slants of pure culture anaerobic strain were received and the laboratory of the plant was recently provided with an incubator, glass bottles and yeast extract, which permitted preparation of the seeding and inoculation of the plant by this strain.

The preparation began on 2 April 1975 and the average results obtained during seven consecutive days from 5 April 1975 until 11 April 1975 are described in the report.

II INTRODUCTION

The distillery plant at "Homs" was erected and put into operation in 1948 by "Skoda Greger" (Czechoslovakia). The nominal capacity of the plant according to the contract, is 9,000 - 9,200 litres of alcohol (100% base) per day (24 hours) but the actual capacity did not exceed 6,500 litres.

The plant was not provided with an automatic or manual weighing scale for weighing the raw treated molasses, which is actually measured by volume and average fixed density of 1.40. For this reason, the yield of alcohol per cent on total sugars cannot be considered accurate.

The specifications were given to the authorities to provide the plant with said equipment as well as with a pneumercator system tank gauge for the storage tanks (1,000 capacity each) of raw molasses.

III EQUIPMENT AND "MODUS OPERANDI"

As shown in Annex 1, the main equipment is composed of four different stations:

A. Preparation of the diluted molasses station

This consists of a raw molasses tank (20 tons capacity) supposed to be calibrated to graduate the volume of the consumed molasses. Two steel tanks of 6 m^3 each receive 2½ tons of raw molasses by gravity and 800 litres of water. After addition of 12 kg. ammonium sulphate + 12 kg. of ammonium phosphate, the mixture is heated to 90°C. The diluted mash at nearly 1.20 density is then cooled through a cooler of 24 m^2 and rediluted to 1.05 density for feeding during propagation or to 1.09 for fermentation. The preparation of the two densities is therefore discontinued and distributed in one single connection. To avoid confusion during feedings, delay in work and loss capacity, it was recommended to separate the two different mashs, 1.05 and 1.09, but this procedure necessitates the increase of the second cooler (6 m^2) and the modification of the system of the second diluter.

B. Inoculum Preparation Station

As it is shown in annex 1, the station is composed of:

1. A copper tank of 200 litres for the preparation of the pure yeast culture.

2. Copper yeast reproduction tanks of 2 m^3 capacity each.

3. Steel tanks of 14 m^3 capacity each for yeast (inoculum) propagation.

All these vessels are closed and supplied with tubing for aeration (perforated rings) in the bottom as well as for steaming. An outer shower ring is connected to cold water for cooling.

On the top there are also connections with the main mash pipe and the carbon dioxyde evaluation, and the bottoms are connected together for inoculum distribution. Unfortunately the tank (200 liters) has not been used since 17 years ago, during which period the plant used the commercial bakers yeast instead of the pure yeast culture strain.

At the same time, aeration during the preparation of the inoculum was not practised at all. The preparation of the inoculum was conducted in the following way: 10 kgs of bakers yeast were broken up manually in an opened tank of 200 liters capacity and mixed with 150 liters of diluted mash. The content of the tank is then transferred to one of the 2 copper tanks (2 m3).

The copper tank is then fed with diluted molasses(1.0[illegible] density) and transferred after 10-12 hours of yeast reproduction, to one of the two steel tanks (14 m3).

As mentioned before, no aeration was practised during the preparation of the inoculum, and the water available in the plant for molasses dilution is artesian, not chlorinated. Samples of this water were sent for bacteriological analysis which demonstrated that such water is not suitable for fermentation (See annex 2).

The management of the plant agreed to import a complete modern chlorination station as soon as possible and specifications for such equipment were given. In the meantime, to ensure the sterility of this water and the whole plant, calcium hypochlorite (powder) is now commonly used.

C. Main Fermentation

It is carried out in steel fermentors of 40 m3 nominal capacity each (See annex 1). Every unit is provided with a group of aeration perforated rings in the bottom (used also for steaming), standard openings for mash feeding, carbon dioxide evacuation, external cooling shower etc. are also assured. The fermented mash is then directed to the distillation unit through a tank (3 m3) and by a centrifugal pump.

D. Distillation Unit (Annex 3)

It consists of a pre-column, a fore-running column, rectifying column and the commercial alcohol column. The investigation on normal work of the unit was satisfactory.

1. The heat exchanger (32 m2) for heating the fermented mash (30°C to 55°C) can be considered normally efficient.

2. The average analyses of the vinasse (slops) by Martins method (bichromate and ferrous sulphate) shows that the loss of alcohol varies between 6 - 7 liters per centhectoliters "vinasse" and such an amount can be considered satisfactory taking into consideration the old age of the distillation unit (1948).

3. The undetermined losses due to technical reasons, bad condensation, loss by degasifying etc. are insignificant.

4. The distillation unit is periodically shut down for 2 to 4 days every two months of consecutive work. This shut down is due to a deposit of incrustations (muds and calcium sulphate and phosphate) on the trays of the first and second column.
This problem will be eliminated as soon as the 2 traps (in the distillery plant) are constructed. The traps consiste of a steel column of 4 m high and 1.250 m diameter, provided in the interior by chicaneries and chains (see annex 4). The fermented mash, before entrance to the pre-column, passes from the bottom of the trap through chicaneries (plated trays) and chains. Meantime, steaming is also provided in the bottom and the temperature of the fermented mash can reach 90° to 95°C, the incrustations at this flow rate are caught on the trays and chains. The effluency of this trap has been proved successful..

IV MODIFICATIONS OF THE FERMENTATION PROCESS

A. Aeration Procedure

After the arrival of the expert it was agreed to adopt the aeration during the preparation of the yeast inoculum. For this reason the air compressor (150 - 170 m3/hr) and its connections were restored and aeration has been in operation since 12.2.1975.

In order to demonstrate its efficiency on yeast propagation and consequently on enzymatic effect, experiments were carried out in the laboratory as well as in the plant. In the lab aliquots of two liters of diluted molasses (1.05) were placed in 2 beakers of larger capacity the same quantity of ammonuim phosphate plus 1 gr of bakers yeast (20 %) as inoculum and sulphuric acid was added and mixed. The first beaker was aerated while the second was left undisturbed. Both were then left for ten hours of 33° - 35°C. The results of analysis were as follows:

	alcohol % fermented mash	count of cell
- Aerated fermented mash	1.80 %	double count
- Non-aerated (undisturbed) fermented mash	0.52 %	single count

After 20 hours of complete fermentation the "richesse" of aerated fermented mash increased to 4.0% alcohol with a triple count of yeast cells whilst the amount of alcohol in the non-aerated fermented mash did not exceed 3.0% alcohol. In the plant, aeration during preparation of the inoculum was carried out for five consecutive days; the quantity of nutrients and bakers yeast were added as usual. Under the same conditions but without aeration the plant worked also during five consecutive days and the registered and comparative data are as follows.

	aeration	without aeration
- Average time for inoculum prep.	18 hours	22 hours
- Quantity of treated molasses	130 tons	122.5 tons
- Alcohol produced (100% base)	36,440	31,400
- "Richesse" of fermented mash	6.4 %	5.5 %
- Liters of alcohol (100%) per ton molasses	280	256
- Liters of alcohol (100%) produced daily	7,290	6,280

It is obvious that according to these experiments, the aeration resulted in:

1. An increase of the yield of alcohol produced
2. High count of yeast cells corresponding to an efficient enzymatic effect.
3. Increase of the capacity of the "cuverie" (vessels)' of the plant

B. Quality of the Water Available for Fermentation

As it was pointed out before the bacteriological analysis of this water showed that it is not suitable for molasses dilution. It was polluted with harmful micro-coliform micro-organisms rendering it not potable (See annex 2). It was insisted upon to provide the fermentation plant with a potable chlorinated water during the experiments but unfortunately this was not actually possible.

For this reason it was necessary to use the calcium hypochlorite in the water feeding tank and to carry out continuous sterilisation of the vessels of the plant with this disinfectant during the experiments. Meanwhile the specifications for the proposed chlorination station was given for possible purchase.

C. Results with Pure Culture Strain Combined with Aeration and Water Chlorination

As indicated before, the commercial bakers yeast (27-30% dry matter) was normally used in the plant as a seeding for the propagation of the "Saccharomyces cervicea"; such procedure cannot be adopted for the following reasons:

1. Pollution of this seeding (the bakers yeast) during the manufacturing steps, packing, transport, and manual manipulations in the distillery plant.
2. This fact was confirmed by the microscopical testing. The commercial bakers yeast attained its logarithmic phase and cannot, therefore, be able to perform the work of an active strain and result in a good yield of alcohol and an efficient capacity of the plant.
3. The use of the commercial bakers yeast as strain is very expensive. The normal consumption of bakers yeast, used as seeding, is about forty kgs per day (24 hours) corresponding to 6000-6500 liters of alcohol (100 % base) produced. For this reason it was advised to import a selected pure yeast strain and fortunately three slants of pure culture was received from Vogelbusch in Vienna. In the meantime, upon searching for another alternative, it was suggested to use a first generation of yeast in the form of milk of yeast from the bakers yeast factory near Damascus which usually provided the commercial bakers yeast to the distillery plant at Homs.

The inoculum of the milk of yeast from Damascus (20 litres corresponding to 160 grms dry matter per litre) was received at Home at the beginning of March 1975.

Experiments in the plant with this inoculum began on 7 March 1975 and lasted for ten consecutive days until 17 March 1975.

The technique of the fermentation during this experiment was conducted according to the French process (Melle-Boinot) which consisted of retaking and reproducing the first seeding (in the milk of yeast) in two propagator vessels (2 m3). During this experiment, no bakers yeast was used. Aeration was practiced at a rate of 25 - 30 m3/Hr in the first propagator vessel (2 m3), and 50 - 60 m3/Hr in the second propagator (14 m3).

The water for dilution was sterilised by manual addition of calcium hypochlorite. All the vessels of the plant were also efficiently sterilised by steaming and calcium hypochlorite.

The optimum and adequate quantities of nutrients were recalculated (diammonium phosphate and ammonium sulphate), taking into consideration previous experiences and the necessary quantity of P_2O_5 and nitrogen, based on the cells count of yeasts.

The nutrient quantity was fixed at four kgs per ton of molasses instead of eight kgs formerly. By this new change the daily amount of nutrients could be reduced to 50 per cent of the initial dose. During the experiment, which continued for ten days, microscopical tests were pursued, and only rare micro-organisms of lactobacillus streptococci were found in the main fermentors during the last days of the experiment. The results obtained were quite successful.

Increase of the capacity of the "cuverie" (vessels) and consequently of the daily capacity of the plant was obtained. A net increase of the yield of alcohol (% total sugars) was also registered and considerable benefit was achieved. The registered results obtained are as follows.

1. Duration of the Propagation Process

- The duration of work of the propagation in the propagator vessel (2 m3 capacity) was 6 hours against 11 hours average before the experiment i.e. before adopting the milk of yeast (of first generation) used in the above-mentioned experiment.

This means an increase of 50 per cent of the capacity of this vessel. The duration of propagation in the large propagator (14 m3 capacity) was seven hours against twelve hours average before use of the mentioned milk of yeast; this represents an increase of forty per cent of the capacity of this vessel.

- The duration of complete fermentation in the main fermentor (40 m3 capacity) was 24 hours against 36 hours which means an increase of the capacity of nearly 33 per cent.

2. <u>Alcohol yield and daily capacity of the plant</u>

As already mentioned, the new strain was introduced in the plant since 7 March 1975 and has been replaced by a second one on 26 March 1975. During that period of twenty consecutive days, the strain continued to give acceptable yield in spite of some little lacto-bacillus streptococciwhich were in the fermenters during the last days of the period. The average results of the first decade (from 9 March 1975 until 19 March 1975) were registered as follows:

	Total amount during 10 days	Daily average
- Molasses treated (tons)	342	34.2
- Total sugars (saccharose + inverted) (kgs)	162673	162673
- Quantity of fermented mash (vin)(m3)	1835	183.5
- Alcohol produced (100% base 1 litres)	90720	9072
- Alcohol % fermented mash (richesse)	7.5	7.5
- Yield alcohol 100% per cent total sugar (litres)	35.77	
- Yield alcohol 100% per cent theoretical (litres)	91.87	

The average results of alcohol yield and daily capacity of the plant for January 1975 and February 1975, during which the commercial bakers yeast was used for seedings without aeration during propagation and nutrient water sterilisation, are as follows:

	January 1975	February 1975
- Average daily treated molasses (tons)	25.160	25.831
- Total sugars % molasses	50.82	50.82
- Daily alcohol 100% produced (litres)	6411	5722
- Yield alcohol 100% per cent sugars (litre)	50.14	51.20
- Yield alcohol 100% per cent theoretical	82.00	83.80

The comparison of the two results indicates:

a) Increase of the daily capacity of the plant from 6566 litre of alcohol 100 per cent to 9072 liters corresponding to 38 per cent increase.

b) Increase of the alcohol yield % sugars from 50.65 litres 100% to 55.77 corresponding to 10 per cent increase.

c) The total reduced quantity of the bakers yeast used for daily seeding, which represents a daily economy of 40 kgs of commercial bakers yeast or more than 12 tons per year. This quantity contributes to cover the local market demand.

d) The nutrient dose for new seedings has been reduced to four kgs per ton of molasses instead of six kgs as formerly used. This reduction represents an economy of 39% on the costs of diammonium phosphate and ammonium sulphate (half-half) consumed before. Such reduction represents an economy of 14-15 tons of these nutrients per annum. Also suggestions were made to determine the content of P_2O_5 and nitrogen in the fermented mash (vin) and reduce eventually this amount further.

e) By the new technique an increase in the carbon dioxyde of at least forty per cent is expected, corresponding to more than four tons of liquified gas/24 hrs instead of 2.5-3 tons produced daily previously as a by-product of the plant used during the Summer for carbonated beverages. The treated molasses during these experiments was a mixture obtained from refining raw sugars imported from Brasil, Argentina and Cuba.

In order to compare with the beet molasses, the plant had been supplied during seven consecutive days from 22 March 1975 to 28 March 1975 by this raw molasses and the average results of these experiments were as follows:

- Average daily beet molasses consumption (tons)	35.357
- Solid matters (brix) % molasses	70.00
- Saccharose % molasses	43.18
- Inverted sugars % molasses	1.70
- Total sugars % molasses	44.88
- Total sugars daily consumed (kgr)	15868
- Alcohol yield 100% per cent total sugars (litres)	54.1
- Alcohol yield per cent theoretical yield	88.54
- Alcohol 100% daily produced (litres)	8583

Conclusion

The results obtained from the beet molasses are little lower than these obtained from the refined sugars molasses as indicated below:

- Decrease of 5 - 6 % on the daily capacity and 3% on the alcohol yield. This decrease should not be attributed totally to the beet molasses compared to the refined sugars molasses. In fact, the quantity of this molasses, object of the experiment, was a residual stock of nearly 300 tons in a main storage tank and which had been diluted by steaming up to 70 brix with consequent invert sugar content of 1.7 per cent.

  Based on this observation, it was recommended that care be taken that the brix of the molasses should not be less than 78 and direct steaming, should be controlled seriously. If necessary, indirect steaming should be applied.

  It was also recommended that fermented molasses should not be used, it should be rejected.

f) Experiment with inoculation by using a seeding of "saccharomyces cervicea" from the brewery of Aleppo

The strain was reproduced in the laboratory and then transferred to the plant through the pure culture vessel (200 litres), and the propagator tanks, until finally to the main fermentors. The duration of the experiment was unfortunately brief (four days) because it was necessary to re-inoculate the plant by the Vogelbusch strain before the end of the expert's mission. It appears, that the results which could be obtained would be satisfactory.

g) Experiment with inoculation of the plant by using a seeding of anaerobic saccharomyces cervicea from Vogelbusch, Vienna

From Vogelbusch (Vienna) three slants of pure culture anaerobic strain were received and the laboratory of the plant was recently provided with an incubator, glass-bottles and yeast extract which permitted preparation of the seeding and inoculation of the plant by this strain.

The preparation began on 2 April 1975 and the average results obtained during seven consecutive days from 5 April 1975 until 11 April 1975 are as follows.

The Capacity of the Fermentors

The duration of propagation was similar to that of the last experiment with the local acclimatised strain and which had increased by 40 - 50% compared with the technique practised before. The duration work of the main fermentor was increased by about 35%.

Alcohol Yield and Daily Capacity of the Plant

Daily Production

Date	m^3 fermented mash distilled	Richesse fermented mash	Liters of alcohol 100%
5.4.1975	120	7.3%	8588
6.4.1975	123	7.2%	8276
7.4.1975	119	7.6%	8888
8.4.1975	107	7.8%	8816
9.4.1975	113	7.5%	8441
10.4.1975	105	7.5%	7868
11.4.1975	120	7.4%	7900

Alcohol yield % sugars

- Alcohol yield 100% per cent total sugars (litres) 55.5
- Alcohol yield 100% per cent theoretical yield 90.69

The results obtained from Vogelbusch's strain were satisfactory in spite of the fact that the strain had not been acclimatised.

Final conclusion

The modifications made in the fermentation process at the distillery of "Homs" (aeration, use of adequate strain and water sterilisation) mainly increased the plant's capacity and yield.

Since 6 March 1975 up till 12 April 1975 the average daily capacity was 6786 kgs corresponding to 8700 litres of alcohol 100% and the alcohol yield per cent on total sugars is about 56 litres 100% in spite of some shortcomings during this period.

The plant is therefore able to continue realising these data. After using successfully the new strain of Vogelbusch, the plant will be able to prepare periodically the inoculum and reproduce new culture acclimatised strains.

In spite of the fact that the treated molasses was relatively viscous due to the causes mentioned in chapter 8, this fact cannot compromise the yield of the plant in large scale, provided that molasses is stored for certain months before use and that the brix (solid matters) should not be decreased below 78 by exaggerated steaming or water dilution.

V. ANALYTICAL CONTROL AND INSTRUMENTATION

During the mission laboratory control, sampling and analytical methods were discussed with the Management. In addition to the normal and classic test by the ebulliometry apparatus for determination of alcohol in the fermented mash (vin), the Martins method (bichromate was introduced and ferrous sulphate) for alcohol determination in the "vin" as well as in the vinasse (slops). Due to the importance of these analyses, sampling of each is taken continuously during the 24 hours of the day and an average of the samples are analysed by the Martin's method. The density apparatuses (aerometers, densimeters and brixometers) were calibrated and correction of each instrument, including temperature corrections, are now taken into consideration. The bacteriological laboratory is under erection. Meantime some necessary apparatuses, such as incubator, glassware and chemicals (malt extract) have been provided to assure, whenever possible the use of the pure culture strain imported from Vienna (Vogelbusch), to perform the experimentation of the new process; instead of the inactive bakers yeast.

VI PERSONNEL

The plant is directed by a chemist and assisted by a second chemist responsible for the laboratory. The continuous fermentation and distillation is carried out in three shifts. In every shift there is one foreman and five assistants distributed between the diluted molasses station, the feeding vats, the densities control, the unit distillation inspection and the pumping services. The staff is now familiar with the new technique adopted and during experimental work of twelve hours per day, the two chemists mentioned carried out work for many days.

The density control of the vats are now registered every hour in a daily bulletin.

For the training of the chemists in bacteriological routine work, a fellowship of two months for the Director of the plant, his assistant and the chemist from the Central laboratory at Homs is suggested.

For placement, it is suggested that the bacteriological laboratory of the distillery plant at Hawandia (Lyza) near Cairo be selected. This distillery belongs to the "Societe des sucreries et de distillerie d'Egypte" and it is producing daily 100,000 litres of alcohol.

VII RECOMMENDATIONS

1. Aeration should definitely be adopted

The existing air compressor, erected in 1948 has a nominal capacity of 200 m3/hour but it does not exceed 130-140 m3 under a pressure of 1.5 kgs/cm2. It is built as a piston compressor and provided with an air vessel for compressed air and a closed horizontal vat for potassium permanganate solution for air sterlisation. It has been recommended to provide the plant with a modern unit as a stand-by with a nominal capacity of 300 m3 and 5 kgs/cm2 fully automatic and with an automatic switch. A new unit has already been ordered locally.

2. Provision of the plant with a chlorination station

As already mentioned, the water available in the plant is artesian and not suitable for molasses dilution without chlorination (see bacteriological analysis, Annex 2).

Specifications for a complete modern automatic chlorination station were given. It was also advised that the treated water should not contain less than five parts chlorine per million. During the experiments which were successfully achieved, calcium hypochlorite was used manually to treat the water. Such procedure is expensive and not quite efficient.

3. Provision for the plant with automatic weighing scale for weighing raw molasses

As mentioned before, the daily molasse consumed is measured by volume taking into consideration a standard density of 1.40. Such procedure can not give an accurate result on the alcohol yield in the plant. An automatic weighing scale with capacity of 5 tons/hour, complete with buffer tank, two weighing tanks, weighing mechanism and counting device with register should be supplied. These specifications were given in detail. Besides, it was advised to provide the two storage tanks for molasses (1000 tons capacity each) with a pneumarcator tank gauge system (model Kelving and Huges, England). With this apparatus the content of the two molasses storage tanks can be calculated in metric tons either after refilling or emptying. The management is convinced about the necessity to provide the sugar factory and the distillery plant with these automatic weighing scales for raw molasses because without these, accurate control in the two plants cannot be undertaken seriously. The specification for this equipment was given.

4. Separation of the diluted molasses 1.05 and 1.10 density

After the preparation of the diluted molasses at 1.20, it is cooled through a cooler of 24 m2, and then it goes through a main diluter for rediluting to 1.05 for feeding the propagation vats, or 1.09 - 1.10 for feeding the main fermentors. The preparation of the two densities is therefore done discontinuously and in one sole collector feeding the propagators and fermentors. Such procedure is always exposed to confusion of distribution, besides the delay which occurs when feeding the two different densities at the same time. For this reason it was recommended to separate the two different densities 1.05 and 1.10, by increasing the capacity of the second cooler (6 m2), and to modify the second dilutor for better mixing. (see Annex 1).

5. Increase in the capacity of the two tanks for the preparation of diluted molasses 1.20 density

The raw molasses is first diluted to 1.20 in two steel tanks 3 m³ each, and heated to 30°C by direct steaming after addition of nutrients (ammonium phosphate and sulphate). It was agreed to replace the two mentioned tanks by two others of 10 m3 each which will enable better sedimentation and elimination of the suspended matters and sludges and separation of the supernatent mash. Such procedure will favour the fermentation and protect the distillation unit from incrustation deposits.

6. Bacteriological laboratory

A new backteriological lab is under erection and will be supplied with the necessary equipment, glassware and chemicals, to enable all bacteriological analyses, separation of pure culture slants locally acclimatised, and the preparation of pure inoculum.

7. Construction of two steel column traps for catching incrustation before entrance into the distillation unit

Regarding the distillation unit it was decided to erect two steel columns of 4 m height and 1.250 m in diameter, provided in the interior by chicaneries and chains (see Annex 3 and 4) on which incrustations and mud could be caught before entrance in the pre-column and thus the periodical shut down of the unit can be avoided.

8. Storage of raw molasses before fermentation

It is a well known fact that molasses should not be treated in the distillery before being stored during certain months. The explanation of this practice can be attributed to certain favourable organic reactions during aging as well as to the deposit of suspended matters by time.

For this reason it was advised not to use the raw molasses, newly produced, before storing it for at least three months, possibly more. To assure this practice, the calculation was made on the total requirements of molasses from beet and refined imported raw sugars, compared to the total capacity of storage tanks distributed between the three sugar factories, the distillery and Lattakia port, and for the total consumption for alcohol production and for bakers yeast.

- Annual production	21000 tons
- Storing capacity	19500 tons
- Annual consumption	16000 tons

From this data it was calculated that the storing capacity be sufficient to assure aging of the molasses for several months before fermentation, provided that the transportation of molasses between factories to the distillery is regular.

9. Mixed process by aerobic and anaerobic fermentation for the production of alcohol, fodder yeast and carbon dioxyde in the distillery at "Homs"

The management of the "Union of Food Industries" was enthusiastic to produce fodder yeast with 50 - 52 per cent proteins on dry matter as it is practiced in the two distillery plants in Egypt. According to the expectations of the "Union" there is future for the production of fodder yeast in Syria.

The policy of the Syrian government is to increase the production of animal proteins (chickens, cattle) and it has been effectively extended during the last years. For this reason, great quantities of fodder for cattle and livestock are imported annually, in addition to the agricultural, vegetable and animal ingredients such as cereals (corn, barley), oil cakes, etc. provided locally.

The mentioned "Union of food industries" would like to introduce a mixed fermentation process for the production of alcohol, and fodder yeast as well as carbon dioxyde in the distilery plant at "Homs".

The new procedure will be established in co-ordination with the extension of the distillery plant at Homs and the creation of three new beet sugar factories.

Certain information and data about experience in the two distillery plants in Egypt in which the mixed process is adopted were requested. It is possible that UNIDO will be requested to provide technical assistance on this matter.

10. Quality of the treated molasses used for fermentation

The molasses treated in the distillery plant is provided mainly from the refining of raw sugar imported from Cuba, Brazil, Argentina and Chile. Only a certain quantity not more than twenty per cent of beet sugar molasses is used.

The molasses used is the by-product of the three sugar factories in Syria where local sugar beet and imported raw sugar available for the production of 150 - 160 thousand tons of granulated white sugar per year.

The information was given that the plant suffers from time to time from the inferior quality of the molasses, especially that from the refining of raw Brazilian sugar. The fermentation was badly performed and the "richesse" of the final fermented mash did not exceed more than 3 - 4 per cent alcohol "vin" with consequent lower yield and lower daily output of the plant.

In order to determine the quality of the available molasses, determination of the viscosity was introduced and it was found that the average registered viscosity for the Brazilian beet molasses is about 20,000 centipoise which is relatively high. This determination was confirmed by the presence of an abnormal content of pectic matters (gums and dextran) of up to 4.5 per cent in raw molasses.

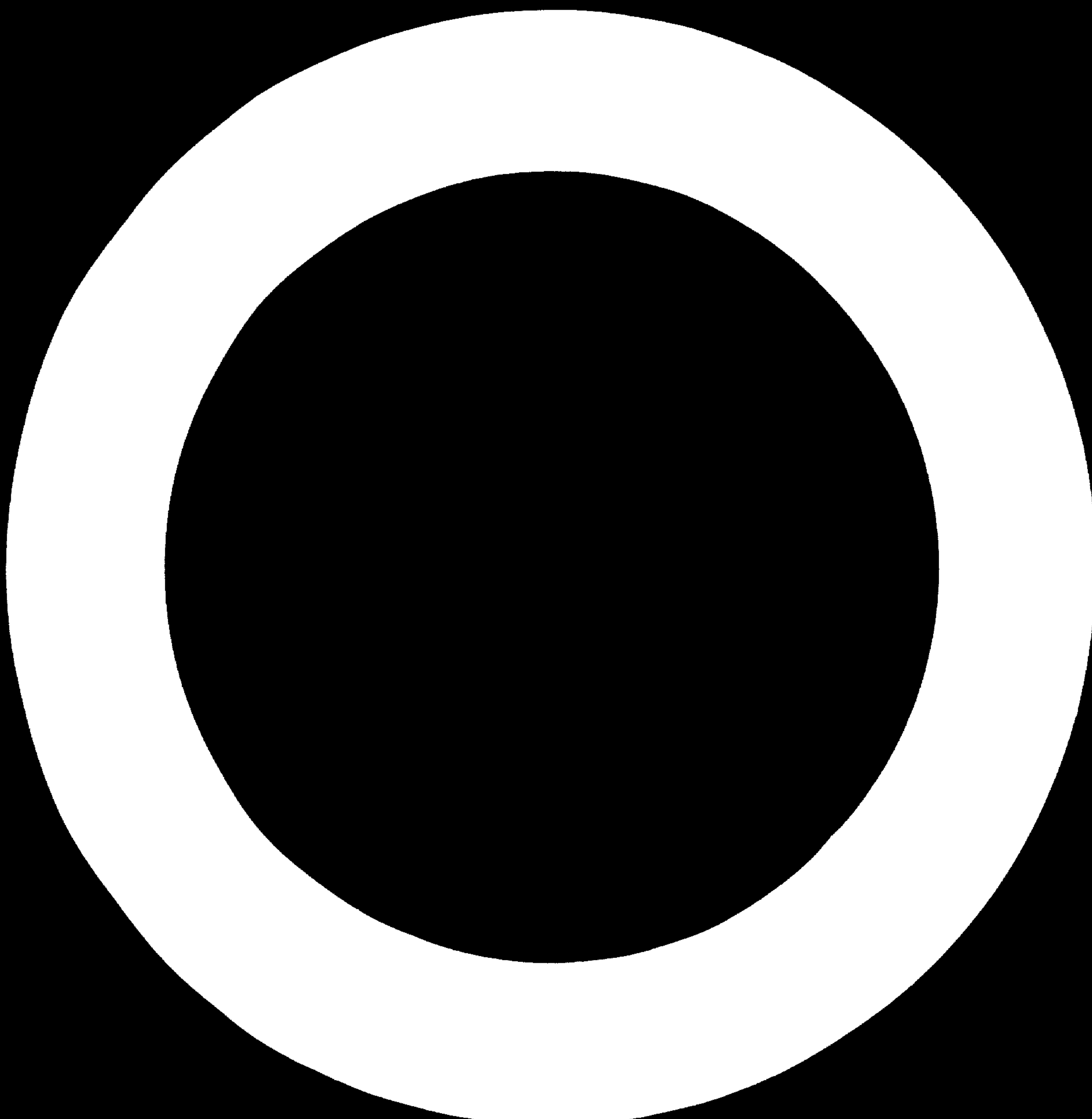
The explanation for such a quality can be attributed to certain factors occurring during the production steps in the sugar factory. These factors, well known by the management, are due possibly to bad defecation of juices and syrups owing to deficiency of CO_2, bad conditions of cooking, to low vacuum (45 - 55 cms H_g) in pans, and super-heated steaming (250°C). The modifications are now taking place in the sugar factory at "Homs" to avoid these gaps and improve the sugar yield as well as the quality of the molasses.

The results which were obtained after modifications of t... [illegible]-nique of fermentation, when using either beet or refined mixture molasses, are quite satisfactory. It was advised never to ferment molasses before a period of storage of at least three months, and possibly more for the beet molasses. Such aging is necessary to improve the quality of this molasses. As it is already mentioned in Chapter 7 concerning recommendations or the storage tanks for molasses, compared to the total production and the consumption, these are sufficient to ensure the aging and to separate the beet molasses from the refined molasses.

The average analysis of the beet and refined sugar molasses, as produced after centrifugation is as follows:

	Refined sugar %	Molasses Beet sugar (%)
Total solid matters (Brix)	83.00	84.00
Water	17.00	16.00
Saccharose	44.60	52.20
Reducing sugars	6.40	0.66
Ash	10.90	13.10
Organic matters	21.10	18.04
Purity sacharore	53.7	62.1
Purity total sugars	61.4	62.8

During the transport, direct steaming and storage, the solid matters of the treated molasses decrease to 78 - 80.



ANNEX II Bacteriological Analysis of the Available Water in the Distillery Plant at "Homs"

تاريخ اخذ العينه : اخذت العينه بمعرفة المرسل بتاريخ ـا ٥/٢/١١٧٥ .

تاريخ فحص العينه : ـا ٥/٢/١٩٧٥ .

مصدر العينـــــة : بئر ارتوازي في معمل السكر .

نوع الفحـــــــص : جراثيمي فقـــط .

العدد الاجمالي لمجموع الكوليفورم في ١٠٠ سم٣ ماء وحضانة ٢٤ ساعة في درجة حرارة ٣٧ ° 2400 units of coliforms in 100 cm3 water incubated during 24 H. at 37°C.	العدد العام لمجموعة الجراثيم النامية في طبق السطحي الاكار آكـــار وحضانة ٢٤ ساعة - في حرارة ٣٧ °
٢٤٠٠	٥

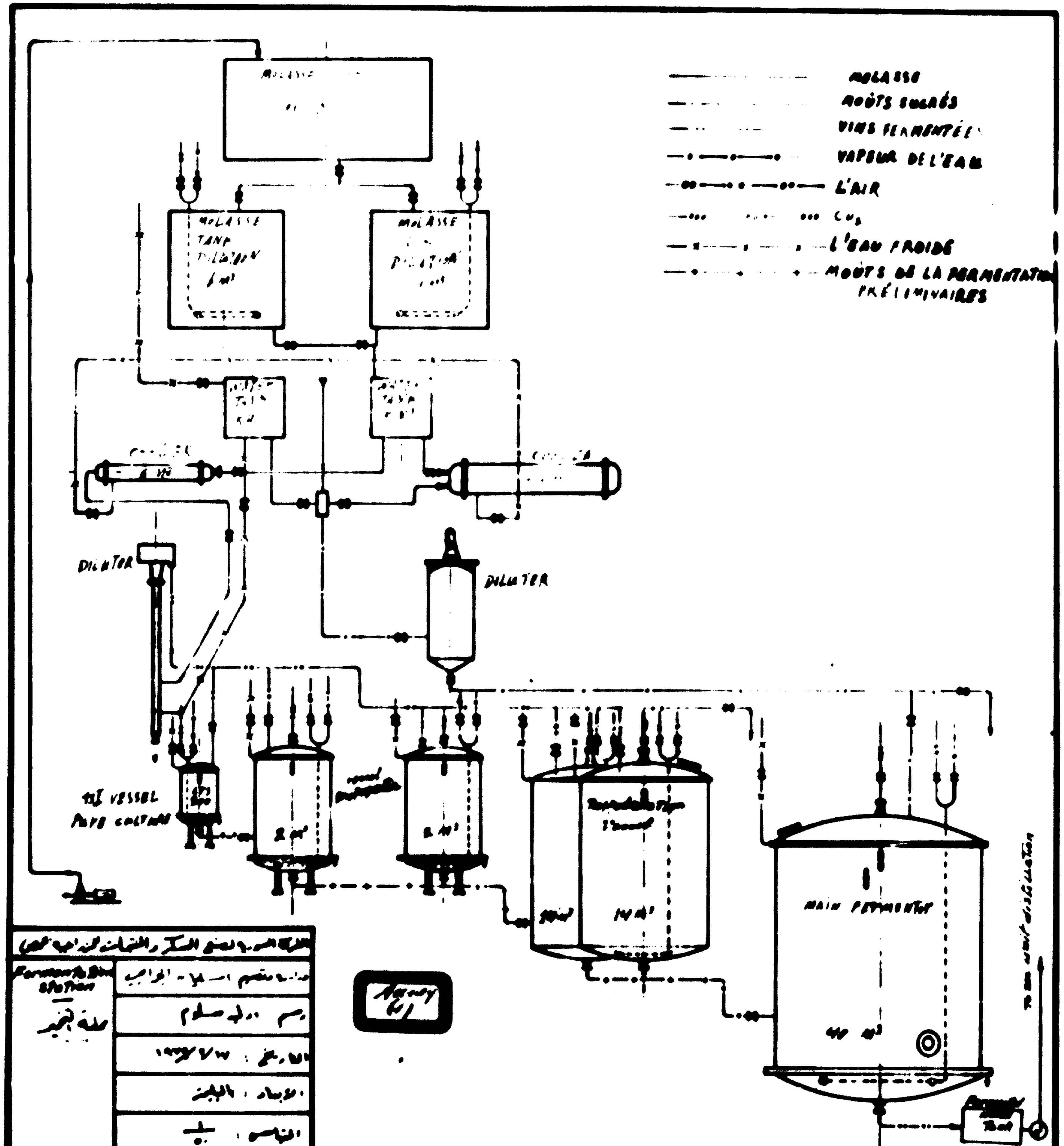
__النتيجة__ :- عينة الماء المرسلة غير صالحة للشرب من الناحية الجراثيمية بالرجوع لتعليمـــم .

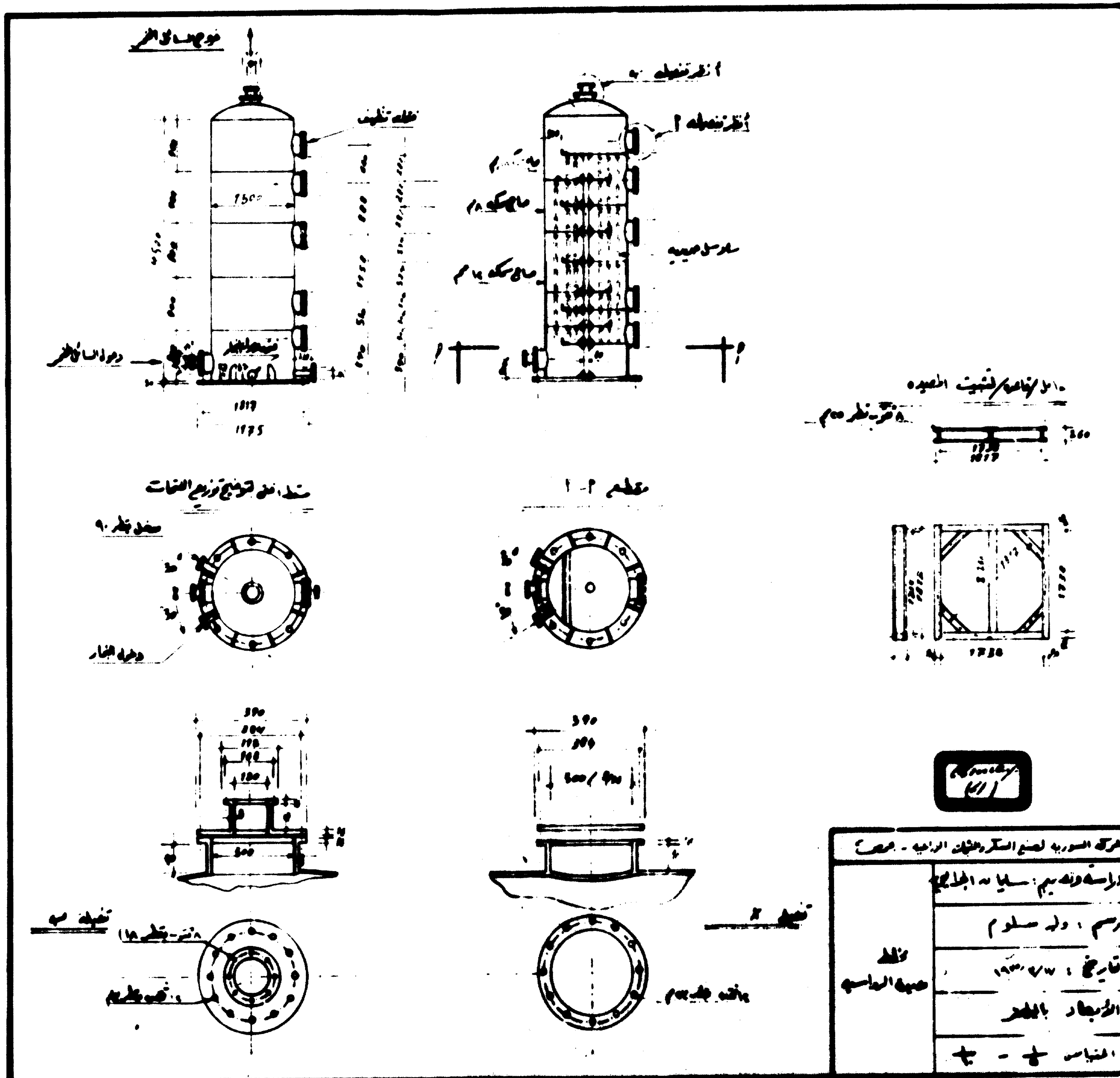
__الكلفــة__ :- /١٥/ خمس عشرة ليرة سورية لا غيـــر .

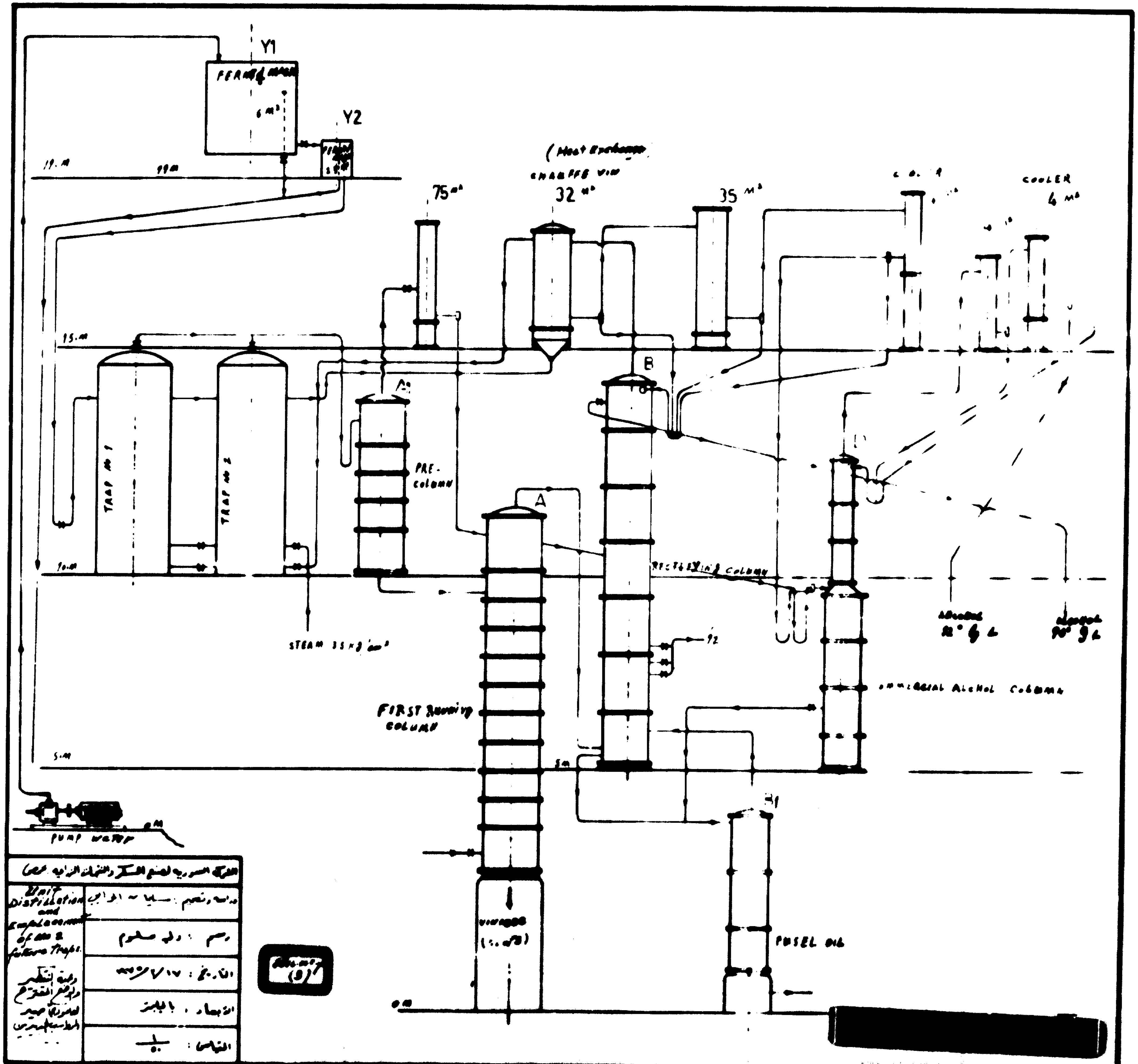
المحلل

رئيس المخبر
الدكتور [illegible] الحسامي

مدير عام مؤسسة مياه حمص
المهندس محمد [illegible] طـــــوان


MOLASSE
MOÛTS SUCRÉS
VINS FERMENTÉES
VAPEUR DE L'EAU
L'AIR
L'EAU FROIDE
MOÛTS DE LA FERMENTATION PRÉLIMINAIRES
MOLASSE
DILUTER
DILUTER
MAIN FERMENTOR
PURE CULTURE


رسم : وليد سلوم
الأبعاد بالمم


Y1
Y2
(Heat Exchanger
75 m³
32 m³
35 m³
COOLER
4 m³
TRAP No 1
TRAP No 2
PRE-
COLUMN
A
B
FIRST Running
COLUMN
RECTIFYING COLUMN
STEAM 3.5 kg/cm²
COMMERCIAL ALCHOL COLUMN
FUSEL OIL
PUMP WATER
VINASSE
Unit
Distillation
and
Emplacement
of ... 2
future Traps.

76.02.04