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SUGAR CANE TRAINING AND DEVELOPMENT CENTRE

DP/EGY/81/010

EGYPT

Technical report: Cane sugar industry development*

Prepared for the Government of Egypt

by the United Nations Industrial Development Organization,

acting as executing agency for the United Nations Development Programme

Based on the work of J. J. Zwaardemaker,
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United Nations Industrial Development Organization

Vienna

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Summary

The visit to the Cairo Head Office of the Sugar Company was delayed due to the introduction of a new public holiday. After introduction to Mr. El Sawah certain aspects of the project were discussed. The journey was carried on to the duty station in Kous.

As the Sugar Factory in Kous was in its last two weeks of grinding, the first importance was to study and observe the factory's operation. Furthermore, information was gathered about the training activities and the number of trainees involved. The training level was assessed. The training and development centre was visited with the Engineer in charge of the training for the engineering department. The buildings were still under construction. The ground floor of one building was in use by the engineering department. The lectures programme was looked into and translation of chapter headings was arranged.

A start was made with the selection of some lecture material which could possibly be used to show the variety of machinery for sugar factories.

Sugar Factories nearest to Kous in Upper Egypt were visited. As the production processes of all factories were using the same parameters only short visits were needed.

During the short vacation which is traditional when a sugar factory finishes the season, a return trip was made to Cairo where some discussions were held at the Sugar Company Head Office, and the opportunity was taken to pay a visit to the Central Laboratory at Hawamdiah. More material from sugar books was made available.

At return to Kous it appeared that since the Ramadan fasting month had started the majority of the factory workers and several staff members had taken up vacation. Consequently, very little maintenance work was done till the end of the fasting.

Trainee lectures started from the first of June and were listened into as much as possible. The copy material was formed page by page into a booklet. However, the copiers were still out of order so the last work had to be done in the Cairo Office. Lists of pilot-plant equipment and typical cane sugar laboratory instruments and equipment were made up and discussed.

Telex contact was sought with Professor Delavier at the University of Khartoum, to obtain information on pilot-plants. It was decided that Professor Delavier would be invited to pay a visit to Cairo.

The existing training programme and variety of subjects lectured were found to be very good, well advanced and of higher standard than the usual training given to factory operators and supervisors. However, the company was not completely satisfied with the method of lecturing.

It was agreed that an expert on training methods would be asked to visit and advise.

A report was made with observations and recommendations for the factories' production process, as well as a report with proposals for research to be carried out by the new laboratory of the Centre in Kous.

A request for a quotation for the Research Laboratory equipment was sent.

CHAPTER 1

Introduction

The project DP/EGY/81/010 to strengthen the technical and training capacity of the Sugar Research and Development Centre at Kous was put on paper in 1981 and had been modified in several ways. The presents terms were described in the job description attached.

The timing of the mission was as follows:

21 April 1985	Travel to Vienna
22-23 April 1985	Briefing at UNIDO
24 April 1985	Travel to Cairo
25-28 April 1985	National Holiday and Week End
28 April 1985	Briefing at Sugar Company Office
30 April 1985	Travel to Kous
1-18 May 1985	Project work in Kous
19-30 May 1985	Project work in Kous
1-14 June 1985	Project work in Kous
15-24 June 1985	Project work in Cairo
25 June 1985	Return to Vienna
26 June 1985	Debriefing at UNIDO

The fasting month of Ramadan coincided with the second half of the mission. The characteristic office and working time reduction and the unfortunate breakdown of photocopy machines resulted in delays.

The Research and Development/Training Centre is still under construction but training is going on in the factory and in a temporary lecture room. This has caused a small change in the off-season programme where first and second year trainees are taking their turn in the class-room every other day. Research is limited to the Central Laboratory's capacity, any-extension is awaiting the completion of the Research and Development Centre.

CHAPTER 2

Background

The sugar industry was established in Egypt in 1855 and is managed by the Sugar and Distillation Company which is owned by the Government. This company operates seven cane sugar factories with an annual processing and production capacity of about 630,000 tonnes of sugar, which is consumed on the local market. There are plans to establish new factories to increase the country's sugar production.

In the past few years the industry started to encounter problems due to changes in cane quality, old machinery and other factors. The high losses in bagasse and molasses as well as the existing technology and mode of operation have to be examined. Possible need for modifications has to be identified.

The facilities of a pilot-plant in very close co-operation with the research laboratory and the factory will serve the purpose of researching the various conditions of capacity, process techniques and the need of other processes to be introduced.

The training centre of the company, providing a necessary number of skilled operators and supervisors, has been relocated at Kous sugar factory for better facilities and new buildings of the Sugar Research and Development Centre. The benefit of the project results will be shared by all sugar factories in Egypt.

CHAPTER 3

Reports on Factories Visited

Kous Factory

The factory was still grinding untill about half of May. The quality of cane was already very bad with old and stale cane being delivered to clear up last fields.

Milling/Diffusion

Cane preparation by the two sets of knives was not very good, because of the toughness of the mentioned quality of cane. Consequently losses in bagasse were high, with the high percentage of bagasse on cane and high sugar residue in that bagasse.

Juice Treatment

Two latest model Fletcher juice scales were present but by-passed. Quantity of juice was arrived at by calculation.

Juice heating seemed instrument controlled at levels of 70° and 105°C.

A triple super-phosphate solution was dosed at a rate of 1/3 kg per tonne of cane, which amounts to 100-125 mgr per litre P_2O_5. This application is very likely the reason for the good clarity of the very dark clarifier juice.

Liming and sulphitation were controlled manually with periodical use of drops of pH indicator solutions on a plate with some juice. Clear juice values of pH were to be maintained at a value of 6.8-6.9. The colour of the resulting juice was much too high and a heavy smell of overtiming hung around the treatment station and clarifiers.

The mud to the rotary vacuum filters was thin, however, in most cases there was a very good pick-up of mud, forming a cake thickness of about 1 cm of good consistency.

A very good supply of a rather coarse (long fibrous) kind of bagacillo as filtration aid was noticed to be used. This most certainly contributed to the cake formation on the filter drums.

The thinness of the mud was regardless of the dosing of a flocculant solution of Separan, said to be equal to 0.5 ppm. Primary a 0.5 ppm dosing of flocculant might show some effect in laboratory test, but in practice on a factory scale has no noticeable effect and presents a waste of a generally very expensive chemical. At factory scale a dosing of less than 1.5 ppm will hardly be noticed, certainly when pH is controlled manually.

Secondary, the flocculant solution was prepared with very hot water which will have distroyed most of the chemicals activity if not all of it. The critical temperature for all known flocculants is 55° C. It is advisable to prepare this chemical with cold water and allow the solution to be left for one hour before use.

Thirdly, Separan is a hydroscopic chemical in powder form, it is very difficult to dissolve without the formation of lumps. These lumps are a totally lost amount of chemical and reduce the concentration of the solution by an unknown amount. However, there are several brands of very good flocculants which are produced in granular form. These can be dissolved without lump formation even in cold water.

N.B.: All flocculants produced in the U.K. are far lower in price and in many cases better products than the U.S.A. ones.

The clarifier juice was fed over half a dozen DSM - type screen to remove the bagacillo carried over at the clarifiers. However, these screens were very much gummed up and some 75% of the clear juice flowed across the screens. There should be more spare screens, more frequently cleaned for replacement.

Evaporation

The levels in all of the four working evaporator sets seemed to be correct at most times because of a fixed-overflow level control, but there was no other brix control than the usual manually periodically used Baumé hydrometer.

Operations at the Vacuum Pan Floor

An excellent system of treatment of pan feed material was being used. Dilution to 70° brix and heating to 60°C while continually stirred, will guarantee that all fine sugar crystals are dissolved and a clear feed is available.

Due to this treatment good clean massecuites were observed in all vac-pans. There is a need, however, for more steaming out of the pans between strikes as an amount of very big crystals was noticed. These can also come from cut-over pipes, which might need some flush-out system with water to chase out residual crystals periodically.

Centrifugals

This station was a variety of machines from semi-automatic and automatic batch machines to several makes of continuous centrifugals. Generally there was a need for more mechanical maintenance and some more cleanliness.

Sugar Driers and Bagging Station

Around the driers on the floor and other equipment there was a considerable amount of sugar dust from the driers cyclones. This represents a sugar loss which is generally higher than thought off. The same counts for the spillage at the bagging stations. It has been noticed that considerable amounts of dirty sugar from the last season were brought back into the factory for reprocessing. Besides the fact that it is impossible to collect all spilled sugar, there is also an extra loss suffered by the reprocessing of the sugar collected.

Special attention should be paid to the Kous sugar factory because of the presence in due course of the Research and Development Centre and pilot-plant for the entire industry's benefit.

Visit to Armant Sugar Factory, 15 May 1985

Armant being one of the oldest sugar factories in Egypt, had recently a new milling tandem installed, which included a shredder. Although this factory was in the last two weeks of its grinding season, it was recording a pol extraction of about 93%, which is better than at Kous at the time of season. The cane preparation with a shredder followed by fine mills, using below 30% imbitition water, seems to be able to achieve a distinctly better extraction than the diffusion combination. Swirling feed throughs at the maceration pumps were noticed. They are a great advantage used with the chokeless pumps to obtain continuous maceration even with varying flow of juice. However, some of the maceration distributers were partially blacked with bagasse, preventing maceration over the full width of the mill. This will have had a reducing effect on the extraction.

Juice treatment, using the same temperature and pH levels, resulted in a clarified juice with much lower colours and fairly good clarity. The pH control was again manual by periodical "drop on plate" testing. A different liming tank with a small capacity was leading limed juice in an enlarged vertical pipe towards the circulation pump of the SO_2 tank. No overliming was noticed here, nor at the Bach Mirrlees-Watson clarifiers which produced a very good clarified juice.

The flocculant preparation and dosing system was of the same kind as in Kous but with a much smaller holding capacity. This will not result in a standard concentration of flocculant solution. Again, much too hot water was used for the preparation of the solution. Noticing a propellor mixer, high speed agitation is also prohibitive because of the shearing effect on the long chain molecules of the chemical.

Although all machinery in this factory are old in type and make, e.g. vacuum pans in particular, in comparison with Kous, the same treatment of pan feed material resulted in the same good clean massecuites. They were practically free of fines, which must result in good purging quality with the much greater uniformity of crystals than the usually encountered massecuites. It is therefore a great pity that the material reaching the pans must have a rather molassegenic nature. From these clean massecuites one would expect lower purities as there are no fine crystals in the molasses.

At the centrifugal station the contrast of the old machines against the new fully automatic batteries was very striking. The condition of the old machines therefore looked very bad, indeed needing maintenance.

The spillage at the bagging stations again seemed much more than normally needs to be encountered. As mentioned before, the losses here are always greater then expected.

Visit to Idfu Sugar Factory, 2 June 1985

This factory is of the same design and practically the same lay-out as the Armant Factory with very much the same machinery, except that Dorr clarifiers are used instead of the Bach clarifiers in Armant Factory.

Of the two milling tandems, one was reduced to four mills as the third mill suffered a broken shaft and was by-passed. Repairs of this nature in the last two weeks of the season cause too much delay. Consequently extraction on this tandem was low, but in general on both tandems, the maceration was very poorly attended to. Masses of bagasse passed from mill to mill with practically no maceration juice applied to it.

The cleanliness on and around these two tandems was indeed very poor.

At the juice treatment station, where again only manual pH-control was done, there was a different design of liming tank. Tall and narrow, its juice level seemingly determined by the fixed level of the SO_2 treatment tank, received the milk of lime from a rather high positioned lime doser. This must have caused sufficient agitation with the juice to result in the best clarified juice seen so far. Light in colour as can be epxected from sulphitation on manual control, it was slightly turbid, although phosphate was added to the mixed juice. However, the observation of two 44 gall. oildrums as flocculant preparation and dosing station goes beyond any possible commend for a factory with a 8000 tonnes per day capacity.

As in Armant Factory syrup sulphitation is applied to a pH value of 5.9. Although double sulphitation is usually practised to produce white sugar, no such sugar was observed at the bagging stations. The extra expense seems unwarranted.

The sugar boiling was not good with plenty mixed crystals and fines of all sizes in all masecuites. Pan feed treatment was not practised as it was considered to increase the colour in pan feed. The final molasses was actually lower than in the two other factories where a purity of about 40 was recorded. In Idfu the molasses purity was 37, which could very well be lower if massecuites without fines could be produced as observed in the other factories.

The centrifugal stations were badly in need of mechanical maintenance as well as cleaning. There was much more spillage of sugar at the bagging station.

The general impression was that Idfu factory needed more cleaning.

Visit to Dishma Sugar Factor/Refinery, 11 June 1985

The factory capacity is about 8000 tcd and the refinery about 700 tcd.

There are two mill/diffuser tandems equal to the type in Kous. Juice scales, possibly Foxboro type, seemed to be in use in this factory. The process differs in the fact that here only lime defecation is practised to a pH value of 7.5. The liming is done by a lime-liquor wheel,proportioning the lime by the amount of juice passing through.

The liming tank was the first one observed to have a mechanical stirrer and a approximate reaction, time of 5 minutes by fixed overflow. However, the limed-up condition of these two proportioning wheels raised the question whether the juice has been properly limed towards the end of the season. One proportioning wheel's overflow was rather blocked up with solid lime. It is a pity that, also in this only 8 years old factory, the automatic pH-control, which was coupled to the proportioning wheels had become inactive and was removed.

It was considered not to be of much importance to properly control the pH in the juice treatment. There was, however, automatic pH-control used on the carbonatation for the refining.

The refinery massecuites observed were of a very mixed crystal, but due to high purities refinery boilings are usually less uniform than raws.

The factory looked rather clean and tidy, except around the centrifugals and the bagging and raw sugar melting stations. The centrifugal covers in particular were noticed to need maintenance and cleaning. As has been the case with all bagging stations and in this case also the raw sugar melting station, there was exessive spillage which must account for a loss in production.

CHAPTER 4

General Factory Observations and Recommendations

Milling

At the factories with milling tandems it was observed that imbibition/maceration was not continuous. Fibre and other solids were preventing an even distribution over the whole width of the mills. At the time of the visit in most maceration applications of two tandems the juice came so intermittently that masses of bagasse passed without any maceration at all. Juice extraction was reported to be low because of the season ending (two weeks to go), however, some low extraction must be due to the above mentioned need of attention.

Juice Treatment

In all factories manual "drop on plate" pH - control was practised at the liming and SO2 treatment. Small differences in the installations resulted in distinctly different quality clarified juice from the same pH-values. This control method can certainly not be called up-to-date.

The difference in installation was greatest at the liming, which showed no reaction time nor agitations or very little reaction time with no agitation and some more reaction time and a possible agitation caused by the flow of juice and lime from fairly high level. Clarified juices varied from dark, smelly, apparently overlimed juice to progressive lighter slightly turbid juice. Good agitation by means of circulation pumps and a certain reaction time by application of fixed overflows on the SO_2-tanks were observed as a contrast to the first treatment.

The flocculation preparation and dosing systems varied from two 44 gallons oildrums to a station with reasonable holding capacity. However, in all factories such very hot water was used for the preparation that the chemical activity must have been very much reduced if there was any left at all. Preparation and dilution water temperature should not exceed 55° C for all flocculante.

Furthermore, the dosing by gravity through valve regulation is for a viscous and very often lumpy solution certainly not a guarantee that these very expensive chemicals are used with good result. In the case of the two 44 gallons oildrums, there is only money wasted for a 8000 t cane per day factory. The muds were thin in all cases, indicating little effect of the chemical applied.

There is a very great need for simple, well designed, liming tank with minimum reaction time of three minutes, stirrers and automatic pH-control of a recognised reputation with proper station layout and good control, not just a known brand of instruments without proper layout and tank design. It is generally recognised that flocculants are very much needed in the sugar production process to facilitate the clarification of juices, syrups and liquors. As it is a relatively very expensive product, it is advisable to install proportioning and positive dosing systems in order to obtain optimal results in the clarification process.

The best and most up to date flocculant [illegible] consists of a preparation tanks with vibrating dispersers [illegible], placed over an equally sized holding tank from which a variable speed monopump sends the accurately measured solution to the juice treatment installation. Preparation and holding tank usually contain an eight hours supply each in order to maintain a standard concentration of flocculant solution.

Clarification

The ample capacity of clarifiers, filters, evaporators and vacuum pans was noticed.

This capacity is in the case of the clarifiers a damaging factor. Over-capacity here leads to excessive retention time of thin juice at high temperatures and will cause unwanted destruction and needless color formation in the juice. This will be the case in particular when pH values of the treated juice are varying greatly, as they must do with manual control, and local overliming can occur. The undesirable color increase can be great and can completely reverse the decolorising effect of the SO_2 treatment.

Modern development in juice treatment is aimed to reduce clarifier retention time (Australian trayless clarifier) were possible by causing fast sedimentation by the use of modern treatment and chemicals.

The latest technique of filtrate clarification, sending treated filtrate to evaporators, is aiming to climinate the recirculation of filtrates. This can allow in turn for a clarifier volume reduction as mixed juice on itself, properly treated, clarifies faster than in presence of recycled filtrate.

It is advisable where possible to reduce the clarifier volume to give the treated juice a retention time of 2.5 hours maximum. In most factories at least one clarifier can be left empty, to the benefit of the process. The high molasses losses could be the result of the excessive retention time for the juice in the clarifiers.

Pan Boiling Operations

The observation of the massecuites in the vacuum pans in Kous and Armant showed very clearly that the treatment of all pan feed material (dilution to 70° brix, mechanical agitation and heating to 60° C) results in very uniform crystals in all massecuites. The practical absence of fines and the crystal regularity enhances the sugar purging quality.

This treatment used to be standard in all sugar boiling operations, but for some time even in the latest built sugar factories this treatment is neglected and even forgotten in the lay-out and design until pan boiling, sugar quality and molasses exhaustion become a problem.

Therefore it is very strongly recommended to insist that the Kous/ Armant type pan feed treatment systems are installed and used on the pan floors of other sugar factories as well.

The heating coils should be kept well below the operation level of the installation and the stirrer should be kept going till after the steam is turned off. This will prevent and minimise possible color increase by local overheating, the normal execuse used for not wanting to use the treatment.

At the sugar drier and sugar bagging stations plenty spillage of sugar was noticed which must represent a substantial loss, even after the greatest effort to collect most of it. The collected sugar needs reprocessing in the following season. Methods to prevent this spillage should be looked into. Maybe it is mainly a matter of more supervision.

The above mentioned recommendations for the different production stages are covering the minimum needs for the four factories visited. As the other three are not of a later design, these recommendations might be taken into consideration for those factories as well.

ANNEX 1

VISIT TO THE HAWAMDIAH CENTRAL LABOATORY

AT 22nd May 1985

The central research laboratory was visited with Dr. Aida Abdel Kader the general manager of the laboratory.

The laboratory has a staff of three persons which include Dr. Kader. It has a library of technical books and professional magazines, bound together or arranged in years of their publication for ready reference concerning the cane sugar industry.

The laboratory itself is spacious and seems to be devided in partitions each with their instruments for various analysis, however a considerable number of these instruments are old or even very old and are in need of replacement by their modern counter parts. Due to the old equipment and also due to the absence of certain other instruments, they often have to take the material to be analysed to one or other University laboratory in order to complete the testing.

This parctice is certainly a waste of much time and effort considering the traffic condition in and around Cairo. This necessity does not improve the efficiency of the research laboratory.

Besides some academical research, such as decolorization of sugar by the use of Ion-exchangers in refineries and the chemical composition of bagasse ash, there is more routine checking work done on factory products like sugar and molasses as well as investigations in factory problems e.g. scaling in evaporators and high turbidity in clarified juices.

The work on factory problems is done on site in which case the needed checking equipment is brought from the central laboratory when possible.

Most of the research laboratory's work can only consist of the above mentioned work in absence of a proper pilot-plant as a research and training factory.

With a pilot-plant the research could be extended to a larger scale than that of the laboratory glass ware and the results of experiments could be followed through into the succeeding stations of the sugar manufacturing process. The larger scale of the experiments is not the only importance, but also the possibility to reproduce the actual factory work in a much more exact way than ever can be done in a laboratory..

Modifications to operational methods could be tried without the possible waste of a large amount of material as on a true factory scale.

However, in the absence of a pilote-plant relocation of the sugar research laboratory near a sugar factory would improve the range of research with the possibility of obtaining fresh material at short notice. Relocation would also give the oppotunity to equip the sugar research lab. with modern instruments and with installations and testing apparatus more directly related to the sugar factory.

Because of the big size of most Egyptian sugar factories the research and development without a pilot size installation will be limited to laboratory experimentation.

The Laboratory for the Research and Development Centre at Kous

This laboratory will have to be quipped with instruments more specially used for cane sugar factory research. These instruments and equipments have been specially designed for, and sometimes even by, the cane sugar industries in order to be able to analyse material and products particular to the cane sugar factory. Much of this equipment can normally be encountered in the sugar factory's laboratories. For a research laboratory it is advisable also to have some instruments for ordinary chemical analyses.

The material and factory products to be analysed should be collected at the main factory and transferred to the research laboratory in the shortest way. This is very important for material in the form of the thin juices from the factory, as they can deteriorate fast in a hot climate. The use of some form of transport might be necessary,on arrival at the laboratory these samples should be stored in a fridge while preparations are made for the analyses.

The kind of research work to be done is very much depending on the need for investigation in the factory, however it is also depending on the initiative of the person in charge. When the very apparent and needed research is taken care of, experiments could be carried out in order to obtain general knowledge about factory material or work.

If a pilot-plant or small research factory is not supplied for the Research and Development Centre the experiment possibility will be very limited and the research work restricted to the possibility in the main factory.

A list of the proposed particular cane sugar laboratory equipment is supplied herewith and quotation is sent for. Some examples of work the laboratory can and should engage in are the following:

With the salometer conductivity ash should be compared to sulphated and carbonated ash done with muffle furnace, of all following products - mixed juice, clear juice, syrup, sugar and final molasses. This should be done weekly through the season. Conductivity ash determinations are faster and less tedious.

Reducing sugar determination with electrically indicated end-point should be done with all juices starting from crusher juice and intermediate juice (also diffuser stages) including syrup and final molasses. Should be done weekly through the season to obtain a pattern of R.S. levels.

Mixed juice and clear juice phosphate levels should be checked also weekly to obtain a seasonal pattern.

With the satura-scope the massecuites of the factory should be tested. The crystal shape and uniformity of these products should be studied and in particular the crystal malformations caused by stale cane and various dextran levels of the juice.

Molasses (mother liquor) purity drop through the cooling system of the continuous crystallisers for the C-massecuites should be studied as well as the primary exhaustion of the A and B masses obtained by their cooling possibilities. The colour of juice should be tested, starting with crusher juice, where contact with stell has been minimal and colour should be close to the cane juice's natural colours, through to dewatering mill juice and mixed juice, treated juice, filterate, clear juice and syrup. This should also be done on weekly intervals through the season to detect a possible pattern of colour.

Direct analyses on cane for brix, pol % and the fiber content should be done on a regular basis as cane is received and/or whenever the quality of cane is questioned. The deterioration rate of the cane should be studied over various days of storage of a cane sample.

Samples of sugars and final molasses accumulated over 10 day periods should be checked. It is assumed that this would be done on the same products of all sugar factories.

For the off-seasons research with or without a pilot-plant, it will be difficult due to a lack of material to work on, most factory intermediate products cannot be stored except for sugar, final molasses and heavy A and B molasses with a brix of 85 or higher. Experiments could be made with very cold storage or freezing of juice and comparing the subsequent analyses with the ones done at the time of collection of the samples.

There is a possibility to obtain cane in small quantities of varying age to be analysed for its seasonal characteristics. Straight forward chemical work could be done with or without trainees, whenever considered necessary.

When a pilot-plant or research factory has been installed, commissioned research work as mentioned above should still be carried out, possibly at longer intervals to make room for the experiments to be done with the research factory.

Of priority is the testing of the parameters presently maintained in the production process of the main factory. These parameters are mainly the values of the PH and temperatures of the juice treatment and the retension times during the treatment and clarification.

Experiments should be made with variations in these paramters.

A more scientifical research could possibly cover the following items:

The influence of physical characteristics of sugar cane and sucrose availability.

The influence of non-sucrose in cane on juice clarification, evaporation, crystallisation and molasses formation.

The influence of different saccharide compounds from fertilisation of cane sucrose echaustion and colour formation in juice during evaporation.

The influence of micro-organism activity on flow characteristics of sugar cane products, radio-active substances which can be used to mark certain materials and trace sucrose losses.

The programming of the research work depends on the priority of each item to be checked. Bearing in mind that most cane sugar factories in this industry are producing mill-whites or direct consumption sugar it can be considered that the analyses on phosphate levels, reducing sugar content of the juices and a colour record or balance through the entire process, are very important.

Special laboratory equipment for cane sugar industry

- Refractometer 60/70, code 10-01, with spare prisms
- Salometer, model K
- Saccharascope
- Rotary dissolving machine (for sugar flasks)
- Reducing sugar estimation
- Crystal observation equipment
- Automatic digital polarimeters (impersonal observation 546 mm mercury)
- Laboratory high speed centrifugal
- Sima wet disintegrator (direct cane analysis)
- Moisture teller (Dietert) with hour timer and spare bagasse
- High speed disintegrator, 2 litre
- Moisture balance, type D (sugar)
- Pocket PH-meter (battery operated model)
- Sartorius single panbalance, max. 200 grs
- Sartorius top pan balance, 3000-6000 grs, with tare
- Vacuum pump/compressor (lab. size)
- Jeffco wet disintegrator, model 291 (bagasse + knifed cane)
- Laboratory roller mill, grinding and mixing
- Set of teiler sieves on shaker
- Stirrer, hotplate/magnetic
- Viscometer "Falling Ball" model B

- Talameter, special sugar colorimeter (Icumsa m.4)
- Platform scale, max cap. 60 kg, div. 20 grm
- Hand-refractometers, 0-50° and 40-85° brix.
- Sample mill for cane

More usual laboratory equipment

- Polarimeter model A (manual visual)
- PH-meter (mains)
- Thermostatic muffle furnace N2 (4" x 6" x 8" internal)
- Thermostatic oven (model JJK)
- Laboratory stirrers
- Still for distilled water
- Water bath, large cap. thermostate control
- Hot plates, one single, one large heating surface with control settings
- Colorimeter with 3 filters
- Microscope, possible magnification range 50-1000
- Flame photometer

The Training Centre at Kous Factory

This centre is divided in two sections, presently a one-story building with a large number of rooms occupied and equipped as lecture rooms and training workshop for electricians, welders, fitters and mechanicians. There are two projectors and a video set available.

Next to this building are two more buildings under erection. One is a four-story building intended as a hotel or hostel for students and the other one is a two-story building purposely designed with workshops and lecture rooms for each of the mentioned technician groups.

The single story building will in due course become available to the second section of the training centre.

The production section or sugar institute is at present occupying some rooms above the factory laboratory amongst the factory offices.

This sugar institute is to train factory process operators, from juice heater attendants, operators of milk of lime and SO_2-gas preparation stations. Juice treatment and clarification attendants, evaporator operators, sugar boilers, centrifugal operators, crystallizer attendants, etc.

This section has no training equipment at present.

There are approximately 60 trainees of which about half are in the second year of training.

The subjects in the existing training programme are chosen over a wide range to give the trainees a broad base of understanding what is involved in the course of the manufacture of sugar.

As can be seen from the training programme about 75% of annual time is used for practical operational work in the season and practical cleaning and maintenance work out of season.

The remaining 25% time, mostly in the afternoon hours out of season, is used for the wide range of informative lectures covering subjects as listed in the programme.

The training and its programme as set out and practised is of an unusual high and wide ranged standard for factory production operators.

Usually new factory operators are trained locally in their factory as second man, on the station he is intended to operate later. Training time depends on the kind of operation required, e.g. sugar boiling usually takes an apprenticeship of a minimum of 5 years, other operator training is mostly completed in one season.

In case some lecturing is done, reproductions and photostatic copies of drawings and photographs from sugar handbooks and engineering manuals and books are used.

Other instruction material such as films, slides or video films covering a part of or the entire sugar production are not normally used, as the scale of the training is usually small and often only seldom needed. It is doubtful whether this kind of material is obtainable in another form than for advertising a certain kind of equipment. Even that form will not cover all sugar factory machinery.

When these training materials are considered to be really necessary for the centre, it is advised to produce these locally with the aid of a good photographer.

In order to make the training course more universal a variety of each main process machinery should be discussed, their differences pointed out in particular where the modern treatment and processes involve new designs.

In the meantime photocopies of equipment should be made and used as long as no more modern instruction material can be obtained.

Present programme of the sugar institute:

First year students:

(a) From the start of the season

Students are in the factory on shifts at various stations:

1. Cane preparation, milling station, actual extraction by mills and diffusers ..... 1 month

2. Clarification stations:
- Preparation of milk of lime
- Preparation of SO_2-gas
- Juice heater operation
- Clarifier operation
- Vacuum filter operation

..... 2 months

3. Evaporator operation

..... 2 months

(b) After the season:

First year student work on maintenance of the station where they worked:

Theoretical

- Electrical engineering	**from 7 - 12 noon** **from 12 - 15 p.m.** by factory electrical engineer
- Drawings	by draftsman
- Mechanical engineering	by mechanical eng.
- Agricultural training	by agricultural eng.
- Laboratory training	by chief chemist
- Sugar technology	by production chief of shift

- Physics and chemistry	by factory chemist
- Mathematics	by chief of shift
- Safety methods	by safety engineer

Second year students:

(a) From the start of the season

- Pan-boiling	..... 2½ - 3 months
- Crystallisers	..... 1 month
- Centrifugals	..... 1 month
- Driers	..... 2 weeks

(b) After the season

Maintenance in the factory	from 7 - 12 noon
Theoretical	from 12 - 15 p.m.
- Sugar technology	by production chief of shift
- Electrical engineering	by electr. eng.
- Steam boilers	by mechanical eng.
- Workshop	by mechanical eng.
- Drawings	by draftsman
- Physics	by factory chemist
- Chemistry	by chief of shift
- Material selection, project planning, trouble shooting	by production chief of shift

Theoretical exams

At the end of the year of training each student is asked to make a report (essay or treatice) about a station or subject given to him by the course leader. The report is discussed later with the tutor.

Training school for sugar production **Production department**

Subject index for the first year

Ser. - Subject	No. of lectures
1. Sugar Technology:	24
- Composition of juice	
- Carbohydrates - sucrose - glucose - fructose	
- Combustion of sulphur furnace	
- Milk of lime preparation	
- Purification	
2. Sugar Technology:	24
- Filtration - continuous filters	
- Evaporation - multiple effect evaporators	
- Clarification - continuous clarifiers	

3. Mechanics/Mathematics: 24
   - Measuring instruments - Newton's laws
   - Velocity - speed - acceleration
   - Clearances (Fits) - work - energy - power
   - Vernier - micrometers - bolts and nuts

4. Operating Instructions: 24
   - Test operation for equipments

5. Control: 24
   - Chemical control for the steps of processing

6. Agriculture of sugar cane: 24
   - Formation of sucrose in sugar cane
   - Plant pathology
   - Diseases of sugar cane
   - Morphology and anatomy of sugar cane
   - Photosynthesis
   - Effect of frost damage

7. Electrical Engineering: 24
   - Ohm's law - electrical circuits
   - Resistivity
   - Calculation of the cross-section of cables used in electrical circuits of the sugar mill
   - Explanation of the electrical circuits of the sugar mill
   - Problems and their solutions

8. Engineering Drawings: 24
   - Drawing of mills - diffuser - heaters - evaporators - filters - clarifiers - SO$_2$ furnaces and the factory equipment

9. Industrial Security: 24
   - The aim of the industrial security in processing
   - The equipment of the industrial security
   - Losses according to lack of security

10. Mechanical Engineering: 24
    - Equipment - pumps - gear boxes - valves lubrication

11. Mechanical Engineering: 24
    - Mills - steam engines - carriers - conveyors - belts and chains

Subject index for second year

Ser.	Subject	No. of lectures
1.	Sugar Technology: - Super heated steam - saturated steam - exhausted steam, valves - kinds of losses - How to decrease the losses	24
2.	Sugar Technology: - Testing of equipment - operation manuals of pans - centrifugals - driers - crystallizers	24
3.	Problems in processing and how to solve them	24
4.	Sugar Technology: - Pans - vacuum - cooling of M.C. - centrifugation - washing of sugar - drying - packing	24
5.	Sugar Technology: - Thermal balance - Calculation of Brix balance	24
6.	Physics - Chemistry: - Measurement units - length - area - weight - volume - density - state of matter - steam - boiling point - specific heat - latent heat - super heat - saturated and exhausted steam - manometers - thermometers	12
7.	Physics - Chemistry: - Precipitation, solubility - saturation - composition of juice - carbohydrates - PH value - the effect of temperature and acid medium of sugar inversion of sucrose	12
8.	Engineering Drawing: - Factory equipment - pans - centrifugals - crystallizers - driers	24
9.	Mechanical Engineering: - Pumps - vacuum pumps - compressor - bearings and housing - driers	24
10.	Mechanical Engineering: - Mill - steam turbine - gear box - start and stop of the steam turbine - hydraulic pressure	24

11. Boilers: 24
    - Different parts of boiler, cleaning and maintenance
    - Characteristics of feed water - the fuel used (Bagasses - fuel oil)

12. Work Shop - Jobs: 24
    - Forging - machine tools - auxiliary machine - machine - principal motion - drilling machine - lathe

13. Industrial Planning - Organization: 24
    - Work study - process preparations - design and projects - central planning

14. Electrical Engineering: 24
    - Inductive current - self induction, electrical units (A.V.) - photo cell, and application - protection from electric damage - trouble shooting.

ANNEX 4

POSSIBLE EQUIPMENT FOR PILOT-FACTORY :

Capacity 5 TCD, or 250 Kg/hr at 80% time. Cane cutter or shredder for prepared cane to five 3 roller mills, 228 mm diam x 305 mm long rolls positioned with inter carriers or shoots, water before last mill, variable speed pumps for maceration in parallel position with mini-diffuser fed by cross-carrier after 1st mill and juice from 4th and 5th mill or by-passed.

A juice strainer (mini-DSM Type) after first mill.

Juice pump through heater or by pass, to two juice holding tanks of 300 Lts. total capacity juice pump (through mentioned heater or by-pass) to Liming Tank, capacity 25 Lts. 300 mm diam x 500 mm H. with variable speed stirrer in centre well and fixed over-flow for retention time continuous operation, to

Limed Juice pump, with re-circulation possibility, to reaction tank for SO_2/CO_2- gas treatment, with variable speed stirrer, capacity 25 Lts., 300mm dim x 750 mm H.with vapour extraction and steam jacket or coils, and fixed overflow;
Treated juice pump, with re-circulation possibility, to filter, with 1 m^2 F.S, or through heater to clarifiers : one with capacity of 63 lts. 1000 mm diam. x 800 mm h., 30^o cone bottom, with two trays variable speed drive on mud scraper; for trails and discontinuous operation .
Second Clarifier , capacity 750 lts, 5000 mm diam. x 3800 mm h., with two or three trays, etc., same as above, for continuous operation simulating real factory operation.

From clarifiers gravitation to filter and clarified juice holding tank, capacity 300 lts. clear juice pump, possibly via pre-heater, to evaporators, four vessels holding 150 lts. each
(800 mm diam. x 2500 mm h.) total 7 m^2 H.S, with possibility to operate under pressure and / or vacuum, as single, double, triple and quadruple effect.

Variable speed pump with vacuum balance to evap.
Condensors, barometric and jet type, large capacity with its own pumps.
Holding tanks for syrup for 300 lts. capacity.
Three vacuum pans, with 1.6 m^2, 0.7 m^2 and 0.3 m^2 H.S. with possible volumes 800 lts, 350 lts. and 150 lts, vacuumm connection to condensors of evap.
Whenever possible gravitation from pan discharge to three cooling crystallisers with water cooling and capacities according to the volume of each of the pans (resp. 900. 400 and 200 lts.)
Gravitation from crystallisers to charge
Two batch centrifugals, capacity 8 kg. and 40 kg. per charge, with variable speeds.

Mini rotary sugar drier, with feed hopper, heat regulator and variable speed blower.

Three molasses holding tanks, 200 lts each with steam coil.

Steam boiler, 200 kg/hr of 180°C and 10 bar.

Diesel generator of 50 kwh, 380/220 volts.

Instrumentation should include:

PH - metering for juice treatment,

Pan- microscope and cuitometer for conductivity boiling, temperature, pressure and vacuum gauges. If possible one vac-pan should be equipped with a mechanical stirrer(variable speed & top drive)

For tansfer pumps possible recommendable the mono - pump type with variable speed with D.C. motors

Pipe sizes to be considered 1" or 25 mm, 3/4" or 20mm ans ½" or 15mm.

Final Conclusions and Recommendations

At a meeting with the National Project Director Mr. El Sawah, Mr. El Naggar, Director of the Sugar production section and Ms. M. Hetata, UNDP Programme Officer and the writer, the findings on the project were discussed and the following conclusions and proposals were arrived at:

1) The research by the Central Laboratory was considered to be practically exhausted and there was no possibility to establish any more extensive research on the present basis. Even the new Research and Development Centre's Laboratory to be set up at Kous will not be able to do much more new research into factory operations. The factor is too big to experiment with.

2) Installation of a pilot-plant or research factory is the only way to enable more extensive research in the present mode of operations and possibly develop improvements to make the sugar production more efficient.

3) In order to further assess the requirements of a pilot-plant and to arrive at the possible costs, it was recommended to request a visit from Professor J. Delavier of the University of Khartoum.

   A visit of approximately two weeks was proposed by Mr. El Sawah.

4) A reply is awaited on a request for a quotation for typical cane sugar research equipment for the new Research Laboratory at Kous. A possible order would be placed nearer to the time of completion of the Research/ Training Centre.

   Equipment for chemical analyses as presently done by the Central Laboratory in Hawamdiah are not included on the list as they are of the more generally obtainable kind for laboratories, however, they should be obtained for the new laboratory as well.

5) The training programme and the range of subjects lectured, were considered to be of an unusually high level for factory operators and supervisors, but Mr. El Sawah expressed his dissatisfaction with the method of lecturing. It was therefore decided to ask UNIDO for an expert on educational methods, with good knowledge of the cane sugar industry. That expert would be asked to look into the teaching method presently applied in Kous and advise on changes and improvements.

   An expert of these qualifications could possible be contacted at the Louisiana State University, Andobon Sugar Institute in Baton Rouge, U.S.A., or otherwise at the C.S.R. Ltd., Sugar Division, P. O. Box 1630 CPD, Sydney 2001, Australia.

As the writer is not at all familiar with educational matters, he is not able to give a much more elaborate description of the expert needed.

6) The participants of a study tour were soon to be selected and mentioned to UNDP Cairo. For the observation of research facilities and pilot-plants, a visit to the Indonesian Research Station at Pasuruan in East Java would be very useful as the research factory there is of a suitable size for Egypt. The Research and training factory of the Andobon Sugar Institute in Baton Rouge, Louisiana, U.S.A. should certainly be considered as well.

For the study of training methods and facilities a choice could be made between the following institutions:

The C.S.R. Ltd, Sugar Institute in Sydney, Australia
The Mauritian Cane Sugar Research Institute, Mauritius
The Khartoum University, Sudan
The Berlin Sugar Institute, Germany

The study tour's programme could be split over two years to facilitate the visits to different parts of the globe.

It should be born in mind that several if not all these institutions are training for a high level of staff for the sugar industries, e.g. production chemists and/or superintendents of production, possibly at B.Sc. level.

During the meeting Mr. El Sawah assured that the Sugar Company can make the modifications needed to up-date the factories and in particular the production processes according to the findings of the Research and Development Centre in due course.

Awaiting replies from Professor Delavier and the Sugar Manufacturers Company on the request for quotation it was concluded that nothing else could be done at the moment to promote the project any further.

The findings and recommendations to the Sugar Company are set out in this report.

ANNEX 6

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO 30 January 1985

PROJECT IN THE ARAB REPUBLIC OF EGYPT

JOB DESCRIPTION
EGY/81/010/11-01/31.7.C

Post title	Cane Sugar Technologist/Chief Technical Adviser (CTA)
Duration	Six months, split into two or three assignments within the period of one to one and a half year
Date required	As soon as possible
Duty station	Kous (Egypt), with travel within the country
Purpose of project	To strengthen the technical and training capacity of the Sugar Research and Development Centre at Kous

Duties

The CTA, in close co-operation with the National Project Director and the staff of the Centre, will be expected to:

1. Assist in making an overall assessment of the technical, technological and economic operation of the existing cane sugar industry in Egypt with the aim of determining future activities of the Centre.

2. Assist in preparing a programme of the Centre's future activities in respect to:
   - research and development;
   - extension services to industrial plants;
   - training of national staff in various fields of specialization.

3. Assist in the preparation of specifications for laboratory and pilot plant instruments and equipment as well as for teaching aids.

..../..

4. Prepare a detailed training programme and assist in the preparation of training material.

5. Co-ordinate the activities of international consultants and assist in their selection and description of duties; and the preparation of their reports.

6. Assist in the preparation of a study tour programmes and programmes of other activities to be carried out within the project.

The CTA will also be expected to prepare periodic reports on the project activities as well as a final report summarizing all the activities, including those of the individual consultants, and setting out the findings of the project and recommendations to the Government on further actions which might be taken.

Qualifications — Food or canesugar industry technologist/engineer with an extensive experience in the operation of cane sugar industry, research and development activities, and training of technical personnel.

Language — English