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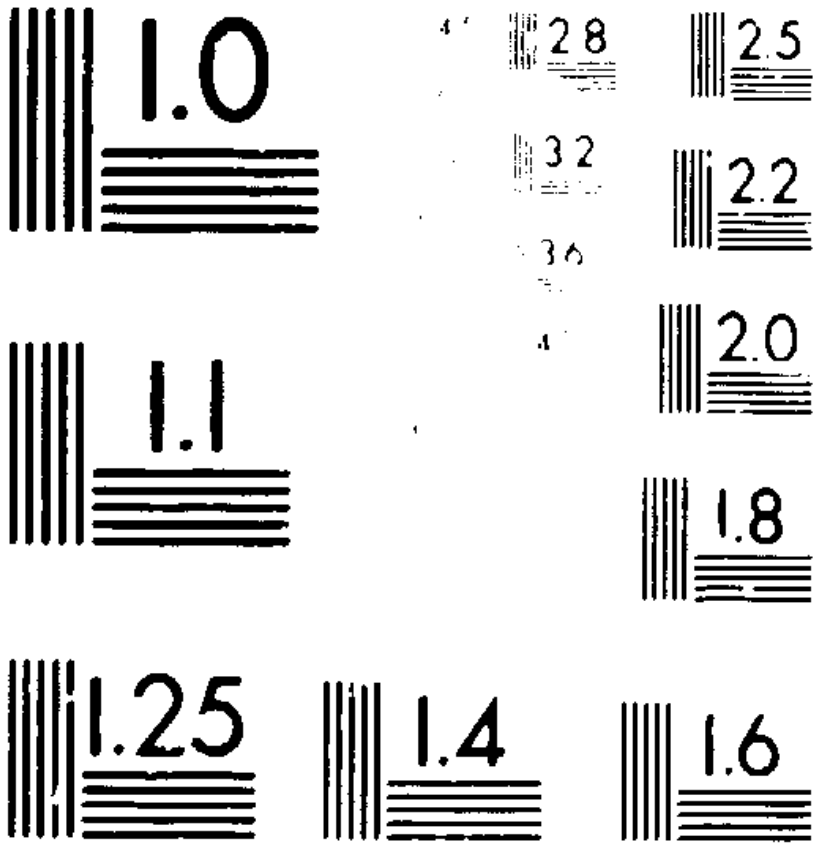
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org



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ADVISER ON PRODUCTION OF GLASS BOTTLES /
SI/CUB/81/802
CUBA

Terminal Report*

Prepared for the Government of Cuba
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations
Development Programme

Based on the work of G. Geier, expert in the
Production of Glass Bottles

2743

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ABSTRACT

Title: SI/CUB/81/802/11-01/31.7.E

Purpose: To make best use of production capacities for glass bottles and to improve quality of the products of existing plants.

Duration: Six months to assist two glass manufacturing plants in raising productivity and quality by analysing existing production facilities in the daily production process.Detect problems and offer solutions for remedy.

There are two fully automatic container producing plants in the country which are responsible for more than 90 % of containers produced.Both factories namely 'Las Tunas' and'Orlando Cuellar' in the following called'San Josè plant suffer from low productivity and low production efficiency.Whilst the'San Josè' plant's equipment is partly outdated has the 'Las Tunas'plant modern facilities of international standard.

The mission concentrated on two main topics which in the view of the expert must be improved to achieve the main objectives of improving productivity and overcoming of production problems by :

a) Standardizing of furnaces and equipment and products

b) Creation of better and more efficient production conditions.

Recommendations to a) for both plants

1, Introduction of one type of standard furnace of 150 tons glass pull per 24 hrs of high international standard to overcome the phenomenon of early destruction of furnaces which causes immense losses in production and expensive refractories. It will

further more reduce high costs of stock keeping of refractories, ruduce costs for moulds of special-shape refractories inevitable when constructing a furnace and last not least the design costs will be reduced to one prottype only.Modern furnaces are nowadays so advanced that not much development can be expected in the near future.(see also page No. 23 and 24)

2, Standardization of hot-glass-forming equipment to two types of EMHART 8-section I.S. 4 1/4 and 5 1/2 inch cc machines in press-blow and blow blow process single and double gob on which in practice all commonly used containers can be produced. Standardizing of feeder to only two types namely Hartford 81 and 115 type.Use of only one type of annealing lehrs. Thus stock keeping of spare parts can be reduced and considerable money saved.

3, The standardizing of products should be pushed ahead to satisfy producer and user,save fuel,reduce raw material costs and run higher speeds of machines.Norm sheets for such containers are available.

Recommendations for 'Las Tunas' plant to b)

1, Complete overhaul of 6 EMHART 8-section machines (C-repair);

2, Use of imported moulds for the time being or purchase of good quality of special-mould-cast-iron or semi fabricates for better quality of moulds.(cast iron is the cheapest component of mould costs);

3, Import of special mould lubricant like 'Cleen Mould' or other equivalent;

4, Improvement of compressed air supply by reducing the at present

very high moisture carried to the mechanisms of EMHART machines;

5, To call in a team of 7 expatriate experts to assist in operating the plant for at least one year.

These measures can be accomplished in a relatively short period of time and will as a result raise production and quality of products decisively and will also ensure a smooth operation of the plant.

6, For the near future the two existing furnaces should be redesigned with strengthened crowns and under-port-firing to ensure a life campaign of 5 to 6 years as it is nowadays standard. Planning for such a modification should start immediately since according to the present condition of both furnaces it is unlikely that they will run a full campaign.It is highly recommemded to entrust such a task to a well reputed company specialized in glass melting furnace construction.

Recommendations for the 'San Josè' plant to b)

This factory needs a comprehensive redesigning of present production facilities .Taking into consideration the favourable conditions for a future computerized planning and control of production and possible standardization as well as the increasing demand in container glass it is recommendable to orientate the complete planning in direction of standard furnaces and standard equipment.This in other words would mean furnaces with a daily capacity of 150 tons and EMHART 8-section machines.However such programmes will reach into the nineties and therefore will not affect immediate needs for higher production.To suffice such needs and since the I.S. 8 and 6-section machines are likely to be integrated at least for a certain time in the future it is recommended :

1, To overhaul all EMHART 6-section machines and feeder completely and upgrade them as far as possible to modern standard.

2, To equip at least one of 6-section machines with the new EMHART T 600 ETS (electronic timing system) to prepare and train personnel on this equipment before introducing entire lines in the future;

3, Complete overhaul of forehearth control equipment (temperature) which now is switched on 'manual' instead of 'automatic';

4, To purchase better moulds or at least special-mould-grey -cast-iron for moulds to be manufactured at the plant.

5, To go ahead with the first phase of planning to replace furnace A and B by one 150 tons capacity modern furnace and two EMHART 8-section and one EMHART 6 section machines. This scheme may be repeated twice to reach in its third phase a daily output of approx.450 tons of glass after replacing all 6-section machines.

INTRODUCTION

The government of the Republic of Cuba has in view of available raw materials in the country developed the glass container industry extensively to a) satisfy the increasing domestic demand and b) also in view of possible exporting of container glass.

Two factories in the country are at present responsible for the production of more than 90 % of container glass manufactured. These are 'Orleando Cuellar' in San Josè and 'Las Tunas' in Las Tunas.Whilst the 30 years old factory in San Josè was expanded twice the Las Tunas plant is in operation only for 3 years.The latter plant is equiped with modern production facilities of high international standard.Both factories work with EMHART glass forming machines of different age on which nowadays 75 % of world production of container glass is manufactured.

Both factories suffer from an overall very low productivity and production efficiency.The writer of this report has refrained from evaluating the accurate figures for their complexity which for this reason will not reflect the real situation.Such factors to mention only a few are : Short life campaign of furnaces and frequent repairs of them,idle standing production equipment, too long shut down periods of glass forming machines,power failures and low plan-production-targets.

It is to the best of the writers belief that the overall production efficiency of the San Josè plant is at present not more than 60 % and that of'Las Tunas' less than 45 %.From the economical point of view an unbearable situation.Comparable to standards of developed and partly also in developing countries the overall efficiency should be at between 80 and 90 %.

In 1981 the Ministry of Basic Industries of the government of Cuba through the executing agency,the Centro National de Envases

y Envalajes (CNEE) approached UNIDO for technical assistance which was approved and granted on a Special Industrial Services base which is restricted in duration to 6 months.Due to other commitments of the expert it was mutually agreed upon that the mission should be split into two terms of 3 months each. The first term started with the arrival of the expert in December 1983 and the second term in May 1984.

In accordance with the request of the government the expert was expected to:

...Analyse the machinery installed and the system of operating the San Josè plant with a view to defining the maximum production capacity and the highest quality levels;

...Study and carry out adjustments to the machinery and rationalization of the methods of operating that plant in order to improve their output as far as possible;

...Make arrangements to ensure the start up of operation in the shortest possible time and maximum utilization of the new glass bottle factory 'Las Tunas';

...Analyse the factors affecting the quality of production and assure that it is improved to the maximum extent aompatible with the technical and economical operating conditions of the plants;

...Train the key operational personnel of both bottle plants;

...Detect proolems which might arise in the production and offer solutions to these problems;

...Study existing production programming methods with a view to deriving the maximum possible benefit from the istalled capacity;

... Study the policy for maintaining and repairing the bottle forming machnines.proposing organizational and technical methods for their better use;

... Study the policy for the operation and repair of the glass melting furnaces,proposing ways to improve their operation.

Already during the first term of the expert's mission it became obvicus that due to the complexity of problems found a single expert is not in a position to achieve the desired results. The authorities therefore in accordance with the expert's recommendations requested through the Resident Representative, Mr.Roland Reifenrath,further assistance from UNIDO with letter of 10 August 1983.This assistance could not be granted by UNIDO for the high amount of money involved and other reasons.

The second term of the mission concentrated mainly on the 'Las Tunas'plant which in the first part for lack of time was neglected.This factory deserves highest priority to develop and consolidate its full potential which at present is far away from its originally envisaged production targets.

There is a lack of knowledge in glass technology for which some lesson were held and one booklet was distributed written by the expert to both plants.Extensive discussions took place in furnace operation,maintenance and technology.

In the following two chapters each dealing with one of the container producing factories the expert will in accordance

with the request of the government of Cuba line out what in his opinion necessary measures have to be taken to achieve the objectives namely to raise production and improve the quality of containers of the plants.He.therefore,will neglect production auxiliaries which are not directly involved in the production process like batch house,compressors and 'cold end' of the production lines.

I. 'LAS TUNAS' PLANT

Findings:

The 'Las Tunas' plant since the last visit of the expert one year ago has improved in many ways. The factory is clean, production flow is well organized, rejected glass in cellar is properly cleared and in contrast to last year the automatic sorting equipment at the 'cold end' is working although with low effect due to bad quality of glass ware to be sorted.

The main problems are the hot-forming-process and coming up signs of weak points of the super structure of furnaces. The latter not affecting yet the production.

Another very severe point which affects the production adversely is the frequent power interruptions beyond the control of the factory's responsibility. As a result production is disrupted, machines dissynchronized and forehearths getting out of control. After restoration of power supply it takes hours to get back the equipment to normal working conditions. During the stay of the expert in Las Tunas an average of three power cuts a day occured lasting some times up to 3 hours. The installed electric generators are not sufficient to maintain the full production process.

A. The hot-forming-process

The low performance of the modern 6 EMHART I.S. ETS (electronic timing system) machines is responsible for the low production efficiency and the low quality of containers produced. The factory after a few performance test runs of the equipment was commissioned

and left allone to the Cuban staff and personnel which although trained in Belgium could not cope with the multiple problems arising at the daily work.A situation frequently found in development countries and even in developed countries.However common practice is in developing countries to provide after commissioning of key-ready plants a skeleton staff or even management to run or assist in running the plant for at least 3 to five years.During this time sufficient experience is gathered to continue independently with the local staff.Since this was not the case as a result the machines can not exercise their normal function anymore.Mistreatment of machines,moisture and rust in the mechanisms of the machines,disrupted central lubrication pipes,damaged holderings by hammer or colliding mechanisms have caused the condition in which at present the machines are found. Also long stop over of machines are adverse to the good function of a machine.As a result moulds are demaged rapidly so that mould maintenance can not cope with the repair work due.

It is obvious that under the prevailing conditions with functional disorder of EMHART machines a normal production on such a sophisticated equipment is not possible anymore.

Recommendations

1. General overhaul of all six EMHART 8-section ETS machines (C-repair) performed by an EMHART engineer including feeder and temperature control equipment of forehearths.After this measure the machines will be virtually new;

2. Restoration of the entire after cooler (condenser) system of the compressors supplying air to the mechanisms of the EMHART machines which are most likely affected by rust of oxidation which blocks the piston rings so that dampering is not possible anymore.All rubber hoses respectively the pipe tips for cleaning I.S.machines must be equiped with

selfclosing valves to avoid excessive compressed air consumption.No compressed air must be used for personnel cooling purposes to reduce air consumption and keep condenser temperatures as low as possible and the velocity of air inside the condenser low;

3. Provision of a good brand mould lubricant like'cleen mould' or Acheson is imperative to run machines successfully.Excessively deposits of carbon and lubricant are thus avoided which lead to irregularities during the hot forming process;

4. Provision of good moulds or at least semi fabricate moulds or raw-grey-cast-iron of special mould quality to manufacture own moulds is absolutely necessary for a smooth production.The main task of moulds is to shape the hot glass and to take away the heat of the liquid glass to become solid.If the heat flow is by porosity or gaseous inclusions interrupted and not smooth on the surface by porosous cast iron moulds can not fulfill their purpose and faulty glass ware will be the result.
One set of moulds should consist of 1 blow mould,2 blanc moulds and 6 neck rings complete multiplied by a certain factor which after 3 years of experience can be determined by the responsible staff and may vary by local conditions.Appropriate supply of alloy-steel powder for spray welding of damaged moulds is a necessity for the maintenance of moulds;

5. To recruit a team of expatriate experts consisting of one glass technologist as team leader,one mould maker, four EMHART machine operators and if possible one expert in electronic control equipment.This team should assist in running the plant and specifically the EMHART machines for one to two years.

B. Glass melting furnaces

Findings

To the glass melting furnaces as the most expensive equipment of a plant much attention must be paid in order to run a full life campaign without major repairs.No furnace so far in Cuba reached 5 to 6 years a campaign which can be considered as normal.No furnace builder on the other hand will be able to guarantee a full campaign for it is easy to damage a furnace. In the 'Las Tunas' plant both furnaces after 3 years of operation show signs of weak points on the super structure (crown and side breast walls).The over-port-firing is unfortunate and may also affect the glass colour negatively by bouncing of the flame onto the batch respectively the glass surface in the melting tank.The whole static of the rear furnace port-wall is weakened by the burner block openings which in a furnace normally are affected first.There is light corrosion visible above the flame direction inside the crown which should not affect the crown seriously.Two thermo couple blocks are already burned through which may create serious problems if not repaired very quickly and properly.The crowns of both furnaces with a span of approx. 7 meters and heavily insulated are with 300 mm thickness definitely too weak.The regenerators though requested could not be seen to draw conclusions from its condition in particular in respect of possible dust deposits on the top layers of checkers. Otherwise the furnaces seem to be in good working condition.

Recommendations

1. Redesigning of the rear burner-port-wall to under-port firing which is nowadays standard and strengthen the crown

from at present 300 mm to 375 mm.This work ought to be done by a specialized and renowned company in furnace constrcution to avoid further setbacks.

2. Supervision of furnace reconstruction by the same company. This is nowadays common practice.

3. Careful observation of all parts of the crowns and in case of weak points (red) removing of insulation and in serious cases application of cooling by ventilators or if difficult by compressed air;

4. If gaps appear which are already burned through immediate action must be taken to fill the slots with zirconium silicate patch 150 or with Fondit K or both components together.Fondit K is not available but the equivalent of a Belgian company. If such defects on the crown are patched only on the surface it will worsen the situation.They therefore must be filled thoroughly.

5. Moisten the glass batch in such a way that it enters the furnace without developing dust.This is easily possible with the modern screw conveyer at the dog house .Water content of the batch 4 to 5 %.

6. By no means should a furnace be shut down to carry out minor repairs.The cooling down and reheating of a fired crown requires a lot of skill apart of losses in the production.

7. Clean regularly and carefully the crown in particular the not insulated expansion joints and thermo couple blocks in such a way that no mortar is blown out of the joints and soda ash from batch can enter the joints.In the opinion

of the writer of this report the latter is the cause of damage of the crowns.

8. At least one peep hole should be built in the side breast walls in such a way that crown temperature can be determined by optical pyrometer favourably in the hotest area close to the second thermocouple seen from the rear wall.

9. In case of hot or cold repairs and if acidic and basic refractory materials join together select carefully neutral materials as between layers to avoid contact reactions at high temperatures and early damage.

10. Watch furnace bottom temperatures carefully. 1250 C should not be exceeded. If bubbling is applied temperatures can be somewhat controlled. Much bubbling means higher bottom temperatures and vise versa.

11. Do not apply unnecessary high temperatures for the melting process. The lowest temperature at which a well fined glass is obtained ist the best one. If seeds appear (extremely small gaseous inclusions) in the glass increase temperature in the melting tank a few degrees.

12. Do not operate a furnace under too high pressure nor under too low atmospheric pressure. The right atmospheric furnace pressure is such a pressure at which no air from outside a furnace is sucked into a furnace. A slight overpressure of one to two mm water column is normally sufficient to maintain such condition.

C. Spare parts

The spare part situation for the'Las Tunas'factory is desperate. To maintain in particular the EMHART machines in good working condition it is necessary to keep a good stock of spare parts.

Recommendation

1. At least two sets of mechanisms of the 2 different types of EMHART machines should be on stock at any time for replacement if the need arises.

2. To purchase at least 5 pcs.voltmeters for the 5 volt line on which the electronic and computer is working with digital read out for one-hundredth volt for the electronic timing system of the EMHART machines.

3. To keep at least two sets of C-repair parts on stock and the same quantity of A and B-repair sets.

4. To keep some components of after cooler elements on stock for easy replacement at the compressor site.

II. "ORLANDO CUELLAR" PLANT IN SAN JOSE

Findings

During the first term of this project the production of this plant came practically to a stand still due to collapsing of parts of the factory's roof.Meanwhile the furnaces and eqipment have been overhauled and the factory resumed its full prcduction.The factory was twice expanded in the past and still runs some equipment and machines from its first stage of development.The EMHART 5-section machines are thus 35 years old.

The factory produces relatively good glass ware.In general machine speed is too slow in particular with smaller items like medicine bottles the moulds are too cold and machines too slowly.

The factory has a very good and experienced staff which makes great efforts in reconditionong of worn parts and equipment. However it is the opinion of the expert that such spare parts are of limited value.

The main problems affecting the low overall productivity of this plant is the short life campaign and frequent repairs of furnaces despite of using high quality refractories;Outdated production equipment which should be drawn out of production; Lack of original spare parts for EMHART machines;Low quality of moulds and mould cast iron;Bad lubricant for moulds;Too long shut down periods of EMHART machines.

The entire plant therefore needs to be redesigned whereby old equipment should be replaced by modern lines step by step

in three phases for which according to information received planning is underway which in principal follows the suggestions made in the technical report of the expert of March 1983,page No.34,annex No.2.

Based on growing demand of containers and possible export and taking into account the very favourable conditions for a future computerized production planning and control but also the aspects of standardizing of essencial equipment within a centralized economy of the country gave rise to a entirely new concept.In such a long term planning going well into the nineties the two factories will be able to produce approximately 750 tons of glass daily on 15 EMHART I.S. 8 section machines with a total of 120 sections compared with at present 94.

The standard equipment therefore should be the EMHART 8-section machine and a standardized 150 ton furnace.

At present 7 EMHART 8-section machines are already in operation so that 8 new units would have to be introduced.

At present all furnaces of the'San Josè' plant are operating under high inside atmospheric presure.The furnace crown of furnace D is definitely too weak.

A. Glass melting furnaces

Recommendations

1. Reducing of furnace inside pressure to such a level that slight overpressure is maintained to avoid air of being sucked into the furnace.In general 1 to 3 mm water column overpressure is sufficient to maintain such state.Excessive overpressure affects refractories negatively;

2. Strengthen crown of all furnaces from 300 to 375 mm to ensure longer life campaigns until new and better furnaces are build.Close all unnecessary holes of furnaces and regenerators.

3. To tackle the planning and go ahead with the replacing of furnace A and B by one modern under-port-fired U-flame regenarative unit of 150 tons daily capacity.Specific melting capacity should be 2,5 tons per sq. meter melting area and a fuel oil consumption of approximately 120 g per kg molten glass should be aspired.
   In order to avoid further setbacks it is again highly recommended to let design and construct such a furnace by a reputed company specialized in furnace construction.To keep costs as low as possible several work may be done by local contractors like foundation,steel work and supply, flue channels a.o.to be negotiated.At any rate the company should be commited to provide full construction documentation to facilitate reconstruction by local staff.Such a furnace could serve as a standard furnace for a long time to come since on this sector no great development will take place anymore.

B. The hot forming process

Recommendations

1. Simultaneously with the construction work of furnace the replacement of 2 EMHART 5-section machines by 3 EMHART 8-section machines can take place and of 2 obsolete annealing lehrs.Already after this first phase of reconstruction the factory will yield approx 90 tons of glass daily more.

2. Redesigning of the'cold end' according to requirements and possibilities.Note : Automatic sorting and checking

is only then meaningful if the container produced has reached a certain standard since the sensors of detectors can not distinguish between cracks or other deficiencies of the production process like strong seams,folds or bad mould joints.

3. C-repair for all EMHART 6-section machines by an EMHART engineer and upgrading them to modern standard.At least one machine should be equiped with the new ETS T-600 electronic timing system which is much simpler to handle and better than the first generation of ETS in order to gather experience for the new lines.

4. If necessary overhaul of the Maul 8-section machine.

These measures will compensate somewhat for production losses inevitable during the erection of the new lines.In such a way all lines can be step by step replaced possibly in 3 stages.

5. Better moulds are to be purchased or if manufactured in the factory semi fabricates or raw-grey-cast-iron of special mould quality imported to satisfy modern requirements until better cast iron is produced in the country.

6. Better mould lubricant is imperative to ensure smooth production on EMHART machines.A good brand of 'cleen mould' or equivalent like Acheson should be purchased.Self mixing of mould lubricant will not yield best results.

If the first stage of planned development is accomplished the factory will produce about 90 tons more so that losses suffered during the construction period will be recovered within a few months.

C. Spare parts

The spare part situation of the San Josè plant differs not much to that of 'Las Tunas'.It is not exactly known whether for the old EMHART 5-section machines still complete spare parts are available.The machine is not manufactured anymore since years.The expert received a list of equipment of the different types of machines and feeder and will after his return to Europe get in touch with EMHART Zurich to get more information in this regard.

Recommendation

1. At least for the EMHART 6-section machines some mechanisms should be purchased to be determined by the staff.
2. One complete set of A;B;C-repair each should be put on stock.
3. Some feeder drive gears purchased and put on stock.

III. SPECIAL CONSIDERATIONS

Glass composition

The glass composition itself does not play the important role as it was assumed in the past.Through the recycling process commonly practiced in developed countries many different kind of cullet are used without affecting the production.This does not necessarily mean that no care has to be taken in the batch house.Batch,a certain percentage of own cullet (up to 80 %) and if recycling is exercised a certain percentage of foreign cullet should be kept as equal as possible to avoid disturbances in the glass preparation process and keep the colour of glass constant.

Modern commercial glass compositions are nowadays simplified to a ordinary sodium-calcium-silicate glass with 1 to 2 % alumina.All additives as they were used 20 years ago like boron,barium and magnesia have been removed for economical reasons.

The compositions used in both factories with 2,5 % magnesia(MgO) represent actually a composition for pressed glass where specific properties are required.However if this glass composition is used successfully there is no reason to change it.Definitely it has some advantage when forming machines are running relatively slowly to avoid cracks.

Hot forming process

THE GLASS CONTAINER ITSELF IS MADE MAINLY IN THE FOREHEARTH AND WITH THE HOT FORMING EQUIPMENT WHICH INCLUDES MACHINES, MOULDS AND MOULD LUBRICANTS.
The criterias,therefore,are outlined clearly.

Trends toward the glass industry is moving

Caused by the tremedous cost increase in fossil fuels in the beginning of the seventies the producer of commercial glass were forced to reorientate the whole production process in order to cope with new situation.Also air pollution and increasing wages played a role to develop:

a) Longer lasting and more fuel saving furnaces which are now consuming approximately 1000 kgcal or 110 g fuel oil per kg molten glass and a specific melting capacity of 2,5 to 2,7 tons per squ.meter melting area.6 to 7 years of life campaign is aspired at.Such furnaces are not expected to develop much more;

b) Lighter glass ware with better glass distribution to keep physical properties and also to

c) Lower raw material costs and consum;

d) Higher speed of forming machines through the lighter glass ware produced;

e) Glass compositions with shorter working range for high production performance;

f) Standardization of container glass toachieve long series on forming machines with more suitable shapes for high performance.

g) Recycling of glass cullet is used to lower fuel costs, save raw materials and avoid pollution.

Incentives for personnel of EMHART machines

From the previously said it becomes clear that the main factor in running a good production lies with the EMHART machines and their personnel which is exposed to the most adverse working conditions that prevail in this area such as heat, oil vapour, shift and Sunday work and also dirt. The operators are in addition expected to be on permanent alert to prevent machines and moulds from getting damaged.

Therefore and also to keep a good staff they deserve regard in respect of production oriented incentives which in the frame of possibilities should be carefully evaluated and granted. Annual bonus or free housing for instance can not be considered as production oriented. In other words the operator of an EMHART machine must with his weekly or monthly salary notice whether he is appropriately remunerated for his hard work he has done.
There may be also the possibility considered that in case of export a certain share of earnings may be deviated to the key production personnel to buy certain goods which are imported and in the free market not available yet as it is practiced in some socialistic countries in Europe.

Spare part supply

To overcome the permanent spare part supply shortage in particular for EMHART equipment it is further suggested that a certain portion of export earnings put at the disposal of the factories to enable them to order quickly certain parts if the need arises.

Literature

There is very little good literature available in the market.
A new edition of 'The Handbook of Glass Manufacture' edited by Fay V. Tooley should be available since January 1984. It is highly recommended to provide the factories with this book.
The book is available by: Ashlee Publishing Comp. Inc., GPO BOX 2343, New York, N.Y. 10116, U.S.A.

Expansion aspects

It is the personal opinion of the writer of this report that an expansion of the 'Las Tunas' plant should be abandoned at the present situation giving preference to develop the potential and consolidate it.The already foreseen expansion by elctric boosters will create new problems with its molybdenium electrodes and the water cooling system of them.In addition an electric booster if not very careful maintained will cause furnace tank bottom problems by heavy corrosion.

The'San Josè' plant in contrast to 'Las Tunas' should go ahead with its expansion planning since there something has to be done to take out outdated production lines and upgrade the factory as far as possible.

Taking into consideration the over all situation the writer would suggest as a transitional measure to integrate the existing EMHART 6 section machines in the development plan so that three furnaces could be operated with 6 Emhart 8-section machines and 3 EMHART 6-section machines.The forehearths however could be already equiped with foreseen standard feeder 81 and 115 in order to facilitate the final withdrawal of all I.S. 6-section machines and replace them by EMHART 8-section machines.
In the third and last phase of development the factory could operate three furnaces with a capacity of approximately 450 tons per day and nine EMHART 8-section machines.

Training facility in Cuba

Since there is virtually no training facility with realistic working conditions in the world for training personnel of EMHART machines it is highly recommended to instal a small unit 4-section machine preferably with ETS for this purpose. This machine could also be used for testing new containers and to run small production series.

Annex No. 1

Glass composition for commercial glass

72,60 %	SiO_2
14,60 %	Na_2O
10,60 %	CaO
1,60 %	Al_2O_3
0,30 %	SO_3
0,20 %	MgO (from Limestone)
0,10 %	Fe_2O_3
100,00 %	glass oxide

This composition can be used for flint-and amber-glass as well.For greenglas it is advisable to add 0,2 % alumina and reduce the same amount of SiO_2 (sand).
This composition fulfills normal requirements of a good commercial container glass.