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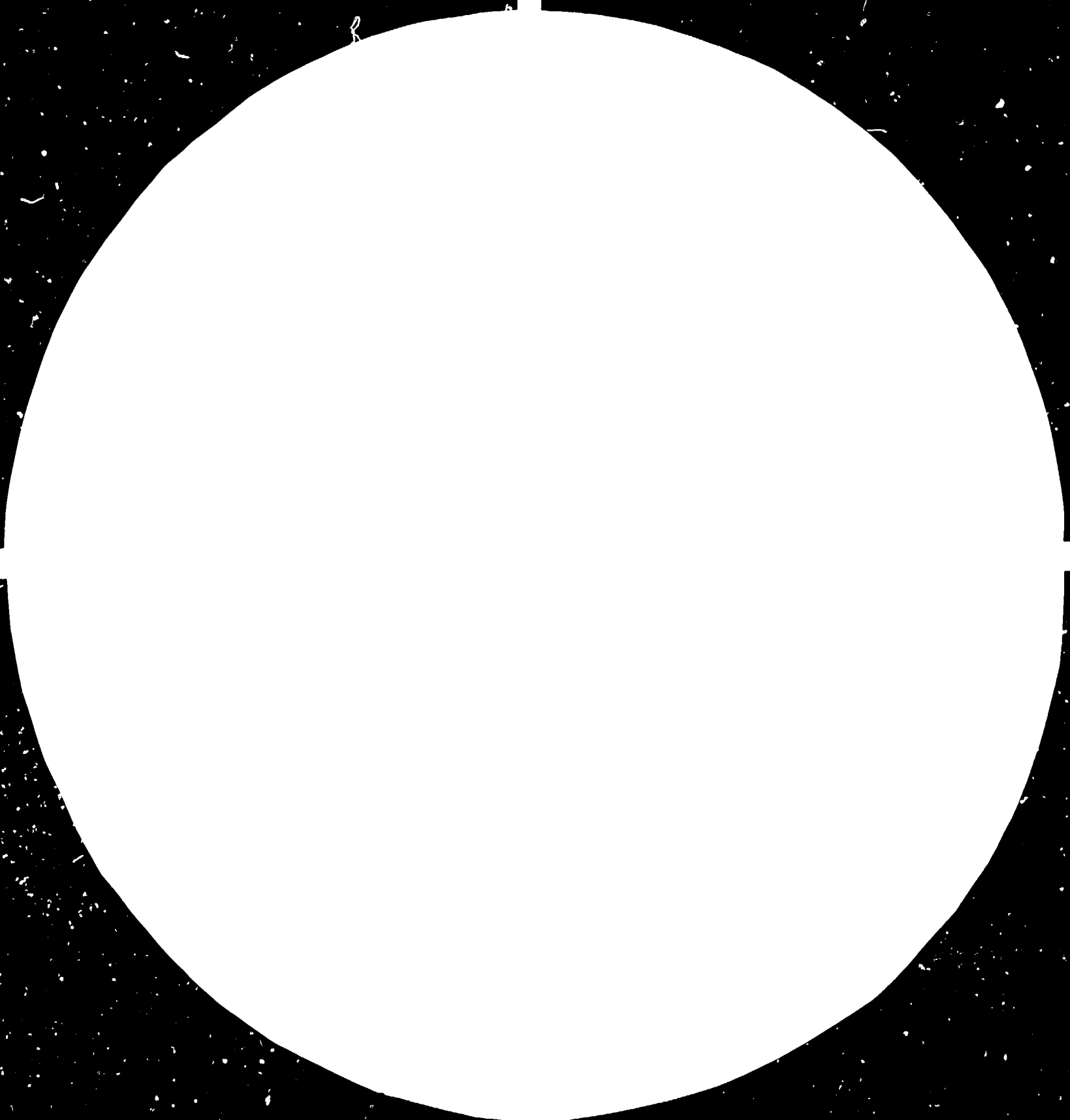


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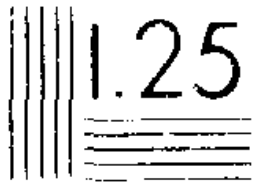
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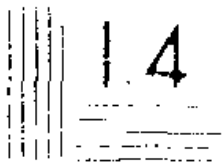
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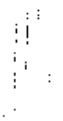
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25 February 1984

CERAMICS INDUSTRY DEVELOPMENT

DP/BGD/77/005

BANGLADESH

Terminal report

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

Based on the work of Gerhard Geier
Glass Technology Adviser

United Nations Industrial Development Organization
Vienna

This report has not been cleared with the United Nations Industrial Development Organization which does not, therefore necessarily share the views presented.

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INTRODUCTION

This final report covers the activities of the Glass Technology Adviser, Gerhard Geier, within the frame work of the original project document signed between the Government of Bangladesh, UNIDO as executing agency and UNDP on 14 respectively 26 August 1978.

The project started with the arrival of the Fine Ceramic Adviser and Team Leader, Mr. H.G. Felbier, in May 1980. The two other experts assigned to the project, one Glass Technology Adviser, Mr. G. Geier, arrived in July 1980 and one Quality Control Adviser, Mr. M.M. Tantawi, in September 1980.

After 3 project revisions and several extensions of contracts the Fine Ceramic Adviser left the project after two years service, the Quality Control Adviser after three years and the Glass Technology Adviser after three and a half years.

The original project contribution of the government projected was	Tk.	149,000
The original project contribution of UNIDO / UNDP projected was	US $	388,050

The grand total contribution after revisions till termination of the project by UNIDO / UNDP was	US $	814,063

The experts were attached to the Bangladesh Institute of Glass and Ceramic in Dhaka under the Directorate of Technical

Education and the Ministry of Education and Religious Affairs.

There was no lecturer nor demonstrator in glass technology at the Institute nor was any fellowship awarded to local staff.

The Government of Bangladesh requested assistance through UNIDO/UNDP:

a) To upgrade technical education and training at the Institute and to render improved services of the Institute to concerned industries of glass and ceramics to improve their products, utilize more local raw materials, remedy defects and increase productivity

b) To support directly the industry and render consultancy services to improve their products, introduce new technics, diversify production by new products and assist in overcoming of problems.

The glass industry of Bangladesh has no tradition. The first factory was established only 50 years ago and in the beginning developed obviously well. Since then tremendous changes have taken place all over the world in the manufacturing of glass not so in Bangladesh. As a result the entire glass industry is ailing and in a state of stagnation and even developed regressively in the past years. The productivity is very low and with rising labour and energy costs the situation is worsening. There are about 50 glass factories scattered all over the country but mainly in Dhaka.

I. DEVELOPMENT OBJECTIVES

The project's primary development objective is to contribute to the saving of foreign exchange through import substitution. This project will contribute to the achievment of this goal by improving the quality of ceramics and glass products and diversifying the product range.The project is also aimed at encouraging the utilization of locally available raw materials and the generation of emplyment of relatively unskilled labour.

II. IMMEDIATE OBJECTIVES

1.To enable the Ceramic Institute to assist the ceramics industry in reducing losses due to defective quality of moulds and other quality defects of final production and in introducing selected new products in these enterprises,and assist the glass-ware industry in removing quality defects due to poor mixing of raw materials,kiln design and firing,and to introduce selected new products in the enterprises.This will be achieved through:

a) Improved quality of products in the ceramics common service facility in the Institute and provision to the Institute of technical knowledge necessary to increase output in the facilities

b) Establishment of common service facilities at the Institute for glass ware so that the Institute is able to assist in the improvement of the quality of production of glass in Bangladesh and to start up production of selected new items at the common service facilities

c) Improved consultancy services by the Institute to the ceramics and glass industries to remove such defects in selected ceramics industries as poor composition of bodies and glazing defects and such defects as poor composition of

raw materials and inadequate firing in selected ceramics and glass ware industries to start up production of selected new products

d) Increased skills of technical personnel in the Ceramics Institute in gypsum mould making so that the Institute is able to assist the industry in preparing moulds for specialized items such as, sanitary ware, large dinner ware items and insulators, and improving the quality of the gypsum moulds so that their life increases from three months to nine months

e) Expanded facilities of the Institute to carry out physical and chemical tests for the ceramics industry in the following fields: determination of efficient and durable sagger mix from various refractory materials, glaze matching and correction to avoid crazing, and green strength of bodies and clay. In addition the project will provide the Ceramics Institute with new testing facilities in the following fields: impact strength testing, measurement of thermal expansion of glazes, determination of particle size, and durability of glazes

2. To enable the Institute to prepare glazes using as many locally available raw materials as possible for use by cottage industry ceramics producers and to assist cottage industry producers in building simple kilns using locally available materials and fuels for the purposes of firing and glazing pottery.

III. ACTIVITIES

1. After the arrival of the glass expert of UNIDO in July 1980 a carefull assessment of all facilities in the Bangladesh Institute of Glass and Ceramics was carried out to determine the activities necessary to achieve the expected outputs as stipulated in the project document. It became obvious that with the existing facilities it is not possible to reach this goal. It also became ovious that the whole 'section' glass was not appropriate assessed in the project document for lack of expertise and knowledge. Even the few tools ordered and received before the arrival of the expert are in no way related to the outputs of the project. These are mainly tools for the manufacture of technical glass instruments a trade which is not foreseen nor incorporated in the project document (item 18 to item 37 of equipment list).

2. The present glass melting facilities at the Institute: one electric heated high temperature furnace supplied under the Colombo Plan Agreement which is not suitable for realistic glass melting for its inaccessibility to charge batch or gather glass. Another furnace supplied under the same Plan is a pot glass melting furnace with ceramic recuperator with oil firing. The 2 delivered covered pots to this furnace made of green clay would last even if undamaged under production conditions only a few months. Under the prevailing road conditions in the country it seems very unlikely that new pots will ever reach the Institute undamaged.

3. Other tools and equipment supplied at the same time to run the small pilot plant are after years of idle lying under adverse climatic conditions rusted to such an extent that a reconditioning is not possible anymore.

4. In view of the said the expert has undertaken the task to elaborate a more realistic pilot plant proposal with the aim to make it selfsufficient as a small production unit and can exist in the future.For this purpose 2 documents have been prepared:

a) "Propositionand Assessment of a Glass-Pilot-Plant for the Glass and Ceramic Institute in Dacca"

b) "Feasibility Study for the proposed Pilot-Plant of the Bangladesh Institute of Glass & Ceramic"

A revised project document was prepared by the team leader, Mr.H.G.Felbier and submitted together with the two documents to the Directorate of Technical Education for consideration and further discussion on 1st February 1982 based on the recommendations of a previous tripartite meeting held on 3 July 1981.

Another meeting took place on 7 September 1981 in which it was decided that all experts due to lack of resources,the lack of a permanent principal of the Institute and other deficiencies shall render more direct support to concerned industries. The government on the other hand shall undertake efforts to find appropriate agencies together with UNDP for funding the project.

At another meeting in the Ministry of Education together with the Planning Cell of the Ministry eventually it was decided that the glass-pilot-plant project should be deferred and priority given to the revitalization of the ceramic-pilot-plant shut down 3 years ago.This meeting was held on 18 March 1982.

5.During this period of time about 80 crucibles and small pots have been manufactured from one of the damaged English glass melting pots and some trial test meltings performed.Among stained glass,selenium ruby and cadmium sulfide glass were molten.For lack of appropriate melting facilities the small electric heated muffle kiln was used with a max.temperature of 1300 C which is not sufficient to demonstrate production

conditions.However it is sufficient to demonstrate melting of different glass to students.

6. In contrast to the Institute's slow progress which also was hampered by the lack of fuel gas and water supply and other deficiencies beyond the control of the experts the direct support to the industry in accordance with the project document developed intensive and favourable.

7. Based on the observations in the factories visited,many problems are caused by inadequate melting facilities,the expert prepared 4 sets of technical drawings for 4 different size of glass melting furnaces with improved design and made it available to interested parties of the industry.The furnaces are designed as continuous tank furnaces of:

   4 squ.metres; 5 squ.metres;7 squ.metres and 9 squ.metres melting area.

8. A simplified regenerator reversal system not used till then and more effective as the commonly used drum system was introduced and is now in use by 6 factories.

9. In close collaboration with one of the three refractory manufacturing plants in Dhaka the first refractory blocks have been produced for melting tank lining and applied in a reconstruction of a furnace with Heyesons Glass.This furnace was also modified by enlarging the regenerators to make it more fuel efficient.Construction work was done from September till November 1982.This furnace was in operation for 13 months and had to be shut down due to high corrosion of the refractory blocks.Reason: lack of proper expertice in the manufacturing of suitable refractory blocks in particular such blocks in contact with glass.

10. A second glass melting furnace with a melting area of 7 squ. metres was constructed with Heyesons Glass between October

and January 1984 under the direct supervision of the expert and this time with Chinese standard fire bricks tank lining and commenced production in January 1984 without the slightest trouble and is producing glass of very good quality at reasonable fuel costs.

11. A new burner system by using a specially shaped refractory burner block instead of the commonly in Bangladesh used cast iron burner was developed in order to avoid local overheating of the rear part of glass melting furnaces as it is frequently observed here in glass factories and is now successfully used in 3 plants.

12. In October 1982 another fruitful cooperation developed with Al Hamra Glass a glass factory which was put into operation just 4 months ago.Due to wrong design the melting furnace drained.This furnace was mdified by better design and also the enlarging of the regenerators.This furnace was in operation till December 1983 producing fairly good glass.

    Also the glass composition was changed as well as the glass decolourization.

13. Since the factory developed well we have been searching for better refractory materials in the country and found eventually a Japanese furnace lying idle since 20 years in a iron plant and still packed in original wooden cases.There was a packing list but no construction drawing available.After careful assessment and inventory it was found that the furnace was a 4 squ.metres continuous tank with recuperator.A decision was made to set up this furnace abandoning the original version with recuperator and modify it to regenerative system with an enlarged melting area of 5,5 squ.metres to yield the required output of 6 to 7 tons glass daily.Since fused cast zirconium and alumina refractories can not be shaped the task was not easy to solve. However we eventually succeeded but had to construct the refiner with Chinese standard fire bricks available in the market. All in all 80 tons of refractory materials have been used for the construction work and also about 10 tons of steel.

The planning started in May 1983 and construction work began in June 1983.All construction materials had to be brought to Al Hamra Glass which is situated in a rural area 30 km from Dhaka.The objective was to run this furnace with 4.000 kcal. fuel per kg molten glass of perfect quality.This both goals were reached and result in an approximatly 60 % of fuel saving to comparable locally built furnaces.
In addition the life span of this furnace with the high quality fused cast materials tank lining is to be expected 5 to 6 years which means it will triple.The factory is in a rural area and without direct communication to Dhaka like telephon or other means which created immense problems.

13. A special problem in constructing glass furnaces in Bangladesh is the high ground water table which in most cases is only a few inches under the surface and does not allow to construct regenerators of reasonable hight with suficient thermal uptake to achieve the necessary velocity and herewith also quantity of combustion air for a smooth and effective operation of a glass melting furnace.A blower or fan could solve the problem but is not recommendable because of the frequent power shut downs. The solution was to create by high gas velocity of the burners a vacuum before or in the burner port necks so that combustion air is sucked in sufficient quantity.

14. In 1983 the Bangladesh Institute of Glass and Ceramic finally was supplied with natural gas so that the ceramic pilot plat could resume operation.
In close collaboration with the principal the glass adviser constructed a small glass melting furnace for pots so that at least small quantities of glass can be melted and glass manufacturing in a small scale demonstrated.4 Glass melting pots with a capacity of 1 gallon or about 10 kg glass have been prepared 4 months ago to serve this purpose.After 3 weeks construction and 1 week heating up 10 different types of glass were melted and worked out by glass makers of a factory.Due to lack of funds the construction work,iron and some chemicals had to be procured and charged against our petty cash account of the project (Approx.US $ 500).Fire bricks and mortar were provided

by the Institute.

15. In 1983 the expert received eventually the ordered Orsat apparatus for waste gas analyses. Since then many analyses have been prepared in glass factories and refractory plants. Natural gas in Bangladesh contains about 95 % methan which makes it impossible to determine the state of flame and burnout visually. In most cases were the waste gas was analysed a considerable better fuel efficiency was attained and fuel saved.

16. In March 1984 5 Annealing muffles with Heyesons Glass were modified and equiped with temperature control equipment. This became necessary to solve the problem of chipping off of rims of tumblers which caused the factory losses of up to 30 %. The problem could be entirely solved so that as a result production increased by appr. 30 %.

17. During all the time consultancy services have been rendered also to Hordeo glass, Meco Glass and others but as previously mentioned such services will not achieve much.

18. Practically all glass factories in the country are lacking the most elementary control devices like scales, temperature control equipment and also technical know how. A simple advice will in most cases not be followed out of conservativity or difficulties in understanding. Consequently in order to achieve results it is necessary for the expert to get directly involved in the daily operation of factories by rendering ad hoc advice. The chemists of the plants are no chemists. Therefore they consider the only glass composition they possess as a secret. In most cases the management has no influence on them and also can not control them. In privacy, however, they are prepared to accept advices and affiliate.

19. Glass compositions in Bangladesh are extremely unusual and marked by their high alkali and silicon but low calcium content. For this reason they come in close range to sodium silicate (waterglass) which is in water soluble. One explanation may be the relatively high iron oxide content of calcium oxide. But this could easily be compensated by using an iron separator to remove the free iron from the silica sand. But scarcely a

factory is prepared to invest US $ 3000 for such a separator. Instead relatively high quantities of expensive selenium are used to decolourize the glass which with the concentration of iron present in the glass is impossible. Consequently almost all glasses in Bangladesh are overdecolourized which means miscolourization tending from brownish to blackish-green depending on the state of iron oxidation and the quantity of selenium applied.

IV. ACHIEVEMENT OF IMMEDIATE OBJECTIVES

1. In accordance with the project's immediate objectives Part II B.1;b)and c) which are related to 'glass' the expert from the very beginning concentrated on rendering direct support to the glass industry. Recognizing the fact that pure advisory services will not produce any results he put emphasis on improving the quality of glass and also better and more efficient melting facilities by designing better and more fuel efficient furnaces. 4 Furances were modified and 2 furnaces completely new constructed whereby one of the latter was built with foreign bricks to such an extent that the proportion of foreign bricks in weight was about 25 % and locally manufactured refractories 75 %. This furnace produces glass of good quality and saves approximately 60 % fuel to common furnaces set up in Bangladesh. For lack of good refractories in the country this could be one solution to solve pressing problems of the industry.

a) In one case the expert persuaded one refractory company to manufacture glass-tank-blocks as they are commonly used all over the world. This experiment was not successful due to high corrosion of the blocks under production conditions. Lack of adequate expertise and the lack of appropriate firing facilities for refractories may have been the reason for no better results.

b) Since no factory in Bangladesh has its own masons and brick layers for constructing furnaces the work is given to contractors and therefore it can be assumed that expertise and technology in

building better melting facilities will gradually spread to benefit the whole industry.

c) Impeding a quicker implementation of new and better technics is the lack of funds and partly also the conservative attitude of many entrepreneurs as well as the lack of adequate education, the lack of any control equipment in the plants and also the geological situation of high ground water table.

2. In the very late stage of the project the expert was able to construct a small glass melting furnace at the Institute so that future students can benefit of such a facility by melting at least small quantities of glass and also working it out under working conditions similar to that of the industry.

a) Several kinds of glass have been melted in reasonable quality like lead glass, borosilicate glass, semi lead glass, stained glass opal glass and lime-sodium glass in small pots.

3. Since the Institute is not running courses in glass technology yet only a few lessons were held in furnace technology by the expert.
The students of ceramic courses however get familiar with glass chemistry due to practically all raw materials of ceramic and glass are identical.

a) The Directorate of Technical Education under the Ministry of Education, however, is preparing to introduce at the Institute a course in glass technology in the forthcoming 5 year plan.

b) There was no counterpart to the glass expert in the Institute.

V. UTILIZATION OF PROJECT RESULTS

1. Industry

Most of the activities of the glass expert have been production orientated and rendered directly to the industry in selected factories to their immediate benefits which resulted in :

a) Improved quality of glass
b) Better utilization of local raw materials
c) Saving of foreign exchange by reducing imported soda ash
d) Reducing fuel costs the highest cost component of factories
e) Analysing waste gas to determine flame condition and burnout to increase the efficiency of fuel and maintain oxidizing furnace atmosphere for best results.

2. Institute:

The activities of the expert have been restricted by the decision of the Ministry of Education to deferre the section glass.However the expert performed several tests of refractory materials to determine their suitability for the glass industry in particular for refractories in contact with glass.By experimental tests the penetration of glass into the refractories could be demonstrated.For lack of specific expertise not much could be done in this field.

a) The setting up of a small glass melting unit at the Institute to enable the students in future to carry out glass melting tests in reasonable sized glass melting pots of 8 to 15 kg glass capacity under realistic working conditions

b) To convert one old ceramic muffle kiln into a glass annealing lehr so that glasses produced can also be annealed

d) The 70 crucibles produced at the Institute can be untilized for tests by students.

VI. FINDINGS

1. Industry:

Bangladesh is a country without tradition in the manufacturing of glass.The first factory was established about 50 years ago and was Hordeo Glass.The factory developed according to the absolete equipment and machinery lying around well and was sound.Nowadays the factory is in a state of stagnation and regression and without new impulses can hardly survive.Practically all factories with very few exceptions are in a similar state of stagnation and develop regressively.Mounting costs of raw materials imported,increasing energy costs and labour wages, lack of know how and education but also the inability of the management to motivate the factories for higher productivity by introducing better and more production related incentives as well as the reluctancy of entrepreneurs to invest and modernize the factories created the unfavourable situation. Since all factories to a more or less extent are copies of Hordeo Glass all factories face the same problems.

2. There have been efforts in the past to establish in the country an institution for education and training in glass technology but these plans never materialized.Again they have been deferred in 1982.There is a huge depressed demand of glass in the market. Considering the fact that for many millions of dollars annually glass is imported like soft drink bottles,pharma bottles and containers,tubes,laboratory glass and bulbs as well as pressed glass and luxury glass a.o.which easily could be produced in the country it is not understandable why not more efforts are made to overcome the situation.

Glass is a commodity without which the modern world is unthinkable. Bangladesh in this regard and as for the production of glass is a dwarf.The daily output of glass in the country may vary between 70 and 100 tons per day.

Nigeria a development country with about the same population produces daily between 1200 and 1400 tons whereby the first factory was established only about 20 years ago.

Developed countries like England, France or Germany with only half the population of Bangladesh produce between 60,000 and 90,000 tons daily.

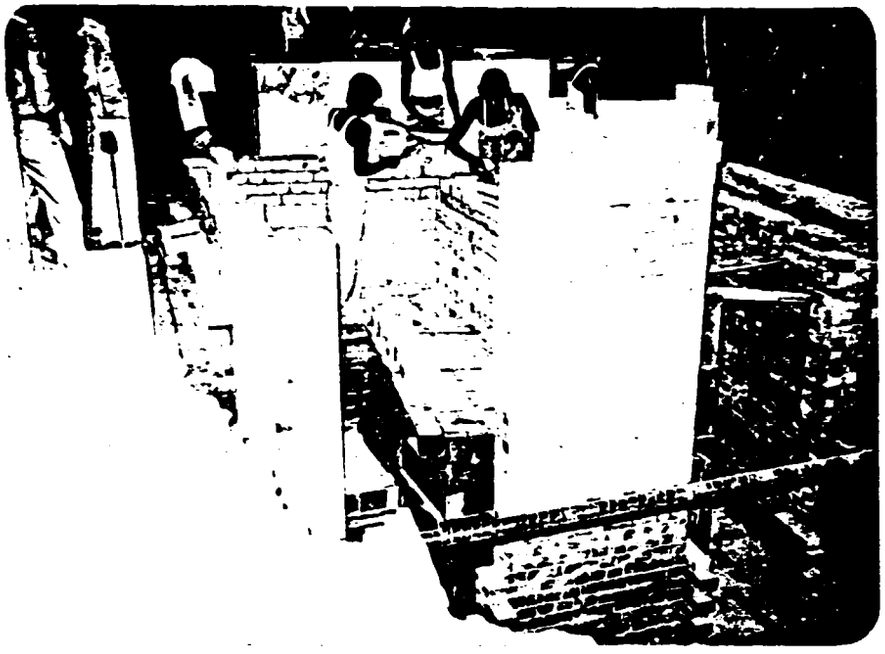
Bangladesh's glass industry in no way has participated in the tremendous development of this industry in the past 30 years. Consequently the industry is ailing and develops regressively. The restructuring of the entire industry is a long lasting process that can not be accomplished in a short period of time.

VII. RECOMMENDATIONS

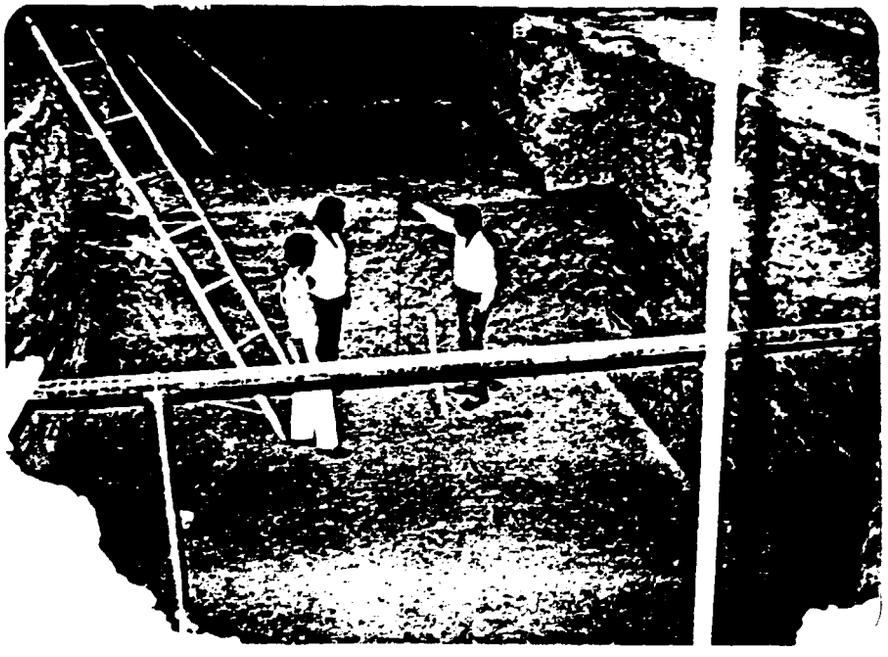
Taking into account the fact that about 70 % of raw materials for the glass melting process and natural gas as the main energy source is available in the country the glass industry of Bangladesh should be in a position to develop favourable and prosperous.

1. The establishment of a good educational and training centre is imperative to overcome the lack of know how in the country.
2. Better trained management capable to motivate production personnel to higher productivity by progressively increasing incentives.
3. Creation of more favourable conditions for entreprenours by the authorities through reducing import taxes for some raw materials and machinery to make investment meaningful and and the plants profitable.

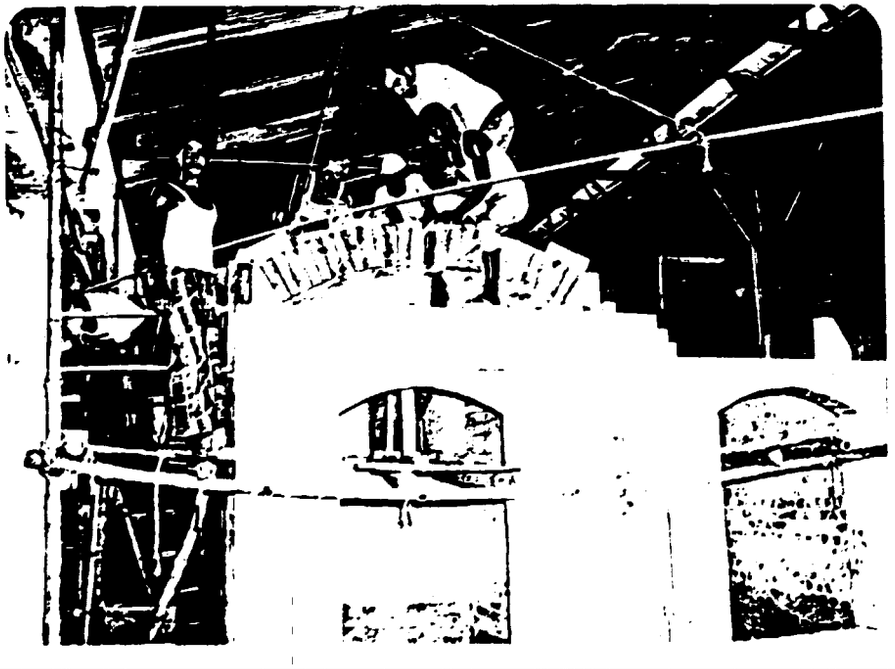
Thousands of jobs could be generated and the drainage of foreign exchange could be strongly reduced.



Construction work on regenerators Al Hamra Glass



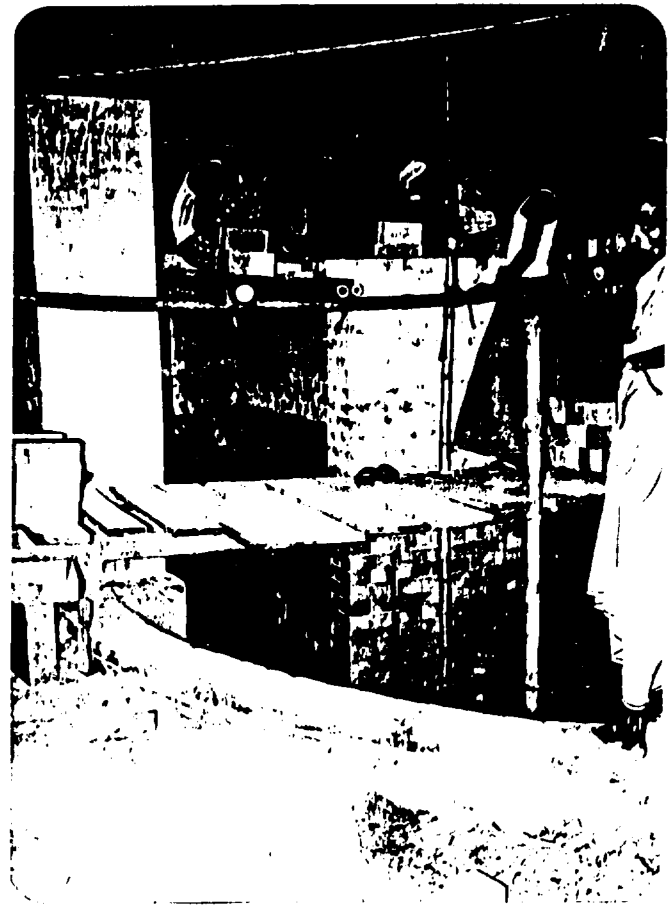
Excavation work for a glass melting furnace



Setting of regenerator crown

Setting of checkers

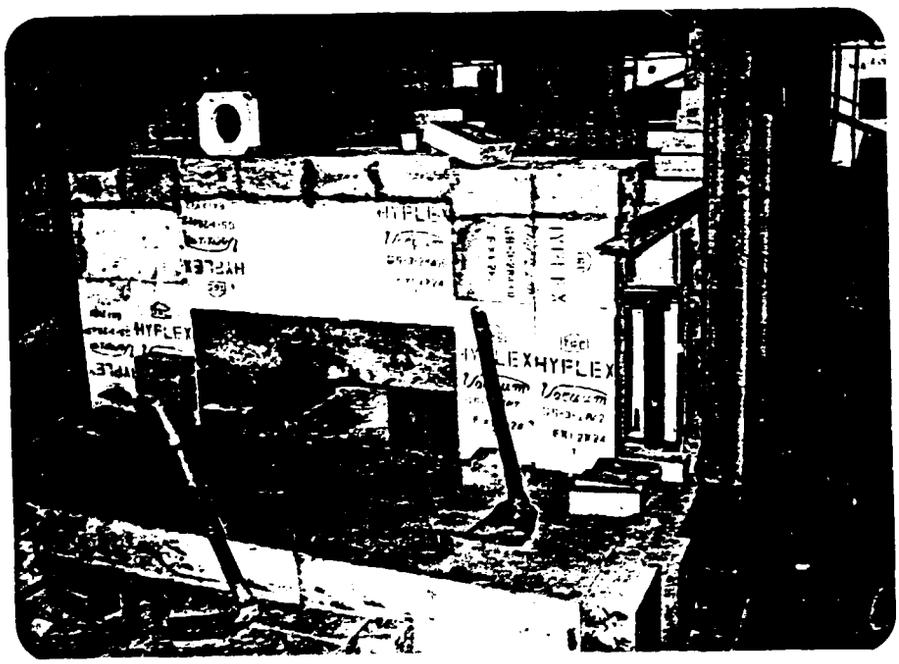
Work on the crown



Construction of regenerators

ANNEX IVa

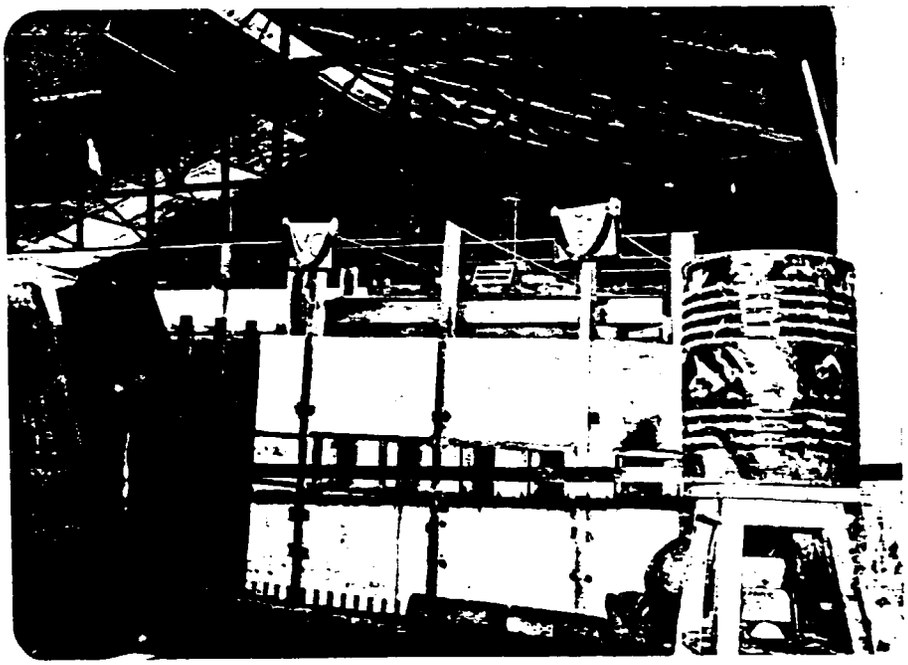
Setting of the the throat of a glass melting tank furnace



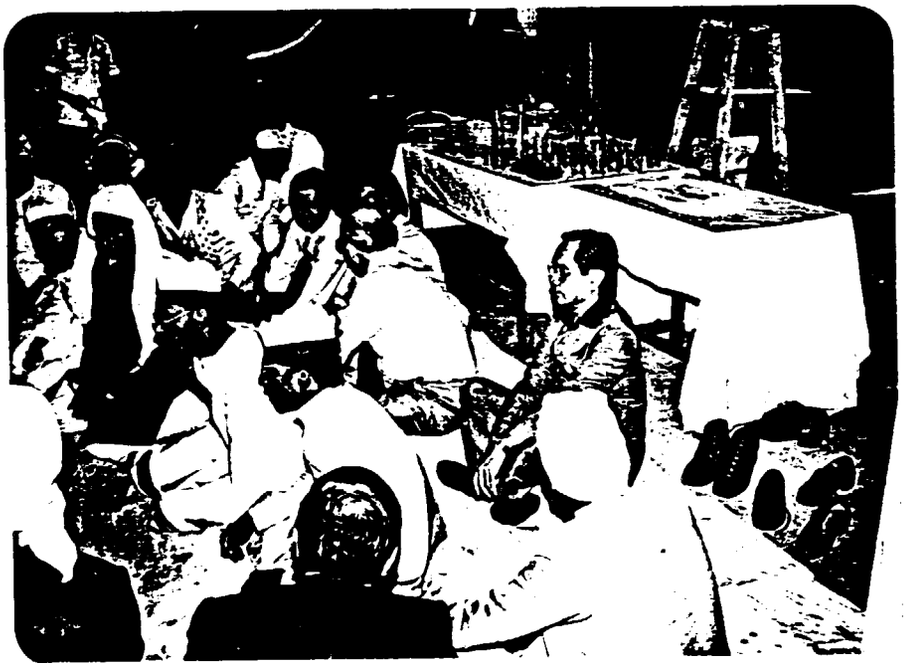
Front view of throat and bridge wall with refiner bottom

Furnace nearing completion

ANNEX IVa



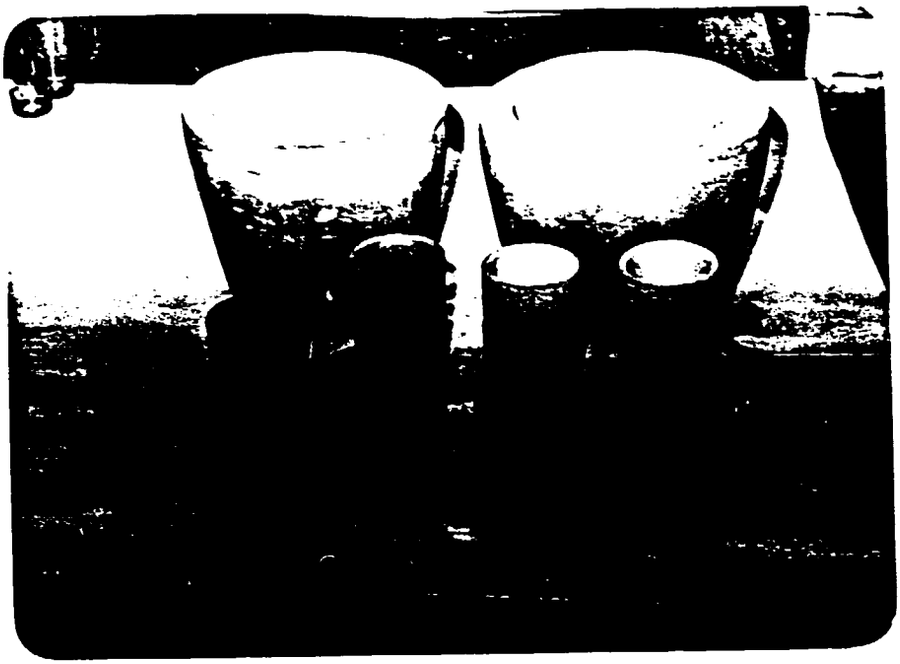
Glass melting furnace before production start up



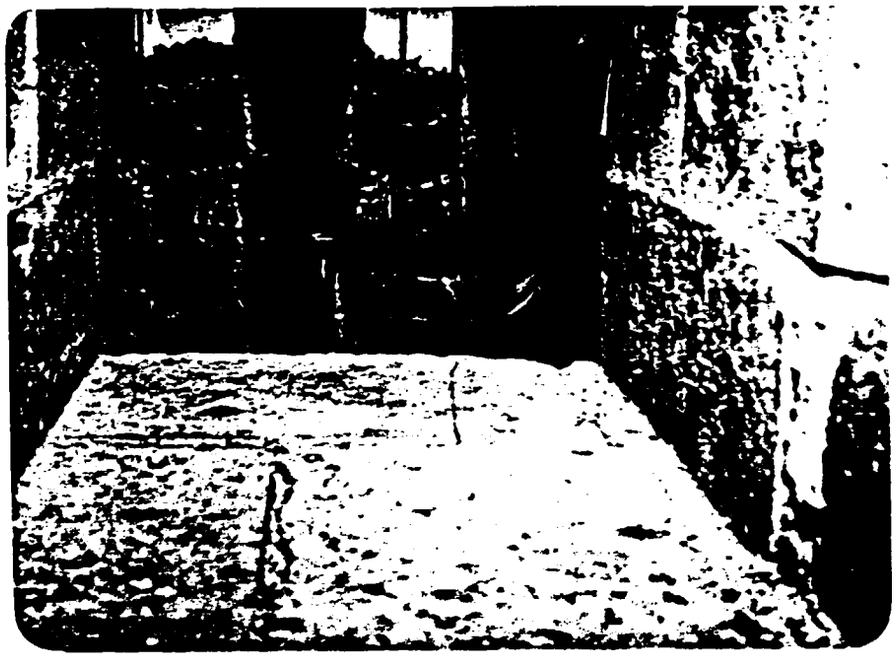
At inauguration with Res.Repr.Mr Holzhausen and SIDFA Mr.Lavides

Gathering the first glass

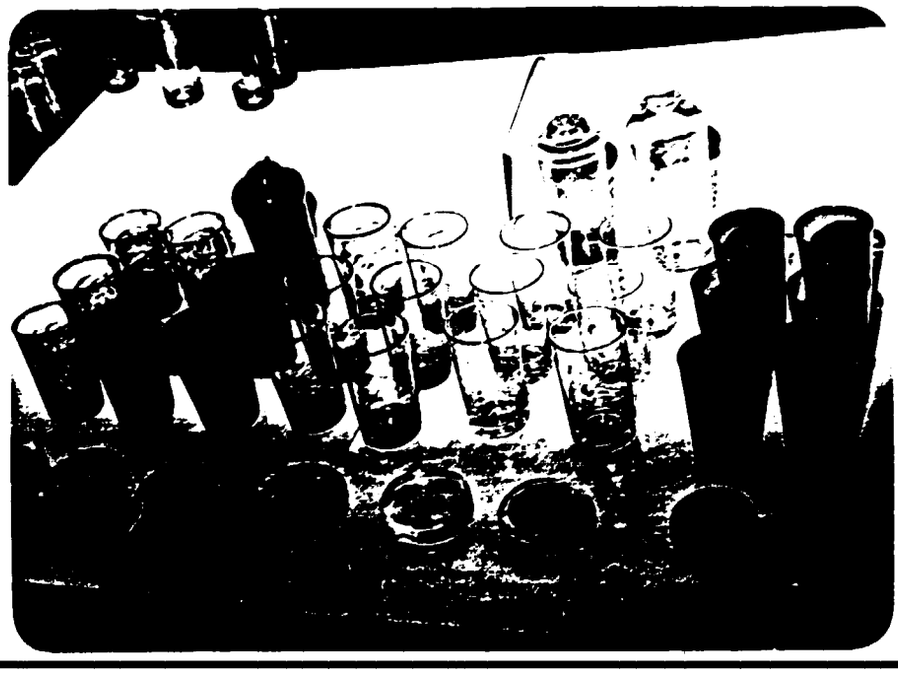
ANNEX Vb



Glass melting pots and crucibles made for the Institute



Glass melting pot in the furnace after firing and melting



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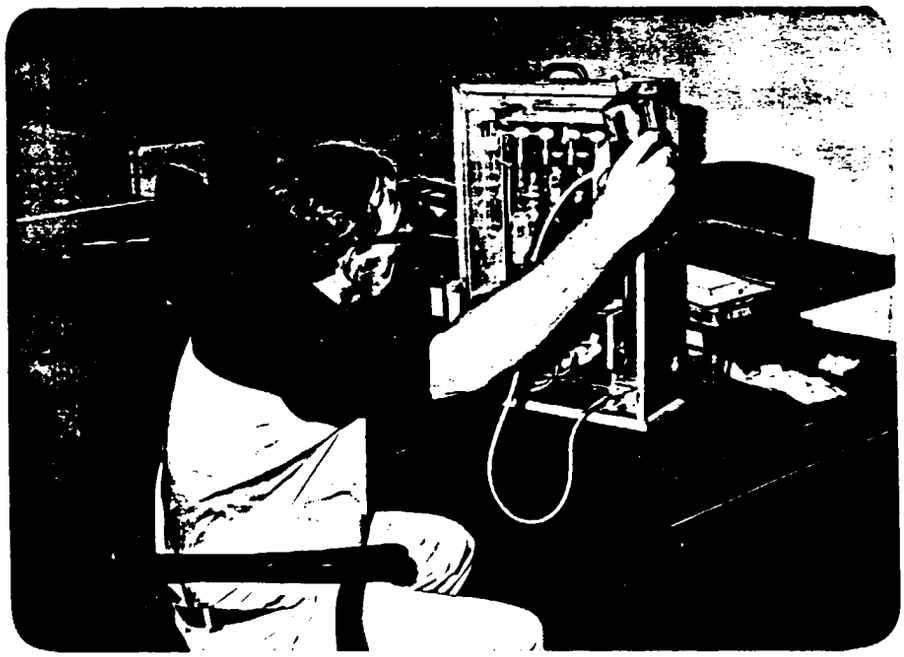
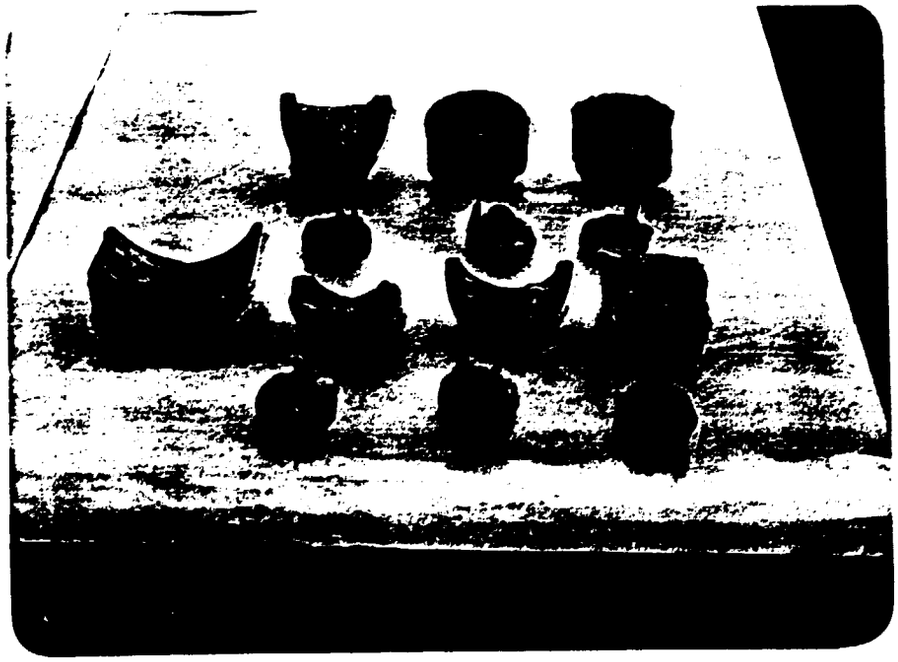
Glasses produced at the Institute

ANNEX Vc

A small glass melting furnace constructed for the Institute



Analysing waste gas with Orsat Apparatus



Tests on refractoties

ANNEX VI(

Construction work on refiner and tank of a glass melt. furnac

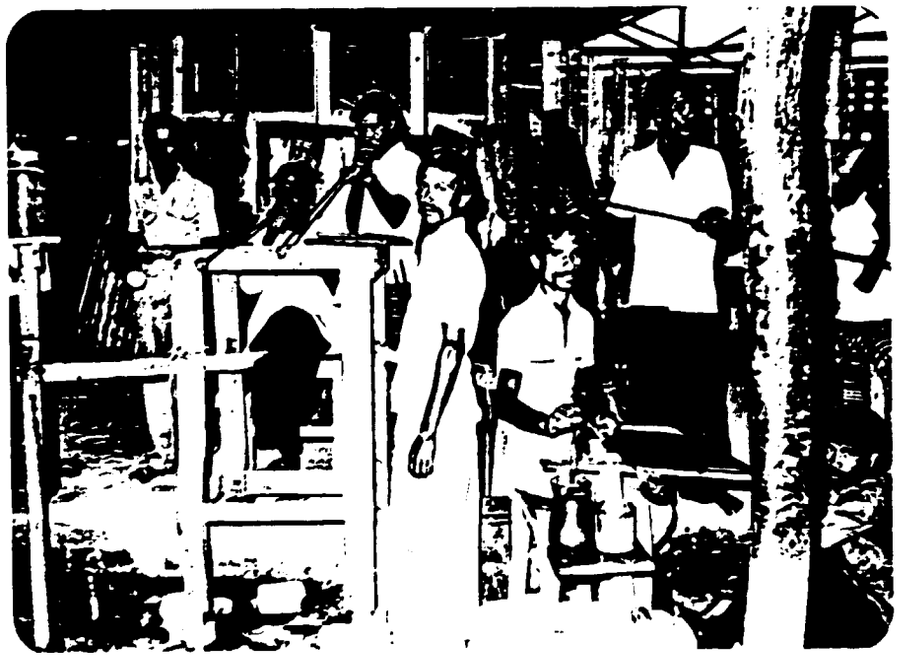
Construction work on throat and tank

Fire brick chipping to equalize bricks

ANNEX VIId

Start up of heating a glass melting furnace at Heyesons Glass

Start up of heating



Glass maker at work

ANNEX VIIIe

Performance report of a newly erected contiuous-tank glass melting furnace of Al Hamra Glass in Savar/BGD

Melting area	5,5 squ.metres
Refiner area	2,3 squ.metres
Glass pull per 24 hrs.	6,5 tons
Specific load per squ.metres	1,2 tons
Melting temperature	1500 C
Working tank (refiner) temperature	1250 C
Regenerator temperatures	1200 C
Fuel consumption (natural gas)	4000 kcal.per kg glass
Quality of glass produced	good to very good

Refractories used:

Tank and refiner bottom	33 % Al_2O_3	fire clay blocks(Hyplex)
Tank walls 1st layer	33% Al_2O_3	fire clay blocks(Hyplex)
Tank top layer and throat	Zirconite and alumina fuese cast	
Dog house	Zirconite and alumina fuese cast	
Side and rear breast walls	Silica	
Crown and burner port necks	Silica	
Crown insulation	Self made (silica sand saw dust)	

Total refractory used for furnace 27 tons foreign made

Regenerators and checkers, flue channels and reg.crown were made from locally available low quality bricks about 53 tons

Grand total of refractories 80 tons

Taking into account the relatively small melting area of this furnace the performance can be considered as very satisfactory. Better results are only possible to reach by applying much more insulation further enlarged regenerators and high quality fire bricks for checkers (Chromium magnesite)

ANNEX IXf

Glass compositions molten
in the Institute:

Lead crystal:

62,59 %	SiO_2
1,17 %	B_2O_3
21,46 %	PbO
9,83 %	K_2O
4,65 %	Na_2O
0,30 %	As_2O_3
100,00 %	oxide

Semi lead crystal:

72,00 %	SiO_2
9,89 %	Na_2O
7,17 %	K_2O
3,63 %	PbO
1,43 %	BaO
0,15 %	B_2O_3
0,33 %	As_2O_3
100,00 %	oxide

Boro silicate glass
Pyrex

80,55 %	SiO_2
12,00 %	B_2O_3
5,15 %	Na_2O
2,15 %	Al_2O_3
0,20 %	As_2O_3
100,05 %	oxide

Opal glass

63,70 %	SiO_2
8,77 %	Na_2O
8,63 %	K_2O
5,50 %	ZnO
3,30 %	PbO
6,30 %	Al_2O_3
3,80 %	F_2
100,00 %	oxide

ANNEX Xf

Selenium ruby

70,00 %	SiO_2
13,00 %	Na_2O
4,60 %	K_2O
6,36 %	ZnO
5,01 %	B_2O_3
0,70 %	CdS
0,33 %	Se (met.)
100,00 %	oxide

ANNEX XIg

Glass compositions

Modern commercial glass:	Commonly molten glass in Bangladesh
72,50 % SiO_2	77,50 % SiO_2
15,00 % Na_2O	17,50 % Na_2O
10,50 % CaO	4,20 % CaO
1,50 % Al_2O_3	0,50 % BaO
0,30 % SO_3	0,30 % As_2O_3
0,20 % others	
100,00 % oxides	100,00 % oxides

Improved compositions for

a) Al Hamra Glass

73,2 % SiO_2
15,5 % Na_2O
8,8 % CaO
0,7 % Al_2O_3
0,3 % As_2O_3
100,00 % oxides

b) Heyesons Glass

75,42 % SiO_2
16,35 % Na_2O
6,89 % CaO
0,14 % B_2O_3
0,90 % Al_2O_3
0,30 % As_2O_3
100,00 % oxides