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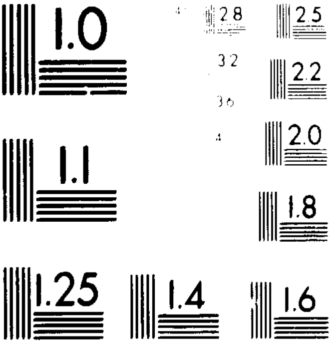

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TECHNICAL REPORT

Syria.

ASSISTANCE TO ABATE POLLUTION IN FERTILIZER PLANTS

HOMS

SYRIAN ARAB REPUBLIC

SI/SYR/82/801/11-01

Prepared for the Government of Syrian Arab Republic by the United Nations Industrial Development Organisation, executing agency for the United Nations Development Programme.

Based on the work of Prof. J.M. Dave, expert on water and air pollution from fertilizer plants.

United Nations Industrial Development Organisation

Vienna

(15 May to 15 November, 1982)

CONTENTS

3. INTRODUCTION

In persuance of their policy to increase agricultural production, the Syrian Government has established a Fertilizer Complex at Homs called the General Fertilizer Co. (GFC) under the Directorate of General Establishment of Chemical Industries (GECI).

The GFC complex is located about 10 km south-west of city of Homs on the shore of Lake Kattinah and adjoining to the village of Kattinah. It consists of the following three subcomplexes as follows :

3.1.1 Calcium Ammonium Nitrate (CAN) complex with following units:

a) Ammonia 150 T/day, 45000 T/year approximately

b) Nitric Acid 280 T/day, 84000 T/year "

c) Calcium Ammonium Nitrate 475 T/day, 142000 T/year approximately.

3.1.2 Ammonia Urea (Naptha Based) Complex

a) Ammonia 1000 T/day, 300,000 T/yr. approximately

b) Urea 1050 T/day, 315,000 T/yr. "

3.1.3 Triple Super Phosphate (TSP) Complex

a) Sulphuric Acid 2 units each, 950 T/day 510,000 T/yr approximately

b) Phosphoric Acid (P_2O_5) 533 T/day 160,000 T/yr approx.

c) T.S.P. 1400 T/day 420,000 T/yr approx.

d) Aluminium Fluoride 9 T/day 2700 T/yr approx.

Each subcomplexes also have utilities units like water treatment, waste water disposal, and supply, steam boilers, laboratories and administrative offices, separately.

The GFC complex as a whole also has office of the General Director and various administrative units under him, Central Workshop, Central Laboratories, transportation and security staff. The combined strength of employees industrial and administrative is about 3500.

These fertilizer units are recognised as heavy chemical industry which release solid, liquid and gaseous substances into the environment polluting soil, water and air with effect on human health, plants, animals and ecology in general.

3.2 The General Fertilizer Co. (GFC) and the Syrian Government being fully aware of this situation were concerned about the status of the environmental pollution from this complex and requested the assistance from UNIDO under the programme of Special Industrial Service (SIS), for an expert in water and air pollution for fertilizer plants to assess the status of environment. The original job description for the expert is given in Appendix I of this report.

On arrival of the expert at UNIDO headquarters at Vienna for briefing it was informed that GFC Homs has also sent another request for a second expert for six months through the Syrian Government which also included item on air and water pollution, related to the original job description. During briefing it was thought to be desirable to check with the Syrian Govt. and Senior Industrial Development Advisor (SIDFA), UNIDO Damascus, if these could be included in this assignment.

In Damascus this matter was discussed with Syrian Govt. officials and SIDFA, UNIDO and the job description was enlarged so that the scope of the assignment to include parts of the jobs requirements from the second expert request.

3.3 Job Description: The revised job description was as follows:

The expert will work with the Government assigned counter parts in General Fertilizer Co. Homs and specifically expected to help :

3.3.1 Monitor Waste water effluents from the plants for pollutants.

3.3.2 Monitor the air born pollutants from their gaseous effluents.

3.3.3 Suggest ways and means to control their plant effluents.

3.3.4 Assist in establishment of a pollution control laboratory.

3.3.5 Assist and provide advice on training of the personnel for pollution monitoring and control work.

3.3.6* To undertake studies on various pollution problems arising out of the fertilizer plant operations and prepare and submit to GFC suitable schemes and specifications for treatment of various effluents from the fertilizer plants.

3.3.7* To provide technical assistance and detailed studies for setting up the pilot plants to serve following purposes

i) Waste Water treatment

ii) Cooling Tower

iii) Nitric Acid Tail gas treatment.

3.3.8* To assist in preparing detailed studies on pollution of Kattinah lake and make recommendations for solving problems encountered in water treatment process.

Note: Item Nos. 6, 7 and 8 marked with * are new additions from GFC, Homs second request for another expert assistance for six months.

Three months assignment was started on 15th May 1982 but after two month's progress GFC Homs felt that the enlarged scope of the project, which included design, construction, erection and the commissioning of the pilot plants in item No. 7 will need additional time of at least three months. The delay in procurement of materials due to Lebanese war and also heavy schedule of maintenance work by the central workshop of GFC necessitiated this decision. The UNIDO agreed to this request of GFC to extend the project upto 15th November 1982. The work was completed on November 15th, 1983.

2. SUMMARY

The mission's assignment was to assist the management of General Fertilizer Company (GFC) Homs, to monitor pollutants/effluents being discharged, into air, water and soil, to establish a monitoring laboratory, to advise on training of the personnel, to suggest methods for control of pollution, to provide technical assistance for pilot plants of (i) Cooling tower, (ii) Waste water treatment plant, (iii) HNO_3 tail gas scrubbing and to develop a programme for water pollution studies for lake Kattinah.

A detailed inventory of the pollutants being discharged by GFC Complex into air, water and soil from the each subcomplexes of Calcium Ammonium Nitrate (CAN) (NH_3, HNO_3, CAN), Ammonia Urea (AU) and Tripple Super Phosphate (TSP) (H_2SO_4, H_3PO_4, TSP, AlF_3) was prepared in detail with actual measurement where possible or based on process flow sheets. The pollutants discharged are: SO_2, SO_3, NO_x, SPM, NH_3, Urea, CO_2, F, acid mists (H_3PO_4, HNO_3, H_2SO_4) into air, NH_3, CH_4, NH_4NO_3, CAN, H_2S, P_2O_5, Urea, oil, grease, and organic sludges into water; Phosphogypsum, phosphate rock, sulphur filter cakes, and sludges, discarded catalysts and calcium-fluoride/Phosphate sludge from TSP waste water treatment plants on the soil.

The total discharge of pollutants from the complex is 6350 T/day into environment consisting of 1953 T/d into air, 46 T/d into water and 4352 T/d on soil (details are given in figure No. 17). The total volume of waste water is 18,800 m^3/d from process needs and 5000 m^3/d as storm water on rainy day as maximum, i.e. 2 T pollutant & 6 m eff./T product

To this emissions are added discharges from the adjoining power plant (120 MW) about 100 T/d of SO_2, 15 T/d of NO_x and 5 T/d of SPM. These combine with gaseous emissions, and waste water discharge to lake Kattinah.

The counter part and the staff were trained in the pollution assessment and monitoring techniques using

available equipments in setting up the laboratories and the improvisations of methods to using available facilities for the measuring of pollutants in air, water and soil.

Assessment of man power availability and how to train additional staff for general recruitment for new staff at university levels and inservice staff for GFC were made after contacting university and others concerned.

The levels of pollutants in air as measured show 320 to 2240 ug/m^3 for SO_2 and 3 ug/m^3 to 39 ug/ml for NO_x during short period of sampling are much higher than desirable air quality.

Similarly quality of effluents from the complex discharged to river Assi, lake Kattinah and natural pond show pollutant concentration more than standards prescribed by many countries.

Methods for controlling air, water and soil pollution from the complex for each units was investigated and recommendations are made how to reduce the pollution for air, water and soil. It was found that these discharges as compared to standards prescribed by other countries for such units are higher in concentration and per unit products.(Table No 32,33)

Control methods wherever possible are recommended for each unit separately. If fully implemented it will save GFC about 8 tons of urea and 4 to 5 tons of ammonium nitrate per day which will reduce air pollution and pay back the control equipment cost in few years. Tail gases from HNO_3 unit can be converted into ammonium nitrate and recycled to CAN unit at rate of about 14 T/day. The design parameter will need further investigation as recommended. These measures will reduce both pollution and economic loss as follows:

				Potential Saving
Urea	- 8 T/day	- 2400 T/Yr.	- SL	1.92 m./yr
CAN	- 4.5 T/d	- 1350 T/yr	- SL	0.675 m/yr.
NH_3NO_4 (HNO_3 Tail gas)	- 15 T/d	- 4500 T/yr	- SL	1.7 m/yr (less for 2100 NH_3/yr)
CO_2 (Pure usable)	- 722 T/d	- 21,6600 T/yr		10.8 (@ nominal price of SL 50/T of CO_2)
			Total	15.09 Syrian Ponds/yr.

The water pollution also needs to be controlled. Suggestions are made to abate it by reducing shock loads with holding tanks for emergency drainages of plants at shutoff or start up, which will contain carbamate biurate, urea and ammonia, or acids from other units. The need for new waste water treatment for the entire effluent from the complex is emphasised, suggestions are also made to utilise the spare capacity in new condensate treatment plant, for recovering urea, CAN and NH_4NO_3 recovered from air pollution control systems.

Design of the three pilot plants were prepared, namely, (i) Cooling tower, (ii) waste water treatment, (iii) HNO_3 tail gas recovery and were submitted to GFC. Cooling tower pilot plant was commissioned fully, while rest were to be fabricated. Suggestions on proper use of these pilot plants for investigation and studies are made in details.

Lake Kattinah shows clear signs of water quality deterioration and first stage of eutrophication due to pollution from sources like agriculture and industry. This has affected the efficiency of the existing treatment plants and process units of GFC. A detailed plan of studies for the pollution levels and sources of pollution was prepared for future work by GFC and staff was trained for it. Suggestions are also made to improve performance of water treatment facilities on how to treat Kattinah water.

Additional assistance outside the mission was also given to other Syrian Government agencies for improving Homs town water supply to city engineer; effluent standard determination methods to water pollution control Directorate, Development of pollution control course syllabii to "Al Bath" University Engineering College.

Detailed recommendations are made on actions to be taken on various aspects of pollution by GFC, GECI, Syrian Government and also how UNIDO can possibly assist them further in implementing them as follow up action.

3. CONCLUSION AND RECOMMENDATIONS

The discharges of effluents and waste waters from the GFC complex contains numerous substances like NH_3, Urea, CAN, SO_2, NO_x, CO_2, Fluorides, Acids mists, SO_3, H_2SO_4, HNO_3, H_3PO_4 and SPM into air, NH_3, CH_4, F, P_2O_5, NH_4NO_3, H_2S, organic sludges, oil, grease, urea, CAN, rockphosphate and suspended solids to water, and phosphogypsum, waste water treatment sludge, sulphur-filter cakes, sludges, and other dusts like rock phosphate, sulphur, CAN, Urea, etc. to soil.

Some of the discharge rates per unit of production including new ones being commissioned exceed the prescribed discharge rate/limits by many countries as shown in Fig. No. 17, and Table No. 27 to 34. They have affected air, water and soil quality already as measured (table Nos. 28, 29, 30) and some of them the values exceed the maximum levels prescribed by many countries. Also, liquid effluents discharges to the water bodies do not meet standards, causing water pollution and constrain the use of river Assi and impounded reservoirs on it from normal use as water resource. The occupational health aspects of the plant are mainly noise pollution and observations of all normal precautions in chemical industries, proper enforcement and training of safty staff is desirable.

Some pollutants can be recovered with reasonable technology to pay for the cost of control equipment, e.g., Urea, CAN, NH_4NO_3, etc. CO_2 can be utilised as raw material for other industries. (See Appendix VII and Sect. 6 Approach)

Detailed investigation on the degree of environment pollution of air, water and soil to determine its extent, patterns and their variation in different climatic situations over a reasonably long period, is urgently needed. This can be done by converting presently established cell into a monitoring unit in GFC and can also be useful to GECI for pollution monitoring in other industries also.

The manufacturing units in the GFC complex can be classified as heavy chemical industries with a high potential of environment pollution. With best control technology it can be reduced to a large extent but cannot be prevented totally. To solve this many countries use proper pollution controls combined with good site selection to minimise the impact by utilising natural factors like wind pattern, large dilution in water bodies, etc. and to avoid populated areas or such sensitive important places.

GFC complex is correctly located on techno-economic consideration in Homs area but a site selection other than present one just a few kilometers away would have helped reduce the impact considerably, particularly on the lake and village Kattinah population.

The techniques of environment impact studies or assessment before a project site selection is finalised would be useful in preplanning in all new projects of polluting nature in future. A unit for Environment Impact Assessment, set up within GECI may help in evaluating different sites to decide most advantages one for all new industries coming up in future in Syria.

All these activities will require trained man power in larger number. The present academic programmes need to be strengthened by introducing environment pollution control in the curriculam and also training medium and senior level personnel on short term basis in GFC and GECI.

RECOMMENDATIONS

Based on the observations, efforts have been made to develop a coordinated approach for the areas of action to reduce pollution from GFC in particular and also on national basis by GECI in general in the following recommendations.

General

1. GFC should create an industrial pollution or environment management unit separately using the staff trained in the mission. This unit should also have laboratory facilities and staff for monitoring purpose which can analyse liquid effluents as well as sample various chimnyes and ambient air for concentration of the pollutants.

This unit can also serve GECI for monitoring pollution from other industries and/or train their staff.

GFC has already equipments available besides new ones on order for supply and also staff trained during the mission and the unit can start functioning immediately. This unit can be later strengthened and be incorporated at sectional level.

The composition of such units is given in Appendix V.

2. There should be a separate laboratory with proper infrastructure of gas, compressed air and power supply for pollution control with adequate space to install equipment already processed for purchase by GFC. It should also have clean filtered water supply in place of raw water from Kattinah being supplied now, as it will help experimental equipment work better.

3. In order to avoid repetition of GFC complex experiences it would be advisable that GECI should have some organisational set up within itself, and environment impact assessment unit or an environmental impact advisor so that for new project, full measures are taken to evaluate environmental issues before a site is selected for new project.

4. The environment pollution control work will need additional training of staff and personnel. This can be done by

(a) Establishing training programmes in educational institutions for general need.

(b) Arranging a special programme for GFC staff for specific needs.

University programmes can include a post-graduate diploma in environment pollution control technology as a special subject, to fulfill general needs. GFC staff may require special training programme and UNIDO may consider to assist them in this area.

5. It would be useful to have orientation courses or programmes for senior offices to create awareness of new developments in environment pollution issues. This can be done by a seminar or symposium for few days and should be addressed to all industrial managers. It can be a regular programme of GECI and UNIDO may be able to assist them in organising the same.

6. For pollution control, first step is proper operation of process units. It would therefore, be advisable that all the manuals on plant operation in French or English be translated into Arabic. This may cost few thousand Syrian pounds but will pay back much more in return by better performance of plants and production with reduced pollution. Alternatively, intensive English language courses can be started for operational staff so that they can follow manuals properly.

7. Rapid pace of industrialisation of Syria with many industrial units coming up in public and private sectors, protection of air, water, soil, conservation of ecology and human health need attention on priority basis. It will involve all Ministries like Industry, Petroleum, Water Resources, State Planning and Health, and therefore, it will require to be dealt with at highest level of administration. Syrian Government may like to consider creating a "High Level Committee" to recommend suitable decree for a comprehensive environment protection. UNIDO may be able to assist by providing suitable assistance.

GFC - WATER POLLUTION CONTROL

8. The volume of waste water discharged is about 580 m^3/Hr from the complex and is too large quantity compared to normal practice in other such plants. Mostly, it is from the cooling water blow down. This should be reduced by proper management of water treatment and blow down should not exceed 10%. The pilot plant of cooling tower can help in optimising chemical treatment of biocide, and anti-corrosive, to reduce waste water to minimum and maintain total dissolved at suitable level, studies on pilot plant already in operation should be taken up for better management of cooling towers and consequent reduction in water volumes.

9. The new treatment plant is designed for a volume of 4000 m^3/day nominal and 4800 m^3/day maximum for condensates only. The condensate volume at present will be about 2400 to 2900 m^3/day leaving spare capacity in the plant. This can be used for recovering NH_4NO_3 from CAN unit steam discharge if scrubbers are used for it and also for urea recovery as recommended.

10. Out of the total waste water of 12,700 m^3/day, the new plant will treat only 4000 m^3/day, rest is being discharged untreated, and needs a full scale treatment plant to control water pollution in river and lake. Steps should be taken to provide a waste water treatment for the effluents for a volume of 7000 m^3/day as recommended in control measures.

11. This effluent contains NH_3, oil, grease, CH_4 and large quantities of organic waste as sludge from water treatment units. The chemical nature of components of waste will need additional carbon source for a good biological treatment. Some will be provided by sanitary sewage and organic sludge but exact parameters need to be solved for a most economical and effective treatment selection. The water treatment pilot plant designed for this purpose during the mission will be useful to study treatability of

wastes, to decide optimum design and prepare a feasibility of treatment for total effluent plant. Therefore, steps should be taken to commission this pilot plant immediately.

12. The present practice of discharging water treatment sludges about 600 m^3/d and storm water nearly 2500 m^3/d to lake Kattinah from TSP complex should be prevented, as they carry treatment chemicals and also all P_2O_5, F etc. from the area during storm which may be very high in quantities. This will cause pollution of the lake. Two sumps with storm water pumps should be provided at the lake entry point of these drains of adequate capacity to divert this water from going into lake to new proposed waste water treatment plant for the entire wastes recommended earlier.

13. The existing liquid effluent holding task for the Ammonia Urea complex is about 1000 m^3 capacity. There is no such facilities for the other two complexes of TSP and CAN. Even existing holding tank is not large enough to contain emergency discharges from AV complex during start up or shut down when flows up to 600 m^3/Hr may occur, containing ammonia, urea, carbamate and such other substances. Hence a larger holding tank about capacity of 20,000 m^3 for such emergency flow should be provided separately. This will moderate the shock load of discharge to river Assi. Also, it will serve the same purpose when new treatment unit for the entire complex is constructed as it can be used as equalisation tank. It will also protect lake Kattinah and river Assi as all TSP discharges will be treated.

14. The existing waste water system needs better operation and supervision. Presently oil separator unit in AU complex are not operated properly and no oil recovery is done, oil sump and oil separater chambers were full with oil overflowing with effluent without any removal. This results in high oil levels in effluent, polluting river Assi, and loss of oil which could be economically used in

steam generating boilers. Steps should be taken for its regular supervision and operation. (Appendix VII)

Old Ammonia Unit (150 T/d) does not have any oil separator and it should be installed at the earliest.

AIR POLLUTION

15. The urea dust from the prilling tower about 10 to 12 T/day can be recovered as dilute urea soluting by simple water spray scrubbing before discharge to air as recommended in control measures.

16. In CAN unit neutraliser steam is discharged to atmosphere directly after being used in first stage evaporator and carries about 4.8 T/day of NH_4NO_3. This should be recovered by a scrubber as recommened in Control Measures.

17. The nitrogen oxides from the tail gases of the nitric acid plant are health hazard and they must be prevented. This can be done with scrubbing the tail gases with ammonium hydroxide or ammonia solution. A detailed investigation with pilot should be done as recommended.

18. The fluorides emission from TSP is very complex as 19 number of stacks discharge small quantities but totalling a significant amount of 6.75 T/d.(4.5 Kg/T SSP), of this major fraction is emitted from H_3PO_4 unit. The efficiency of scrubber are best as can be obtained as per flow chart. Only alternative to reduce impact of this fluoride emission is to combine them and raise the height of the discharge points. Feasibility on this aspect as well as to examine the other alternative must be done immediately.

19. The chimney heights of dryer/granulation unit of TSP should be raised to at least 60 meter to prevent the downwash of phosphoric acid and fluorides caused by eddies due to nearby tall buildings. There should also be provision of additional heat source (.oil burners) to raise the flue gases' temperature for better bouyancy and dispersal, as down wash of acids mist, occurring at present is not desirable.

20. The ground rock phosphate receiving unit by the rail-wagons has inadequate dust control. A dust standard wagon tippler dust enclosure and extraction fans with cyclones will reduce phosphate rock dust emission in the area.

SOLID WASTES

21. The decision on recommendation of UNIDO expert for the phospogysum disposal, should be expedited by GFC as it needs urgent action.

22. Filter cake from the sulphuric acid plant about 15 T/month will contain almost 50 percent sulphur besides kiesel-gher (diatomacious earth) can be used as raw material in producing sodium metabisulpite, or disposed off properly.

23. Vanadium pentoxides from the sulphuric acid plant is discarded as spent catalyst about 20 m^3/yr or 50 T/yr. This needs a very special disposal at site where it will be safely away from water bodies.

OCCUPATIONAL HEALTH

24. Noise levels in all three units as of ammonia (new), urea and nitric acid are high, reaching levels of 118 db. This may affect the hearing of the persons working in area if not protected. Since no controls are possible at this stage, training of the employees on safety rules and their observance would be helpful.

25. AlF_3 plant, H_3PO_4 and TSP will also need special training of employees on safety and health hazards. A programme to train staff would be useful. UNIDO may help in this matter.

26. For all units safety equipments like emergency shower, eye wash-basins should be kept in good operational conditions as it was observed that large number of them were out of operation or broken.

27. Safety section in Fire fighting should be strengthened and persons trained for better management.

WATER SUPPLY MANAGEMENT AND TREATMENT

28. Lake Kattinah is the only source of water supply for all industries in Homs area including GFC complex. Water quality data show a steady deterioration in last few years, possibly partly due to agricultural fertilizer and partly due to pollution by the GFC complex and power plant. This has affected the quality of the raw and treated water required for the process in the plant and the productivity. A detailed study, prepared in this mission, for the lake to evaluate pollution status and to find out the sources for remedial action is urgently required. This can be done by GFC using staff already trained or if required in collaboration with Water Resource Department.

29. As immediate measure, the water treatment by demineralisation units may be changed as follows to cope with increased organics load due to pollution of lake water

(i) Increase the regeneration period twenty five percent for cation, anion and mixed beds.

(ii) Raise the regeneration solution temperature to about 40 to 45°C by installing steam coils in solution tanks.

(iii) Use sodium hydroxide in place of sodium chloride once in five to six weeks to remove deposited organic matter and better regeneration.

(iv) Remove iron and other immunities from sodium chloride solution by settlement.

(v) C.O.D. test should be used to determine organics in addition to the KMO_4 tests used now to obtain better index of total organics.

(vi) If problem of organic still persists, air diffusers be installed in clear water tanks after filtration. This will need blowers of 10 m^3/hr at 0.5 bar delivery pressure for 100 m^3/Hr water treatment capacity. This will reduce KMO_4 value by 40% as demonstrated in laboratory studies.

30. There are three separate water treatment units with installed capacity of about 3300 m^3/Hr. This will meet all the present and future water requirements of the complex. Therefore, it is recommended that coordination and integration of these units should be done by making interconnections in distribution system to render more economic and efficient service with considerable saving in water and treatment chemicals.

4. PROJECT FINDINGS

The sequence of presentation in this report follows the order of the tasks carried out as per terms of reference of the mission. These are environmental analysis of location and site of the plant, and its impacts, determination of sources, assesment of volumes and discharges rates for each pollutant, suggestions for control measures follow up actions in administration, creation of infrastructures and manpower development etc. Details of each are as follows.

4.1 Location: The city of Homs is strategically located on the western plateau at height of about 500 meter near the natural gap between the mountain ranges of Lebanon and Anti-Lebanon on south and Ansaria on the north along the west coast of Syria. This makes Homs, Syrian Gate to mediterrarian Sea, linking central and eastern Syria to the coast. It is an important traffic and communication centre because of its geographic position at a point where all important roads to both sea outlets of Lattakia and Tartous, from south to Damascus, Daraan and from eastern plains to Deir-ez-zor and the north south highway linking Allepo-Turkey and Europe also passes through Homs.

Homs is connected by railroad to the harbour of Tartous and to Allepo in north which continues to Turkey and Europe. It has been recently connected by a new railroad line to the phosphate mines in Palmira area.

Homs city has concentration of major industries in Syria such as oil refinery, sugar mills, textile, cement and large number of small scale industries engaged in sheet metal fabrication, tiles, marble and block making.

The centre of prime agriculture area of Syria most of which is in the western part in Assi and Barada valleys surrounding Homs.

It has good infrastructural facilities of water resources from Kattinah lake, and power from local thermal power plant. It has plenty of skilled manpower, built-up by establishment of other industries and training institutes in the area.

Homs has moderate continental climate with temperature ranging from -5°C in winter to about 35°C in summer. The rainfall average is about 350 mm, occuring mostly in winter from October to April, with dry period from May to September. Due to gap in the mountain ranges on western side described earlier, Homs has unusually strong windy conditions, blowing mostly from west in spring and summer. In fall and winter seasons, winds are northerly or easterly with stable conditions and also inversion occuring at night.

Geologically area has mostly limestone formation with basaltic ones on west and north-west side. Generally it has good bearing capacity for the heavy structures.

The ground water table in this area varies from few meters below ground in the Assi river valley on the western side to very deep on dry eastern side.

The basic consideration in choosing a suitable location for the fertilizer plants to minimise the costs are:

1) Proximity of raw materials and its transportation costs,

2) Infrastructures like, skilled labour, water, power, roads, railroads, or water ways, etc.

3) Distance to consumers, markets and harbour for export,

4) Civic amenities for employees like housing, schools, colleges for children, medical care and entertainment.

Homs area is ideally suited for the location of the fertilizer complex from the above point of view as proximity of refinery as naptha source and to phosphate rockmines, availability of water, power, transports, communication and excellent climate.

The Fig. No. 1 gives the site of the complex with respect to important roads, railroads, power plant, village Kattinah, lake Kattinah, refinery, Homs city, nearby villages and agricultural land surrounding it. It also shows wind pattern as available.

4.2 The Site: GFC is the biggest fertilizer plant in Syria and the complex is sited in the broad valley of the river Assi (Orantes) on the beautiful shore of the lake Kattinah, formed by the damoon the river Assi, where old recreational park is existing since longtime for Homs public. The complex also adjoins the village of Kattinah with a population of about few thousand.

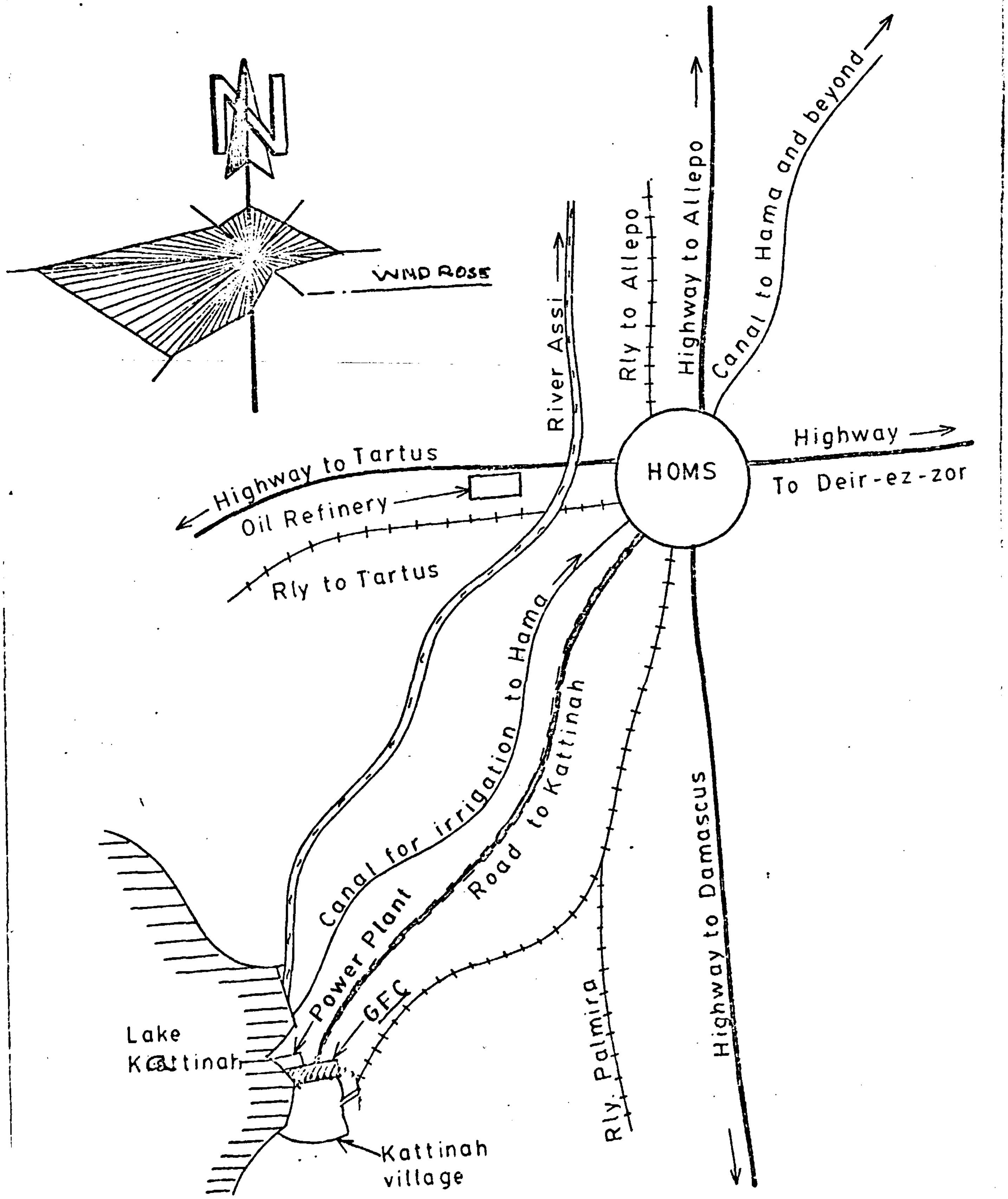


Fig. No.1. (not to scale)

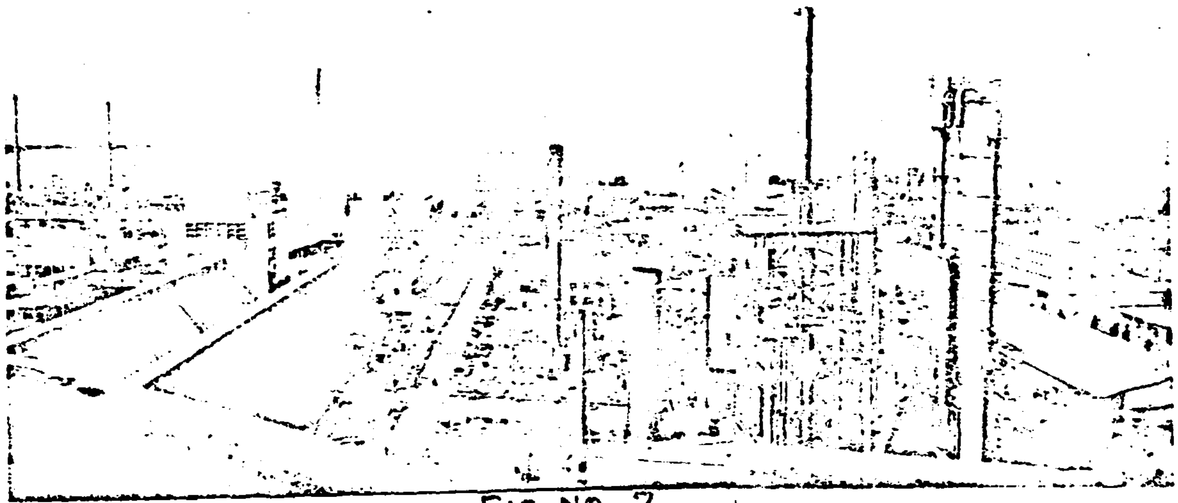


FIG NO. 2

FIG. No. 2.
CAN, AU. COMPLEX
LAKE BEHIND.

FIG NO. 3

FIG. NO. 3.
T.S.P. COMPLEX
Village IN
BACK GROUND.

FIG NO. 4.

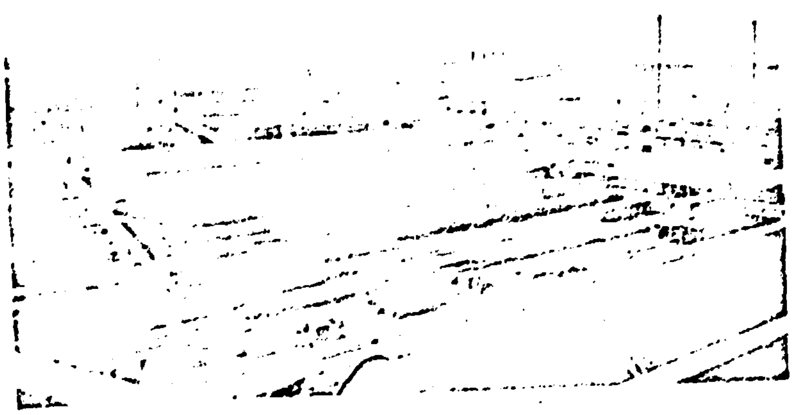


FIG. No. 4.
T.S.P. COMPLEX
LAKE BEHIND.

The site is in the important agricultural area of the country and is about 10 km south-west of the city of Homs.

The area of the complex is approximately one square kilometer, 1200 meter long and 800 meter wide. The ground is plain with gentle slope towards lake Kattinah on the west side and towards river Assi on the eastern side.

The layout of the complex is shown in Fig. No. 2, showing different units, their liquid effluent drains and gaseous emission points/sources. It also shows the shore of lake Kattinah, village of Kattinah and the thermal power station, and approach roads (Fig. Nos. 2, 3, 4 give general views of the complex from the Urea Prilling tower).

The GFC complex consists of three separate sub-complex, self sufficient in utilities etc., they are :

1. Calcium Amonium Nitrate
2. Urea Ammonia
3. Triple/Single super phosphate.

The utilities provided for each are water treatment and supply, waste water transport, stream boilers, laboratories and maintenance workshops.

There are common facilities also for these complexes such as central workshop for major repair and maintenance, central laboratories, civil and electrical maintenance, fire-fighting and safety services, utility management, transport and security staff.

The administration of the entire complex is also located in the same area. The General Directors Office along with other disciplines like Finance, accounts, administration, technical service, planning, research, quality control laboratories, marketing, purchase, security, transport etc., are all located in anaadministrative building, within the complex.

The total staff working on the complex for both administration and technical persons on the production unit is approximately 3500 persons.

There are separate facilities for catering to these staff with including all services and buildings.

4.3 General Assessment of Environmental Impacts:

Fertilizer production is classified as Heavy Chemical Industry with an environmental pollution hazard by many countries like, USA, USSR, European countries, Japan, India, etc. Agencies like UNIDO, UNEP have also made special recommendations on environmental pollution aspects of such industries.

The likely discharges of pollutants from such complex are ammonia, urea, fluorides, oxides of nitrogen, oxides of sulphur, acidic fumes of phospheric, sulphuric and nitric acids, phosphates, nitrates or their compounds and heavy metals into water, air and soil. If these are not properly managed, ecological damage may occur effecting equatic life, fishes and plants, agricultural crops, trees, animals and human health.

The solid vastes generated like, large quantities of phospho-gypsum, sulfur filter cake, discarded catalysts and sludges from waste treatments are of equal concern for soil ecology.

Besides the industrial waste, human waste generated by the large number of employees, combined with laboratory wastes will also add to the pollution problems.

Thus the pollution of environment and ecological damage is very important consideration in selecting sites for such industries.

The assessment of environmental impact show that pollution from the complex can affect the health of the residents of village Kattinah, ecology of lake Kattinah and Assi river and agricultural activities around the plant. The area around the complex are of the natural asset of Syria and therefore, proper control measures will have to be adopted if it is to be protected from pollution.

4.4 MONITORING, POLLUTION SOURCES AND INVENTORY

4.4.1 Pollution Sources: GFC already has good analytical laboratory and trained chemists/staff who are conversant with water and other chemical analysis. Also regularly river Assi water and plant effluents are being monitored. In this mission full use is made of their past data and new data generated utilising their help with enlarged scope of analysis and parameters. Based on experience with similar plants elsewhere, the programme of emission inventory for each unit was taken up systematically for all possible sources from the units, types and quantities of pollutants released by them in the environment were estimated either by actual analysis, material balance or Vendor's guarantees where plants were non-operative. The simplified flowsheets discharged to air, water and soil were developed to prepare "Pollution Inventory" for entire GFC complex, Results and findings for different units are as follows :

4.4.2 Calcium Ammonium Nitrate Complex: It consists of three units as follows :

a) Ammonia 150 T/day, based on Naptha (Snam projectti/ Humphy Glasgow design commissioned 1968/72.

b) Nitric Acid Plant 275-280 T/day based on ammonia, Russian Design and construction, commissioned in 1972.

c) Calcium Ammonium Nitrate plant, 480 T/day, Czechoslovakian design and construction, commissioned in 1972

d) Utilities

i) Steam boiler 10 T/Hr capacity

ii) Water treatment 30 m^3/hr

iii) Cooling tower 600 m^3/hr (1982 - newly installed).

The inventory of pollutants and their rate of discharge for each units are as follows :

Ammonia Unit - 150 Tonnes/day Capacity

This unit was non-operative during the mission period. The details of pollutants generated was obtained on basis of available technical data and flow sheet on theoretical basis. Table Nos. 1, 2 and 3 give the quantities released in air, water and soil. Besides these calculated figures there are other unaccounted sources such as splillages and leakages of ammonia from valve glands leakages and spillages of oil from compressor house. These add to both air and water pollution amounts calculated and tabulated. Figure No. 5 shows the basic flow sheet for the process and pollution sources.

Air Pollution: The total pollutant released in air are given in table No. 1. These values are calculated on theoretical basis and actual values when the plant is operative may differ from these. It shows that this unit has relatively higher rate of ammonia loss at 1 kg/tonne produced. Beside this other pollutants are 112 kg/day of

CAN. AMMONIA UNIT 150 T/d.

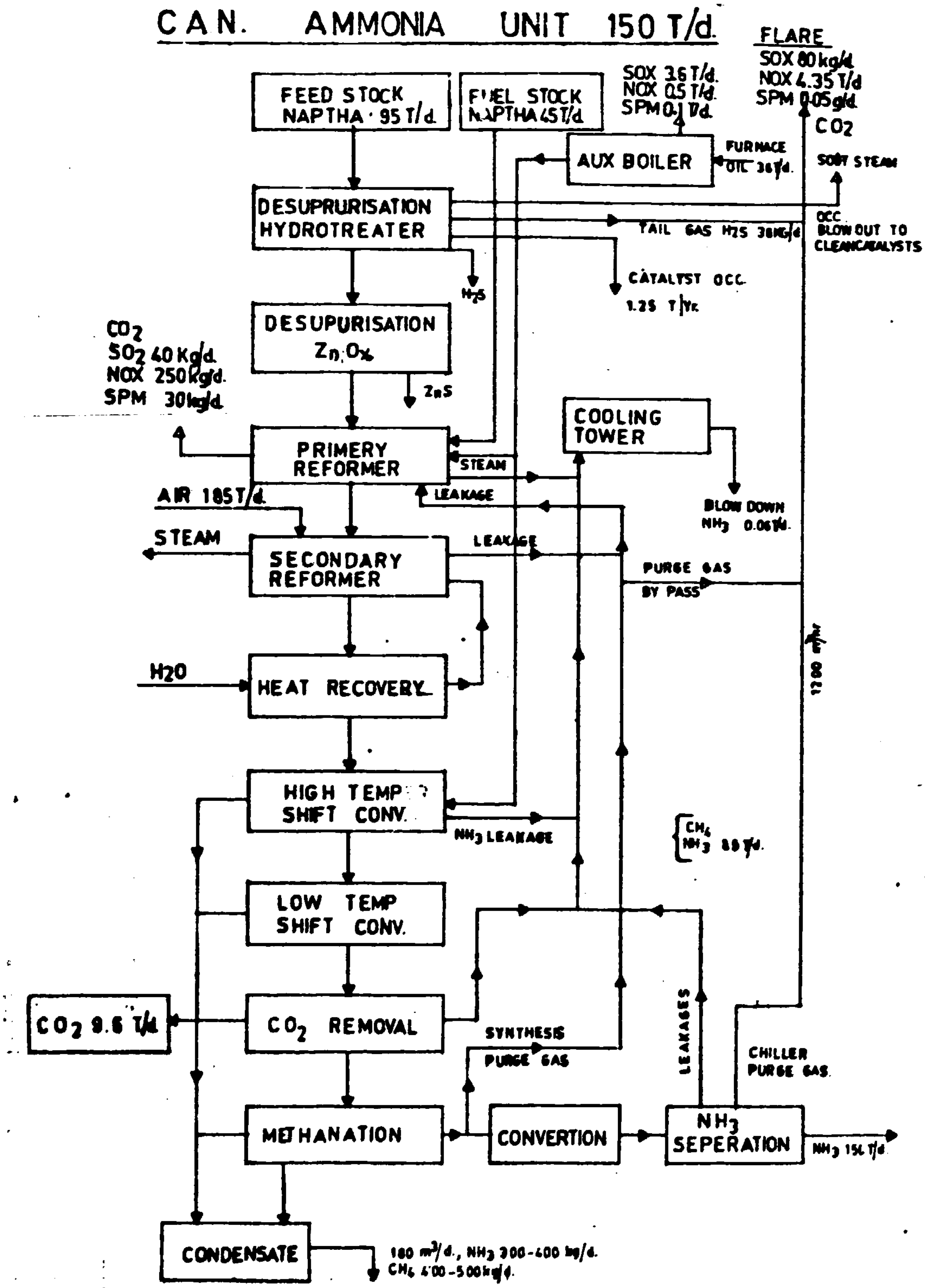


Fig. 5

SO_2 (0.8 kg/Tonne), 45 kg/d of Particulates (0.3 Kg/T), 4.68 T/day of NO_x (31.2 kg/T) and 136.6 T/d of CO_2 (910 kg/T). The important recoverable component of these pollutants are 9.6 T/day of pure CO_2 which can be recovered as industrial raw material as discussed later in the report.

Water Pollution: As given in table No. 2, these values are calculated ones only. The total volume of water used per day is 2960 m^3/day including 2760 m^3/day for cooling for the entire CAN Complex. The ammonia unit's process discharge is 180 m^3/day from H.T. and L.T. shift conversion and Methanation units. The pollution loads carried by it are ammonia, methanol, oil, etc. and are quite high compared to accepted norms in similar other units per ton of ammonia produced.

Solid Waste: Spent catalyst from desulphurisation as ZnS,∠V_2O_5 from Carsol solution are 1 to 2 kg/day on dry basis.

4.4.2.1.5 Noise Pollution: No measurements could be done as plant was not operative.

CAN COMPLEX

Pollutant Inventory Ammonia Unit 150 T/day

TABLE NO. 1: AIR POLLUTION AMMONIA UNIT 150 T/d

Tons/day

Source	NH_3	SO_2	SPM	CO_2	NO_x	Remarks
Desulphurization	-	0.108	-	-	-	Includes 50 kg H_2S in flare converted to SO_2
Primary Reformer	-	0.040	0.030	127.0	0.62	CO_2 as flue gas and not usable
CO_2 Removal	-	-	-	9.6	-	Pure CO_2 - usable
Conversion and NH_3 separation	0.150*	0.015	-		4.06 0.29	In flare
Total for 150 T/day	0.150	0.112	0.045	136.6	4.68	
Kg per ton	1	0.8	0.30	910.0	31.2	

Note: 1) *indicates occasional discharge, NH_3 leakage at may be at 0.2 litres/minute per valve which will add to atmospheric pollution.

2) NH_3 at the rate of 2 Kg/T loss to air = 150 Kg/d = 0.15 T/day.

TABLE NO. 2: WATER POLLUTION AMMONIA 150T/d

T/day

Source	Volume	Ammonia	Methanol	Oil/Greese	Others	Remarks
H.T.L.T. Shift Conv. Methanation	7.5 m^3/Hr 180 m^3/day	4.32	0.36	-	-	
CO_2 Removal	-	-	-	-	K_2CO_3 Diethanolamine (DEA) and V_2O_5	Spillage
Cooling water	115 m^3/hr 2760 m^3/day	0.41	0.51	0.35		Combined cooling water with all units
Total T/day	2940	4.73	0.87	0.35		
Kg per T/Product	19.6 m^3/T	31.53	5.8	2.33		

TABLE NO. 3: SOIL POLLUTION

Zinc Sulphide about	2.5 m^3	Every four years
or	6.5 T	

Vanadium Pentoxide - handling, spillage and losses 1 to 2.0 Kg/day.

Note: This plant was out of commission for refitting the reformer tubes since early 1982. The firuges are based on plant process material balance only.

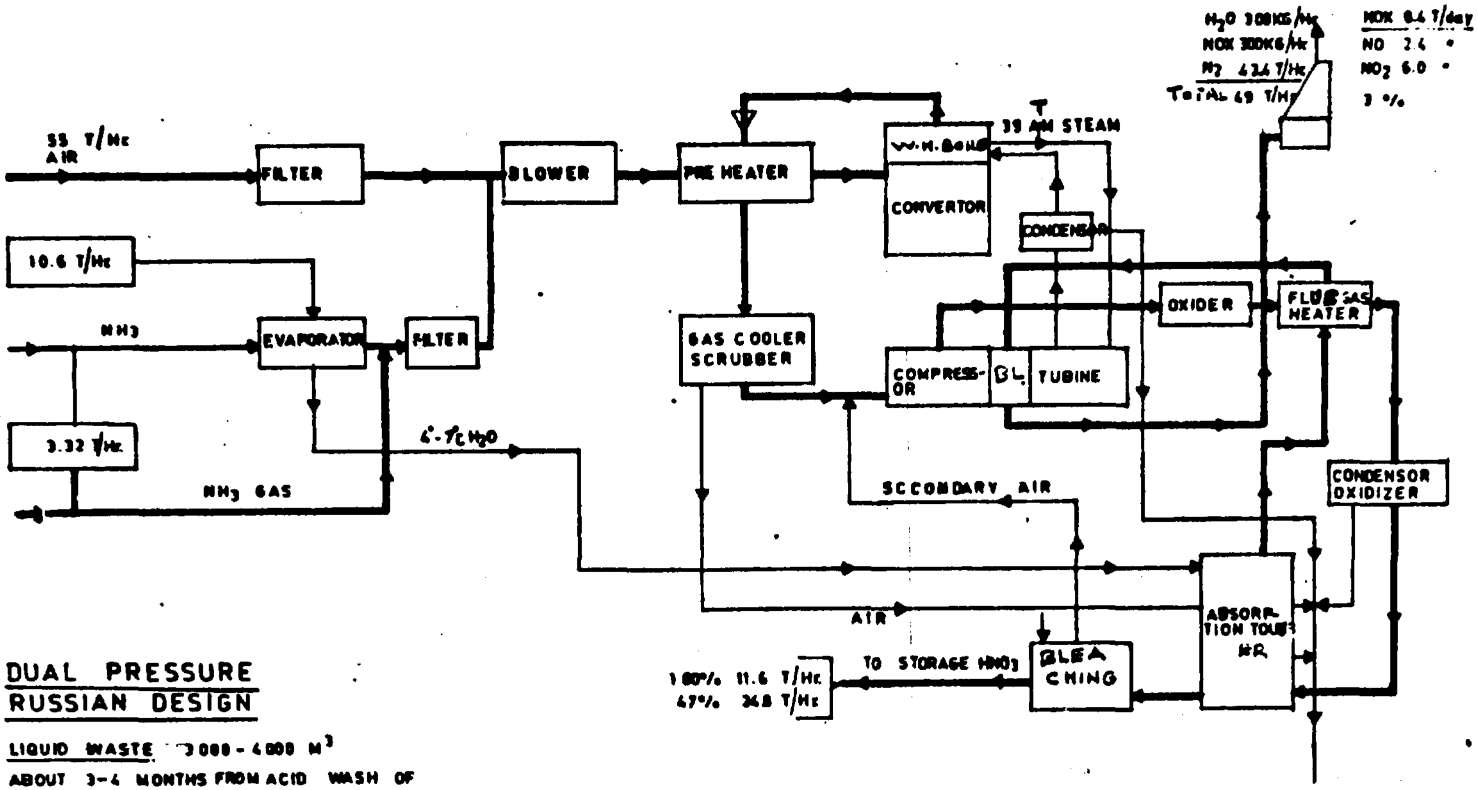
NITRIC ACID UNIT - 280 T/day

This unit uses ammonia oxidation process with dual pressure system as shown in Fig. No. 6. It was fully operative during the mission. The data collected are on actual observation or calculated theoretical bases on flow sheet. Besides identified sources of air, water pollution floor washing, maintenance, etc. also contribute to environment pollution as specifically mentioned in the case.

Air Pollution: As shown in Fig. No. 6, the principle sources of emission to the atmosphere, are tail gases which carry about 8.4 tonns of NO_x per day consisting of NO - 2.47 and NO_2 - 6 Tons per day each. This values are higher compared to emission standards from different countries as discussed in detail later in the report, control measures would help reduce it.

Water Pollution: There is no effluent being discharged from this plant except occasionally once in three to four months when acid wash is given to condensors, coolers and absorption tower. The volume of water is about 3000 to 4000 m^3/day and is generally neutralised before discharge to river. These will

CAN - HNO_3 UNIT 280 T/D



DUAL PRESSURE
RUSSIAN DESIGN

LIQUID WASTE 3000 - 4000 M^3

ABOUT 3-4 MONTHS FROM ACID WASH OF COILS OF COOLER CONDENSORS AND ABSORPTION TOWER

GAS EOUS NOX NO. 2.4 T/day
NO_2 6.0 T/day
8.4 T/day 3%

FLOW SHEET HNO_3 (280 T day 100%)
AT G.F.C (RUSSIAN DESIGN)

FIG NO. 6.

Nitric Acid Unit - 280 T/day

TABLE No. 4: AIR POLLUTION

Source	NO_2 (T/day)	NO (T/day)	NH_3 (T/day)	Remarks
Absorption	6.0	2.4	-	
NH_3 Evaporator	-	-	0.003	Valve-leakages
Kg per ton	21.43	8.57	-	

Note: 1) Water Pollution: 3000 to 4000 m^3 once in four months when acid wash of coils in condensors, absorptontouer etc. is done. It is neutralised before discharge.

2) Soil Pollution: Nil.

Material Balance

Input		Output		
Air/O_2	11.00 T/hr	HNO_3	24.8 T/Hr	
H_2O	10.55 T/hr	Fluegas	43.6 T/Hr	
NH_3	3.32 T/hr	Total	68.4 T/Hr	
Total	68.87 T/Hr		- 0.47 T/Hr	Unaccounted losses
			68.87 T/Hr.	

TABLE No. 5: NOISE MEASUREMENT IN NITRIC ACID PLANT

Date: 4-9-1982 Time: 11.00 AM to 12.00 Noon

Place	Door Open	Noise Level
Steam Turbine House		91-92 db. A.
at Ground floor		92-94 db. B.
Entrance		94-97 db. B.
Below turbine directly		
Near Source - Turbine		90 db. A.
Shieded-body		91 db. B.
Accoustically covered		92 db. C.
Reactors 1st floor		110-115 db. A.
		115-116 db. B.
		116-118 db. C.
Air Blowers		
1st one		102 db. A.
		104 db. B.
		107 db. C.
2nd one		107 db. A.
		109 db. B.
		112 db. C.
Absorption Column		95 db. A.
		96 db. B.
		96.5 - 97.5 db. C.
Control Room	Door Open	Door Closed
	73-75 db. A.	65-67 db. A.
	75-78 db. B.	67-68 db. B.
	78-79 db. C.	68-69 db. C.

A, B, C are standard weightage on frequency scale.

A for 100-1000 Hz - Low Frequency

B for 200-2000 Hz - Medium Frequency

C for 1000-10000 Hs - High Frequency.

carry some quantities of Calcium Nitrate as neutralisation products. Since no washing was done during mission exact data could not be collected.

Solid Wastes: This plant has no solid waste generation.

Noise Pollution: The main sources of noise are steam turbines, air blowers to the combustor and the absorbor column. Table No. 5 gives the values for Steam Turbine House for below and above turbine floor, Air blowers and Absorption column, Reactor floor and Control Room. The maximum value 118 db was too high for the health of workers. With almost all values above 90 db and in Reactor floor all values around 110 db will require protection for the workers.

CAN UNIT

It is a two stage neutralisation process and figure No. 7 shows the process flow sheet along with pollution sources and quantities into air, water and soil. Table Nos. 6 and 7 show the quantities of various pollutants discharged into air and water. This unit was fully operative during the mission and discharge rate were obtained by actual measuring except where it was not possible due to inaccessibility.

Besides the measured and calculated discharges there are also leakages of ammonia and nitric acid

CAN COMPLEX - CAN UNIT 480 T/d.
POLLUTION INVENTORY

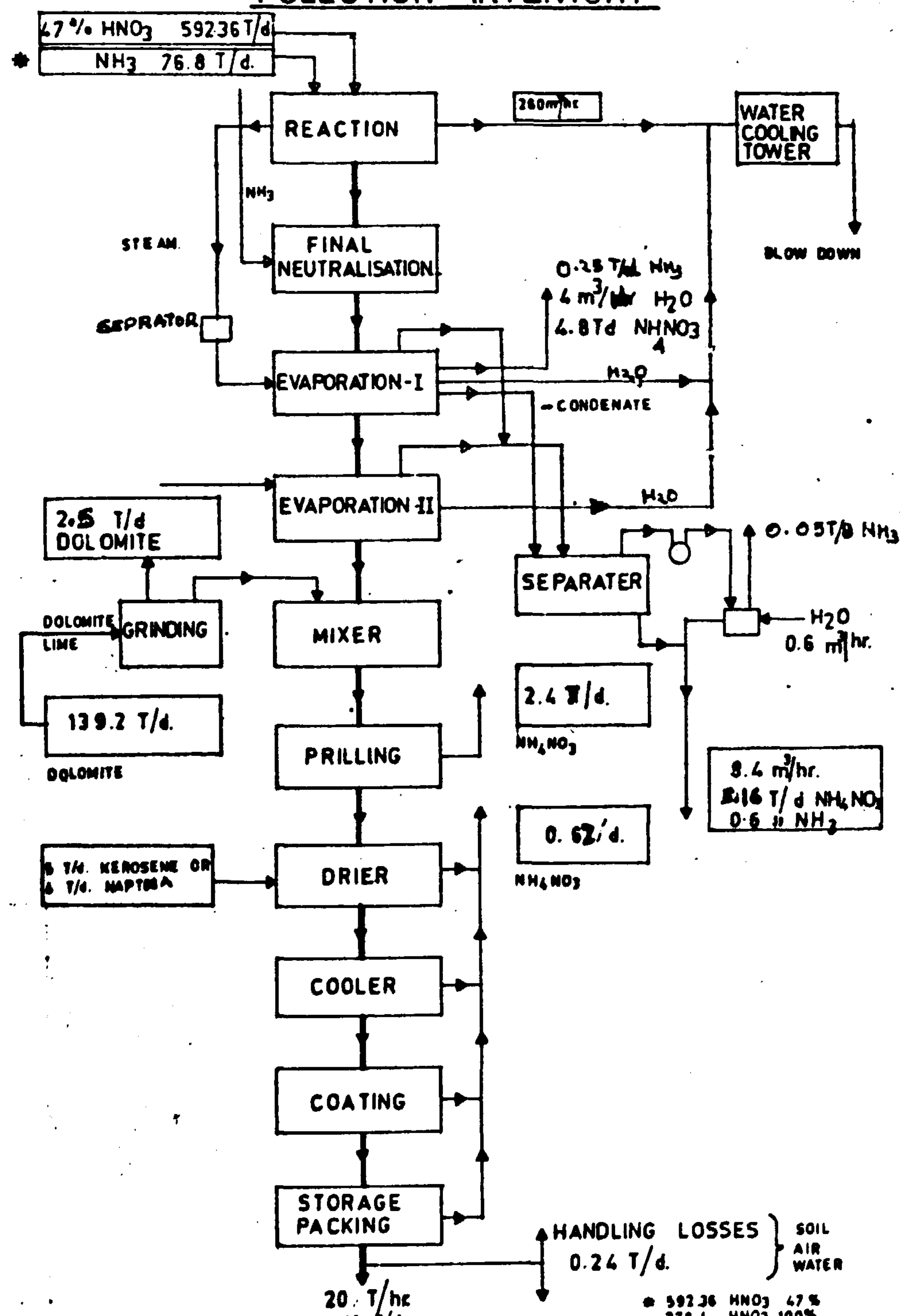


Fig. 7

Table No. 6

CAN UNIT POLLUTANT INVENTORY; Capacity 480 T/day (Actual: 460 T/day)

Material Balance

Input Input

Ammonia-	76.8 T/day	
Nitric Acid (47%)-	592.34 "	(278.4 T/day 100%)
Dolomite -	139.20 "	
Total	808.34 T/day	

Output

CAN -	460.00 T/day	
Steam -	313.00 "	
Total	773.00	
	16.36	- Losses accounted for
	789.36	+ losses unaccounted for (19.0) = 808.34 T/d

Table No. 7: AIR POLLUTION

T/day

Source	NH_4NO_3	NH_3	SPM	Remarks
Reactor (as steam from evaporator I)	4.8	0.25	-	In solution in steam
Vacuum Pump	-	0.05	-	From evaporutors I & II
Dolomite grinding	-	-	2.5	Dolomite
Prilling Tower	2.4	-	-	CAN Fines
Drier	0.6	-	-	CAN Fines
Total	7.8	0.30	2.5	
Kg/T of CAN	17.00	0.625	5.43	

Table No. 8

CAN UNIT: **WATER POLLUTION** Vol. 200 m^3/day

T/day

Source	NH_3	NH_4NO_3	Remarks
Ev. I & II Condensate	0.4	3.0	From water scrubber at 8.33 m^3/Hr
Reactor steam	0.2	2.16	
Total T/day	0.6	5.16	
Kg/T/CAN.	1.25	10.75	Water 416 litters/ Ton CAN

Note : Cooling water is separate and included in combined flow for all units.

SOIL POLLUTION

Nil

which generally flow to the process drain. But spillages during handling particularly of CAN on floors etc. finds its way into storm drains when washed down with water.

Air Pollution: The main sources of air pollution in the unit are the reactor and prilling tower. The final off-gases of reactor carries 4.8 tons/day (estimated) of NH_4NO_3 along with 313 tons of steam per day some of which settles down on the roof of the building and rest is carried by wind. (The effluent steam had average 1.53 per cent ofCAN. The other air pollutants discharged are ammonia, 0.25 T/day (reactor off gases); dolomite, 2.5 T/day (grinding, handling, etc.) and Prilling tower, 2.4 T/day of CAN. The fines from drier account for another 0.6 T/day.

Total CAN loss is 7.8 T/day or about 17.0 Kg/Ton of product, this appears to be too high and should be recovered as recommended later in the report.

Water Pollution: The total volume of water used in this unit is 3140 m^3/day for process and 265 m^3/day for non-process, i.e., 3405 m^3/day. The main source of pollution is condensate separator which discharge 8.4 m^3/Hr waste water with 5.16 T of NH_4NO_3 and 0.6

T/day of NH_3. The cooling water is combined for all the three units and has a common discharge from cooling tower of 125 m^3/Hr as blow down (approximated at site). Thus water used is about 7 m^3/T of CAN and appears to reasonable for such a plant. The CAN loss in effluent is 10.75 Kg/Ton (at rated capacity) rather on higher side for such a plant. The new effluent treatment plant will recover large part of it for recycling purpose and will reduce pollution considerably. (Table No. 8)

Solid Waste: None from the process. But some CAN losses during handling, loading etc. would be around 0.25 Tons/day - mostly during loading of trucks etc.

Noise Pollution No measurements were made as there was no major source of noise.

UTILITIES: CAN COMPLEX

These are: (1) Water treatment, (2) Demineralisation unit, (3) Auxilary steam boiler, (4) Common Cooling tower. The pollutants discharged from each are as follows :

(1) Water treatment - Capacity 30 m^3/Hr has clarification, filtration, disinfection units. Waste water from disluging clarifiers and back wash water for filtration units is estimated to be 3.6 m^3/Hr or about 86.4 m^3/d with 3.0 T/day of organics from sludge.

(2) The Dimineralisation also has same capacity of 30 m^3/Hr. The waste water from regeneration of resins is 7 to 9 m^3/day with 3 to 5 kg of Acid/ Alkali per day.

(3) The Boiler has a capacity of 10 T/Hr but it was not operative. Therefore, it has no pollution.

(4) Cooling Tower: It is newly commissioned in 1982 and has capacity of 600 m^3/Hr. The normal blow down from it should be about 30 m^3/Hr but it was reported to be as high as 100 m^3/Hr sometimes. It carried NH_3, NH_4NO_3 and compounds used as biocide and anticorrosine in nominal concentrations.

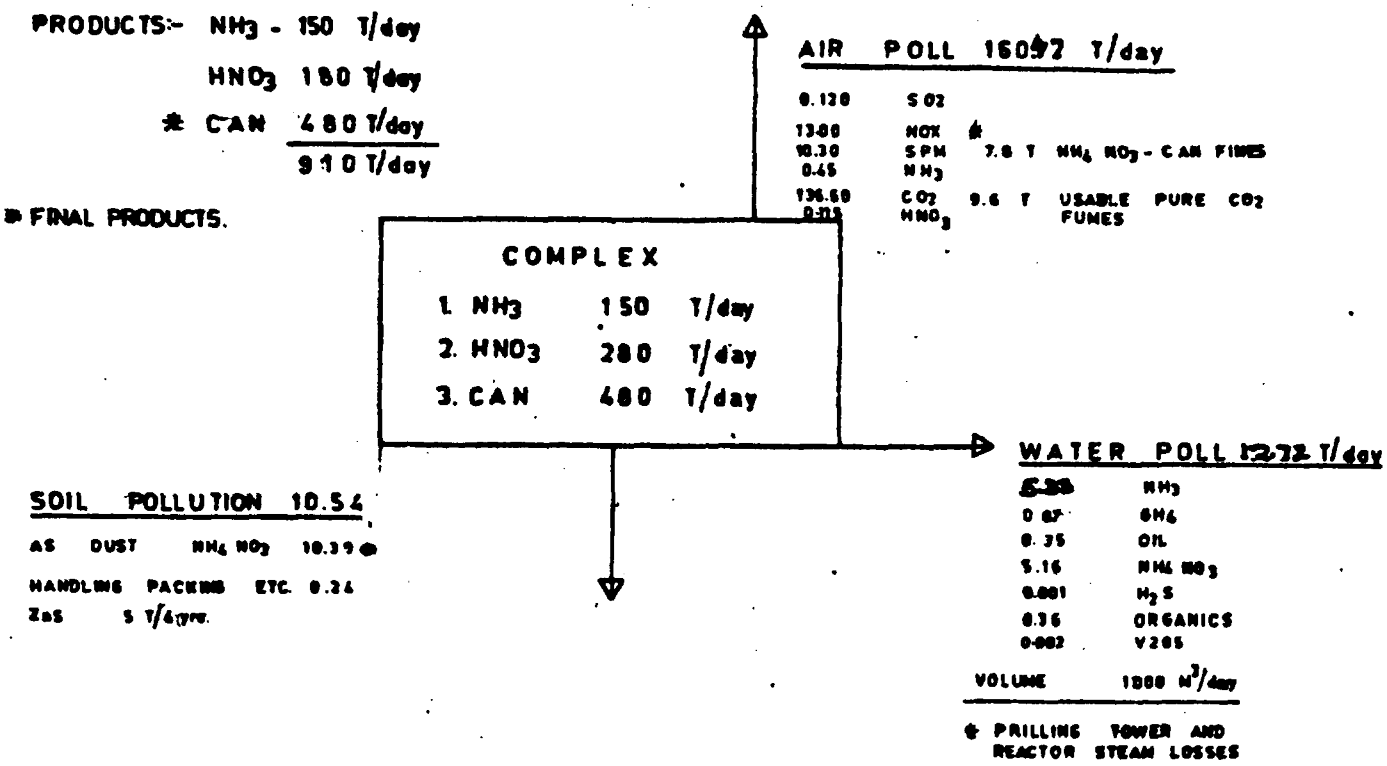
ENTIRE CAN COMPLEX

The total discharges to air, water and soil are given in figure No. 8. The quantities of pollutants estimated are combined for all three units of Ammonia, Nitric Acid and Calcium Ammonium Nitrate, including utilities, in table No 9.

The soil pollution by NH_4NO_3 is calculated on assumption that after discharge into air it will be deposited on soil eventually.

The total pollution discharged to air, water and soil is 173.68 Tonns/day. The volume of water

TOTAL POLLUTANTS FROM CAN. COMPLEX



NOTE.
DATA BASED ON FEW OBSERVATIONS
MATERIAL BALANCE AND FLOW CHARTS

Fig. 8

CAN COMPLEX

Table No. 9: TOTAL POLLUTANT QUANTITIES

Water Volume

Process	720 m^3/day	
Non-process	265 m^3/day	
	985 "	Say 1000 m^3/day

Pollutants

		Note
NH_3	5.33 T/day	Most of the air pollutants will get deposited on soil as soil pollution eventually
CH_4	0.87 "	
Oil	0.35 "	
NH_4NO_3	5.16 "	
H_2S	0.001 "	
Organic sludge	0.36 "	
Total	12.72 "	

Air

	Pollutants T/day	
SO_2	0.120	
NO_x	13.00	
SPM	10.00	included 7.8 T NH_4NO_3 CAN
CO_2	136.60	9.6 T/day pure CO_2 Rest fuel combustion
NH_3	0.45	
Total	160.47 T/day	

Soil

ZnS	5.0 T/4 year

Spent catays' from Desulphurisation - ZnS nominal quantity.
VZO5 from 1 Carsol solutive 1 to 2 Kg/day.

used is 1000 m^3/day. The total NH_4NO_3 loss is 12.96 T/day or 27 Kg/T of CAN produced is too high. The volume of water per ton of CAN (Final Product) is 2.5 m^3/Ton. This appears to be on lower side.

4.4.3. AMMONIA UREA COMPLEX

This complex is most recent and was just commissioned before the mission. It has two major units with utilities.

(i) Ammonia 1000 T/day capacity commissioned fully in 1981-82 (Kellog-Pulman ICI Process) Neptha based.

(2) Urea 1050 T/day commissioned in 1981-82 (Stemi carbon process)

Utilities

(3) Steam Generation (Boiler) two units 55 T/Hr each, total of 110 T/Hr.

(4) Water treatment - 500 m^3/Hr

(5) Dimineralisation units, 2 Nos. 130 m^3/Hr each total installed capacity 260 m^3/Hr.

(6) Cooling Tower about 1000 m^3/Hr capacity

(7) Waste Water Treatment Unit.

The inventory of environment pollutants, their sources and rate of discharge for each is as follows :

Ammonia Unit: 1000 T/day Capacity: This unit was commissioned fully during the last part of the mission. The values reported are mostly based on flow sheet and guarantee figures given by the vendor. The pollution levels in water were determined by actual measurements. The noise levels are also determined values. The rest are calculated on material balance. The liquid effluent was measured as it over-flowed the Weir at outlet of the plant. Fig. No. 9 shows the flow sheet with pollution sources and their quantities.

Air Pollution Total amount of pollutant discharged from this unit is 1682.92 Tons/day, of which 1622 T/day is CO_2, of this, 792 tonnes of pure CO_2 has good potential for use as by-product. The other pollutants discharged are NH_3, NO_x and SO_2 and particulates and are well within the limits for naptha based ammonia plant. Occassionally NO_x from primary reformer stack was observed to be too high but this can be controlled by proper operation. Table No. 10(a) gives the sources of different air pollutants, their quantities and the emission rate per ton of products.

Water Pollution: Table 10(b) gives the average amount of pollutants being discharged by the different processes for each pollutant and their quantities. The volume of water discharged finally was

AMMONIA UNIT 1000 T/day

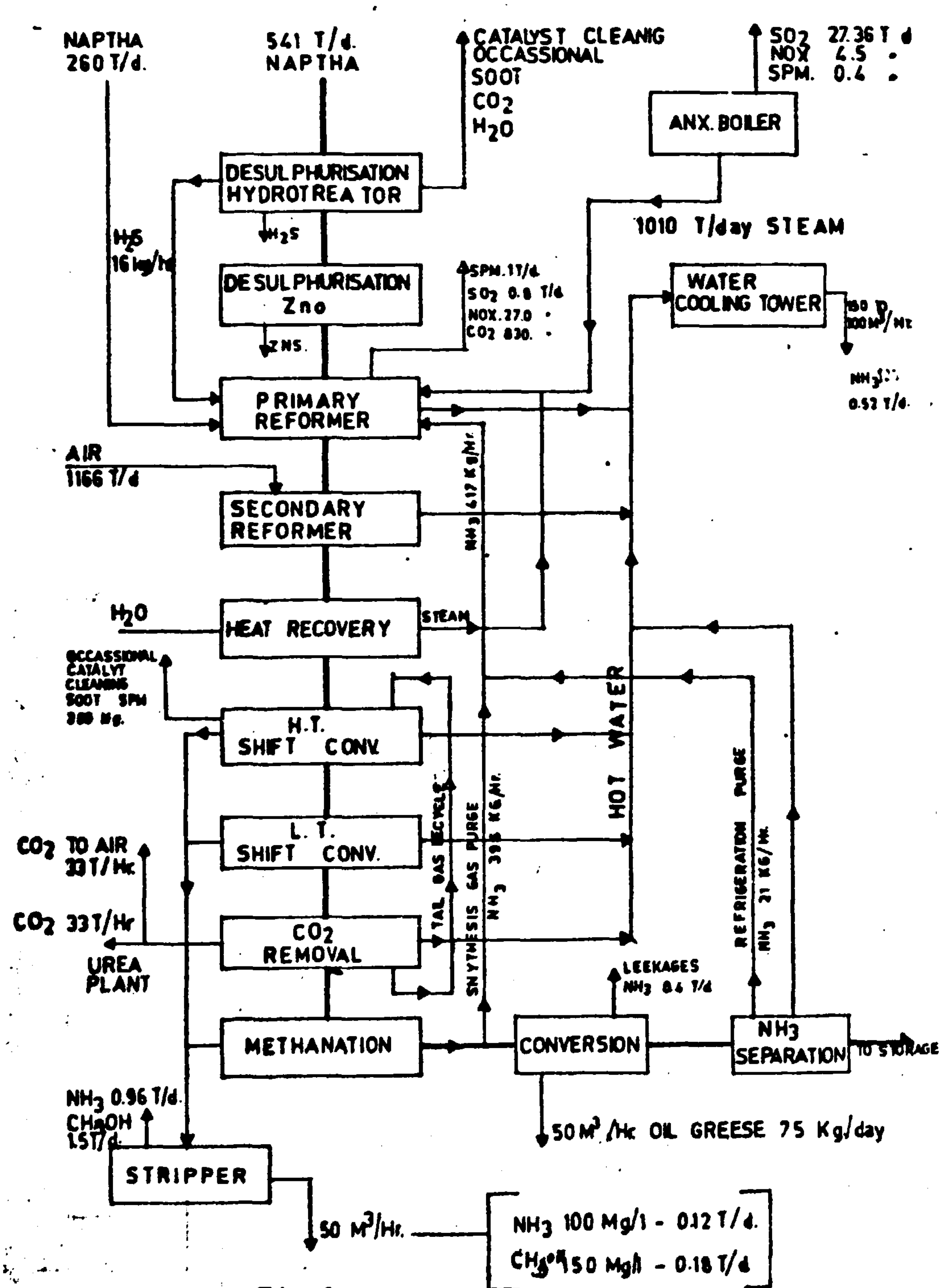


Fig. 9

AMMONIA UNIT 1000 T/day

TABLE No. 10 (a) AIR POLLUTION T/day

Source	NH_3	NO_x	SO_2	PM	Others	Remarks
Desulphrisation Hydrotreater	-	-	-	Occa-sional	Soot catalyst	While cleaning catalyst bed
Primary Reformer	-	27.0	0.80	0.1	830 CO_2	Fluegas
Shift Conv.	-	-	-	-	Cat. dust	Occasional on cleaning
CO_2 Removal	-	-	-	-	792	Pure CO_2 unused
Conventor	0.40	-	-	-	-	-
Cond. Stripper	0.96	-	-	-	-	-
Aux. Boiler	-	4.5	27.26	0.4	Soot	Occasional Steam coil cleaning and Soot Blowing
Total T/day	1.36	31.5	28.06	0.5	1622.0	: 1682.9 T/day
Kg/T Product	1.36	31.5	28.06	0.5	1622.0	

TABLE NO. 10 (b): Water Pollution. T/day 250 m^3/Hr.; 6000 m^3/day

Source	NH_3	CH_4	Oil	Others	Remarks
Condensate Stripper	0.12	0.18	-	0.01	H_2S from bottom Condensate 0.01 mitler
Conversion	0.10	-	0.75	-	Compressor House Waste 500 m^3/Hr. cooled
Cooling Tower	0.525	-	-	-	100 to 150 m^3/Hr
Total	0.745	0.18	0.75	0.01	
Kg/T. Product	0.745	0.18	0.75	0.01	

(c) Soil Pollution

ZnS - 171 m^3/4 yrs - 43 ton/4 years

Exhausted catalys from Desulphurisation.

250 m^3/Hr (6000 m^3/d). The maximum amount of NH_3 is from cooling tower giving average value of 12.5 mg/l of NH_3 in final effluent. Also quantity of oil and grease 750 kg/day or 125 mg/litre and CH_4 30 mg/litre are too high compared to any standards. The effluent plant which has oil separator, equalisation and neutralisation only was not properly maintained with result that all the pollutants were escaping fully to the river Assi. This needs to be rectified as suggested later. Since the plant was in commissioning process, there were surges increasing these amounts of pollutants many times the values when process units were drained. The effluent plant is combined for both Ammonia and Urea units.

Solid Wastes: The wastes generated will be ZnS in desulphurisation of neptha. It will be about 173 m^3 or 43 tons. spread over a period of three to four years. So far no replacement was done or any solid waste discharged. This can be toxic material if not disposed off properly.

Table No. 11

NOISE MEASUREMENT

NH_3 Unit in Process of Commissioning - Primary Reformer Being Steamed. Compressor Not Operative. Steam to Flare

Date: 19-8-1982 Time: 9.30 AM

1)	Control Room + NH_3	65-70 db. Door closed 75-80 db. Door opened
2)	Secondary reformer and Waste heat boiler area	105-108
3)	Auxiliary Boiler - for primary reformer (Near burner)	(i) 103-104 110-112
4)	Compressor House (due to flare echo)	95-102
5)	(i) CO_2 Removal/Absorber column	90-95
	(ii) Pumps area (Pumps not working)	Not taken
6)	Near flare (cooling tower areas)	105-108

Note: This measurements were made on integrated scale of the instrument where all three ranges A, B and C are combined to give a total value.

55

Table No. 12

NOISE MEASUREMENT IN NH_3, 1000 T/day

UREA PLANT COMPLEX

Date: 31st August, 1982 Time: 9.15 to 11.45 AM

(1)		Cooling tower area (No flaring of gas)	75-78 db. A. 80 db. B.
(2)	(i)	CO_2 removal - Column	86-87 db. A. 89 db. B
	(ii)	CO_2 removal-pump area	92 db. A. 94 db. B. 96 db. C.
(3)		Auxillary Boiler (Primary Reformer area)	105 db. A. 107 db. A. 109 db. C.
(4)		Area between Primary and Secondary Reformer	94-96 db. A. 95-96 db. B. 96-98 db. C.
(5)		Primary Reformer East side at Ground Level near the burners	89-90 db. A. 91-92 db. B. 92-93.5 db. C.
(6)	(i)	Ammonia Plant Control Room Door closed	70-72 db. A. 72-74 db. B. 76 db. C.
	(ii)	Ammonia Plant Control Room Door open	75-77 db. A. 77-79 db. B. 80-82 db. C.
(7)	(i)	Compressor house (ground level)	105 db. A. 104 db. B. 103 db. C.
	(ii)	Compressor Operation Floor Control Pahels	103-104 db. A. 102-104 db. B. 102-103 db. C.
	(iii)	Inside workers Cabin	92-93 db. A. 94 db. B. 94-97 db. C.

A. 100-1000 Hz

B. 200-2000 Hz

C. 1000-10,000 Hz.

Noise Pollution: Since the plant was in process of commissioning, two sets of measurement were made. One on August 19, 1982 when it was being commissioned and second on August 31, 1982 when both ammonia and urea plants were fully operative. Table 11 and 12 give the sound levels at different units during and after comissioning. It will be seen that on 19 August, all measurements show high value above 90-95 db with maximum of 112 db near the auxiliary boiler (furnac burner), except control room where it is 65 to 70 db. When it was fully operative on 31 August 1982, areas around primary reformer, auxiliary boiler show slightly lower noise levels, the rest all show very high noise levels particularly in compressor house, ground floor and operational floors. Even workers' cabin has very high levels of 97 db. (Table No 11,12)

These noise levels may have adverse effect on the workers' health, particularly hearing ability, unless proper protective steps taken.

UREA UNIT A.U. COMPLEX

This unit was commissioned for a very short period at the end of the mission. Therefore, very limited observations were possible for actual measurements. It has water and air pollution sources only and has no solid waste discharge. The values given for air are measured at prilling tower rest are from flow sheet calculation or vendors guarentee figures. For waste water volume is assumed as per flow sheet as both ammonia and urea units have a combined drain and separate measurements were not possible. Also concentrations are based on vendors data sheets. The various sources for air and water pollutions are given in figure No. 10.

Air Pollution: The main sources are Reactor High Pressure Scrubber outlet evaporate condensate and prilling tower. The values are given in table No. 13. Total discharges are NH_3 2.72 Tons/day and urea 10 Tons/day against vendors figures of 0.12 T/day NH_3 and Urea dust 0.5 T/day. Since plant was still in process of commissioning these are very high loss per ton of urea (10 kg/Ton urea). This should be recovered.

Water Pollution: The volume water as estimated in the flow channels was 850 m^3/day compared to the flow sheet figure of 840 m^3. This may be due to water tap leakages etc. The values of pollution load are given in table No. 14. These are 0.12 T/day for

A.U. COMPLEX

POLLUTION INVENTORY UREA UNIT 1050 T/day.

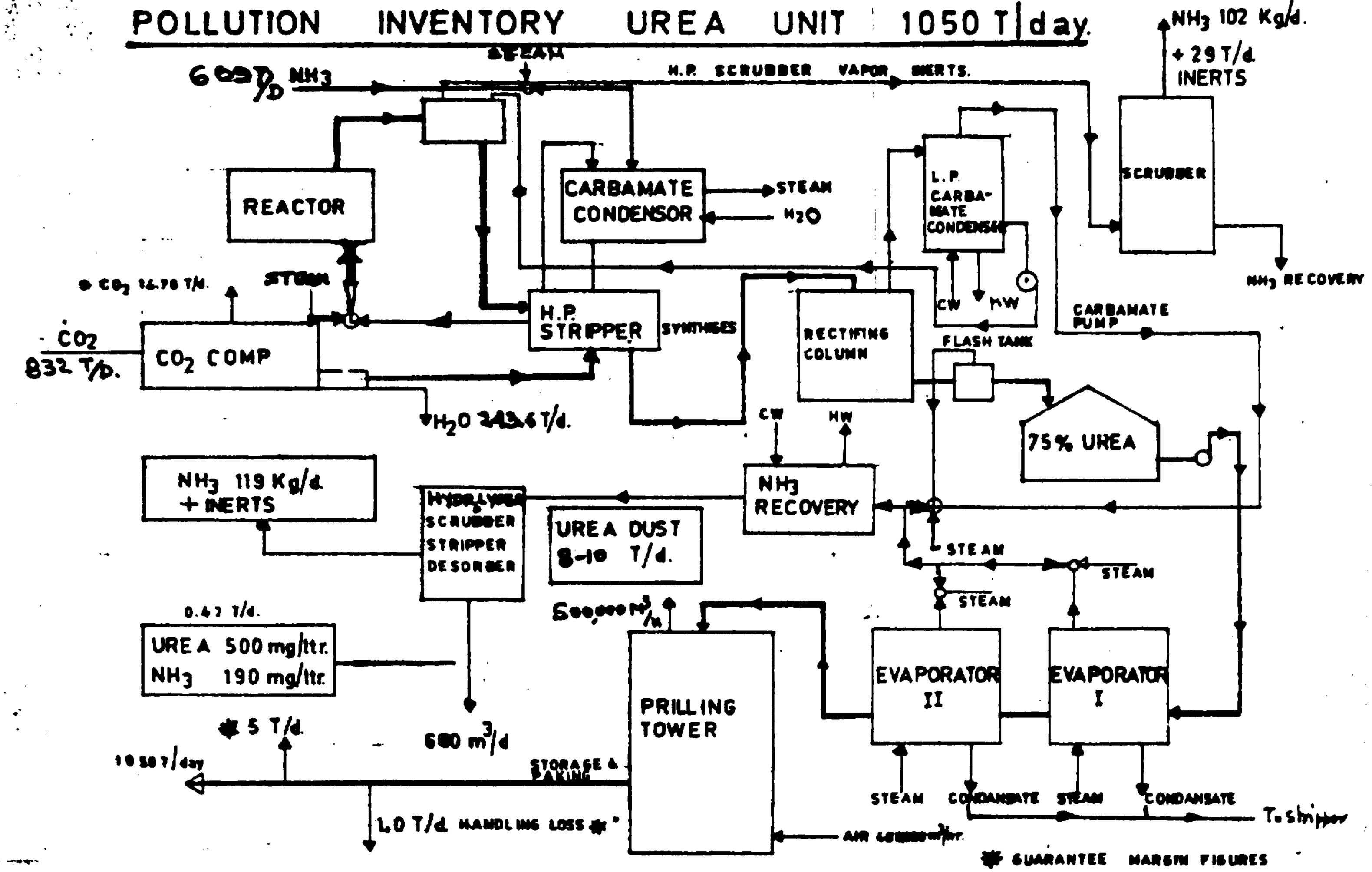


Fig. 10

NH_3, 0.3 T/day Urea and 0.015 T/day oil and greese. The values in final effluent combined with ammonia unit were as follows :

Date of Sample : 31/8/1982

Flow - Volume: 280 m^3/Hr

pH: 9.82

Conductivity: 800 uMHO

Total Dissolved Solids: 480 mg/l

Total Hardness: 310 mg/l as $CaCO_3$

Calcium Hardness: 278 mg/l "

Magnesium Hardness: 58 mg/l "

Alkalinity Methyl: 478 mg/l

Alkalinity Phenolpthalene: 176 mg/l

Chlorides: 25.8 mg/l

Sulphates - SO_4 : 129 mg/l

Nitrates - NO_3 : 53 mg/l

Nitrite - NO_2 : 0.69 mg/l

PO_4 : 1.4 mg/l

NH_4 : 127.58 mg/l

Urea : 60.5 mg/l

C.O.D.: 460 mg/l

Oil and grease : 138 mg/l (Average 125 mg/l)

Total ammonia: 23 kg/hr, i.e., 552 Kg/day

Total Urea : 30 kg/hr, " 720 "

These loads are high for river Assi, which has a min. flow of 3600 m^3/Hr.

Table No. 13: Air Pollution, Urea Unit

Source	T/Day NH$_3$	Urea	Others	Remarks
H.P. Scrubber Tail gas	0.102	-	28.0	Inerts
Evaporator Condensate	0.119	-	-	Inerts 29 T/Hr
Prilling Tower	2.5	6-10	-	500,000 m^3/Hr Air 500-1000 mg/m^3
Total	2.72	10 (max)	-	
Kg/T	2.59	10		

Table No. 14: Water Pollution, Urea Unit

Total volume - 843.6 m^3/day - 35.15 m^3/Hr

Source	NH$_3$	Urea	Others	Remarks
CO_2 Compress	-	-	0.015	10.0 m^3/Hr. 240 m^3/d
Condensate (NH$_3$ recovery)	0.120	0.300	-	25 m^3/Hr - 600 m^3/day
Total T/d	0.120	0.300	0.015	
Kg/T	0.114	0.286	0.015 Kg/T	

Note: No direct Soil Pollution.

Urea dust in Handling	1.5 T/day
and from Prilling Tower by way of settlement from air	10.0 T/day

Material Balance for Urea Unit

Input

	T/Day	
NH_3	600.00	
CO_2	832.34	
H_2O	2.40	as steam in CO_2
Total	1443.74	

Output

	T/Day	
Urea	1050.00	
Steam	322.40	
Losses	17.72	as accounted
	1390.12	
Unaccounted	53.62	- Possibly Guarantee margin
Total	1443.74	

Table No. 15: Noise Measurement, Urea Plant

Dt.: 31-August, 1982 Time: 10 AM to 11.45 AM

		Place	Noise Level
1)	(i)	Control Room - Door open	76-78 db. A. 75-80 db. B 80-82 db. C.
	(ii)	Control Room - Door Closed	68-70 db. A. 69-71 db. B. 72-74 db. C.
2)	(i)	CO_2 Compressor house (Ground floor)	103-104 db. A. 102-103 db. B. 101-102 db. C.
	(ii)	CO_2 Compressor floor (Control panel)	99-99.5 db. A. 98.5-99.5 db. B. 98.5-99 db. C
	(iii)	Workers Cabin (door closed)	85-87 db. A. 85.5-86 db. B. 86.5-87.5 db. C.
3)		Pumps area : Urea Pumps (Open area near Prilling Tower)	93-94 db. A. 99-96 db. B. 95-96 db. C.

Note: A - 100-1000 Hz;

B - 200-2000 Hz;

C - 1000-10,000 Hz.

Soil Pollution: Directly Nil, but most of the air pollution will deposit on soil and vegetation as it is particulate.

Noise Pollution: Only one set of measurements were made in this unit as given in table No. 15. The maximum noise level of 102-104 db recorded was in CO_2 compressor house on ground floor below the compressors. The control panel floor has also a high level of 98 to 99.5 db. Rest of all the area show over 95 db levels, except workers' cabin and Control room, which show slightly lower values.

Generally noise levels in this unit are over safe limits requiring protection measures for the workers.

Utilities

Steam Generation (Boilers): There are two boilers of 55 T/Hr capacity each, using total of 9 T/Hr of fuel oil with maximum of 5 per cent sulphur. The air pollutants discharged from this units will be SO_2 - 21.6 T/day, NO_x - 3.24 T/day, and SPM at about 800 Kg/day.

The water pollution component will be blow down at rate of 132 m^3/day with anticorrosive and scaling compounds.

Water Treatment Plant: Clarification and filtration with chlroniation treatment is provided for the 500 m^3/hr capacity plant. Of this 260 m^3/Hr goes to demineralisation unit and 240 m^3/Hr to cooling tower, process units and domestic use in the plant. The waste generated is only liquid effluents from clarifier and filtration, as sludge and backwash waters. This will be 30 to 40 m^3/Hr and will contain organics and Alum. Hydroxide as sludge at the rate of 8 tons/day.

The demineralisation unit has capacity of 260 m^3/Hr with two units of 130 m^3/Hr each. These will also generate only liquid wastes with volumes of 20 m^3/Hr. Alkaline, 25 m^3/hr acidic and 20 m^3/Hr from mixed bed regenerations, give a total of 65 m^3/hr mostly they will carry dissolved salts with residual acids and alkalies which would generally neutralise each other.

Cooling Tower: This is a combined unit for entire Ammonia Urea Complex. It releases waste water at rate of about 150 m^3/Hr. Mostly it contains ammonia 0.52 T/day with traces of oil greese and water treatment chemicals like bioeides and anticorrosive compounds.

Waste Water Treatment Plant: This unit receives all the liquid effluents discharged from ammonia, urea and cooling water discharges. With total loads listed from each separately in table No. 10(b) and 14. The volume of water handled by this unit is about 300 m^3/Hr. The major flow entering the systems are 250 m^3/Hr from the Ammonia Unit (including cooling tower blow down) and about 35 m^3/Hr from the urea unit.

The unit has one oil separator, equilisation tank and neutralisation with pH monitoring. The other pollutants like, urea, ammonia, etc. are affected only marginally and mostly go out to river Assi.

Sample was collected on 20/8/82 at 1200 noon and analysed in the laboratory next day. The results are as follows :

pH	-	8.8
Conductivity	-	808 u MHO
Total Dissolved Solids	-	482 mg/l
Total Hardness	-	306 "
Calcium Hardness	-	286 "
Alkalinity-P	-	171 "
Alkalinity-M	-	475 "
Chlorides	-	26.0 "
Nitrate	-	59.0 "
Nitrite	-	0.7 "
Free Ammonia	-	130 "
Sulphates	-	128 "
Phosphates	-	1.6 "
Urea	-	48.7 "
BOD	-	280 "
COD	-	450 "
Oil	-	260 "

It will be seen that the plant is improving water quality very marginally. Also oil separator was full oil levels are high but if properly operated, it would be much less.

<u>Total Pollution from A.U. Complex</u>

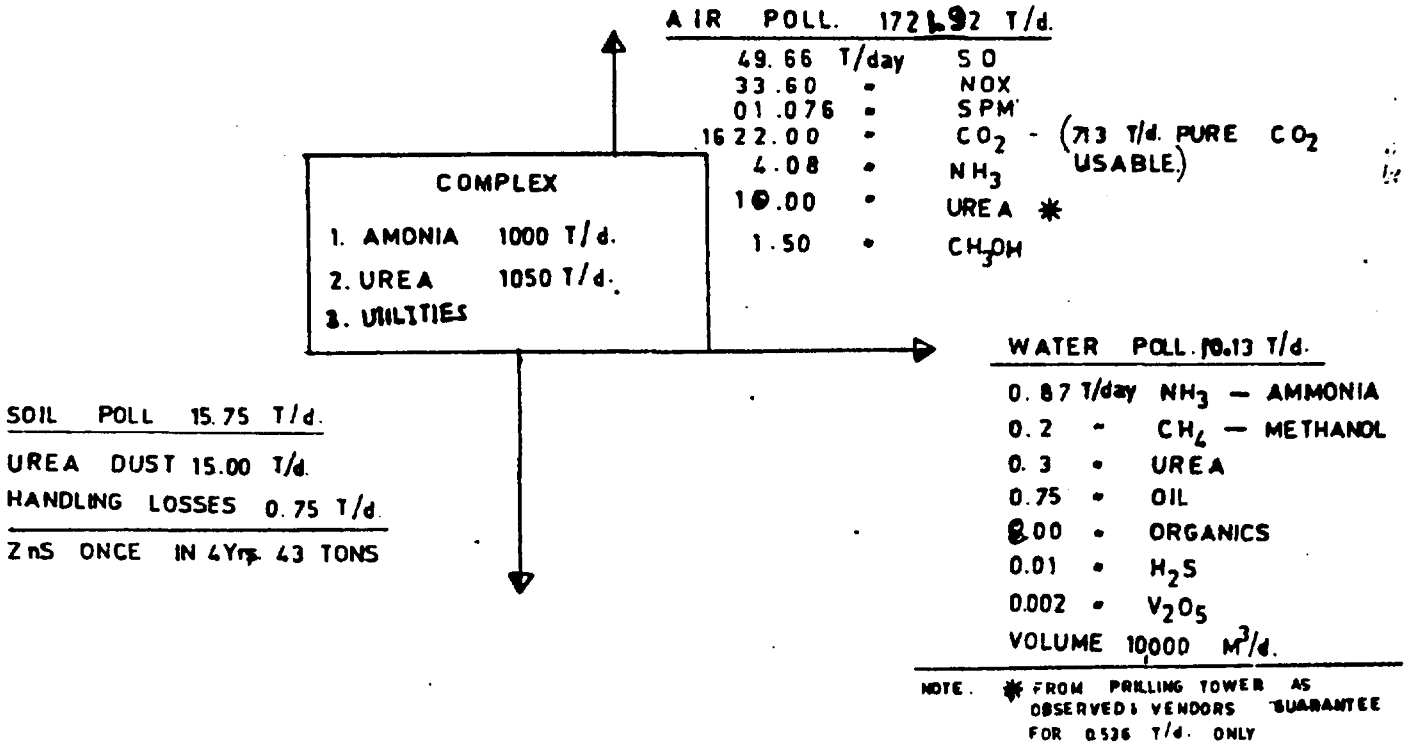
The ammonia-urea sub-complex is an important part of the entire GFC Complex. The total pollution from this sub-complex into air, water and soil is given in table No. 16(a), (b) and (c) and shown in figure No. 11.

The total water consumed in the complex as estimated is about 9,660 m^3/day, say, 10,000 m^3/day, which works out to about 10 m^3/T of urea produced. This figure also appears to be lower compared to other such plant where volumes range from 15 to 30 m^3/T of urea. This is possibly due to use of Naptha as raw material.

The total load of water pollution discharged is 10.13 Tons per day most of which goes straight to river Assi.

The air pollutants emitted by this complex is 1720.34 T/day of which major component is CO_2 1622 T/day. The pure CO_2 discharged as surplus is 713 T/day and has a potential for commercial use in aeration of bottled drinks or dry ice manufacture.

TOTAL POLLUTANTS FROM AMMONIA UREA COMPLEX.



NOTE :- ALL DATA BASED ON LIMITED ISOLATED OBSERVATION OR ON MATERIAL BALANCE AND FLOW CHARTS.

Fig.11

Table No. 16 A.U. COMPLEX (NH_3, UREA)

TOTAL POLLUTION QUANTITIES

Waste Water Quantities

Process :	290 m^3/Hr	6900 m^3/day
Non-process	115 m^3/Hr	2760 "
Total	405 m^3/hr	9660 m^3/day

say, 10,000 m^3/day

Total waste water per tonne of Urea: 10 m^3/T

(a) Water Pollutants

NH_3	0.87 T/day	
CH_4	0.2 "	Note: Carsol sol. containing 3.5% DEA and 5000 ppm V_2O_5, 15 to 20 kg/day as spillage is excluded from here.
Urea	0.3 "	
Oil	0.75 "	
H_2S	0.01 "	
Organics	6.00 "	
Total	10.13 T/d	

(b) Air Pollutants

SO_2	49.66 T/day	- 21.6 T/day from service Boilers.
NO_x	33.60 "	
SPM	1.076 "	
CO_2	1622.0 "	
NH_3	4.08 "	
Urea	10.00 "	713 T/day CO_2 pure can be used. CO_2 from flue gas is included.
Total	1720.344 T/day	

(c) Soil Pollutants

Urea dust -	10.00 T/day	- Through air
	0.75 "	Handling
Total	10.75 T/day	

Desuphurisation Catalyst 171 m^3 - ZnS 43 T/4 years.

The rest of the air pollutants are SO_2 - 49.66 T/d; NO_x - 33.6 T/d and Urea 10 T/day. The urea dust loss from prilling tower is high and should be controlled as recommended later.

The solid wastes are urea dust as handling loss, and zinc sulphide (171 m^3) per four year weight 43 tons. This should be disposed off properly to prevent soil pollution.

Since plant was operational for only short period data on Carbamate quantities released during shut-down/ drainage of units was not available. This is discussed later in recommendation for necessary action.

4.4.4 TRIPLE SUPER PHOSPHATE (T.S.P.) COMPLEX

This complex is designed, supplied and erected by the Romanian Company. It was still in the process of testing and checking and was non-operational during the mission period. It consists of following units :

1) Sulphuric Acid plant 1700 T/day - Two units 850 T/day each, using D.C.D.A. process.

2) Phospheric Acid plant 533 T/day capacity Dihydrate process.

3) Triple/Single Super phosphate plant - 1500 T/day.

UTILITIES

(4) Water treatment plant - 2700 m^3/Hr.

(5) Demineralisation unit - 250 m^3/Hr.

(6) Boilers: 4 Nos. Two 75 T/Hr - 10 Bars; one 30 T/Hr - 45 Bar; One 30 T/Hr - 16 bars.

(7) Cooling Towers for H_2SO_4 and H_3PO_4 - T.SPP. plants (combined)

(8) Waste water Treatment - 438 m^3/Hr.

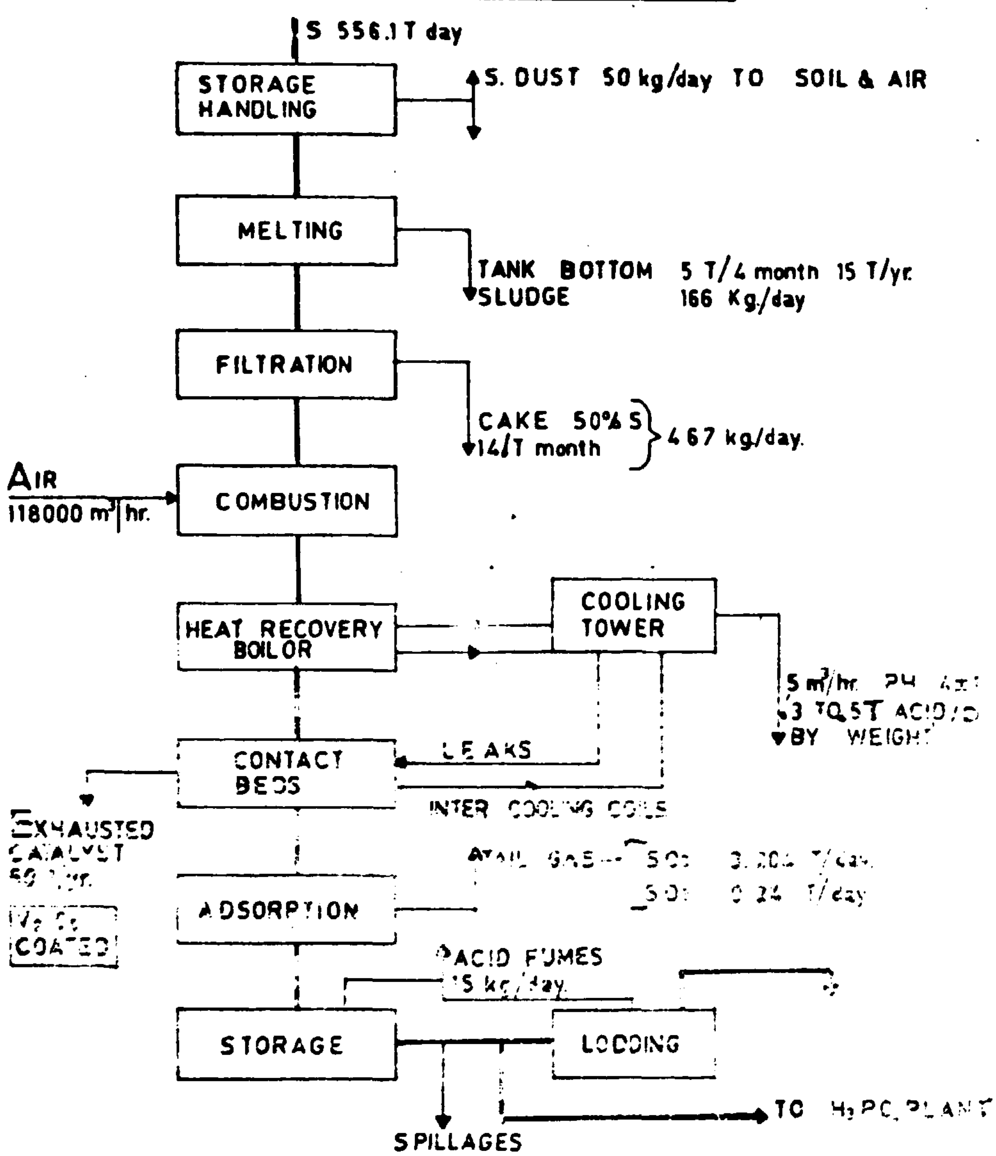
Since this plant was nonoperative all values for air pollutants, water pollutants, and solid waste presented are based on Vender's flow sheets, material balance and guarantee figures. No actual measurement or sampling was done. Though some of the figures were not yet finalised as per actual operational conditions they are presented as an approximation.

Granulation units were being commissioned and some of the actual observations are also included. The detailed inventory for each unit is given separately as follows :

H_2SO_4 Plant 2 x 850 T/day (1700 T/d)

This plant was not operative during the mission. Its basic flow sheet is shown in figure No. 12 along with pollution sources from various operations in the process. The material balance calculations are also included in it to indicate the losses to air and water as pollutants.

T.S.P. COMPLEX SULPURIC ACID UNIT
CAPACITY 950 T/d X2 – 1700 T/day
D. C. D. A PROCESS



H_2SO_4 50 TO 100 kg/day OR S. 35 kg/day

SULPHUR BALANCE ENTERING SYSTEM	566 1	T/d.
IN PRODUCT 1700 T/d H_2SO_4	555.1	"
TO AIR	1.7	"
OTHER LOSSAGE TO WATER/SOIL	9.3	"
	566.1	T/d

RATES – SO_2 1.89 KG/T.
SO_3 0.15 KG/T.

Fig 12

Air Pollution: Two major pollutants are discharged from this unit is SO_2 - 3.20 T/day and SO_3 - 0.24 Tons/day. These are well within the limits prescribed by many countries. Table No. 17 gives details of these along with assumed sulphur dusts amounts during handling.

Water Pollution: The sources of water pollution are only leakages and spillages in cooling waters and drains. The values are assumed on basis of experience in other such plants where good operation is practised at rate of 0.02 per cent. This works out to be about 0.3 T/day of H_2SO_4. Actual value during operation may differ considerably. Table No. 18 indicates the rates.

Soil Pollution: The main sources of solid waste discharges are melting unit sludge and filter cakes. Contact bed will also need change of catalysts at about ten per cent volume per year. These are all given in Table No.19 with rates worked out per ton of H_2SO_4 produced.

Noise Pollution: Main sources are air blowers. One hundred thousand cubic meter per hour - three numbers with 1800 mm guage pressure blowers would generate considerable noise. Since they were nonoperative no measurements could be made, but noise levels would be about 95 to 100 db minimum around these blowers.

T.S.P. Complex: Pollution Inventory

H_2SO_4 - Plant 1700 T/day (850 x 2)

Table No. 17 Air Pollution

Source	SO_2 (T/day)	SO_3 (T/day)	Others (T/day)	Remark
Tail gas	3.20	0.24	-	-
Handlings	-	-	1.7	- S as Sulphur dust
			0.1	-H_2SO_4 as Fumes
Total	3.20	0.24	1.8	
Kg/T	1.88	0.14	1.0	

Table No. 18 Water Pollution

Source	H_2SO_4 (T/day)	Others	Remark
Cooling Tower	0.3	-	-
Total	0.3	-	
Kg/T	2.0		

Table No. 19 Soil Pollution

Source	S (T/day)	V_2O_5 (T/day)	Others (T/day)	Remark
S. Storage	1.7	-		
Melting	0.166	-	0.16	Tar as sludge
Filter	0.41	-	0.57	Tar
Conversion Contact Beds	-	0.167	-	Used catalysts
Total	2.276	0.167	0.73	
Kg/Ton	1.34	0.1	0.05	

Phosphoric Acid Plant - 533 T/day (P_2O_5)
(Includes AlF_3 plant 9 tons/day as by product)

This plant was commissioned only in last few days of the mission and was in process of stabilization. Therefore all the figures given in this report are based on flow sheet and material balance supplied by the vendors or as per the guarantee figures given by them. The basic flow sheets are given in figure Nos. 13 and 14 for fluorides and phosphates separately along with material balances. The details of air,water, soil and noise pollution are as follows:

Air Pollution: The major air pollutants from this unit are 6.04 tons/d of fluorides and 1.69 tons/day P_2O_5 are discharged from ninteen different stacks/outlets with hights of about 16 to 25 meters from ground. All the units like reactor, evaporator I and II, and AlF_3 plants are provided scrubbers and water is treated with neutralisation to precipitate fluorides and is recycled totally. The values given are exit gases after scrubbing. Details of each unit operations and amounts are given in table No. 20. The emission rates per unit of products are 3.17 kg of phosphate and 11.33 kg of fluorides per ton of P_2O_5 (100%). These appear to be on higher side compared to similar other units.

Water Pollution: The pollution loads are worked out on basis of material balance in the flow sheet. The waste water produced is 438 m^3/day and is supposed to be

TSP COMPLEX POLLUTION INVENTORY – F in H_3PO_4 AlF_3 PLANTS AT G.F.C. HOMS

CAPACITY 533 Td. P_2O_5

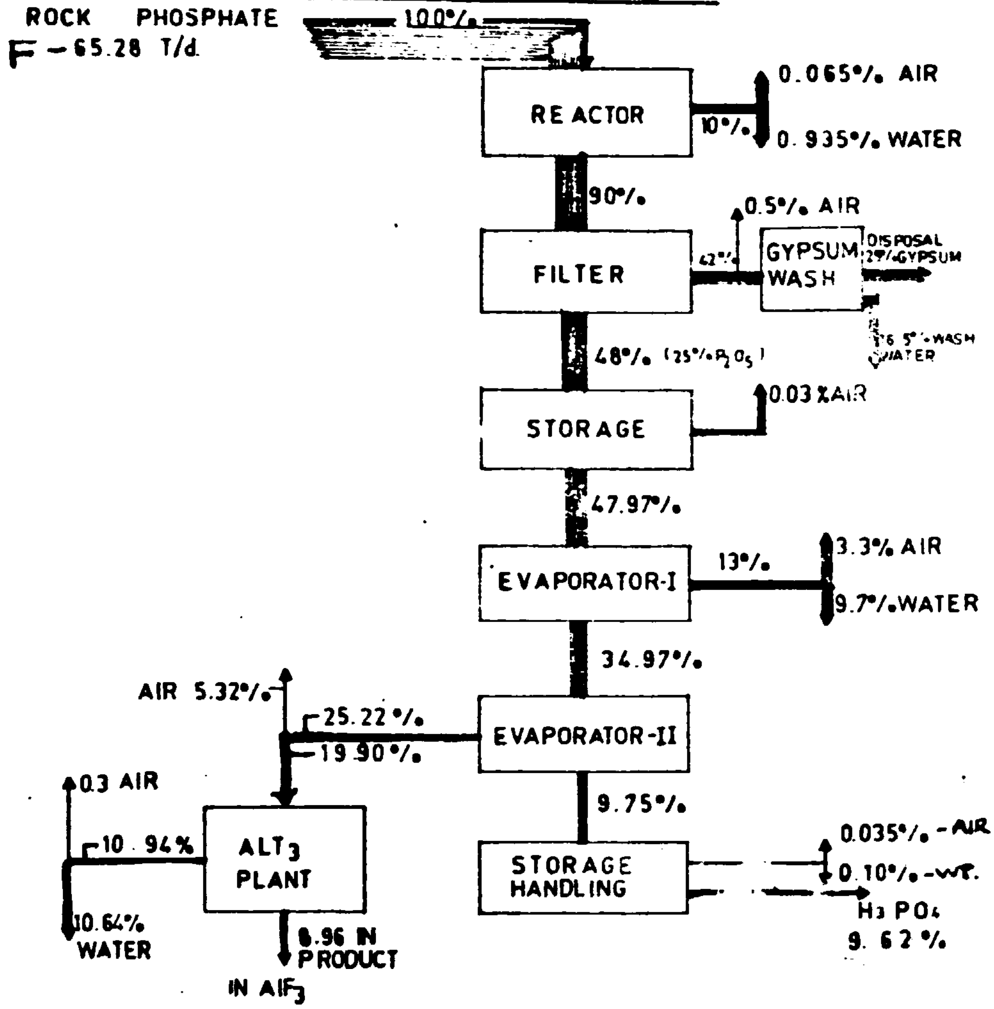


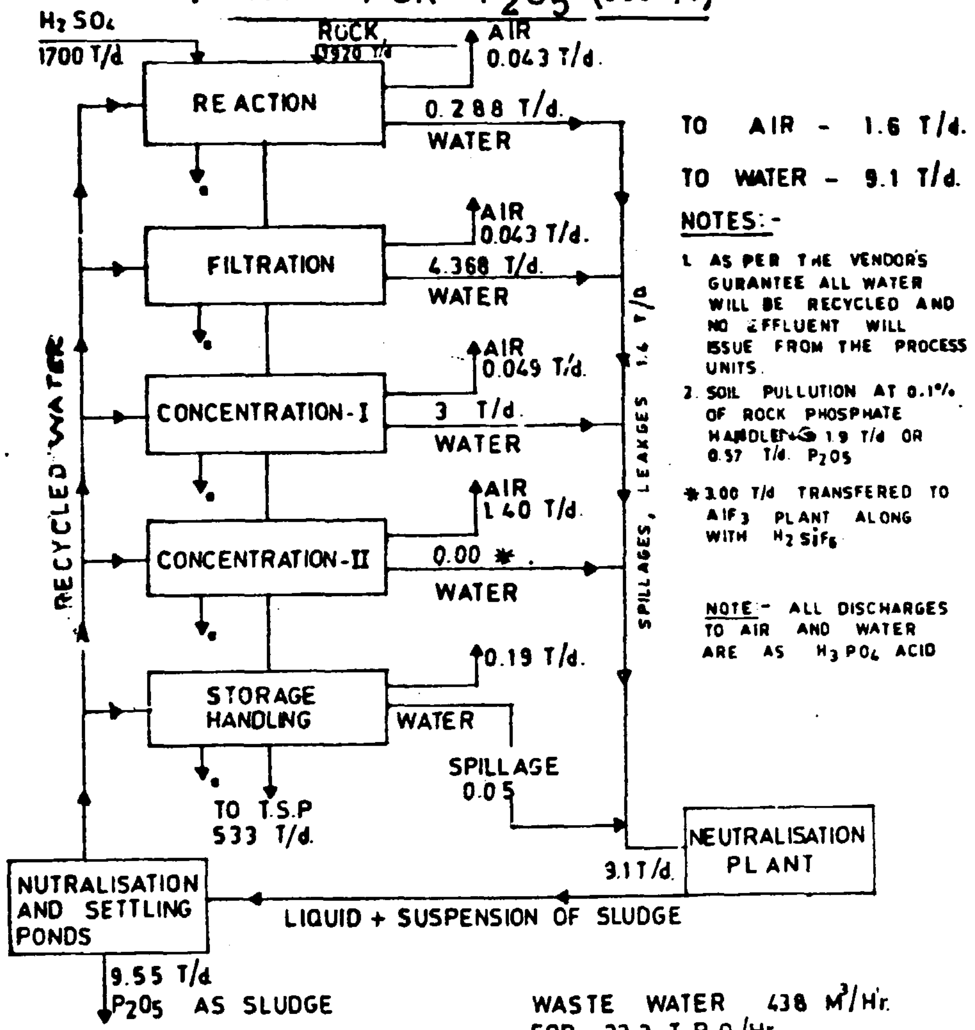
TABLE NO. FLUORIDE POLLUTION

UNIT		AIR	WATER	SOIL	PRODUCT	TO AlF_3
H_3PO_4	%	9.25	36.23	25.00 *	9.62	19.90
	T/d.	6.04	23.65	16.32 *	6.28	12.99
AlF_3	%	0.30	10.64	–	8.96	–
	T/d.	0.19	6.95	–	5.85	–
TOTAL	T/d.	6.23	30.60	16.32 *	12.21	–
100 % (65.28 T/d.)		9.55	46.87	25.00 *	18.71	–

* F WILL BE TRANSFERED TO AIR BY EVAPORATION AND TO SOIL BY RAIN WATER WHICH MAY BE ABOUT 10% OR ABOUT 6.5% T/d

Fig. 13

TSP COMPLEX - H_3PO_4 UNIT POLLUTION - INVENTORY FOR P_2O_5 (533 T/D)



WASTE WATER 438 M^3/Hr.
FOR 22.2 T P_2O_5/Hr.

RATE OF WASTE WATER GENERATED 19.73 M^3/T. P_2O_5 SAY 20M^3/T

MATERIAL BALANCE FOR P_2O_5.. ALL FIGURES T/d.

TOTAL ENTERING SYSTEM	585.6	1920 T/d AT 30.5% P_2O_5
IN PRODUCT	533.0	GUARANTEE FIGURE
IN AIR	1.69	
IN WATER	9.55	
IN PHOSPOGYPSUM	22.32	
TO AlF_3 PLANT	3.00	
	569.50	
UNACCOUNTED 3%	16.04	POSSIBLY GUARANTEE MARGIN FOR P_2O_5 % OR VARIATION IN ORE OR LOSSES.
	585.60	

EMISSION	RATES	
AIR	3.17	KG/T
WATER	17.91	KG/T
SOIL	41.88	KG/T

Fig 14

T.S.P. Complex Pol. Inventory

H_3PO_4 Unit - 533 T/day

Table No. 20 AIR POLLUTION

T/day

Source	P_2O_5	F	Others	Remarks
Reaction	0.043	0.042	-	
Filtration	0.048	0.326	-	
Conc. I	0.049	2.154	-	
Conc. II	1.40	3.670	-	
Storage Handling	0.150	0.042	-	
Total	1.69	6.234		
Kg/T P_2O_5	3.17	11.69		

Table No. 21 WATER POLLUTION

T/day

Source	P_2O_5	F	Remarks
Reaction	0.288	6.485	Volume 438 m^3/d Recycled fully.
Filtration	4.368	10.771	
Conc. I	3.000	6.332	
Conc. II	-	6.95	Through AlF_3 unit
Storage and Handling spillage	1.9	0.0653	
Total	9.556*	30.6*	
Kg/T P_2O_5	17.23	57.41	

* Neutralised and removed in sludge 350 T/day.

Table No. 22 SOIL POLLUTION

T/day

H_3PO_4 - Spillage	-	0.1	
Rock posphate	-	0.5	
Gypsum 30% H_2O	4	4000 -	with 16.33 Tons of F and 22.32 tons of P_2O_5

totally recycled after treatment where all the 30 tons of fluorides and 9.56 T/day of P_2O_5 are precipitated as calcium phosphate/fluoride and removed as sludges. The utilities waters as discussed are discharged to lake Kattinah and Assi river as given in table No. 21.

Soil Pollution: The principal problem of soil pollution is huge quantity of phosphogysum 4000 T/day generated from this unit. Analysis of Gypsum is given in Table No. 23. Efforts are being made to dispose it off or use it by the plant authorities. UNIDO Expert has already submitted a detailed report on this covering all possible uses and disposal methods. The GFC authorities are actively considering these recommendation for implementation. The problems of transportation and land availability which are being examined in details for immediate disposal by an expert committee will take some time to decide finally. Till then it is likely to be continued to be dumped in Alwaar area which drains to Lake Kattinah.

The phosphogysum carries with it 16.32 T/day of fluoride and 22.32 T/day of P_2O_5 as residuals and this may be leached by the rains and transported to the water body if proper precautions are not taken. Also, it contains trace metals in phosphogypsum as shown in table No. 23. A part these may also be leached and transferred to soil, ground water or to surface waters by rain runoff. To

To contain these pollution special care will be required in selecting proper disposal site and its management by GFC authorities. These are discussed in details in the recommendations by the expert (UNIDO Report No.SI/SYR/78/801)

The other soil pollutants are minor sources of H_3PO_4 spillages and rock phosphate dust in handling and transporting. The other soil pollutants is the sludge generated by neutralisation in the setting ponds. This is 350 T/day and will contain P_2O_5 and F besides other compounds and tracemetals. This will need careful disposal to avoid ground water pollution.

Noise Pollution: Since the plants were not operative it was not possible to measure it anywhere. However, it is likely to be around 80 to 90 db in steam ejector operations.

Table No. 23 Phosphogypsum from H_3PO_4 Unit

Chemical Analysis

Parameter	Concentration on Dry Basis
Ca^+	28.19%
SO_4^-	67.60%
P_2O_5	0.75%
K_2O	0.02%
Al_2O_3	0.07%
F	1.02%
Si	2.25%
Mg	0.01%
Cl^-	2.5 ppm
As	0.5 "
Cd	20.0 "
Cr	4.0 "
Cu	10.0 "
Ni	14.0 "
Pb	50.0 "
Zn	25.0 "
Sr	980.0 "
Ba	200.0 "
Ti	75.0
U	5.1

Analysis report by M/s Fisons Fertilizer to GFC, 15 July 1982.

Table No. 23 (a) TRACE METAL ANALYSIS - T.S.P. Complex

Element	Concentration		
	1	2	3
Ag	0.088 mg/l	0.006 mg/l	2700 ppm
Cd	0.017 "	0.017 "	500 "
Cr	0.024 "	0.020 "	1000 "
Cu	0.030 "	0.020 "	800 "
Pb	0.038 "	0.008 "	860 "
Zn	0.20 "	0.10 "	3000 "
As	0.001 "	0.001 "	50 "
Bi	0.028 "	0.028 "	600 "
Hg	0.001 "	0.001 "	50 "
V	0.096 "	0.096 "	190 "

TSP Neutralised Waste Water.

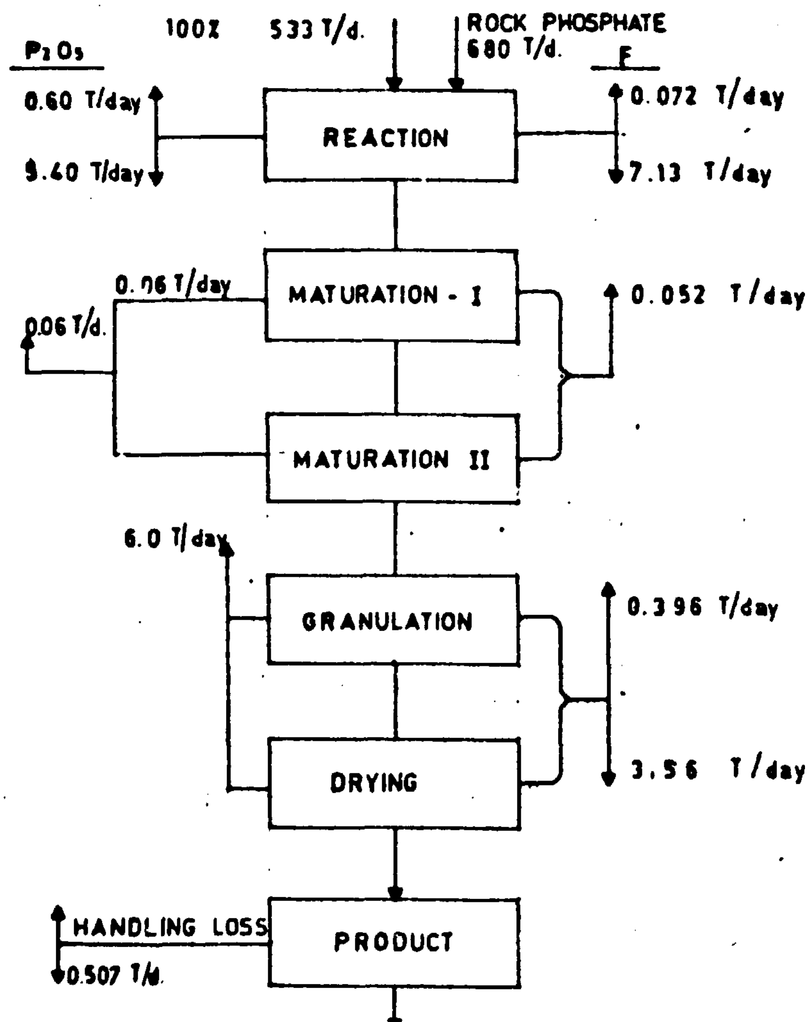
1. Waste Water settling pond sample
2. Seepage from the settling pond water sample
3. Phosphogypsum sample.

Triple Super Phosphate Plant (TSP)
Capacity 1500 T/day

This plant consists of reactors - three five-hundred tons per day each and two granulators, seven hundred fifty tonnes per day each. Only at the later part of the mission, the granulation units were operative and the rest of the plant was non-operative. The discharge rates for various pollutants are based on the flow sheet, material balance and gaurantee figures or calculated ones as no actual measurements were possible. The flowsheet of the process is given in Figure No. 15. The various pollutants discharged into air, water and soil are as follows :

<u>Air Pollution</u>: The pollutants discharged are from reactors and granulation-drying operations. The two pollutants emitted in to air are fluorides and phosphate or phosphoric acid mist. Table No. 24 gives details of each pollutant, amounts per day and their sources. The total of 6.66 T/day of P_2O_5 and 0.532 T/day of F is released daily into air at rate of 4.4 kg of F and 0.35 Kg of P_2O_5 per ton of TSP. Both of these are discharged from very low height chimeny about 25 to 35 meters only. This may cause higher concentrations at ground levels in surrounding area of village Kattinah and lake.

T. S.P. COMPEX 1500 T/day T.S.P UNIT POLLUTION INVENTORY FOR F AND P_2O_5



T.S.P 1500 T/d.

BALANCE FOR - F

F ENTERING SYSTEM	21.60	T/day
TO AIR	6.52	T/day
* TO WATER	10.69	"
TO PRODUCT	10.39	"
	21.60	T/day

BALANCE FOR - P_2O_5

ENTRY	705 TO 710 T/day
TO AIR	6.6–10.0 T/day
* TO WATER	5.4 – 6.0 T/day
PRODUCT	690 T/day.
UNREACTED	4-5 T/day
TOTAL	706-710 T/day

EMISSION RATES

AIR F -6.35 KG/T ; P_2O_5 - 5.53 KG/T.

* WATER F 7.13 KG/T ; P_2O_5 - 3.8 KG/T.

* TRANSFERRL TO SOIL AS SLUDGE AFTER TREATMENT OF WASTE WATER

NOTE:- All FIGURES ARE VENDOR'S GUARANTEE

Fig. 15

T.S.P. COMPLEX

T.S.P./S.S.P. Unit 1500 T/day

Table No. 24 — AIR POLLUTION

T/day

Source	P_2O_5	F	Others	Remark
Reaction	0.60	0.072	Traces H_2PO_4	
Maturation I) Maturation II)	0.06	0.052	"	Fugitive emission.
Granulation Drying	6.0 to 10.0	0.396	-	33% as H_3PO_4
Total	10.66	0.520		
Kg/Ton	7.10	0.35		

Table No. 25 — WATER POLLUTION

T/day

Source	P_2O_5	F	Others	Remarks
Reaction	5.4	7.13	-	Neutralized removed in treatment
Maturation	-	-	-	Occasional as floor washing 100 m^3/Hr or 2400 m^3/d
Granulation Drying	1.6	3.56	-	
Total	7.0	10.69	-	
Kg/Ton	4.67	7.12		

Both P_2O_5 and F removed by lime neutralisation in treatment unit.

SOIL POLLUTION

Directly - None

Indirectly through deposition of air-borne pollutants.

Water Pollution: Most of the water used in this unit is for scrubbing the exit gases from reactors driers etc. The total volume used is 100 m^3 per hour and carries 7 tons of P_2O_5 and 10.7 tons of F per day, all of which is neutralised and precipitated in the treatment pond. The rate of discharge is 4.67 kg of P_2O_5 and 7.12 kg of F per ton of TSP, none of it escape to environment as per design. Actually there was sepage from the settling pond some of it may reach ground waters.

Soil Pollution: There is no direct solid waste discharge from this unit. But there was handling loss of rock phosphate while receiving, grinding etc. covering large areas with rock phosphate dust.

4.4.4.2.4 **Noise Pollution**: No measurements were made as unit was non-operative.

UTILITIES

Water treatment: Designed capacity of the water treatment plant is 2700 m^3/hr but actually used is only 2500 m^3/hr. This unit was operative during the mission to supply water for other requirements. The pollution load generated is sludge and backwash water about 150 to 250 m^3/hr. with organic and alum sludge about 20 tons per day, which flows to lake Katinnah.

Demineralisation unit: This unit has capacity of 240 m^3/hr or 5760 m^3/day, large part of which is fed to process units and steam boilers. There is only liquid effluents from these units at the rate of about 60 m^3/Hr and this will carry acid and alkalies. The entire volume is mixed into the waste water flow to the neutralisation and sedimentation treatment for recycle. Therefore, there is no effluent from this unit. There is no air or soil pollution from this unit.

Boilers: There are four steam boilers - 2 Nos. 75 T/hr - 10 Bar pressure. 1 No. - 30 T/Hr - 45 Bar and 1 No. 30 T/hr - 16 Bar. They use 15660 T/day of furnace oil and 200 m^3/hr of demineralised water per day. Pollutants generated are SO_3 - 36.6 T/day, NO_x - 5.64 T/day, SPM - 1.5 T/d into air and about 60 m^3/day boiler blow down into water as liquid effluent.

Cooling Towers: There are two cooling towers in this complex, one for H_2SO_4 - unit and another one for H_3PO_4 unit. The blow down from both is mixed with acid effluents from the plant and is recycled after treatment with neutralisation and settling, and no water pollution is likely from these.

Waste Water Treatment: The acid waste waters generated in the TSP complex are first combined and the neutralised with lime in the complex. This neutralised waters are then pumped to settling ponds in Alwaar about 3 kms away, from complex. The settled water is then pumped back for recycling in the TSP Complex plants.

The settling ponds are made of earthen embankments with stone pitching on inside. The soil formation around and under the pond is rocky with nominal soil cover. The general slope of the land drains into lake Kattinah and River Assi. There was some seepage observed around the ponds which drained into a natural pond across the road which in turn drained to lake Katinnah. Samples of water from the settling pond, seepage and the sludge were examined for various metals and dissolved solids. Table No. 25 gives the various parameters determined including trace that the water seeping out from the pond is polluted and will run down to lake.Kattinah during rains or to River Assi and will possibly cause pollution. It would be therefore desirable to prevent seepage by suitably lining the ponds if the seepage does not stop by self sealing of the ponds.

Another aspect of these ponds is the lime neutralisation sludge - 350 T/day. It will contain fluorides, phosphates and sulphate and trace metals in very high concentration. The present arrangements have no systematic method of removal of this sludge nor its disposal. It is necessary that it should be removed as slurry and disposed off with Gypsum which is under consideration on a regular basis.

Table No. 25

Water and Sludge Analysis of the Settling Ponds at Alwaar ior T.S.P. Complex

Parameter	Settling Pond samples, mg/l	Seepage near pond mg/l	Pond sludge
pH	6.8	7.5	-
$^{+}SO_4$	1160	1015	59.6%
T.D.S.	6280	5360	-
Total Hardness	5800	5100	-
Cl^-	2570	2360	-
NO_3^-	16.5	10.7	-
PO_4	15.70	6.8	0.63%
F	680	465	0.73%
Moisture	-	-	43%
As	$<$0.001	$<$0.001	50 ppm
Cd	0.017	$<$0.017	500 "
Cr	0.024	0.020	1600 "
Cu	0.030	0.024	800 "
Ni	0.046	0.038	497 "
Pb	0.038	0.008	860 "
Zn	0.20	0.10	3100 "
Sr	0.010	0.007	460 "
Ti	0.008	0.004	47 "
U	$<$ 0.001	$<$0.001	$<$1.0 "

Total Pollution from T.S.P. Complex

This entire complex was non-operative during the mission except last few days of the mission when granulation and drying units were operated. Therefore, all the data are based on either old analysis of assumptions made as per the flow sheets and material balance and figures of guarantees. Fig. No. 16 and table No. 26 give the details. The total pollution discharged from this complex is 4500 T/day into the environment, with 4352 T/day as solid waste, 65.77 T/day emission to air and 86.43 T/day to water. This means for every ton of TSP produced it releases 3 tons of pollutants in the environment. The major pollutants is the phosphogypsum, settling pond sludge amounting to 4352 T/day so far no disposal or utilization has been worked out and it needs priority action.

The air emissions estimated total 65.72 T/day. These are discharged from 25 stacks ranging in height from 16 to 30 meters, most of them just above roof tops of the plant buildings except H_2SO_4 units which are higher. Also not accounted for fully are fugitive emissions at ground levels mostly from storage maturing piles and handling. These will cause high ground level concentration. The dust pollution by rock-dust sulphur, and Al_2F_3 also need

TOTAL POLLUTION - T.S.P. COMPLEX

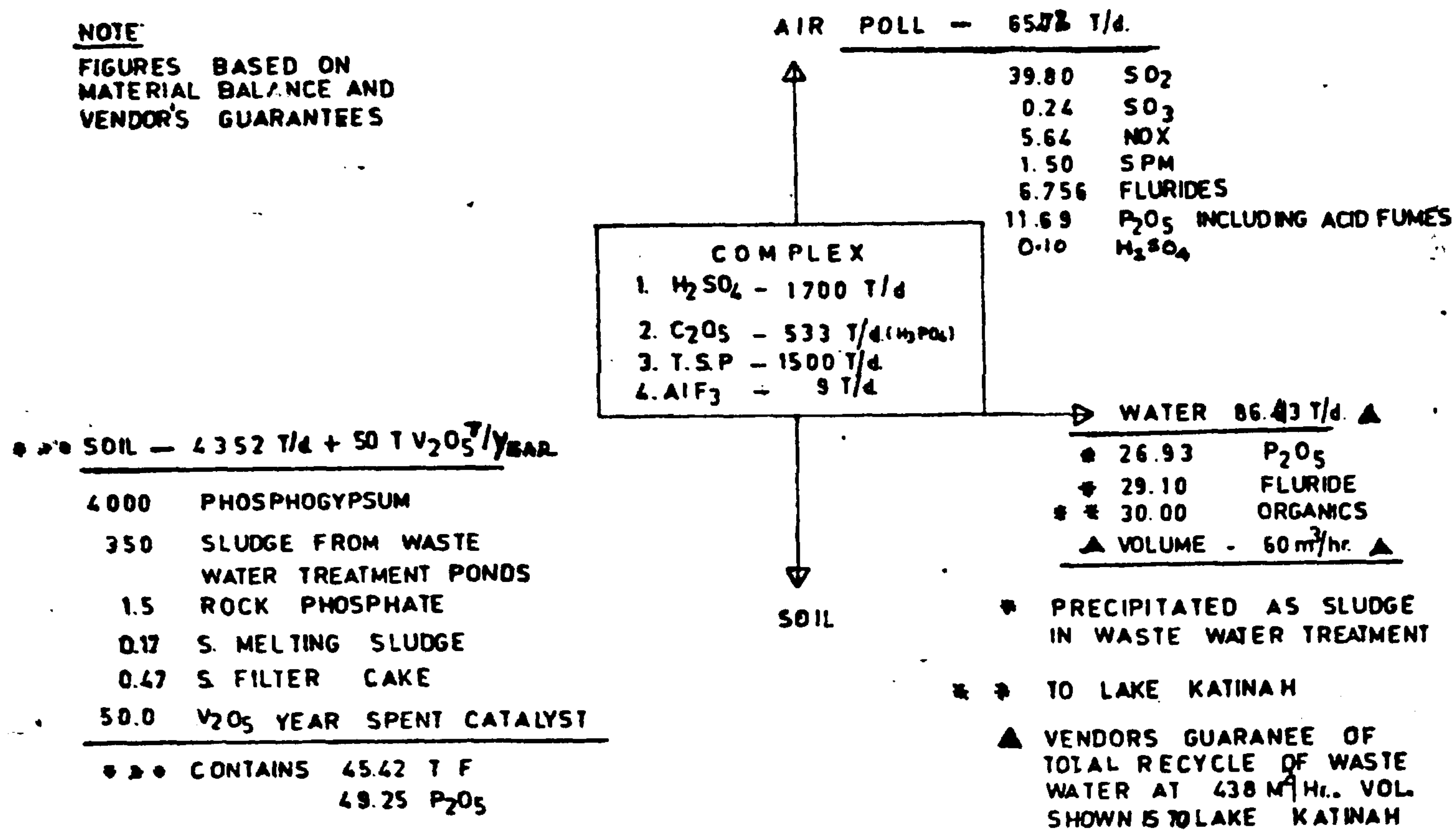


Fig. 16

Table No. 26

T.S.P. COMPLEX

(All three, H_2SO_4, H_3PO_4, T.S.P. units combined with Utilities)

Total Pollution Qualities

Water - Volume 438 m^3/Hr. for complex pross. waste	}	18,200
320 " " " non-process	}	m^3/day

Note: This entire quantity of 438 m^3/Hr is recycled after treatment, i.e., 10,500 m^3/day is not discharged leaving 7700 m^3/day going to lake Katinnah and river Assi.

Pollutant Load - Water

P_2O_5	26.93 T/day
F	20.10 "
Trace Metals	0.40 "
Organics	30.00 "
	86.43 T/day

All of this will be removed as sludge and transferred to soil with sludge - about 200 T/day dry weight basis or @ 40% moisture - 350 T/day from the neutralisation ponds as per vendors guarantee.

Air Pollutants

H_2SO_4	0.10 T/day
SO_2	39.80 "
SO_3	0.24 "
No_x	5.64 "
SPM	1.50 "
F	6.756 "
P_2O_5	11.69 " (includes H_3PO_4 acid mist from drier @ 0.85 T/day)
Total	65.72 T/day

<u>Solid waste</u>

Phospogysum	4000 T/day	43 T/day P_2O_5; 32 T/day F
Pond sludge	350 "	20 T/d F; 26 T/d P_2O_5
Rock Phosphate	1.5 "	- 0.45 T/day P_2O_5
Sulphur Cake Filteration	0.47 "	- 0.24 T/day S.
S. melting sludge	0.17 "	
Total	4352.04 T/day	- 69.45 T P_2O_5; 52 T F.

Catalyst - Annually V_2O_5 as 5.0 T/day.

<u>Total pollution discharged to Environment</u>:

Air	86.43 T/day
Water	65.72 "
Soil	4352.04 "
	4504.19 say, 4500 T/day.

Per ton of product - $\frac{4500}{1500}$ i.e., 3 Tons/ton of TSP.

special attention as all grounds are covered with it around the plant and is blown around with wind.

The water discharge is only 7700 m^3/day and most of it as water treatment backwash, and sludges. They carry organics 30 T/day and chemicals used in treatment which are discharged to lake Katinnah at present. Besides all the storm water drains from this complex are connected to lakes. They discharge 10,000 to 15,000 m^3/hr of waste water, carrying all spilled TSP/Rock phosphate dusts etc a heavy load of nutrients to it.

4.4.5 Administration and Services:

These consist of administrative offices staff, security staff, service staff for electricity water supply and maintainance of the buildings, central workshpp, fire fighting and safty, transport, catering etc. Totally about 3500 persons are employed on the complex. They generate mostly liquid waste due to normal activities. Their volumes as estimated are :

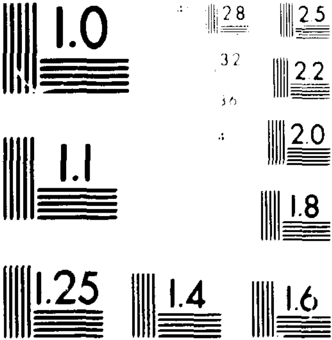
Laboratories	-	200 m^3/day
Toilets		600 "
Catering		250 "
Workshop		50 "
Total		1100 m^3/day

These are all combined with other effluents and are discharged to river Assi.

4.5 THE TOTAL DISCHARGE FROM GFC COMPLEX

The total wastes discharged from the complex to environment is 6350 T/day along with a maximum waste water volume of 23,800 m^3/day. This is distributed as 1953 T/day to air 46 T/day to water and 4352 T/day to soil. The volume of water is discharged to lake Kattinah and River Assi. The details of these as summarised are given in Fig. No. 17 and Table No. 27 gives the details of amounts and type of pollutants released into air, water and soil.

Though it appears to be a large quantity only a part of it is of environmental consequence as discussed in details in the recommendation. The total rate of wastes discharged per unit of final products 3080 T/day (1100 T- urea + 1500 T. TSP, + 480 T. CAN) works out to be about 2 T per ton of product and 8 m^3 of waste water per ton of product.



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS

STANDARD REFERENCE MATERIAL 1010a

(ANSI and ISO TEST CHART No. 2)

TOTAL POLLUTANTS GFC COMPLEX – 6350 T/day

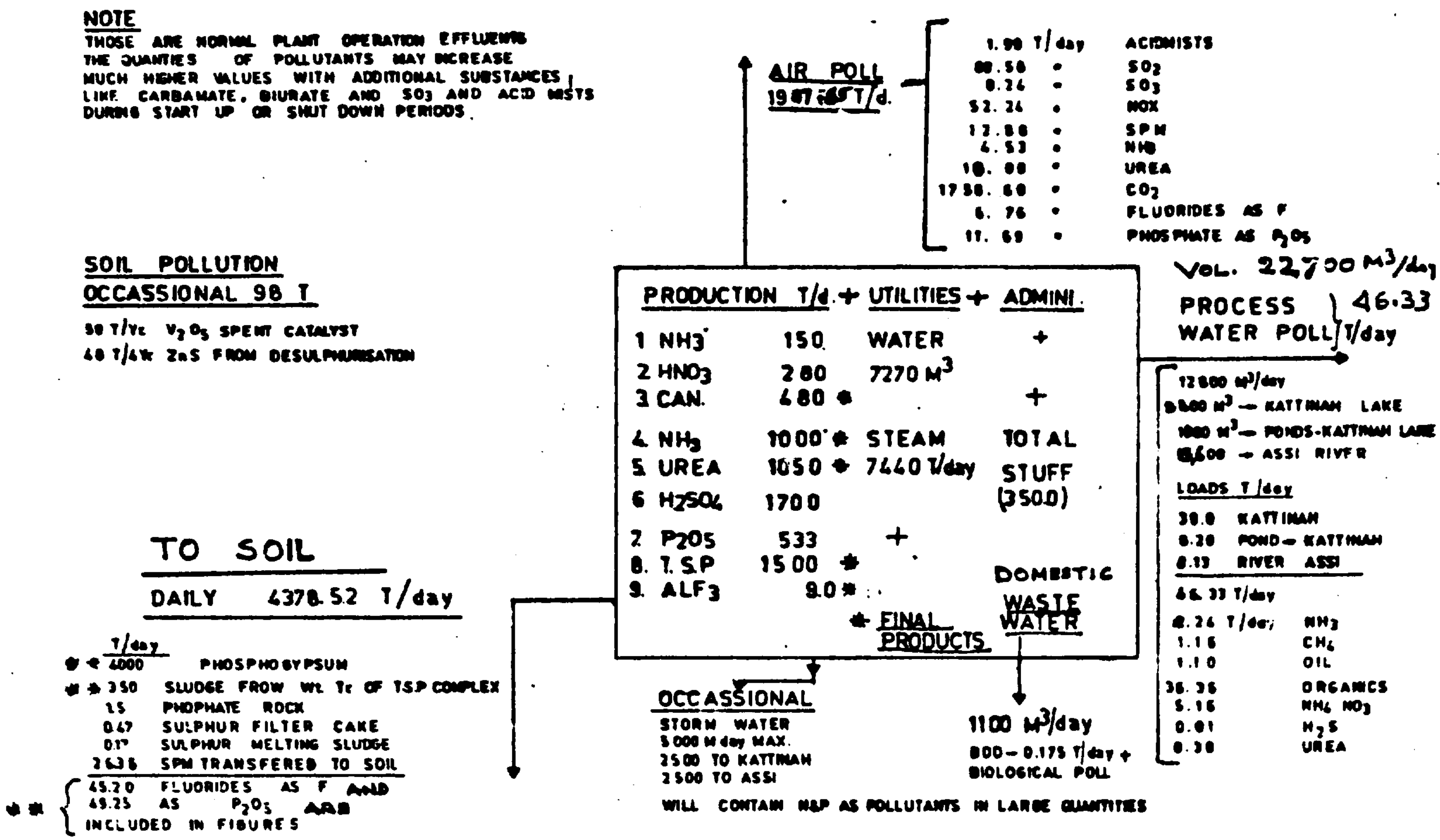


Fig. 17

Table No. 27

ESTIMATED TOTAL POLLUTANTS FROM ENTIRE GFC COMPLEX

(a) Air Pollution (Volumes of all the gaseous effluents could not be determined)

Pollutants	T/day	Remarks
Sulphur dioxide (SO_2)	89.56	
Sulphur trioxide (SO_3)	0.24	
Acid Mists - H_2SO_4	0.15	- Estimated as plant not commissioned fully.
H_3PO_4	0.85	- do -
HNO_3	0.15	
Ammonium Nitrate + CAN-(NH_4NO_3)	7.80	Recoverable product
Nitrogen oxides -(NO_x)	52.24	
Ammonia - (NH_3)	4.53	
Suspended Part Matter (SPM)	5.08	
Urea as dust (Urea)	10.00 -	Recoverable product
Carbon dioxide (CO_2)	1758.60 -	722 T/day pure CO_2 - usable for chemical process
Flourides (F^-)	6.76	
Phosphates (P_2O_5)	11.69	
Total	1947.65 T/day, say 1950 T/day.	

(b) Water Pollution

Waste Water volume Distribution to Water Bodies

Water Body	Volume m^3/d	Pollution T/d	Remarks
Lake Kattinah	9,200	30.0	Includes 2500 storm water occasionally.
Natural Pond	1,000	8.2	Overflows to Lake Kattinah
River Assi	13,600	8.13	2500 m^3/d as storm water occationally included
Total volume	23,800 m^3/d		

Table No. 27 (contd..) Water Pollution

Pollutants		T/day	Remarks
Ammonia	NH_3	2.24	Maximum value can be six to ten times higher
Methanol	CH_4	1.16	
Oil/Greese	Oil	1.10	
Organics	Sludge	36.36	Sludge from water treatment units
Ammonium Nitrate	NH_4NO_3	5.16	Can be recovered as product
Hydrogen sulphide	H_2S	0.01	
Urea	$(NH_2)_2CO$	0.30	
	Total	46.33 T/day	

(c) Soil Pollution - Volume 2750 m^3/day approximately

Pollutant	T/day	Remarks
Phosphogypsum	4000.00	With 52.00 T/day F, 69.50 T/d P_2O_5, which will wash to ground in rain partially
T.S.P. Waste water Tr.sludge	350.00	
Rock Phosphate	1.50	30% P_2O_5
Sulphur filter cake	0.47	50% S
Sulphur melting sludge	0.17	60% S.
Total	4352.04 T/day	

Heavy Metals

V_2O_5 - 50 T/yr (20 m^3) Spent catalyst from H_2SO_4 plant

ZnS - 48 T/4 yr (19 m^3) Spent Reactant from Naptha desulpurisation units.

Table No. 27 (contd...)

Total Pollution:

To Air	1952.65	T/day
To Water	46.33	"
To Soil	4352.04	"
Total	6351.02	Tons/day, say, 6350 T/day.

Product 3080 T/day, i.e., 2 T/T of product is produced as waste.

Notes:

1. These figures are based on limited measurements of A.U. and CAN complexes. For T.S.P. Complex, they are based entirely on material balances, performances guarantees or data from similar plants elsewhere as T.S.P. complex was not yet fully commissioned.

2. The figures represent good operation of the plants as per vendor's recommendations. The exact pollution will be higher if it is not followed or during mishaps.

3. The amounts of pollution at time of start up or shut down though for very limited period can be as much as 15 to 20 times higher than shown.

4. THESE VALUES ARE BASED ON ONLY FEW LIMITED OBSERVATIONS AVERAGE VALUES MAY BE LESS OR MORE, AND PROLONGED AND REGULAR MONITORING CAN ONLY DETERMINE THEM CORRECTLY.

5. No correct estimate for pollution by Storm Water could be done but aspper prevailing situation observed in the complex, large quantities of spillage of ground rock phosphate, and handling losses of urea, CAN, TSP will all be washed to water bodies along with runoff water, causing possibly very heavy pollution.

4.6 OCCUPATIONAL HEALTH IN GFC COMPLEX, ASPECT OF

There are two types of occupational health or working area environmental problems in such plant. One is the level of concentration of chemical compounds like Ammonia, Urea, Nitrogen fumes, phosphoric acid fumes, sulphuric acid fumes, dust/particulates like urea, calcium ammonium nitrate, aluminium floride etc. in the working area.

Second one is the noise generated by the machinery in the plant area, the survey were undertaken in these machines for both these objectives and the following are the observations:

(i) Environmentas inside the Plant

The concentration of Ammonia and other acid fumes working in other areas of Ammonia, Urea and TSP plant were observed to be reasonably within the limits most of the time except occassionally when exceeded. Also, there appeared need for more awareness of the importance of these. There is safety unit in Fire Fighting section, but it did not have sufficient well-trained staff. It would be advisable to provide special training to the employees on safety measures and protection from health hazards due to working in these plants.

For all units safety equipment like emergency shower, eye wash basin, special wash basin, etc. are provided in all strategic locations. It would be desirable to keep them all in good operational conditions and good working order as it was observed that some of them were non-operational during the visit.

(ii) Noise:

The noise levels were measured in Ammonia, Urea and Nitric acid plant as detailed earlier. Some places they are levels as high as 118 db. This may affect the hearing ability of the persons, who work in the area if not well protected. Since no controls are possible in this stage in these units, it would be advisable that the workers/ employees are educated in safety rules and observations of of precautions like using ear plugs and other facilities.

5.0 ENVIRONMENTAL IMPACTS OF POLLUTION

The pollutant discharges from the GFC complex will affect quality of air, water and soil and also workers, adjoining population, plants, animals, property, etc. In order to understand these ambient air quality, and water quality monitoring was done.

5.1 Air Quality: Due to limitation of equipment only one air quality measuring site was possible. The convenience of power supply and other factors, the laboratory window of the administrative block was chosen for this purpose. Sulphur dioxide and oxides of nitrogen ($NO-NO_2$) were measured by using innovative modified techniques as no conventional equipment could be procured. SO_2 was monitored initially using "Drager Tubes" bought earlier for industrial Hygiene purpose. Later, after procuring glassware etc. H_2O_2 method was developed. For No_x-NaOH absorber with "Hach" indicator had to be developed. The staff was shown all procedures especially as it was a new programme.

The data obtained for air quality are given in table No. 28. It has also be to mentioned that there is a power plant adjacent to the GFC complex. It uses furnase oil with sulphur content of 5 per cent and discharges 80-100 tons of SO_2 and 8-10 T of No_x per day. The significance of this on air quality is reflected in the data as on days of its shut down SO_2 levels drop considerably.

No fluoride measurements could be done as TSP complex was non-operative.

5.2 Water Quality: The water quality is being monitored by the G.F.C. authorities regularly. The staff is well trained to determine many parameters and they are monitoring waters from ten sampling sites regularly. Table No. 29 gives some of the values at various points of water quality.

The equipment was available in the laboratory for BOD, COD and staff was trained to conduct BOD, COD, and turbidity as additional parameters. Table No. 30 gives the data as obtained during the mission.

Table No. 28

Air Quality Data at G.F.C. Complex

Station	Date	ug/m³ SO_2	ug/m³ NO_x[3]	Remarks
Laboratory	14/8	335[1]	-	Thermal Power Plant shutoff
Window outside	15/8	112.5[1]	-	
"	16/8	996[2]	-	
"	18/8	2240[2]	-	
"	19/8	1120[2]	-	
"	21/8	320[2]	107	Power Plant shutoff
"	26/8	896[2]	35	
"	29/8	1250[2]	24	
"	30/8	508[2]	20	
"	31/8	844[2]	40	
"	2/9	610[1]	34	
"	4/9	940[2]	32	
"	11/9	1160[2]	49	
"	12/9	330[1]	29	Power Plant shutoff
"	14/9	660[2]	33	

1. Drager tube method
2. H_2O_2 method
3. Nitrate/Nitrite (Hack method) using NaOH.

Note: Sampling period was four hours continuously as integrated sample from 9 Hrs to 13 Hrs.

Table No. 29

Typical Water Quality data as Measured Regularly at GFC (mg/l, except conductivity - uMHO and pH)

Parameter	1	2	3	4	5	6	7	8	9	10
pH	4.0	7.0	9.16	7.94	8.12	9.10	6.4	6.8	6.75	6.20
Conductivity uMHO	6700	5000	310	4700	720	900	1130	6000	9500	9400
T. D. S.	4020	3000	260	2820	432	570	678	3600	4600	4610
Total Hardness	2800	3500	240	450	290	320	480	1700	780	780
Ca Hardness	2100	1700	180	200	198	180	230	575	380	300
Alkalinity P	-	-	95	-	-	171	-	-	-	-
Alkalinity M	50	55	172	143	220	475	63	20	-	-
Chlorides Cl^-	1410	1065	23.50	106.5	39.5	30	18.9	71	-	-
Nitrate NO_3^-	9.4	374	46.2	11.0	39.0	37.5	396	1100	474	470
Nitrite NO_2^-	0.06	1.9	1.32	1.48	1.98	0.3	8.1	3.2	2.1	3.1
Ammonia Total	2.58	450	19.8	32.6	7.10	150	85	645	38.5	31.61
Sulphate	1850	1850	350	80	40	100	150	1220	860	812.5
Phosphate	17	16	1.25	0.73	0.22	0.34	0.2	3.75	2.58	2.30

Note: Sampling sites

1. T.STP. Settling Pond entry
2. T.S.P. Settling Pond exit
3. Assi River 2 km Down Str. from GFC.
4. Storm water discharge to Assi
5. Domestic Sewage
6. A.U. Effluent
7. Discharge to Assi
8. Natural Pond- CAN Discharge
9. Seepage from 8
10. Entry of seepage to Kattinah lake.

All the Samples are not on the same date.

Table No. 30

Water Quality Survey During Mission

Parameter	River Assi Down Stream		A.U. Effluent		Storm Water Discharge to Assi	
	14/8	10/10	14/8	10/10	14/8	10/10
pH	7.7	8.14	7.6	9.14	9.32	8.9
Conductivity	600	370	545	890	580	480
T.D.S.	360	222	327	534	330	288
T.H.	240	165	233	320	205	208
Ca.H	134	70	188	117	126	130
P- Alkalinity	0	0	0	171	67	65
M- "	151	157	138	475	238	278
Cl^-	29.11	18.46	17.69	27.69	40.8	38.7
NO_3^-	66	60.5	33	42.9	85.8	49.6
NO_2^-	0.399	0.825	0.46	0.297	28.7	8.7
NH_4^+	19.67	2.709	7.74	100	87.6	1677.0
SO_4^{--}	400	23	50	150	2,98	58.1
PO_4^{3-}	0.15	0.45	0.31	0.34	0.19	0.47
F^-	-	-	-	-	-	-
CN^-	-	-	-	-	-	-
Dissolved O	7.7	8.7	7.1	9.4	6.9	7.8
BOD_5^{20}	26.8	37.6	48	98	26	110
COD	93.0	142.0	56	580	1160	2580
Urea	NT	NT	60	58	NT	NT
biuret	-	-	-	-	-	-
Oil	-	-	30.8	17	115	160
T.O.C.	-	-	-	-	-	-
Turbidity	58	58	46	60	22	48
Trace Metal	-	-	-	-	-	-

Biological analysis for algae was also done and the following species of algae were identified.

Lake Water: Cosmarium, Eudorina elegans, Closterium, Vancheria, Spirogyra.

Cooling Water: Symura, Cyclotella chactoecreas, Diatoma vulgare, Spirogvra, Cosmarium, Chroococcus (Blue-green), Cosmarium, Voucheria and Molomonas.

5.3 Soil Pollution: Most of the soil pollution was by dumping solid waste concentrated near lake Kattinah. Therefore, it was difficult to separate soil from Gysum, and results obtained showed only gypsum. Due to limitation of staff and short duration of mission, soil analysis of the land surrounding GFC complex could not be taken up.

5.4 Assessment of Pollution

5.4.1 Air: The release of pollutants into atmosphere from the GFC complex are much higher than standards prescribed by many countries. The emission rates per unit products as given in table No. 31 shows the comparison. The discharge of NH_3SO_x NO_x, Fluorides, H_3PO_4, HNO_3 and H_2SO_4 mist and urea, calcium ammonium nitrate-dusts with other suspended particulate matters with large quantities of CO_2 and combustion products has affected the air quality of the surroundings of GFC complex. This in turn will affect the health of the people, animal, crops and vegetation around the complex.

Table No. 31

Ambient air quality standards in some developed countries (24 hrs Average)

Country	Standards ug/m^3								
	Particulates	NH_3	SO_2	SO_3	NO_2	HCl	Fluorides	CO mg/m^3	H.C.
U.S.A.	75	-	80	-	100	-	0.8-4.0	100	160
JAPAN	100	-	110	-	400	-	1 - 5	-	150-200
ITALY	300	-	19	-	39	0.05	200	-	2600
GERMANY	400	60	150	100	2.0	10	-		
CANADA	-	-	60-150	-	-	-	1.0-2.0	6-15	160
U.S.S.R.	200	-	100	-	85	-	0.1	1.0	-

Refere Table No 28 for comparision.

The air quality data obtained during the mission limited to only two parameters SO_2 and NO_x for short averaging time of four hours for one month show consistently higher levels of pollutants compared to any national standard (Table No. 32, 33). It also indicates that the emissions from GFC has affected air quality considerably.

In order to determine the concentration of all the pollutants discharged from GFC and to understand its pattern with dfferent metereological conditions a regular survey of air quality covering F, SO_x, NO_x, NH_3, SPM, acid mist is urgently required. This should be with a larger number of stations about six to eight suitably located and for few years at least to arrive at a definite conclusion on degree and extent of pollution.

5.4.2 Water: Waste water quantity and quality discharged from GFC complex exceeds the desirable levels of concentration specified in effluent standards prevailing in other countries, as given in table No. 39. River Assi and lake Kattinah are already showing the effects of this, as massive growth of alagae making them green.

Waters of the lake Kattinah, and other dams on river Assi are mostly used for irrigation purpose some industries and few stray villagers also use it.as water source. Besides this lakes created by dams at Kattinah, Rastan and rivers Assi itself have good potential for recreational use as only major fresh water resource in Western Syria.

Table No. 32

Gaseous Effluent Discharge Rates per Ton of Products into Atmosphere

Substance	Process units								
	NH_3 old Kg/T	HNO_3 Kg/T	CAN Kg/T	NH_3 New Kg/T	Urea Kg/T	H_2SO_4 Kg/T	H_3PO_4 Kg/T	TSP Kg/T	AlF_3 Kg/T
SO_2	-	-	-	28.0	-	1.88	-	-	-
SO_3	-	-	-	-	-	0.14	-	-	-
S.P.M.	0.3	-	5.43	0.5	-	-	-	-	-
NO_x	31.2	30.0	-	31.5	-	-	-	-	-
NH_3	0.8	-	0.625	1.36	2.59	-	-	-	-
CO_2	910	-	-	1622.0	-	-	-	-	-
Urea dust	-	-	-	-	10.00	-	-	-	-
NH_4NO_3	-	-	17.0	-	-	-	-	-	-
HNO_3 (Mist)	-	NA	-	-	-	-	-	-	-
H_2SO_4	-	-	-	-	-	0.01	-	-	-
F	-	-	-	-	-	-	11.25	4.5	2.33
H_3PO_4 (mist)	-	-	-	-	-	-	0.29	0.34	-
H_3PO_4 (fumes)	-	-	-	-	-	-	0.01	0.03	-
S P M	-	-	6.5 (lime)	0.16	-	-	-	0.75	0.2

Table No. 33

Standards for allowable emissions from fertilizer plants in some developed and developing countries

Country	Source	Pollutants	Emission Limit	GFC
U.S.A.	Nitric acid plants (30-70% HNO_3)	Nitrogen oxides as NO_2	1.5 Kg/T 100% acid, maximum 2 hr average	30 Kg/T
		Opacity	10%	-
	H_2SO_4 plants	SO_2	2 Kg/T 100% acid	1.88 Kg/T
		Acid mist as H_2SO_4	0.075 Kg/T 100%	0.14 Kg/T
		Acid mist opacity	10%	-
	Wet process phosphoric acid	Total Fluorides phosphoric acid	10.0 gm/T of equivalent P_2O_5 feed	11.4 Kg/T
	T.S.P. Plants	Total Fluorides	0.12 Kg/T of equivalent P_2O_5 feed	4.5 Kg/T
	D. A. P.	Total Fluorides	30 gf/T of equivalent P_2O_5 feed	-
GERMANY	HNO_3 plants	Nitrogen oxides	1 g No/m^3 of tail gas	5.2 gm/m^3
	H_2SO_4 plants: (DCDA)	SO_2	Conversion efficiency 99%	
		Acid mist	0.4 Kg SO_3/T H_2SO_4	0.14 Kg/T
	SC SA To be used only when SO_2 in the gas 60%	SO_2	Conversion efficiency 97.5%	-
		Acid mist	0.6 Kg SO_3/T H_2SO_4	-

contd...

Table No. 33 contd...

Country	Source	Pollutants	Emission Limit	GFC
GERMANY	H_2SO_4 matallurgical plants	SO_2	Minimum Conversion 97.5%	-
		Acid mist	2 Kg SO_3/T H_2SO_4	
	H_2SO_4 Chamber plants	SO_2	5 mg/m^3	-
		NO_2	1.2 g/m^3	-
	Phosphate fertilizer plants	Fluorides	20 mg/m^3 as HF	30-150 mg/m^3
	Different Sources	Dust	50 - 150 mg/m^3	
INDIA	H_2SO_4 plants	SO_2	12 - 16 Kg/T acid 100%	-
	New H_2SO_4 plants	SO_2	4 - 12 Kg/T acid 100%	1.88 Kg/T
	Existing and new plants 200 T/D	SO_3	0.5 - 5 Kg/T acid 100%	0.14 Kg/T
	H_3PO_4 plants	Fluorides	0.65-1.5 Kg/T of P_2O_5	11.4 Kg/T
	T S P plants	Fluorides	0.075-0.3 Kg/T product	4.5 Kg/T
		Dust	4 Kg/T product	-
	S S P Plants	Fluorides	0.1 - 0.5 Kg/T product	-
		Dust	500 mg/Nm^3	-
	New HNO_3 plants	Nitrogen Oxides as NO_2	3 Kg/T of 100% HNO_3	30 Kg/T

It is therefore, desirable to restore river water quality by reducing the pollution. This will provide tourist attraction for Swimming, Boating and such water sports. Also, it will be able to meet water quality requirements as drinking water supply for twons and villages when required, as it happened in case of Homs in 1982 in emergency or normal course.

5.4.3 Soil: The disposal of phosphogysum near lake Kattinah has already affected the water quality of the lake and small natural ponds nearby in the catchment area of the lake. The effect of phosphate nutrient to any water body is proved to be the mainfactors for algal blooms and eutrophication. It could not be correctly estimated how much P_2O_5 from phosphogypsum enters lake fully due to short time of the mission but the conditions of natural pond indicated significant amounts.

Also it will contain tracemetals which may also gradually leach into lake and ground waters if present practice is continued further.

Lastly the sheer volume of the gypsum is major problem, it will cover three hactors of land for one meter or one hactor with three meter depth daily. The present site has not enough land for disposal for even a few years, as already the present site in nearly full of gypsum nearly upto a height of three to four meters.

6. SUGGESTIONS FOR APPROACH AND WAYS AND MEANS TO CONTROL THE POLLUTION

6.1 National level approach

The findings of these reports were discussed with the Syrian Government officials and after discussion it was felt that for future developments there is a need for a national programme to control pollution. This will control environment pollution by industries i.e. air, water, soil and ecological damage and also help take preventive action in case of new industries.

As suggested an outline of a "Decree" on environment pollution is given in appendix No.V. Its details may need full consideration by a high level committee which can be appointed by the Syrian Government. It also gives existing Decree No.584 for the Directorate of Water Pollution Control.

The Syrian Government may like to examine all issues and alternatives such as to create a separate Directorate for Environment Pollution Control or to enlarge the scope and functions of the present Directorate on he Water Pollution Control to cover all aspects or vice versa.

6.2 GFC Pollution Control

The specific issues of environment pollution control for solids, liquid and gaseous pollutant sources and possible approach and techniques to be used are described as follows:

6.2.1 Solid Waste

As summarised the total pollutants from the GFC complex is about 6350 T/day of which major component is solid waste 4352 Tons/day. This will contain mostly calcium sulphate with about one per cent fluorides and 0.75 to 1 per cent P_2O_5. The present method of disposal near lake Kattinah should be replaced by those recommended by UNIDO Expert report SI/SYR/78/801 as soon as possible. These include reprocessing it for different products as raw materials.

Till final decision is made on it, it should be systematically dumped away from the present site at any of the two sites under consideration, near villages of Namia or Karetein. The soil investigation required should be completed at the earliest along with construction work.

The other solid wastes like sulphur filter cakes, and melting sludge, discarded catalysts etc. should not be dumped along with gysum near lake Kattinah. They should be separated and transported to land on eastern side of the Damascus Highway and disposed off on low lying areas so that it does not affect any water bodies.

6.2.2 Liquid Waste:

The total liquid waste volume of 23,800 m^3/day from the entire complex (Fig. No. 17) is presently discharged into three separate manner: 19,200 m^3/d to Lake Kattinah, 1000 m^3/d natural Pond and 13,600 to river Assi and carry 46.33 T/day of pollution. These will affect the water quality of both lake Kattinah and river Assi adversely and it is desirable to prevent this at the earliest. GFC authorities have already taken action in this matter and a new effluent plant for nitrogeneous wastes water was nearing completion, for treating condensates from urea and CAN units containing NH_4, urea and NO_3 (Appendix IV). The installed capacity will be 200 m^3/Hr. and expected condensate flow volume will be about 165 m^3/Hr leaving a spare capacity of about 35 m^3/Hr. The total flow treated will be 4800 m^3/day.

This plant will approximately reduce 5.5 T/day of nitrogeneous pollution load going to river Assi and natural pond near lake Kattinah.and will help improve water quality considerably. This still leaves about 19000 m^3 flow with 41 T/day of pollutant per day. To reduce pollution of water bodies following suggestions are made:

(1) Provide another biological treatment plant based on pilot plant studies for the entire volume of effluents from the complex. This may consist of biological units

(Activated Sludge) to remove all pollutants entering river Assi. This unit should have a capacity of 7000 m^3/day as expected flow from all fertilizer process units is about 6500 m^3/day, rest being reserved for emergency flow, storm water and back wash waters from water treatment units. This will provide proper treatment and then can be safely discharged to River Assi. This unit will receive combined both CAN and A.U. Complex effluents and there will be no discharge to natural pond.

(2) The storm water from T.S.P. complex, about 2500 m^3/day (occassionally) and waste water treatment effluent should be diverted to river Assi and prevent its flow to lake Kattinah. This will reduce phosphate pollution of the lake. This can be done by constructing a new storm drain to Assi, with a sump and pump arrangement near the entry point of the storm drain into the lake. Some of the highly polluting drain from phosphoric acid plant and storage area should be diverted to holding pond recommended later as it will provide necessary nutrients and reduce cost of treatment.

(3) Emergency or shut down drainage from ammonia urea units and CAN complex are all discharged directly to river Assi or natural pond in Alwaar. These may carry large quantities of ammonia, urea, carbamate and biurates and would affect aquatic life adversely. There should be a combined holding pond for these discharges and should

be treated in the new proposed waste treatment plant of 7000 m^3/d before release to river Assi. These ponds should have atleast capacity of 20,000 m^3 or three time volume of tripping flow of the units which ever is more as holding capacity. This ponded discharges can be then gradually treated in the waste treatment plant, which will have additional capacity of 500 m^3/hr as suggested earlier.

(4) Unusually large volume of waters are discharged from the cooling tower in all the units as blow down sometimes as much as twenty to thirty percent. This must be reduced to decrease the volume of waste waters and water consumption. New pilot plant for cooling water already commissioned as designed and built during the mission should help optimise chemical doses for biocide and corrossion control to reduce blow down. Studies on pilot should be completed at the earliest so that all cooling towers water consumption can be optimised.

(5) The new pilot plant designed during the mission for waste water treatment should be commissioned first to decide most economical and effective treatment process for the waste waters of the entire complex. The new suggested treatment plant should be specified on bases of various parameters derived from studies on this pilot plant. Construction and commissioning this pilot plant should be

taken up on priority basis to determine various treatment parameters and to finalise waste water treatment plant design at the earliest.

6.2.3 Air Pollution

The total load discharged to the atmosphere from the GFC complex is 1950 T/day approximately of this 1760 Tons/day is carbon dioxide and has not much ecological significance. The rest - SO_2 - 89.56 T/day, NO_x - 52.24 T/day and F - 6.76 T/d, P_2O_5 - 11.69 T/day along with acids 1.15 T/day (mists) need special consideration. Also there are recoverable products like urea and NH_4NO_3 which can be recovered and pollution reduced. Following steps are suggested for air pollution control :

(1) Prilling tower for urea showed higher emission rate of 500 to 850 mg/m^3 against venders guarantee of 50 mg/m^3. This means per day about 10 T urea is lost. This can be recovered by providing scrubbers on all four forced draft fan outlets. The required construction is of annular rings spray with down deflectors and recirculation pumps (

). This can be fabricated locally using stainless steel or glass fibre reinforced plastic in Central Workshop of GFC. The estimated cost of this would be about US $ 150,000 including recirculation pumps, piping nozzle etc. for each or about 600,000 thousand U.S. dollors for all four. This will recover about 3000 T/yr and will pay back the cost (including operational expenses) of the capital in one year (US $ 250/T urea). This will at the same time reduce pollution. The dilute urea solution (20 to 30%) can be concentrated into evaporators of the new waste treatment plant and added to CAN mixer for better nitrogen content. The total saving per year would be about 0.75 million US dollors.

(2) The CAN Unit discharges about 90 to 100 Tons of steam per day directly into atmosphere, from neutraliser, after its use for heat recovery in the first stage evaporator. It carries about 4 to 5 tons of CAN and 0.25 NH_3 with it in vapours. This can be recovered by a simple spray scrubber. The recovered NH_4NO_3 solution (20-30%) can be concentrated in the evaporator of the new treatment plant and recycled to first evaporator of NH_4NO_3. This will recover about 1200 to 1500 T of NH_4NO_3 per year with a saving of US $ around 150,000 to 200,000 annually. The cost of these scrubber will be about 500,000 US $, including addition ducting, foundations and civil construction, pumps etc. which can be paid for in few years.

(3) Quantity of nitrogen dioxide fumes from the nitric acid plants was estimated to be about 6 T/day. and NO about 2.5 T/d in tail gas. This can be controlled either by catalytic reduction with a carbon source like natural gas or scrubbing. It is recommend that on basis of the

laboratory studies an ammonia scrubber will be more economical. This will need about 7 T/d of ammonia and will produce 14 to 15 T/d of NH_4NO_3, which can be concentrated in evaporators and recycled to CAN. The scrubber will need some more detailed investigations to arrive at correct engineering and cost. It will save about US $ 0.4 million per year excluding the cost of ammonia and operation and will pay back the capital investment in few years.

(4) Flouride emission from TSP complex is from 19 chimneys of rather low heights at roof tops from all units. The total amount emitted is 6.75 T/d or 4.5 Kg/T of TSP. The major fractions are from the H_3PO_4 and TSP units. The efficiencies of the scrubbers are best (99%) can be obtained as per the flow sheet. Only alternative to reduce the impact of this fluoride emission on ground levels is to combine adjoining chimneys into one and raise the height of the discharge points. Feasibility studies of this method or other alternative must be taken up immediately.

(5) H_3PO_4 acid fumes and fluorides discharged from drier and granulator chimeney of low height are down washed around the unit due to eddy currents caused by nearby tall buildings, and causes acid burns to passerby. To prevent this the discharge stack height should be raised

about 60 meters and also provide heat source like oil burner to raise flue gas temperature for better bouyancy and dispersal.

(6) The ground rock phosphate rail wagon tippler has no dust control resulting in heavy dust pollution around it in the unloading operation. It should be provided with dust enclosure and extraction fans with cyclones to remove dust. This will reduce rock phosphate dust pollution in the complex and its transport to water bodies.

(7) Both rock phosphate and sulphur handling need trained persons to systematically to reduce dust emissions. A training programme for this will be helpful.

6.2.4 Occupational Health:

The problems of occupational health in such complex are acid fumes, ammonia, fluorides and noise. Since all plants are new and under commissioning stage - except CAN unit, no specific concentration were measured for indoor air.

The factory safty section does have good equipment to monitor these.all parameters. They also have noise meter which was used to measure levels in different units during this study. The noise levels were measured on three scales: A- 100-1000 Hz; B- 200-2000 Hz, C- 1000-10,000 Hz. Levels on much higher than occupational safty and Health Act (OSHA) USA of 90 db-A for 8 hours (Table No. 34) in all units namely HNO_3, NH_3 and Urea. This will

Table No. 34

OSHA* PERMISSIBLE SOUND LEVELS

Daily Exposure hours	Sound level Slow Response, dBA	Optional Octave Band Sound-Pressure Levels db							
		63	125	250	500	1000	2000	4000	800[illegible]
8	90	110	103	97	91	88	86	86	8[illegible]
6	92								
4	95	128	116	106	98	92	89	83	9[illegible]
3	97								
2	100		125	115	106	99	94	93	9[illegible]
1½	102								
1	105		135	127	116	107	100	98	10[illegible]
½	110		135	135	125	115	107	104	11[illegible]
¼	115		135	135	132	121	112	110	11[illegible]

*Occupation Safty and Health Agency of USA, 1976.

affect the health of the persons working in these area if not well protected.

(1) Since no controls are possible at this stage training of the employees for following safty rules and their observance like use of ear muffs etc. should be implemented early.

(2) Handling of chemicals such as AlF_3, NH_3, HNO_3, H_2SO_4, and H_3PO_4 require safty precautions. A special programme of training should be given for this by help of expert if available from UNIDO or ILO.

(3) Safty equipment like emergency shower, eye-washer basins etc. were broken on non-operational in same places, they should be all repaired and restored to normal working order.

(4) The safty section in fire fighting section should be strengthened and made more active by providing special staff on safty observations and training as per (2) above.

7.0 ENVIRONMENT POLLUTION MONITORING LABORATORY AND TRAINING OF THE STAFF FOR MONITORING TECHNIQUES AND CONTROL

GFC has good **central** laboratory for quality control of the product and has well trained personnel. The laboratories are well equipped (Appendix. IIIA) and organised under the directorship of Mr. R. Hourani.

They have facilities for testing Ammonia, Urea, CO_2, S, H_2, H_2, hydrocarbons, P_2O_5, H_3PO_4 and all types of acids alkalies etc. for purity and quality. These can be easily adopted for air, water and soil monitoring.

They have also water analysis facilities and were routinely testing treated waters, demineralised water and also effluents, lake and river waters.

As part of the mission a separate cell of staff and laboratory for pollution monitoring was established under the Director, with Mr. M. Ali Hussain as Head of the Cell, with Ms Faiza Farah as biologist and Ms Salva Abdul Aziz as analyst. Some important parameters for water like COD, BOD, and testing for air and soil was additional requirement. New techniques for air, water and soil analysis were developed specially using locally available facilities in GFC. Also, existing equipments like refrigerators, pumps etc. were modified to convert them to incubators' and samples, or fabricated in the workshop (e.g., depth samplers).

Chemical techniques normally used in water analysis developed by Hack chemical Co. were used to monitor air pollutants like NO_x, SO_2, etc. with successful results.

The counter parts were explained fully the basic principles of monitoring and methods of sampling, along with the importance of sampling point locations and frequency.

Routine monitoring programmes for the following were established.

(1) Water quality monitoring for chemical, biological and physical parameters (Table No. 29, 30).

(2) Air quality monitoring for ambient air, emission source stack monitoring for parameters like SO_2, NO_x, NH_3, acid fumes, fluorides, urea, CAN and particulates (Table No. 28).

(3) Soil monitoring for metals, pH and specific pollutant being discharged from the complex.

(4) Noise measurement techniques in different areas of the plants and units (Table Nos. 5, 11, 12, 15).

There appear to be formal training available for environment pollution monitoring and control at undergraduate or graduate levels in science or engineering desciplines. Contacts were made with Al Bath University (Homs), president Dr. Abdul Majeed Sheik Hussein, and other faculty members in chemical Engineering faculty to discuss possibilities of including environment pollution monitoring and control in the syllabii ~~fxx~~ of their courses; an outline of the course content was also suggested.

LGFC. The laboratory has no standard equipment required for air pollution monitoring and needs it urgently as requested in the mission's beginning. Though temporarily innovations were made to use existing facilities for training and demonstration purpose it would not feel the need for reliable standard equipment. It is desirable that equipment given in Appendix III-B should be procured as early as possible.

8. <u>TECHNICAL ASSISTANCE AND DETAILED STUDIES FOR SETTING UP PILOT PLANTS</u>

Three pilots plants identified during the mission for assistance and studies were :

(1) Cooling Tower

(2) Waste Water Treatment

(3) Nitric Acid plant Tail Gas-treatment.

8.1 <u>The Cooling Tower</u>: The deterioration of the water quality in lake Kattinah had affected the efficiency of the existing cooling towers which showed signs of algal growth. Also large quantities of waters are being wasted (as high as 20 to 30 percent) as blow down, increasing the volume of waste water to be treated.

A detailed study of raw water was done for chemical and biological parameters and it was found that both anit-corrosive and biocide chemicals would be required to maintain water quality acceptable to process condensors after cooling tower.

After discussion with counter-part, water treatment division personnel and workshop engineers, a pilot plant for cooling tower of 10 m^3/Hr capacity was designed. Detailed working drawings were prepared and submitted to the Central Workshop. They have excellent fabrication facilities with skilled workers and design engineers. The pilot plant was fully commissioned before end of the mission (Fig. No. 18), and was functional. The pilot plant has facilities for studying algal growths, corrosion rates on test pieces and temperature control to determine heat dissipation factor for unit surface area. It also has facilities to alter surface area of water flow. The operation and investigation techniques were demonstrated on the pilot plant to help studying followings :

(1) Optimise the dose of biocides to obtain best algal growth control

(2) To determine corrossion rates of different metals (three at a time) and to decide minimum anticorrossion compound dose

(3) To determine minimum blow down quantities and reduce water wastage

(4) Test new chemicals available in market for their effectiveness and suitability.

The above studies will improve the performance of the process condensors, reduce the heavy corrossion, as it was seen in old opened condensors.

It will also help reduce waste water quantities which are more expensive to treat with large volumes.

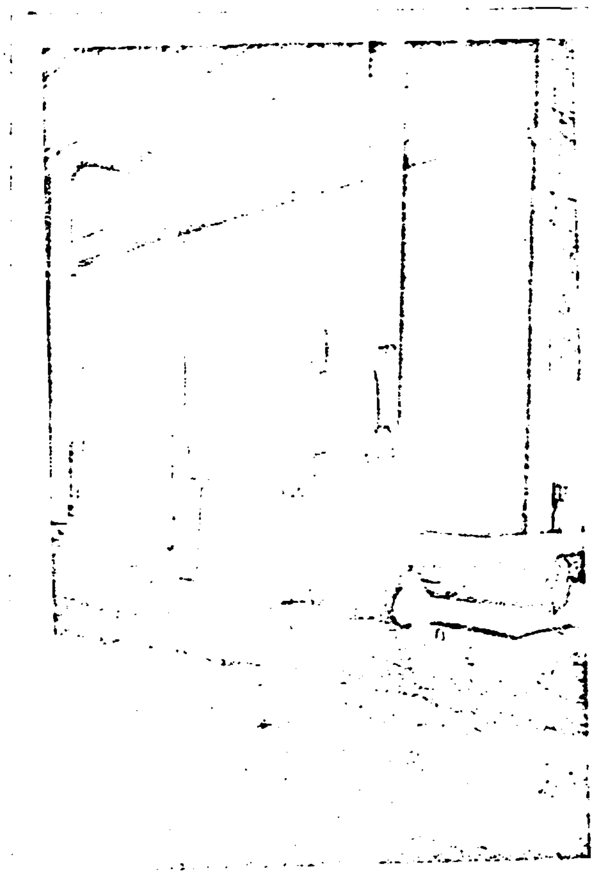


FIG. 18. A

FIG 18 A-B

COOLING TOWER PILOT PLANT IN OPERATION.

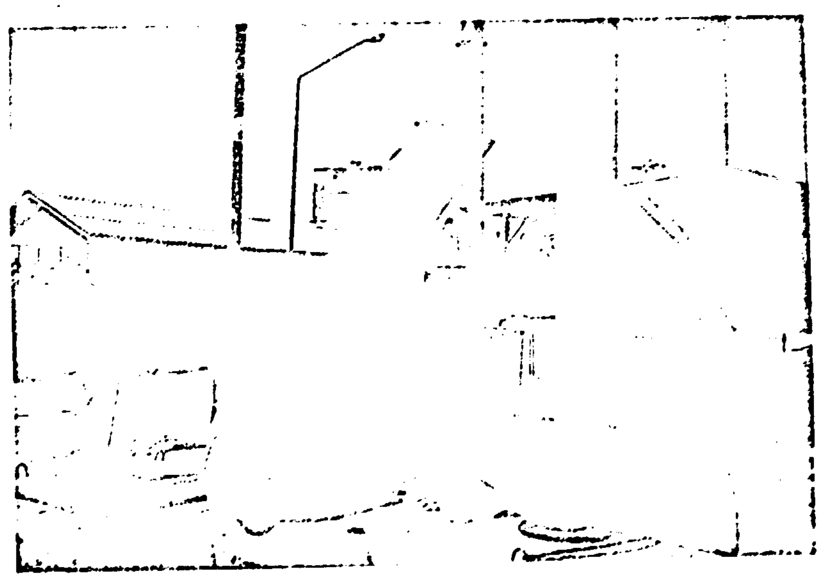


FIG. 18B.

Since the pilot plant will operate in parallel with existing cooling tower these studies will be possible under similar waters and conditions without disturbing the main plant operation. Also findings can be directly applied to cooling tower on full scale.

8.2 <u>Waste Water Treatment Plant</u>

A pilot plant capable of treating 1 m^3/Hr or 24 m^3/d of liquid effluent was designed on the basis of tested characteristics of the GFC effluents. It contains NH_3, Urea, F, SO_4, NO_3, NO_2, phosphates oil and greese. The pilot plant therefore had to be a very versatile and flexible to incorporate all the unit operation of waste water treatment. The designed pilot plant included.following unit operations :

(1)	Settling/Clarification Hoppor bottom type -	2 units
(2)	Aeration-nitrification reactors Inca-type aeration	3 units
(3)	Denitrification -	1 unit
(4)	Filtration - Rapid Sand filter	1 unit
	- Pressure filter	1 unit
(5)	Trickling/Biological filter (stone media) -	1 unit
(6)	Demineralisation - Cation, anion and polishing unit using Duolite A-61, C-26 and mixed bed one unit each - total -	3 units
(7)	Back wash, regeneration tanks, piping valves and all necessary fixtures.	

Detailed working drawings, specifications of the pilot plants were prepared and submitted counter part but it could not be fabricated in time due to process of delay in procuring various components.

The waste treatment pilot plant will be useful to study following :

1) Treatibility of the complex fertilizer effluent containing urea, ammonia, nitrates, oil and grease etc. in combination with effluents from TSP and CAN complexes.

2) The techniques of hydrolysing urea biologically in a facultative (both anaerobic and aerobic) system using a carbon source (Methanol or such other or domestic waste) along with addition of nutrient of P and K. It will give

(i) Reaction time or detention period in facultative reactor to determine its capacity

(ii) Ratio of other effluents and amounts of nutrients, and carbon source required for effective reactor functioning

(iii) Energy or air requirements for the reactor per unit removal/hydrolysis of urea.

3) Detention period for nitrification (aerobic or activated sludge) and denitrifications, energy requirements for it and sizes of the units and amount of carbon source required.

4) Comparision of biological process with dimineralisation process using resins of different types.

5) Suitability of different operations like filtration, sedimentation, for complex effluents in treatibility studies and arriving at design parameters like overflow rates, detention periods surface areas and sizes for the units like clarifiers, filtration, demineralisation or cation and anion resin and polishing units. The pilot plant will also provide facilities to study the water treatment effectiveness from lake Kattinah to arrive at correct parameters to reduce organics etc. as it can be used for water treatment easily.

It will also serve the purpose of demonstration, training and research by the GFC staff and the students of the Al Bath University at Homs.in control technology for liquid effluents.

8.3 Nitric Acid Tail Gas Treatment

The nitric acid plant was started in 1972-73 and is continuously working since then. It was observed that amounts of NO and NO_2 in the tail gases was about 2000 ppm by volume. This means daily discharge of about 8.4 Tons. The alternative techniques available to reduce it are:

(a) Alter processes by providing additional chilling of acid entering final scrubber, or use larger scrubber

(b) To provide catalytic reduction using a carbon or hydrogen source

(c) To provide an alkaline scrubber.

Since it was not possible to incorporate first alternative in the old plant, and unfavourable economics of the second alternative third one was chosen as most suitable. A scrubber using ammonia, which is available in plenty in the GFC, will reduce tail gas emission by almost 90 percent and will recover valuable product of ammonium nitrate making it a control effective and economical.

Based on earlier experience, a small pilot plant scheme was developed. It consisted of a small ventury scrubber using ammonia liquor as scrubbing fluid. The design and drawings were prepared and submitted for fabrication.

This pilot plant studies will help to develop following parameters for a fullscale palnt

(a) Optimum ammonia concentration for most effective scrubbing

(b) Fluid to air ratios

(c) Effect of various throat velocities and corresponding efficiencies of scrubbing

(d) Determine the pressure drops and energy requirements for the scrubber

Based on the above findings, feasibility of using a fullscale scrubber can be determined. This will produce about 14 tons of ammonium nitrate per day.

For preparing final drawings design and cost estimates further detailed study will be required of the existing plant, its ducting system and availability space etc. This may require possibly services of a design expert if it is to be built by GFC or alternatively GFC can seek assistance from renouned companies dealing in scrubbers like Dorr Oliver, Peabody, etc.

9. LAKE KATTINAH POLLUTION SURVEY

Lake Kattinah is a man-made reservoir created by damming river Assi (Orantes) near village of Kattinah. It has been principally used for irrigation purpose by storage of water, regulating discharge of river Assi and also direct irrigation by canal and distributory network to fields in Homs and Hama areas.

It had also been used in past for water supply source for city of Homs and Hama but has been abandoned as source due to pollution of water.

Recently, industries established in Homs area such as power plant, Refinery, GFC Complex and many such other industries use Kattinah lake or its water supply and also discharged effluents into river Assi.

Initially the water quality was quite acceptable for industrial purpose as per the analysis data for the year 1968 as given in Table No. 35. It has deteriorated considerably since as data from June 1982 shows it in Table No. 30.

Table No. 35

RAW WATER CHARACTERISTICS - 1968

Available raw water originating from the lake is assumed having the following average design composition: (1 ppm $CaCO_3$ = 0.20 mval/lt) within an expected range of ± 10% unless otherwise specified.

Ca	105 ppm $CaCO_3$
Mg	100 ppm $CaCO_3$
Na	48 ppm $CaCO_3$
M Alkalinity (HCO_3)	190 ppm $CaCO_3$
Cl + NO_3	41 ppm $CaCO_3$
SO_4	22 ppm $CaCO_3$
Salinity (cations = anions)	253 ppm $CaCO_3$
pH (20°C)	7.5 ± 0.5
SiO_2	8 ppm SiO_2
Suspended matter	(max) 450 mg/lt
Organic matter	(max) 32 mg/lt $KMnO_4$
Temperature	+ 5° + 30°C
Pressure	2 atm (gauge) approx. (as measured at ground level).

A very high count of Algae indicates the presence of nutrients like nitrogen and phosphorus in water and of pollution. These may have come partly from the leaching of the nutrients from the increasing use of fertilisers as almost entire catchment up stream is used for agriculture, partly from the industrial effluents being discharged by plants located on its shore and increased population in catchment which also contribute considerable pollution.

The polluted water has definitely affected performance of plants of the GFC complex adversely. The demineralisation units for water treatment were not designed to handle such high organic loads in raw water and hence increased organics have fouled demineralisation unit resins, has also scaled and corroded the heat exchangers and condensors badly. These all eventually effect the performance of the process units and productivity. Leakage of silica in higher concentration from fouled resins in demineralisation plants may even damage units, like ammonia plant compressor turbines due to deposits.

Lastly aesthetically, it is a beautiful lake and it should be conserved as natural asset of Syria.

It is, therefore, urgent that lake Kattinah pollution status is examined thoroughly. The Survey will help to determine whether pollution is limited to the area near the plants or it is throughout the lake. It will also help to identify the pollution sources for future corrective measures to be taken by the authorities to reduce the pollution.

<u>The Survey Programme</u>:

1) It should measure levels of nutrients entering the lake at regular interval of once a month by analysing the waters entering of Assi river and other streams into the lake and water leaving the lake. The tests should cover NO_3, NO_2, P_2O_5, SO_4, Hardness, Chlorides, BOD, COD and total algal counts. The information about the catchment area and the land use in it, agricultural, forests, hills, and habitation etc. along with crop pattern and amounts of fertilizers consumed should be collected from authoritative sources. Some field survey to veryfy details and missing data will also be necessary. It should be done in selected area sample survey. This may also include statistics on population, water supply and sanitation.

2) The material balance for input and output of nutrients and water of the lake should be determined. This will require data on run off quantities entering the lake, total discharge from the lake and evaporation losses on annual basis. Some of the data may be available with department of water resources and rest will have to be collected by arrangement of flow measurements at suitable selected points.

3) The water quality survey should be carried out for the entire lake by sampling water at about 15 points, of this about 5 should be near shores and rest should be selected to over the entire lake surface area. The water

sample should be collected at three levels namely at surface, one meter below surface and about one meter above the bottom of the lake. These samples should all be analysed for the tests given in 1 above.

4) All the industrial and domestic effluents entering lake should be analysed for pollutants loads they carry and their volumes should be determined by installing flow measuring devices where required. These effluents should be sampled compositely for 24 hours under normal operation and should be repeated at least thrice to obtain reliable data.

5) The nutrient and water balance with data on inputs and outputs together with information on build of levels in lake will help understand status of the pollutant material balance. It will also help identify the areas of action required and nature of abatement for pollution required.

6) Based on the above studies and identification of the nutrient and pollution sources, lake restoration programme should be developed. It should consist of (a) better control and management of all pollution sources like effluents from industries to reduce them. (b) Modified techniques for fertilizer use in agriculture and management of crops. (c) Provide controls for domestic waste from communities living in the lake catchment area. (d) Manage water flows particularly outlets releases. (e) Soil conservation measures should be developed in the entire catchment.

Since part of the river catchment lies in the Labanon, some cooperation may have to be worked out between the two countries, steps taken in Syrian partly will help improve lake considerably.

The survey can be carried out by the same pollution monitoring cell working in GFC, with some strengthening in Staff and equipment as suggested in recommendations.

10. <u>Water Treatment Improvement</u>

The lake Kattinah is the only water source for industries in Homs area. Its waters seem to have degraded in quality in the last decade (1968-1980) considerably affecting the efficiency of water treatment processes and their reliability. Major change appears to be growth of algal blooms increasing organic matter and biochemical oxygen demand. This results in reduced steeling in clarifier and clogging of rapid sand filters in conventional treatment with large carryover of organics. These in turn foul up resins in boiler water demineralisation units causing higher silica contents. It was apprehended that silica in boiler water and stream will cause deposition on compressor blades with possibly serious consequences.

To solve this problem encountered in water treatment a detailed study was done in Kattinah lake water as reported earlier. It was found that problems are mostly caused by pollution of increased organics and to tackle it, the following suggestions are made :

i) Prechlorination along with copper sulphate dosing be practiced in all water treatment units. The dosage of copper sulphate should be about 0.5 to 0.75 mg/l and chlorine about 1 to 2 mg/l. This will improve clarifier performance and reduce algae carry over to sand filters.

ii) Boiler and process feed demineralisation units regeneration methods be modified as follows to cope with increased organics caused by lake water pollution :

(a) Increase regeneration period by about 20 to 25 per cent (i.e., longer) for all, cation, anion and mixed bed units.

(b) Increase regeneration solution temperature upto about 40 to 45°C by installing steam coils or electrical heating coils in the solution tanks.

(c) Use of sodium hydroxide in place of sodium chloride once in every five to six weeks to remove the deposited organics and better regeneration.

(d) Remove settlable impurities like iron and others by settling the sodium chloride solution before using it.

iii) Use C.O.D. test (as demonstrated) for organics in place of $KmNO_4$ test used now, to obtain better index of total organics in water.

iv) If the problems of organics still persists, the aeration of the treated water may be used. As demonstrated in laboratory it would reduce $KMnO_4$/C.O.D. value by 40 per- cent. The aeration can be done by installing Inca type diffusers in clear water tank with aeration capacity of 10^3 air/100 m^3 of treated water, or if required additional aeration unit may be added before clarifier.

v) There are three separate water treatment plants in the complex, each operated independently with total installed capacity of 3300 m^3/Hr. This will meet all their present and future demands. In order to overcome the problems of decreased plant efficiency etc. by pollution, it would be desirable to have a single distribution or interconnected distribution system so that water can be transferred from one to another in case of need. This will prevent plant dousers due to failure of a unit. It is also desirable that all the plants be managed in coordinated manner.

11.0 Additional Assistance Rendered to Govt. of Syria

In addition to the terms of the reference for the mission technical assistance was also given to other agencies of the government besides GFC. These are :

11.1 <u>Homs Water Supply Authority</u>: The demand of water, during summer and particularly for Ramadan period, could not be met with Ain-Tanour Spring water supply system. For additional water there was need to recommission old plant abondoned based on Kattinah lake water. The filter effluent showed Nitrates and H_2S due to clogged filter bed by algae.

Advice was given to restore filtration plant to normal working condition and also to operate it for treating difficult Kattinah lake water. Chlorination technique for the filter beds and to operate sludge blanket clarifiers for such water were demonstrated. Assistance was also given in testing and analysis of water samples for quality control to correctly check the performance of the plant. The commissioning of the Kattinah Lake water Supply helped Homs city to overcome shortage with additional safe water.

11.2 Effluent Standards for Discharge to River Assi: Discussions were held with the Water Pollution Control Directorate on Assi Rivers. Information was given on similar Indian and other countries river pollution control programmes and also how effluent standards for industrial and domestic wastes are ebing used by them, their application techniques and methods of their development. One complete set of effluent standards was also handed over to them for reference and use.

11.3 Pollution Control Teaching: In view of the shortage of trained persons in industrial pollution control technology discussion were held in the Al Bath University, Homs with the president and the Dean of Chemical Engineering and the faculty to include a programme on environment pollution control technology in undergraduate curricula. Details of syllaby for the similar teaching in other countries and India were given to the Dean. The University has sufficient laboratory facilities for such a course. Lectures were also delivered at the Students' Camp organised by the University on environment pollution and control technology.

11.4 Site Selection for Phosphogypsum Disposal: The GFC authorities had constituted a committee with consultant to recommend a suitable site for disposal of phosphogypsum. After considering alternative sites too at near village Namia and Karitene were selected for visit to obtain field data on surrounding habitation, agriculture and soil characteristics. Report was prepared recommending actions required for both the sites.

11.5 Evaluation of the Diffusion Model Report for T.S.P. Complex: The evaluation of the air pollution diffusion report by the vendors of T.S.P. units was also looked into and comments were given to obtain more reliable estimates of the ground level concentrations for SO_2, F, P_2O_5 and H_3PO_4 fumes.in the area surrounding the complex. Suggestions were also made to obtain specific additional metereological data to give more reliable values for ground level concentration for short and long period duration in villages of Kattinah, Mubarakia and surrounding agricultural land.

12 Acknowledgement

In the implementation of the project all available information from UNIDO*, such as previous reports on the GFC complex and other publications and reports on projects dealing with environment pollution were utilized. Meetings and discussions were also held with the Governor of Homs, and other senior officials in the Government of Syrian Arab Republic, in Directorate of the General Establishment of Chemical Industry, Meeting was also arranged with officers in Directorate of Water Pollution Control, the Chairman of the Al Bath University Homs, and the Dean and the faculty members of the Chemical Engineering Institute Homs. These meetings and discussions were very useful in understanding their view point on issue of pollution, specially related to the GFC complex.

The Director General GECI, and the staff must have special mention for their keen interest and full support to the mission. In GFC excellent cooperation and help was extended by the General Director, Laboratory Directors, Chiefs of the units, Workshop and all concerned officers. The counterparts were closely associated in all the project activities with active participation and contribution in successful completion of the project.

The officers and staff at the UNDP field office at Damascus and in particular SIDFA UNIDO in his official and

personal capacity, have rendered most valuable assistance in the project. The mission(s completion would not have been possible but for their interest, contribution, and assistance. The list of the persons associated with the project and those contacted during the mission is given in Appendix No.II.

Appendix I

Original Job Description for S1/SYR/82/801/11-01

The expert will work with the Syrian Government assigned counterparts in General Fertilizer Company Homs, and specifically is expected to help:

1. Monitor Waste Water Effluents from theplants for pollutants.
2. Monitor Airborne pollutants from their gases effluents.
3. Suggest ways and means to control their plant effluents.
4. Assist in Establishment of pollution control laboratory.
5. Assist and provide advice on training of the personnel for pollution monitoring on control work.

APPENDIX – II

Following Persons' help is gratefully acknowledged during the Mission

<u>UNIDO</u>

1. Mr. H. May,
   Dy. Director, Division of Industrial Operational
   and Head, Chemical Division,
   UNIDO, Vienna.

2. Mr. S.E. Sazonov
   Industrial Development Officer
   Chemical Industries,
   Industrial Operation Division
   UNIDO, Vienna.

3. Dr. A.S. Salem
   SIDFA, UNIDO, Damascus, Syria.

<u>UNDP</u>

4. Mr. Rober P. Thompson
   Regional Representative in-Charge
   UNDP, Damascus, Syria

<u>Govt. of Syria - GECI/GFC</u>

5. Er. N. Maalas
   Director General
   GECI, Govt. of Syria
   Damascus.

6. Er. A. Turk
   General Director
   GFC, Homs, Syria

7. Mr. R. Hourani - Counterpart
   Director of Laboratories,
   GFC, Homs

8. Mrs. M. Ali Hussien - Counterpart
   Head Pollution - Unit

9. Ms. Faiza Farah, Biologist, Poll. Unit

10. Ms. Salva Abdul Aziz, Analyst, Poll. Unit.

11. Special Thanks are due to Heads, Chiefs and all GFC Staff in units for their help and cooperation.

Other Syrian Agencies

12. Er. M.H. Sharafly, General Director
Industrial Testing and Research Centre
Damascus.

13. Er. Saad A. Shawwaf, Director,
Water Pollution Directorate
Damascus.

14. Dr. A.M. Sheikhussein, President
Al Bath University, Homs.

15. Dr. M.A. AlShaar,
Dean, Faculty of Chemical Engineering,
Al Bath University, Homs.

Appendix III-A

LIST OF INSTRUMENTS AVAILABLE IN GFC

- Naptha distillation apparatus
- Total sulphur in naptha
- West hoff for gas analysis
- Orsat apparatus
- Carbon and sulphur in steel alloys
- Flash point for oil (Nepski type)
- Pour point for oil analysis
- Automatic titrator
- Hack system DR-EL12 for water analysis
- Flame photometer for (Na, K) Perkin Elmer
- Conductivity meter (Hach model)
- BOD_5 Back
- Turbidity meter
- Viscosity meter
- Gas chromatograph perkin Elmer Model 201
- Gas moisture meter
- Nillipore system
- Sodium analyzer
- Copper corrosion meter ASTM D 130
- Total Nitrogen (coleman)
- CO - CO_2 analyser 0-50 ppm
- NH_3 analyser 0-10 ppm
- H_2 gas analyser 0-5% (L.T. Shift reduction)
- Gas chromotograph perkin Elmer Model 3700
- Hydrogen generating unit
- Gas chromatograph varian Model 3700
- Atomic absorption (Shandan)
- Balances (Electrical) Mettler, Sartorious
- Mufflue furnace carbolite
- Spectrophotometer SP6-550 Pye Unicam
- pH meters
- Ovens with Temp. Controls from 20° - 250°C
- Sterilizer steam with 1 Bar C $1577/M^2$) pressure
- Vacuum pumps of different capacity.

Appendix III-B.

LIST OF EQUIPMENTS/INSTRUMENTS RECOMMENDED FOR PURCHASE BY GFC

1.	Dry gas/air flow meter 10-15 m^3/Hr capacity - (Karlkolb Catalogue No. 273-842 or eq.)	2 units
2.	Wet gas flow meter 15 m^3/Hr capacity - low pressure (Karlkolb catalogue No. 273-737)	1 unit
3.	Compressor/Vacuum Pump 15-20 lit/min; Pressure 2 Atm. Vac. 0.6 Torr - Model No. A-AMB 40C G230 Cx (G.E. Fort Wayne Ind. USA make or Karlkolb Catalogue No. 317-500 with 1/10 KP induction 220 V, 50 Hz motor)	2 units
4.	Bausch and Lomb Spectronic 121 Spectrophotometer (USA)	1 unit
5.	High Volume Particulate Sampler (Research Appliance Co. Pittsburg, Pan. USA)	6 units
6.	Mechanical Wind Velocity and disc on Recorder, Range 0-60 m/sec and 0-360 dir (Karlkolb catalogue No. 514-160)	2 units
7.	Hand held Cup Anemometer Range 0-100 Km/Hr, 2/1 Km Div. (Karlkolb Catalogue No. 514-110)	2 Units
8.	a) Automatic Tape Sampler for particulate	2 units
	b) Reflecto/Densito-meter for above	1 unit
	(Research Appliance Co., Pittsburg PA, USA)	
9.	Stack Sampler, complete with built-in pitometer, velocity manometer different size nozzles, Thimble holder, Condensor flow meter, pump etc. (Joy Instrument Co. USA S.F. Co. Stockholm, Sweden Research Appliances Co, Pittsburg, PA, USA).	1 unit

Appendix IV

NEW WASTE WATER TREATMENT DETAILS

(1) Biological Unit for Nitrogen Recovery

Design flow	90 m^3/Hr
Max. flow	110 m^3/Hr

Influent Characteristics

NH_3	110 mg/litre	Actual
Methanol	55 mg/litre	
Urea	220 mg/litre	

(2) Pressure Filtration and Iron Exchange Units

Design flow	165 m^3/litre
Max. flow	210 m^3/litre

Influent Characteristics

NH_3	685 mg/l
NO_3	910 "
Methanol	5 "
Oil	7 "
TDS	1350 "

(3) Performance Guarantee

Influent			Effluent	
			(Oil	10 mg/l
Flow	165 m^3/Hr.)		(NO_3	30 mg/l
NO_3	969 mg/l)		(NH_3	10 "
NH_3	606 ")		(Urea	10 "
Urea	121 ")	Influent-effluent	(Methanol	-
Methanol	12 ")		(BOD5	20 "
Oil	7 ")		(COD	30 "
pH	6 - 9)		(SS	30 "
			(TDS	1000 "

Appendix V

SUGGESTED POLLUTION SURVEY UNIT COMPOSITION IN GFC.

1. Head of the unit - Chemical Engineer or Chemical Technologist.

2. Two Chemists for Analysis - One for Air, one for Water

3. One Metereologist (same level as Chemist)

4. One bacteriologist or Microbiologist for biological examination of waters.

5. Three assistants of these two should be males so that they can attend to field work like, collecting samples, observe reading on instruments installed in the field, etc.

6. One vehicle with driver for sampling etc. This staff will be in addition to the waste water plant operator staff as required.

Appendix VI

SUGGESTED
OUTLINE OF THE CONTENT FOR DECREE FOR ENVIRONMENT PROTECTION IN SYRIA

1. To enable the creation of Environmental Protection Directorate in the Government of Syria, with a Governing Board.

2. It may have a Governing Board possibly with representatives from the concerned Ministries like Industry, Agricultural, Water Resources, Health, Public Works and Transportation, Petroleum, etc. The Board can meet few times a year to decide the policy for the Directorate of Environment and give directions to it.

3. The Directorate may be headed by a Director, whose functions will be to organise and implement programmes for protection of environment with necessary staff, equipment and establishment for its effective functioning.

4. The directorate functions should include the followsing

   i) To conserve environment from pollution as directed by the Board.

   ii) To lay down environmental impact assessment requirements for new projects

   iii) Lay down standards for discharges into air, water and on soil.

   iv) Establish Laboratory for monitoring pollutants in air, water and soil, and sources of pollutants for air, water, soil, it may also have centres at selected places in the country for this purpose where required for efficient functioning.

v) It should have an inspectorate system for checking the emission/discharge rates from sources of air, water and soil pollutants by sampling and analysis.

This will apply to stationary effluents sources like industry, power plants, domestic sewage, etc. and also to mobile sources like cars, trucks, etc.

vi) To lay down standards for ambient air quality for water quality in streams, lakes, ground and coastal waters, standard for levels of pollutants in soil.

vii) Hold discussions with industries, government agencies and all those concerned with or responsible for the discharge of pollutants, to comply with required standards.

viii) To conduct and promote research and investigations in laboratories to develop suitable technologies in the field of environment pollution control and management and monitoring.

ix) To obtain and disseminate information on environment quality, technologies and to cultivate public opinion.

x) To take steps as directed by the Board for enforcing the standards by the authorities in-charge of sources of pollution for compliances the Directorates requirements.

5. The set up of the Directorate may need separate sections for enforcement, analysis, technical activities and infrastructure of provision of buildings, staff, equipment and others required facilities for its functioning smoothly.

This may be done when details are looked into.

Consideration may also be given to the possibility of enlarging the scope of presently functioning Directorate of Water Pollution to cover these additional responsibilities as an alternative to creating a new Board. This may need revision of the already existing Decree No. 584 already in force, as given in Appendix XVIA

Appendix VI-A

Syrian Arab Republic
Ministry of General Works and Water Resources
General Directorate of Water Pollution Prevention.

DECREE NO. 584

His Excellency Minister of General Works and Water Resources, referring to Prime Minister Decree No. 76 issued in 1960 which states the organization of the Ministry, and its annexes issued in the decree No. 2145 dated 14-9-1971, and according to fundament decree of employment in Syria and after reviewing the internal regulations of the Ministry, and to the recommendations of the General Director of Water Pollution Prevention, Prevention Directorate and to the approval of Deputy Minister for Technical Affairs, order the following :

Article: 1 Article No. 11 mentioned in the decree No. 192 of 29-4-1972 and Decree No. 1138 of 15-11-1980 should be substituted by the following Article:

Article: 2 The General Directorate of Water Pollution Prevention compose the following departments -

1. Central Directorate (General Directorate of Water Pollution Prevention)

2. Centres of General Water Resources Pollution Prevention for water basins located in various areas of Syria which are :

Barada and Alawaj basin, Assi Basin, Al Yarmouk basin, Allepo basin, Euphrates basin - Al Bagyah basin, Beach basin.

A. Standardization Office: Its main responsibilities are:

1. To issue standard and tolerance limits for water and discharged waste water.

2. To follow-up with concerned government bodies issuing the necessary decrees which may help in protecting water resources from pollution.

3. To carry-out consultation with authorities in charge of surface water about specifications of discharge

waste water, also, the standardization office x should be responsible for issuing standards and limits for waste water discharge in areas which do not have authorities in charge of surface water resources.

4. To make recommendations and suggestions for establishing well equipped pollution monitoring laboratories.

B- Standards Control and Checking Office: Its main responsibilities are :

1. To monitor the wastes, whatever its origin, to measure pollutant quantities and check if it is meeting the standard or not, to check the performance of waste water treatment plants, in case plants failed in fulfilling the required performance.

2. To check characteristics of general water resources and follow the traces of pollutants, and to find its sources, and to compare all obtained results (including the monitoring stations) with the standards.

3. To decide the degree of water pollution which may lead to soil pollution and recommend the necessary measures to protect both animals and agriculture.

4. To prepare quarterly reports about the progress of works.

C- Technical Studies and Advisory Office: Main activities are

1. To discuss with pollutars the details of their plans and projects for water pollution abatement.

2. To give to centres the required informations and recommendations on how to make use of waste water standards, and to participate in solving technical problems encountering the centres.

3. To give technical recommendations and advices to pollutars, as a step to approach optimum solutions.

4. To study the locations of discharge points.

5. To check the design of waste water pollution treatments.

6. To discuss with centres the schedule of sampling from the discharge points to rivers, various points of rivers and streams, and to evaluate the obtained result

7. To co-operate with Health Ministry in studying effects of pollution on health and suggest the methods of pollution abatement.

8. To coordinate with harbour directorate in Syria for marine pollution caused by oil.

9. To coordinate with concerned agricultural bodies about soil pollution and how to protect the agricultural land.

Centres of General Water Resources Pollution Prevention compose of the following departments :

A. Technical department, and B. Laboratory department.

A. Technical Department: Main activities are:

1. To study the quality of general water resources within the center district (rivers, lakes, ground water, surface water, sea shore, drinking water), and to evaluate the analysis obtained from the automatic monitoring stations.

2. To study the characteristics of pollutant affluents, and to discuss with pollutars towards finding out the optimum waste water treatment methods.

3. To undertake studies for improving the quality of water in the basin, and to recommend the required standards.

4. To prepare quarterly reports about the progress of works carried-out.

B. Laboratory department

1. To carry out all the required tests for checking the pollution of the rivers and ground water.

2. To carry out the periodical checks and maintenance if required for the automatic monitoring stations.

APPENDIX - VII

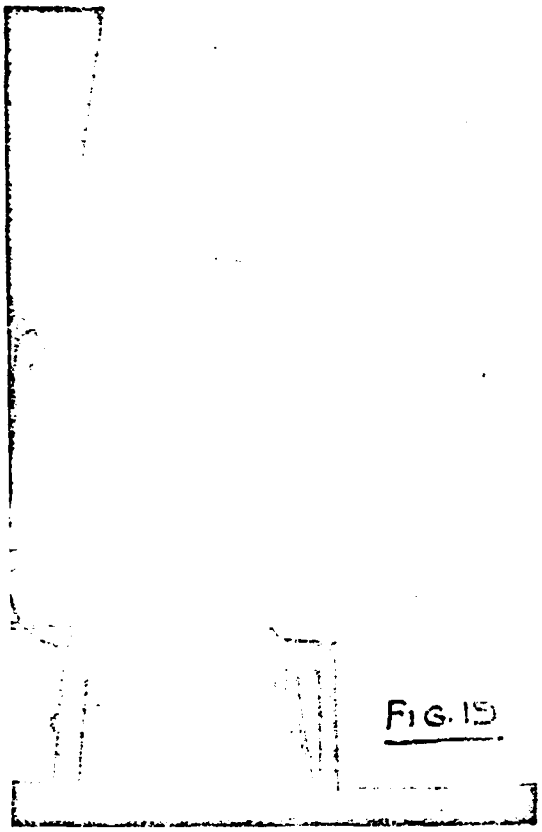


FIG. No 19

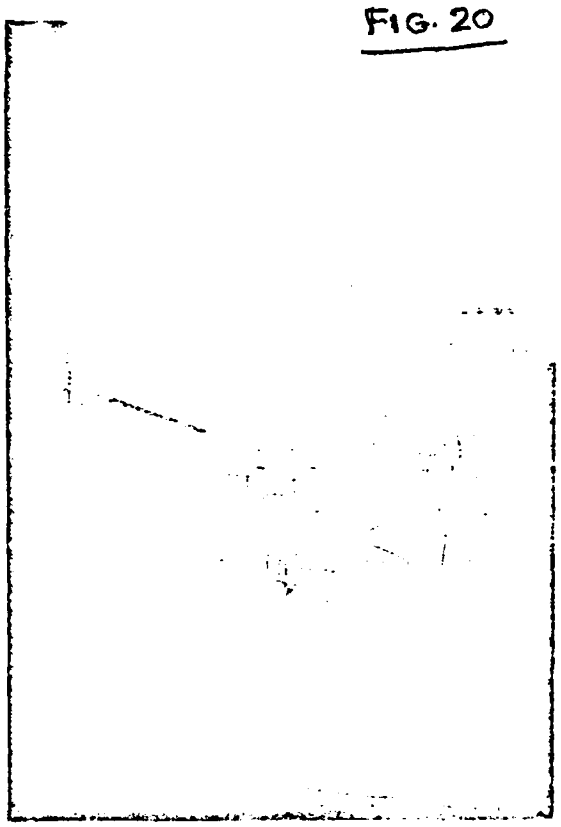


FIG No. 20

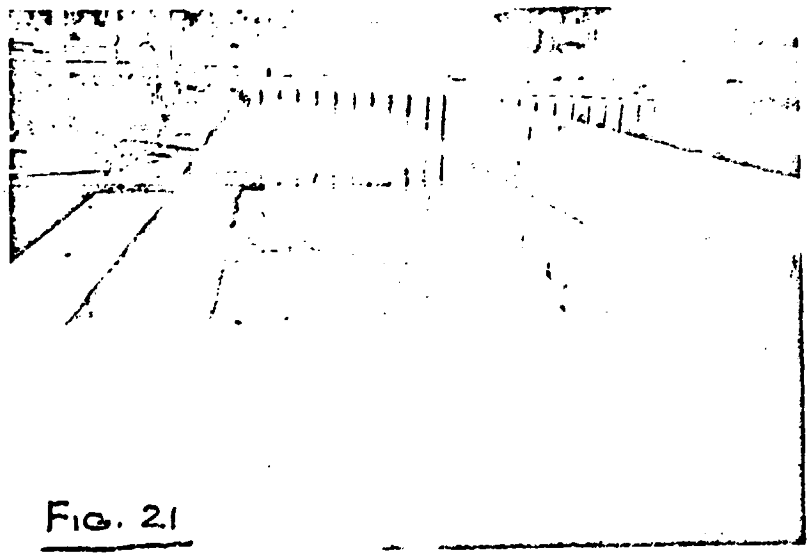


FIG No. 21.

SEE NOTES.

FIG 22

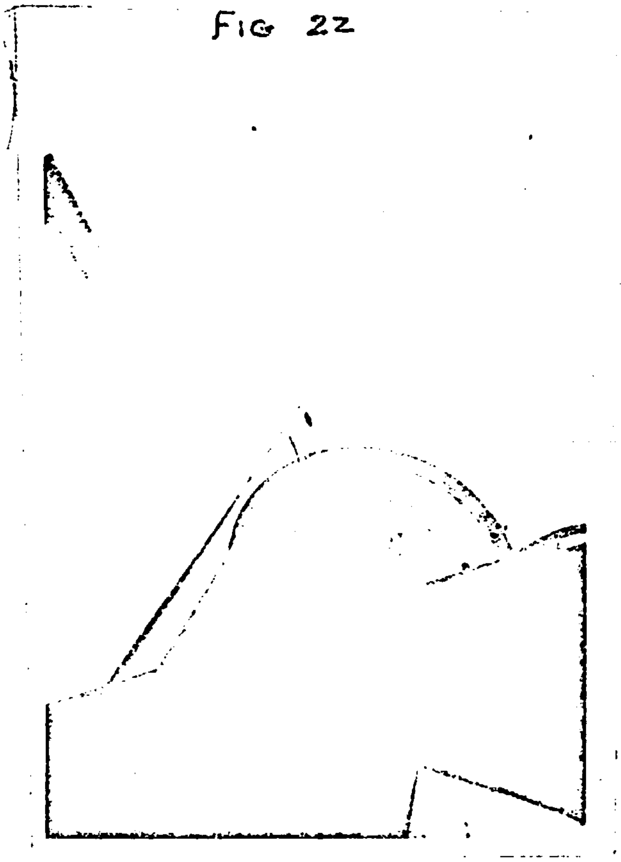


FIG No 22.

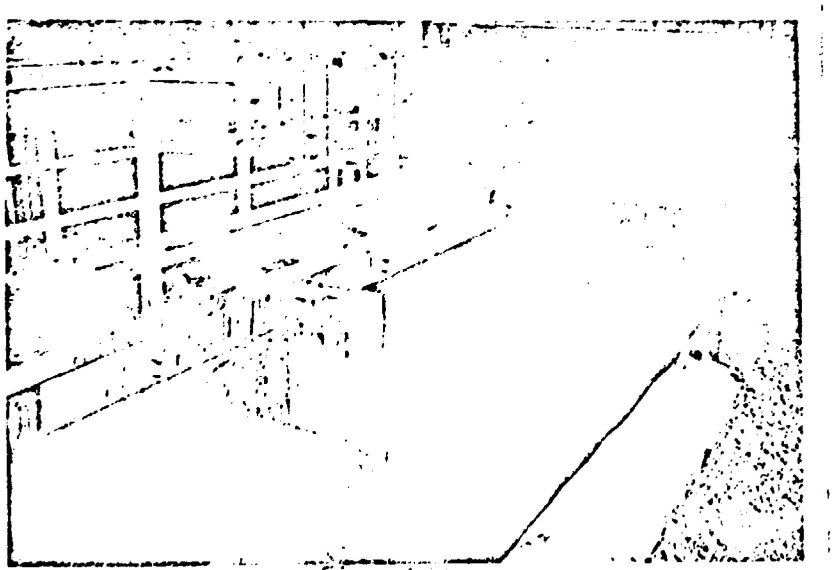


FIG 23

FIG. No. 23

APPENDIX VII (CONT.)

NOTES:-

1. FIG. NOS. 19 and 22 show Urea dust discharge from prilling tower draft fan outlets.

2. FIG No. 20 shows CAN Dust discharge from evaporator and prilling tower.

3. FIG No 21 and 22. show oil and grease escaping from separators in liquid effluent plant.

Refer Text
on discharges from differrent units.
Sections. 4.4.2 to 4.4.6.