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REVAMPING OF THE FERTILIZER PLANT OF THE SOCIETE INDUSTRIELLE ET CHIMIQUE DU NORD DE LA GRECE

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I. - INTRODUCTION

The SICNG fertilizer plant was built and started in 1966, according to the PECHINEY-ST GOBAIN process. The production target was of 200,000 t/year of ammonium sulphate-phosphate (16.20.0), which amounts to a production rate of 26 t/h.

In order to meet the increasing fertilizer consumption in Greece, which has doubled in 20 years and to reduce the production costs at the same time, the company has had to carry out a series of conversions of the plant.

The progressive revamping of the plant, carried out with the technical assistance of the company AZF, has enabled:

1. The capacity to be increased: the current production possibilities exceed 500,000 t/year, which amounts to a production rate of approximately 70 t/h, with instantaneous rates of 80-100 t/h depending on the formulae.

2. The yields to be increased: for the range of raw materials considered as a whole, the yields are of 97 to 98%.

3. The quality of the finished product to be improved: particle size grains, suitability for binding.

4. The formulae produced to be diversified: binary NP - 16.20 - 20.10 - N.P.K. - 11.15.15S - 15.15.15 - 12.24.12S -

PK - 00.20.255.

5. The production costs to be reduced: by diversifying the raw materials used, by increasing the production rates and by reducing fuel consumption.

II. - INITIAL EQUIPMENT OF THE COMPLEX FERTILIZER PRODUCTION PLANT

According to the original process, the plant consisted of the following equipment:

Reaction part:

2 ammoniation tanks in series, 17 m^3 and 13 m^3 respectively in size, with gravity flow of the slurry to a granulator-ammoniator Ø 3.25 m - length 6.3 m.

Cleansing ensured by a cyclone column type gas scrubber, supplied with industrial water or with phosphoric acid.

Granulation loop - drying:

It consisted of:

1 dryer of Ø 4 m - length 31.6 m, supplied with fuel oil combustion gas, with oven and sealed connecting chamber.

Total gas flow rate through the drier of 180,000 m_3/h, ensured by two fans arranged downstream of the cyclones and before the "Air-Mix's".

Primary screening, with 4 vibrating screens each containing 2 tiers 9 m^2 in size.

Coarse grinding, with 4 three-cylinder grinders.

Material handling equipment (elevators - transporters) for a total delivery of 300 t/h.

Cooling and finishing the commercial product

18 m^2 fluidized-bed cooler, arranged along the circuit of the commercial product leaving the screens.

1 2-tier 9 m^2 finishing screen.

III. - MODIFICATIONS INTRODUCED TO THE PLANT

Since 1974, two average-sized modifications were introduced to the plant:

The first consisted in replacing the 13 m^3 neutralization tank with a 78 m^3 tank, the aim being the possibility of producing TSP.

The second, carried out from 1974 to 1978, consisted in modifying the cleansing circuits for the gaseous effluents, either on the gases leaving the drier, by the installation of 2 batteries of bag filters with an area of 4,000 m^2, or for the treatment of the vapours and the gases of the neutralization tanks, by replacing the original column with a polyester scrubbing column, with neutralization with phosphoric acid.

The most important modifications of the plant which were of a real revamping nature, were introduced since 1981. In order to reduce plant stoppages to a minimum these modifications were carried out in stages.

1. - Complete replacement of the gas scrubbing system

A new gas scrubbing system was planned, built and started up in 1981, with the collaboration of the company AIR-INDUSTRIE.

The equipment installed consists of two scrubbing sections:

a) One for scrubbing the gases leaving the reaction tanks and the granulator.

b) One for the treatment of gases leaving the dryer.

The design of equipment was based on the following operating parameters:

	Cleansing, granulator and neutralization tanks	Cleansing gases from the dryer
Temperature	100°C	110 to 120°C
NH_3	500 kg/h	500 kg/h
F^-	200 kg/h	3 kg/h
H_2O	51,750 kg/h	20,400.-
Air	37,100.-	137,000.-
Dusts	1,000.-	1,300 kg/h (after cyclones)

Equipment installed

Cleansing granulator and tanks:

At the outlet of the granulator, the equipment consists of the following items in series:

1 Venturi type scrubber
1 scrubbing column

The gases leaving the column are then directed to the entry to the scrubbing system which treats the gases coming from the neutralization tanks.

This system consists of 2 columns in series, of the cyclone tower type with spraying in layers and no packing.

The two scrubbers are supplied with a sulphuric acid solution as a scrubbing additive.

Removal of droplets at the outlet of the first scrubbing column is ensured by a demister. An identical device is installed at the outlet of the second column, in order to avoid droplets being carried away in the gases discharged into the atmosphere.

Gas cleansing at the drier outlet

Two Venturi type scrubbers were installed at the outlet of the cyclones so as to reduce the dust load at the inlet of the scrubbing tower.

The latter is of the cyclone type with several stages of spraying.

Scrubbing liquid circuits

The pH of the scrubbing liquids of each column is adjusted with a small addition of sulphuric acid, in order to enable optimum ammonia absorption to be effected.

A methodic circuit enables the additional quantity of water to be limited to a minimum so that the ammonium sulphate solution resulting from the scrubbing of all the gases, could be reintroduced into the reaction-granulation loop, without affecting the water balance.

Plant guarantees and performance

For the whole cleansing system, the guaranteed levels of pollutants in the gases discharged to the atmosphere should be as follows:

NH_3 : 8 kg/h
F^- : 2.7 kg/h

Dusts: 6 kg/h

The values actually obtained are given in the table below:

Pollutant levels

Maximum values for the whole system

Component	Inlet kg/h	Outlet kg/h
NH_3	970	6.83
F^-	3.8	2.36
Dusts	300 to 400	6
Droplets	-	30 to 40

This modification has a very significant effect on the NH_3 yield of the plant. It increased from a value of between 92 and 93% to 97% after the installation of the new equipment.

2. - Modification of the burner-combustion chamber and connecting to the drier

Objectives:

Use of second grade heavy fuel, reducing the unburnt fractions at the same time.

Increasing the rate of heating.

Modification of the connecting chamber in order to provide the best operating conditions to the chute of the granulator-drier link.

The modifications consisted in:

1. - Replacing the 15,000 Th/h burner with mechanical

spraying, with a 15,000 Th/h burner with steam-assisted spraying, with a new adapted combustion chamber.

2. - In omitting the connecting chamber, the injection of hot gases into the drier being carried out with heat resistant steel injection nozzles.

Under these conditions, the chute of the granulator outlet is no longer subjected to heating. This leads to a minimum of clogging, with the effect of reducing considerably the stoppages caused previously by the frequent clogging of this chute.

The substitution of heavy fuel for light fuel which was used previously has resulted in a saving, which, at the present exchange rate (1 US$ = 145 Drs), is in the region of $ 30,000/year.

3. - Installation of a tubular reactor according to the AZF technique in the granulator

Despite the conversions made between 1964 and 1980, the plant capacity proved to be insufficient to meet market demands.

Therefore, following the advice of GESA, now AZF, it was decided to install a tubular reactor in the granulator in order to increase the instantaneous production rate to:

90 tonnes per hour of 16.20.0
70 tonnes per hour of 20.10.0

It should be noted that the granulation of the formula 20.10.0 at a rate of 40 t/h was difficult and as a result, the ammonia yield was poor.

With the existing plant, the ammonia consumption required for meeting the production targets was 17 to 18 t/h, which could not be achieved without significant loss of yield. The factors limiting production were as follows:

Difficulty of ammonia absorption of more than 8 tonnes per hour in the preneutralizer.

An excessive amount of water introduced into the slurry.

Granulating problems with the formula 20.10.0.

Drying problems.

A significant increase in ammonia losses.

Atmospheric pollution problems (fluorine and ammonia).

Based on their experience in the design and use of tubular reactors in many of their plants, GESA proposed the installation of a tubular reactor in the granulator, which would enable the sulphuric acid and the phosphoric acid to be neutralized simultaneously by ammonia. This reactor, the largest to be built by GESA at the time, had a neutralization capacity of ammonia of 9 t/h.

Description of the equipment used

Tubular reactor:

It was designed for the following rates of supply:

22 t/h of 95% strength sulphuric acid
9 t/h of liquid ammonia
37.5 t/h of 28% strength P_2O_5 phosphoric acid

Investment figures

In 1982, the total costs covering licensing fees, purchasing material and the installation thereof was $400,000.

Results obtained

Acceptance trials of the plant were carried out in May 1982 over a period of about fifteen days.

The guaranteed capacities, 90 t/h of 16.20.0 and 70 t/h of 20.10.0 were achieved without difficulty.

Total ammonia losses in the reaction system (tank-tubular reactor-granulator) were 7.2%, whereas the guaranteed value was 10% for the formula 20.10.0.

The possibility of operating with the tubular reactor alone was also tried and this gave very satisfactory results. The plant can therefore be managed with a very high degree of flexibility.

The achievement of a product which is dryer at the outlet of the granulator and the increase in the production rate also manifested themselves in a significant reduction in fuel consumption. Especially in formula 20.10.0, the fuel consumption was reduced from 23 kg/t to a value of between 5 and 10 kg/t.

In conclusion, after over four years of operation, it can be asserted that the installation of the tubular reactor has enabled considerable progress to be made in the operation of the plant.

4. - Complete overhauling of the fertilizer finishing loop

Because of the increase in capacity compared with the original capacity, the need for a complete review of the finishing chain of the fertilizer before being sent for storage, soon became apparent.

The storage of a product of heterogeneous particle size (presence of a significant amount of fine particles <1 mm) when it is hot (temperature $> 70^{\circ}C$) led to caking. This had the following consequences:

Need for using a mechanical shovel to level the heaps.

Insufficient screening of the product before packing.

Return of a significant amount (5 to 10%) of the product, to the granulation plant.

In order to rectify these shortcomings and to improve the quality of the finished product, the following items of equipment were installed:

1 new 120 t bucket elevator, carrying the commercial product from the primary screen outlet.

1 new 2-tier vibrating screen, each tier representing a screening area of 14 m^2, upper cut of 4 mm and lower cut of 2 mm.

Screening efficiency of 95%, with a view to obtaining a particle size of 2 to 4 mm for 95% of the finished product.

It should be noted that since the product is not cooled before its arrival on the screen, the latter functions at a temperature of the order of $100^{\circ}C$.

1 fluidized bed cooler according to the specification laid down by AZF and designed to ensure the cooling of 100 t/h of NP or NPK fertilizers from $95^{\circ}C$ to a temperature of $\leqslant 30^{\circ}C$.

It consists of 3 chambers and its total surface area is 34.2 m^2.

The fluidization and the cooling are ensured by 3 centrifugal fans of capacity 82,000 m^3/h.

The hot gases leaving the first table are, after partial removal of dusts, recycled as diluting air at the oven outlet.

The hot air leaving the second and third chambers is directed to an NH_3 evaporator, where it is cooled, before being reintroduced into the air stream created by the fans. The gaseous ammonia produced as a result is consumed in the neutralization tanks, in substitution for liquid ammonia.

The total heat recovered in this way is estimated at approximately 2,000,000 kgCal/h.

1 new coating device, 3 m in diameter and 7.5 m long, was installed with the related circuits, for the storage, preparation, dispensing and injection of solid and liquid coating substances.

Profit-earning capacity of the modification carried out

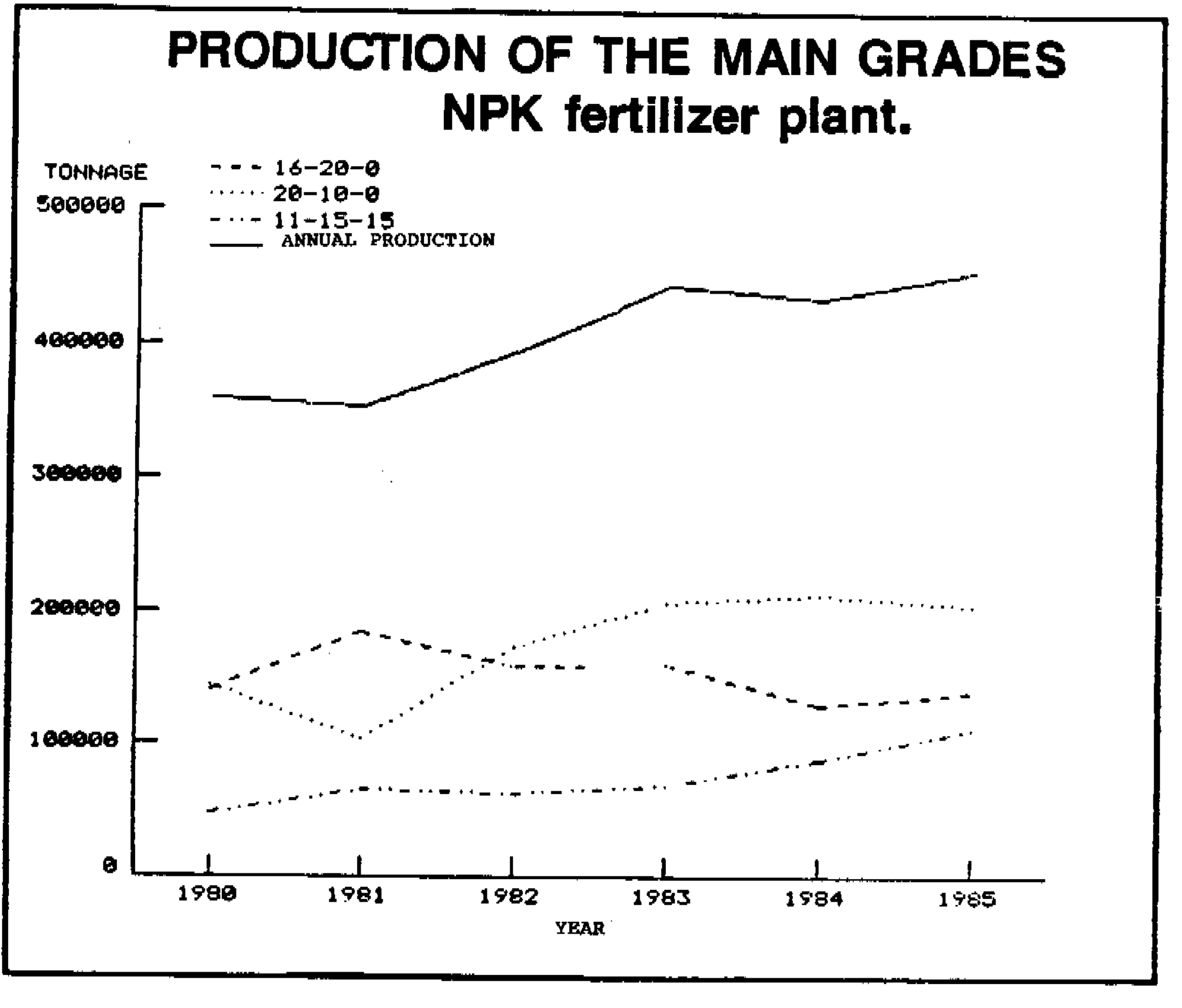
In addition to the improvement of the quality of the product offered to clients, the new plant is profitable in the following respects:

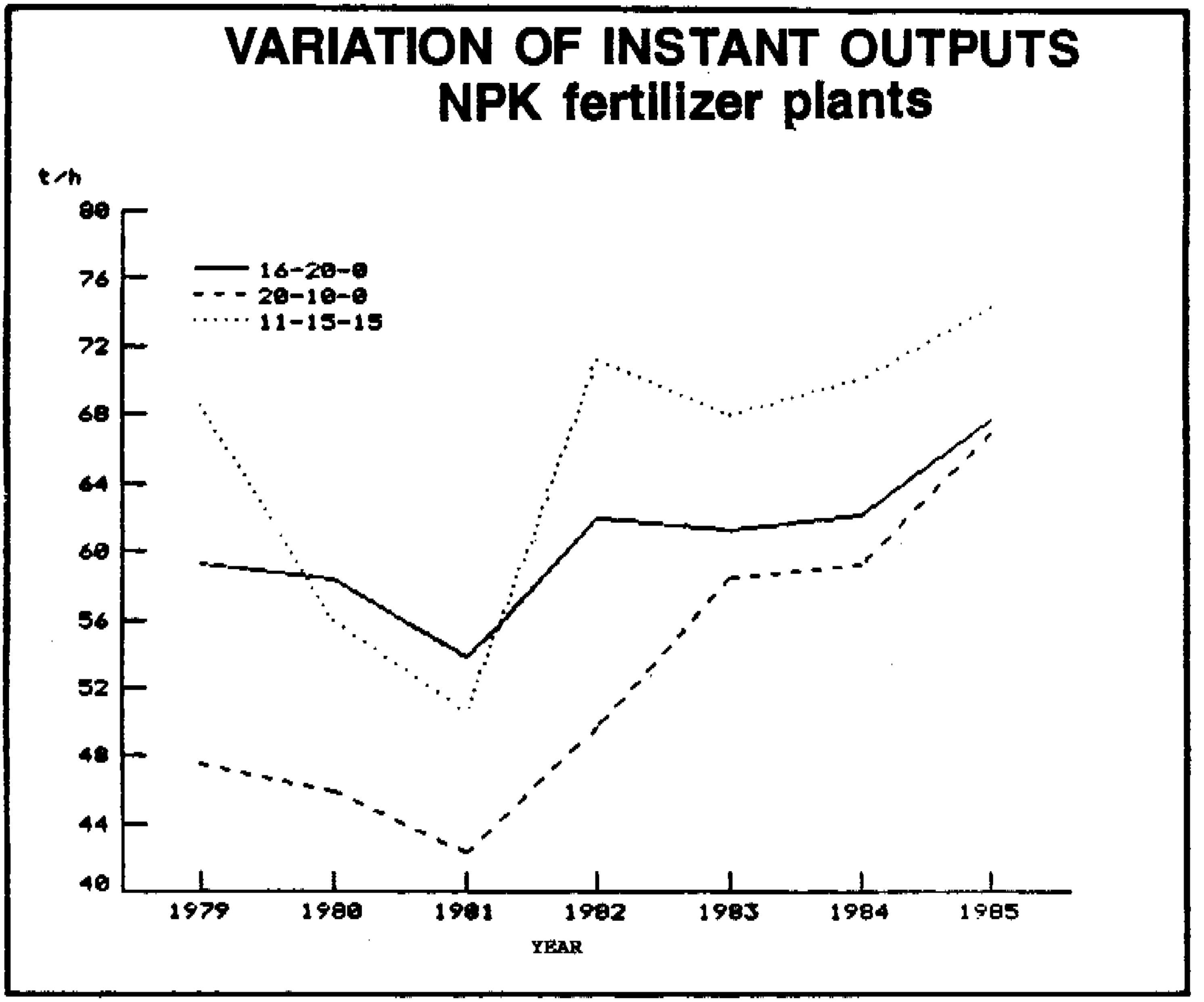
Heat recovery from the hot air, especially from the first chamber. It amounts to a minimum saving of 500 t of fuel per year.

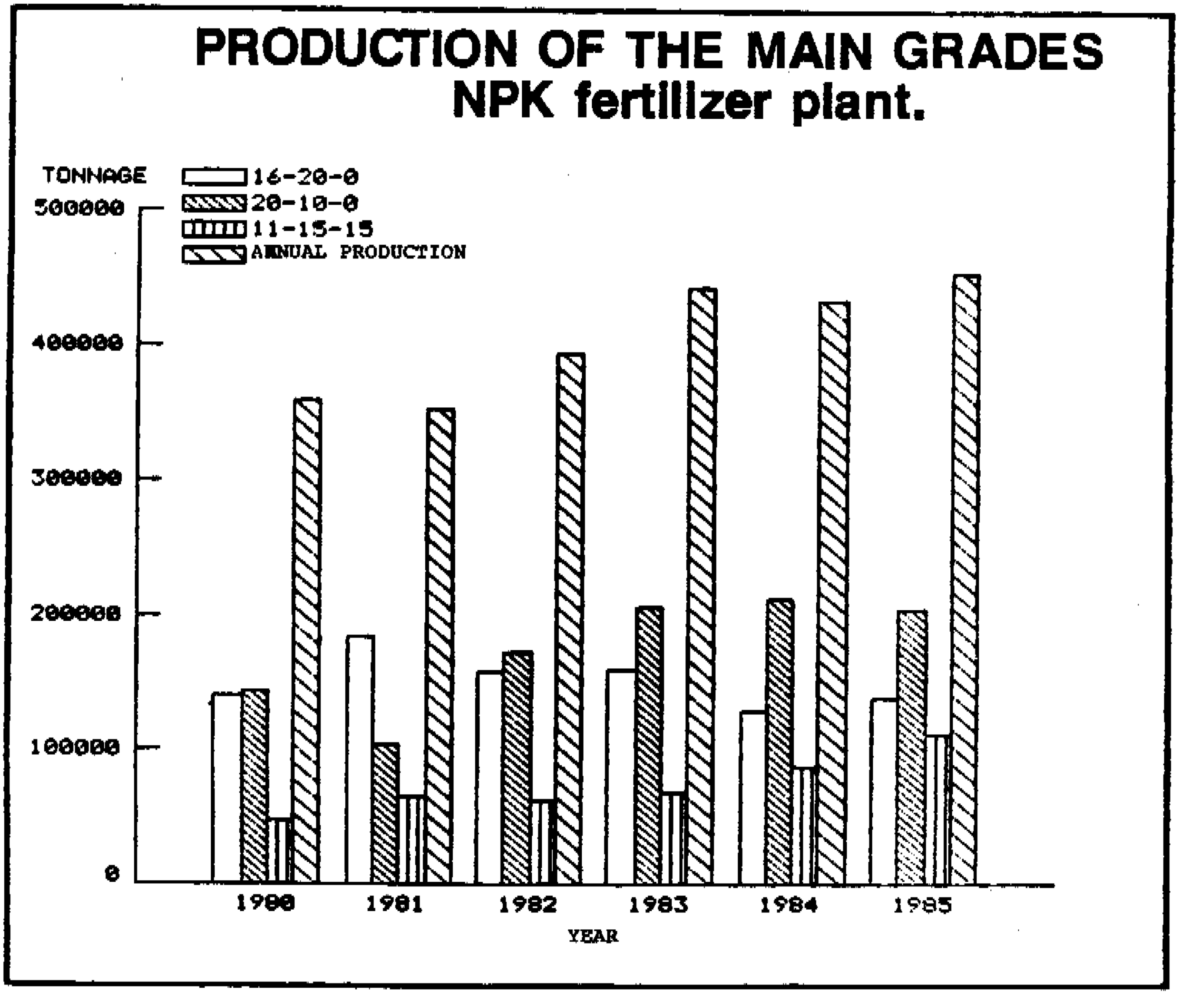
Evaporation of ammonia, for supplying to the reaction tanks. Based on a mean evaporation rate of 3 t/h, gas saving for the concentration of phosphoric acid may be estimated at 2 t/h.

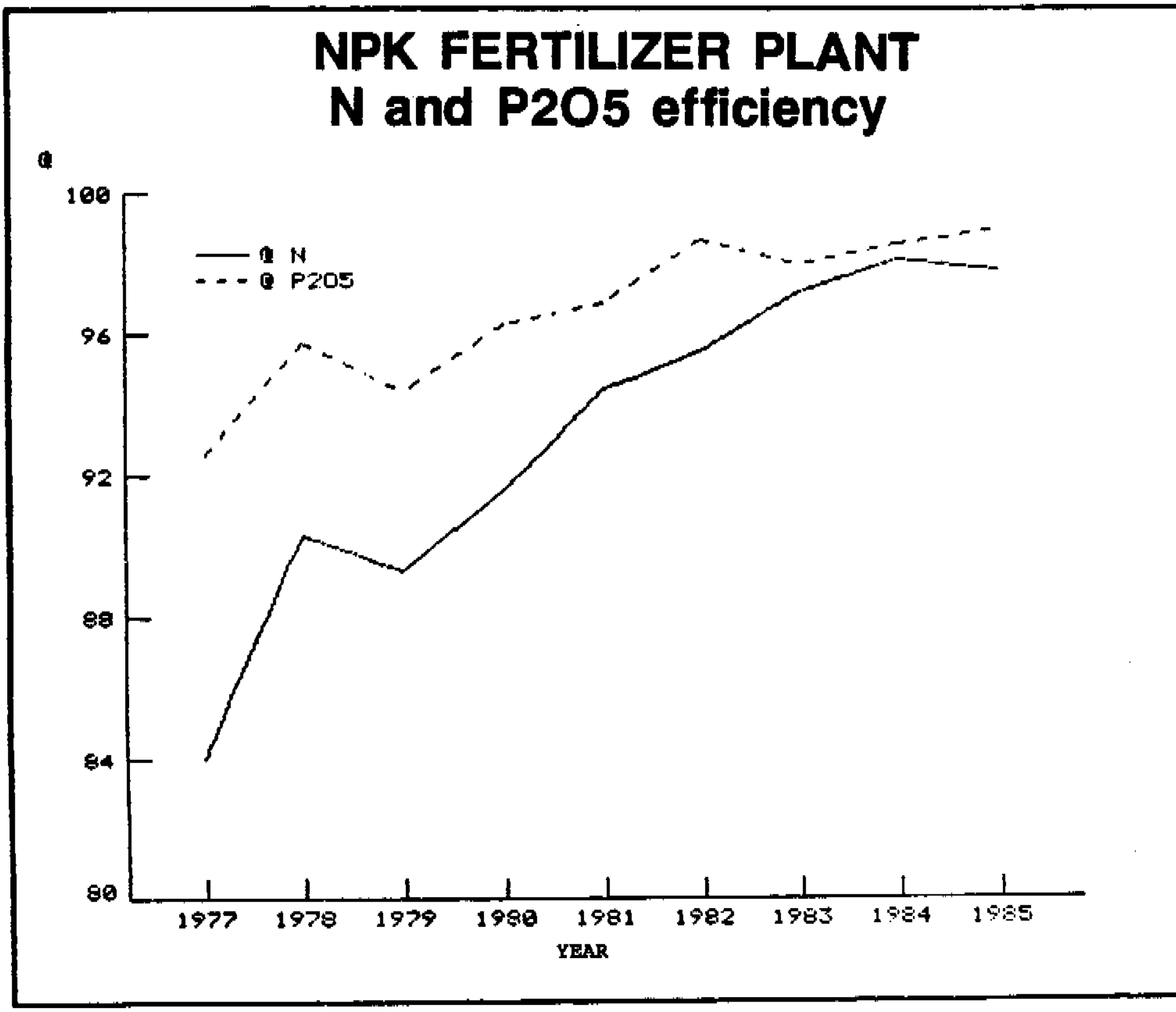
The decrease in the screening rejects in the fertilizer conditioning plant, enables savings to be achieved in the handling costs and makes it possible to increase the annual production capacity of the granulation loop, which is estimated at 5% in the case of the SICNG plant.

On completion of these modifications, the installation of a tubular reactor at the dryer inlet as well, in order to improve the plant performance, is planned by the plant.

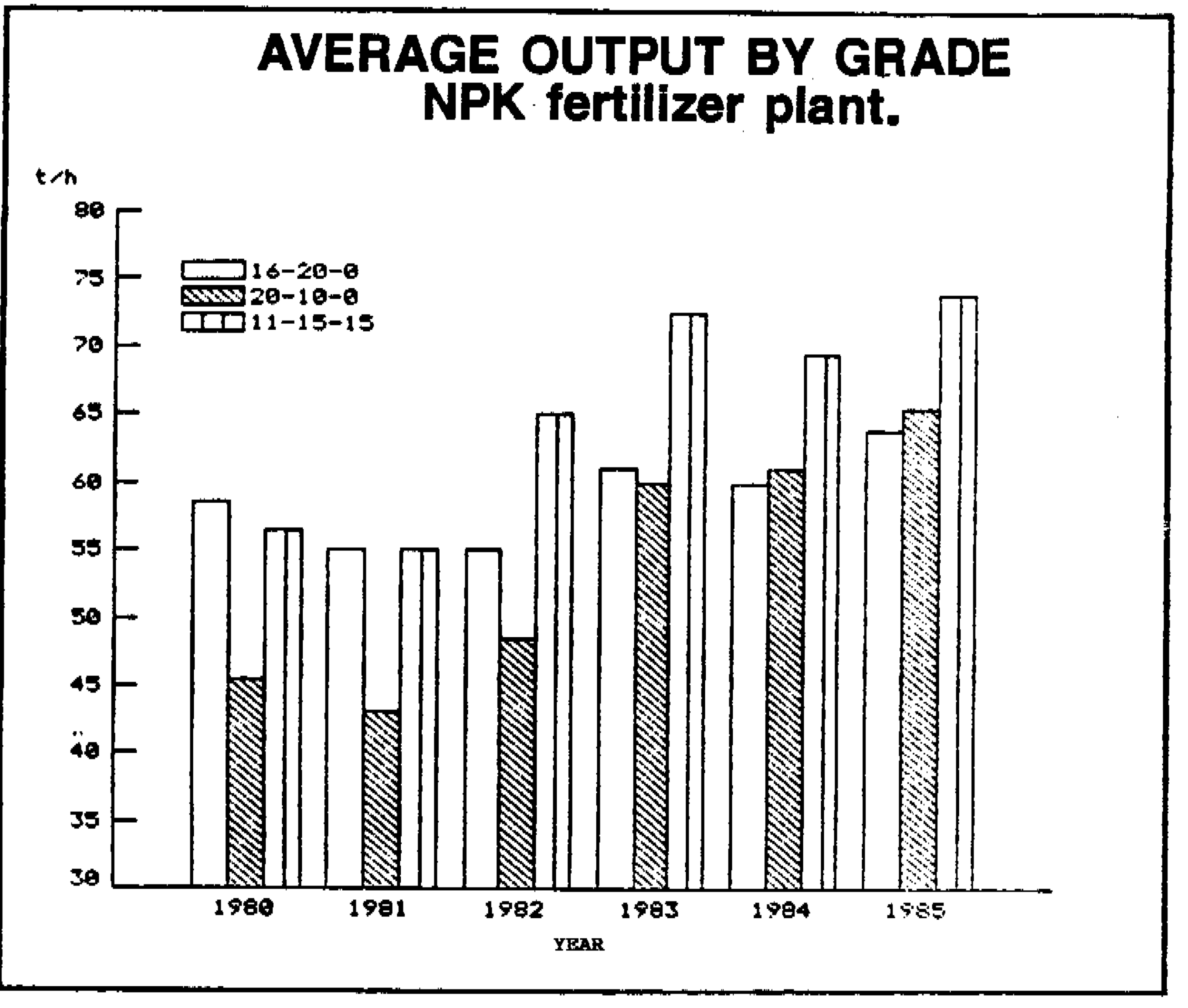

PRODUCTION OF THE MAIN GRADES
NPK fertilizer plant.
TONNAGE
16-20-0
20-10-0
11-15-15
ANNUAL PRODUCTION
500000
400000
300000
200000
100000
0
1980
1981
1982
1983
1984
1985
YEAR

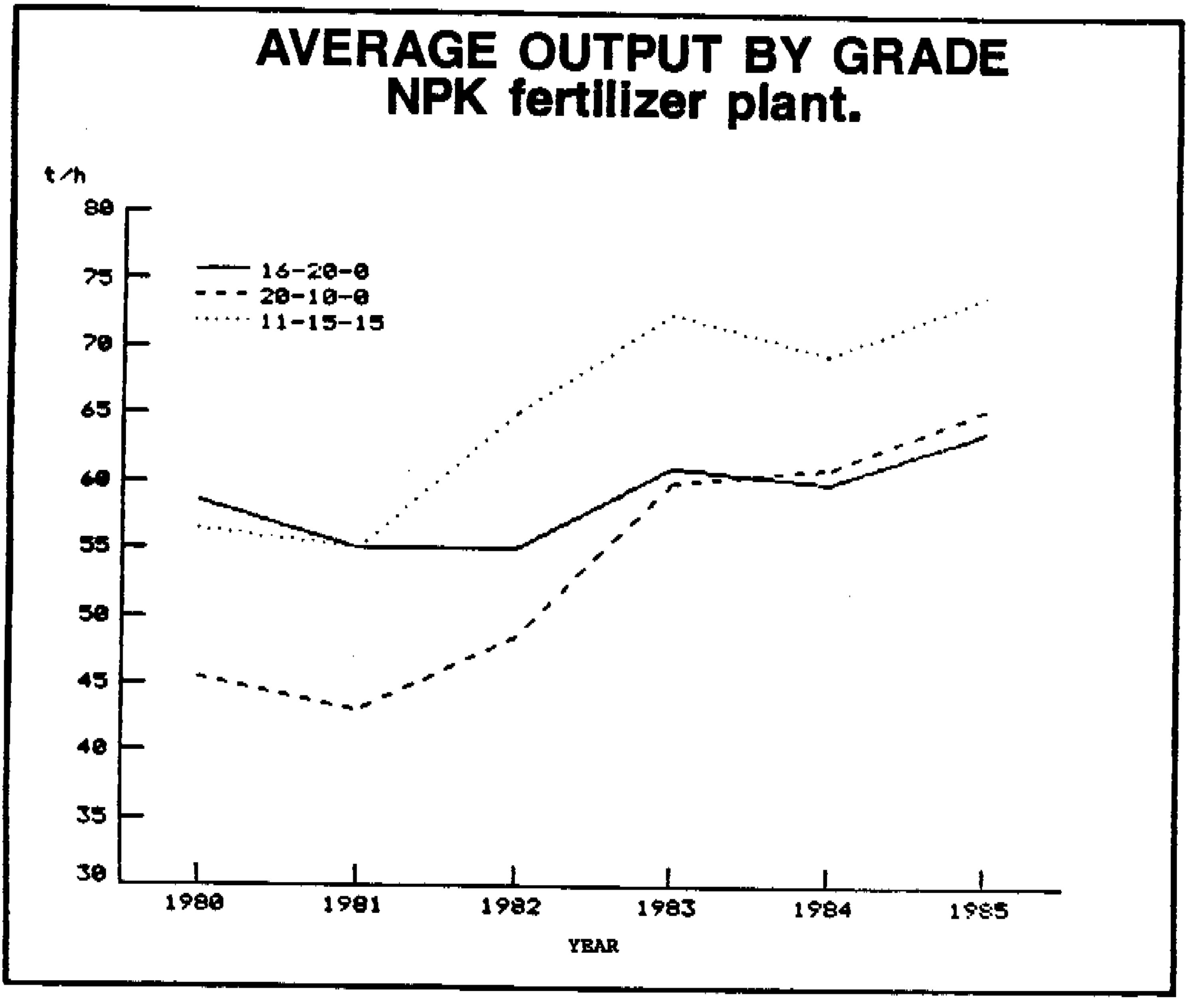

VARIATION OF INSTANT OUTPUTS
NPK fertilizer plants
t/h
80
76
72
68
64
60
56
52
48
44
40
16-20-0
20-10-0
11-15-15
1979
1980
1981
1982
1983
1984
1985
YEAR

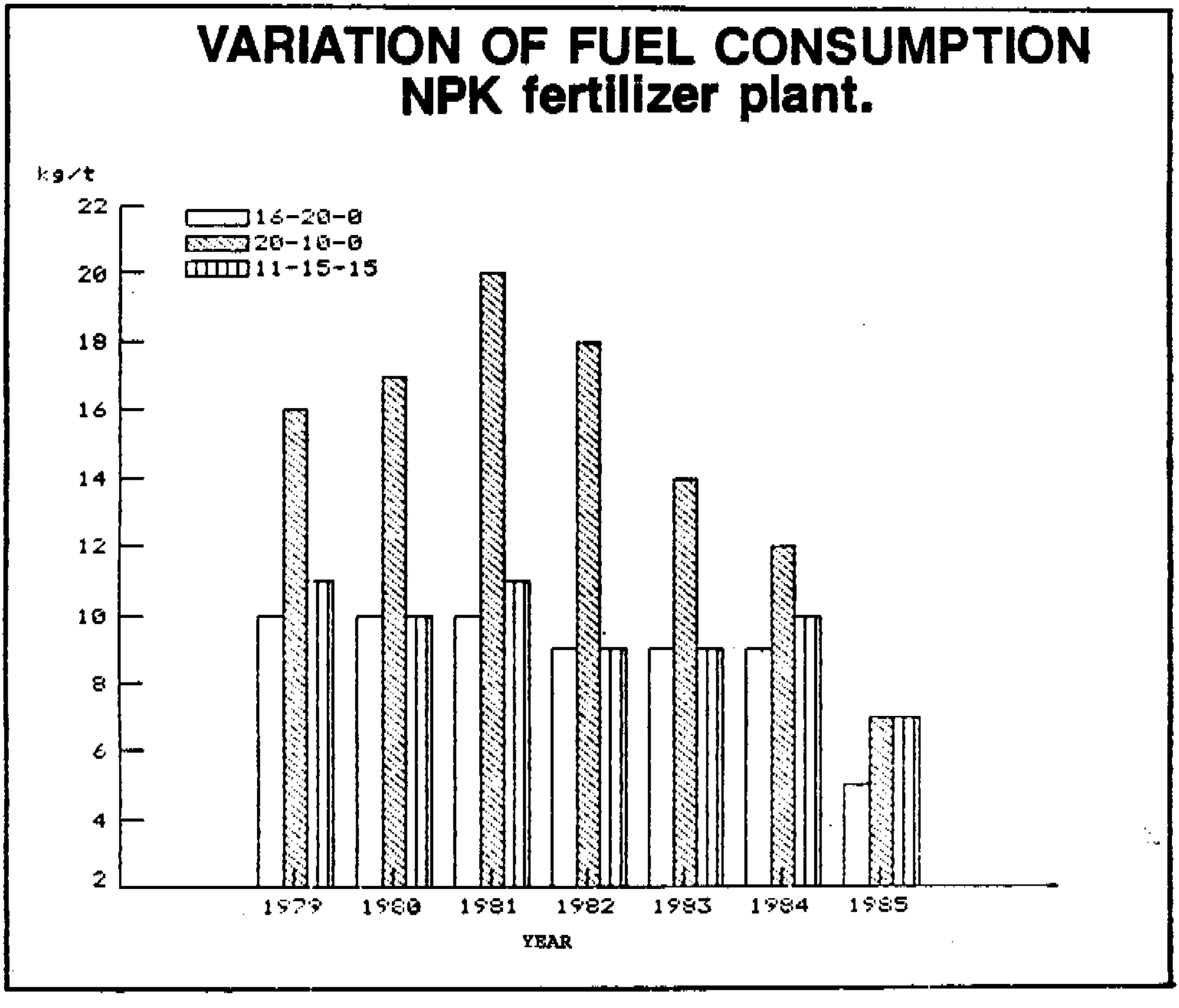

PRODUCTION OF THE MAIN GRADES
NPK fertilizer plant.
TONNAGE
16-20-0
20-10-0
11-15-15
ANNUAL PRODUCTION
500000
400000
300000
200000
100000
0
1980
1981
1982
1983
1984
1985
YEAR

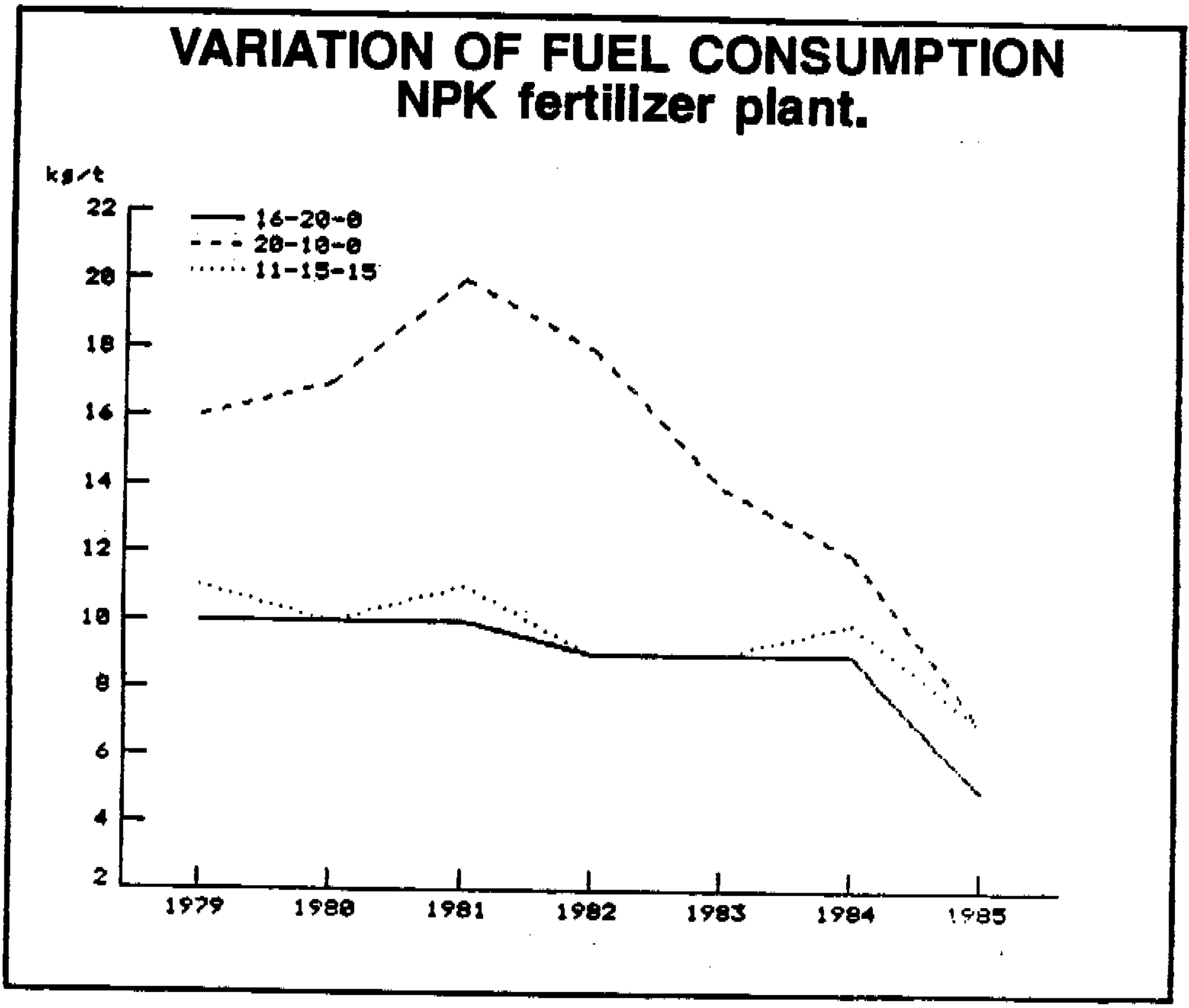


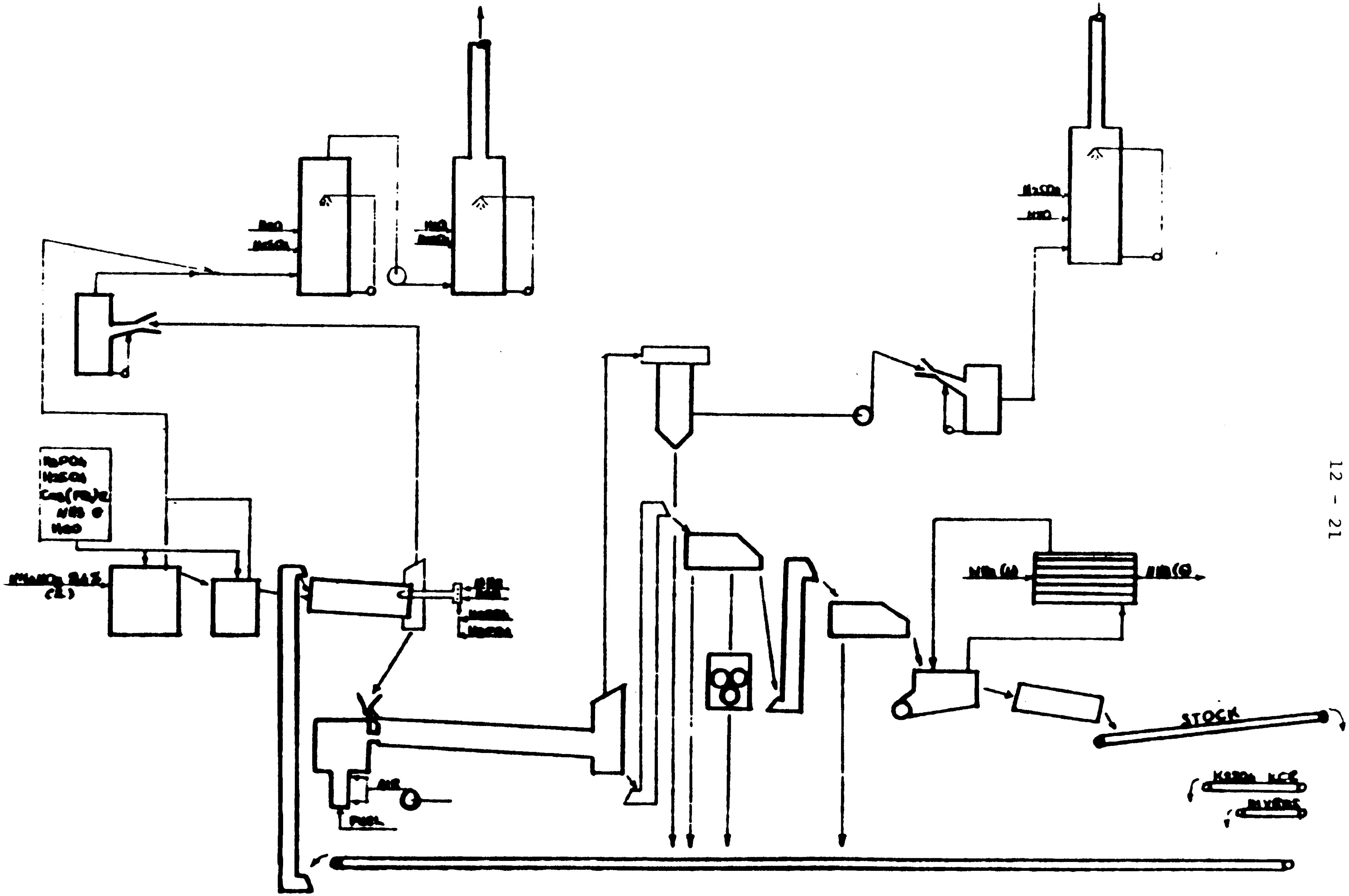
NPK FERTILIZER PLANT
N and P2O5 efficiency
%
100
96
92
88
84
80
% N
% P2O5
1977
1978
1979
1980
1981
1982
1983
1984
1985
YEAR


AVERAGE OUTPUT BY GRADE
NPK fertilizer plant.
t/h
80
75
70
65
60
55
50
45
40
35
30
16-20-0
20-10-0
11-15-15
1980
1981
1982
1983
1984
1985
YEAR

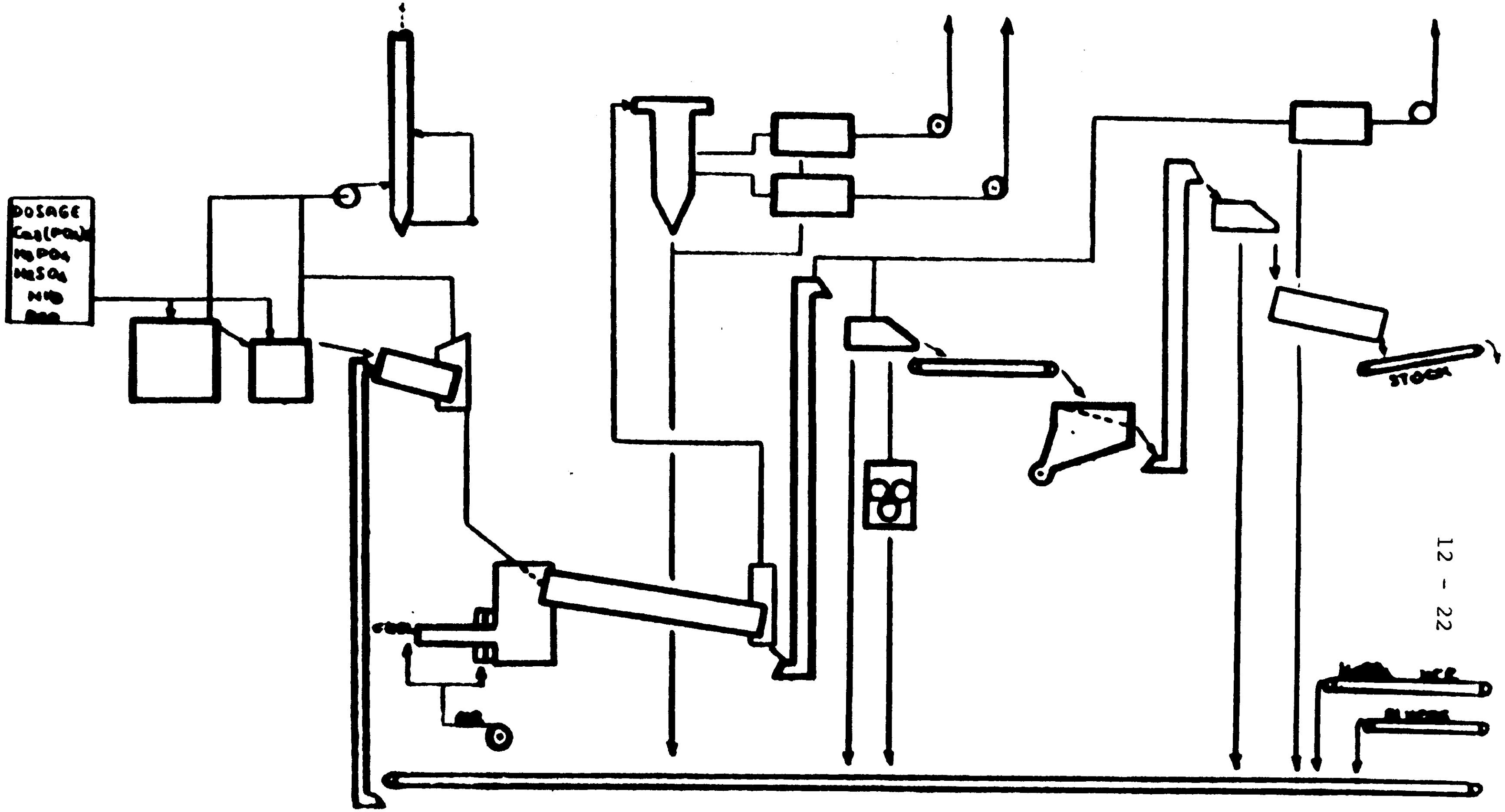

AVERAGE OUTPUT BY GRADE
NPK fertilizer plant.
t/h
80
75
70
65
60
55
50
45
40
35
30
16-20-0
20-10-0
11-15-15
1980
1981
1982
1983
1984
1985
YEAR


VARIATION OF FUEL CONSUMPTION
NPK fertilizer plant.
kg/t
22
20
18
16
14
12
10
8
6
4
2
16-20-0
20-10-0
11-15-15
1979
1980
1981
1982
1983
1984
1985
YEAR

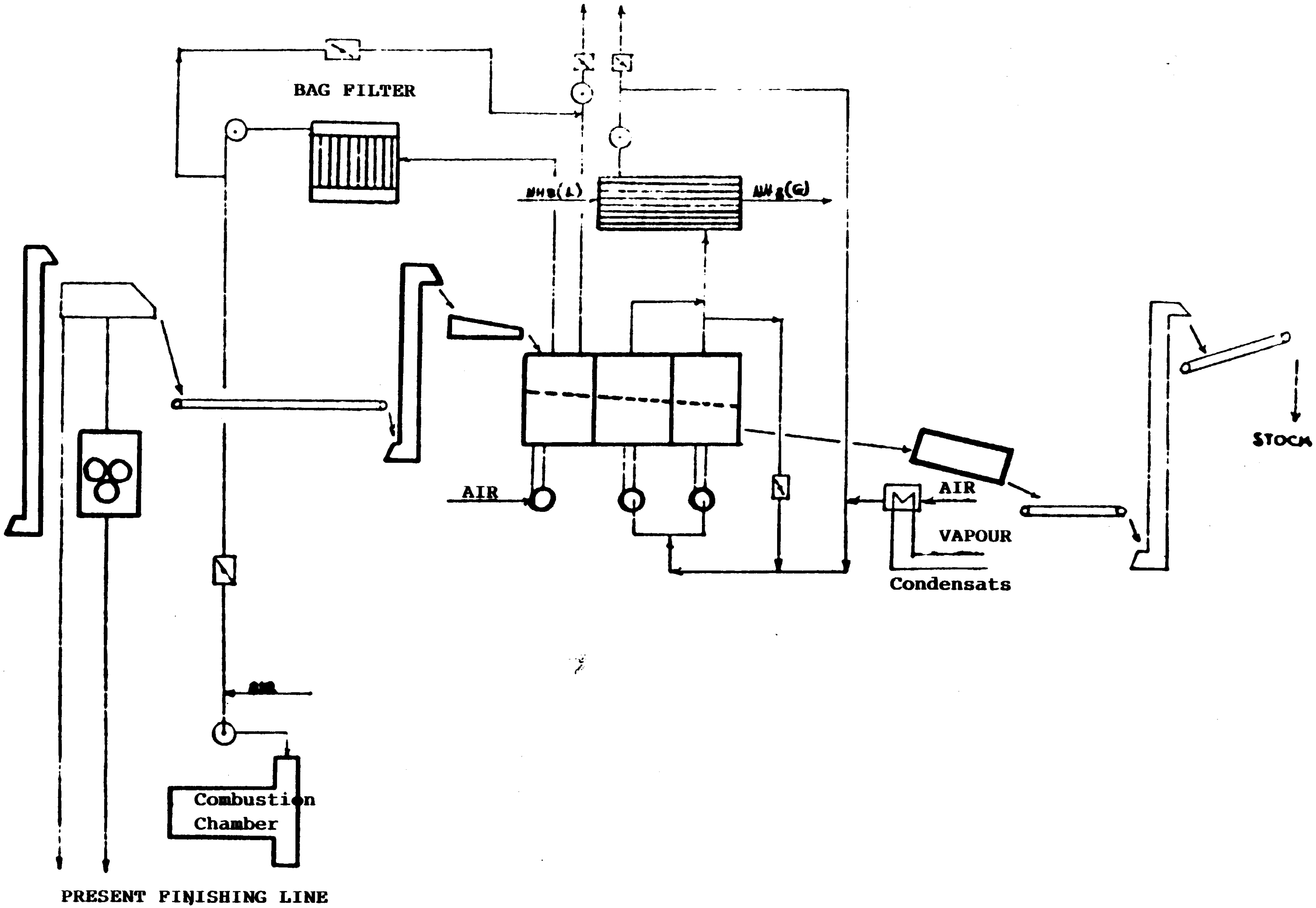

VARIATION OF FUEL CONSUMPTION
NPK fertilizer plant.
kg/t
22
20
18
16
14
12
10
8
6
4
2
16-20-0
20-10-0
11-15-15
1979
1980
1981
1982
1983
1984
1985

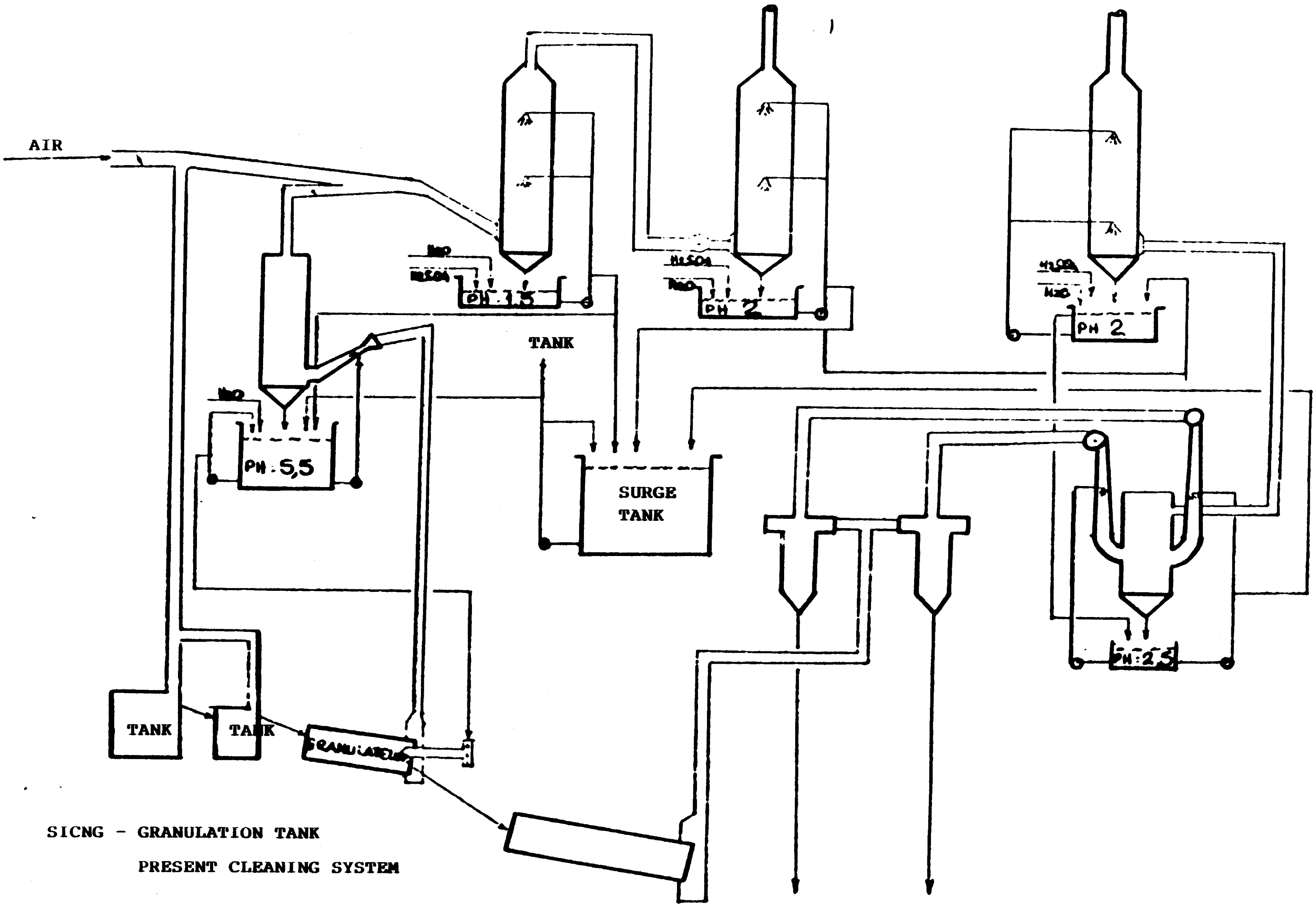


SICNG- Granulation plant
Present process flowsheet



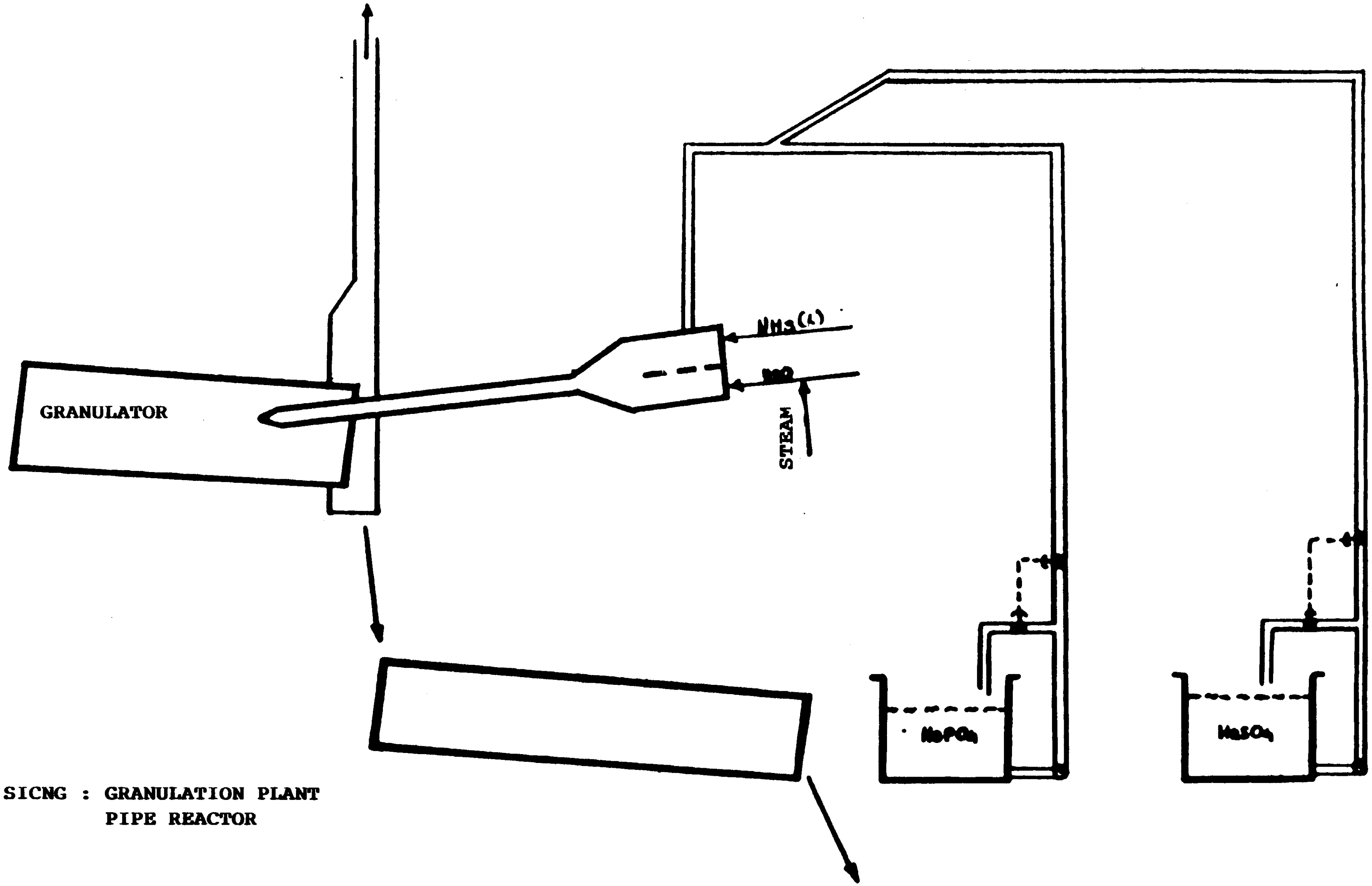
SICNG - Granulation plant
Process flowsheet before transformation


BAG FILTER
NH3(L)
NH3(G)
AIR
AIR
VAPOUR
Condensats
STOCK
Combustion
Chamber
PRESENT FINISHING LINE



SICNG - GRANULATION TANK

PRESENT CLEANING SYSTEM



SICNG : GRANULATION PLANT
PIPE REACTOR

TA/86/12 Revamping of the fertilizer plant of the Société Industrielle et Chimique du Nord de la Grèce by
A. Constantinidis, J. Laine & D. Bellis, SICNG, Greece

DISCUSSION : (Rapporteur T. Loyer, COFAZ SA, France)

Q - Mr. P.T. LAMMI, Kemira Oy, Finland

1. What is the electricity consumption in your process (expressed in kwh/t product)?

2. How do you measure emissions of pollutants in the stack?

A - 1. 2,200 kwh for the production level indicated.

2. The operational staff monitors the pH of exhaust gases from the scrubbing towers and the laboratory does periodical analyses.

Q - Mr. M. BARLOY, SCPA, France

Does the NH3 content of gases emitted from the plant, indicated on page 4, take mist entrainment into account?

Are you satisfied with cyclogalax with regard to clogging and efficiency?

A - Gas control was carried out during the production of NPK and NP formulations.

The comparison of formulations with and without potash gives an indication of the importance of mist entrainment.

The cyclogalax does not induce substantial mist entrainment, nor droplet fall-outs in the vicinity of the plant, nor clogging.

Q - Mr. B. CHRISTENSEN, Superfos, Denmark

1. How could the substitution of heavy fuel for light fuel result in an annual saving of $ 130,000?

2. How often does the ammonia dusty air exchanger require cleaning?

A - 1. There is an error in the paper; the annual saving is only $ 30,000.

2. We encountered problems of dedusting the air leaving the first fluidized bed and, hence, problems of scaling in the ammonia evaporator. This plant is recent and we are considering improving dedusting.

Q - Mr. J.M. BIRKEBAEK, Superfos, Denmark

1. Can you describe in more detail the results obtained with bag filters?

2. Did you try to reduce the load of bag filters, which seems high (250 m3/h/m2)?

A - 1. There is no problem of load: the filters can be clogged by moisture when the plant stops. Filters should be heated during stops.

We decided to replace the dry filters, only effective for solids and ineffective for gases, by scrubbers.

2. The amount of air is 180,000 m3/h for 8,000 m2.