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PRACTICAL ASPECTS OF FERTILIZER PRODUCTION AND ENVIRONMENTAL CARE

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Abstract

Today environmental care has to be understood in a broader context than some years ago.

As stated in our Life Cycle Analysis, major part of environmental impacts appear in the phase of the use of fertilizers. About 80% of total impact is there (Pictures 1-4).

Nevertheless the environmental impacts of fertilizer production phase are still:

Of public interest
Under authority control
Subject to strict control of the site and plant operational management

This presentation has a double focus:

1. Project EFMA and Kemira Agro-wide benchmark viewpoint
2. Use Siilinjärvi, Finland, as a good example of a well designed set of several operating plants constructed in phases over 1968-1991.

Siilinjärvi Site

Overall in Europe and in Finland as well, the present environmental legislation is younger than the oldest operating sites. That is why the historical burden of the old site, its soil, processes and people's behavior are expensive to correct.

The Siilinjärvi site as an entity was set up with extensive care thus having been born under lucky stars. The slightly older site, Uusikaupunki, faced newcomers' problems which have been costly to correct. It is not a big surprise that the site of high environmental performance is very cost effective as well. The European Fertilizer Manufacturers' Association (EFMA) keeps benchmark of all operating plants in terms of emissions and costs.

Siilinjärvi site and its processes are in full EFMA-BAT-1995 compliance and is well positioned in terms of cost and emission benchmarks.

The NPK plant by using Kemira reactor system and by-products of the local mine operations is very cost-efficient.

Environmental awareness of the company's personnel varies by country. Kemira Agro has launched a Health, Safety and Environment (HSE) programme which focuses on environmental safety and EFMA-BAT compliance in mid-range time from the beginning 1998 in the Siilinjärvi site, the whole personnel is very well environmentally motivated.

Kemira Group has internal engineering company which can provide proprietary know-how of environmental review, elaborate pollution prevention plans and make detailed process design including scrubbers and other abatement techniques.

[1] *Paper presented at the IFA Technical Sub-Committee and Committee Meeting, 15-17 September 1999, Novgorod, Russia*

How to cope with site history today? The biggest issues determining a balance sheet are:

1. Contaminated soil
2. Sensitive site location
3. Unclear water collection system
4. Old processes and weak pollution prevention systems

Overwhelmingly the biggest issue normally is the old large soil contamination, which has been detected recently. Kemira now conducts in all its acquisition an extensive soil study and leaves, if possible, its own liability at minimum with pre-transfer contract.
Prevailing bookkeeping rules demand clearly the disclosure of obvious financial burden. Certain insurance practices can be used.

When an originally remote plant becomes encroached by a surrounding neighbouring city, the site location becomes sensitive. That situation tests operational practices and demands less fugitive emissions and other pollutions, e.g., like noise.

The Siilinjärvi site was constructed in 1968 at a remote, sensitive area.

It is in the eastern part of Finland. An extensive study was carried out to ensure the soil quality not to deteriorate by nutrient leaching to pollute a nearby lake that is very sensitive to phosphate and nitrogen. The design requirement leads to site water control system where all

The soil is of moraine and clay and has very low water permeability
Rainwater of the site area is collected by bunds
Site frontiers are provided with control dikes
Groundwater purity is monitored with deep control wells
Only gypsum pile and phosphoric acid plant area waters are collected into dedicated nitrogen free system which can purified with lime
The water system of the NPK plant and bagging unit is fully closed and no process water leaked to the sea.

The present set of production units are:

Phosphate mine and concentrator
Phosphoric acid plant
Sulphuric acid plant
Nitric acid plant
NPK plant

The current water balance is:

Input	
Rainfall	620 000 m^3/annum
Raw materials +process	150 000
From other plants	80 000
	850 000
Output	
Gypsum pile	320 000 m^3/annum
Evaporation	230 000
Products	130 000
Chemical treatment	170 000
	850 000

The gypsum pile has been separated from surroundings with a special design.

The NPK plant process and the area water input and output must be well in balance. The dedicated pond and presently tank reservoir act as a long term buffer and emergency protection.

After 30 years operations of Siilinjärvi units, one can say that all four requirements were met, understood properly and already taken fully into account in design phase of the site and processes.

Finland's first operating fertilizer site, Uusikaupunki, constructed few years before Siilinjärvi was less successful in the early operating years. The gypsum pile was poorly protected; water runoff, and process waters from the plants sometimes overflowed to the sea and caused, in early operating years, notable alga formation. Gradually the gypsum pile protection was improved and now the surrounding sea is again in its original state.

Kemira Agro has faced some soil contamination cases when it acquired certain European fertilizer companies. The future remediation liability has been avoided by pre-transfer contract with previous owners of the sites.

Minimizing Environmental Impacts of Fertilizer Processes

In Siilinjärvi all processes constructed had to comply with the following requirements:

- The air emission shall not cause any damage to sensitive, mostly coniferous, trees. The critical substances in that respect are SO_2, NO_2, fluorine and ammonia.
- The processes separately and collectively have to cope with water balances round the year.

For the environmental process design (Picture 5), Kemira Agro has implemented its proprietary techniques:

- Kemira NPK process
- Kemira Engineering's scrubbers for NPK and phosphoric acid
- Double contact design for sulphuric acid plants

And the best available techniques (BAT) for:

Ammonia
Nitric acid NO_2 abatement, mostly using selective catalysis

On comparison the current environmental legislation in Finland is fairly extensive and the limits set by the authorities are tight on an international scale. In recent years the protection of Baltic Sea has created HELCOM (Helsinki Commission) in which the multinational body has set up quite binding recommendations for the fertilizer industry. Siilinjärvi site complies well with both the local and HELCOM requirements.

The permit procedure in Finland is public, open and set up case by case.
That provides option for local people, interest groups, local university, etc., to participate in the permit process.

From environmental technology viewpoint the Siilinjärvi processes are:

- Mine and concentrator: no water and air pollution risks
- Sulphuric acid plants: double contact for SO_2, heat recovery with protected heat exchangers
- Nitric acid plant: selective catalytic NO_2 abatement
- Phosphoric acid plant: gypsum landfill, closed water cycle, fluorine scrubbers
- NPK plant: Kemira process provided with double phase scrubbers

NPK production and scrubber processes are well integrated in terms of:

- Water balance
- Nutrient recycle

- Solids separation and recycle

Pictures 6 and 7 show the Kemira NPK process.

EFMA - BAT comparison

Effective environmental care needs the right people

The cornerstones of Siilinjärvi site's environmental success are:

1. Right, proactive understanding of risks, future requirements all taken into account in original site and process design
2. Operating management adopted the absolute care from the beginning
3. All process operators were full informed on environmental care
4. Last but not least: environmental laboratory people are well educated, motivated and they have the right to ask reasons for deviation and to stop plant operating when having too high emission.

Quality management standard ISO 9001 has been implemented and ISO 14001, environmental management is under consideration.

EFMA, Kemira and Siilinjärvi Benchmark:

EFMA has carried out the review of its member companies emission levels and reports back confidentially. The review concerns all:

Ammonia plants
Nitric acid plants
AN/CAN plants
NPK plants
Urea & UAN plants

The emission levels are reported in graphs as emission (kg/ton) / capacity. Unfortunately the full review of the data is not possible here.

In 1995 EFMA produced booklets of "Best Available Techniques" (BAT) for the above mentioned processes: sulphuric acid, phosphoric acid, and two NPK (nitrophosphate and mixed acid) separately in 8 booklets

The work serves for EU's IPPC (integrated pollution prevention and control) on directive.

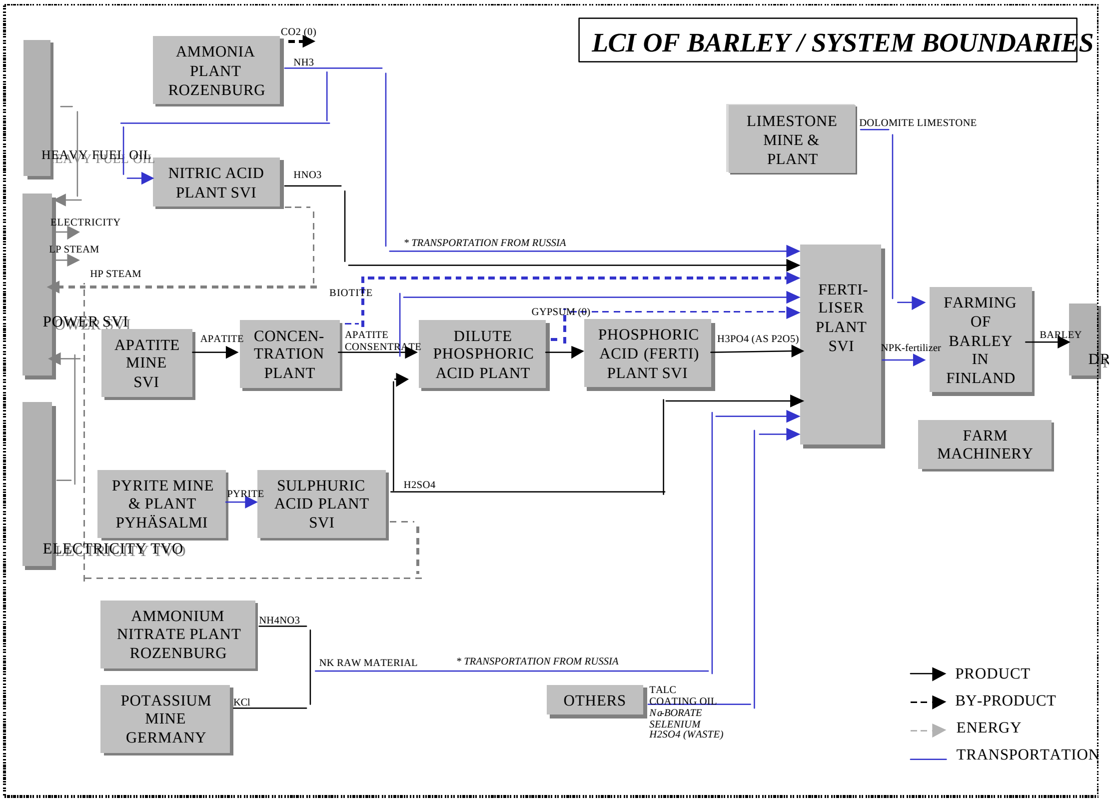
Some examples of BAT compliance:

Ammonia plants	-	36 units	BAT 0,9 kg NO_2/ t	60% compliance
Nitric acid	-	91 units	BAT 400 ppm NO_2	80% "
NPK	-	34 units	BAT 0,2 kg NH_3 /t	80% "

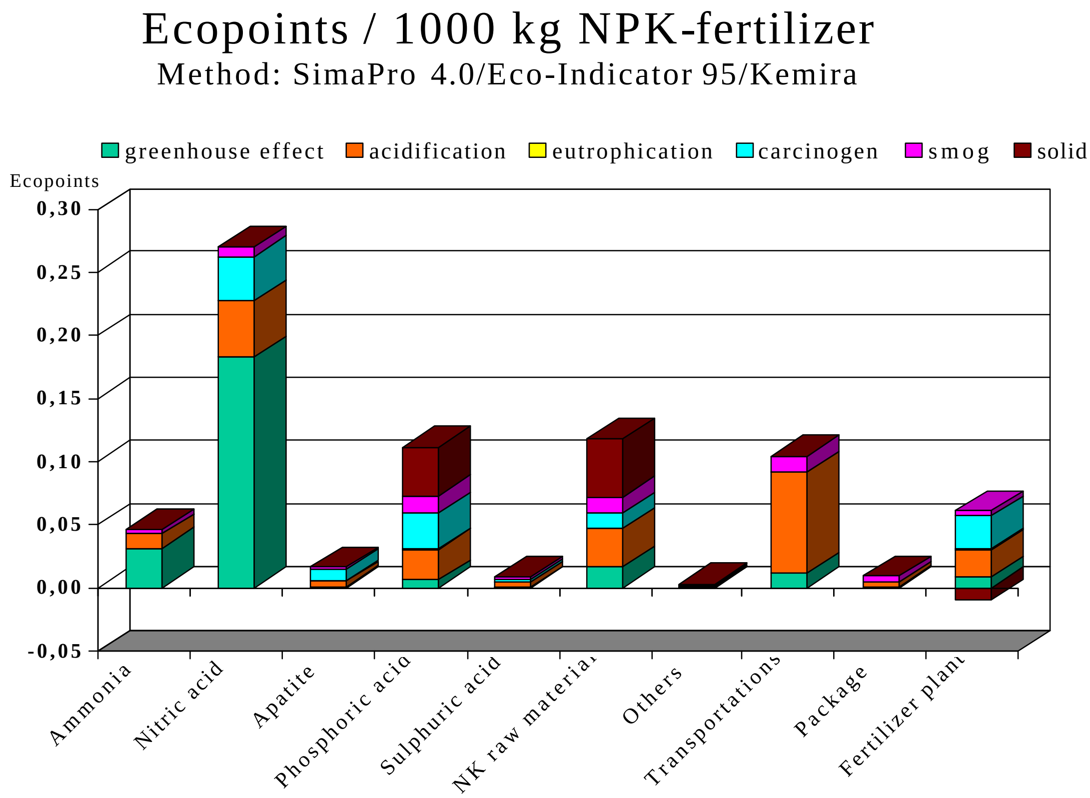
All booklets are available from EFMA. The revised work is near to completion and would be issued this year. In general, the booklets serve as good guidance for environmental process design.

Kemira Agro complies well with all BAT requirements. And all Finnish units comply 100% with the BAT levels.

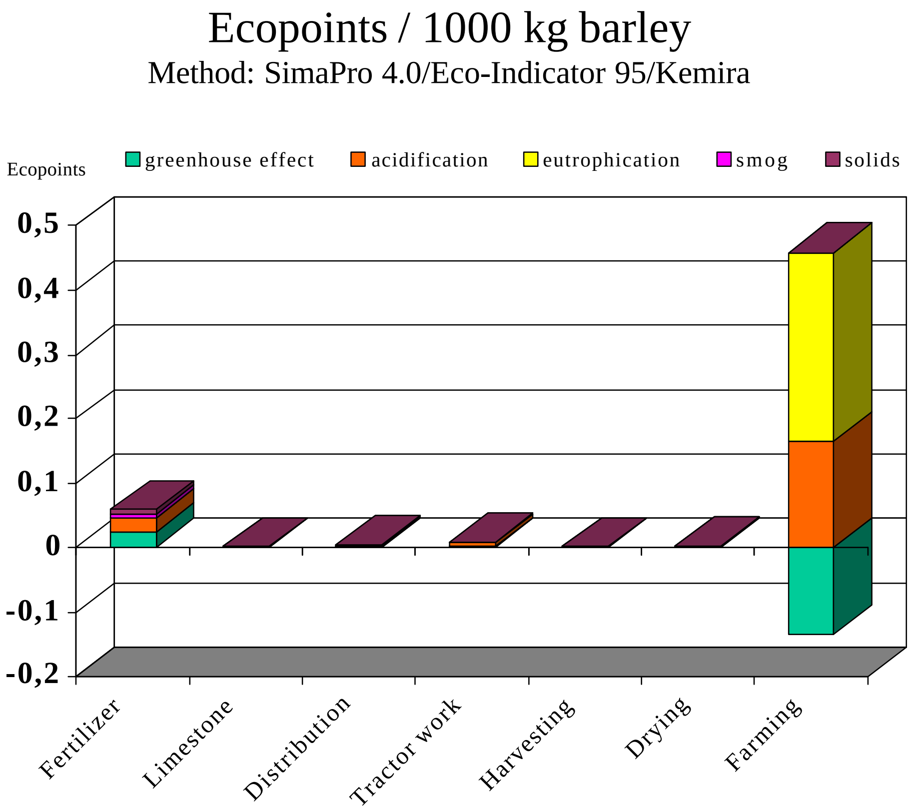
Picture 1


LCI OF BARLEY / SYSTEM BOUNDARIES
AMMONIA PLANT ROZENBURG
CO2 (0)
NH3
HEAVY FUEL OIL
NITRIC ACID PLANT SVI
HNO3
ELECTRICITY
LP STEAM
HP STEAM
POWER SVI
LIMESTONE MINE & PLANT
DOLOMITE LIMESTONE
* TRANSPORTATION FROM RUSSIA
BIOTITE
GYPSUM (0)
APATITE MINE SVI
APATITE
CONCEN-TRATION PLANT
APATITE CONSENTRATE
DILUTE PHOSPHORIC ACID PLANT
PHOSPHORIC ACID (FERTI) PLANT SVI
H3PO4 (AS P2O5)
FERTI-LISER PLANT SVI
NPK-fertilizer
FARMING OF BARLEY IN FINLAND
BARLEY
DR
FARM MACHINERY
PYRITE MINE & PLANT PYHÄSALMI
PYRITE
SULPHURIC ACID PLANT SVI
H2SO4
ELECTRICITY TVO
AMMONIUM NITRATE PLANT ROZENBURG
NH4NO3
NK RAW MATERIAL
* TRANSPORTATION FROM RUSSIA
POTASSIUM MINE GERMANY
KCl
OTHERS
TALC
COATING OIL
Na-BORATE
SELENIUM
H2SO4 (WASTE)
PRODUCT
BY-PRODUCT
ENERGY
TRANSPORTATION

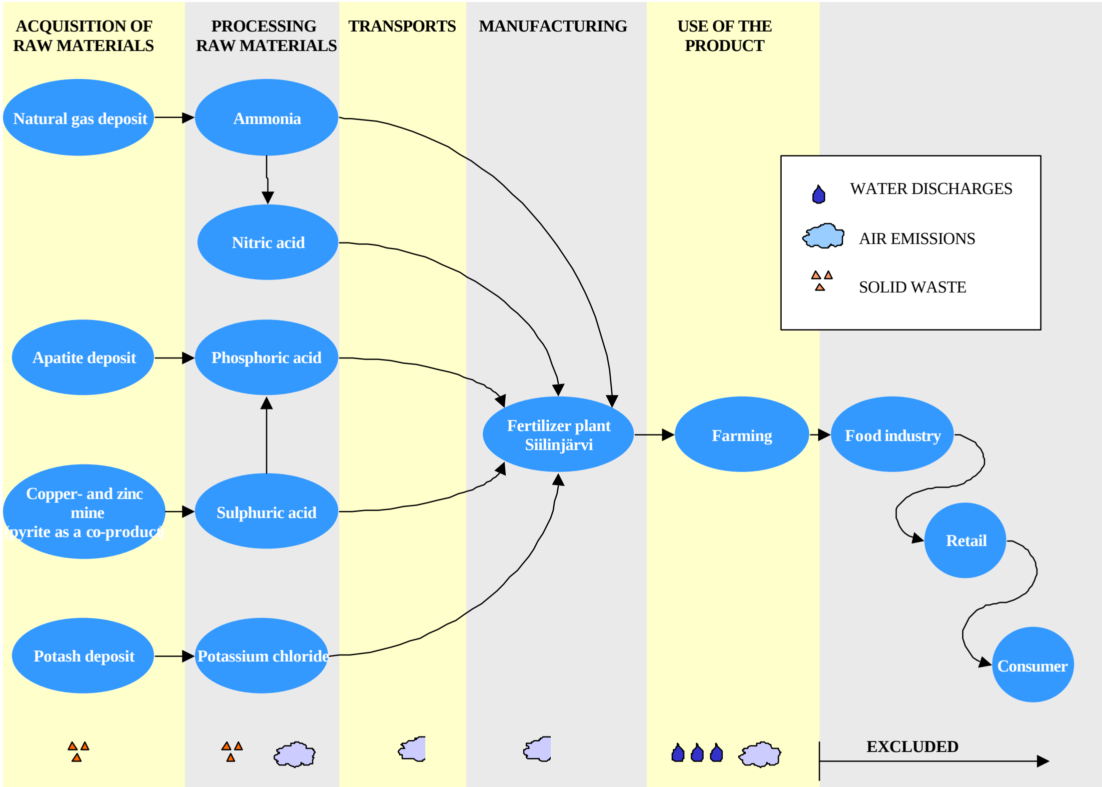
Picture 2


Ecopoints / 1000 kg NPK-fertilizer
Method: SimaPro 4.0/Eco-Indicator 95/Kemira
greenhouse effect
acidification
eutrophication
carcinogen
smog
solid
Ecopoints
0,30
0,25
0,20
0,15
0,10
0,05
0,00
-0,05
Ammonia
Nitric acid
Apatite
Phosphoric acid
Sulphuric acid
NK raw material
Others
Transportations
Package
Fertilizer plant

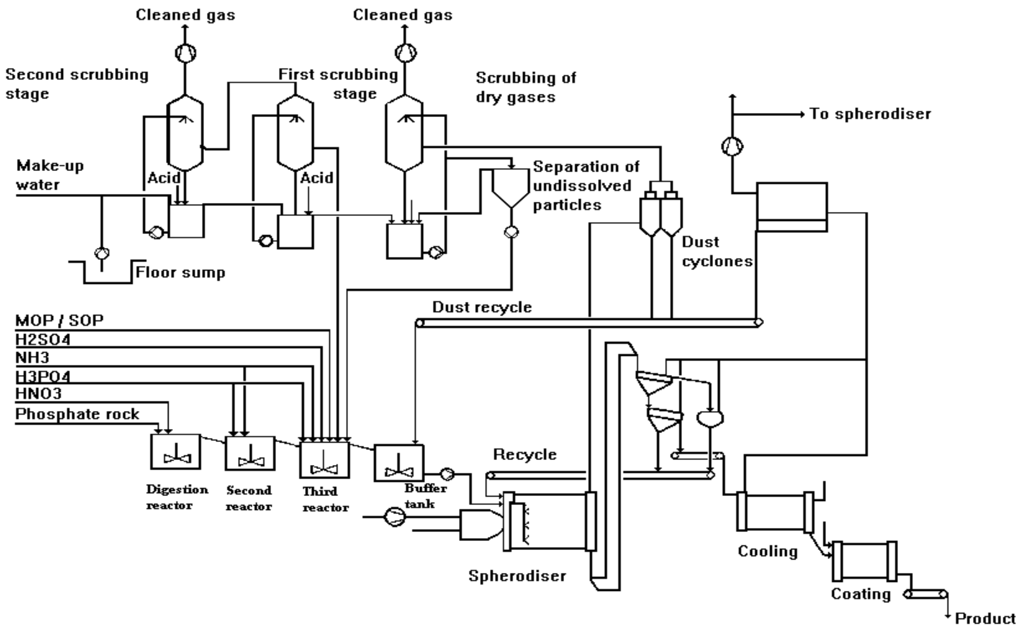
Picture 3


Ecopoints / 1000 kg barley
Method: SimaPro 4.0/Eco-Indicator 95/Kemira
Ecopoints
greenhouse effect
acidification
eutrophication
smog
solids
0,5
0,4
0,3
0,2
0,1
0
-0,1
-0,2
Fertilizer
Limestone
Distribution
Tractor work
Harvesting
Drying
Farming

Picture 4

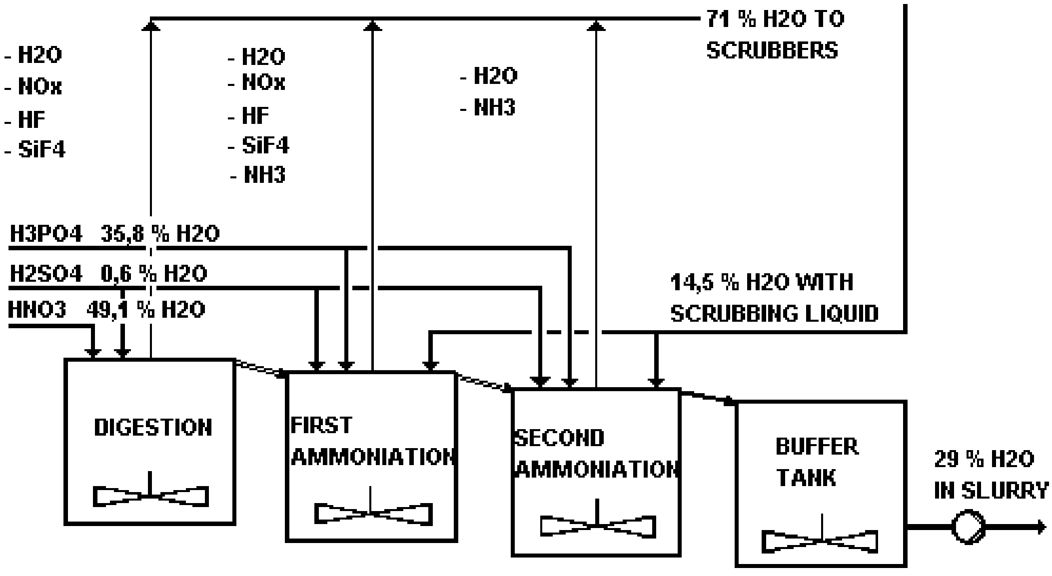

ACQUISITION OF RAW MATERIALS
PROCESSING RAW MATERIALS
TRANSPORTS
MANUFACTURING
USE OF THE PRODUCT
Natural gas deposit
Ammonia
Nitric acid
Apatite deposit
Phosphoric acid
Copper- and zinc mine
pyrite as a co-product
Sulphuric acid
Potash deposit
Potassium chloride
Fertilizer plant Siilinjärvi
Farming
Food industry
Retail
Consumer
WATER DISCHARGES
AIR EMISSIONS
SOLID WASTE
EXCLUDED

Picture 5



Cleaned gas
Cleaned gas
Second scrubbing stage
First scrubbing stage
Scrubbing of dry gases
To spherodiser
Make-up water
Acid
Acid
Separation of undissolved particles
Floor sump
Dust cyclones
MOP / SOP
H2SO4
NH3
H3PO4
HNO3
Phosphate rock
Dust recycle
Recycle
Digestion reactor
Second reactor
Third reactor
Buffer tank
Spherodiser
Cooling
Coating
Product

Picture 6


71 % H2O TO SCRUBBERS
- H2O
- NOx
- HF
- SiF4
- H2O
- NOx
- HF
- SiF4
- NH3
- H2O
- NH3
H3PO4 35,8 % H2O
H2SO4 0,6 % H2O
HNO3 49,1 % H2O
14,5 % H2O WITH SCRUBBING LIQUID
DIGESTION
FIRST AMMONIATION
SECOND AMMONIATION
BUFFER TANK
29 % H2O IN SLURRY

Picture 7

THE REACTOR WATER BALANCE 15-15-15

The water enters with the raw materials and leaves the through the stack. Along water mainly nitrogen oxides, components and ammonia enters to the nutrient recovery.