BALTIC COMPASS

REPORT

Conversion to manure concentrates, Kumac Mineralen

- Description of a case for handling livestock manure with innovative technology in the Netherlands

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Baltic Sea Region Programme 2007–2013

Conversion to manure concentrates, Kumac Mineralen - Description of a case for handling livestock manure with innovative technology in the Netherlands

Reference: Foged, Henning. 2011. Conversion to manure concentrates, Kumac Mineralen - Description of a case for handling livestock manure with innovative technology in the Netherlands. Published by Agro Business Park A/S, Tjele. 24 pages.

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1: Introduction

The Netherlands has the highest livestock intensity in the EU, equal to 226 kg N in livestock manure per ha agricultural land in average, and statistics says that there in addition to that is a consumption of 636 kg N per ha agricultural land in the Netherlands (Foged 2009). The following Figure 1 illustrates the situation on basis of figures from 2010.

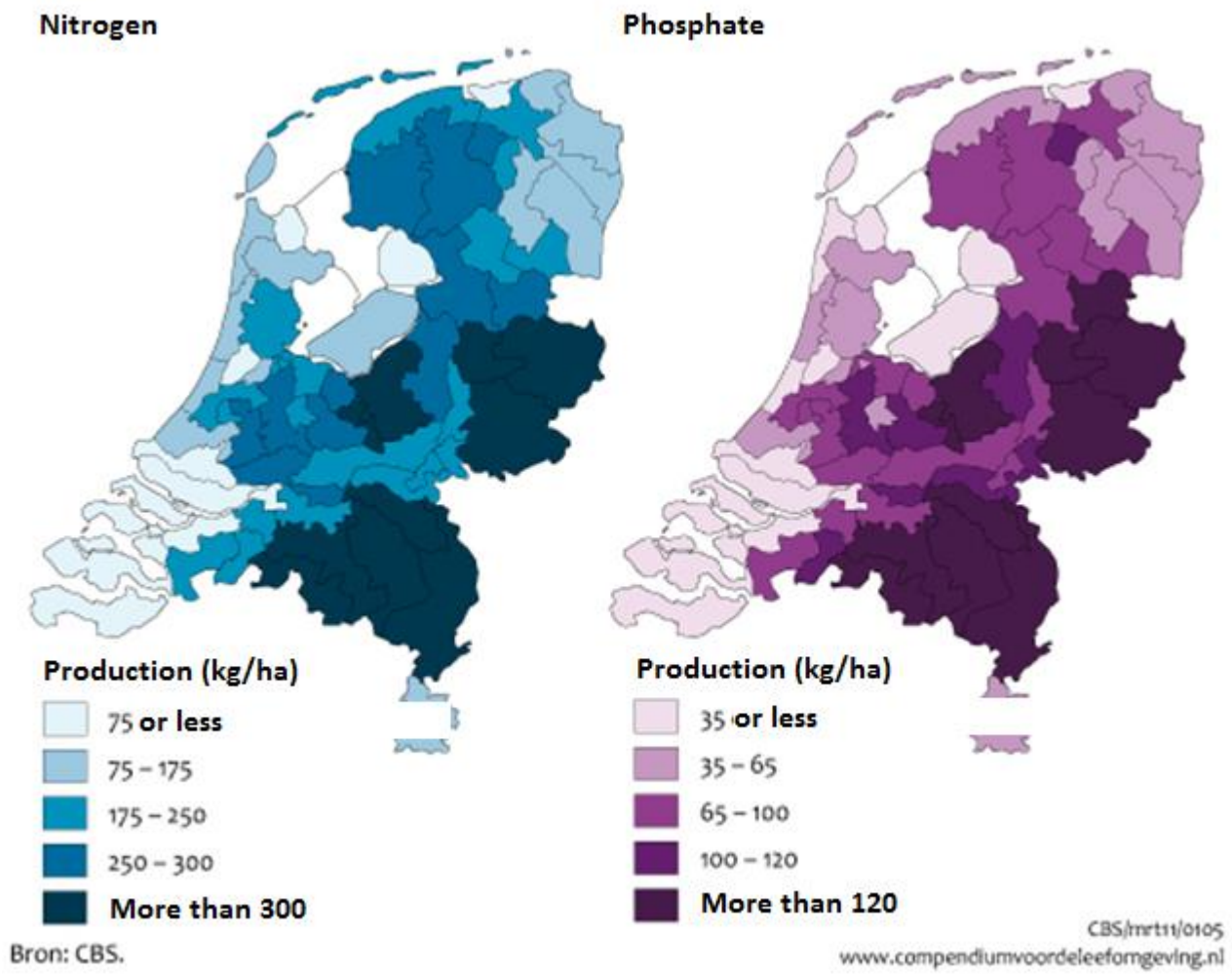

Figure 1: Production of N and P in the Netherlands distributed regionally.

The situation can only be maintained due to re-distribution and processing of the livestock manure, and because the Netherlands were granted a derogation from the Nitrates Directive, so that the spreading of livestock manure can be as high as 250 kg N per ha on cattle farms that use grazing, under strict conditions which are specified in the derogation decision[1].

[1] Commission decision 2010 / 65 / EU, OJ L 35, 6.02.2010, p. 18

The Kumac Mineralen is established in connection to the machine pool company Loonbedrijf Kuunders, who is involved in the transport business concerning livestock manure and has 10 trucks for that purpose.

Picture 1: Mr Kuunders runs a large machine pool, among other having 10 trucks for servicing farmers with transport of slurry.

Kumac Mineralen receives around 70,000 tonnes of pig slurry annually from 43 farms in the region. 70% of the received slurry is from production of fattener, the rest from sow units. Farms in the region normally pay 15 - 25 € per m^3 to dispose their slurry; the price is highest in the winter time because the manure then has to be loaded and unloaded (and also sampled / analysed) two times. In the Netherlands, livestock manure can only be spread in the period from 1 February till 1 September, wherefore it has to be kept in an intermediate storage during the winter time. Renting of intermediate storage capacity in the wintertime costs 4-5 € per tonnes (for the whole winter). Typically the slurry is taken to stores or farms in the northern part of Holland (app. 150 km away), while a part is pasteurised and exported, especially to Germany.

It should also be mentioned that the P content in the soils in the region is too high in relation to national legislation, which allow a maximum phosphorus balance of 70 kg per ha.

Loonbedrijf Kuunders is only dealing with field spreading activities in the local area. The received pig slurry holds a dry matter of about 8 %, which compared to pig slurry in many

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other countries is very high. The reason for this is the widespread use of wet-feeding systems in Holland, whereby dripping from drinking nipples is avoided.

The establishment of Kumac Mineralen has the purpose to reduce the high costs for disposal of livestock manure in the region.

Picture 2: Trucks for slurry transport.

2: General description of the plant

Kumac Mineralen is situated in the Brabant region – see figure 2, which with reference to figure 1 is one of the most livestock dense regions in the Netherlands. 7 million pigs are kept within a radius of 50 km, in addition to cattle and other livestock.

Figure 2: Kumac Mineralen is located in the Brabant region at Loonbedrijf Kuunders, Lupinenweg 8A, 5753 SC Deurne, Netherlands.

Some further details about Kumac Mineralen is presented in the following table.

Table 1: Details about Kumac Mineralen

Issue	Description
Name and address	Kumac Mineralen Lupinenweg 8A 5753 SC Deurne Netherlands
Tel.	Tel: 0493-312721 Fax: 0493-310379

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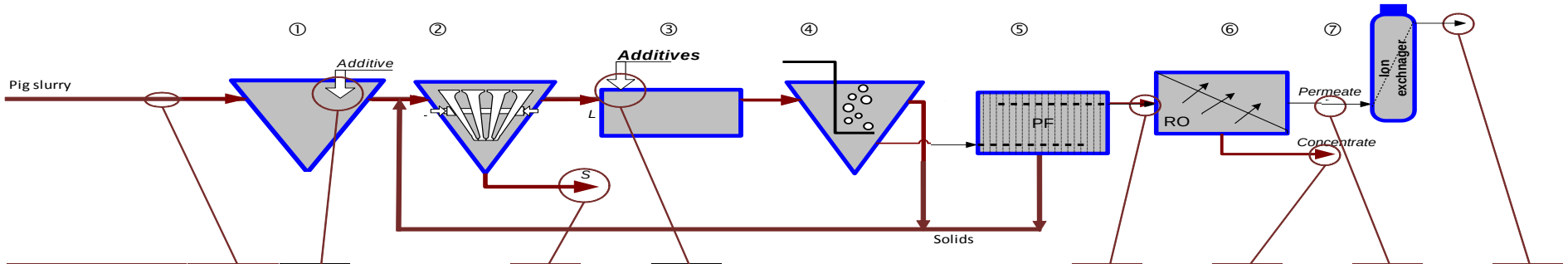
E-mail	info@kumanl
Web	http: / / www.kumanl
Owners and organisation	▪ Loonbedrijf Kuunders (50%) organisa the daily management and the transports in and out of the plant. ▪ Demac (Deurnese Mineralen Afzet Coöperatie) (50%) handles the trade agreements concerning slurry delivery agreements and sale of the products.
Design and construction	Mr Henry van Kaathoven, an engineer that has specialised in manure processing and runs his own company – see http: / / www.mestverwerking.eu. Mr van Kaathoven has since 2006 worked for Kumac Mineralen, and has built up the plant with components from different suppliers.
Daily management of the plant	It is claimed that the daily operation of the plant itself only require a labour input of max. 1 hour per day. The daily management is coordinated by Loonbedrijf Kuunders.
Year of start-up	2006

The following figure illustrates the configuration of the Kumac Mineralen livestock manure processing plant.



Flow rate, ton/year	80000	9	16002	91		64007	24003	40005	40005
Total solids, ton/year	6314		4910			1403	1389	14	8
N_{total}, ton/year	509		231			277	274	4	
P_{total}, ton/year	134		134			1	1		
K_{total}, ton/year	342		92			250	245	5	
Na_{total}, ton/year	74		16			58	58		
NH_4^+-N (ammonium), ton/	338		76			262	259	3	1
Crude ash, ton/year	1753		944			809	799	10	
Cl, ton/year	118		115	120	estimated	123	85	38	1
B, kg/year	576		310			266	205	61	36
Ca,kg/year	144800		138935			5865	5669	196	191
Cd, kg/year			< 1			< 1			
Co, kg/year	4		155	*160*	estimated	9	9		
Cr, kg/year	31		31			< 1			
Cu, kg/year	1751		1740			11	7	4	
Fe, kg/year	14040		11155			2885	2842	43	23
Mg, kg/year	75226		55902			19324	19301	24	17
Mn, kg/year	3730		3393			338	338		
Mo, kg/year	38		38			< 1			
Ni, kg/year	43		16			27	27		
Pb, kg/year			< 1			< 1			
S, kg/year	56222		333227	*500000*	estimated	222995	222564	431	42
Se, kg/year			< 1			< 1			
Zn, kg/year	5753		4741			1012	484	528	2
SO42– (sulphate), kg/year	33		440	*1900*	estimated	1493	1484	9	
NO3--N (nitrate), kg/year									
El. conductivity, mS/cm	29					40	39	1	0

Figure 3: Flow diagram of the processing plant, including mass balance. Incoming pig slurry is processed by the following treatment technologies: 1) Flocculation with use of polymer. 2) Filter belt press, 3) An additive is used, among other to reduce smell. 4) Flotation (using 20 litres of air per m^3), 5) Paper filtration, 6) Reverse osmosis, 7) Ion exchange. Liquids are after de-mineralisation disposed of in the nature. The mass balances are based on 12 analysis datasets provided by Kumac Mineralen, sampled in the period from 25 June 2009 to 27 August 2010.

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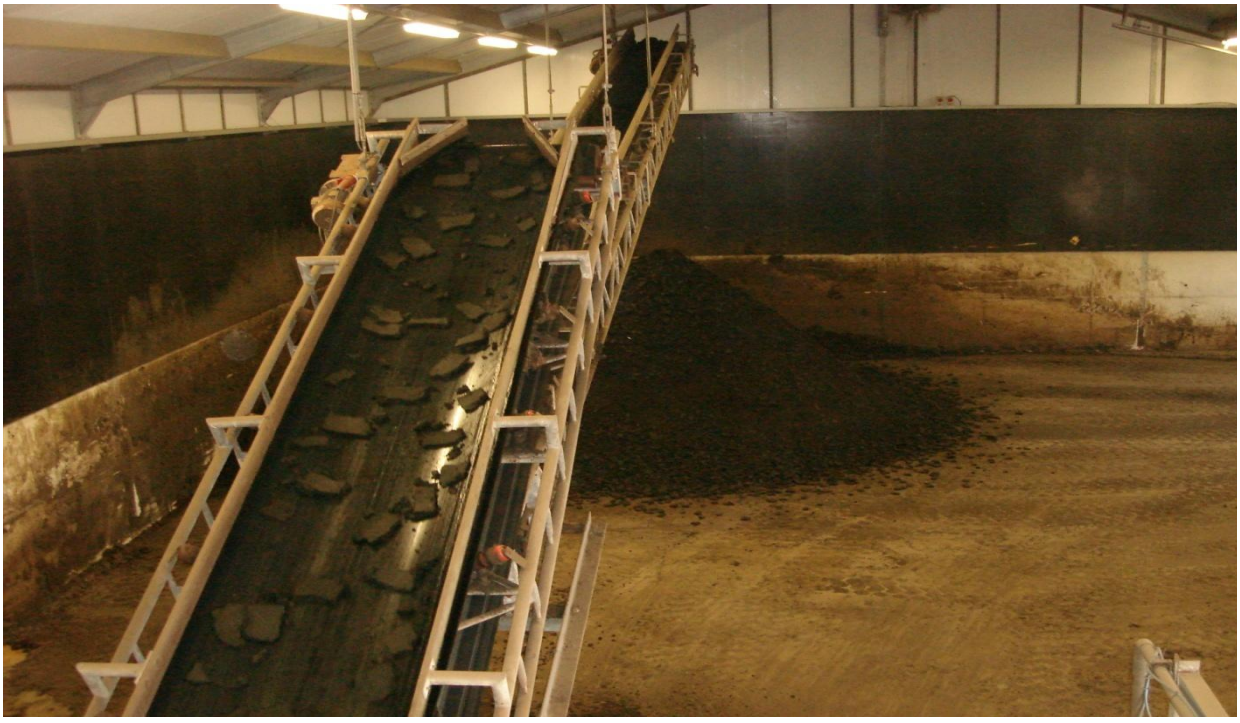
Picture 3: Slurry tank for reception of slurry.

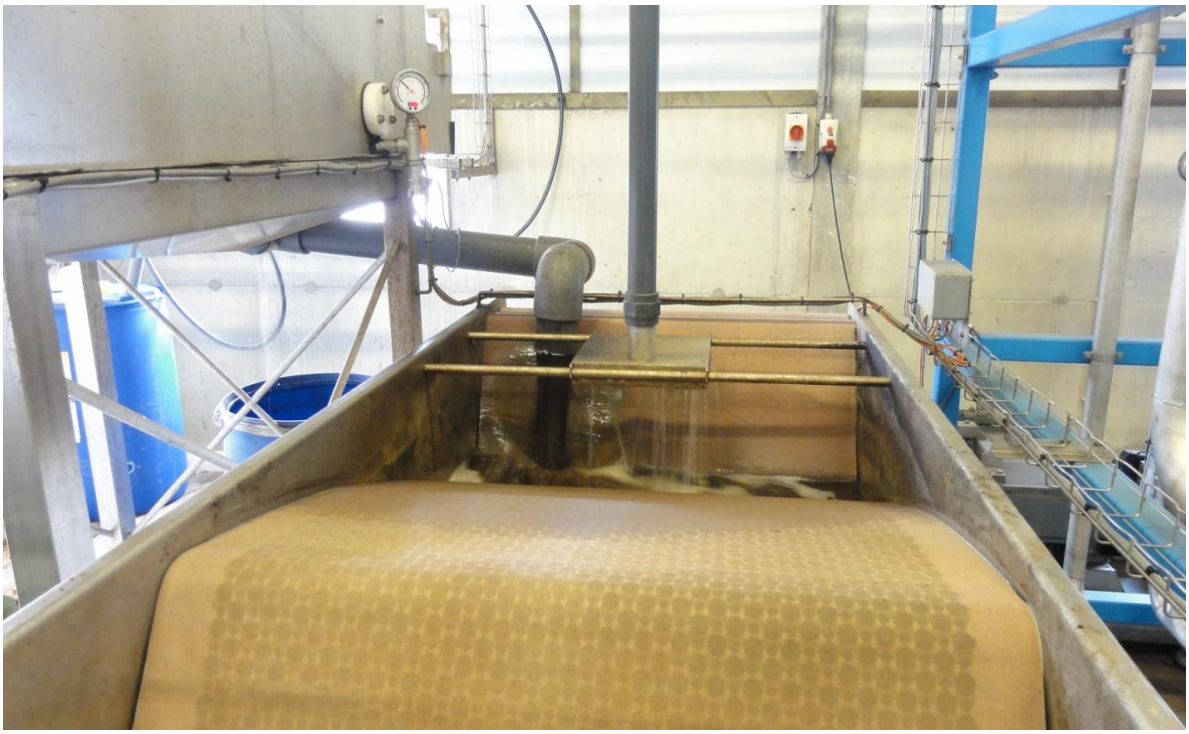
Picture 4: Separation with filter belt press, after treatment with an additive and a polymer.

Picture 5: Separation solids are scraped off the filter belt press.



Picture 6: Separation solids are placed in a roof-covered manure clamp via a conveyor belt.

Picture 7: Scrapers remove the flotation sludge from the flotation unit.



Picture 8: The liquid from the flotation treatment pass a filter paper before the reverse osmosis unit.

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Picture 9: Reverse osmosis unit.

Picture 9: The liquid fraction is de-mineralised in the final step before being deposited in the nature.

Picture 10: The nitrogen rich fraction is kept in covered storage tanks, and here loaded by a truck. A representative sample is taken during loading.

3: Technical data

3.1: Mass balance

Figure 3 shows a flow diagram with mass balance for the Kumac Mineralen livestock manure treatment plant.

The used additive (see figure 3) is informed to contain iron (Fe) and has an acidifying effect on the slurry, whereby it prevents evaporation of ammonia, methane and other greenhouse gasses and smelling compounds.

The end products are:

- Roughly 50% of input amounts come out as purified water, which can be discharged in nature – Kumac Mineralen has on basis of analyses been allowed to dispose the water in the nature by the Dutch environmental authorities.
- Approximately 30% of input amounts come out as a liquid fraction holding 7-12 kg N and 7-10 kg K per tonnes. Kumac Mineralen is marketing this liquid end-product under the name Fertraat.
- Almost 20% of input amounts come out as a solid solids fraction with 28-32% total solids, and holds almost all of the phosphorus in the livestock manure coming into the system. Kumac Mineralen is marketing the separation solids as a product called Fertex, which they claim is comparable to a 12-17-5 NPK fertiliser.

3.2: Energy balance

The livestock manure treatment plant does not produce energy.

Kumac Mineralen informs that the electricity consumption is 9.2 kWh per m^3 treated pig slurry. This is the total energy consumption while consumption for the individual technological processes has not been registered. The energy consumption appears to be low, considering the use of reverse osmosis alone normally consume 1.5 to 10 kWh per m^3 (Flotats et al., 2011).

As the treatment plan, in comparison to the reference situation, saves 816,000 km truck transport per year with an energy consumption of 0.718 kWh / km – see section 4, there is a saving of 585,888 kWh per year, or a saving of 7,3 kWh per m^3 input slurry.

The net energy consumption is therefore only 9.2 minus 7.3 = 1.5 kWh per m^3 treated slurry.

4: Environmental data

There has not been registered or measured airborne emissions from the Kumac Mineralen livestock manure treatment plant. The estimates presented in the following table are based on Flotats et al. (2011).

Table 2: Environmental data for the livestock manure processing plant of Kumac Mineralen, based on indications by Flotats et al. (2011).

Process	1: Flocculation	2: Filter belt press	3: Adding "pre-polymer"	4: Flotation	5: Paper filtration	6: Reverse osmosis	7: Ion exchange
Estimated CH_4 emissions (kg / year)	-	-	-	-	-	-	-
Estimated N_2O emissions	-	-	-	-	-	-	-
Estimated NH_3 emissions	-	-	-	Would normally be high, but difficult to quantify. It is claimed that the use of a special "pre-polymer" prevents ammonia emissions.	-	-	-
Estimated equivalent CO_2 emissions of greenhouse gases	-	-	-	-	-	-	-
NOx	-	-	-	-	-	-	-

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Process	1: Flocculation	2: Filter belt press	3: Adding "pre-polymer"	4: Flotation	5: Paper filtration	6: Reverse osmosis	7: Ion exchange
Other	Polymers in the form of PAM (polyacrylamide) may degrade to momomers in the nature and produce toxic, even carcinogenic compounds.	There can be some emission from the store with separation solids, similar to emissions from composting [2].	-	-	Emissions are estimated to be low because of a short exposition of the liquid fraction to the atmosphere.	Emissions are considered to be almost zero because reverse osmosis happens in closed tubes.	

All in all the Kumac Mineralen livestock manure treatment plant is estimated to produce a minimum of emissions, seen from a theoretical point of view. This estimate is also backed by several visits to the plant, giving the impression of a relatively low smell and nuisance level, which is an indicator for the level of airborne emissions of ammonia and other. The plant is, in line with this, not installed any air cleaning system.

However, in the reference situation, there are transported 80,000 m^3 slurry for 150 km to the northern part of the Netherlands, i.e. 300 km both ways, and as each truck can hold an average of 25 m^3 , which gives 960,000 km of truck transport per year. In the present situation the transport only concerns slurry into the plant (for a distance of approximately 30 km); consequently, transport of slurry to Kumac Mineralen takes 96,000 km per year. Additionally 40,000 ton of separation solids and manure concentrates (Fertraad) is transported back to farms and this require around 48,000 km truck transport. Therefore, in comparison with the reference situation, the Kumac Mineralen treatment plant saves 960,000 km minus 96,000 km minus 48,000 km truck transport per year, equal to 816,000 saved km truck transport per year. A truck has an energy consumption of 0.718 kWh / km (based on OCCC (2011), assuming 11.6 kWh / l diesel), with an equivalent CO_2 emission of 675.27 g CO_2 / km (OCCC, 2011).

This means, that the saved transport saves 551 ton CO_2 emission per year. This is equal to 6.89 kg saved CO_2 per m^3 treated slurry, or 0.92 kg saved CO_2 per kg treated N in the influent.

The noise level inside the plant is quite high, and persons supervising the plant are recommended to wear earmuffs.

[2] I.e. ammonia, methane, and nitroux oxide (Flotatas et al., 2011), but this is not measured at this plant, and the emissions might be small as the solid fraction is removed with few days interval.

5: Economical data

5.1: Investments

Investments in the plant are made equally by the two owners, Loonbedrijf Kuunders and Dema

The total investment in the livestock manure processing technology amounts to M€ 1.1. The technology is situated in an un-insulated building of 400 m^2, also containing a 300 m^3 under-floor intermediate store (in 6 compartments) for the concentrate, and an in-house clamp for temporary storage of the separation solids. It is estimated the building costs at least € 700,000, including building ground, access roads, piping and connections. The building of a separate reception tank for slurry of a size of 2,000 m^3 has cost € 125,000, including cover, reception tank, pipes and pumps.

The gross investment is therefore around € 1,925,000 for the plant with an annual capacity of 80,000 m^3.

The building ground as well as connection roads and connections et were already available, therefore there were no extra costs associated to those items.

The following table shows the fixed costs, assuming the above investment prices.

Table 3: Investment costs of the Kumac Mineralen livestock manure treatment plant.

	Installations in house
Gross investment price, €	1,925,000
Average depreciation time, years	15
Depreciation, % per year of the gross investment	6.75
Depreciation, € per year	129,937
Real interest rate, %	3.25
Annual interest payment, €	62,562
Maintenance, costs, % of gross investment	2.5
Maintenance costs, €	48,125
Total capacity costs	240,625

5.2: Operational costs

The following table shows the operational costs.

Table 4: Operational costs of the Kumac Mineralen livestock manure treatment plant, based on information provided by Kumac Mineralen.

	Unit	Unit cost, €	Units per year	Total cost, €
Dry polymer	Kg	2.50	9,100	22,750
"Pre-polymer"	kg	0.12	91,000	10,920
Electricity	kWh	0.12	733,333	88,000
Labour	Man-hours	22.5	365	8,213
Transport costs, slurry	ton	2,00	80,000	160,000
Transport costs, end products	ton	2.00	40,005	80,009
Spreading costs, Fertraat	ton	5.00	24,003	120,014
Disposal of separation solids	ton	12.50	16,002	200,023
Total operational costs	€			689,928

The separation solids should theoretically have a value due to its content of plant nutrients and organic matter, but presently Kumac Mineralen pays a biogas plant € 12.5 per ton for taking it, which seems a high price, but it should be kept in mind that there is a high livestock density in the region and that the normal price for disposal of slurry is 15-25 € per ton.

5.3: Income

The following table shows the income.

Table 5: Income of the Kumac Mineralen livestock manure treatment plant, based on information provided by Kumac Mineralen.

	Unit	Unit price, €	Units per year	Total income, €
Fertraat	ton	7.5	25,475	152,850
Total income	€			152,850

5.4: Net cost per m^3 slurry and per kg N removed or per kg N recovered and sold

Based on the above, the following table shows the net costs.

Table 6: Net costs of treating livestock manure at the Kumac Mineralen livestock manure treatment plant.

	€
Capacity costs per year, €	240,625
Operational costs per year, €	689,928

	€
Income per year, €	152,850
Net costs per year, €	777,703
Net costs at 70,000 m^3 treated per year, € / m^3	9.72
Net costs at 509,000 kg N_{total} treated per year, € / kg N_{total}	1.53

The price of 9.72 € / m3 slurry treated at the Kumac Mineralien livestock manure treatment plant is less than half of the normal costs in Brabrant region in the Netherlands for disposal of slurry, which is around € 20 per ton (average for winter and summer). The price of € 1.53 per kg N_{total} for re-circulated nitrogen is comparable to the market price for nitrogen in mineral fertiliser.

The largest challenge for Kumac Mineralen is to realise a higher income from sale of the end-products.

It has to be mentioned that currently concentrates are used above the limit of 170 kg N / ha / year established by the Nitrates Directive, given that their application to land is also part of the above mentioned pilot project, which means that the market value might be higher than if the products fall under the scope of the standard of 170 kg N / ha.

6: Social aspects

The Kumac Mineralen livestock manure treatment plant is well accepted by the neighbours. There have been problems with smell from the plant, but this problem was solved by use of the self-invented additive, informed to contain iron and have acidifying effect, as one of the first treatments – see figure 2.

The effect on the local job creation is marginal.

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7: Other

The Kumac Mineralen livestock manure treatment system is part of a pilot project financed by the Dutch Government and undertaken by Wageningen University, with the purpose to investigate the possibilities for total removal of organic compounds from livestock manure, and thus have end and by-products with characteristic comparable to those of mineral fertilisers.

Henry van Kaathoven, who has developed the livestock manure treatment system for Kumac Mineralen has met a large interests from other investors.

8: Summary

Henry van Kaathoven has for Kumac Mineralen developed a livestock manure treatment system, which converts pig slurry into app. 20% separation solids, 30% concentrates, and 50% purified water.

The processing comprise 7 livestock manure treatment technologies, which by various separation and filter technologies splits the slurry in a fraction with high concentration of organic matter, a fraction with high concentration of plant nutrients, and a purified water fraction.

The net cost for the livestock manure treatment is calculated at € 8.07 per m^3 treated slurry, equal to € 1.27 per kg N_{total} in the pig slurry.

The treatment plant thus makes it possible to dispose of pig slurry in a much cheaper way than the normal for the Brabrant region in the Netherlands, which is as high as around € 20 per m^3 due to the high livestock density. This is, of course, also influenced by the fact that concentrates are used above the limit of 170 kg N / ha / year established by the Nitrates Directive, given that their application to land is also part of the above mentioned pilot project

The following table summarize technical, economical and environmental key performance of the plant.

Table 7: Technical, economical and environmental key performance of the Kumac Mineralen livestock manure treatment plant.

Issue	Parameter value
Technical performance	
Major processing technologies	A series of separation and filtration technologies
Mass balance	
Influent, m^3 per year	80,000
▪ Pig slurry	80,000
End and by-products, ton per year	
▪ Separation solids	16,002
▪ Concentrate from reverse osmosis	24,003
▪ Purified water	40,005
Energy balance	
▪ Net consumption of energy per m^3 treated livestock manure	1.5

Issue	Parameter value
and other, kWh / m^3	
▪ Net energy production per m^3 treated livestock manure and other, kWh / m^3	-
Environmental performance	
▪ Net influence on emissions (leaching, evaporation, other) of nitrogen, kg / m^3 treated	0
▪ Net influence on production of greenhouse, gases, kg CO_{2e} / m^3 treated	- 6.89
Economical performance	
▪ Net cost of processing including subsidies, € / m^3	8.07
▪ Net cost of processing including subsidies, € / kg N_{total}	1.27
▪ Net cost of processing excluding subsidies, € / m^3	8.07
▪ Net cost of processing excluding subsidies, € / kg N_{total}	1.27