International **M**eeting on
Chemical **E**ngineering, **E**nvironmental
Protection and **B**iotechnology

Abstracts of the lecture groups

Environmental **T**echnology **S**ustainable **D**evelopment **W**ater **R**ecovery and **S**aving

ACHEMA
97

EVAPORATION SYSTEMS
FOR

TREATMENT OF VAPORS AND CONDENSATES CONTAINING AMMONIA AND AMMONIUM NITRATE IN ORDER TO OBTAIN CONDENSATES CONTAINING LESS THAN 10 PPM OF TOTAL NITROGEN

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1 - Abstract

The synthesis of ammonium nitrate solution generates about 0.5 tons of vapor per ton of ammonium nitrate. Such vapors contain 4 000 to 10 000 ppm of total nitrogen present a free ammonia and as ammonium nitrate.

The usual treatment columns allow to reduce this contamination to 100 to 400 ppm total nitrogen.
During the last years the liquid effluent requirements became more stringent and to the total nitrogen acceptable is the waste water became limited to 5 to 10 ppm, which is impossible to obtain with the usual Systems.
A technology based on evaporation appears as the one that could fulfill the new requirements. However, it is known that evaporators are energy consumers on a big scale and an optimization study of the solutions that could be proposed to the potential customers was realized by KT's evaporation and crystallization department, taking into consideration the operating conditions of the ammonium nitrate's synthesis unit.

2 - Description of an ammonium nitrate solution synthesis plant using treatment columns

Flowsheet N° AOC41008 presents a configuration of an ammonium nitrate solution synthesis plant. Vapors produced in the separator F101 can be at atmospheric pressure or at 5 to 7 bars abs. After treatment in the treatment column F125 they are either condensed or used as heating medium.

The treatment column is composed of a lower part containing packing and upper part having trays. Ammonia is recovered in the packing watered from top with a recirculated solution in which nitric acid is added. Vapors pass then through a set of bubble cap trays that stops entrainment of ammonium nitrate. Trays are fed with process condensates. The solution produced in such system is at about 15 % of ammonium nitrate.

3 - Evaporation Systems

Figures 1 and 2 give the quality of condensates in terms of free ammonia that can be obtained with falling film evaporator, at certain operating conditions. The analysis of the same condensates indicates that the ammonium nitrate content is also less than 5 ppm.

Several combinations and configurations of evaporators were analyzed in order to optimize the investment and operating costs (MVR, multiple effect up to 6 effects, thermo-recompression), taking into consideration the fact that the distribution of the energy produced by the reaction of ammonia and nitric acid varies from one plant to another, and that the effluent that needs to be treated can be present as vapors, condensates, or both, in variable proportions.

Among the Systems studied, multiple effect units appeared as the most economical one, compared to MVR or thermo-compression units.

Double effect units can be used for the most cases. Even with this type of unit, there's an excess of process vapors that needs to be condensed separately than re-evaporated. The limit for using multiple effect unit is fixed by the ratio: volume of vapors/total volume of effluent to be treated. This ratio needs to be greater than 20 %; in this case a sextuple effect is used. For smaller ratios, multiple effect unit combined with thermo-compression is necessary.

4 - Economical comparison

Table 1 gives an economical comparison between a treatment based on evaporation or usual treatment columns, for *a* 1 200 t/day of ammonium nitrate solution plant, operating at atmospheric pressure (1.4 bar abs.) or at 5 bars abs.

For treatment column System, vapors are treated then used as heating medium or condensed.

For double effect System part of vapors is condensed because they are used as heating medium or they are under vacuum; it is then sent as condensates to the treatment System.

For the sextuple effect System, we consider that with this System a big part of vapors is condensed in the ammonium nitrate plant. The treatment cost is given for information only; it can't be compared to the two first Systems.

It appears from this table that the initial investment is higher for treatment with evaporation than for treatment with columns. It can vary from 130 % to 200 % depending on the number of effects selected for the evaporation System. However, the operating cost for the evaporation System, including depreciation, is comparable or slightly higher than for treatment with columns.

Tabelle 1:Vergleich Wirtschaftlickeit

		Hochruckreactor			**Atmosphàr. Reaktor**		
	Dimension	Einfachkolonne	Dopcel	6Fach	Einfachkolonne	Doppel	6Facn
Kapazitat							
-Dampf	kg/h	26200	17726	4300	26200	21 305	4800
Kondensat	kg/h		6837	21 000		3846	21 000
Investition	French Francs	3 000 000	4 000 000	6 000 000	3 000 000	4 000 000	6 000 000
		100%	133%	200%	100%	133%	200%
Verbrauch							
- Strom	kWh/h	25	25	25	25	25	25
-Kùhlwasser	m3/h	1278	1340	643	1382	1338	492
- Dampf	kg/h	0	0	0	3190	2042	2042
Betriebskosten							
- Versorgung	FF/Jahr	4169600	4368000	2137600	6033600	5 341 760	2634560
- Wartung	FF/Jahr	150000	200000	300000	150000	200000	300000
-Nutzen an Ammoniumnitrat	FF/Jahr		48720	48720		54320	54320
Summe	FF/Jahr	4319600	4519280	2388880	6183600	5487440	2 880 240
FF/m3		20,61	23,00	11.57	29,50	27,27	13,95
%		100%	112%		100%	92%	
Absctireibung	-F/jahr	600000	800000	1 200000	6COOCO	800000	1 200000
Gesamtkosten	'F/jahr	4919500	5319280	3588880	6783600	6287440	4 080 240
FF/m3		23,5	27,1	17,4	32,4	31,2	19,8
		100%	115%		100%	97%	

5 – Conclusion

It appears from the example treated above that it is possible to have an efficient effluent treatment System by evaporation, fulfilling with stringent environmental regulation, at a cost comparable to less efficient System by scrubbing and neutralization, although the initial investment is higher for the evaporation System. This cost depends on the operating conditions of the ammonium nitrate plant. To be optimized, an optimization of the operating conditions of the whole plant is necessary.

Par Tners
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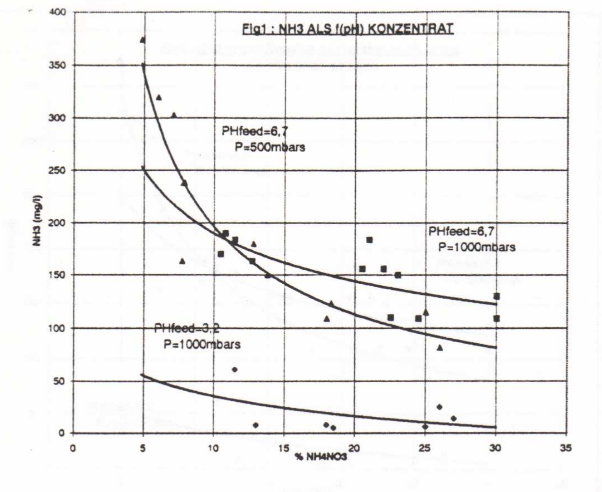

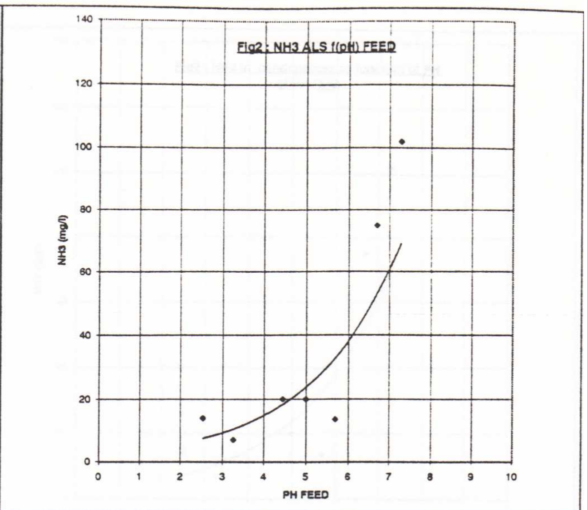

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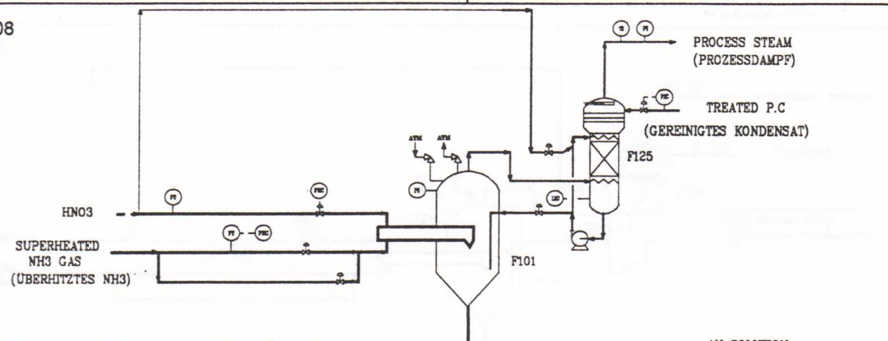

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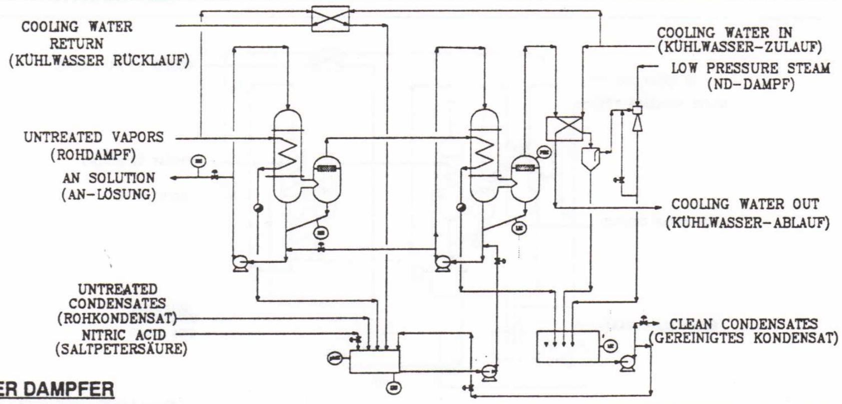

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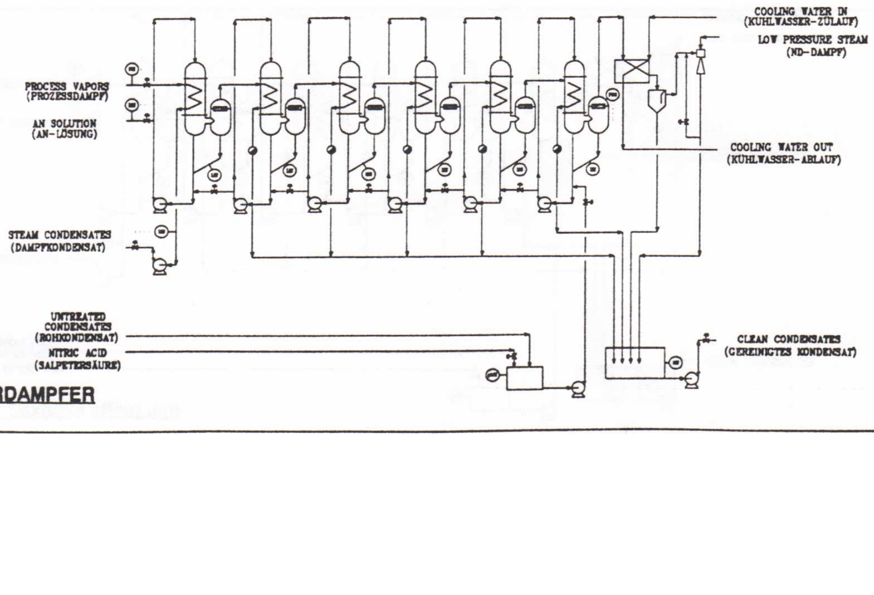

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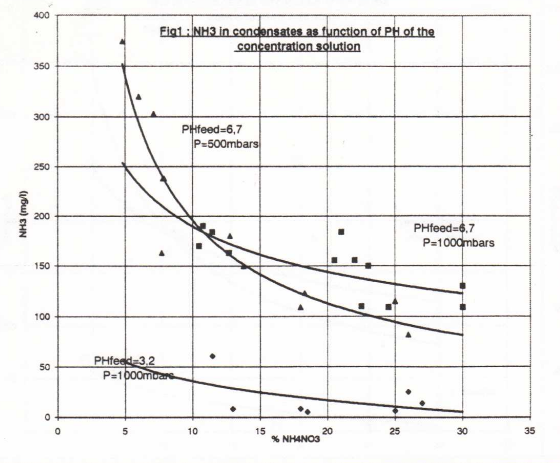

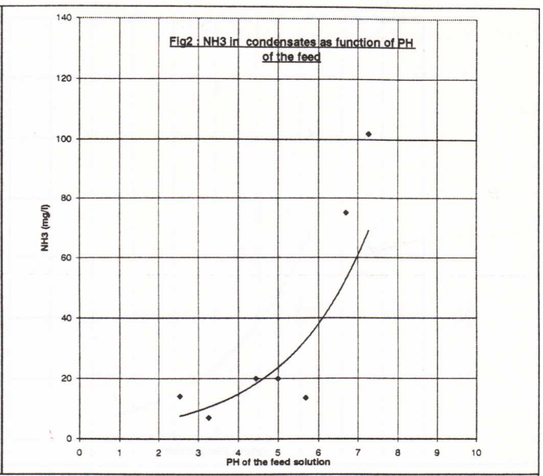

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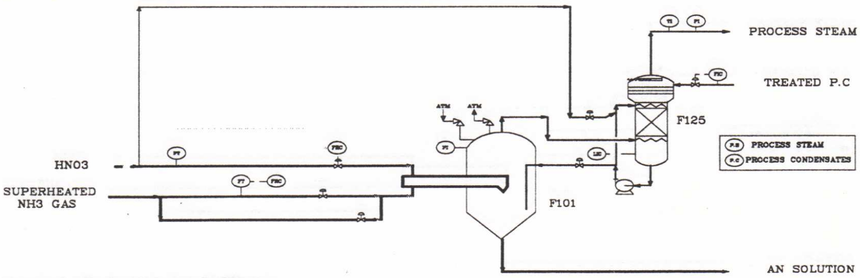

Ammonium nitrate solution synthesis

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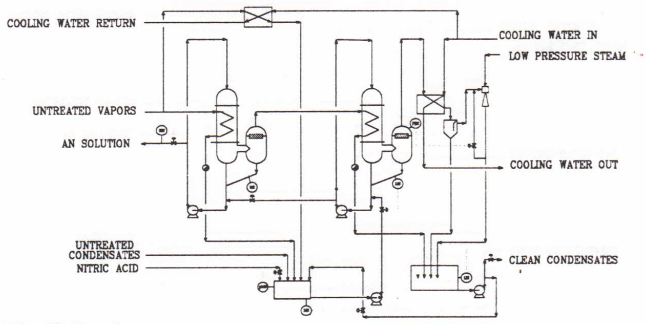

Evaporation : Double effect unit

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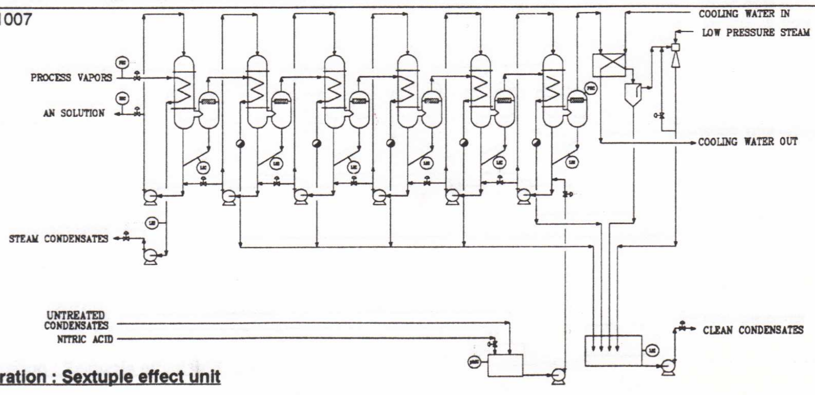
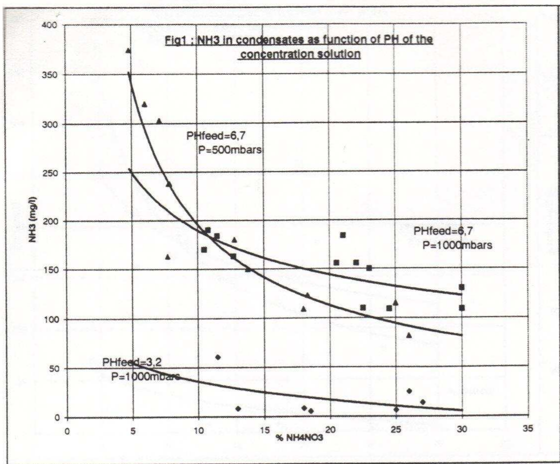
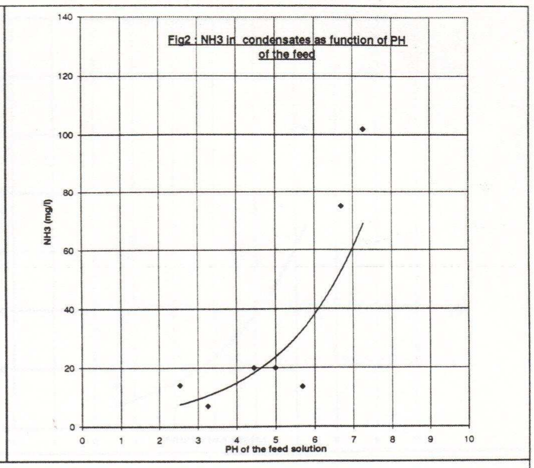


Evaporation : Sextuple effect unit





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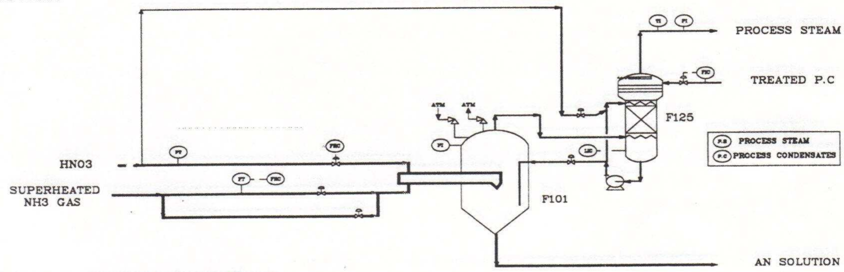

Ammonium nitrate solution synthesis

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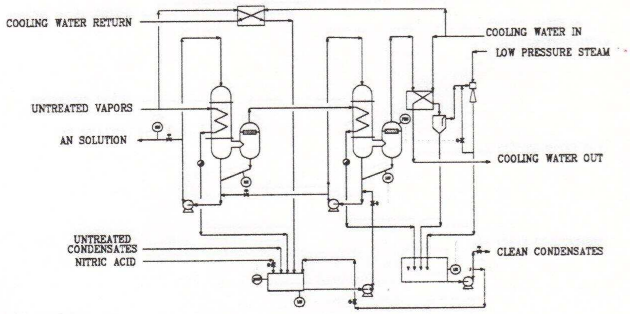

Evaporation : Double effect unit

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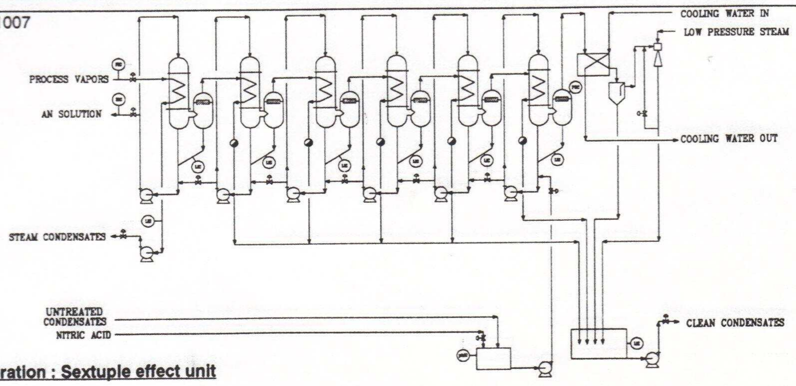

Evaporation : Sextuple effect unit