

Hybrid Dryer Exhaust Air Processing

Presenter:

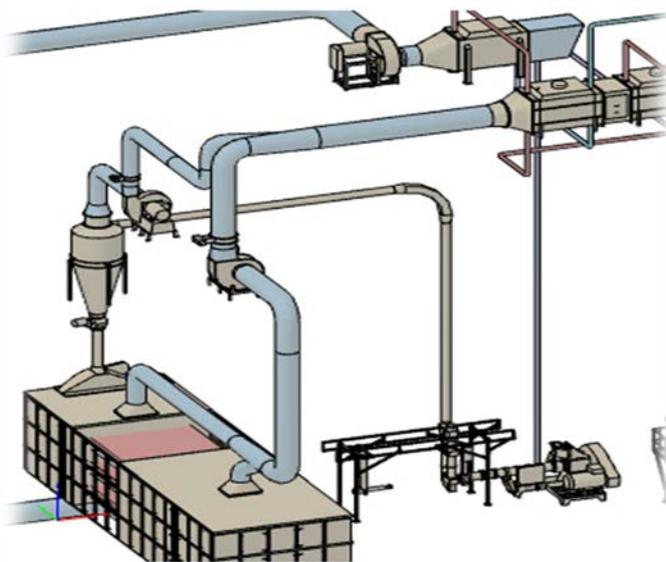
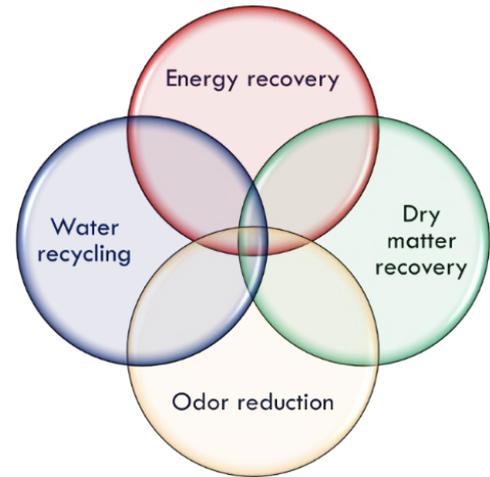
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Introduction

Hot air drying is one of the most widespread drying methods in extruded feed production. The exhaust air from hot air dryers are malodorous, humid and warm. Traditional processing invokes the use of separate process steps to allow reduction of odor emission, in order to obey local legislation and keep a positive relation to neighbors and the local community. Additional processing steps are sometimes involved to achieve energy recovery, with a possible additional option to condense some of the water in the air to allow internal recirculation of spent drying air. Whilst all of these solutions serve a purpose and have a positive impact on the process, each unit comes with significant capital costs, footprint and yet, only serves a single purpose. Furthermore, the availability of fresh water resources is in some areas of the world limited, and it has so far not been considered safe or interesting to reuse condensed water from the drying process. The ideal solution would indeed integrate the goal of reducing odor, recover energy and reuse condensed water back into the process, in a single end-pipe solution. This has been the aim in a recent collaborative development project, subsidized by the Danish Ministry of the Environment, between Graintec A/S and customers in fish feed and pet food production.

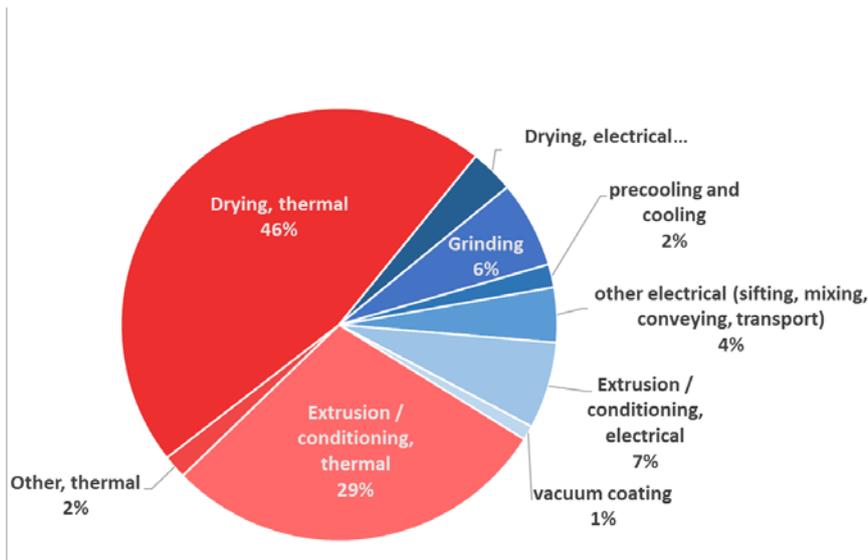


This paper, and the associated presentation at Aquafeed Horizons 2017, aim to highlight experiences from this project, and demonstrate applications and potential of the technology in future pet- and fish feed plants, as well as when retrofitted onto existing lines. Results from pilot-scale experimental stages are presented: condensation based odor abatement efficiency, energy recovery potential and feeding trials using feed produced with recycled water, condensed from the drying process. To adapt to different requirements, legislative as well as economical, three different solutions are presented; the EWOTEC solutions. These new solutions bring a promising alternative to the existing technology pool, promising an eco-efficient and sustainable technology to simultaneously reduce odor, increase process energy efficiency and safeguard fresh water resources for future generations.

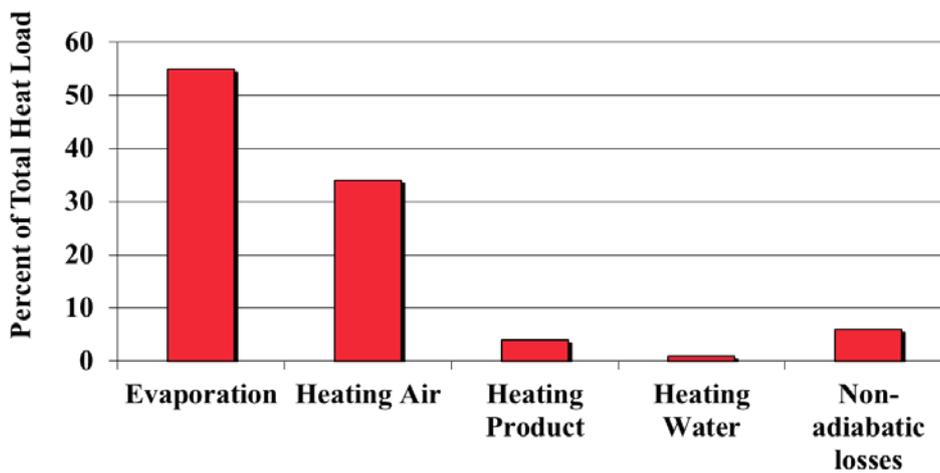
energy efficiency and safeguard fresh water resources for future generations.

Drying of extruded fish feed

Extrusion followed by hot air drying is one of the widespread production utilities within the pet food and aquafeed industry. In the extrusion process 10% – 20% water is added as a process aid, and this water is removed again in the drying process, most often using hot air. This. The energy consumption of the drying process is often 45% - 50% of the total process energy consumption, dependent on dryer type, facility layout, geography, etc. A lot of the energy is utilized to evaporate water, but a significant amount it used to heat the air. The energy distribution chart for the whole process as well as for the drying process itself is visualized below.



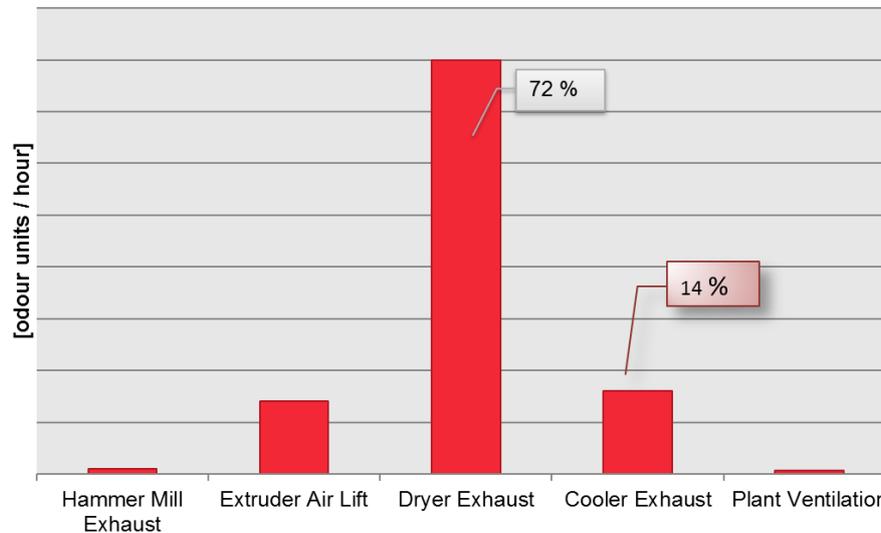
Typical energy distribution in extruded fish feed production



Typical energy distribution for thermal energy consumption in the drying process for extruded fish feed production

Unpleasant odorous components are carried away with the humid dryer exhaust air as well as with the flash off from extrusion in the transport process from extruder to dryer. This is visualized in below figure that illustrate each process units' contribution to total odor emission.

Process units' contribution to total odour emission



The dryer exhaust and the extruder flash off / airlift typically contribute very significantly to an extruded feed production facility's total odour emission.

Industrial Research activities

From above charts, it seems highly viable to pay attention to the combined dryer exhaust air and extruder air lift stream. Aim is to identify a solution that at the same time could address abatement of odour emission, energy recovery and water recycling from the warm, humid dryer exhaust air and the extruder airlift. This focus, hybrid dryer exhaust air processing, have been subject to thorough investigations and analyses by GRAINTEC A/S and collaborative partners; aquafeed and pet food production companies, Danish Certified Technology Institutes as well as the Danish Ministry of the Environment.

The following industrial research activities have been carried out:

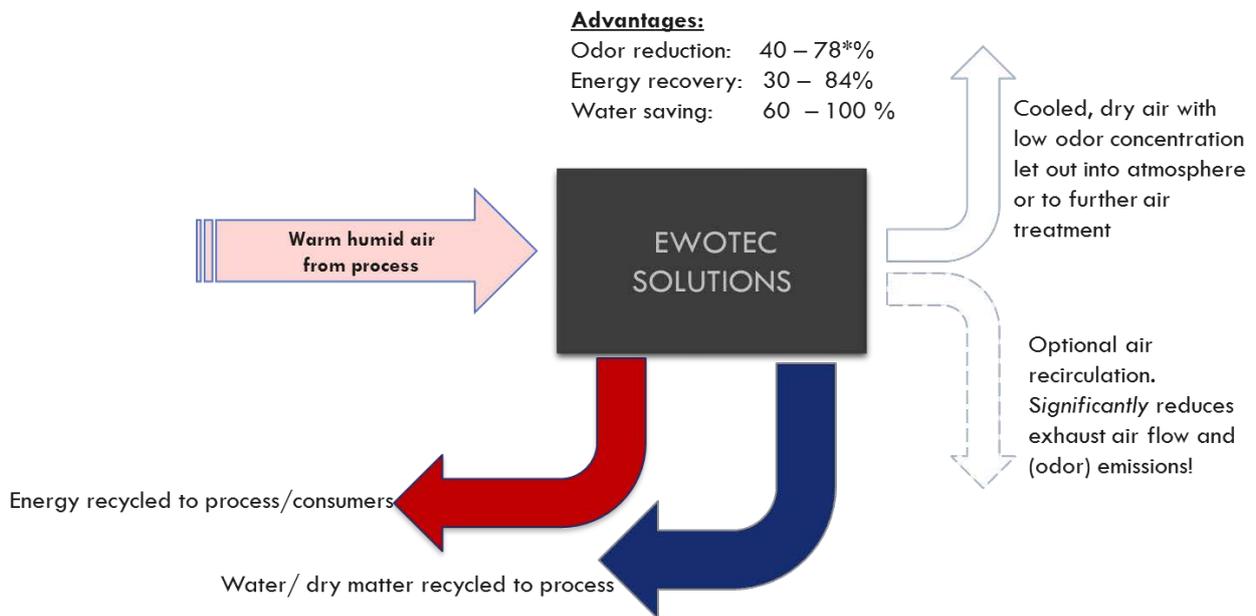
- Odour reduction experiments using condensation
- Pilot scale production of aquafeed using water recirculation from condensation
- Feeding trials
- Front-end engineering design
- Energy recovery analyses and simulations

It was identified that condensation is key in obtaining all these three goals at the same time – in fact it can even serve a fourth goal of capturing and recycling airborne dry matter content, together with the condensed water. Feeding trials utilized feed produced using recirculated process water. Feeding was done for 8 weeks and involved pathological screening, feed conversion and digestion analyses. All results significantly demonstrated that no abnormalities were found compared to feed produced using fresh water.

This new technology aim to recycle available energy in the dryer exhaust to available energy consuming processes, i.e. to preheat dryer makeup air, boiler water, auxiliary heating, etc. When cooling the exhaust air, condensation will at some point start to occur. Obviously, this redeems the potential for process water recycle, but at the same time involves reduction of odour concentration in the feed stream. Many odorous components in the air are solid microparticles or water soluble molecules. Hence, these will be 'scrubbed away'

when water droplets start to condense. Consequently, the odor and particle concentration in the dryer exhaust is reduced significantly. All, or part of the separated water can be reused in the extrusion process saving water as well as dry matter. Therefore, implementation of this technology will render the use of cyclones and bag filters unnecessary. In further, the exhaust air that have been cooled and dried, following the condensation, can optionally be recirculated back to the dryer. This reduces the odor emission and total air exhaust volumes *significantly*.

Project definition and maturation phases have pinpointed that a flexible solution is required, to adapt to the different needs and requirements for different production facilities worldwide to recover Energy, recycle Water and abate Odor. Hence, the 'EWOTEC Solutions' is born. Results from the experimental phases of the research project as well as a principle process sketch of the EWOTEC Solutions are sketched below:



EWOTEC encompass hybrid dryer exhaust air processing. It facilitates energy recovery, process water recycling and odor abatement in a single solution. The actual quantities as stated in the figure depend on a variety of variables; the actual EWOTEC solution targeted, existing process layout, climate, recipes, etc.

EWOTEC Solutions

EWOTEC is a concept that targets energy recovery, water recycle and odor emission reduction, to a level that satisfies the customer's individual needs and requirements, either from legislation, economy or corporate environmental commitment.

The concept has now been developed and three overall solutions can be offered for existing as well as new factories. For each solution, feasibility and payback analyses as well as detailed design will obviously be tailor made to match plant layout, production conditions, climate, recipes, etc. All EWOTEC Solutions start with the 'EWOTEC Basic':

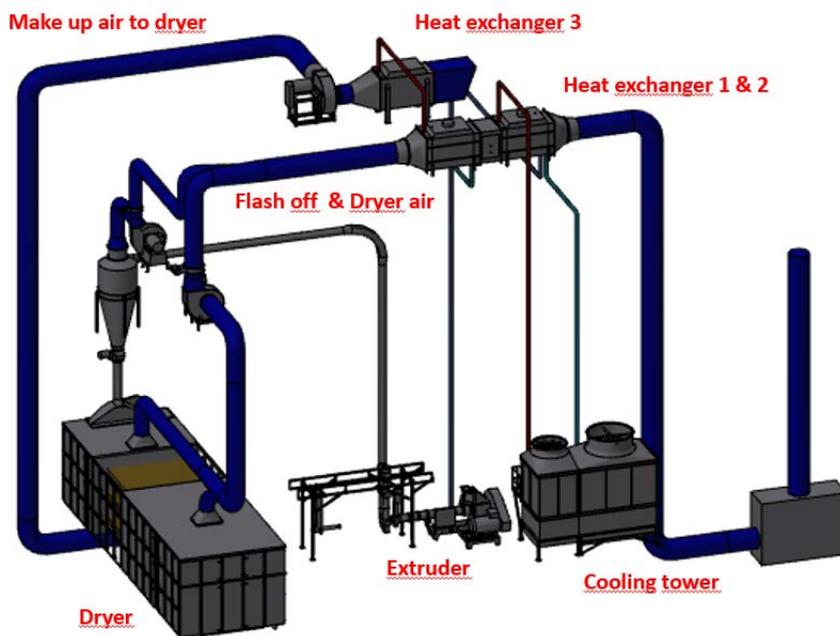
EWOTEC Basic

- Condensates water from the dryer and flash off air
- Recovers energy and sends it back to the process
- Reduces odor
- Reduces dry matter loss

Equipment:

- Heat exchanger 1: (Air to water) anti fouling with CIP system
- Heat exchanger 2: (Air to water) anti fouling with CIP system
- Heat exchanger 3: (Air to water) finned heat exchanger
- Cooling tower

Process air from the dryer and flash off passes heat exchanger 1. In heat exchanger 1 some of the latent heat is taken out and transferred to heat exchanger 3. Heat exchanger 3 heats up the make-up air to the dryer. The air passes to heat exchanger (H2), the water side is associated with a cooling tower. Another part of the latent heat is removed here, and this will condensate part of the water in the process air. This condensate can be used as water in the extruder.



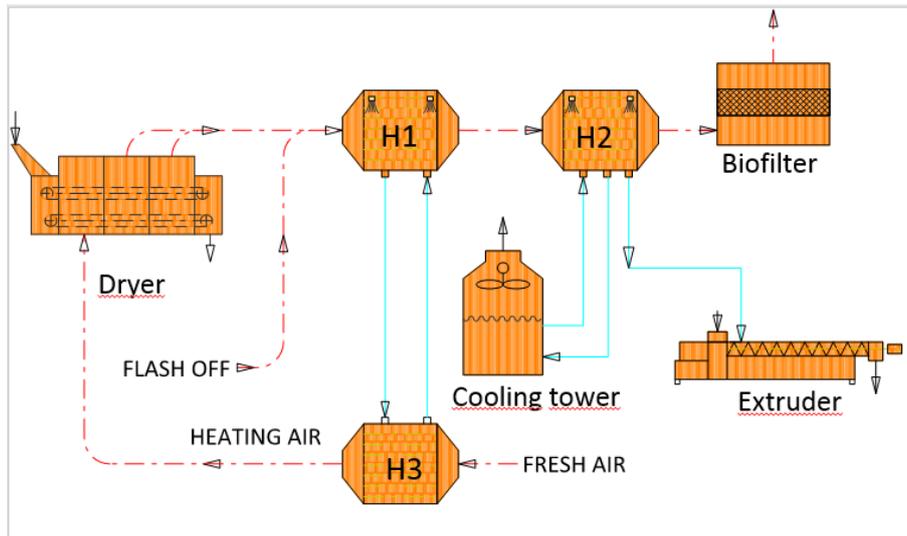
Conceptual design layout for the 'EWOTEC Basic'

For further requirements on odor abatement or when feasible to enhance energy recovery, the 'EWOTEC Basic' can be supplemented by the 'EWOTEC Air Clean' or the 'EWOTEC Max'. Hence, EWOTEC Basic is utilized as 'starting point' for all EWOTEC solutions.

EWOTEC Air Clean

- EWOTEC Basic
- Adjusts air conditions for specific final air treatment
- Final air treatment designed for local requirement

EWOTEC Air Clean uses the EWOTEC Basic concept with a final odor reduction system and/or an air stack to control the odor dispersion profile when measured on ground. Stack height, if necessary, will be determined based on odor emission and metrological conditions. For final odor reduction, choices are biofilter, carbon filter or ozone treatment facility. Final emission can be reduced by 90 – 95%.



EWOTEC Air Clean comprising the EWOTEC Basic solution and an end-pipe supplemental air cleaning unit (here, a biofilter). Latter can be designed to be smaller than without the upstream EWOTEC Basic solution, since inlet odor emission will be lower following condensation of odorous particles.

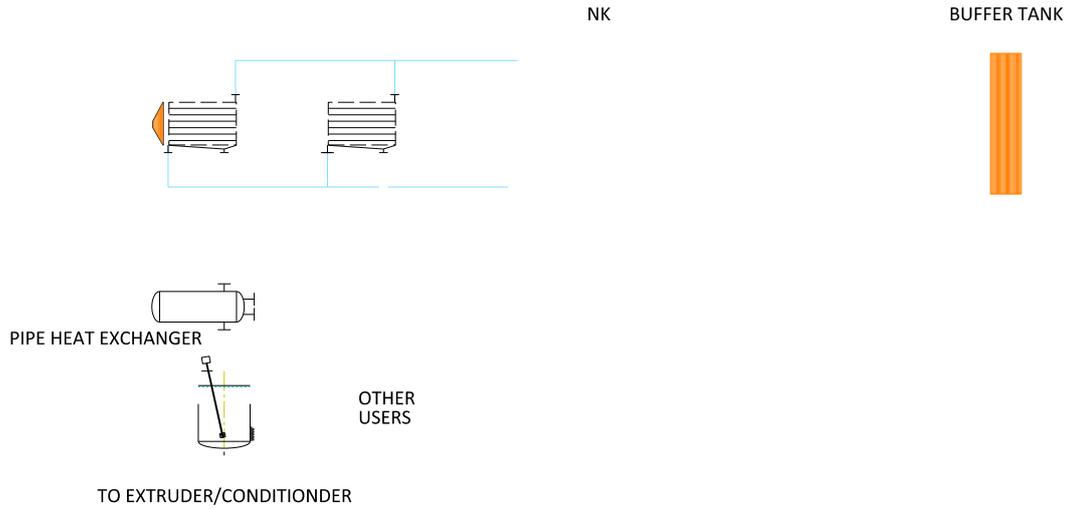
EWOTEC Max

- EWOTEC Basic or EWOTEC Air Clean
- State-of-the-art heats pump system network, for enhanced energy recovery

EWOTEC MAX reuses the EWOTEC Basic concept, but uses a detailed heat pump system network, rather than interconnected heat exchangers. The system will allow to recover as much as 80 % of the thermal energy in the combined dryer exhaust and airlift air. The odor reduction will be up to 65% and the water reduction will be up to 100%. With the EWOTEC MAX it will be necessary to find an external energy consumer to use the large quantities of recovered energy. Examples are:

- Heating of Make Up Air to Dryer
- Hot Water Generation
- Liquid Heating
- Boiler Feed Water Heating
- General Room/Warehouse Heating Purposes
- Export to Other Users

The conceptual design of the EWOTEC Max is illustrated on the next page:



The 'EWOTEC Max' reuses the design concept from the 'EWOTEC Basic' solution, supplemented by a detailed heat pump network. This allows extensive energy recovery potential from the dryer/airlift exhaust air, significant odor reduction and to recycle all liquid process water in the extrusion process.

Below table compares the EWOTEC Solution performance for each of the three categories energy, water and odor.

EWOTEC Type	Cleaning device	Odor Reduction	Energy reduction	Water reduction
Basic	None	35%-55%	10 - 20%	45%-70%
Air Clean B	Biofilter	90%	10 - 20%	45%-70%
Air Clean C	Carbon	95%	10 - 20%	45%-70%
Air Clean D	Ozone	90%	10 - 20%	45%-70%
Max	None	40%-65%	75%-80%	100%

The three different EWOTEC Solutions compared in efficiencies for relative reduction in resources energy and water as well as reduction of odor emission.

Conclusion

Hybrid Dryer Exhaust air processing can be facilitated using the EWOTEC Solutions. These address the integration of water and dry matter recycling, energy recovery and odor abatement - in a single solution. Their 'payback' are often superior compared to conventional solutions, since they involve multiple resource recovery. In further, it is a green technology that could redeem subsidization opportunities as well as strengthen company profiles through increased corporate environmental responsibility. The EWOTEC solution has been tested in feeding trials. Recirculated water does not constitute a health risk towards fish. The EWOTEC Solutions are tailormade and eco-efficient technology that reduces odor, increase process energy efficiency and safeguard fresh water resources for future generations.