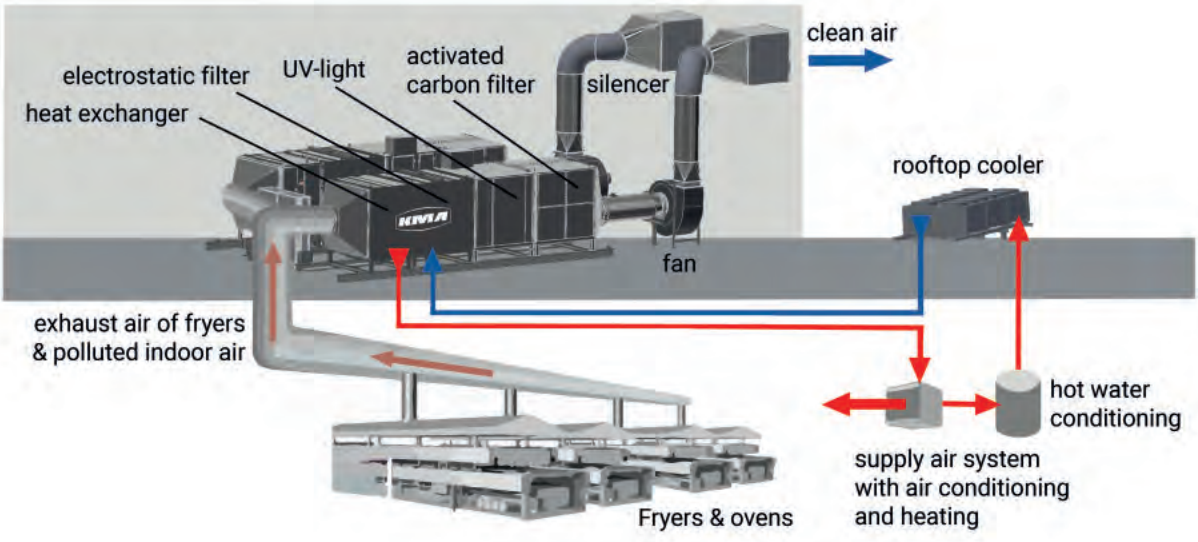
FLEISCHWIRTSCHAFT international 2_2022



Source: KMA Umwelttechnik FLEISCHWIRTSCHAFT international 2_2022

As part of a capacity expansion at Tönnies, the integration of new fryers and cooking ovens into the exhaust air and ventilation technology became necessary. The sustainable KMA exhaust air filter system convinced with a significantly better energy efficiency compared to other processes.

Invest in an exhaust air filter system

Tönnies group produces sustainable meat products in line with CO_2 emission reduction targets

The proper handling of production exhaust air is a central task in modern meat product production. It must be ensured that the exhaust air produced is removed and replaced by fresh air so that the air quality and hygiene in the production areas meet the strict workplace regulations (1) and quality assurance requirements. Against this background, the Tönnies Group invested in an energy-efficient exhaust air filtration system for fryers and cooking ovens in 2020. The relevant motivations for the selection of the process are presented in this article.

By Friederike Schmedding

The official operating permissions stipulate increasingly strict requirements for the permissible emissions of substances and odours for the exhaust air, which requires an effective filtered exhaust air treatment. Due to rising energy costs and the requirements for sustainability in the food industry, the goals of energy efficiency and heat recovery are of great importance to many companies. Those in charge of technology and the internal environment in numerous companies are confronted with the challenge of implementing appropriate solutions which, on the one hand, precisely meet the formulated requirements and objectives for handling production exhaust air and, on the other hand, leave sufficient flexibility for the design of the production processes. The investment by Tönnies in a new exhaust air filter system for deep fryers and ovens will meet the challenges and goals.

The Tönnies Group of Companies, headquartered in Rheda-Wiedenbrück in eastern Westphalia, is manufacturer of high-quality food products. In addition to meat and sausage, the family business, founded in 1971, produces sauces, soups, vegetarian and vegan foods for the German and European markets. As part of a capacity expansion planned for 2020, it became necessary to integrate new deep fryers and cooking ovens into the exhaust air and indoor air technology. Different meat products are produced in the facilities, from schnitzels, gyros and hamburgers, kebabs and toasties. Despite clear growth plans, the company did not want to deviate from the CO_2 emission reduction targets set out in Agenda t30. Therefore, all necessary measures and the solution concepts offered were closely scrutinised.

A thermal afterburning plant, the still widely used conventional process for exhaust air purification, was ruled out for various reasons. The high consumption of fossil fuels and the high secondary emissions such as NO_x and CO_2 were central factors in this fundamental decision. After considering various alternative processes, the decision was finally made in favour of a multi-stage exhaust air filter system with integrated heat recovery from KMA Umwelttechnik. The tried-and-tested KMA Ultravent exhaust air filter system is used in many different branches of industry and, thanks to its modular design, can be specifically tailored to the customer's requirements. For those responsible at Tönnies, various aspects were important for the design of the exhaust air technology.

The design of the exhaust air system had to be based on the fact that the exhaust air from nine different deep fryers and ovens is combined. The individual exhaust air temperatures are up to 130 °C and have a very high relative humidity of up to 90 – 100%, especially in the cooking ovens. In addition, a defined amount of odour-contaminated indoor air should be collected and removed. The aim was to achieve a 20-fold air exchange in the production area (2). The extracted exhaust air is replaced by fresh air that is cooled or heated to the specified room temperature. The various exhaust air sources result in an exhaust air mixture of 40,000 to 45,000 m³/h, which can have a high total temperature of up to 90 °C, depending on the recipe and production capacity utilisation, and which also carries a high load of aerosols from fats and oils in addition to the moisture.

Exhaust air filter system brings energy advantages

The alternative exhaust air purification processes had in common that the potentially high exhaust air temperatures should first be lowered to approx. 60 °C to ensure effective separation of substances and odours. In this respect, the solution concept from KMA Umwelttechnik offered the decisive advantage of integrated heat recovery (3). In the filter system, the exhaust air stream is first routed through fin heat exchangers in which thermal energy is transferred to a circuit with cooling medium. In the process, valuable reusable process heat is extracted from the hot exhaust air flow and at the same time the temperature is lowered to the desired 60 °C for optimal particle separation.

In alternative processes without this heat recovery, the proportion of indoor air would need to be added to the exhaust air mixture which would significantly increase in order to reduce the overall temperature to the required low level. This means that the polluted production exhaust air would have had to be mixed with, for example, three times the proportion of room air. However, since this extracted room air must always be replaced by cooled or heated supply air, the increase in the size of the supply air systems and high energy consumption would have been required. Likewise, the entire exhaust air system including the ducting would have to be dimensioned for higher air volumes, which would also have increased the investment and operating costs.

In contrast, the heat recovery of the Ultravent process allows the energy-efficient use of process heat for heating supply air and heating water. Excess energy is removed via a rooftop cooler. Overall, this approach convinced with a significantly better energy efficiency compared to the other processes. Of course, the focus was also on efficient separation of substances and odours. KMA's solution concept provides for a multi-stage process that has proven itself many times over.

Two-filter systems for a total exhaust air volume of 60,000 m³ clean the odour-laden exhaust air and recover process waste heat. *Photo: KMA Umwelttechnik*

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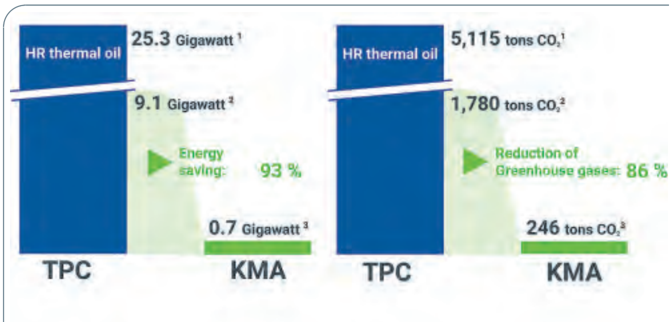
Thermal Post Combustion

Operating costs and secondary emissions are important variables in the decision between Thermal Post Combustion (TPC) and alternative exhaust air purification methods.

The principle of TPC is based on the complete combustion of the organic carbon compounds in the exhaust air to H_2O and CO_2.

In the food industry, afterburning systems must be operated at high temperatures above 750 °C in order to adequately separate emissions and odours. In particular, compliance with CO_2 limits requires operation at high exhaust air temperatures. The permissible limit values of the purified exhaust air can thus be achieved, but at the expense of the environment: The supply of fossil fuels necessary for these high temperatures consumes immense natural resources and releases secondary emissions such as CO_2 and NO_x.

The multi-stage exhaust air purification process of KMA Umwelttechnik purifies the exhaust air entirely without combustion and thus consumes significantly less energy than a TPC. This is clearly reflected in the energy demand and the life cycle assessment in the comparison of the two processes.



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Example calculations for the comparison of energy consumption and CO_2 emissions:
[1] Power requirement TPC taking into account 50% air preheating.
[2] Power requirement TPC taking into account heat recovery for preheating thermal oil. [3] KMA power requirement without taking into account savings through heat recovery for supply air heating.
Assumptions: 6,912 annual operating hours; 42,000 Bm³/h exhaust air volume; 95 C° exhaust air temperature

Filter system combines electrostatic filter and UV light

A stainless steel demister serves as a pre-filter. It separates large particles from the exhaust air and also promotes the formation of droplets from the grease and oil aerosols. The exhaust air is then lead through the heat exchanger already mentioned. The reduction of the exhaust air temperature causes the relative humidity of the exhaust air to increase and gaseous substances to partially condense together with water and to be separated. In the next step, the cooled exhaust air is intensively cleaned of fats, oils and other particles in a two-stage electrostatic filter. By ionising the air with the help of many electrodes arrayed in the air flow, a strong electric field is built up. Due to the resulting charge difference, fine particles and aerosols in the exhaust air stream are captured by the metal plates of the downstream collector zone and thus removed from the air flow. All this is done with a very low energy input, as the power consumption of the electrostatic precipitator is in the range of less than 0.1 ampere. The liquid part of the filtered substances drips off the collector plates. The second fraction forms a greasy or solid coating on the filter surface. Compared to mechanical filters, electrostatic separation has the great advantage that only a very low air resistance is generated. Moreover, the electrostatic filter is not clogged by the separated grease and oil. The energy required for conveying the exhaust air thus remains low.

The separation of particles in the electrostatic filter already makes an important contribution to reducing the odour load of the

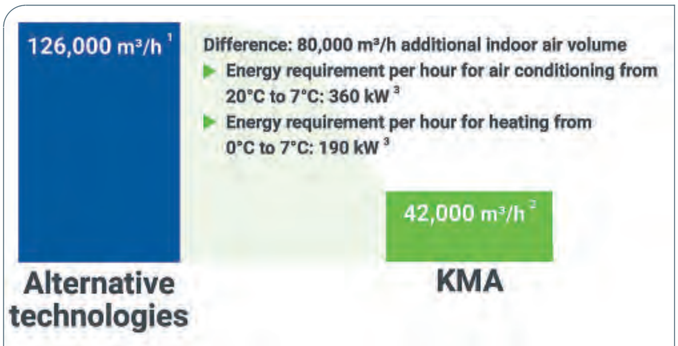
Heat recovery

Integrated heat recovery and required admixture of indoor air are important variables for the choice among alternative exhaust air purification processes.

The reduction of high exhaust air temperatures below a certain level (for example 60 °C) is usually necessary for alternative exhaust air purification processes in order to be able to maintain the required efficiency in the separation of substances and odours. This reduction in temperature can be achieved in two ways.

On the one hand, the hot exhaust air from the production facilities can be mixed with odorous indoor air and thus cooled. In the case of deep fryers and cooking ovens with exhaust air temperatures of approx. 120 – 130 °C, however, this leads to a considerable amount of required indoor air, depending on the room temperature. For example, a mixing ratio of 3:1 between indoor air and system exhaust air may be required. This larger volume of extracted indoor air must be permanently replaced by cooled or heated fresh air.

On the other hand the exhaust air purification system with integrated heat recovery presented in this article makes it possible to extract the heat from the exhaust air via a coolant circuit and makes it usable for recycling (for example, for heating fresh air in winter). The limitation of the volume in the overall system of exhaust air treatment and supply air supply is clearly reflected in the energy demand of the two approaches.



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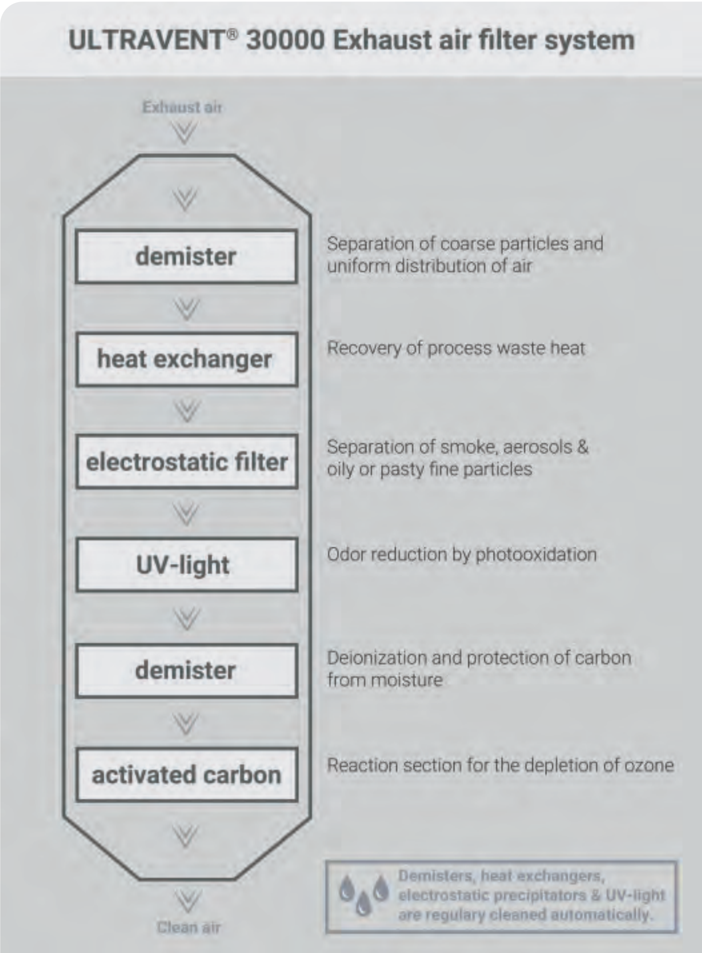
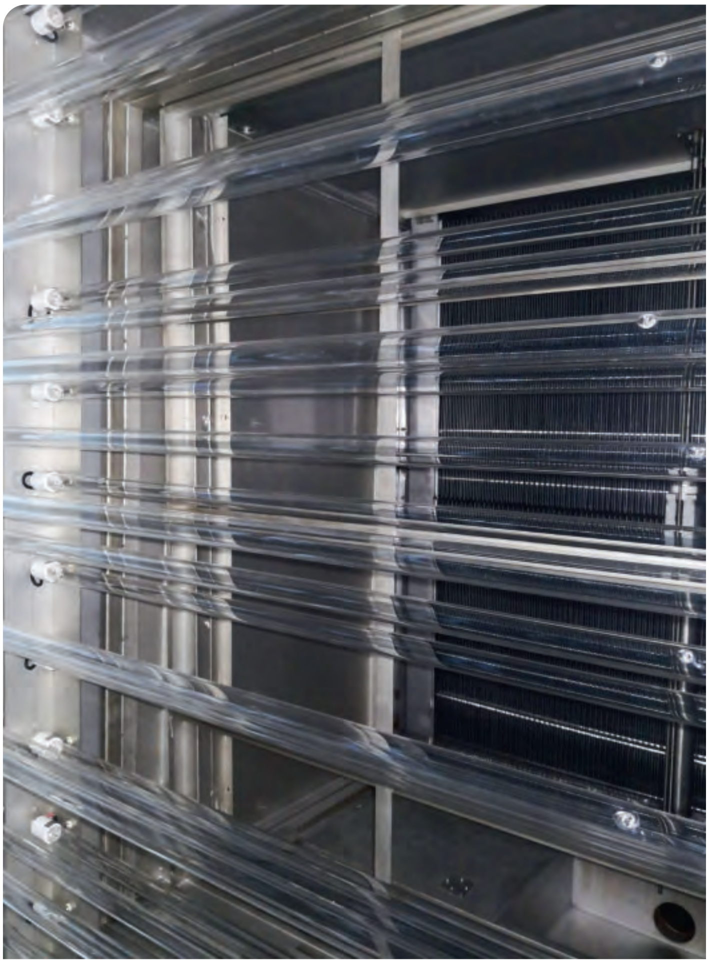
Example calculations for the comparison of required room air volumes:
[1] Exhaust air volume incl. 2 parts indoor air for alternative process
[2] KMA exhaust air volume without extraneous air admixture
[3] Hourly power requirements for cooling or heating of the additional necessary air admixture for alternative technologies
Assumptions: 6,912 annual operating hours; 42,000 Bm³/h exhaust air volume; 95 °C exhaust air temperature



The multistage KMA Ultravent filter system combines electrostatic precipitators and UV light for high efficiency. *Source: KMA Umwelttechnik*



Combination of electrostatic precipitator and UV light for efficient treatment of fryer exhaust air. *Photo: KMA Umwelttechnik*

exhaust air. In order to achieve a further reduction of odours, the exhaust air is intensively irradiated with UV light in the next process stage. The resulting photochemical reaction produces ozone and oxygen radicals which, together with the light waves, neutralise the odour-forming molecules. After UV light treatment, the exhaust air is finally lead through an activated carbon catalyst. The excess ozone is bound in the carbon.

To ensure a continuously high efficiency of all process stages, the filter system is equipped with an automatic cleaning system (Cleaning In Place, CIP). Like an integrated dishwasher, the demister, heat exchanger, electrostatic precipitator and UV light tubes are cleaned fully automatically with heated water and a biodegradable detergent via various movable nozzle blocks. The cleaning fluid circulates multifold between the water tank and the filter system in order to achieve a high cleaning effect while at the same time conserving resources. The activated carbon catalyst is shielded from the cleaning water by a demister.

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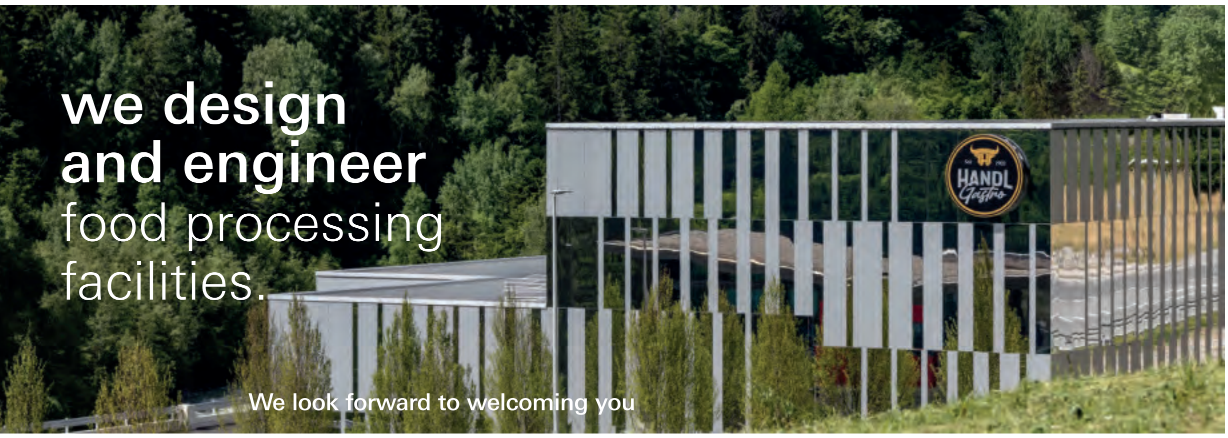

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Invest in an exhaust air filter system

The central filter system is located in the weather protection housing on the roof. *Photo: KMA Umwelttechnik*

To allow continuous operation of production, the exhaust air filter system was designed with a certain reserve (safety margin). Two filter units with an exhaust air capacity of 30,000 m^3/h each were connected in parallel to create a theoretical total capacity of up to 60,000 m^3/h of exhaust air, of which only about 40,000 to 45,000 m^3/h are used during regular operation.[4] If one filter unit is taken out of operation for cleaning or maintenance, the second unit with 30,000 m^3/h capacity bridges the gap without interrupting production. Equipped with powerful silencers, this twin unit was installed on the roof of the Tönnies plant and enclosed with a weatherproof housing.

Exhaust air technology offers high efficiency and flexibility

With this exhaust air filter system with integrated heat recovery, those responsible for exhaust air and room air technology at Tönnies have not only created an energy-efficient and effective system for exhaust air treatment. The solution also offers another advantage, as it creates flexibility. Even when it was subsequently planned to change the production area from an air-conditioned area to a thermal area with a higher room temperature, those responsible were able to give the green light with peace of mind. With the system, all conceivable production scenarios and room temperatures can be addressed. The traditional company Tönnies can thus concentrate on producing high-quality meat products with a clear conscience towards the employees and the environment through effective cleaning of the exhaust air and an important contribution to the sustainability goals of Agenda t30.

Annotations

1. Specifications for the required air exchange rate are summarised in the workplace guideline ASR 5. The main criteria for indoor air quality or the respective air exchange requirement are air pollutants, humidity, odour, heat and number of people. (Guide "Increasing resource efficiency in the food industry" J. Meyer, p.80). – 2. The air exchange per hour is called air exchange rate, the unit of which is 1/h. If the entire air volume of the enclosed space is exchanged exactly once within one hour, the air exchange rate is 1/h. (FVLR recommendation: Natural ventilation of large rooms; guideline 10: August 2014 edition). – 3. The supply and exhaust air should be operated in a targeted manner, if possible via heat recovery. In the case of high air pollution, systems with integrated exhaust air purification equipment can be used. (Guide "Increasing resource efficiency in the food industry" J. Meyer, p.81). – 4. The energy-efficient process of multi-stage exhaust air purification offers solutions for a wide technical range from 5,000m^3 to 60,000 m^3 exhaust air volume.

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