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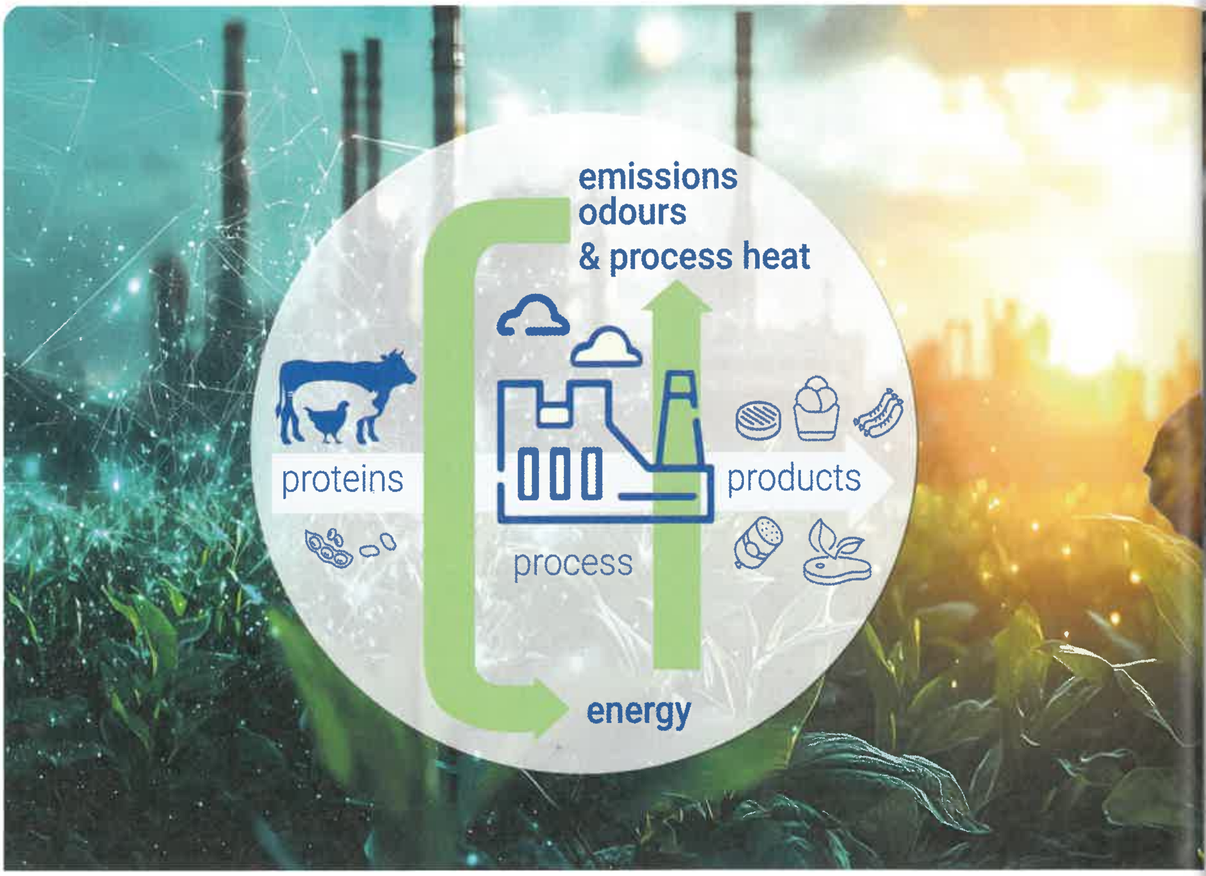

Fig. 1: The industry must significantly reduce emissions in the value chain while maintaining its competitiveness. Meat processors can solve this dilemma with modern environmental technology and benefit from the green competitive factor.
Source: KMA Umwelttechnik

Future-proof meat processing

Dual benefits through emission control and cost reduction thanks to innovative environmental technology

In 2022, the ten largest German meat companies produced a total of almost 30 million tonnes of CO_2 equivalents[1]. This corresponds to one third of the emissions produced by car fuel combustion in Germany in 2022. The industry faces the major challenge of significantly reducing these emissions in the value chain while remaining competitive. Modern environmental technology in meat processing offers solutions to this dilemma. The following article presents which specialists in meat and protein products are already benefiting from this green competitive factor in Germany.

By Friederike Schmedding

It is not only the operators of emission-intensive frying, roasting and cooking systems or smokehouses that are facing major challenges in Germany: while legal requirements for reducing emissions are being tightened, rising energy costs are driving up the operating costs of all processed meat and protein producers. They are required to implement sustainable solutions that take into account both environmental requirements and economic aspects.

From improved energy efficiency through heat recovery from polluted production exhaust air to energy-saving exhaust air purification to comply with applicable emission limits – tried and tested environmental technology is presented by leading meat processing companies that pay off both ecologically and economically.

Legal requirements set emission limits

In Germany, the Federal Immission Control Act (BImSchG) and the Technical Instructions on Air Quality Control (TA-Luft) regulate the permissible emissions from meat processing plants. These laws define how much pollutants such as organic carbons and other volatile organic compounds (VOCs) may be emitted into the environment from production processes. Companies must prove that their emissions do not exceed these limits.

At international level, there are a large number of agreements and regulations on reducing emissions. In addition to the Paris Agreement, there are various European directives (such as the BREF, short for Best Available Techniques Reference) that are integrated into national laws. Compliance with these international standards is necessary for companies not only to fulfil national regulations, but also to ensure their competitiveness on a global level.

Dilemma: High emissions and energy losses

Compliance with the increasingly restrictive emission limit values often requires the use of additional technical systems, which not only entail investment costs, but also considerable operating and maintenance costs. At the same time, energy prices are rising, making the operating costs of traditional processes such as gas-fuelled thermal oxidiser, the 'waste incineration of exhaust air', increasingly unattractive for many companies.

Nevertheless, the production of meat and protein products, e.g. during cooking, roasting, frying or smoking applications, generates exhaust air flows with high temperatures, pollutant-containing aerosols and volatile organic substances that need to be treated.

However, conventional methods of exhaust air purification such as thermal oxidation consume enormous amounts of fossil fuels and cause high CO_2 emissions. This leads to rising operating costs and additional CO_2 taxes, which further jeopardises their economic viability.

Vegan Mühlen Frikadellen, cooked and fried, are manufactured in an energy-saving and low-emission process.
Photo: Rügenwalder Mühle

The dilemma between emission limits and profitability cannot be ignored by manufacturers of meat products in Germany.

Particularly in economically weak phases, many companies fear high investments in sustainable technologies and underestimate the savings potential offered by modern exhaust air purification systems. Yet the waste heat from process exhaust air is a valuable, often unutilised resource that can make a significant contribution to energy efficiency.

The choice of suitable process technology depends primarily on the specific properties of the exhaust air. Decisive factors include the type and concentration of aerosols (particles, gases, volatile substances, and odours) as well as moisture content and temperature.

Modern exhaust air purification systems rely on multi-stage technology that combines electrostatic precipitators, heat exchangers, UV light, activated carbon filters and wet scrubbers. The biggest advantage: these systems do not require fossil fuels and consume up to 98% less energy compared to conventional post-combustion processes.

Electrostatic precipitators are characterised by a high separation efficiency with low energy consumption and separate up to 99% of particles and aerosols from the exhaust air. Additionally integrated heat recovery systems also allow the process heat to be utilised for heating supply air systems or for hot water preparation.

Exhaust air purification process drives energy costs

Operating costs and secondary emissions are important factors when deciding between the various exhaust air purification methods. The principle of thermal oxidation is based on the complete combustion of the organic carbon compounds in the exhaust air.

Regenerative thermal oxidiser (RTO) is also based on high-temperature combustion, but uses a heat recovery system with ceramic heat exchangers. These store the heat from the purified exhaust air and use it to preheat the incoming polluted exhaust air.

In the food industry, however, all thermal oxidiser must be operated at high temperatures above 750°C in order to separate emissions and odours in accordance with the applicable limit values. The supply of fossil fuels required for these high temperatures consumes immense natural resources and releases secondary emissions such as CO_2 and NO_x.

Modern exhaust air purification processes clean the exhaust air completely without combustion and therefore consume significantly less energy than a post-combustion plant. This is clearly reflected in the energy requirement and the life cycle assessment when comparing the processes. The following sample calculation illustrates the difference:

A meat-processing company refines its products using a deep-frying system with an exhaust air temperature of 60°C and an exhaust air volume of 7 500 m³/h and needs to purchase an exhaust air purification system in order to comply with the applicable emission limits.

The operating costs required to operate the technical exhaust air filtration system are made up of the energy costs and the EU taxes associated with the CO_2 emissions (€55 per ton of CO_2). With 5 000 operating hours per year, this results in operating costs of over EUR 350 000 for the incineration plant compared to approx. EUR 12 500 for the modern environmental technology. The 1 000 tonnes of CO_2 saved not only make a big difference ecologically, but also economically.

Rügenwalder Mühle relies on environmental technology

Since 2002, KMA Umwelttechnik has been supporting Rügenwalder Mühle Carl Müller GmbH & Co. KG in optimizing their production processes with a focus on environmental performance and sustainability. In the course of production expansions and the introduction of new product lines, particularly in the production of meat alternatives with increased odour emissions, targeted investments were made in environmental technology systems.


Sustainable exhaust air treatment during frying and roasting in Bad Zwischenahn for improved energy efficiency through targeted heat recovery. *Photo: KMA Umwelttechnik*


Two exhaust air filter systems treat a total exhaust volume of 60 000 m³, effectively removing odours and recovering valuable process heat. *Photo: KMA Umwelttechnik*

At the Bad Zwischenahn site, meat alternatives are processed in various frying, grilling, and cooking systems. Odour emissions are released in hot, oily production exhaust air, particularly in such applications. This applies to the larger application of frying and roasting processes in industrial food production similar to frying or roasting in the home kitchen. The challenge is to neutralise the VOCs and odours generated by the production processes effectively and in an environmentally friendly manner.

The ULTRAVENT® H 30000 air filter system used combines several process modules and has a heat exchanger, an electrostatic precipitator, UV light and a carbon catalyser. The exhaust air flow first passes through a finned heat exchanger, which transfers the heat energy it contains to a cooling circuit. This extracts valuable process heat from the hot exhaust air flow and at the same time reduces the temperature to an optimum level for subsequent particle separation in the high-performance electrostatic precipitator. The integration of an automatic filter cleaning system (CIP – Cleaning in Place) contributes significantly to the longevity of the filter system and the heat recovery system, as it reliably removes impurities and aerosol residues from the electrostatic precipitator, UV light module and heat exchanger.

This efficient exhaust air purification not only minimises typical production odours at the property boundary, but also makes targeted use of the recovered thermal energy – for example to heat cleaning water, which is stored in a buffer tank.

The consistent use of environmental technology thus offers Rügenwalder Mühle effective emission protection and at the same time improves energy efficiency through targeted heat recovery from the polluted production exhaust air.

Tönnies relies on efficient exhaust air treatment

At its headquarters in eastern Westphalia, the Tönnies Group produces not only meat and sausages but also a wide range of high-quality food products for the German and European markets. As part of its Agenda t30 sustainability strategy, the Group has set itself the goal of reducing CO_2 emissions by at least 50% by 2030 compared to 2010. Great importance is attached to energy-efficient production and building technology.

To accommodate increased production capacity, the integration of new fryers and cooking ovens into the existing exhaust and ventilation infrastructure became necessary. The production facilities produce a wide variety of meat products, including schnitzels, gyros, hamburgers, kebabs and toasties.

The resulting exhaust air flows reach temperatures of up to 130°C and have a high relative humidity of up to 90 to 100%, particularly in the cooking ovens. The total exhaust air volume, resulting from the various exhaust air sources, amounts to 40 000 to 45 000 m³/h.

Depending on production capacity utilisation and recipe, the exhaust air can reach a total temperature of up to 90°C. In addition to the high humidity, the fryer exhaust air

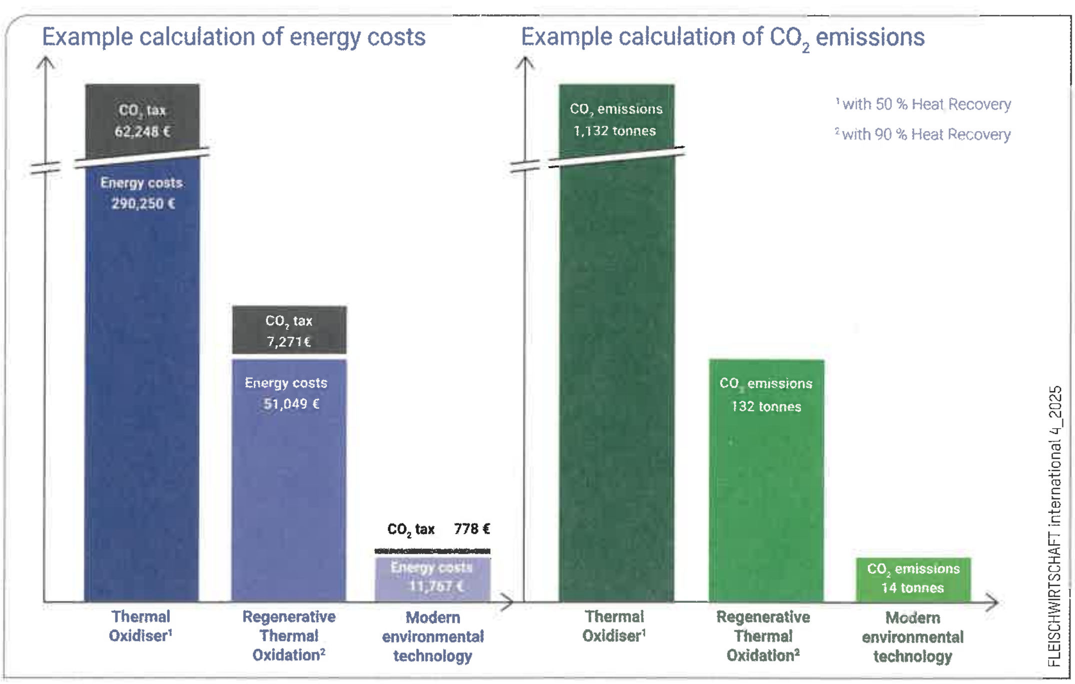

Fig. 2: Calculation basis: exhaust air volume: 7500 m³/h, exhaust air temperature 60°C, operating time: 5000 hours/year, natural gas price 5 cent/m³, electricity price 20 cent/kWh, EU CO_2 tax 2025 at 55 €/tonne CO_2. *Source: KMA Umwelttechnik*

contains a considerable amount of aerosols, fats, and oils. To ensure effective separation of pollutants and odours from the hot exhaust air, most exhaust air purification processes without thermal oxidation require the temperature of the exhaust air to be reduced below a certain level - for example 60°C.

Reducing high exhaust air temperatures

One option is to mix the hot exhaust air from the production facilities with odour-laden room air, which reduces the temperature. In processes such as plasma, ozone or standalone UV light systems without integrated heat recovery, the proportion of room air added must be significantly increased in order to reduce the overall temperature to the required low level and comply with the emission limits. However, particularly in processes with high output temperatures, such as in deep fryers and ovens with exhaust air temperatures between 120 and 130°C, this can require considerable amounts of room air. Depending on the ambient temperature, a mixing ratio of 3:1 between room air and system exhaust air may be necessary, which leads to a tripling of the operating volume including larger dimensioning of the exhaust air, supply air systems and pipework. As the increased room air volume must be continuously replaced by cooled or heated fresh air, additional energy is required for the air conditioning and ventilation of the production areas.

The second option for reducing the exhaust air temperature is to extract the heat from the contaminated production air using heat exchangers and utilise it for further energy recovery. Modern exhaust air purification systems with integrated heat recovery can treat hot fryer exhaust air directly without mixing in room air and thus achieve significantly more efficient air management of smaller capacity.

The integrated heat exchangers extract the heat from the exhaust air via a coolant circuit and use it to heat fresh air or process water, for example. This offers the operator of the efficient environmental technology three advantages: The compact operating volume enables a leaner dimensioning of the air technology, the heat recovery provides thermal energy for subsequent processes and the building technology can design production scenarios more flexibly. The room temperatures can be adjusted according to the desired production scenario (air-conditioned or thermal area) without having to consider a change in the mixing ratio of the exhaust air/room air and the total volume. The solution of efficient exhaust air treatment without room air admixture therefore offers more flexibility.

Meat alternatives drive demand for green tech

As with meat production, the manufacture of alternative protein products is also associated with the emission of odours and other volatile organic compounds (VOCs).

In Germany, plant-based burger patties, nuggets, minced meat or chicken are particularly popular among the so-called 'convenience' meat alternatives. According to the GFI Alternative Protein Company database, frozen and chilled products account for 84% of sales of meat substitutes.

The exact composition of the flavourings used in the manufacture of these products remains a closely guarded trade secret. However, there is no question that alternative proteins – similar to conventional meat products – develop intense odours during frying or deep-frying, which can vary depending on the marinade, breading or spice mix used. At the same time, the environmentally conscious target group attaches great importance to sustainable production, as their consumption of alternative proteins is largely motivated by environmental and climate protection concerns.

Consistently sustainable value chain

The experts at endori food GmbH & Co. KG, a manufacturer of pea-based meat and fish alternatives, are also aware of the importance of sustainable production. The company produces plant-based alternatives such as schnitzel, burger patties, sausages, mince, chicken and many other products.

With the guiding principle 'from field to fork', the company is a pioneer in sustainably promoting a consistent green value chain.

The manufacturers of the popular meat-free products are also faced with the challenge of analysing the environmental impact and carbon footprint of their own production at the production site in Stegaurach. This includes both the sustainable handling of emissions into the environment and the ecological footprint of production. For the pea schnitzel, vegan chicken, vegan nuggets or vegan burgers, it also goes through the deep fryer or roaster at endori. As with all manufacturing processes in the value chain, the pea specialist also addressed the sustainability of the necessary exhaust air treatment in order to meet the defined emission limits.

When the company was founded in 2015, it opted for a sustainable multi-stage exhaust air purification process without burning fossil fuels instead of an energy-intensive gas-fuelled thermal oxidiser, with an energy cost advantage and CO_2 savings of 80% compared to a thermal oxidiser.

These practical examples prove that sustainable technologies are not only worthwhile from an environmental perspective, but also bring tangible economic benefits. Thanks to the German federal subsidies for energy and resource efficiency (BAFA Module 4), companies can also apply for attractive subsidies for investments in energy-efficient exhaust air purification systems.

If you want to remain competitive, you have to act. In view of the economic situation, the reluctance to purchase new environmental technology is understandable at first glance. However, the practical examples of future-proof meat processors in Germany show this: Innovative exhaust air filter solutions and heat recovery systems not only save energy costs and CO_2 emissions while complying with the applicable emission guidelines, but also improve production processes.

Companies that rise to the challenge secure a decisive competitive advantage for the future – both financially and in terms of sustainability.

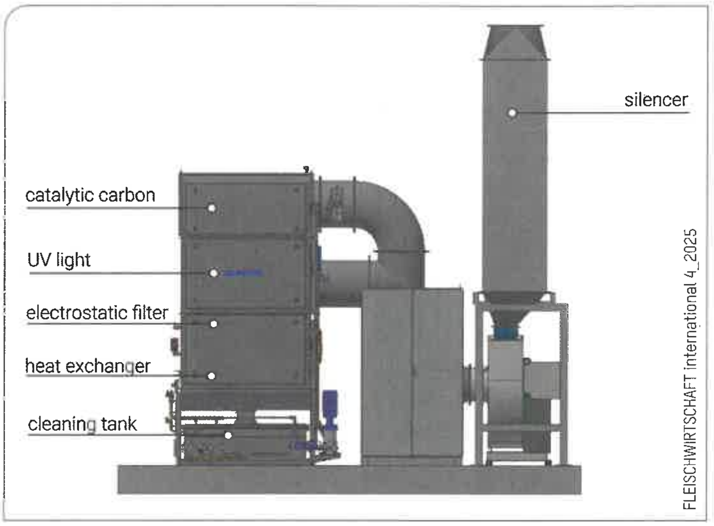

Fig. 3: Functional components – heat exchanger, electrostatic precipitator, UV light, catalytic carbon and automatic cleaning – are integrated into the KMA Ultravent filter system to save space. The filter system can be installed on the roof or inside the production hall. *Source: KMA Umwelttechnik*

Source
1. Tsilimekis, K., 2025, 'Super-Emittenten' der Fleisch- und Milchwirtschaft in Deutschland, www.germanwatch.org/de/91962

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studied International Marketing Management at the University of St. Gallen. Before joining KMA Umwelttechnik, she was a marketing expert for explanation-intensive products in various industries. She is now responsible for the company's global marketing activities and business development.

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