Safe meat products with a good taste

Modern machinery translates traditional smoking methods into reproducible practice

Smoking is one of the oldest processes to make meat products safe for human consumption. Nowadays different machine-supported smoking technologies are introduced in the food-business. Every single technology has its special advantages.

By Andre Budesheim

The history of smoking can be traced back a long way. Ever since mankind discovered fire and used it to prepare foods, meat has been preserved with smoke. Even archaeological findings document that smoking alongside salting and drying already played a key role in preserving foods at an early stage of human development. Smoking, often in conjunction with salting, became increasingly significant in subsequent centuries. This simple but effective method protected meat products against spoiling by surface rotting and mould. The flavouring effect was initially secondary and more of a pleasant side effect. Later, when farmers slaughtered their animals themselves for self-sufficiency purposes, the lack of cooling opportunities meant that their only option was to cure and smoke large pieces of meat. For this the meat pieces were hung up in the smoke rising from open fireplaces in living quarters and kitchens and cold-smoked there for five to ten weeks. Later chimneys and flues were constructed in brick and stone for the fireplaces, doing away with the possibility of open smoking. As a consequence special smoking cabinets or entire smoking huts were built. These buildings, found especially in North Germany, were used by farmers from the surroundings to smoke mettwurst sausages and raw ham. After slaughtering their animals and subsequently salting/ripening the meat pieces, they took their products to the master smoking craftsman who then smoked them on their behalf.

The introduction of machinery and technology into the meat industry and craft trades brought major changes. Today, smoke generators have to satisfy stringent conditions regarding environmental protection and residues. The high demands made of product quality and reproducibility challenge manufacturers of smoking facilities. The food retail trade and its customers played a large role in this development. The retail trade demands ever more homogenous products, irrespective of whether it is summer or winter or whether fluctuations in the raw material contradict uniformity of the smoked colour and smoked flavour.

Alongside the structural features of a smoking facility, such as for example arrangement and size of the injection fan nozzles or the feed air duct, size of the mixing chamber and ambient air flow rate, the smoke generator plays a significant key role as regards reproducibility and product quality. The uniformity of the facility is equally important, especially in the upstream smoking stages such as for example drying, for only uniformly pre-conditioned surfaces can be treated uniformly with smoke.

Smoke generation is a thermal process

Smoke development can be divided into two phases. In the first phase the thermal products of decomposition are formed and in the second phase these are oxidised under the influence of oxygen. A large number of substances affecting aroma, colour and taste are formed in the pyrolysis of the wood used for smoking. Not all products developing during smoking have been analysed or identified yet, but it is reckoned that they number up to 1,000 different substances. The active mechanisms can be explained on the basis of the 200 substances already identified. For instance mainly phenols, organic acids, carbonyl compounds and polycyclic aromatic hydrocarbons (PAH) have been detected. (Fig. 1) As wood can contain various resins, essential oils and other substances alongside its 50% cellulose, 20% hemicellulose and 30% lignin, the selection of the wood type also affects the taste.

Fig. 1: The glow smoke generator comes closest to traditional smoke generation by glow burning of wood chips.

Smoke is an aerosol, which means that it contains liquids and solid constituents alongside air and gases. The solid constituents are generally soot and ash particles. The gaseous components consist of nitrogen, hydrogen, methane, oxygen and ethane. A distinction is made between four different systems of smoke generation that can be divided into two categories. While the classic glow smoke belongs to the exothermal methods, friction and steam smoke are counted among the endothermal methods.

The range of methods and equipment is large

■ Glow smoke generators: In glow smoke generators, smoke is developed by an electrically controlled agitator passing wood shavings to the process chamber. There the shavings are either ignited in the actual down-pipe or on burning plates using an electrical heating rod. (Fig. 2) Pyrolysis and oxidation take place at temperatures between 550 °C and 750 °C. As a consequence, more undesirable by-products such as tar and ash residues develop in this smoking process. Glow smoke is the most widespread smoke generator and can be used for all meat products. The preserving effect on raw sausages and hams with this smoking method is higher than with other smoke generation methods.

The firm Schröter based in Borgholzhausen, Germany, produces a series of glow smoke generators with various outputs. Alongside the classic glow smoke generator R90 for smaller plant systems, they also manufacture the equipment types R91 and R91 S (sawdust) for larger installations and the new generation of the RH family. The RH04 and RH09 work with a closed system and thus offer a constant smoke volume with low sawdust consumption. All Schröter glow smoke generators are equipped with a blower that divides the airflow into combustion and conveying air by means of an air divider. The combustion air, like the entire air flow, can be regulated and serves to achieve optimal smoke quality and furthermore ensures compliance with the legal national requirements.

The smoke intensity can also be controlled by various setting options. For example alongside the air supply and sawdust filling e.g. the agitating times too can be altered for several temperature ranges. These options make this smoke generator one of the most flexible systems in the Schröter portfolio, as it can be adapted to individual customer needs. The RH09 especially is an ideal compromise between smoke volume produced and waste gas volume to be cleaned.

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■ Friction smoke generators: Friction smoke generators work on a quite different technical principle. Here squared timber/ wooden bars are pressed mechanically, hydraulically or pneumatically against a rotating friction wheel. The friction generates a mild smoke at temperatures between 300 °C and 400 °C, but such smoke contains fewer preserving ingredients than glow smoke. This smoke generator is suitable above all for products requiring a strong smoked colour but a mild smoked taste. Friction smoke generators operate in a "closed system", i.e. the transport air that conveys the smoke from the smoke generator into the system is extracted from the system and returned to the smoke generator. Accordingly the friction smoke generator operates with very low waste gas volumes, corresponding roughly to the volume of the chamber and pipe in m^3. That is why energy-consuming exhaust air cleaning is usually not necessary here.

The friction smoke generator Smokjet® RF presses pieces of squared timber or wooden bars (100 x 100 x 1000 millimetre) pneumatically against a rotating friction wheel. (Fig. 3) The pressure is applied via a robust and long-life conveyor chain. The magazine above the conveyor / pressure facility with space for five wooden bars guarantees long smoking times. Smoke is produced alternatingly and the pressure periods and breaks in-between can be varied. This ensures that the smoking wood pyrolysis takes place precisely within the defined temperature range. Like the glow smoke generators, the friction smoke generators are also equipped with permanent temperature monitoring that extinguishes the fire automatically when a pre-set maximum temperature is reached. For safety reasons the extinguishing facility is also triggered in the event of a power cut. No exhaust air cleaning is necessary for friction smoke generators.

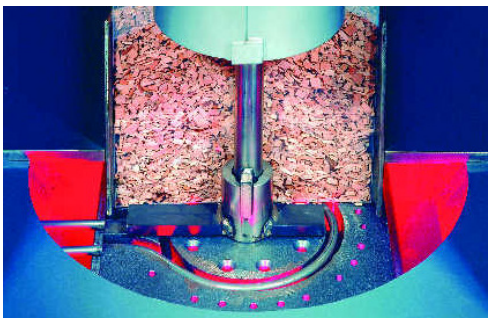

Fig. 2: In the glow smoke generator the wood chips are passed from the wood chip hopper via the mixing arm and downpipe to the burning plate via the interval control circuit of the geared motor.

■ Condensate or steam smoke generators: A continuous conveyor device supplies the condensate smoke generator with wood chips. In the reaction chamber the wood chips are passed via a perforated or slotted pipe section or plate and superheated saturated steam flows through them. (Fig. 4) The steam, which has first been heated by an electrical heating package to 340–430 °C, causes pyrolysis with subsequent oxidation. As the smoke is warmer and damper than the product surface, it condenses excellently on the casing surface. The steam smoke generator is ideal especially for small-calibre hot-smoked boiling sausages. The smoke has an extremely well-flavoured aroma and the residues (e.g. PAH) are normally below the detection limit. Thanks to the defined starting conditions such as uniform wood chip supply, steam temperature, moisture and smoke temperature, the steam smoke generator offers excellent opportunities for standardising processes. The exhaust air cleaning is also very simple. As the smoke is bound in the steam, a scrubber that condenses the smoke out through atomised water suffices. The washing water can then be disposed of via the sewage system.

The steam smoke generator Smokjet® RD is a machine for the hot smoking segment, for continuous wood chip supply, constant pyrolysis temperatures and moisture guarantee a maximum of reproducibility and uniformity. As the temperature of the superheated steam can be regulated between 380–420 °C, it is possible to adjust the aroma and intensity of the smoke within certain frameworks. Moreover the smoke can be cleaned very simply via a scrubber.

■ Liquid smoke: Liquid smoke assumes a special position. In the production of the smoke condensate, wood chips are glowed as in the traditional method. The resulting smoke is then subsequently brought to condensation and freed from undesirable products by fractioning (e.g. centrifuging, extraction) and/or set to the desired taste type. The smoke condensate is applied to the meat products by atomising, sprinkling and immersing methods. In atomising, either the smoke condensate alone is finely atomised in the system directly via a nozzle, or the liquid smoke device operates with "dual component nozzles". In this system liquid smoke from the stock container is passed through one nozzle in the line and the compressed air necessary for fine atomising is passed to a second nozzle. The flow rate can be set via the air pressure at the stock container and the nozzle pressure regulates the spray and atomising pattern. For purposes of process standardisation, care should be taken to ensure that all nozzles have the same flow rate. This is particularly important in systems with several nozzles. Liquid gas equipment does not require any waste gas cleaning either and the installation itself can be cleaned very easily thanks to the minimal soiling.

The liquid smoke facility Smokjet® RL rounds off the

Schröter smoke producing portfolio. In this system an adjustable volume of liquid smoke is drawn via compressed air from the liquid smoke stock container and passed to several dual component nozzles in the process chamber. There the smoke condensate is atomised very finely together with the compressed air that is supplied separately. The intervals between spraying and circulating can be tuned precisely to the product and the desired taste.

Stability and sensory properties

Nearly all the smoke constituents influence the aroma and colour of the products. Alongside the colorant smoke constituents, Maillard reaction products and the nitrogen oxide (NO) contained in the smoke affect the colour development. The reaction between the carbonic acids contained in the smoke and the meat proteins is one of the key reactions in the smoking process and influences the colour, the casing strength and the product stability. The own skin formation in peelable casing products also evolves from this carbonyl-protein reaction. The meat colour prescribed by the formulation (type of meat, myoglobin content, NOMb etc.) and the condition of the meat products also play a significant role in the smoking colour.

The wood influences the aroma

The aroma depends on the wood used for smoking (softwood or hardwood), smoke development temperature and smoking method. The smoke taste is a product of all the smoke ingredients together. However the chemical compound 4-methyl guaiacol, isoeugenol, dimethylphenol and syringaldehyde (Jira, 2004) also play an important part in the flavour formation. In some regions it is customary to mix spices or twigs and bushes in with the smoking material for the glow smoke method, for example for production of the well-known Black Forest Ham. For this either pine shavings or pine twigs are added to the smoking meal. The main difference by comparison with hardwood is the higher content of terpene hydrocarbons. These cyclical hydrocarbons are released during pyrolysis due to the higher content of essential oils and thus provide a modified taste profile.

Fig. 3: The taste of products smoked in a friction smoke generator is medium strong. No waste air cleaning or fresh air supply are necessary.

Conservation of the smoked material

Prolonging stability by smoking was the most important property in former times. Today, this plays a significant but subordinate role. Precisely controllable climatic conditions during ripening, cold storage and minimal storage duration reduce the risk of microbial spoiling on the surface of meat products. The objective is to allow the antimicrobial constituents to act both on the surface and by partial diffusion in the edge areas by applying smoke to the outer layer.

The phenols and their derivates, aldehydes, ketones, organic acids such as e.g. formic and acetic acid and alcohols, esters and furanes contained in the smoking smoke are chiefly responsible for the preservative action. Especially the protein-networking effect of the formaldehydes (belonging the aldehydes) leads to a change in the protein network of the microorganisms, which has a lethal effect on the microorganism. Furthermore, on natural casings these smoke constituents serve to build up a protein network that acts directly on the firmness of the edible sausage casings (especially natural pork and mutton/lamb casings). In certain products this casing hardening is desirable. For example this property produces the necessary casing stability for canned sausages during sterilising. In the case of small (frankfurter-type) sausages sold loose as counter products or in self-service modified-atmosphere packaging, excessive casing hardening is totally undesirable for bockwurst or wieners. Various technologies and process steps can be taken to counteract this. However, these are not discussed in any further detail here.

Fig. 4: In a steam smoke generator the wood chip contents are expelled by superheated steam. The smoke taste is medium to strong.

The anti-oxidative properties of the phenols are also a definite advantage, especially for raw sausages. Phenols are able to counteract fatty acid radicals by giving off atomic hydrogen. This property is important and desirable particularly in the case of long-ripened raw sausages. That is why for instance e.g. short smoking stages are sometimes included in the process during ripening of air-dried products too, such as e.g. Hungarian salami.

Smoke generators bring reproducible results

True to the slogan "Leading Quality", Schröter guarantees its customers optimally reproducible process results with best processing quality. This is backed up by 50 years of experience in plant construction for the meat and fish processing industries and continuous further development of the company's technical and technological know-how.

References

1. Jira, W. (2004): Chemische Vorgänge beim Pökeln und Räuchern. Mitteilungsblatt BAFF *43* No. 163, 27–38. – 2. Müller, W.-D. (1984): Kulmbacher Reihe Band 4, Technologie der Brühwurst: Füllen und Räuchern, Bundesanstalt für Fleischforschung Kulmbach. – 3. Sielaff, H. (1996): Fleischtechnologie: Erzeugnisherstellung – Pökelwaren und Räuchern, Behr's Verlag Hamburg.

Supplementary literature

Institut für Mikrobiologie, Toxikologie und Histologie der Bundesanstalt für Fleischforschung Kulmbach: Kulmbacher Reihe Band 5, Mikrobiologie und Qualität von Rohwurst und Rohschinken, 1985

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