

# Formation of volatile compounds in cooking oil fumes

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# Who we are

- Accident prevention and insurance association of
  - Food processing industry
  - Catering trade
  - Cigarette industry
- 1.7 million insurants
- 393 000 businesses



# Our tasks

- Prevention of occupational accidents, occupational diseases and work-related health hazards
- Restoration of health and working capacity (rehabilitation)
- Financial compensation



# Why dealing with cooking oil fumes ?

- High number of occupational diseases of the respiratory tract in the catering trade and the baker's trade
- One reason may be the exposure of the employees to cooking oil fumes



# Typical workplaces



frying pan



doughnut drainer



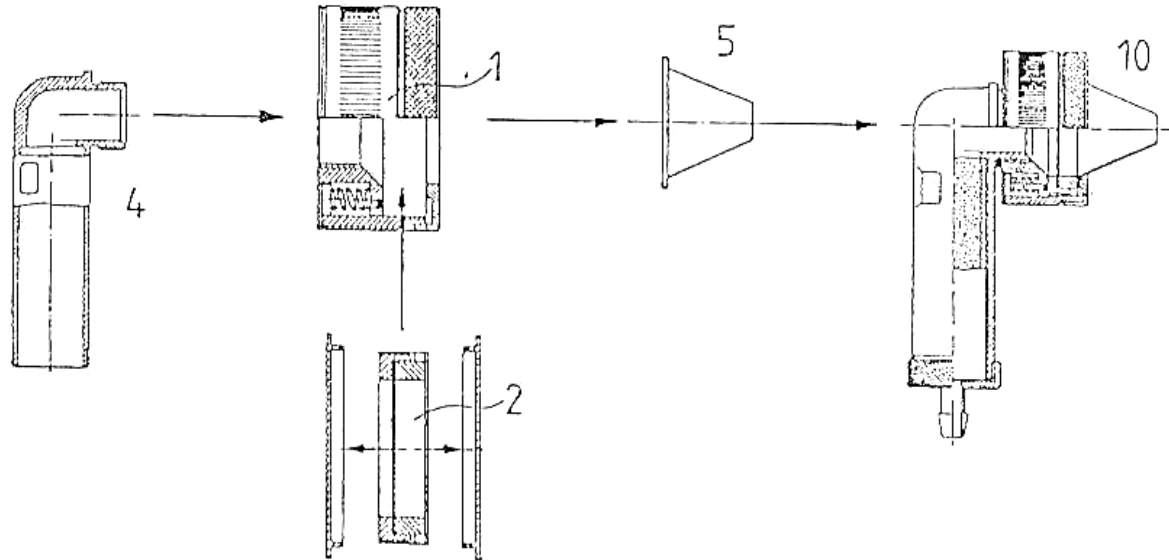
# Typical workplaces



- Vapours and aerosols are released into the surrounding air
- Pyrolysis products of fat and fatty aerosols
- Aerosols are airborne and contain an array of hazardous substances

deep fryer

# Sampling device



## COLLECTION SYSTEM

1 Filter holder

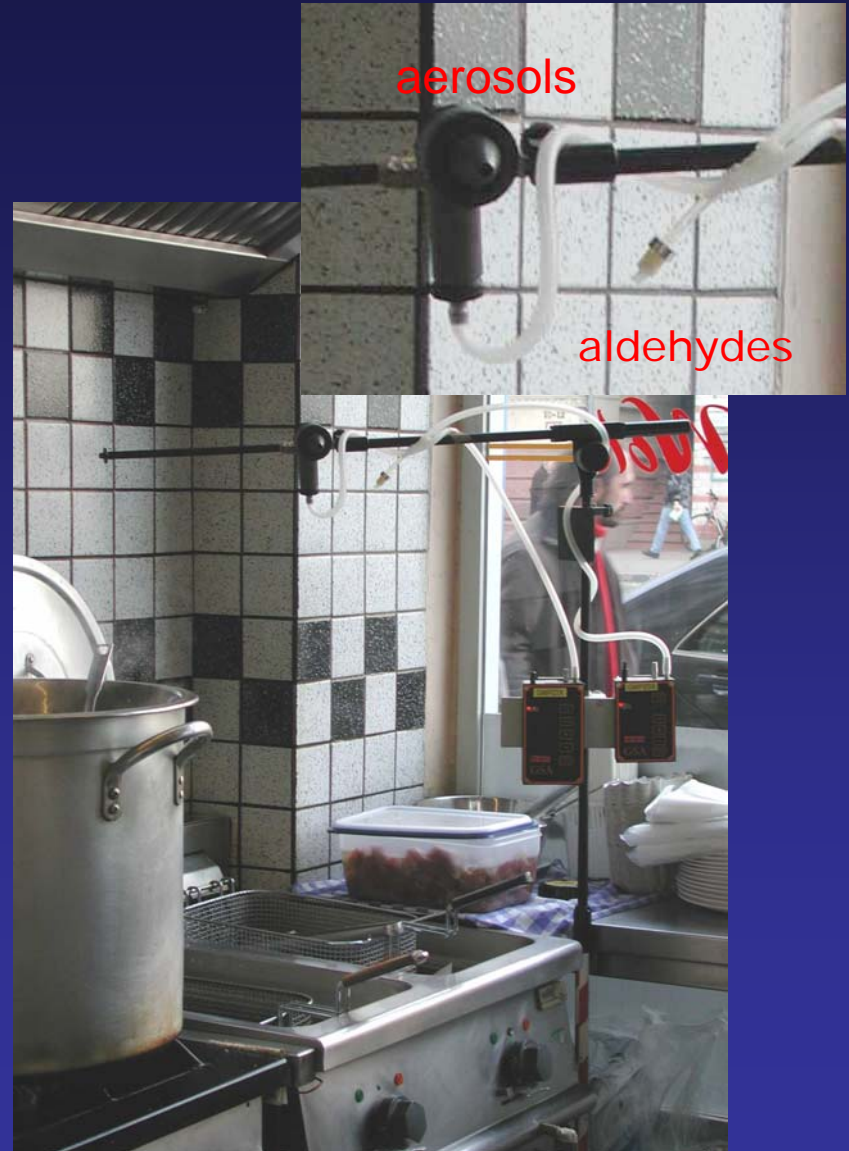
2 Filter

4 Cartridge



# Air Sampling

- Sampling is performed at the breathing height
- Aerosols
- Volatile compounds
- Aldehydes





# Results I

- Aerosols
  - Major compounds:
    - triglycerides
    - fatty acids (oleic acid, palmitic acid, stearic acid and in a few cases linoleic acid)
  - Minor compounds:
    - Butyl- and isobutylesters of fatty acids, squalene, sterol and vitamin derivatives
- Volatiles
  - BHA, BHT, derivatives of furane etc.
- Saturated and unsaturated aldehydes (C1-C11)



# Results II

Measurements were performed in kitchens, that were different in room sizes and ventilation systems. Various foodstuffs were prepared.

- Aerosols: n.d.-11mg/m<sup>3</sup>
- Up to 90% of aerosols are triglycerides and fatty acids
- Aldehydes: 0.1mg/m<sup>3</sup>- 4mg/m<sup>3</sup>
  - Acrolein: 0.02- 0.72 mg/m<sup>3</sup>
  - Caproaldehyde: 0.02- 1.12 mg/m<sup>3</sup>
  - Nonanal: 0.02- 0.59 mg/m<sup>3</sup>
  - Decadienal: 0.03- 1.19 mg/m<sup>3</sup>



# Conclusions I

- High concentrations of aerosols at frying pans are found
- Aerosol concentrations at deep fryers are not above  $1\text{mg}/\text{m}^3$
- Threshold Limit Value of acrolein ( $0.25\text{mg}/\text{m}^3$ ) may be reached at insufficient ventilation conditions
  - poor quality of the fat used
  - the fresh oil/fat contains high levels of linoleic acid (30-40%) and linolenic acid (6-8%)



# Conclusions II

- for the estimation of the air quality in kitchens it is sufficient to determine the concentration of aerosols and acrolein
- if the aerosol concentration is  $< 2\text{mg}/\text{m}^3$  we will speak of a “well ventilated kitchen”



# Measurements at a doughnut drainer

- Cooperation with IGV (Institute of Cereal Processing, Ltd.)
- Measurements of the volatile compounds were performed at the breathing zone above a doughnut drainer (fryer)
  - two different types of fat are heated without foodstuff
  - Influence of the deep frying process on the formation of volatile compounds is studied
  - Influence of a ventilation system



# Experiment I



- 12 kg fat were heated at 180°C
- 8 hours at 5 days
- no ventilation system
- no deep frying process
- “worst case” measurement



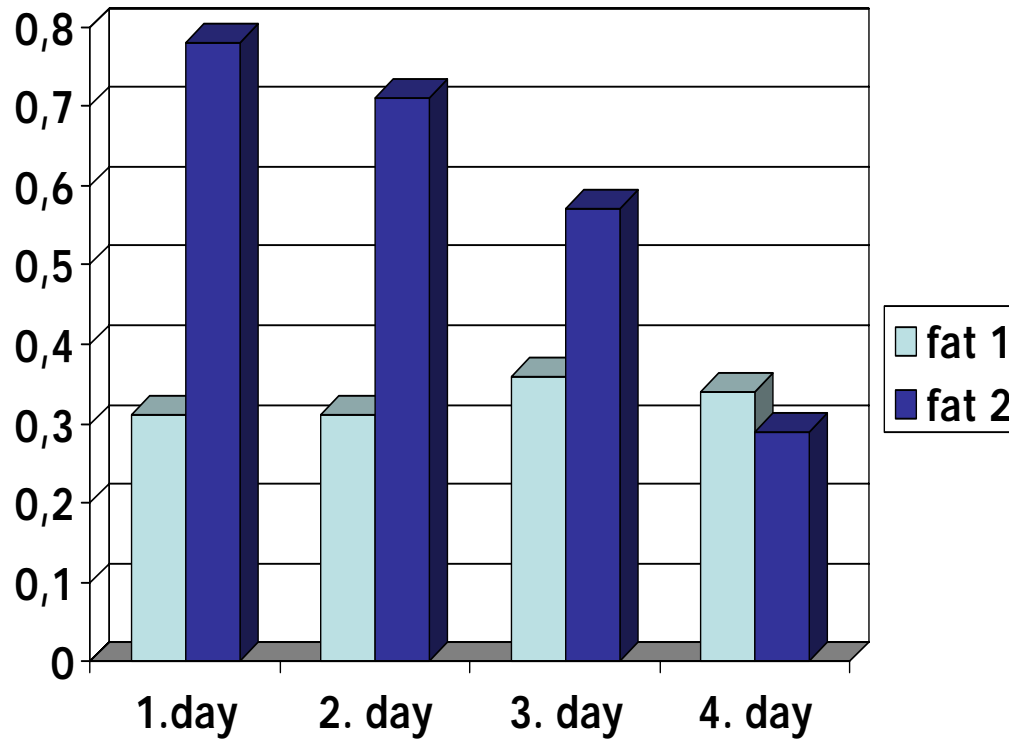
# Comparison of two fats/ fatty acid composition

	Fat 1 Hardened peanut fat, amount in [%]	Fat 2 Based of palm oil, amount in [%]
.....		
Palmitic acid	10.2	42.1
Stearic acid	6.8	4.5
Oleic acid	67.4	41.1
Linoleic acid	4.1	10.0
Linolenic acid	-	-
....		



# Concentration of acrolein after 2 hours of heating

mg/m<sup>3</sup>



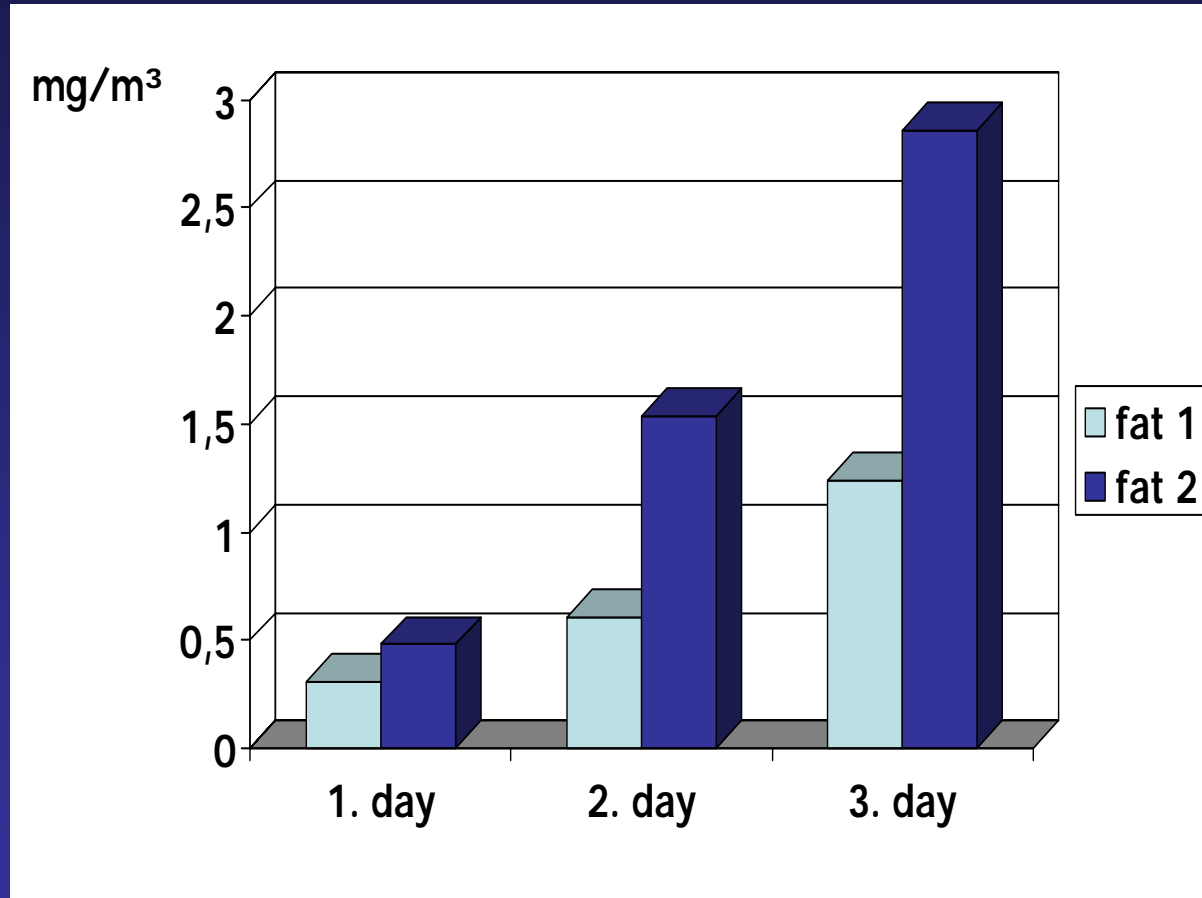
- Type of chemical reaction: oxidation and pyrolysis





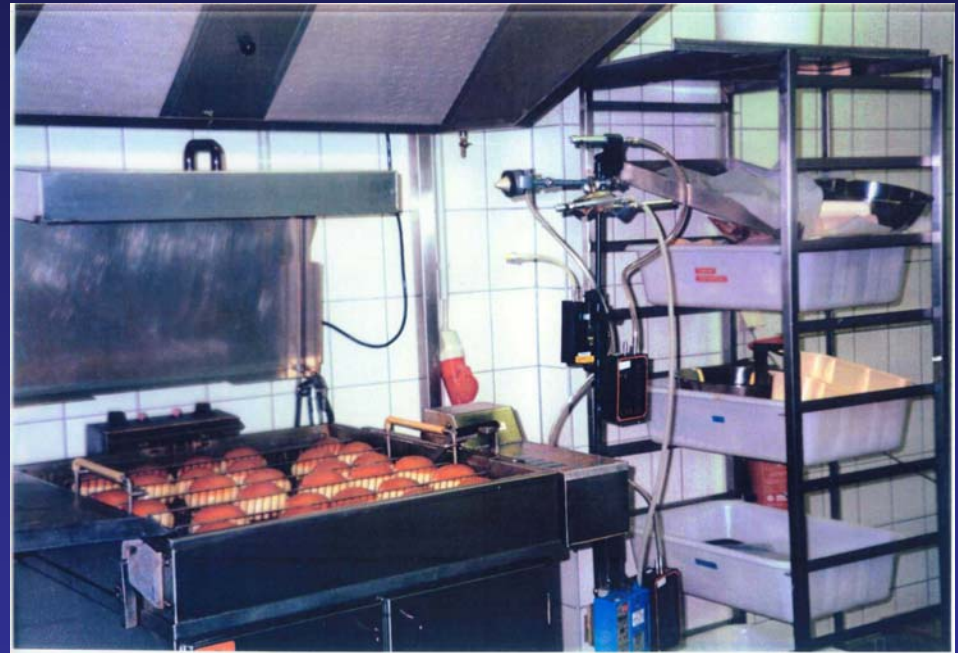
# Concentration of aerosol/smoke particles

- sampling time of 4 hours
- Fat 2: a visible formation of smoke from the 3. day on

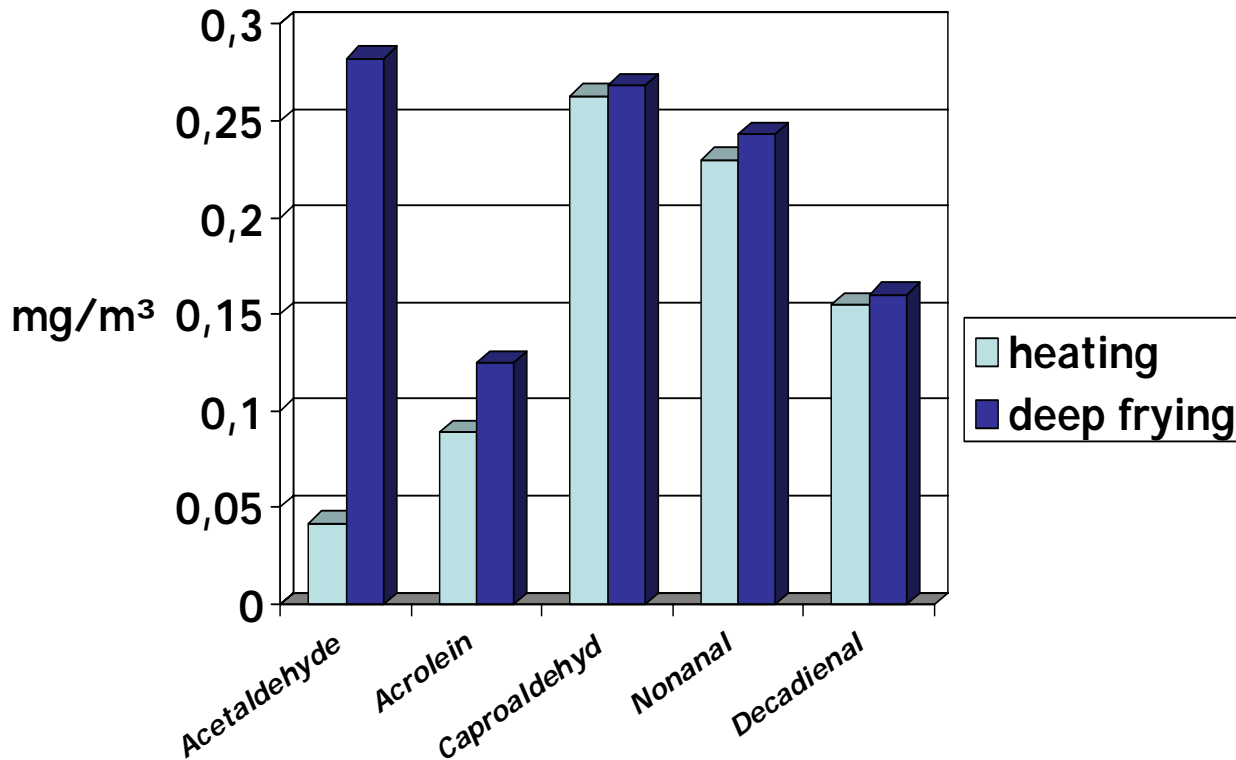


# Experiment 2

- Influence of the deep frying on emission of volatile substances
  - 2h,  $T=177^{\circ}\text{C}$ ; 300 doughnuts (Berliner Pfannkuchen) were prepared; hardened peanut fat is used
  - next day: 2h heating without foodstuff;  $T=177^{\circ}\text{C}$
  - fat quality was tested with Oxifrit (Merck)



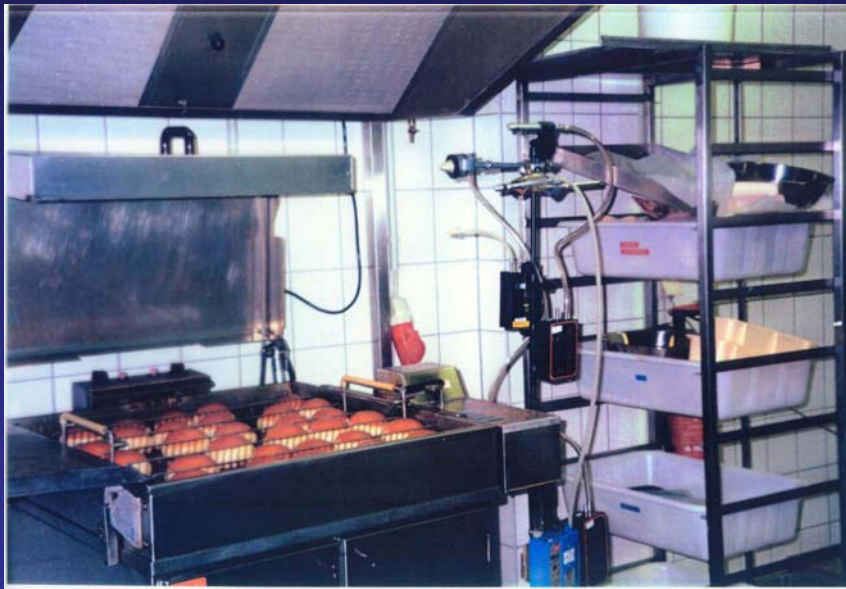
# Results



- Acetaldehyde: fermentation process of foodstuff
- Acrolein: also hydrolysis reaction
- Others: fat deterioration



# Experiment 3/ Ventilation



- 2h deep frying of 300 doughnuts
- Ventilation switched on
- Reduction of aldehyde concentrations by 70-90%



# Summary

- Prevention of occupational diseases of the respiratory tract will be successful
  - if the formation of irritant substances is minimized
  - if the ventilation system works very efficiently

