# The impact of disinfectants on residue formation on endoscope surfaces

**Holger Biering**

# Topics

- Objectives
- Options for active substances
- Impact of residue formation depending on active substance
- Conclusions

# Objectives

Focus on residue formation by interaction between disinfecting agents and proteins

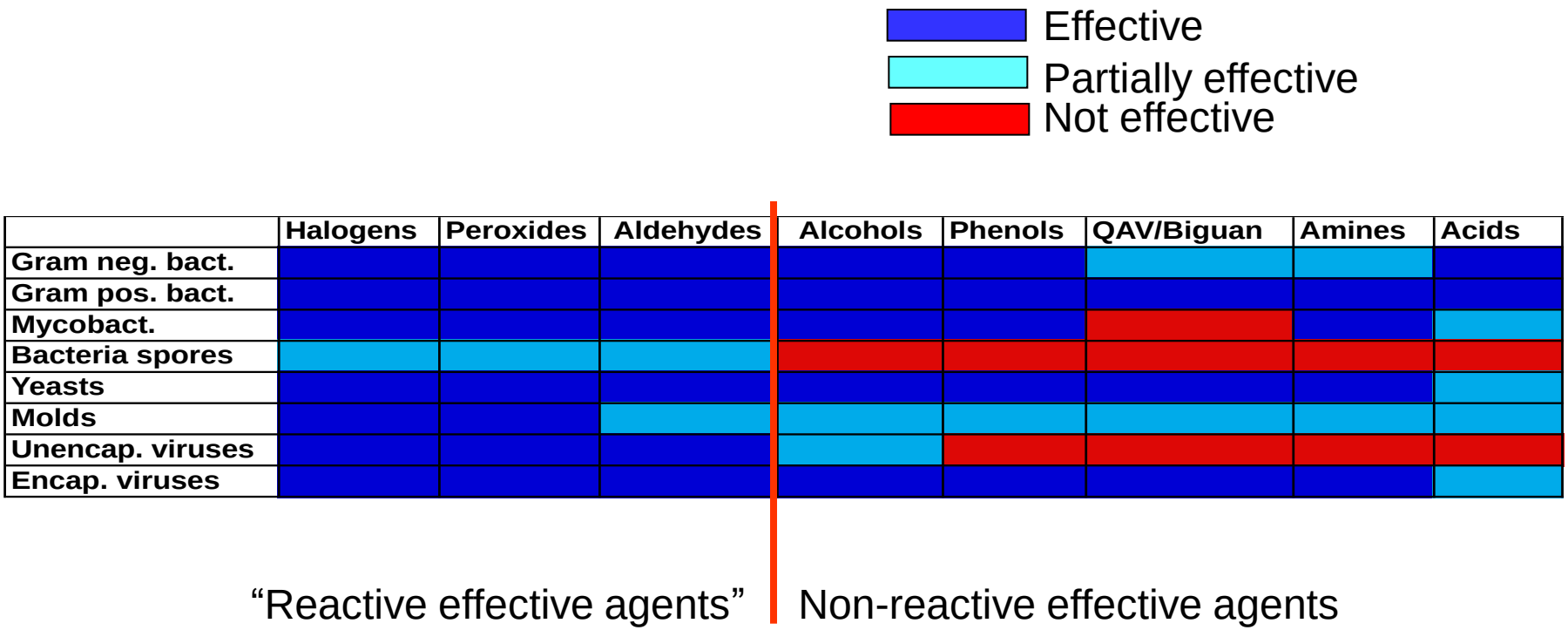
Two questions will be discussed

A) Are there large molecules formed?

B) Does the disinfecting agent support the link between large molecule and the endoscope surface - fixation?

# Options for Active Substances

Range of effectiveness of various disinfecting agents



# Options for Active Substances

Active Substances used for endoscope disinfection:

Aldehydes:
- ✓ Glutaraldehyde
- ✓ o-Phthalaldehyde (OPA)

Oxidising Substances:
- ✓ Chlorine dioxide
- ✓ Hypochlorous acid
- ✓ Hydrogen peroxide
- ✓ Buffered peracetic acid

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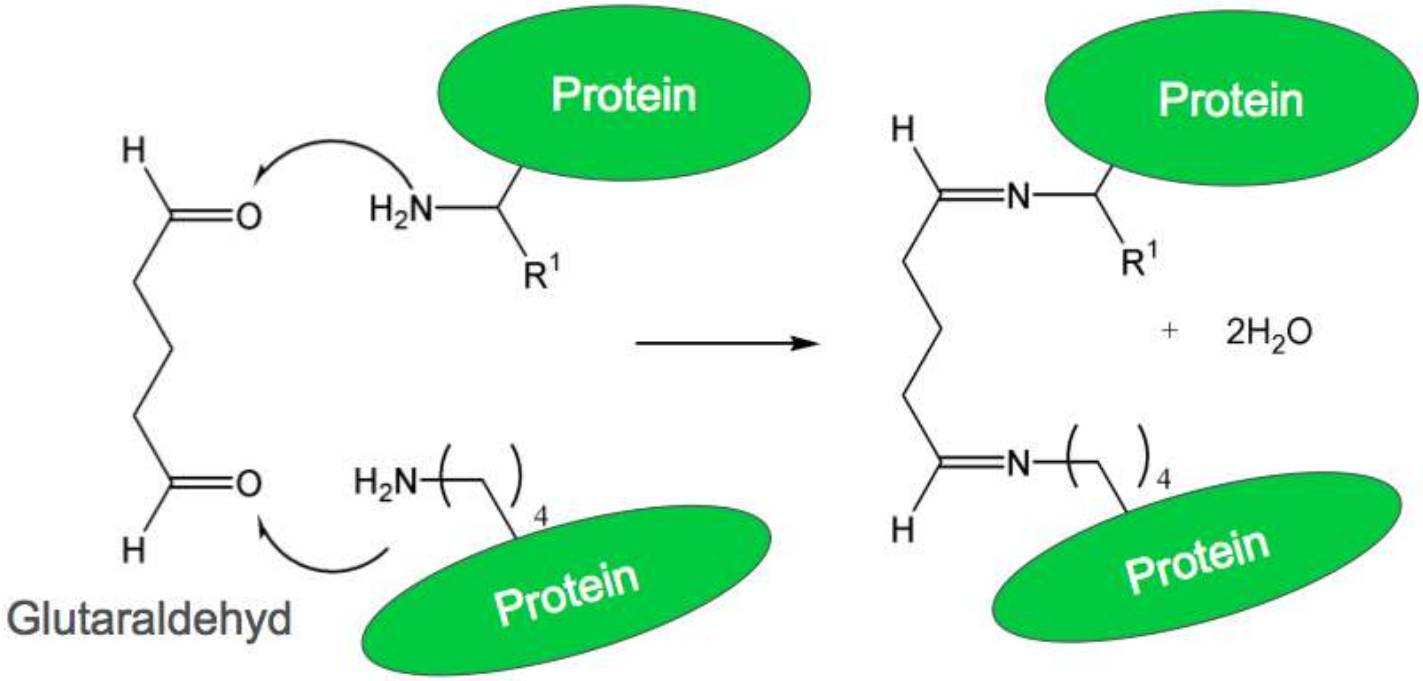
# Glutaraldehyde
# Formation of large molecules

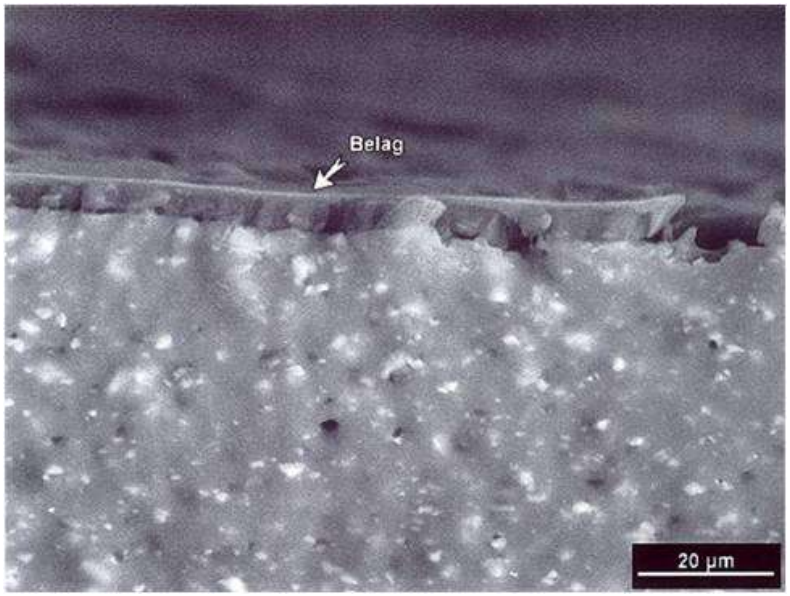
**Reactions between glutaraldehyde and proteins:**



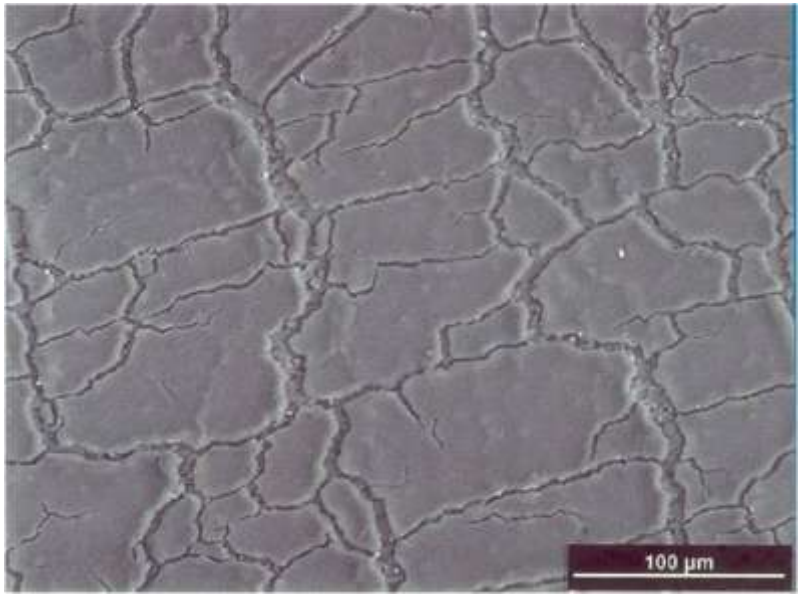

- **Glutaraldehyde is a protein cross-linker.**
- **Large molecules are formed.**

# Glutaraldehyde
# Fixation of large molecules

- Deposits on the outer surfaces of insertion tube are observed.




Magnification: 1000




Magnification: 275

Source: M. Kamer, Dr. Weigert

# Glutaraldehyde
# Fixation of large molecules

Deposits on the other surfaces of insertion tube are observed.

Residues in channels are observed as well.

Reason:
Insufficient protein removal after use and before disinfection with glutaraldehyde?

Question:
Why is the residues limited on the area of insertion tube coming in contact with the patient?

# Glutaraldehyde
# Fixation of large molecules

Explanation:

- Glutaraldehyde adsorbs in the disinfection phase in small amount on the plastic surfaces and will not be complete removed by the following final rinsing.
- Absorbed glutaraldehyde reacts with proteins during the endoscope contact with the patient.
- Formed large molecules can not totally removed in the following reprocessing procedure.
- Residue layers are built-up in several reprocessing cycles.

# Glutaraldehyde Summary

- Consider residue formation by fixation of large glutaraldehyde-protein molecules during endoscope use.

- Strong focus on
  - ↳ improved final rinsing
  - ↳ mechanical support in the cleaning phase due to difficult to remove larger molecules

# o-Phthalaldehyde (OPA)

**Formation of large molecules:**

- OPA reacts with proteins
- Probability to form large molecules is much lower than glutaraldehyde

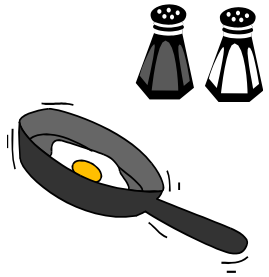
**Fixation of large molecules:**

- Likelihood low
- Less experience
- Should be investigated

# Oxidising Acids
# Impact of pH-value

**Example: Hydrochloric acid**

**Acid** ⟺ **Salt**



**Oxidising acids:**

| | | | | |
|---|---|---|---|---|
| **Hypochlorous acid** | ⟺ | **Buffered hypochlorous acid** | ⟺ | **Sodium hypochlorite** |
| **Peracetic acid** | ⟺ | **Buffered peracetic acid** | ⟺ | **Sodium peracetate** |

# Oxidising Acids
# Impact of pH-value

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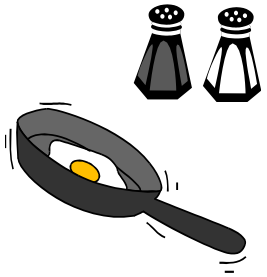


## Oxidising acids used in endoscope disinfection:

**Hypochlorous acid** ⟺ **Buffered hypochlorous acid** ⟺ **Sodium hypochlorite**

**Peracetic acid** ⟺ **Buffered peracetic acid** ⟺ **Sodium peracetate**

# Hypochlorous acid

**Formation of large molecules:**

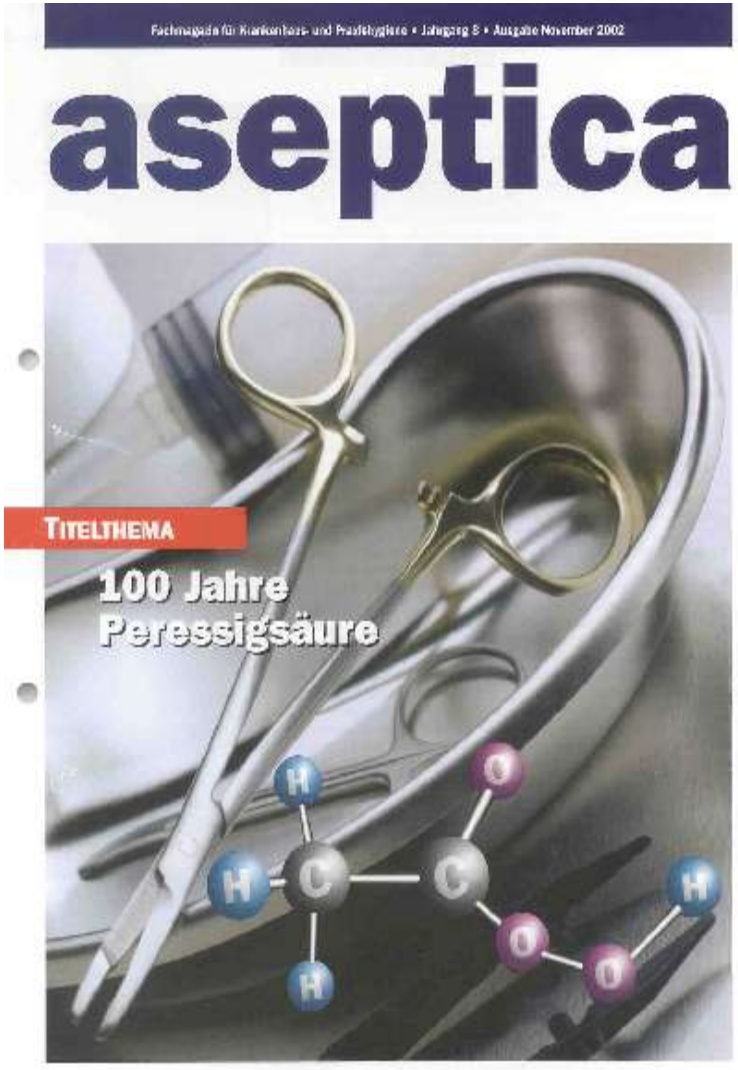
- Acid related protein coagulation is possible.
- Intermolecular reactions have been observed with milk proteins.

**Fixation of large molecules:**

Likelihood low because of:

- low concentration of active agent
- fast reaction between hypchlorous acid and proteins
- device detect the lowest accepted concentration
- decomposition of active agent – no adsorption

# Peracetic acid
# History




**1902** **First publication on the microbiological effect of peracetic acid by Frier and Novy**

**1949** **Comparison of 23 antimicrobial effective agents**
- **Peracetic acid is the most effective substance**

**1955** **First use of peracetic acid in raising experimental animals free of germs**

**1960 - 70** **Ground-laying experiments on stability, analysis and material compatibility in work groups in Erfurt and Prague**

**1970** **Introduction of first peracetate-based antimicrobial cleaner for surgical instruments to the market**

# Peracetic acid and its salts
# Applications in the medical field

- Antimicrobial cleaner for surgical instruments

  pH-value: alkaline

- Disinfection of haemodialysis devices

  pH-value: acid

- Chemo-thermal disinfection procedure for hospital linen tested by RKI

  pH-value: alkaline

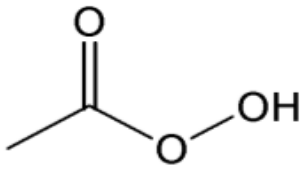
- Hand and skin disinfection

  pH-value: buffered

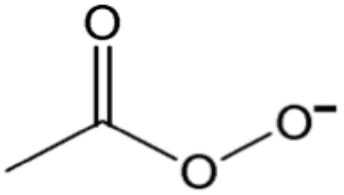
- Disinfection of medical instruments, including flexible endoscopes

  pH-value: buffered

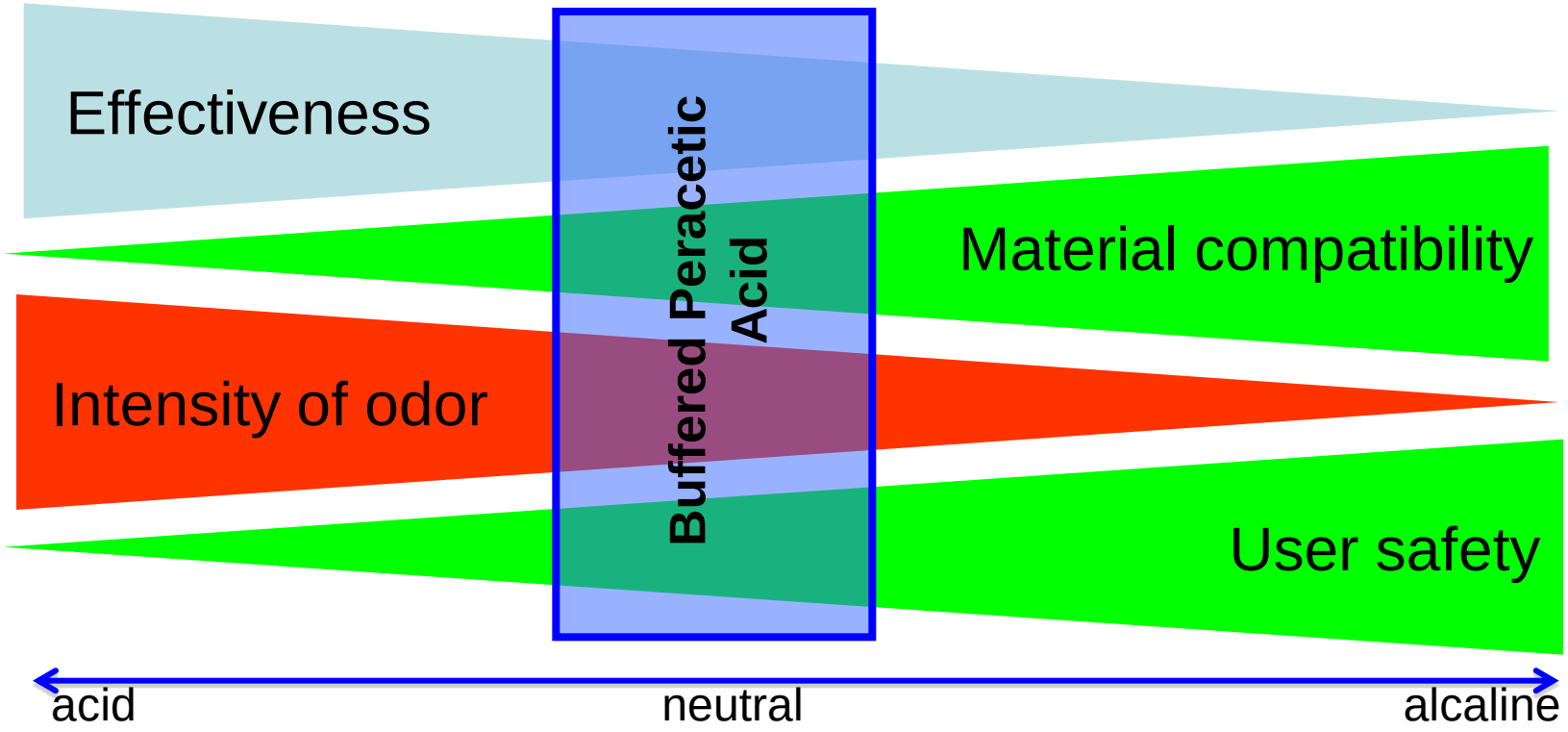
# Peracetic acid and its salts
# pH-value impact




pH 1

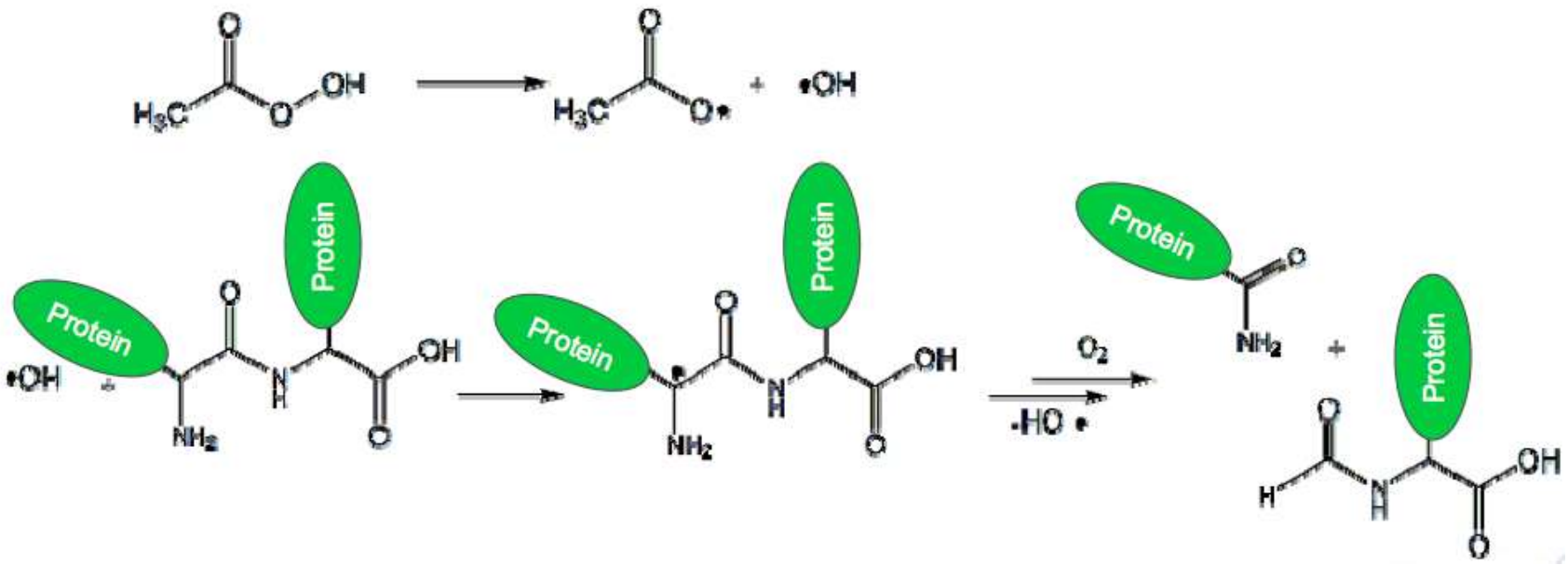



pH 14



# Buffered peracetic acid
# Formation of large molecules

Free-radical reaction with proteins




Decomposition of protein chains by peracetic acid

Kerkaert B, et al. J Agric Food Chem (2011) 59: 907-914

# Buffered peracetic acid
# Fixation of large molecules

- One lab study with artificial blood described the fixation of large protein molecules (fibrin) on stainless steel plates.
- Fixation of fibrin could not observed on synthetic surfaces in other lab studies
- Field studies and practical experience in endoscope reprocessing show no residue formation on endoscope surfaces

# Buffered peracetic acid
## Remove of glutaraldehyde-protein deposits

Endoscope channels after routine reprocessing with glutaraldehyde followed by cycles with buffered peracetic acid:

After routine disinfection with glutaraldehyde

After 30 cycles with peracetic acid and no mechanical support

After 30 cycles with peracetic acid and with mechanical support

Meyer B. HygMed 2004; 29: 106-109
Tucker RC, et al., ASAIO J 1996; 42: 306-313

# Buffered peracetic acid
## Remove of glutaraldehyde-protein deposits

**Practical experience:**

- Deposit remove on outer surfaces after couple of reprocessing cycles
  - ↳ Brightening the ring markers

- Stiffness of brushing during the transition period
  - ↳ Deposits are removed

# Buffered peracetic acid Summary

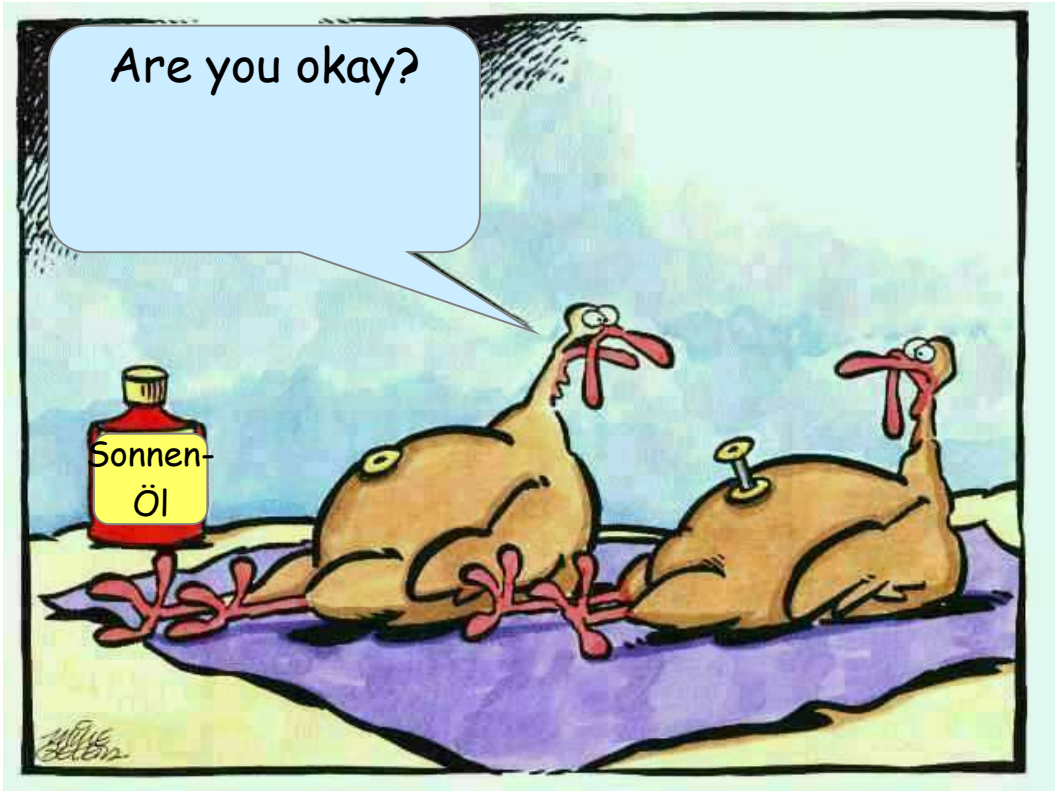
- Because of steric hindrance, intermolecular reactions plays a minor role in interaction with proteins.
- Formation of bigger molecules are not expected.
- Even though lab study show fixation of large molecules on stainless steel plates, comparable effects on synthetic materials are not observed.
  - ↳ no residue formation under reprocessing conditions in the field
- Glutaraldehyde/Protein deposits are removed by repeated disinfection with buffered peracetic acid.

# Conclusions

- Glutaraldehyde cross-link proteins
  - ↳ Risk of residue formation should be considered.
  - ↳ enhanced rinsing, brushing and cleaning is required.

- Minor probability for protein cross-link and fixation of formed molecules in case of o-phthalaldehyd (OPA), hypochlorous acid and buffered peracetic acid

- Glutaraldehyde/Protein deposits can be removed by repeated treatment/disinfection with buffered peracetic acid




Thank you for your attention!