# New Technology of Anti-Corrosion Protection of Tanks Containing Crude Oil, Petroleum Products and Fuels


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# *Main topics:*

- ***Fuels used in automobiles;***
- ***Corrosiveness of fuels to metals;***
- ***Corrosion control in fuels;***
- ***Examination and choice of coatings in fuels;***
- ***Antistatic coatings;***
- ***Experience of anti-corrosion protection of tanks containing fuels.***

# Fuels Used in Automobiles

- Gasoline
- Diesel fuel
- Liquefied Petroleum Gas (LPG)
- Compressed Natural Gas (CNG)
- Biofuels: Bioalcohols and Biodiesel
- Hydrogen

***Why are crude oils, petroleum products and fuels aggressive to metals, alloys and polymeric materials?***

# Corrosiveness of Fuels

$H_2O$

$O_2$

$H_2S$

Certain S- and O- organic substances

# *Corrosion of Metallic Constructions and Equipment in Fuels*

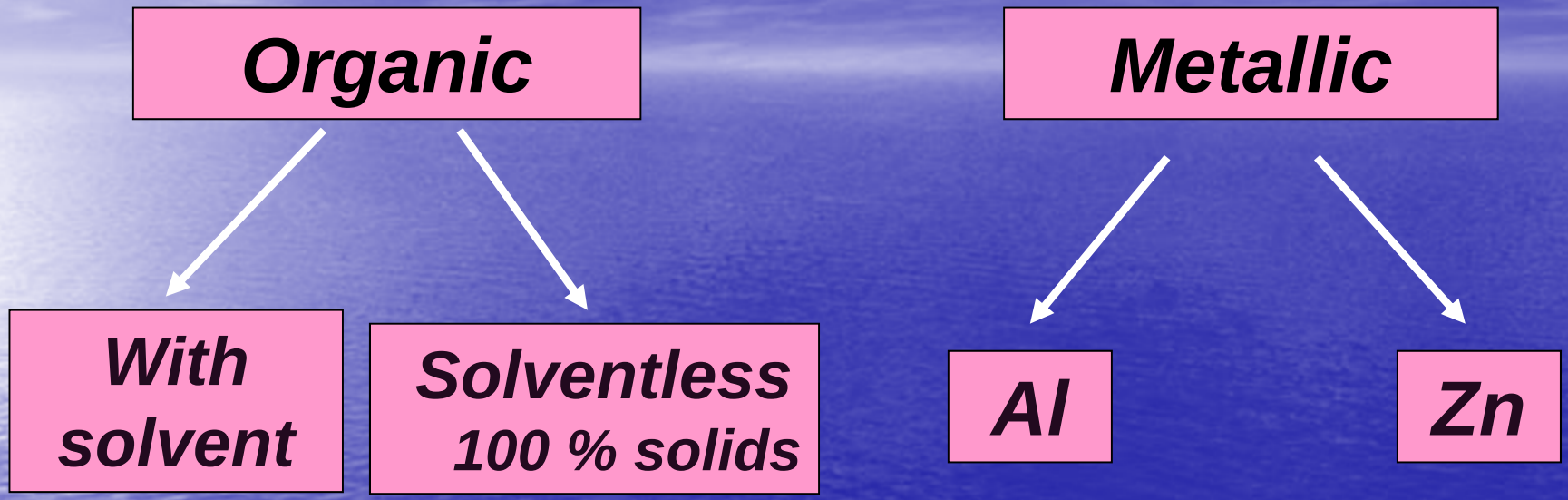
***Naphtha***

***Gasoline***

***Diesel fuel***

# Corrosion Prevention in Systems Containing Fuels

## Coatings




API 652: Lining of Aboveground Petroleum Storage Tank Bottoms

Two types of coating systems: thin (< 500 $\mu$m) and thick (> 500 $\mu$m)

- Porosity,
- Resistance to $H_2S$, hot water, spark.

# Thin Coating Systems (< 500 μm)

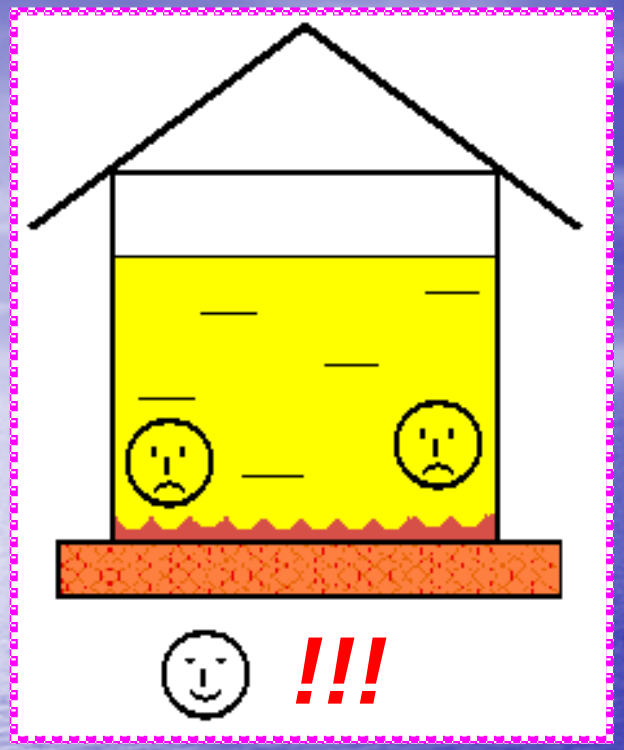
Zn silicate, Epoxies, Phenolic epoxy, Novolac epoxy, Polyurethane, PVC, Silicone-Epoxy, Polysiloxane

## Antistatic coatings for inner surface of gasoline and naphtha AST

Electro-conductive (R < $10^3$ Ohm);
Antistatic (R = $10^4$–$10^5$ Ohm);
Non-conductive coatings (R > $10^6$ Ohm)

Coating systems for protection of outer surface of AST: >250 μm

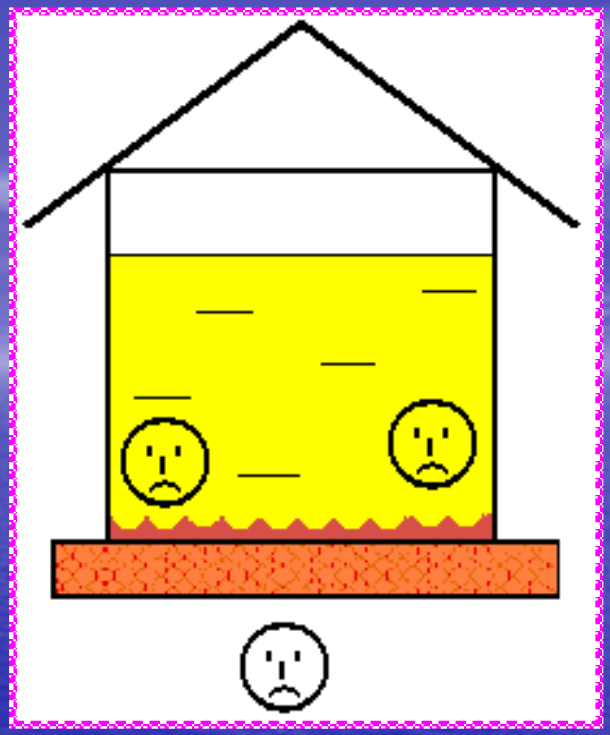
# Thick Coating Systems




*New or Older Tanks where only internal corrosion is occurring*

*900 – 1,400 μm*

*Vinyl ester, Epoxy vinyl ester*

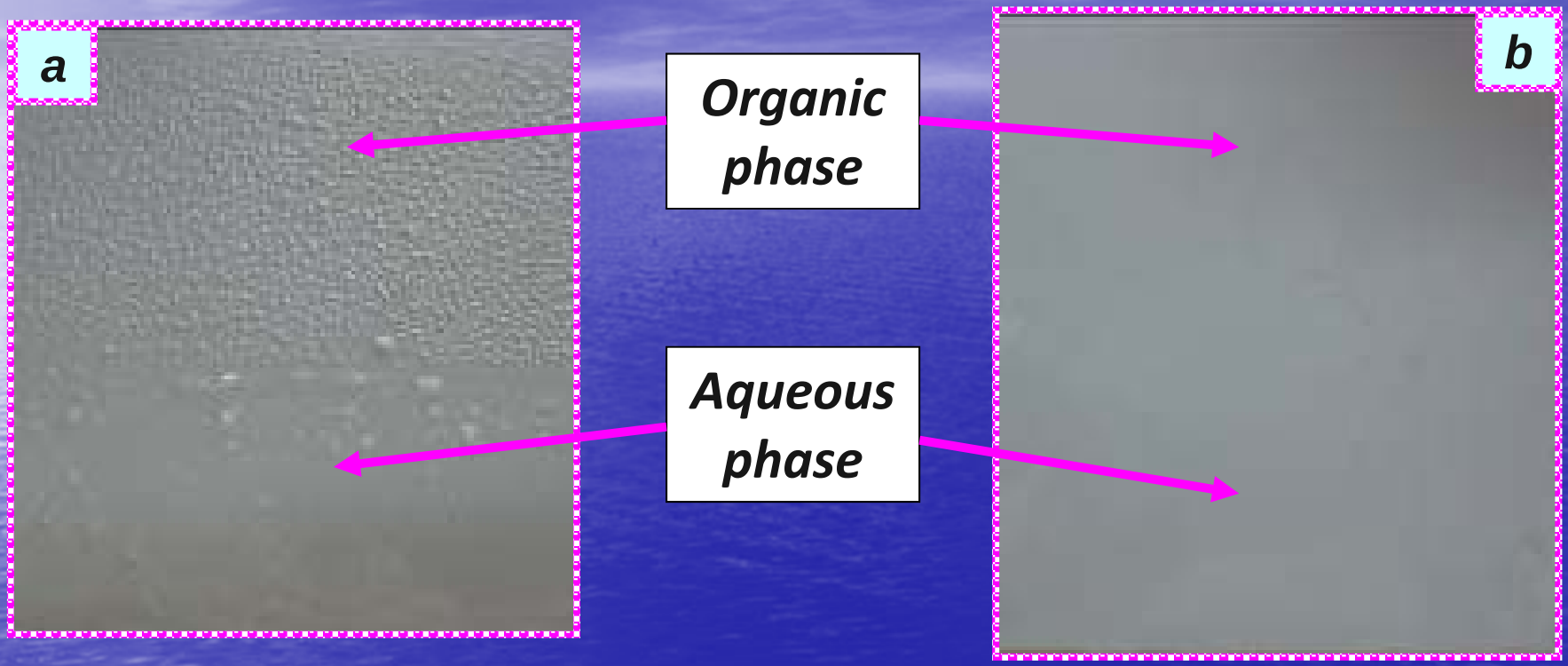


*Older Tank bottoms that have corroded both internally and externally*

*2,000 – 3,000 μm*

*(Glass Reinforced Lining Systems)*

# Testing of coating compatibility under the conditions of fuel storage tanks




*PVC (180 μm) after 3 months: a – aqueous phase (3% NaCl + 0.2% $NaBO_3$), organic phase (65% iso-octane + 35% xylene); b - aqueous phase (3% NaCl + 0.2% $NaBO_3$), organic phase (85% iso-octane + 15% MTBE); T=22°C.*


*A –PATTI 2 for measuring of adhesion*


*B - an aluminum stub glued to measured coating*

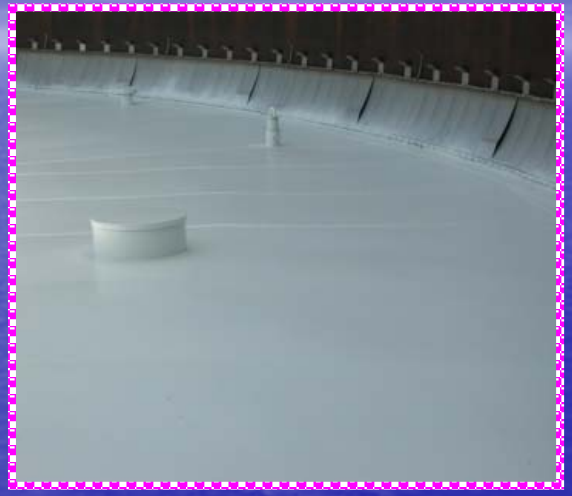

*C - measuring of adhesion of coating on the pipe*


***Adhesion > 1000 psi must be!***

*D - a stub after measuring of adhesion*

# *Experience of anti-corrosion protection of AST*

*Inner surface of the bottom coated by novolac epoxy. Kerosene AST*



*Outer surface of the floating roof: tolerant aluminum mastic epoxy + polyurethane. Gasoline AST*

*Epoxy primer + Epoxy high build + Polyurethane.*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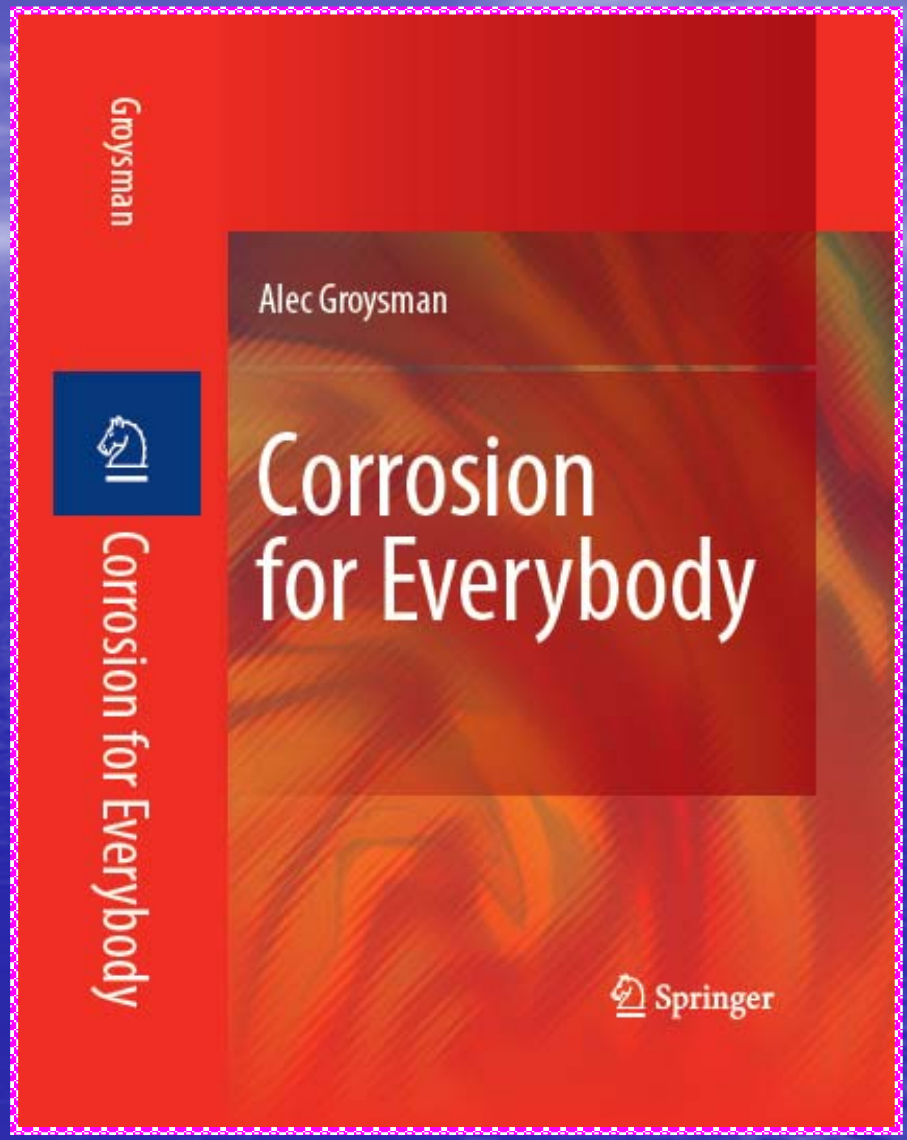
Corrosion in Systems for Storage and Transportation of Petroleum Products and Biofuels
Identification, Monitoring and Solutions
Springer
Corrosion in Systems for Storage and Transportation of Petroleum Products and Biofuels

2014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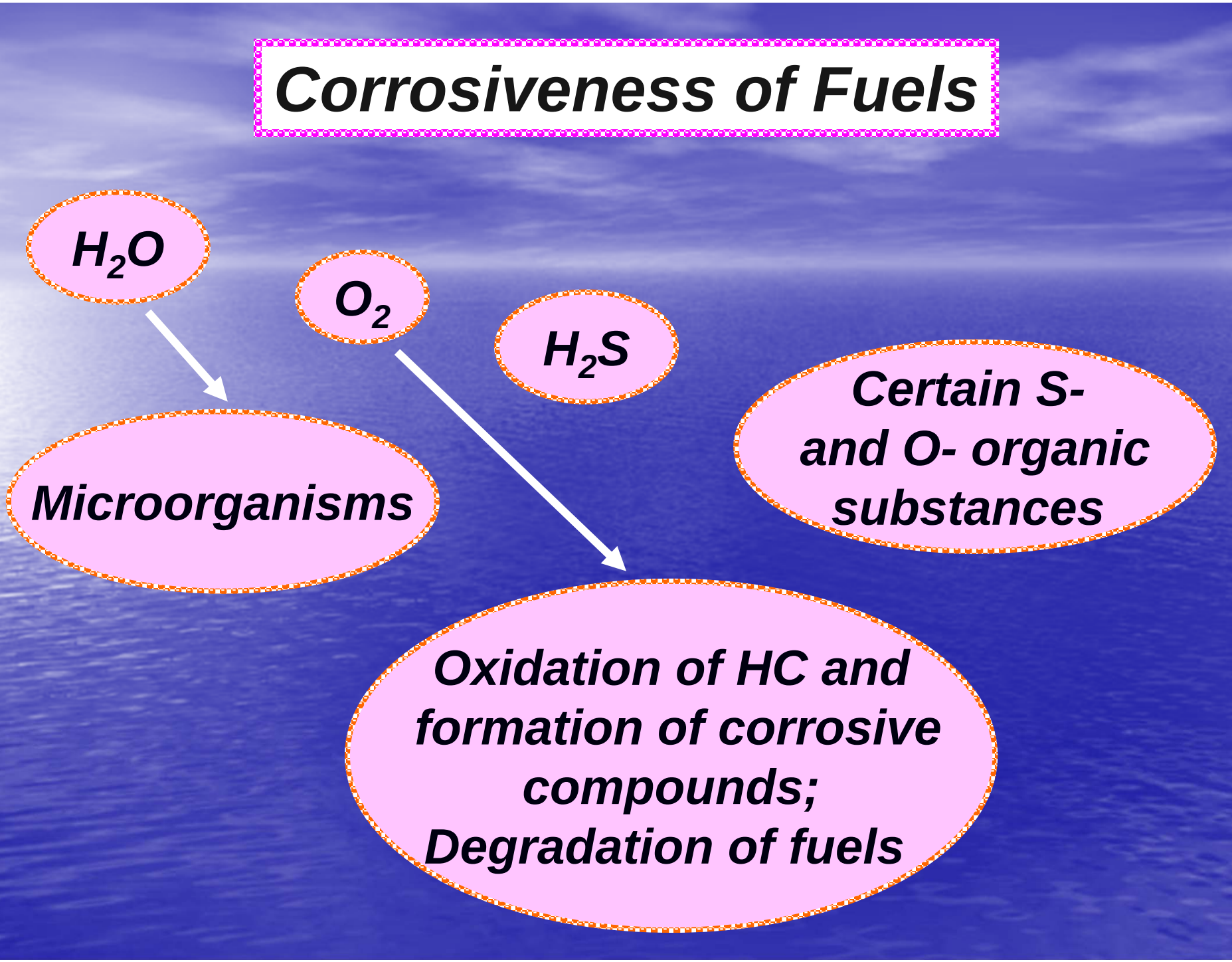
Corrosion for Everybody
Springer
Corrosion for Everybody

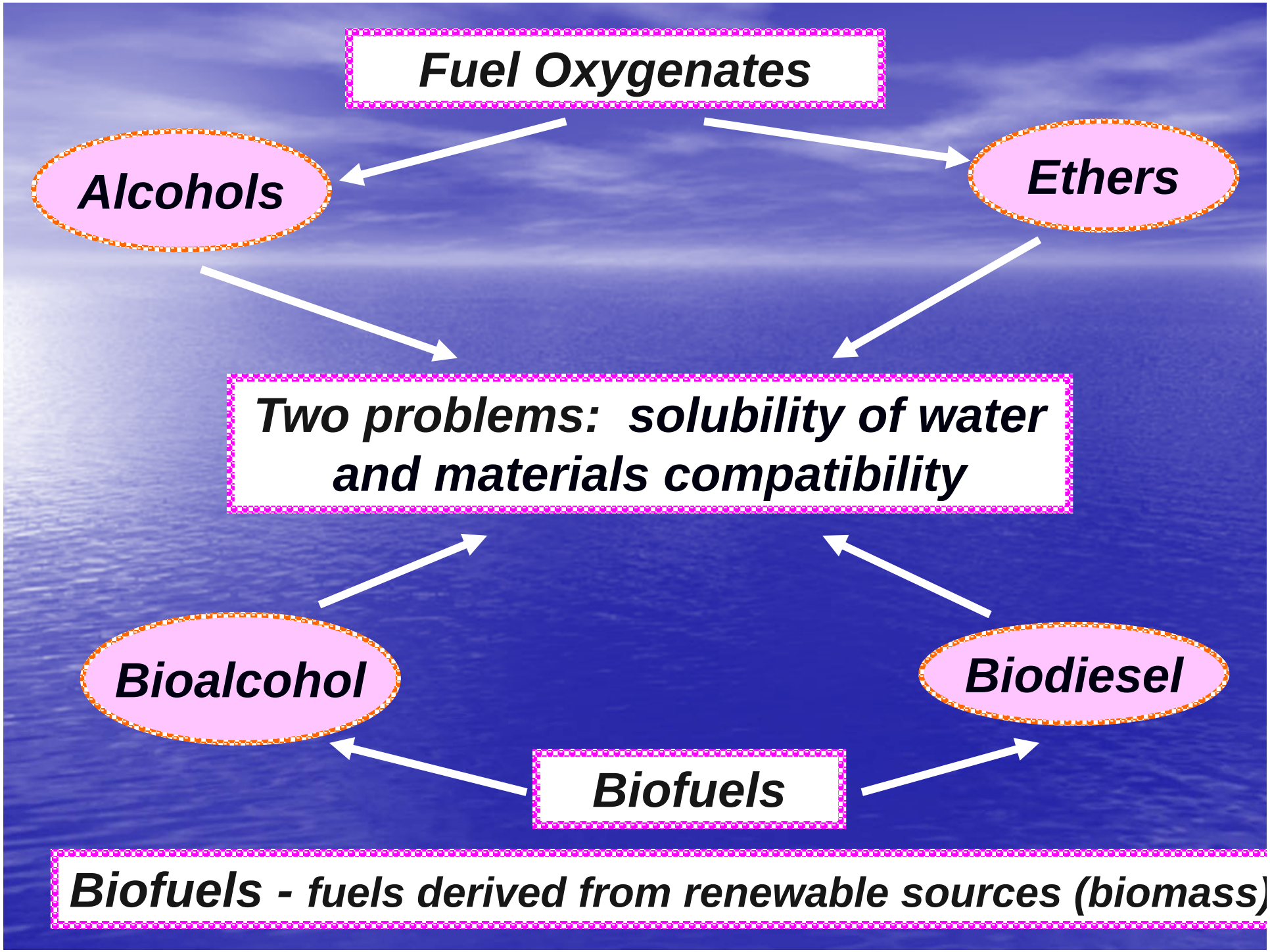
2010

***The focus: development of new technology of anti-corrosion protection of inner and outer surfaces of tanks containing crude oil, petroleum products and fuels.***


***Liquid fuels: liquefied petroleum gas (LPG), naphtha, gasoline, kerosene (jet fuel), gas oil (diesel fuel), and fuel oil.***

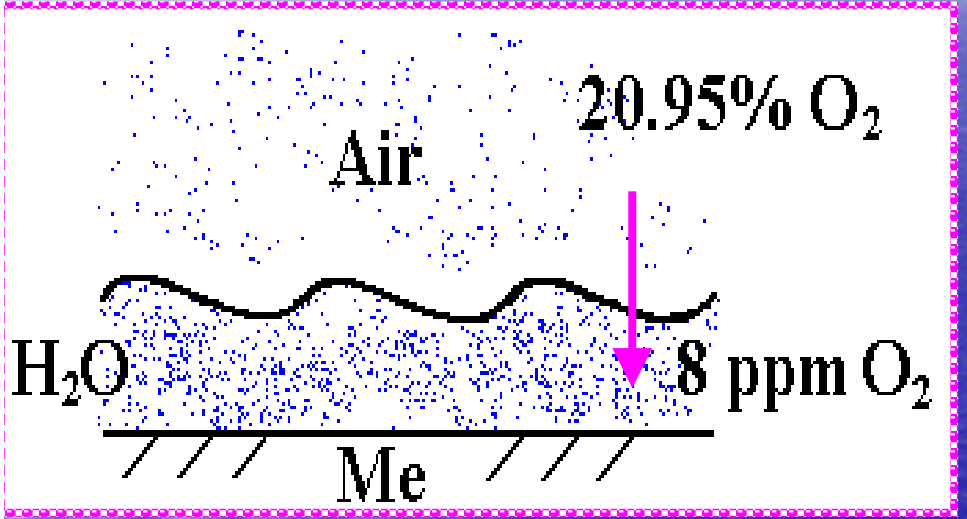
# Corrosiveness of Fuels



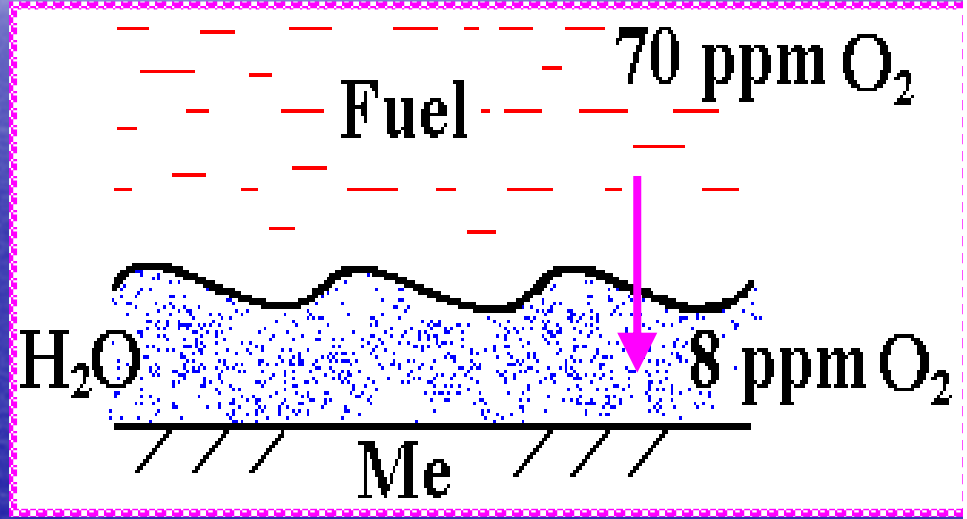

Fuel Oxygenates
Alcohols
Ethers
Two problems: solubility of water and materials compatibility
Bioalcohol
Biodiesel
Biofuels
Biofuels - fuels derived from renewable sources (biomass)

# Corrosion Mechanism

## in atmosphere



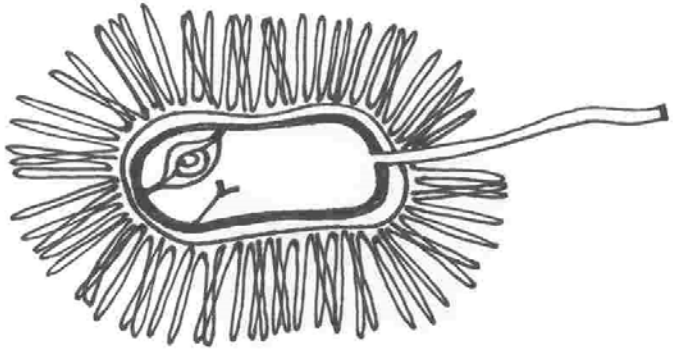

## in fuel

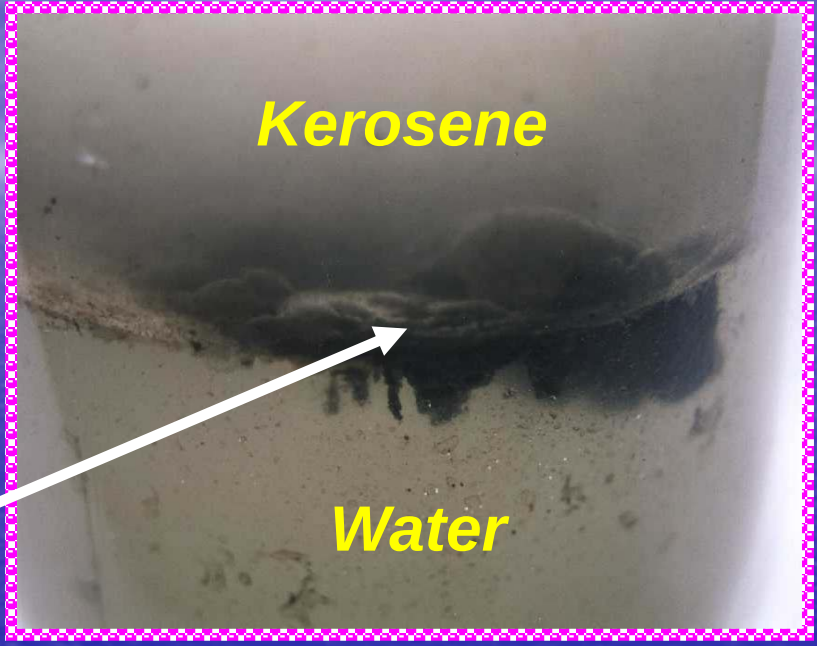



***Uniqueness:***
***Fuel is a reservoir of oxygen***

***Common: cycle "drying – wetting"***

# *Microbial Contamination of Fuels*






***Biofouling***

***Consequences: Deterioration of fuel quality; Fuel haziness; Formation of sludge, Degradation of fuel additives; Filter plugging; Appearing of odor; CORROSION!***

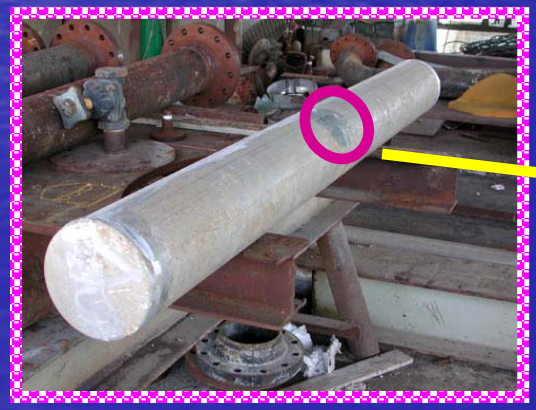
# Participation of Microorganisms in Corrosion of Metals in Tanks Containing Fuels (Bottoms)

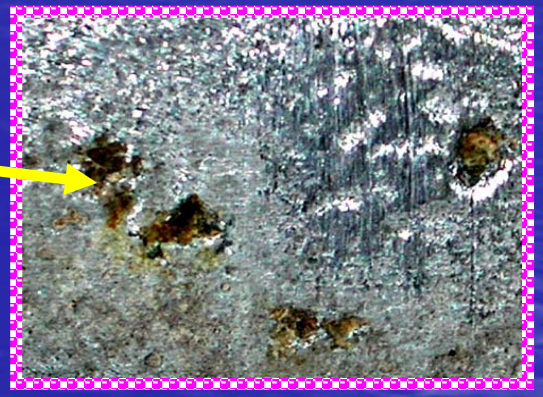
Crude oil

Fuel oil

Gas oil

Kerosene





Pontoon made from aluminum alloy Al 5052 after a 3-week hydrotest

# Polymeric Materials in Systems for Transportation and Storage of Fuels


*a – original seal (natural rubber); b – after 6 months of service in kerosene.*


*c – original kerosene; d –kerosene after one day of contact with natural rubber.*


*Flexible hoses (NBR) for water drainage from the AST roof: e - fuel oil after 5 y; f - industrial atmosphere after 1 y.*

# Polymeric materials in Gasoline

| Media | | Polymer | | |
|---|---|---|---|---|
| | | NBR | Viton | Teflon |
| Gasoline | Neat (100%) | R | NR | R |
| | + 15 % vol. MTBE | R | NR | R |
| | + 35 % vol. BTX | NR | R | R |
| BTX (100 %) | | NR | R | R |
| MTBE (100 %) | | R | NR | R |

# Rating of polymers according to swelling in fuels

| Swelling, % vol. | Effect on polymers` properties |
|---|---|
| < 10 | Little or no effect |
| 10 to 20 | Possible loss of physical properties |
| 20 to 40 | Noticeable change |
| > 40 | Excessive change |

# *Kinetic curves of polymers' swelling (% vol.) Neoprene 50 in three types of fuel, T=22°C*