# ROAD PAVEMENT FORUM
# MAY 2011

## Testing the effect of cement types on slurry

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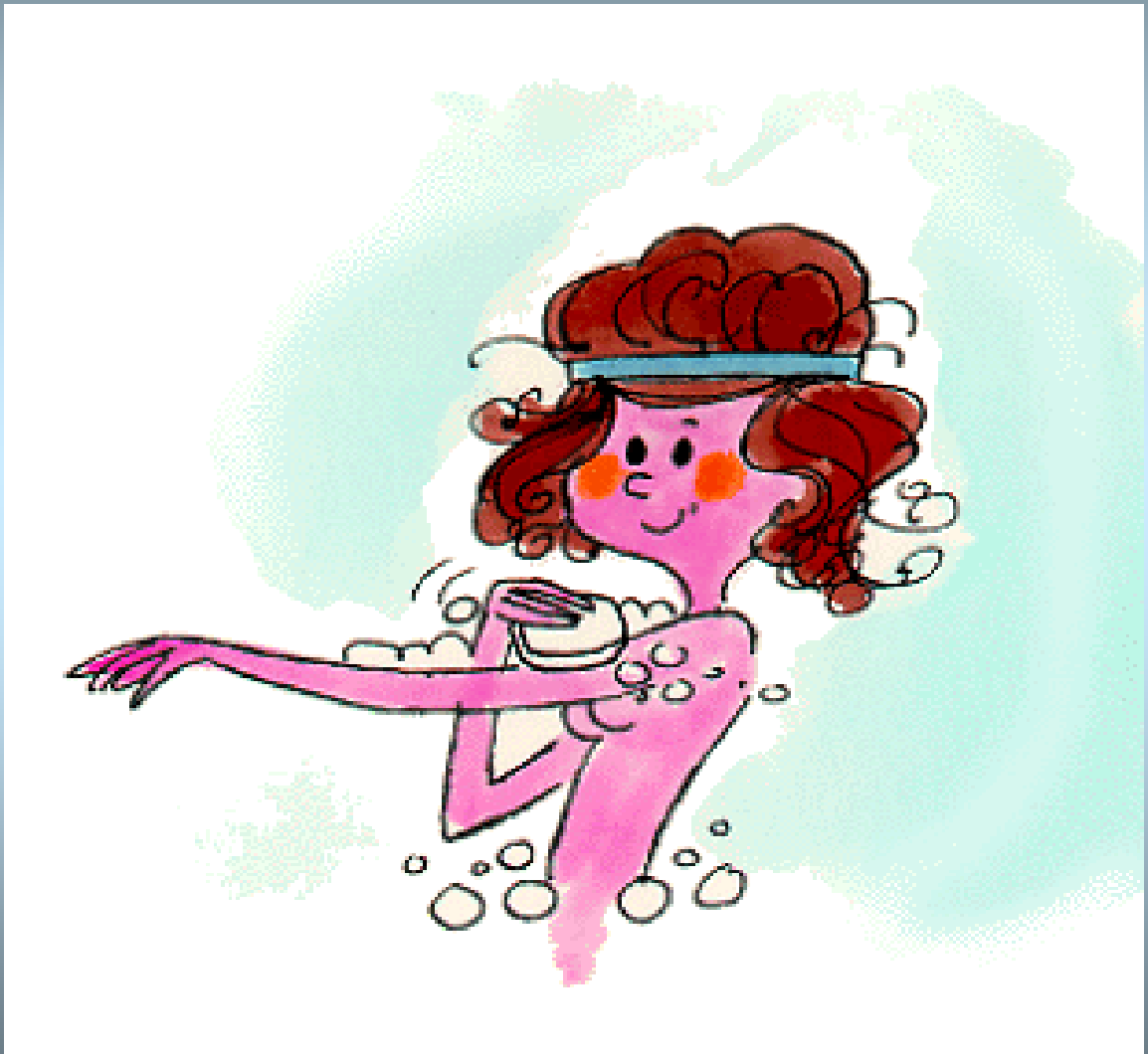
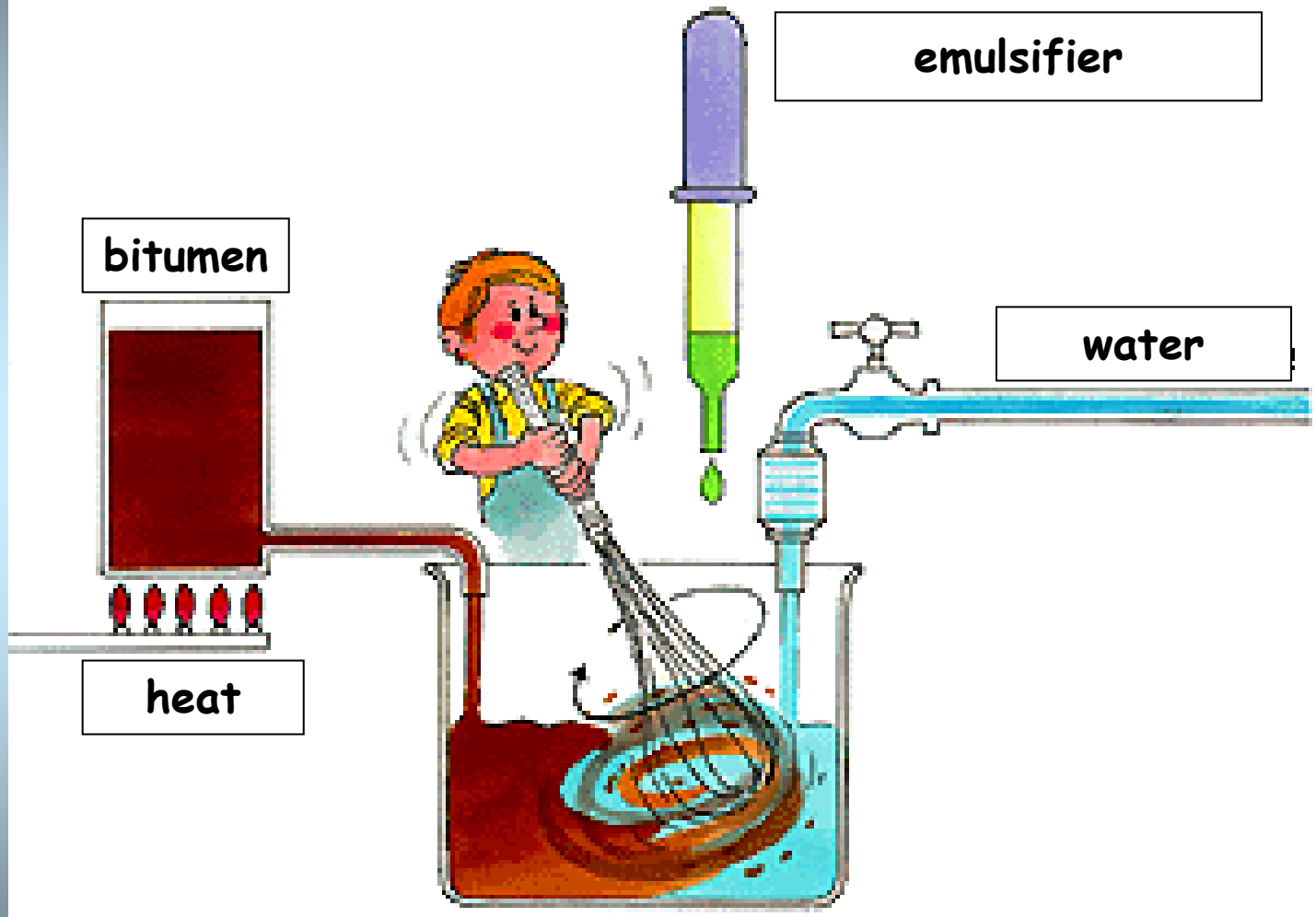
# Need for testing

- **Manual 28 (SAT Seminars)**
- **The effectiveness of CEM V cement questioned**

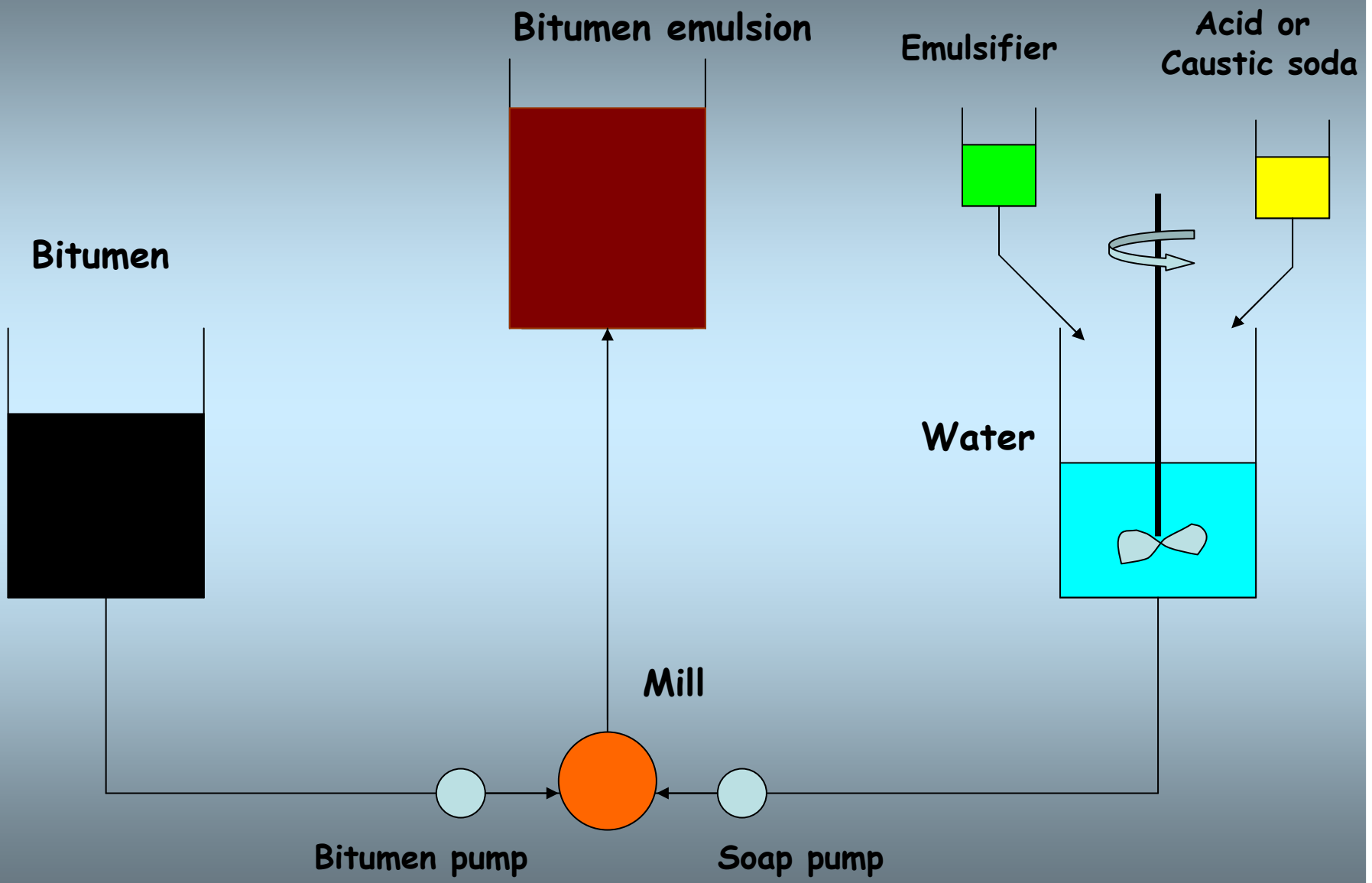
# Background

# Surfactants (soaps) form part of every day life !!!

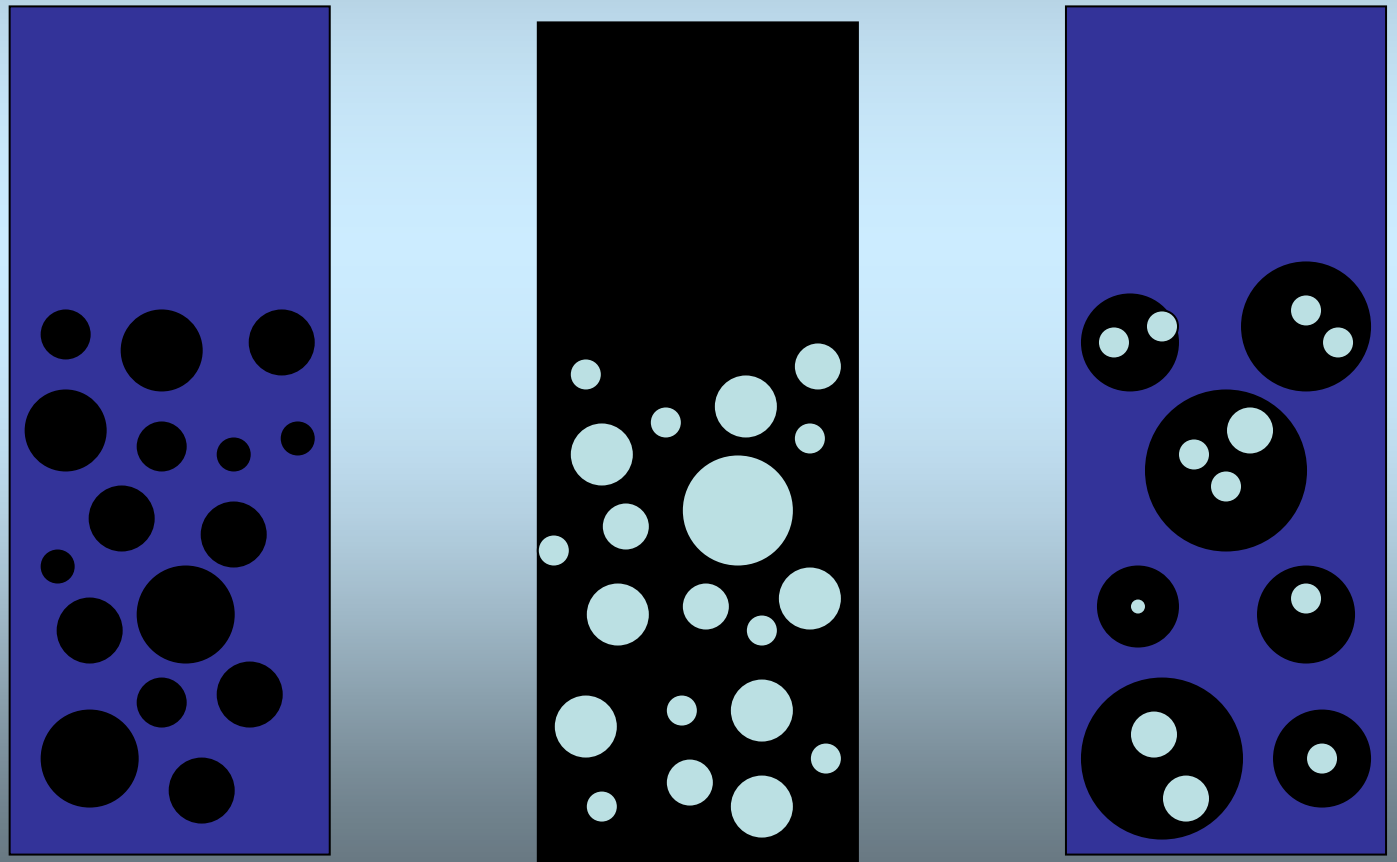



emulsifier
bitumen
water
heat

# Manufacture of bitumen emulsion – batch plant



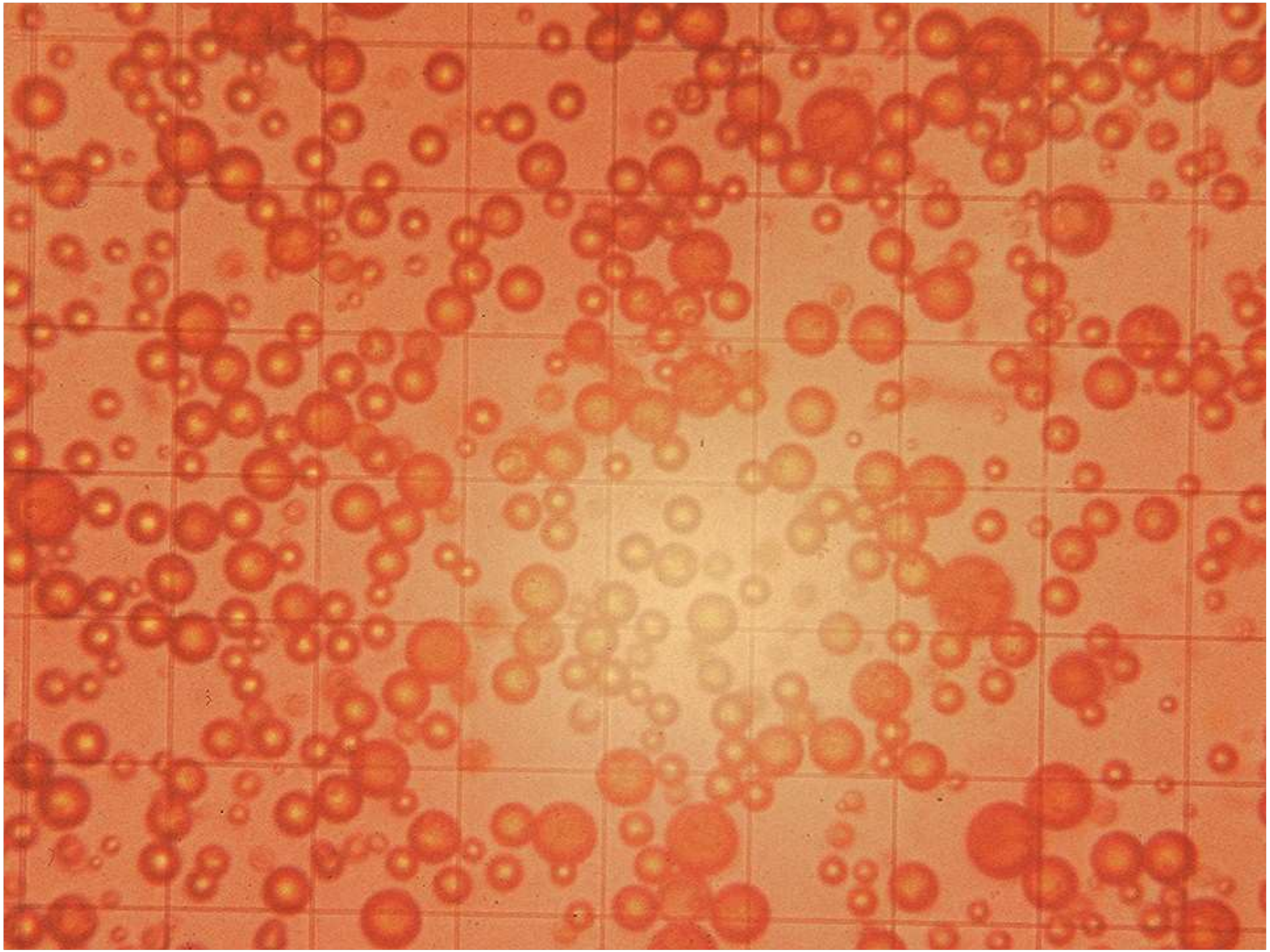
# Three main types of emulsion

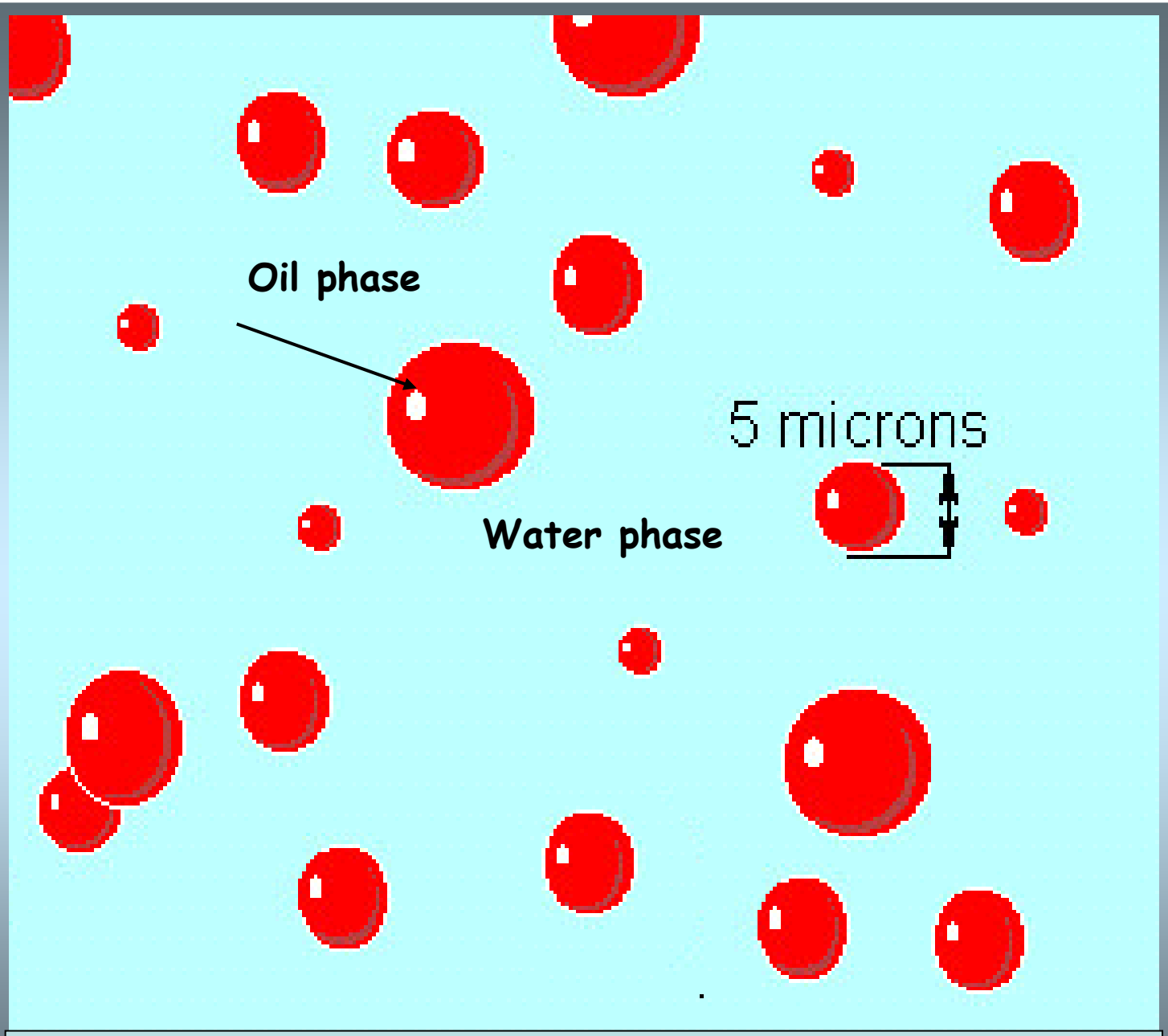


Oil in water

Water in oil

Multiple





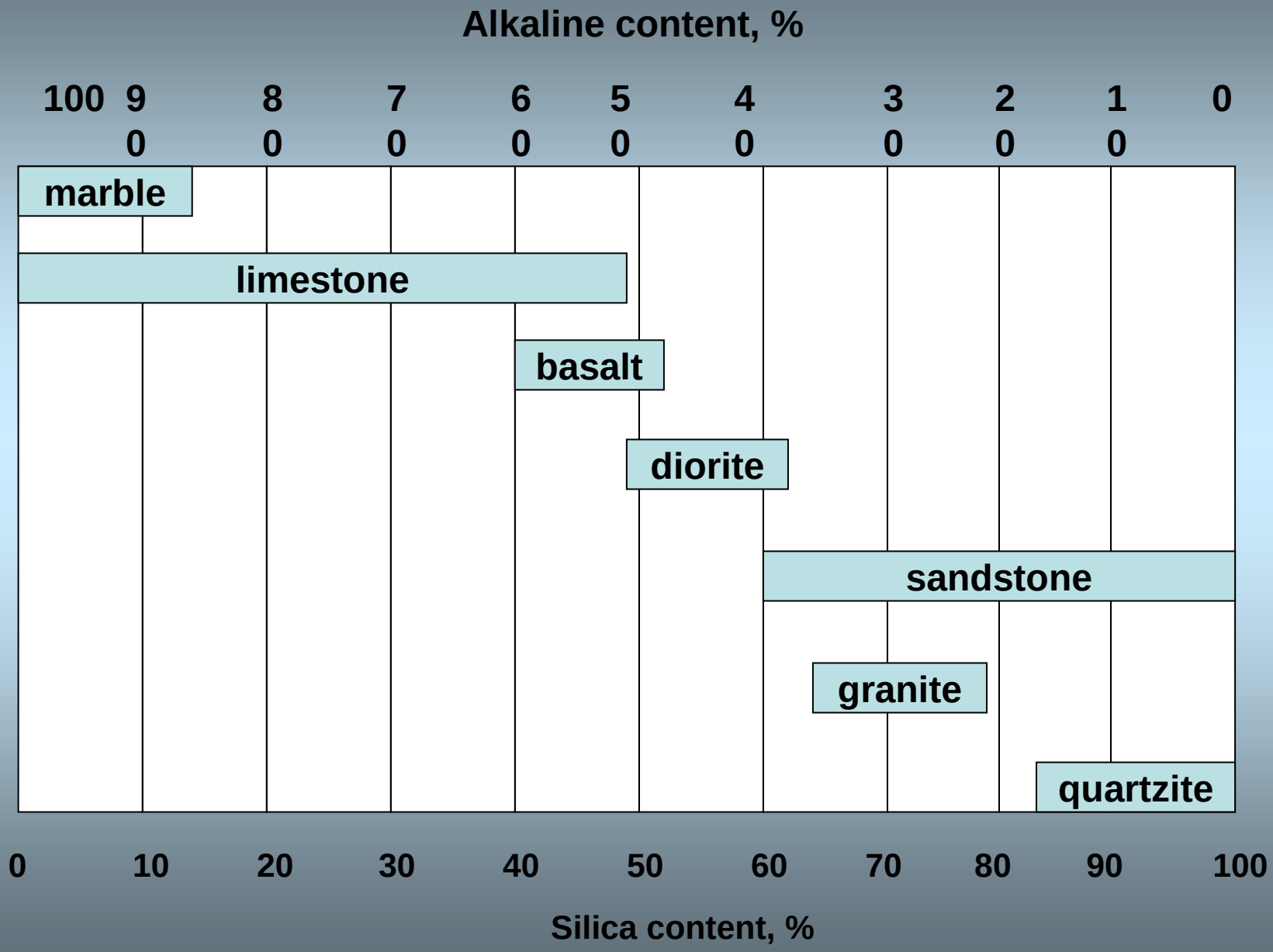

Oil on water emulsion (O/W)

# The breaking of reactive cationic emulsions

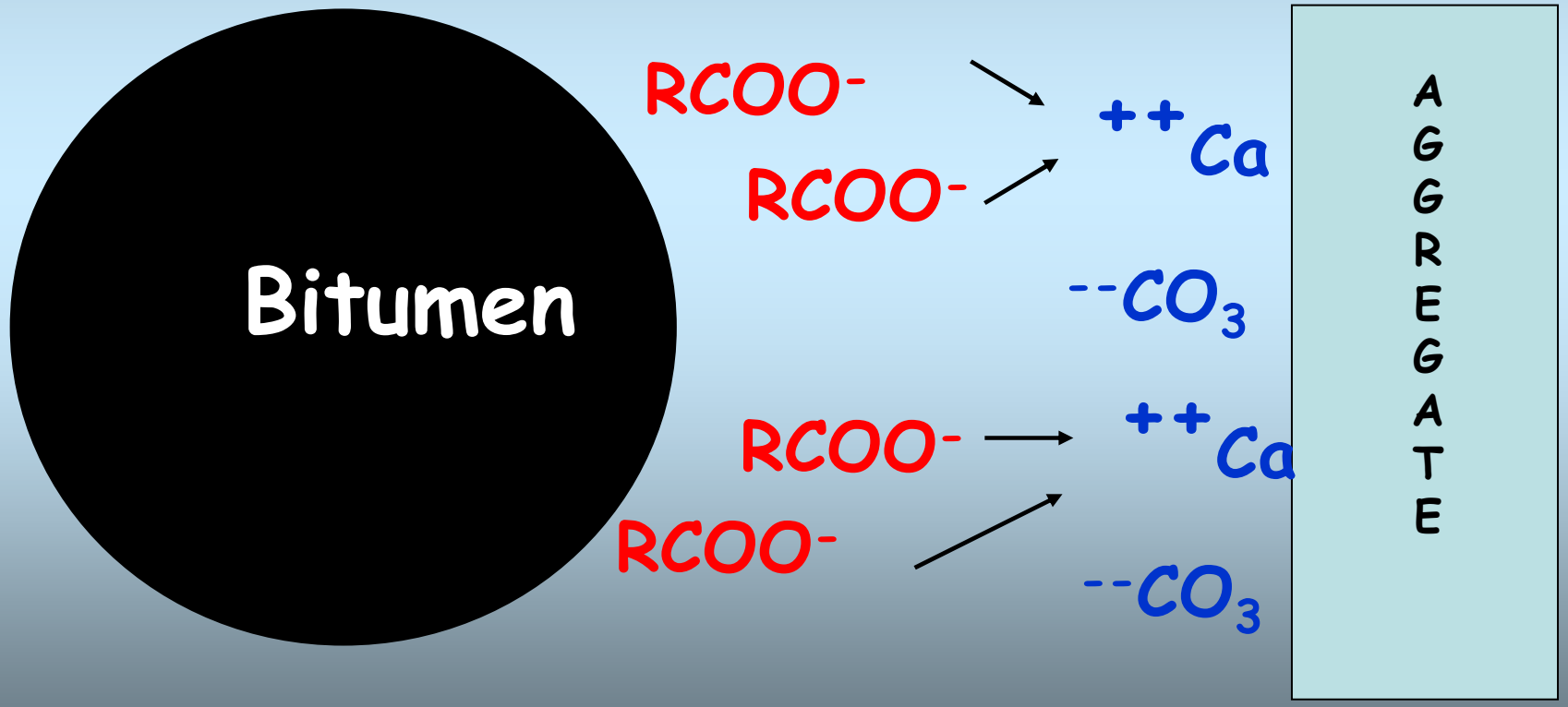
By one or more of the following mechanisms:

* Adsorption of free emulsifier on aggregate
* Adsorption of bitumen particles on aggregate
* Rise in pH caused by aggregate or cement
* Loss of water

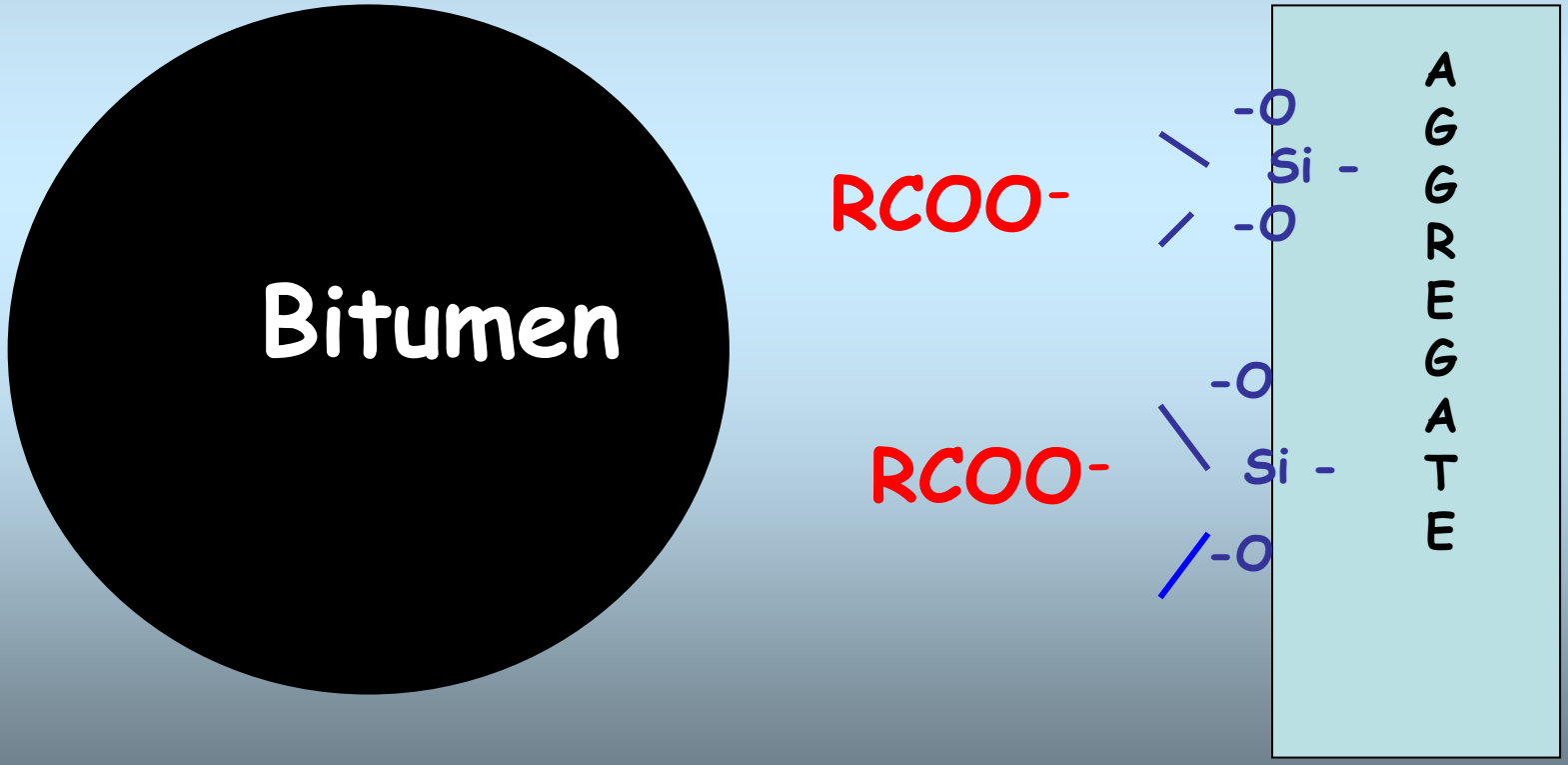
# Classification of aggregates



# Reaction of anionic emulsion with basic aggregate

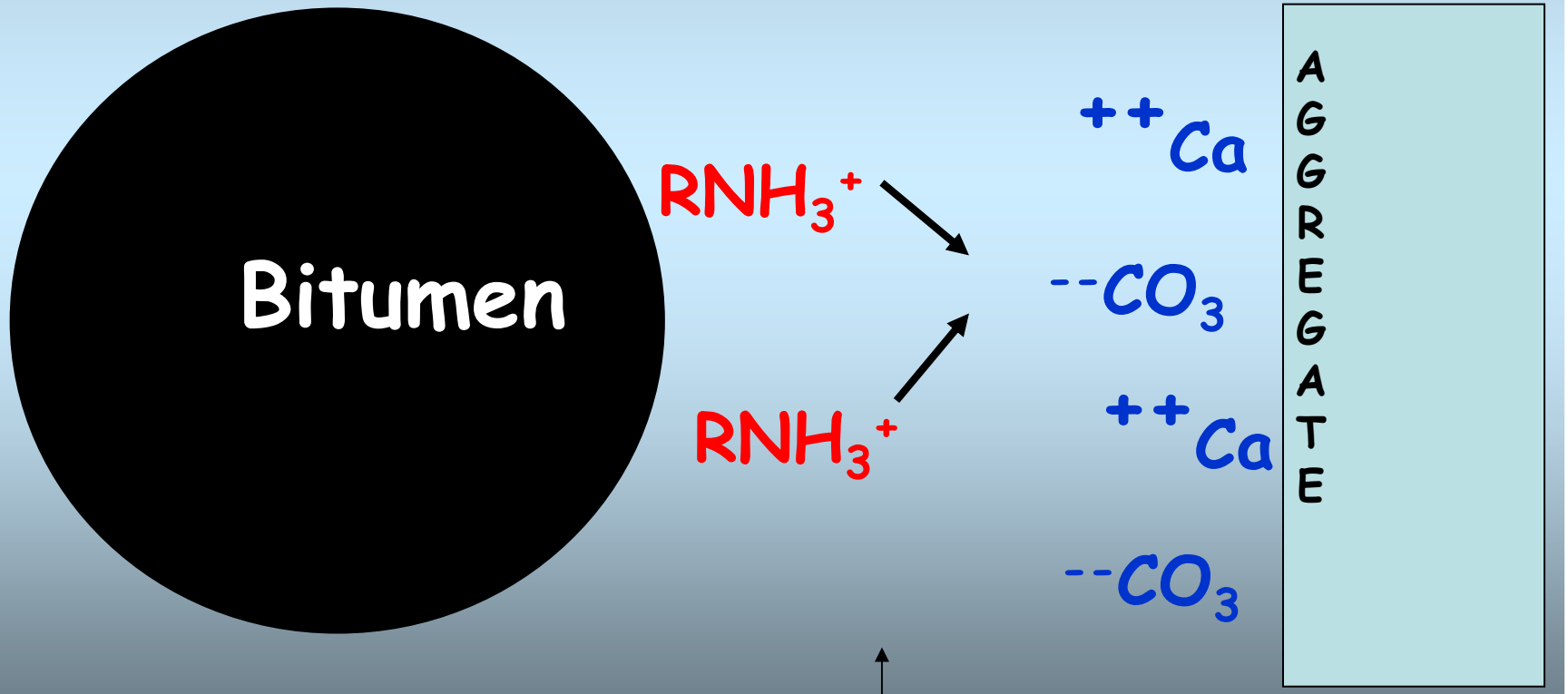


# Reaction of anionic emulsion with acidic aggregate



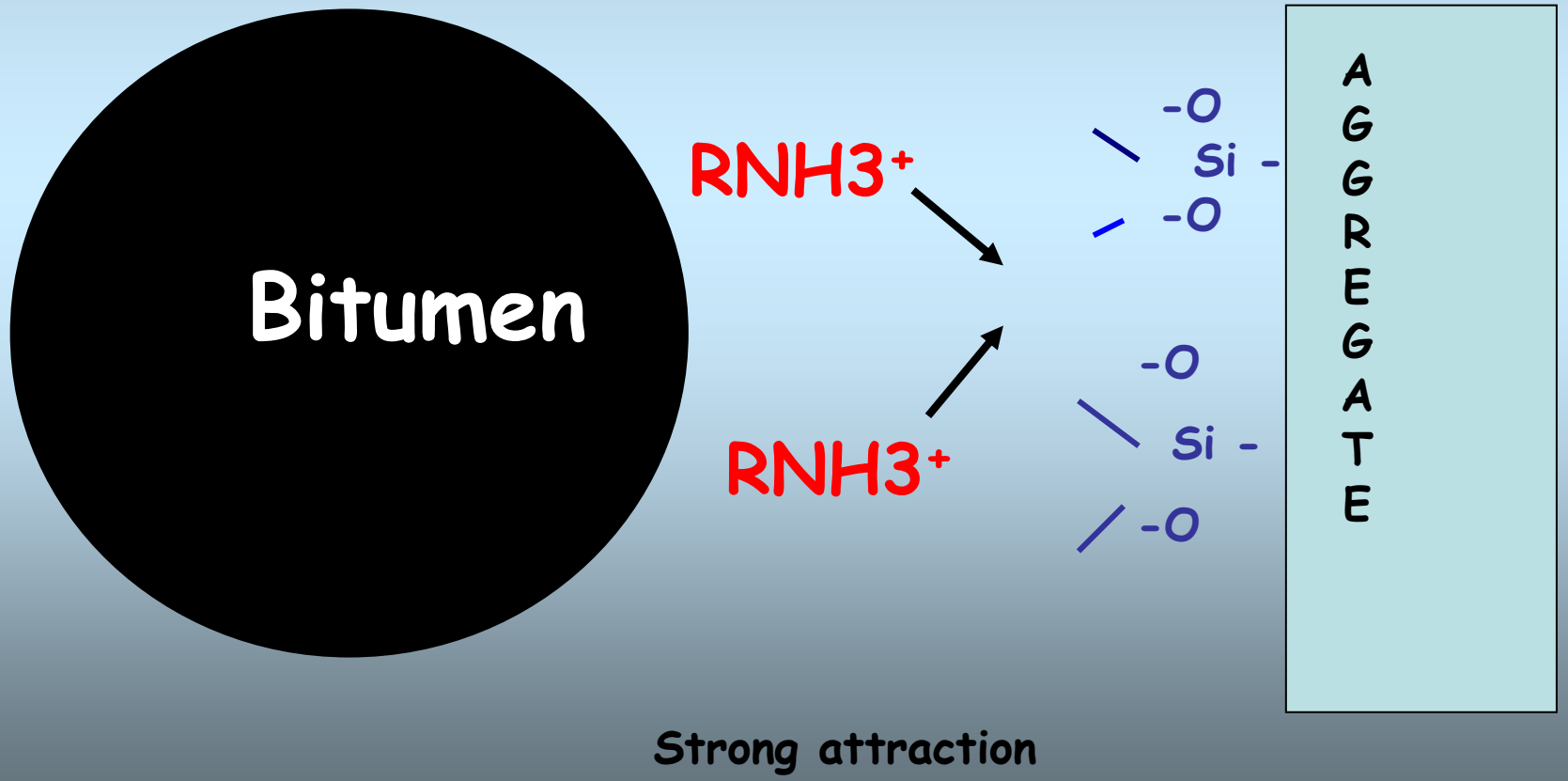

No attraction

# Reaction of cationic emulsion with basic aggregate




Also $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$

# Reaction of cationic emulsion with acidic aggregate



# Use of emulsions for slurry

- **90% Anionic emulsion**
- **Limited use of Cationic emulsions**
  - Eastern Cape – practitioners preference

# Hydration of cement

- **Cement reaction with water**
  - $Ca(OH)_2 \leftrightarrow Ca^{++} + 2(OH)^-$

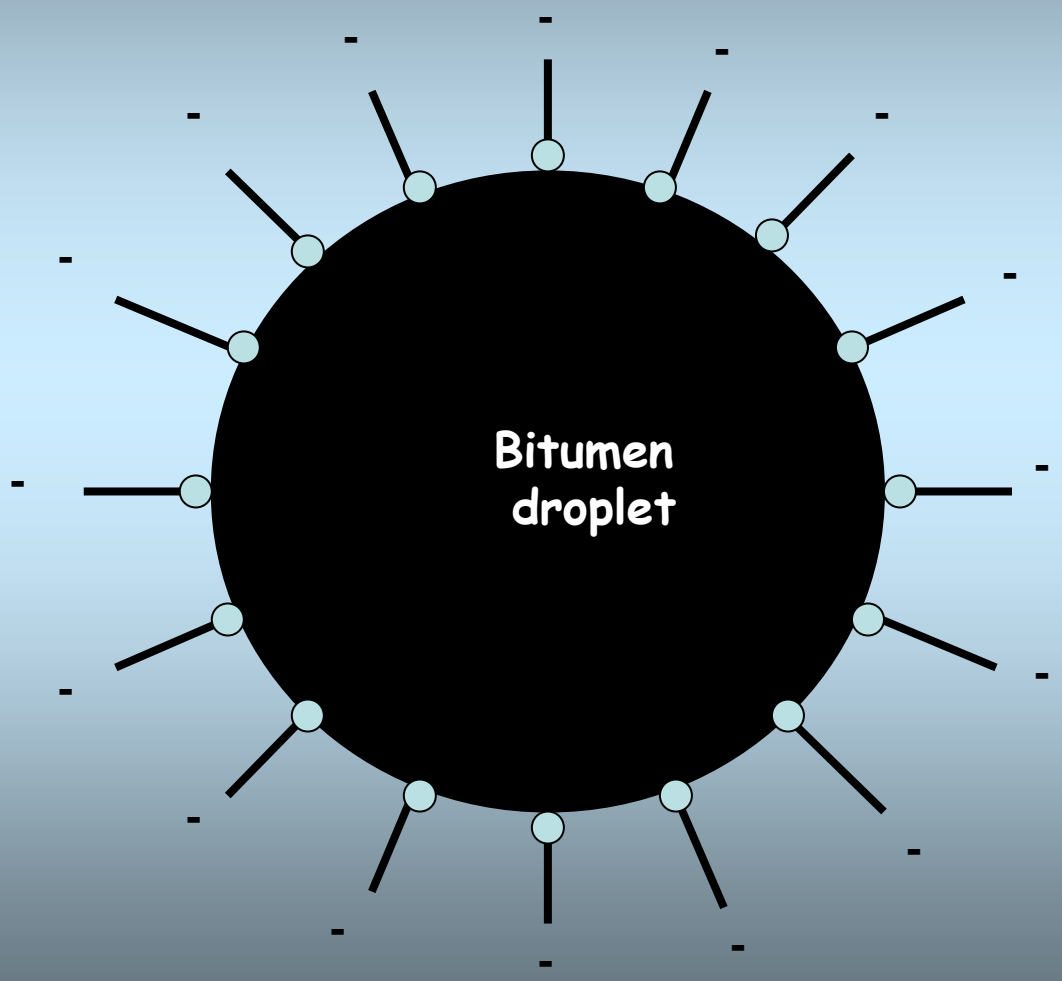
**These ions react with emulsion**

- **CaO higher for CEM1 and Lowest for CEM V**

**65%** **43%**

# Anionic Emulsions

Fatty Acids/Rosins + Caustic Soda =
negatively charged soap = $RCOO^-$ =

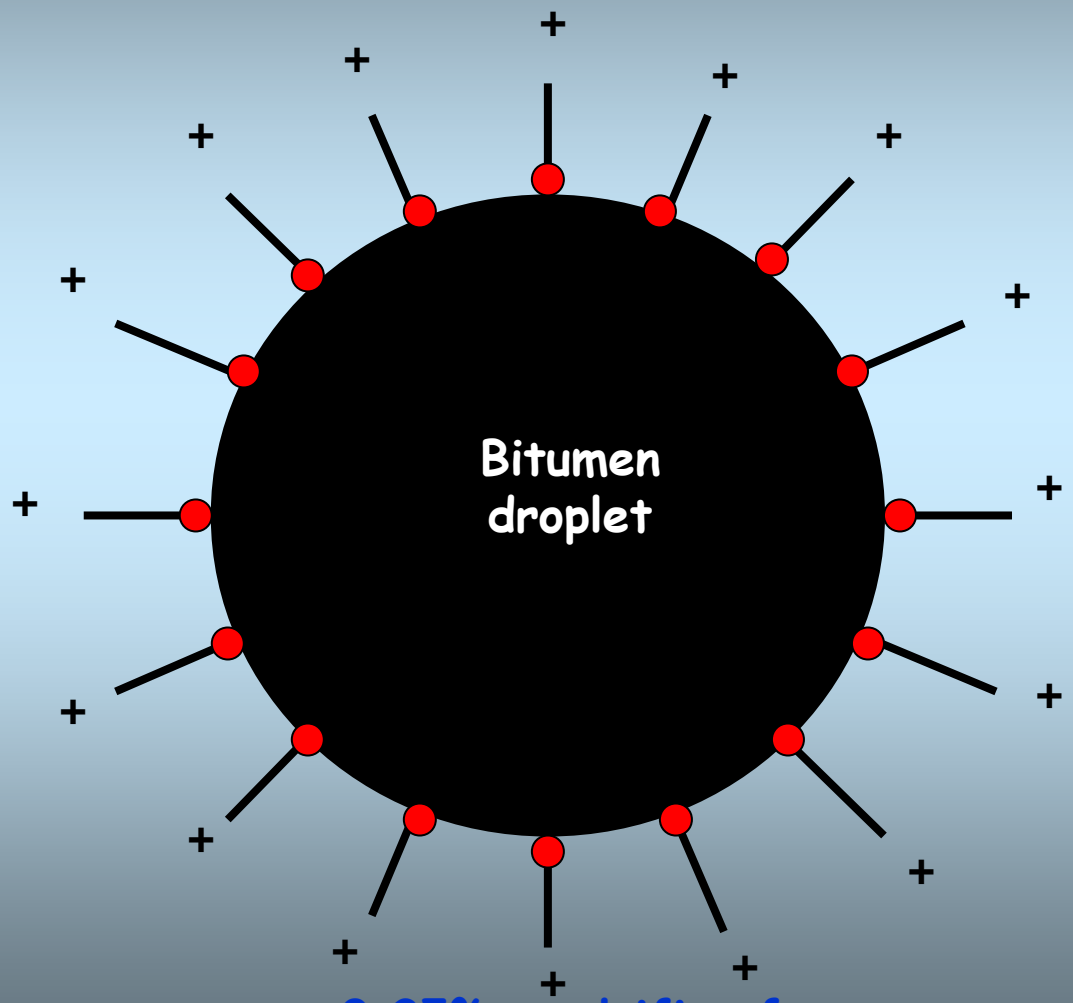



pH > 11

# Cationic Emulsions

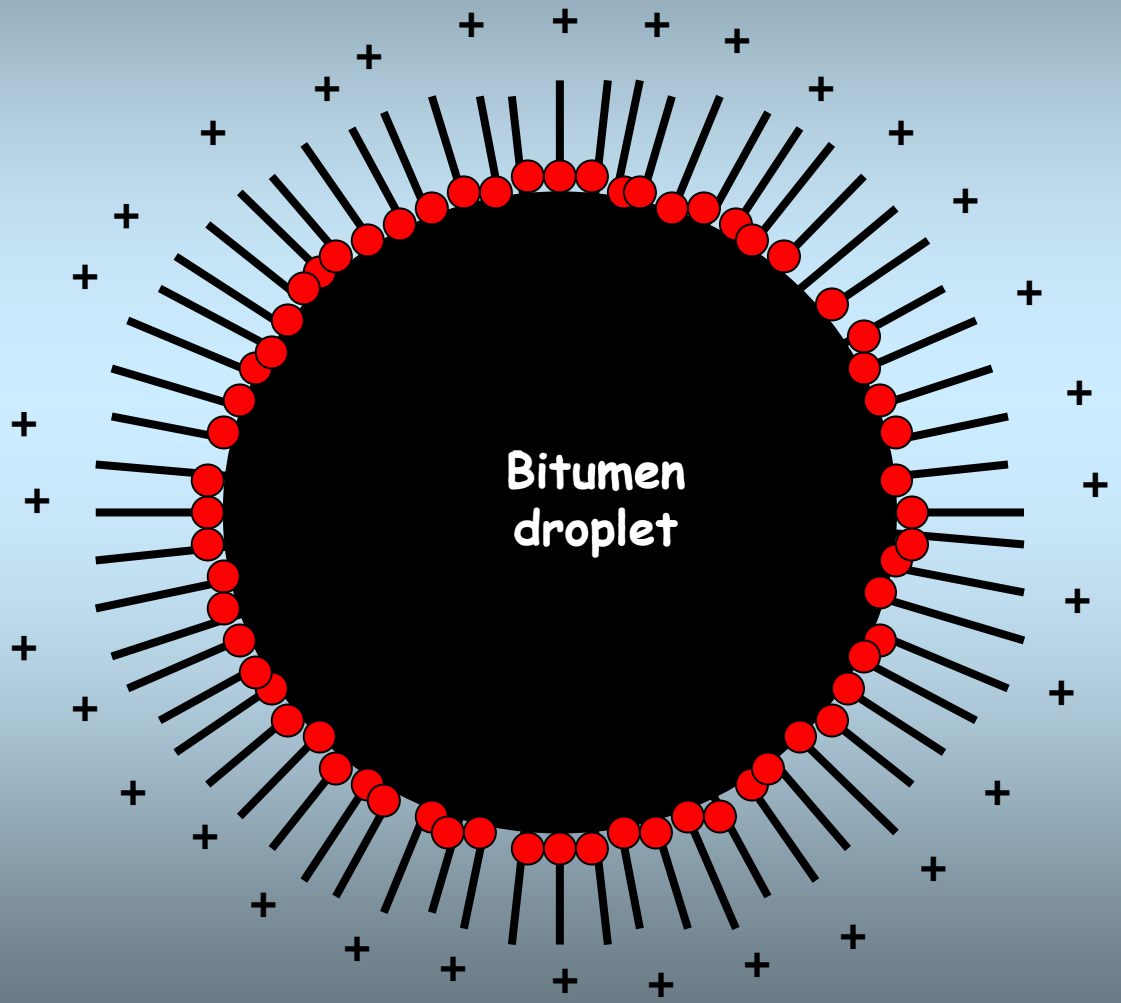
Amines + Hydrochloric Acid = positively charged soap = $RNH_3^+$ =

pH < 4




0,25% emulsifier for spray grade

# Cationic Stable Grade




1,0 to 1,5% emulsifier


# The effect of cement on stable mix emulsion

# Slurry mixes without cement

- **Both Cationic and Anionic emulsions**
- **Slurry segregates**

# Slurry mixes with Cement

- Causes emulsion to thicken
- Resulting in homogeneous creamy mix

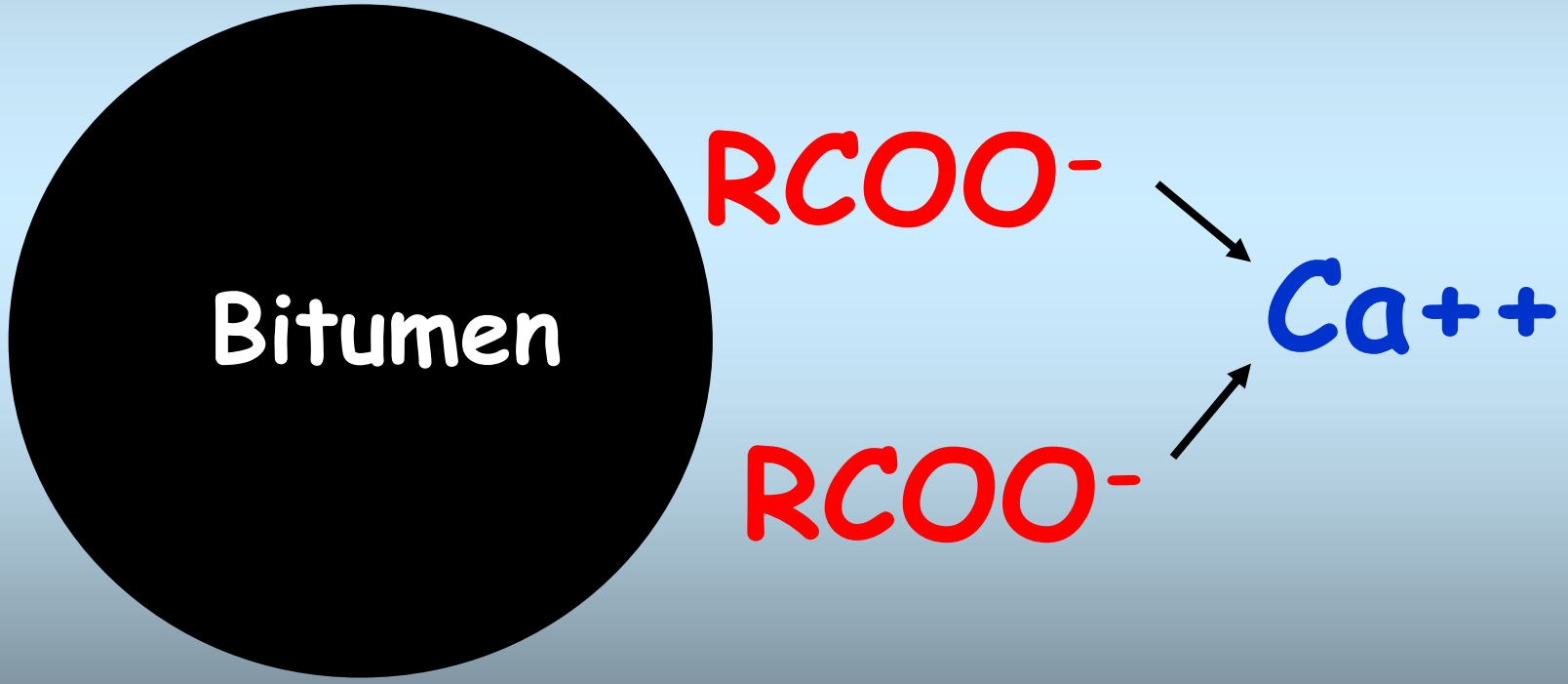
# Reaction of cement (Anionic Emulsions)

- **No PH change (both alkaline)**
- **Under microscope**
  - Ionic character destroyed
  - No further electrostatic attraction of emulsion to aggregate
  - Bond now due to interaction of the cement and emulsifier molecules adsorbed on the bitumen droplets

# Reaction of cement (Cationic Emulsions)

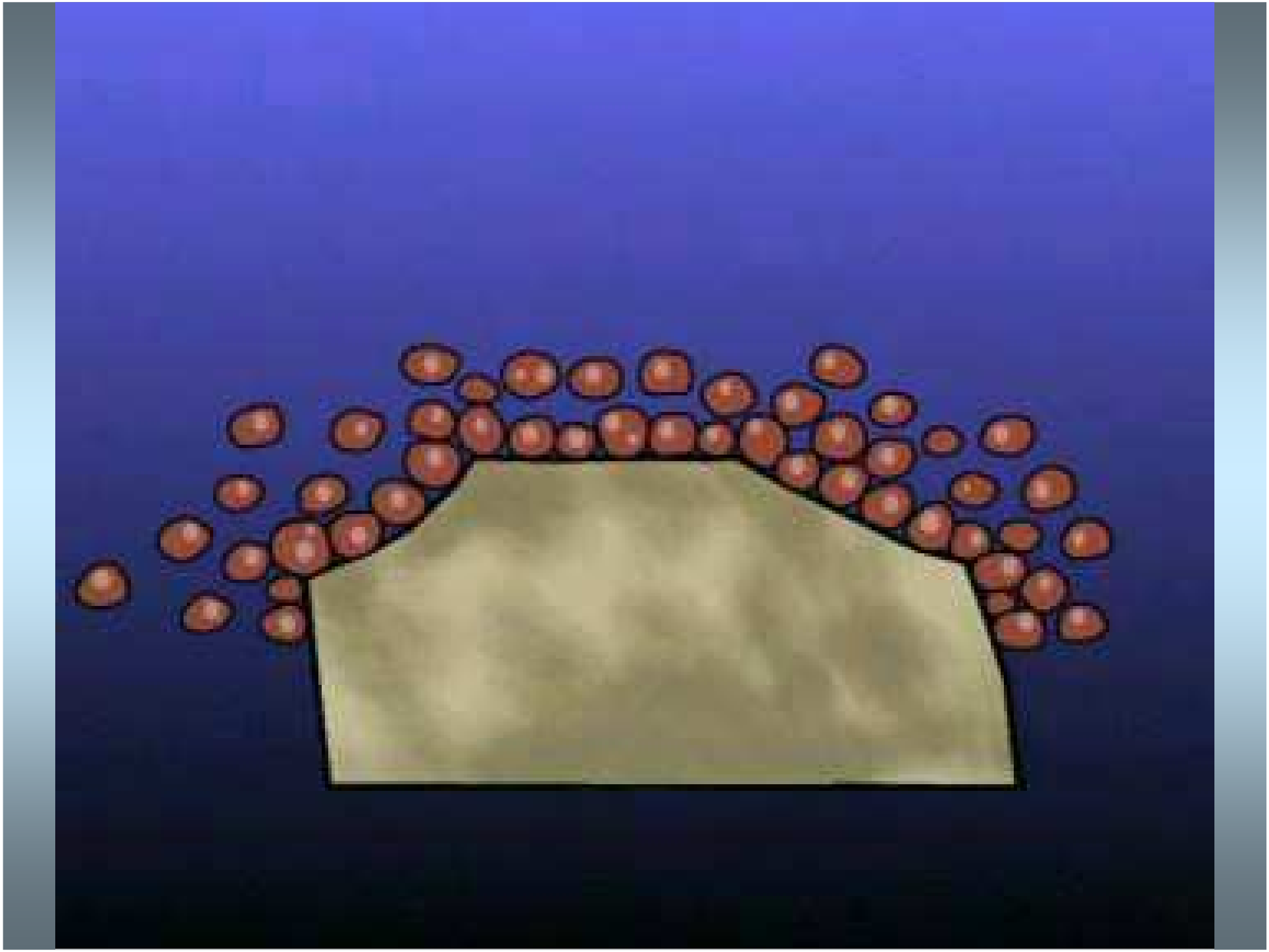
- **PH changes as a result of (hydroxide ions)**
  - < 4 to >10
- **Under microscope**
  - Ionic character of emulsion destroyed with addition of cement
  - As with Anionic emulsions the bond now due to interaction of the cement and emulsifier molecules adsorbed on the bitumen droplets

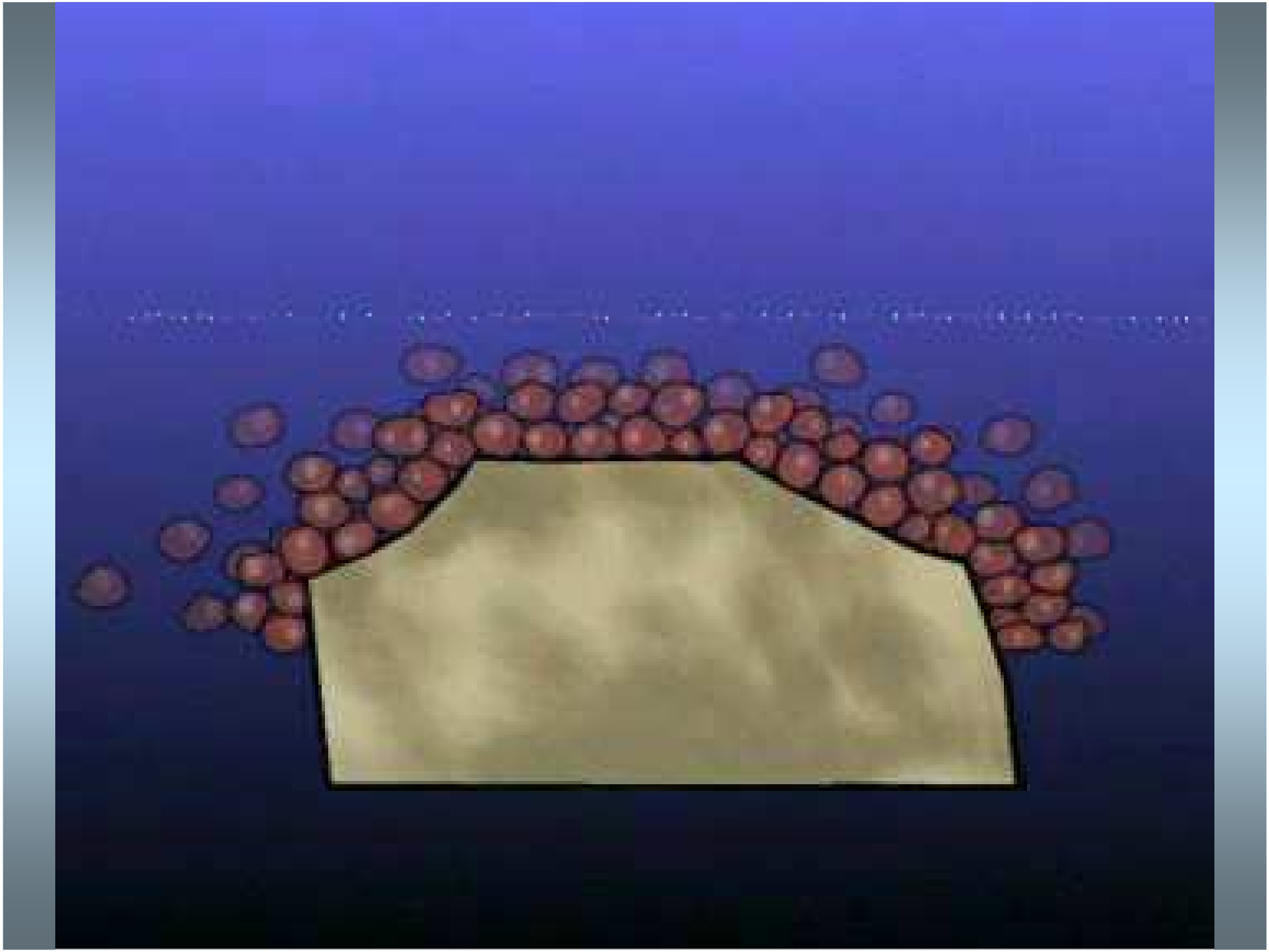
# Reaction of cement or lime with anionic slow set emulsion

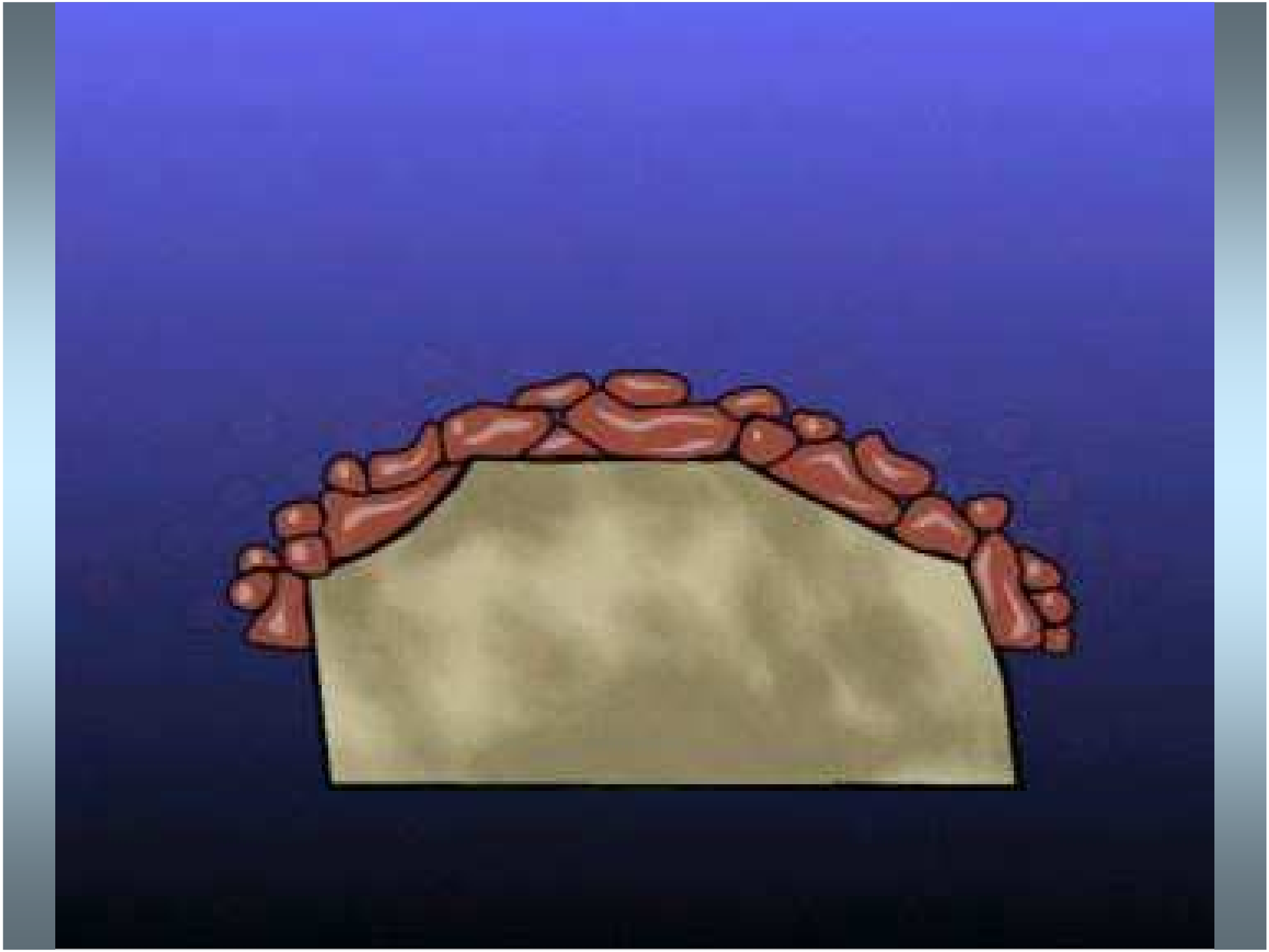


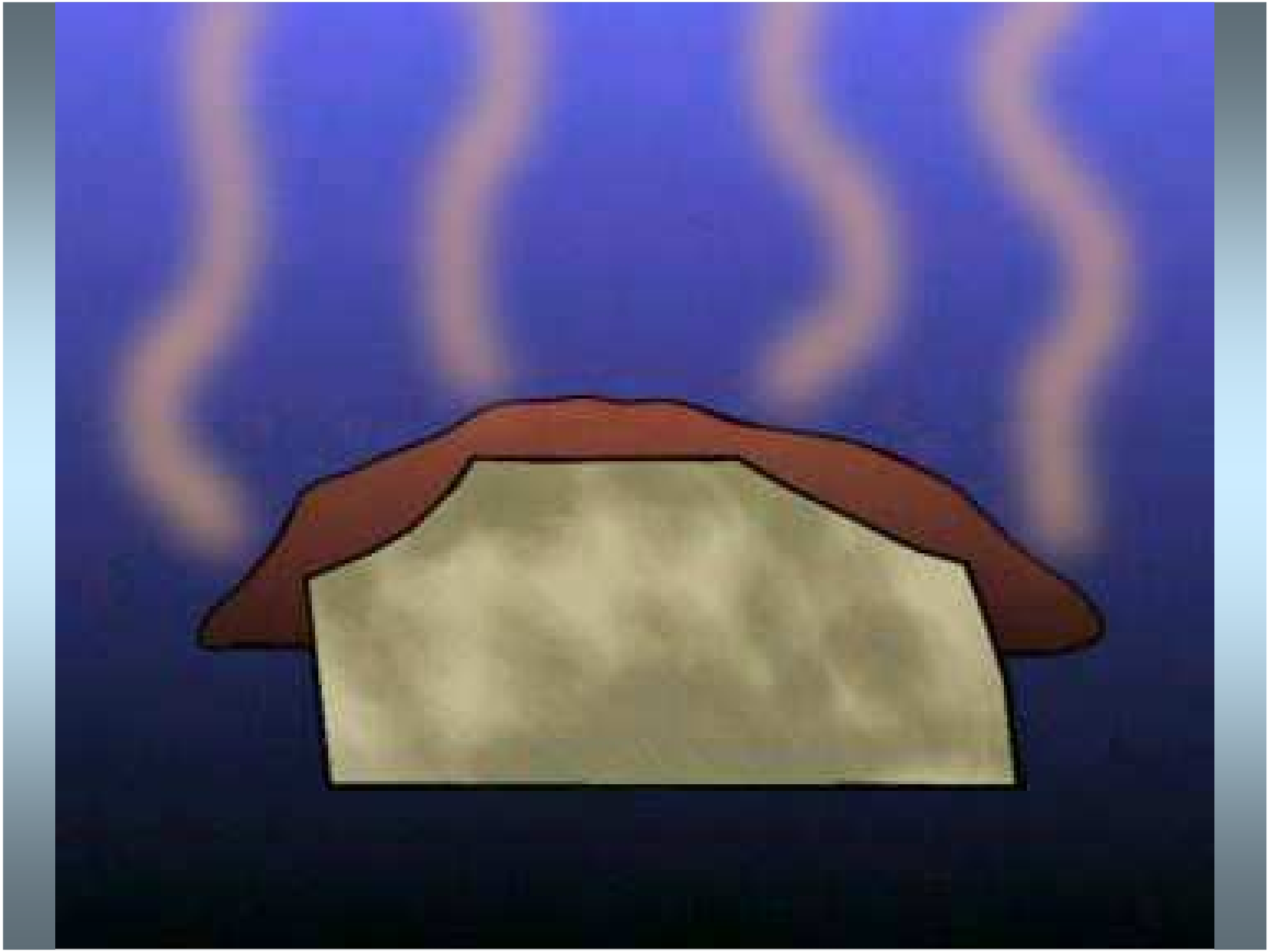
# CONCLUSION

- **Conventional slurry cures mainly as a result of water evaporation**









# Study

- 4 Cement manufacturers
- 11 different factories
- 22 cements obtained

# Cement Types

- **CEM 1 -** Portland cement (comprising Portland cement and up to 5% of minor additional components)
- **CEM II -** Portland–composite cement (Portland cement and up to 35% of other single components)
- **CEM III -** Blastfurnace cement (Portland cement and higher percentages of blastfurnace slag)
- **CEM IV -** Pozzolanic cement (Portland cement and up to 55% of pozzolanic constituents) (volcanic ashes)
- **CEM V -** Composite cement (Portland cement, blastfurnace slag or fly ash and pozzolana)

# The mixing/coating test

- **Done with all cements**
- **Cationic and anionic**

**Slurry > 5 minutes**

- **All cements effective CEM I – CEM V**

# Testing effect of Calcium Oxide Content

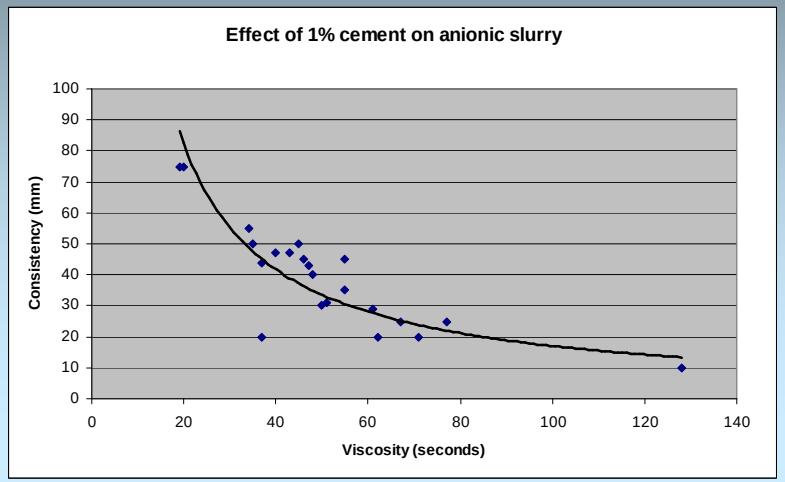
- Medium grade crusher dust (Quartzitic)
- 1% Cement by mass
- 15% emulsion (Cationic and Anionic)
- 11% water

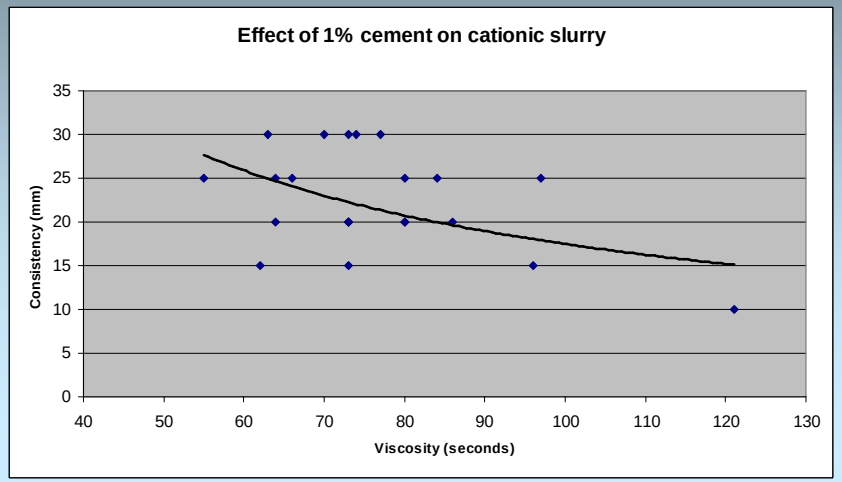
- Viscosity test (Stormer viscometer ASTMD562)
- Consistency Test ASTM 3910

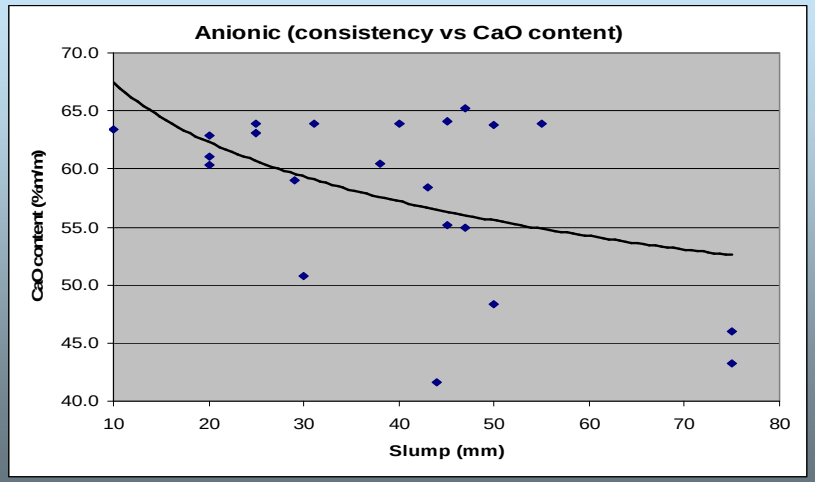
# Consistency test

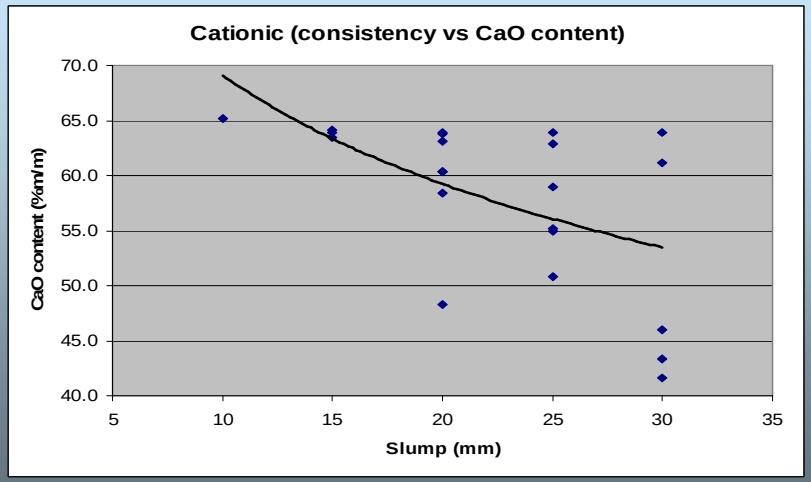
| Application | Target Flow |
|---|---|
| Slurry bound macadam | 60 mm |
| Texture treatment or Cape Seals | 30 - 40 mm |
| Slurry overlay | 20 - 30 mm |
| Micro surfacing | 10 - 20 mm |

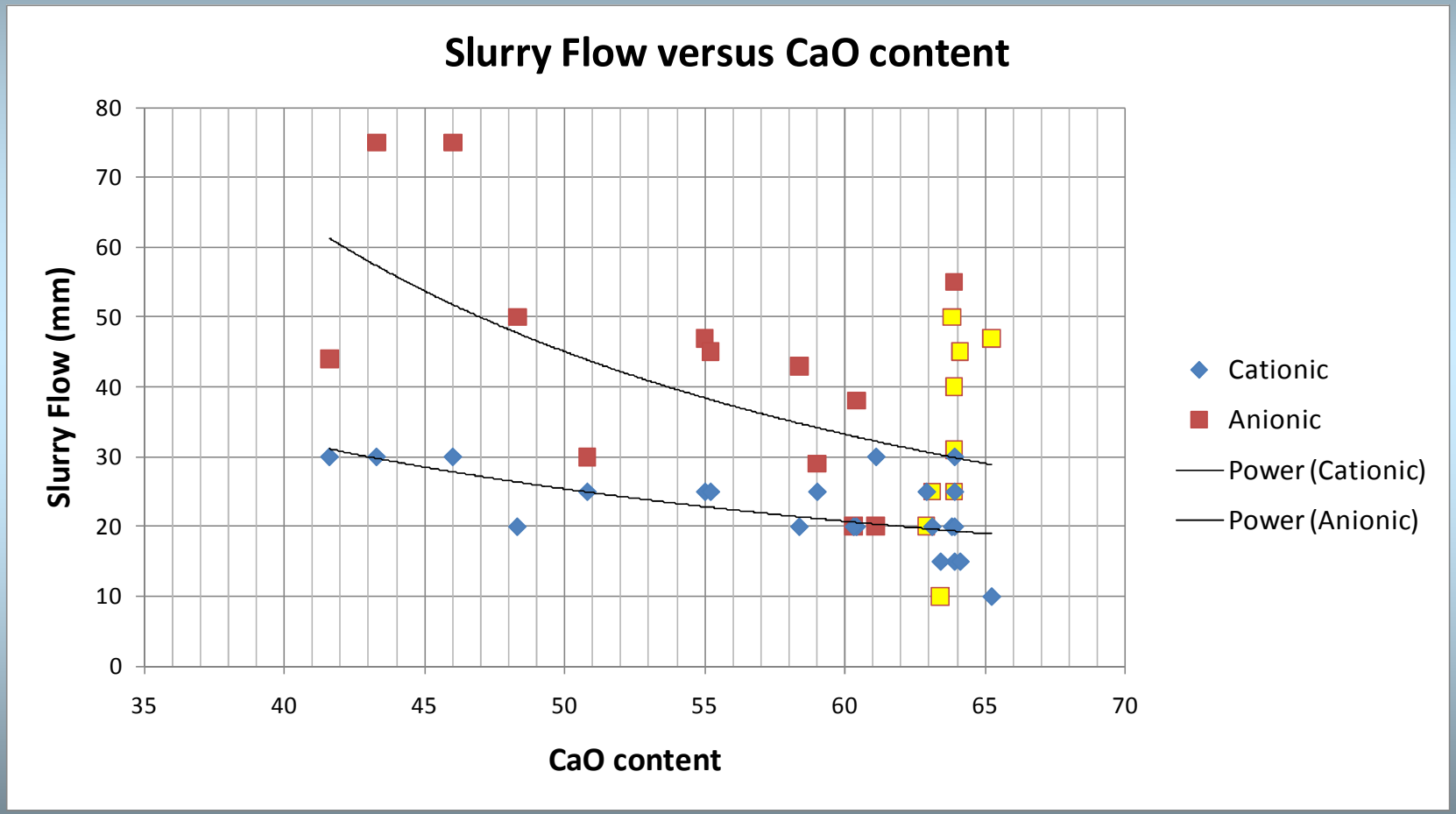
# Study Results




Slurry Flow versus CaO content
Slurry Flow (mm)
80
70
60
50
40
30
20
10
0
35
40
45
50
55
60
65
70
CaO content
Cationic
Anionic
Power (Cationic)
Power (Anionic)

# CONCLUSIONS

- **Good correlation between viscosity test and consistency (slump) test**
- **Consistency of cationic slurry much higher than anionic slurry**
- **Therefore, cationic slurry has higher water demand to obtain target flow**
- **Different CEMI cements react differently, specifically with anionic emulsions**
- **Therefore, re-evaluation of water demand is necessary when:**
  - Changing cement source
  - Age of cement

# End