

REMOVAL OF PARAFFIN DEPOSITION USING YEAST'S MANNOPROTEIN

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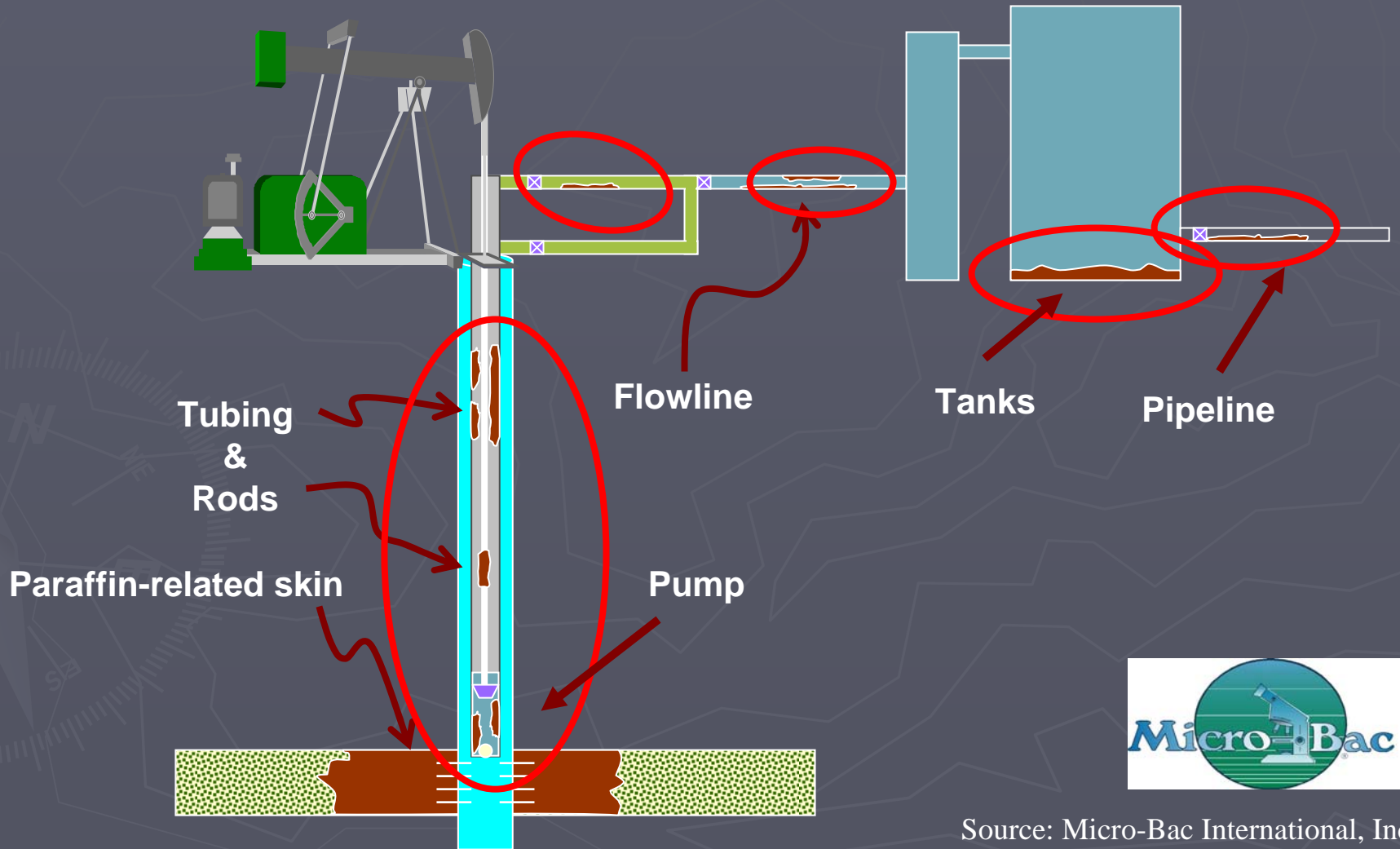
Dr Firdausi Razali

PARAFFIN DEPOSITION

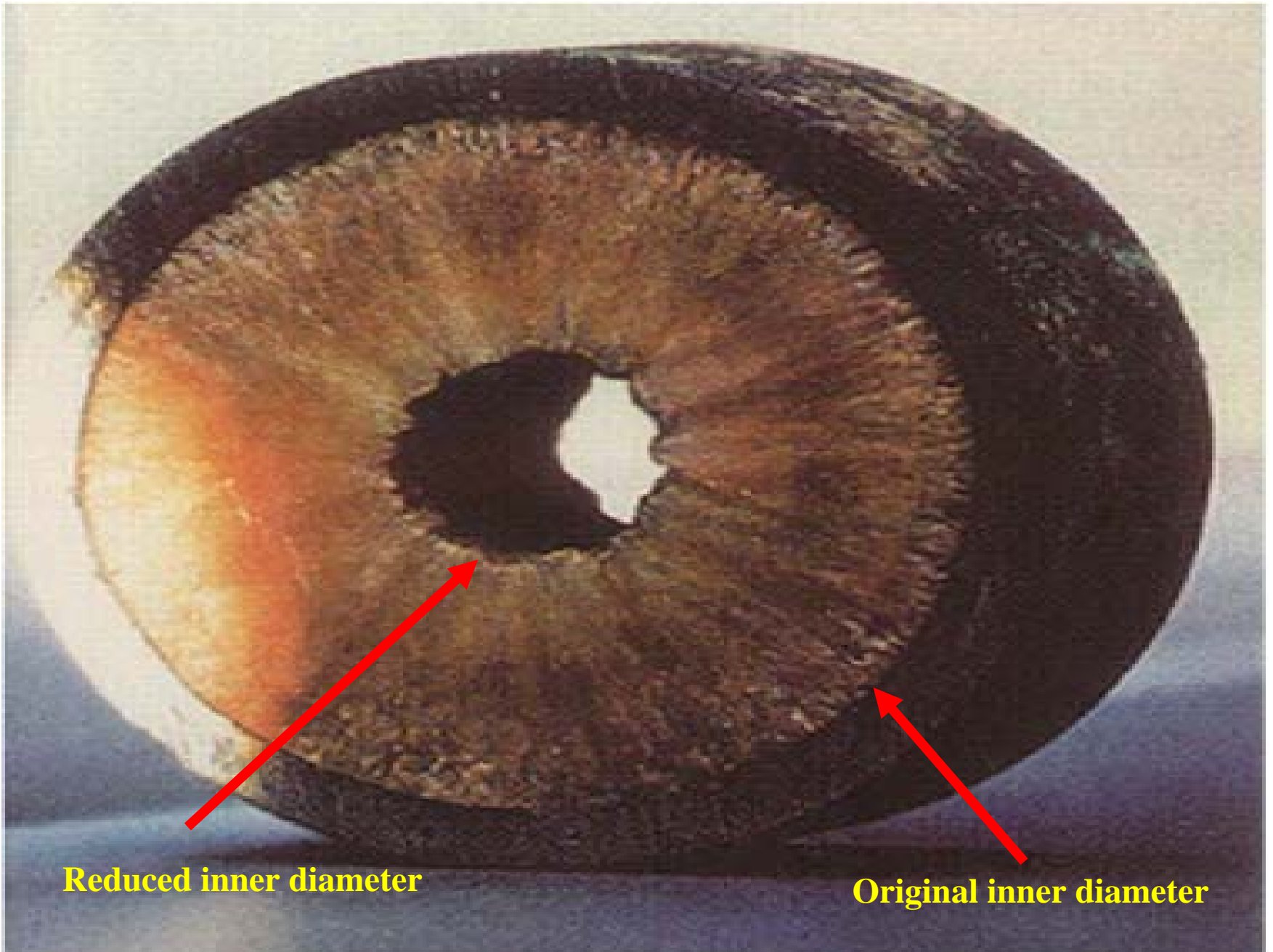
- ❌ Paraffin deposition occurred when the oil temperature falls below the **Wax Appearance Temperature**
- ❌ These deposits generally consist of straight and branched chain hydrocarbons

Problem Statement

Paraffin Accumulation in Production System



Source: Micro-Bac International, Inc.



Reduced inner diameter

Original inner diameter

Paraffin deposition control methods :



- ✘ Chemical
- ✘ Mechanical
- ✘ Thermal
- ✘ Electromagnetic
- ✘ Biological

Biological Methods

TWO MECHANISMS:



Dispersion

Metabolic by-product of microorganisms or the microorganisms itself as **biosurfactant** act to loose the paraffin deposit.

[Micro-Bac International, 1993-1995]



Solubilization

When the bacteria increase the solubilization of the oil by :

- increasing the percentage of oil volatilities
- increase solubility of long chain

[Fabien Marino, 1998]

Biosurfactant used in HC Removal

- ✘ Surfactin from *B. subtilis* [Makkar & Cameotra, 1997]
- ✘ Rhamnolipid from *P. aeruginosa* [Noordman *et al.*, 2002]
- ✘ BOD-Balance™ from cactus [Nakhla *et al.*, 2003]
- ✘ Sophorolipid from *C. bombicola* [Schippers, 2000]
- ✘ Trehalose-6monocoryno-mycolate from *Rhodococcus arithropolis* [Marino, 1998]

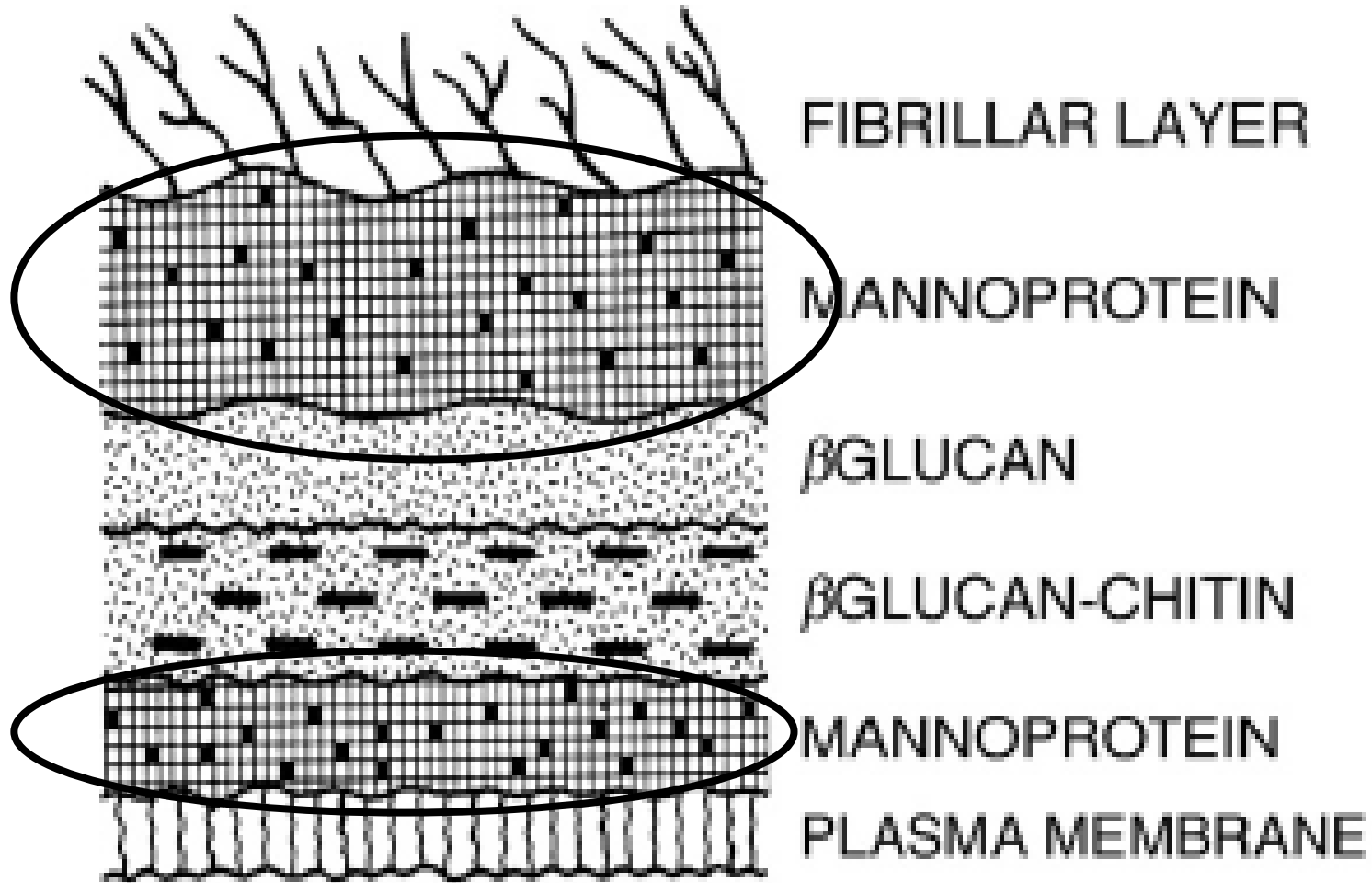
Mannoprotein from Baker Yeast

- ❌ Widely-used in food industry as emulsifier
[Manwart,1979; Torabizadeh *et al.*,1996; Freimund *et al.*, 2003]
- ❌ Currently used in preservation of immunological properties [Richard *et al.*,2005]
- ❌ Not extensively investigated in petrochemical industry
- ❌ However, a report indicated a success attempt to solubilize HC [Michael & George, 1984; Jeffrey *et al.*,1999;]

Mannoprotein

- ✘ Located in the outermost layer of *S. cerevisiae* cell wall [Kappeli & Fiecher, 1976; Jigami, 1998]
- ✘ Polysaccharide-fatty acid complex [Kappeli & Fiecher, 1977]
- ✘ Belong to one of two classes of compounds
 - i. macromolecules of the yeast cell: 10% protein and 90% carbohydrate
 - ii. mannan enzymes :30–50% protein, 50-70% carbohydrate

Slice of the Cell Wall Structure of *S. cerevisiae*



OBJECTIVE

To explore the potential of employing yeast's mannoprotein to disperse wax deposit

SCOPE

- ✘ To quantify the percentage of surface area reduction of the wax at 5, 10 and 20 w/v% yeast concentration
- ✘ To investigate the stability of complex hydrocarbon-mannoprotein emulsion

An aerial view of a large offshore oil platform in the middle of a vast blue ocean. The platform is a complex of yellow and white metal structures, including a large white cylindrical tank on the left and a smaller white building at the bottom. The sky is clear and blue.

METHODOLOGY



MELTING
PROCESS



MOLDING PROCESS



SOLIDIFIED AT ROOM
TEMPERATURE



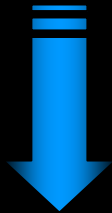
WAX OBTAINED
FROM Merck KGaA,
Darmstadt, Germany

SAMPLE OF WAX

- HOMOGENOUS SHAPE
- FLAT SURFACE



CELL DISRUPTION



3 DIFFERENT CONCENTRATIONS

- 5 % w/v
- 10 % w/v
- 20% w/v

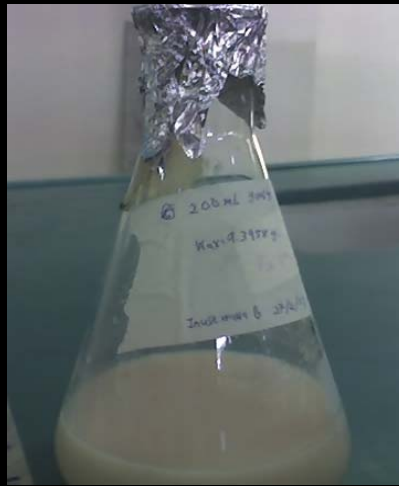


HOMOGENISATION

[Harrison *et al.*, 1991; Middleberg *et al.*, 1991; Baldwin & Robinson, 1992]



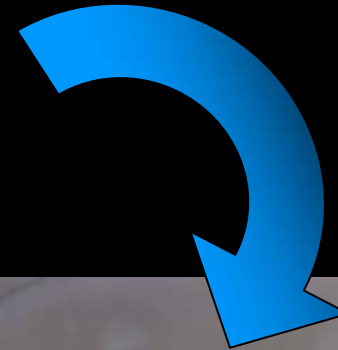
WAX



YEAST SOLUTION

SHAKE FLASK ON
ROTARY SHAKER

- room temperature
- 75-100 rpm
- 7 days

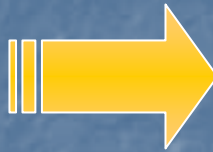


**REMOVAL PROCESS
OF WAX**

After 7 days of removal process :



Wax in yeast solution



weighing



Measurement of
weight(m) reduction

Initial weight – final weight = m reduction

[Method described by
Giedraityte *et al.*, 2001]

EMULSION TEST

6 ml HC



6 ml yeast solution

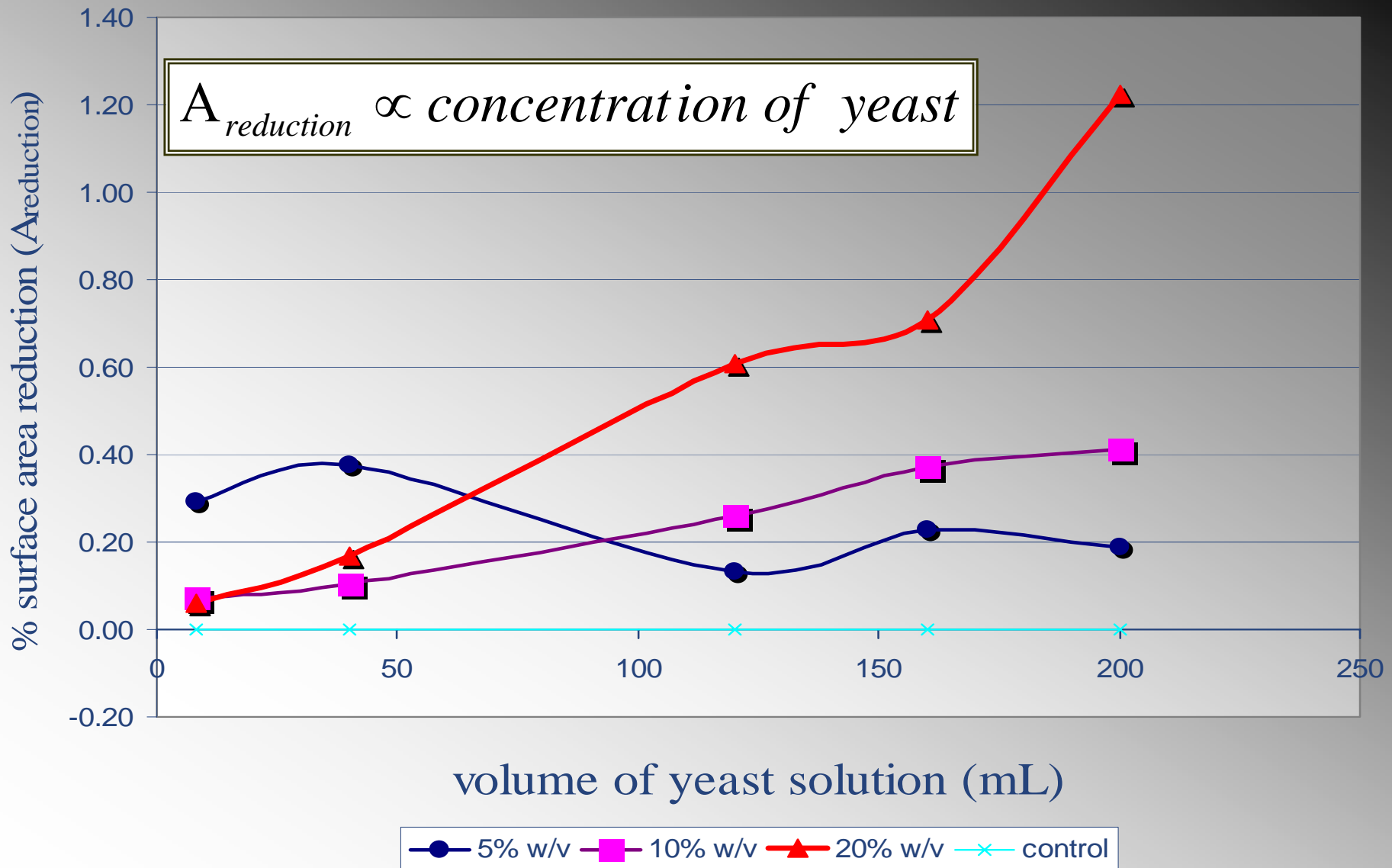


[Modification of the method described by Bosch *et al.*, 1988 and Willumsen and Karlson 1997]

**VORTEX FOR 10 MINUTES
& LEFT FOR 24 HOUR**

RESULT & DISCUSSION

Percentage of Surface Area Reduction



Yeast can disperse the wax &
consequently the surface area will be reduced

Observation of Physical and Surface Changes

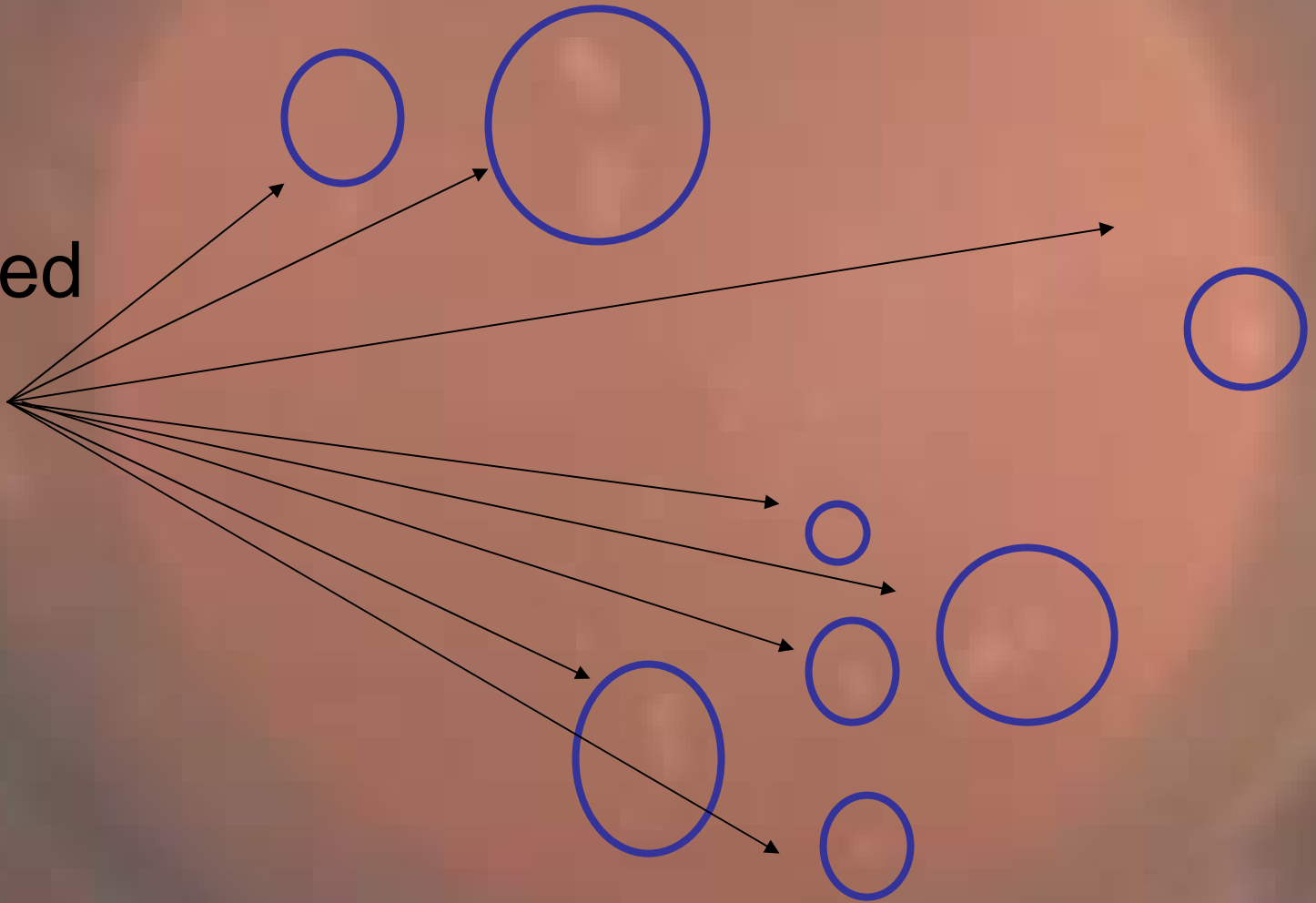
**Control- wax in distilled water- no
change after 7 days!**

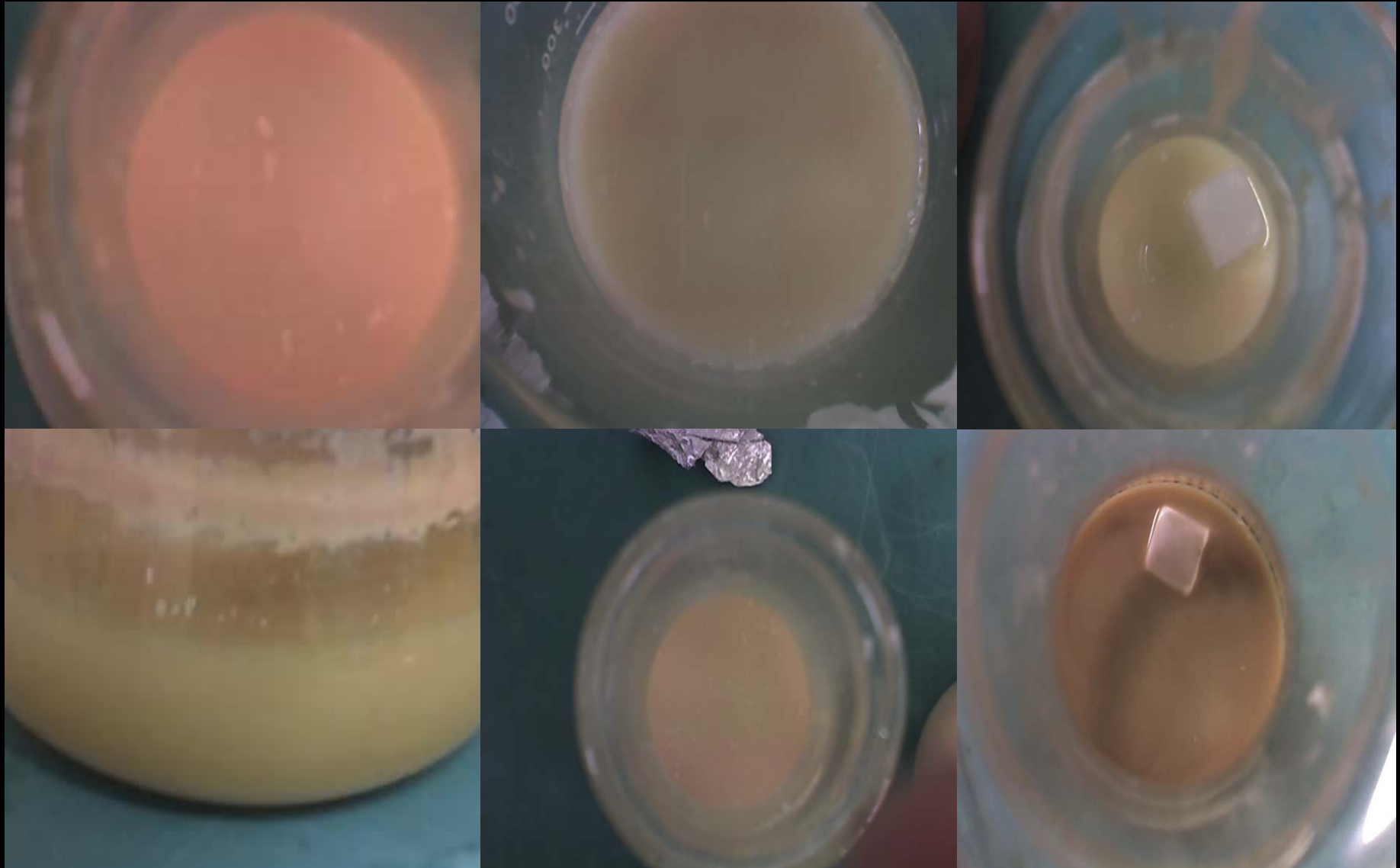
Sample wax



Wax in 20%w/v yeast- small particles of dispersed wax floating in the shake flask after 7 days!

Dispersed
wax





MANNOPROTEIN CAN PEEL OFF THE WAX SURFACE



**SACCHAROMYCES CEREVISIAE CELL CAN ATTACH
TO THE WAX SURFACE!**



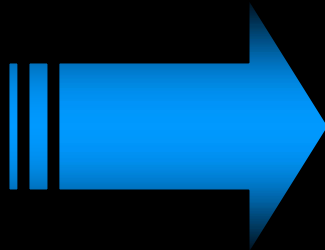
**MANNOPROTEIN attach ON THE WAX SURFACE
and THAT CAUSES THE OUTER LAYER OF WAX
DISPERSED!**

Wax with yeast

Control (distilled water)

Effect of Lysis on Emulsification of Complex Hydrocarbon

Emulsion test



After 24 hour

Oil lubricant

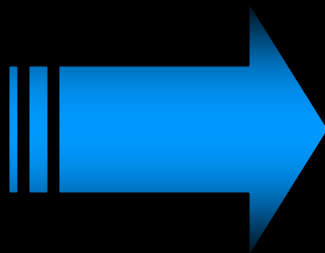
Emulsion

Aqueous

10% w/v Yeast Lysate



Emulsion test



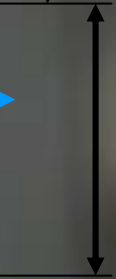
After 24 hour

Oil lubricant

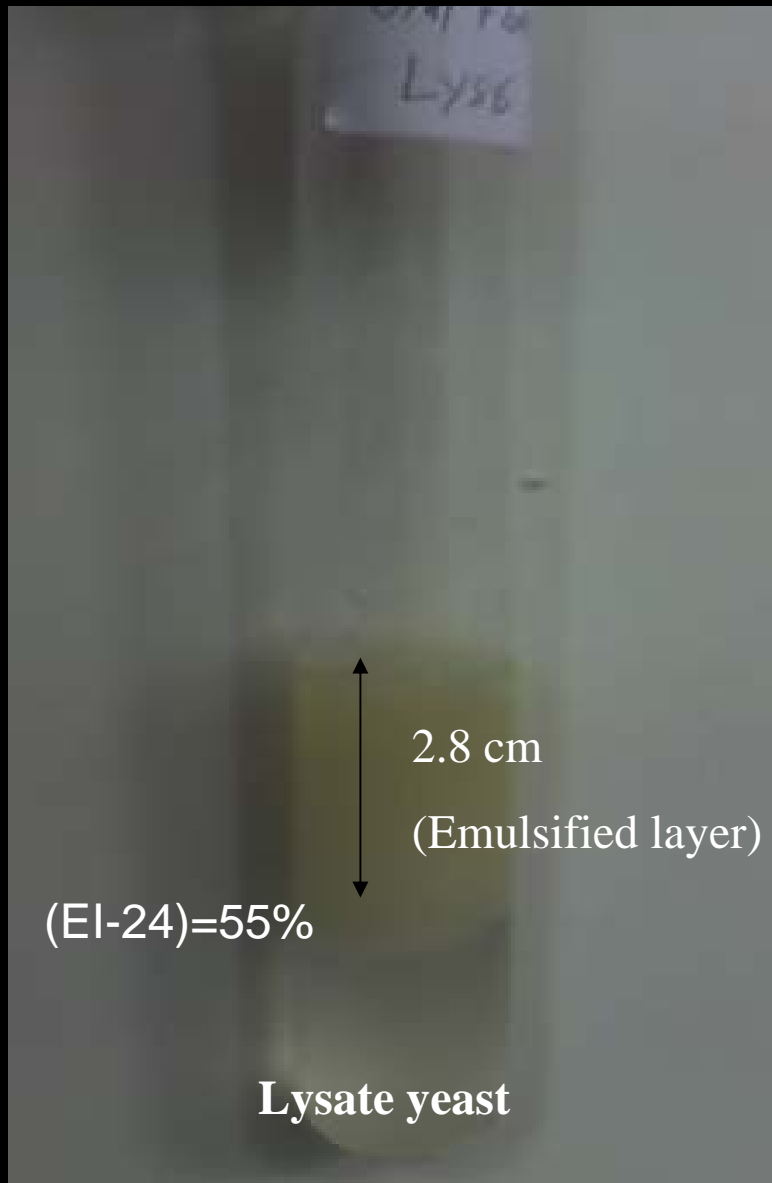
Emulsion

Aqueous

10% w/v Intact Yeast



Emulsion phase remains
after 24 hour



Emulsion phase reduced
after 24 hour



CONCLUSION

Current investigation indicated some promising results

HOWEVER

the potential of employing mannoprotein to remove wax deposit on the site is still inconclusive due to the following factors:

- i. Low adherence & emulsification decrease the transfer mode of HC to the cell surface of *S.cerevisiae*
- ii. Low mannoprotein released from the lysate insufficient to completely react & resulting of low removal rate
- iii. Low removal rate, may not economically attractive

FUTURE IMPROVEMENT

- ✘ Investigate the influence of other factors such pH, ionic charge, affinity and hydrophobicity effect
- ✘ Combination with other biosurfactant may enhance the *S.cerevisiae* potential in dispersing wax deposit
- ✘ Technically :
 - ✓ Increase close contact between mannoprotein and wax surface
 - ✓ Raise the amount of mannoprotein release via harsh, simple and inexpensive extraction method

Thank You



Why emulsion test was conducted using oil lubricant?

- ❌ Problem with wax emulsification - no appropriate experimental approach to conduct wax-mannoprotein emulsion test
- ❌ Oil lubricant represent the complex hydrocarbon with low solubility

HOW TO CALCULATE $A_{\text{reduction}}$?

$$\rho = m/V \dots \dots \dots (1)$$

$$V = Ah \dots \dots \dots (2)$$

Put equation (1) into (2)

$$m/\rho = Ah$$

Thus,

$$A = m/\rho h$$

ρ = density (g/cm³)
 m = weight of wax (g)
 V = volume (cm³)
 h = height (cm)
 A = surface area (cm²)

Emulsion test

❌ The emulsions produced are thick and viscous

❌ The emulsification index (EI-24)
= $\frac{\text{Height of emulsion layer}}{\text{Total height of liquid column}} \times 100$

❌ EI-24 \geq 50% \longrightarrow STABLE EMULSION

Why mannoprotein?

- ✘ Abundant component from cheap source
- ✘ Non toxic due to its widely-used in food industry
- ✘ Fulfills the current consumer demand for natural and environmentally safe products