Why Isn't My Program Working?

Exploring Microbial Resistance at the Wet End

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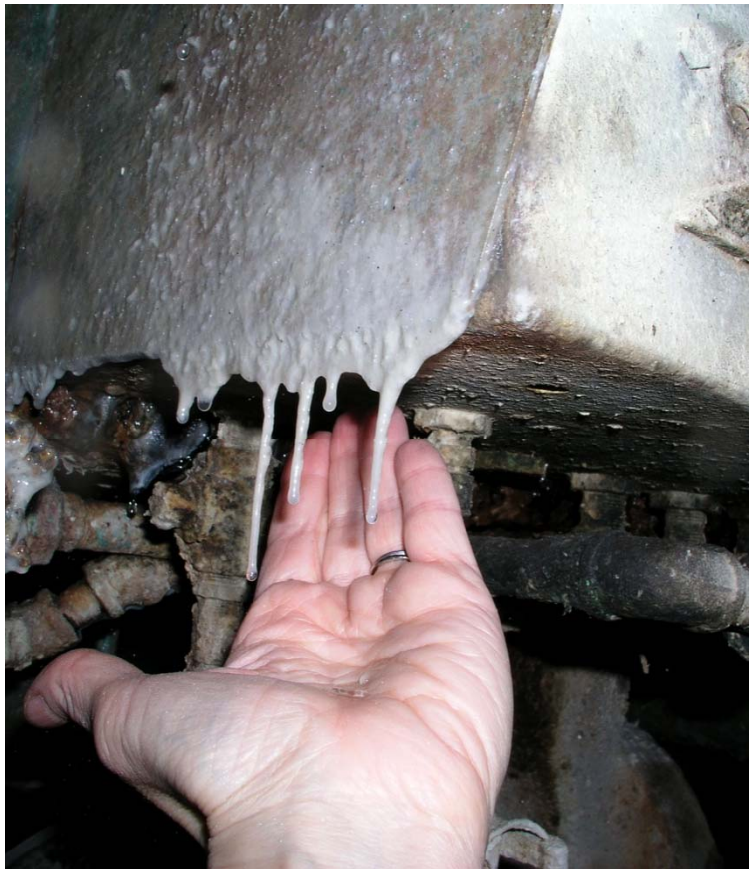
RETHINK PAPER:
Lean and Green

Wet end contamination



- Machine covered in stringers
- Bacteria and fungi forming biofilms/deposits
- Slime can drop and cause sheet defects

Antimicrobial Biocides

- Used to reduce microbial growth on machines
- Activity depends on:
  - System chemistry
  - Types of microbes present

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What is resistance?

"Resistance is a description of the relative insusceptibility of a microorganism to a particular treatment under a particular set of conditions."

From: Gilbert and McBain. *Potential Impact of Increased Use of Biocides in Consumer Products on Prevalence of Antibiotic Resistance*. Clinical Microbiology Reviews, 16(2)189-298. 2003

Tolerance (change in population) MIC >10X

Resistance (genetic change) MIC 20-50X

From: Jana Rajan. *Development of Microbial Resistance to Biocides. Myth or Reality?* Dow Chemical Webinar June 2010

Real World

- Wrong biocide for the population or application point
- Biocide incompatible with chemistry
  - ORP
  - pH
- Water system closure increases
- Biocide simply doesn't "work"
- Biocide works initially; stops "working"
  - Counts increase at constant biocide dose
  - Slime, defects and downtime increase

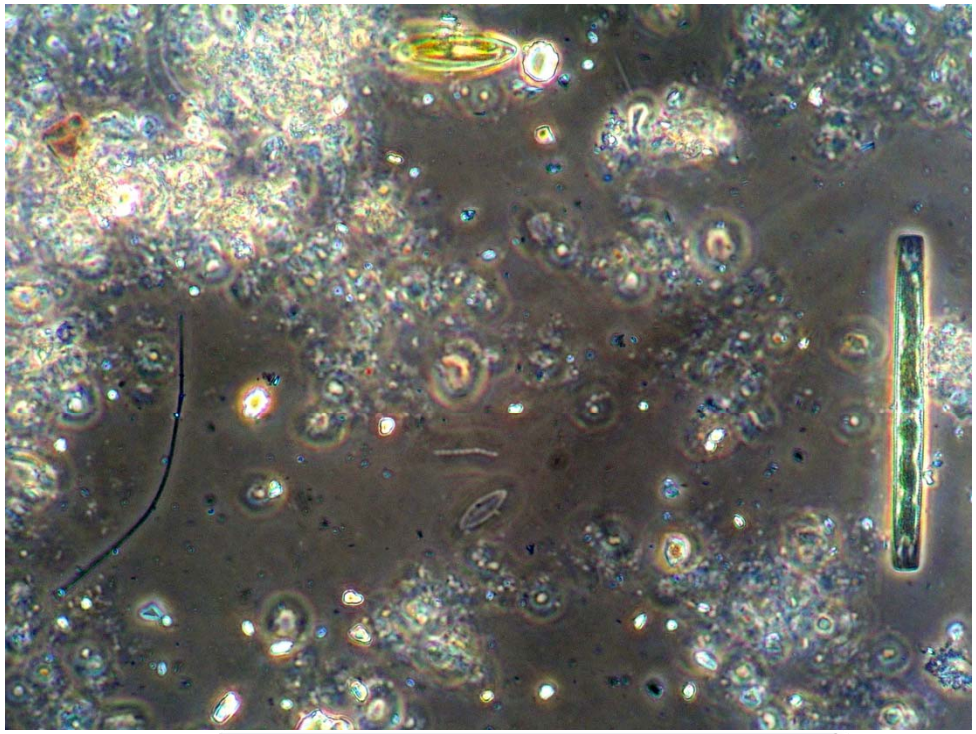
Inappropriate biocide for the population or application point

Fresh water

- Speed of kill
- pH
- Turbidity
- Sheathed & filamentous bacteria

Machine

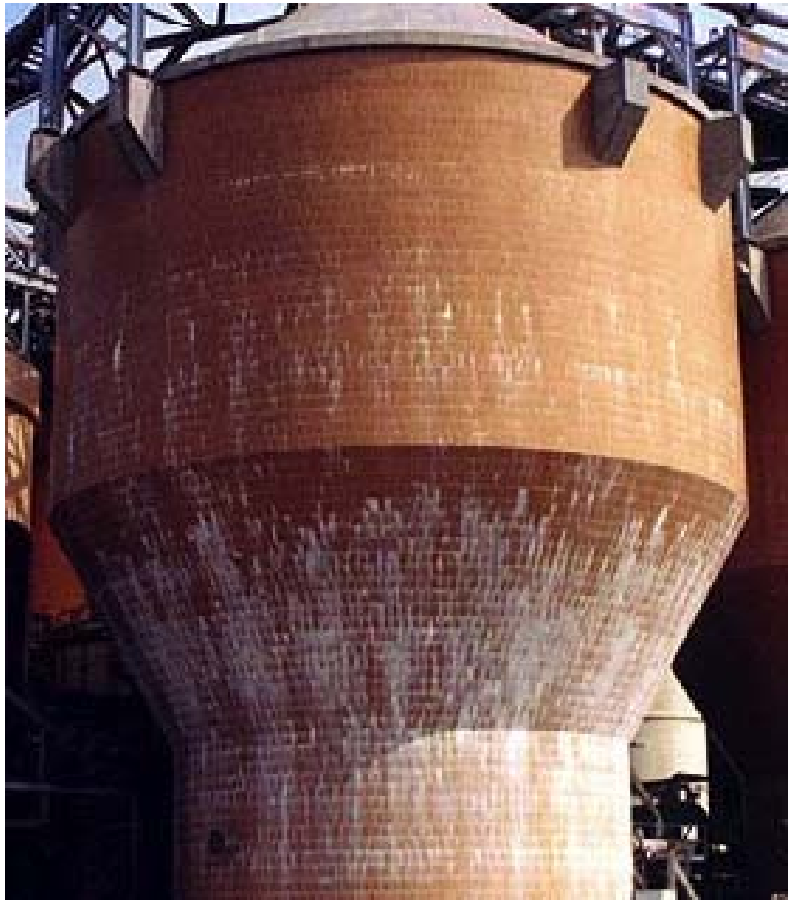
- Fungi/Bacteria



Filtered freshwater gauze sample

Biocide incompatible with chemistry

- ORP
  - Spoilage
  - Sulfites
  - Oxidants
- pH

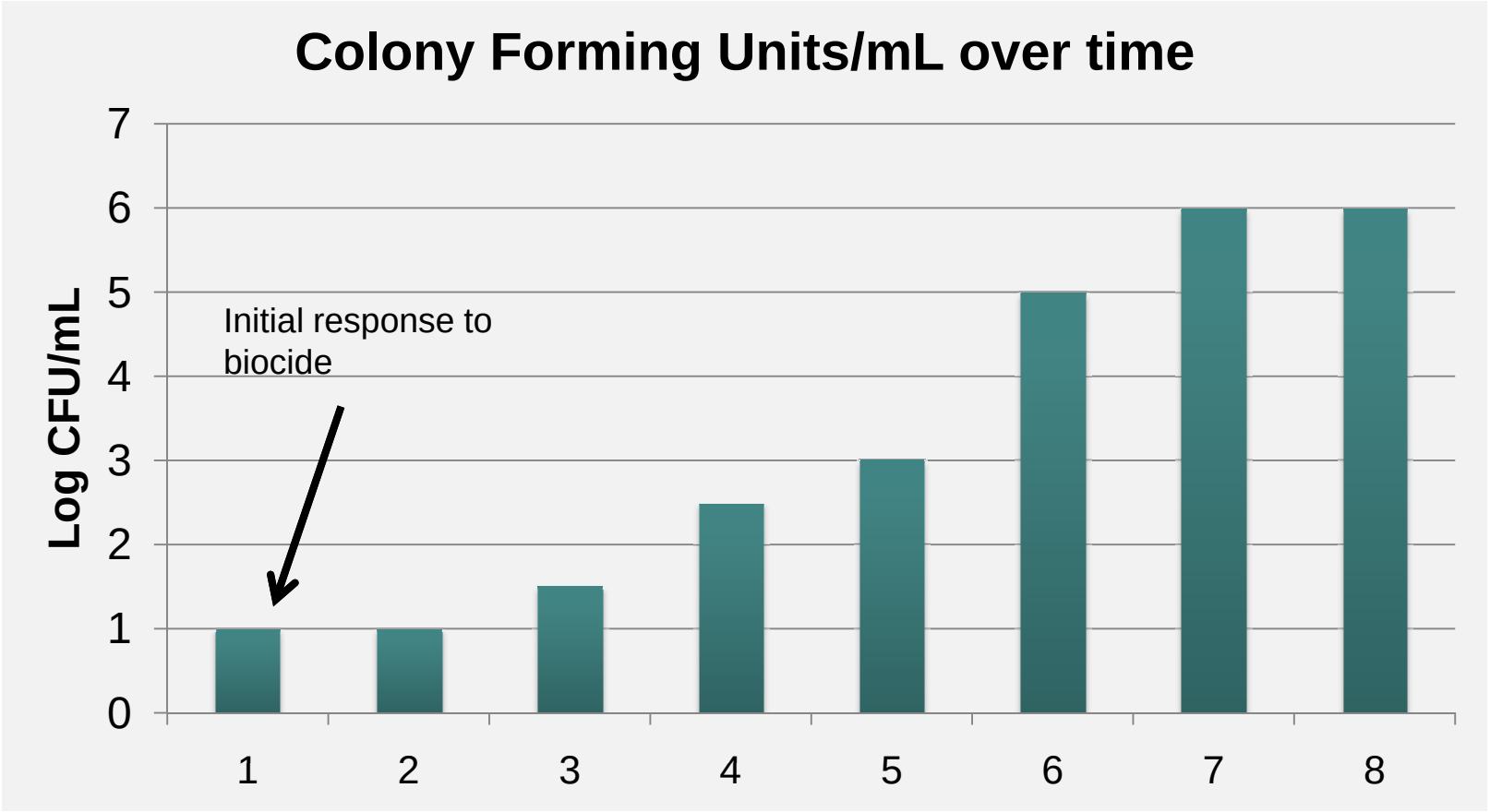


Biocide doesn't "work"

- Lack of adequate screening studies to determine activity prior to start of trial
- Picked 'wrong' biocide

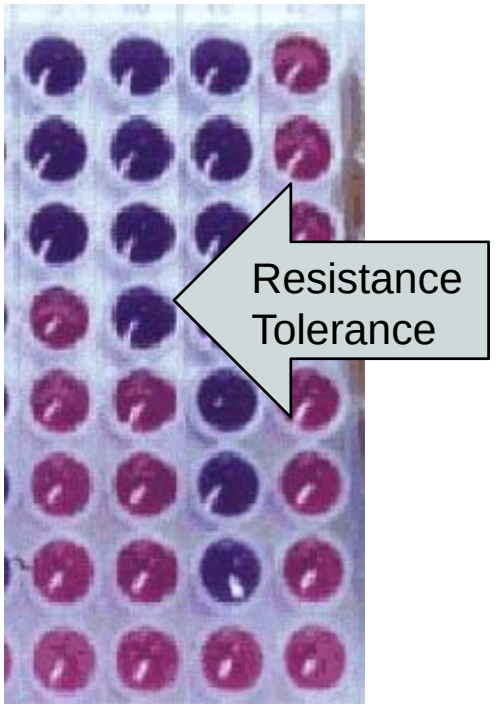
Blue inhibited
Pink reduced/micro activity

Pattern found with resistance
Biocide slug feed response
Application rate constant



Biocide stops “working”

- Minimal inhibitory concentration was initially at 16 ppm
- After 6 months it takes 125 ppm to show inhibition



Blue inhibited
Pink reduced/micro activity

Biocide Examples

- Cross resistance:
  - Isothiazolin
  - Glutaraldehyde
- Concentration
  - DBNPA/Glutaraldehyde
    - Limited activity against fungi
- Oxidants
  - Activity differs between oxidants
  - Chemistry strongly affects activity
  - Resistance example: *Deinococcus*

Modes of action:

Oxidation of thiol groups

Disruption of:

- Cell membranes
- Respiratory enzymes

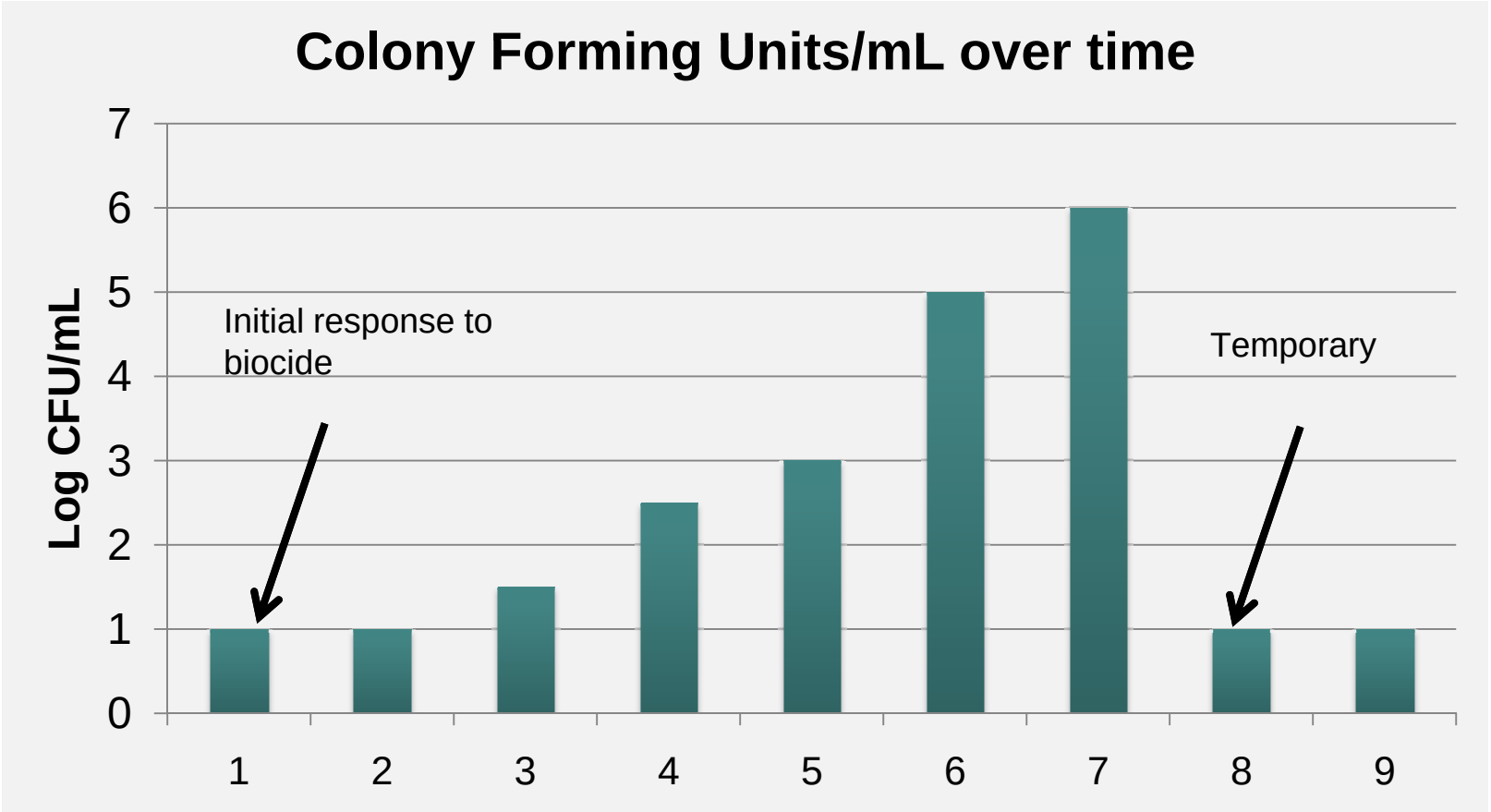
Enzyme inactivation

Metal ion chelation

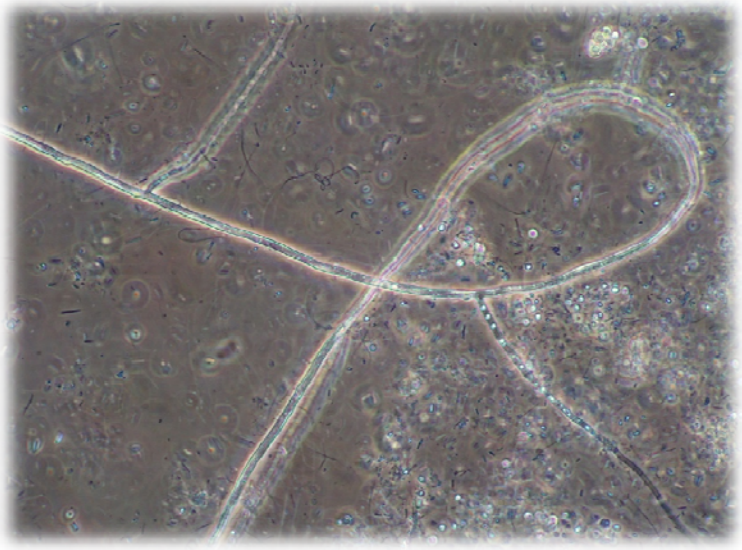
Minimizing tolerance issues

- Program approach
  - Multiple biocides
  - Different modes of action
- Appropriate biocide for pH/system chemistry/microbes
  - Adequate screening studies conducted
- Use of alternate biocide for a set period of time

Biocide slug feed response
Use of temporary biocide



Goal



Minimizing biocide use

Maximizing machine cleanliness

Avoiding downtime