Protein Crystal Growth in Space

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Goals of Crystal Growth

• Pharmaceutical advancement
  – Understand structure of protein molecules
  – Grow high purity crystals in space

• Current protein experimentation
  – Lung disease in children
  – Liver regeneration
  – Alpha-Interfuron (Leukemia, AIDS related disease, hepatitis Band C)
How does a Crystal Grow?

- in solution at low concentration
- gradual increase to slowly initiate growth
- crystal growth initiates
- growth at optimum speed

concentration

time
Crystal Growth Experimentation

- Both diffusion and fluid flow play a part in designing an experiment
- Scientists design experiments involving different mixtures designed to promote crystal growth
$V_p = 2 \mu L/min$

@ $C_{in} = 70\%$

$V_c = 1 mL$, $C_o = 30\%$

Diffusion Apparatus
Analysis of Existing Design

- Assume thorough diffusion occurs between pump cycles
- Crystals begin to grow in each chamber sequentially

![Graph showing crystal growth across chambers over time](image-url)
Design Evaluation/Improvement

- Perhaps it is desired to activate crystal growth in each chamber simultaneously.
- Final concentration is the single variable.

![Graph showing concentration over time for C1 to C5](image-url)
Diffusion Model

\[ x = 2 \left( \frac{Dt}{\pi} \right)^{1/2} \]

\[ t = \left( \frac{\pi x^2}{4D} \right) = \left( 0.01 \text{m} \right)^2 \pi / 4 \times 1.35 \times 10^{-9} \text{m}^2/\text{s} \]

\[ = 58000 \text{ seconds} = 16 \text{ hours} \]
Design Recommendations

- Add mixing
- Appropriate choice of chamber inlets

VS.
Conclusion

- Benefits of Protein Crystal Growth include pharmaceuticals, pure science
- Improve design of apparatus by adding mixing mechanism
- Suggest experimentation to accurately model diffusion mechanism
References

- http://wwwssl.msfc.nasa.gov/ssl/msad/pcg/
- http://science.msfc.nasa.gov/newhome/headlines/msad11jul97_1.htm
- http://science.msfc.nasa.gov/newhome/headlines/msad97aug15_1.htm