

Engineering Insight for Mixing through Colorimetric Diagnostics

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DISMT

Dual Indicator System for Mixing Time

FOB

Formation of Byproduct

CONCEPT:

Methyl Red changes from red to yellow at pH=5.
Thymol Blue changes from yellow to blue at pH=9
Both indicators are in both solutions.

Set initial pH's so that yellow zone occurs only when mixing fraction is within +/- 5% of infinite time mixing fraction

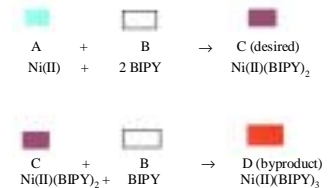
Mixing time is the time for the entire solution to turn yellow



CONCEPT:

- Many industrial reactions are of the form:
 $A + B \Rightarrow C$ (desired product)
 $C + B \Rightarrow D$ (byproduct)
- Design of mixing processes can be improved by knowing when byproduct is formed
- Nickel(II) reactions with the ligand 2,2'-bipyridine can mimic the two reactions.
- Complexes with different coordination numbers have different colors; formation of byproduct can be followed.

REACTION SCHEME:



Advantages:

- See the whole mixing volume at once
- Color--not intensity--carries the information
- Videotaping (inexpensive) stores the runs
- Simple to use, cheap, and easily regenerable
- Provides "engineering insight" into mixing

Jet Mixing Demonstration with DISMT

(images are above)

6 L of red (acid) solution is added to tank, then 6 L of blue (base) solution enters tank through jet at lower right.

Number is the time in seconds after start of the blue (base) jet flow. Yellow is obtained only when the mixing fraction is within 5% of final mixing fraction.

Mixing time is the time for the entire solution to turn yellow.

Legend for figure

- Start adding Ni(II) solution; jet of liquid is visible;
- End of addition of Ni(II) solution;
- Start adding BIPY solution; upper zone is stirred and reaction occurs;
- More BIPY has been added;
- Approximately half of BIPY has been added; upper solution color looks like "desired" product;
- All of BIPY has been added -- exactly enough to make the 1:2 (purple) complex -- but poor mixing leads to formation of 1:3 (red) complex = byproduct.
- Color of solution (f) after stirring.

Acknowledgement: Min Zhan conceived of this FOB system and carried out the experimental work.

Jet Mixing Process (jet enters from lower right)

