Sample Agendas for Agitation Courses, with CEU or PDH credits if needed

Agitator Design Principles for Bioprocessing and Pharmaceutical Applications
Day One: Major Agitator Design Principles and Biopharm Applications

Agitator design basics

- **Nomenclature**
- **Principal dimensionless numbers, correlations**
- **Impeller classifications**
- **Flow patterns**
- **Agitated heat transfer**

Design for liquid motion

- **Calculating pumping capacity**
- **Characteristic velocity**
- **Scale of Agitation**
- **Why power, rpm both important**
- **Sample problem**
- **Use of commercial software**
- **Comparing impeller performance**

Gas dispersion principles and issues

- **Power**
- **Flooding**
- **Holdup**
- **Mass transfer**

Agitation Scale-up

- **Goal of scale-up**
- **Process versus physical scale-up**
- **Single versus multiple scaling parameters**
- **Impact of scaling method on equipment size**

Bioprocessing application classifications and guidelines

- **Simple blending**
- **Cell culture bioreactors**
- **Anaerobic fermentation**
- **Aerobic fermentation**

Sanitary design guidelines

- **Shaft seals**
- **In-tank couplings**
- **Impellers**
- **Steady bearings**

Day Two: Aerobic Fermentation Design

Pilot plant protocol

- **The problem with most pilot studies**
- **Start with estimated correlation**
- **Estimate full scale design**
- **Design pilot runs to mimic full scale tentative design, ranging above and below**
- **Fit model to new pilot conditions**

Full scale design, power optimization

- **What to do if limited or no pilot data available**
- **Ideal: start with "good" mass transfer correlation**
- **Calculate peak OTR**
- **Calculate combinations of power, air flow meeting OTR.**
- **Minimize combined power**

Impeller system design

- **Impeller types**
- **Gassing factor effects**
- **Example of effects of impeller types**
- **Impeller size effects**
- **Example of effects of impeller size**
- **Viscous effects**

Cell Culture Bioreactor Design Issues

- **Mass transfer**
- **Shear damage: agitation**
- **Shear damage: bubble rupture**
- **Minimizing concentration gradients**

Use of Computational Fluid Dynamics

· Flow around coils
· Velocity profiles
· Bubble size distribution
· Gas holdup distribution
· $k_l a$ distribution
· Blending simulation
· Reaction simulation
· Future technology

Conclusions

· Fermenter design is a complex subject
· Seldom is there sufficient data
· Both process and mechanical aspects are important
· Exciting things are developing for future design tools