Enhancement of Fermentation with Effective Impeller System

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#1. Impeller System Design.
Basic Impeller Types
Axial Flow.
Radial Flow
Mixed Flow

#2. Radial Flow Impellers
Staged flow pattern
Fine bubbles
Vary widely in terms to power, gas handling capacity, unloading

#3. Radial flow examples 1
D-6 (Rushton) Np = 5.5 Pg/Pu = 0.4
Gas capacity = 2.4

#4 Radial flow example 2.
- CD-6 Np = 3.2 Pg/Pu = 0.65
Gas capacity = 5.4

#5. Radial flow example-3.
- BT-6 Np = 2.4 Pg/Pu = 0.85
Gas capacity = 5.4

#6. Mixed flow Examples
P-4 (Pitched blade turbine)
Reversing pitch
These are poor at gas dispersion, average at blending. Not very useful in fermentations.

#7. Axial flow examples 1
Divided into high and low solidity

High solidity (Maxflow, A-315, etc)
Can disperse gas, provide intermediate flow performance. Unstable when directly gassed down pumping

#8. Axial flow examples 2
Divided into high and low solidity

Low solidity (HE-3, A-310, etc)
Requires pre-dispersion by a radial impeller, but provides best blending and heat transfer

#9. Axial / Radial vs All Axial
Hybrid system compares the followings;
Higher system Kla
Greater gas handling
More mechanical stability
More shear (a possible disadvantage)
Longer blending time
Higher Pg/Pu if CD-6 is used

#10. Up vs down pumping in Hybrid system
Up pumping provides the following advantages;
Shorter gassed blend time
Higher Pg/Pu ratio
Greater gas handling
Greater mechanical stability at higher gas flow rates

#11. Gas Flow Profiles

#12. Power Draw Profiles

#13. Kla Profiles

#14. Viscous effects
Heat transfer exponent about 0.33
Kla exponent about 0.3 ~ -0.5
Large O/T ratio about beneficial
Gas handling ability reduced.
Blending may be more important than mass transfer in some systems: all-axial systems have proven beneficial in viscous gum fermentation > 2,000 cps.

#15. Conclusions
More data loads to a better design
Total cost is influenced by many considerations
Modern impeller design allows very large systems to be designed while monimizing blending and stability issues.