Coal Slurry Mixing for IGCC Powerplants

GLOBAL INFRASTRUCTURE X PROCESS EQUIPMENT X DIAGNOSTIC TOOLS

Introduction

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PNEUMATIC PRODUCTS

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ROTHEMÜHLE

JOHNSON PUMP

KEMP

SPX offers Solutions throughout the Power Industry

Utility Scale IGCC

- Dry Feed Process
  - Siemens
  - Mitsubishi
  - KBR – Southern Company
- Slurry Feed Process
  - GE Energy
  - ConocoPhillips

Multiple Competing Process Routes

Utility Scale IGCC Challenges

- Size
  - Utility Scale requires large volumes (1 MM gallons!)
  - Large Volumes require large agitators and complex design
- Slurry Characteristics
  - 60-65% solids slurry (lowest water content)
  - Difficult mixing application
  - Feedstock dependent
- Reliability
  - Baseload generation requires high availability and reliability
  - Periodic maintenance with no/low downtime

Specific Design Issues Exist

Utility Scale IGCC Solutions

- Size
  - Reliable, predictable and proven scale up methods required
- Slurry Characteristics
  - Variable Conditions
    - Percent Solids
    - Particle Size and Distribution
    - Feedstock Composition
- Reliability
  - Equipment design for 24/7 Operation
  - Lengthy maintenance intervals

It's more than a Mixer… It's a Solution!

Lab Testing

- Accurate measurement of Slurry Viscosity is critical
- Characterization of slurry pseudoplasticity also vital
- Testing with real product gives performance clues
- Multiple geometries can be studied
- Process and Mechanical options can be developed, presented and reviewed for trade-offs.
  - Power, Capital and Maintenance costs swing on slurry variables

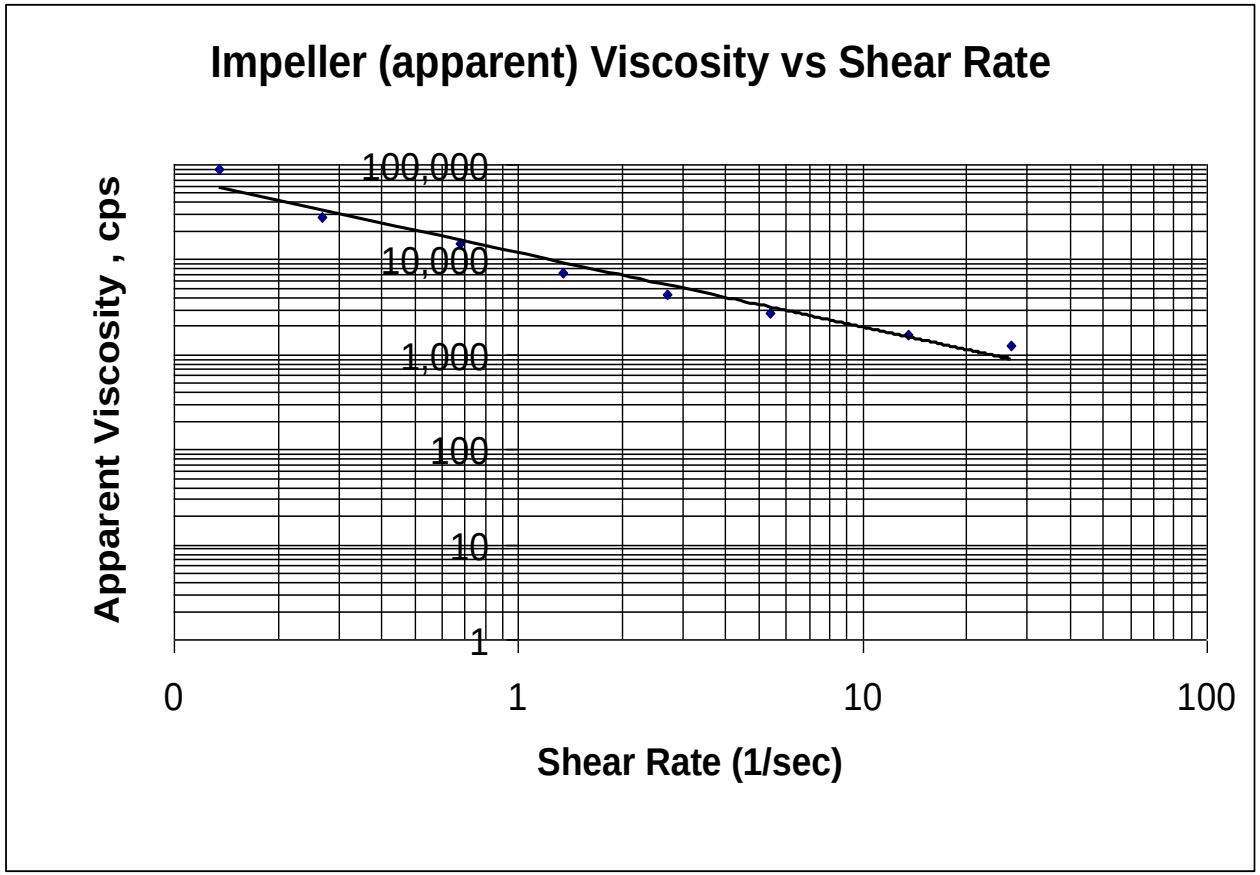
Understanding the Process Enables the Solution

Viscosity Testing of Slurries

Text Header

- Slurry Variables
  - Percent Solids
  - Particle Size
  - Size Distribution
  - Specific Gravity
- Agitator Sizing
  - Impeller Viscosity
  - Average Shear Rate
- Shear rate at 100/sec is not helpful to mixer sizing

Viscosity versus Shear Rate



All Slurries are created Differently

Pseudoplastic Behavior

- "Shear Thinning" (viscosity drops as shear is applied)
  - Impeller operates at lower "apparent" viscosity (better pumping)
  - Impeller forms a "cavern" of lower viscosity fluid
  - Average shear rate determines wall viscosity
  - Geometry, average shear rate affect movement at tank wall

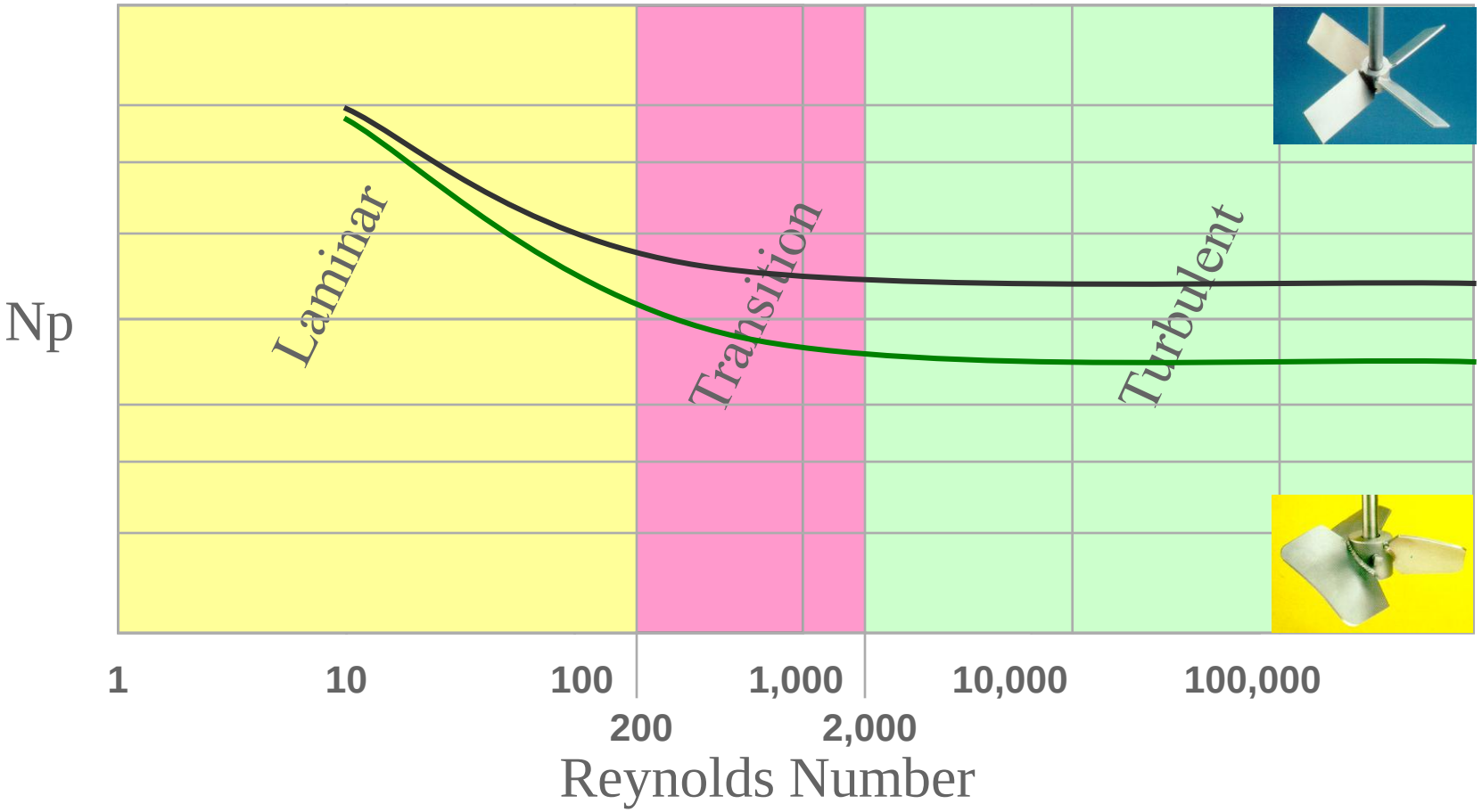
Small changes in viscosity could mean large changes in mixer

Slurry Reynolds Number

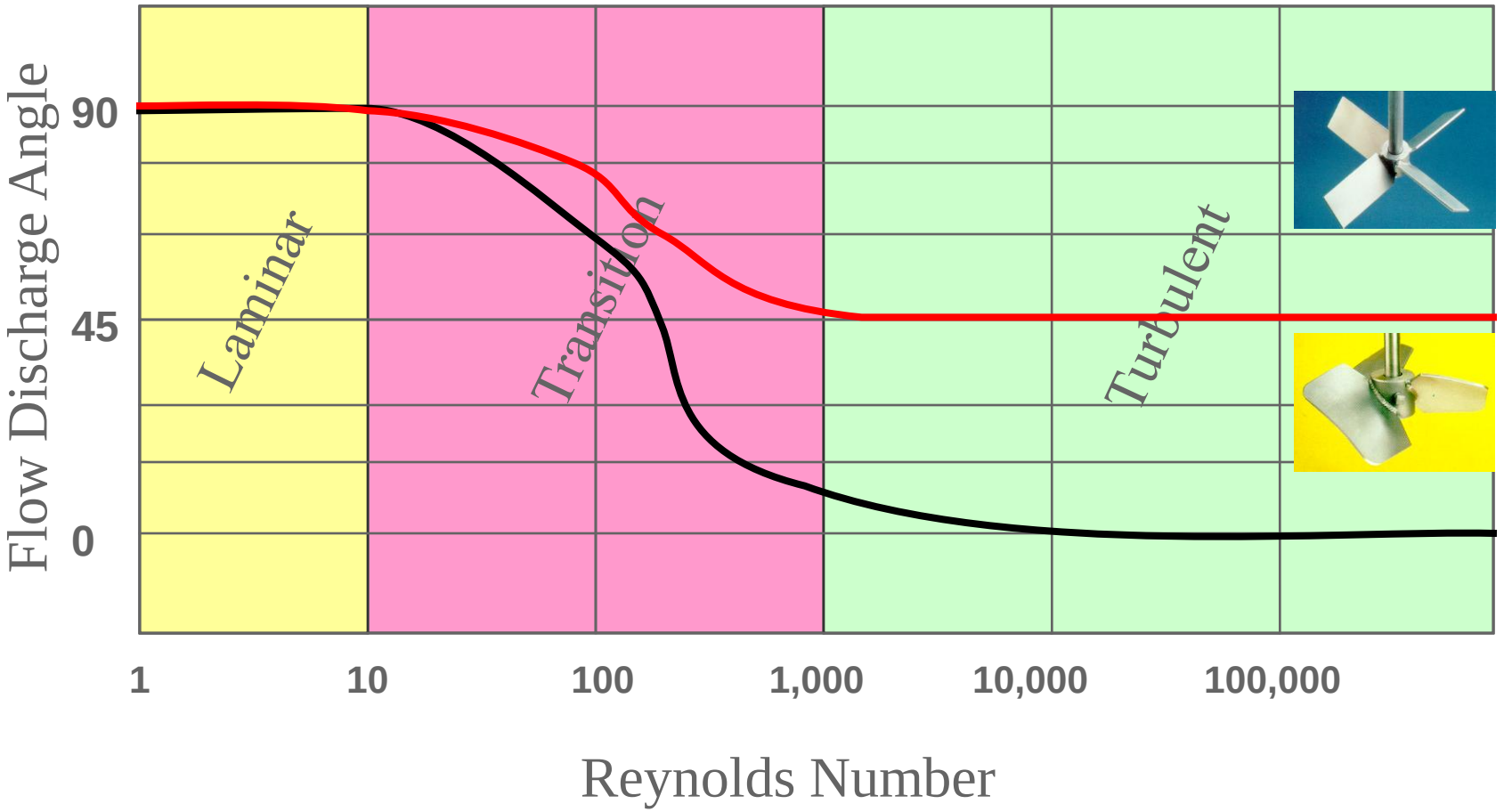
$$N_{re} = 10.754*SG*N*(D^2) / \mu$$

- Nre = Reynolds Number
- SG = Specific Gravity
- N = Impeller Speed
- D = Impeller Diameter in Inches
- μ = Viscosity in cps

Effect of Reynolds Number



Flow Discharge Angle vs. Reynolds Number



Scale Up Principles

- Test multiple geometries – maintain geometric similarity
- Test multiple volumes to determine scale up exponents
- Test multiple impellers and configurations
- Consult with client (witness, webex, video) on desired process results and trade offs
- Use proven scale up methods to guarantee process results

Conclusions

Sizing and selecting agitators for Utility Scale IGCC utilizing the slurry process is a complex and critical step in the plant design. This decision will impact the ultimate plant performance.

- Full Scale Experience?
- Lab Testing Capability?
- Guaranteed Scale Up Performance?
- Robust Equipment Design?

Make Informed Decisions on Vendor Selection

Any Questions?