**OBJECTIVE:**

**To Determine the Status of Mathematical Models to Predict Hydrodynamics in Circulating Fluidized Beds**

- **Sent out Data to Several Researchers**

- **Asked Them to Predict Results For Sand and FCC Obtained in a 20-cm-Diameter Column, and Data for Sand Obtained in a 40-cm-Diameter Column**

- **Obtained Responses From Ten (10) Groups**

- **Some Modeled All Data**
  **Some Modeled Only FCC Data**
  **Some Did Not Model Mass Flux**
  **Some Did Not Model Acceleration Zone**
  **Some Only Sent Limited Results**

**Table 1. List of Modelers**

1. Arastoopour and Kim (Illinois Inst. of Technology)

2. Bernard (Elf Antar France)

3. Chaouki, Godfrey, and Patience (Ecole Polytech., and DuPont)

4. Chen (Lehigh University)

5. Gidaspow and Sun (Illinois Inst. of Technology)

6. Johnsson (Chalmers University of Technology)

7. O'Brien and Syamlal (METC)

8. Pugsley and Berruti (University of Calgary)

9. Rhodes and Wang (Monash University, University of Leeds)

10. Sundaresan (Princeton University)

| | | DATA MODELED | MODEL TYPE |
|---|---|---|---|
| 1. | Arastoopour and Kim | FCC Catalyst | Case III |
| 2. | Bernard | FCC Catalyst[1] | Case II |
| 3. | Chaouki et al | All | Case II |
| 4. | Chen | Selected Conditions | |
| 5. | Gidaspow and Sun | FCC Catalyst | Case III |
| 6. | Johnsson | All[2] | Case II |
| 7. | O'Brien and Syamlal | Selected Conditions | |
| 8. | Pugsley and Berruti | All | Case II |
| 9. | Rhodes and Wang | All | Case II |
| 10. | Sundaresan | FCC Catalyst[3] | Case III |

1 Only modeled density as f(r)
2 Did not model mass flux, requires pressure drop over riser height
3 Model valid only for full-developed flow

## CLASSIFICATION OF MODEL TYPES

- **Harris and Davidson Have Classified Models Into Three Groups:**

  **I Models Which Predict the Axial Solids Suspension Density, but Not Radial**

  **II Models Which Predict the Radial Variation in Suspension Density by Dividing the Flow into Two or More Regions**

  **III Models Which Predict Hydrodynamics from Fundamental Equations**

- **All of the Models Submitted Were Case II and Case III Models**

# OVERALL ANALYSIS

## AXIAL $\Delta P/L$ PROFILE

No Models Show High Pressure Drops at the Top Due to Exit

Data Shown are Not at Fully Developed Flow, But Several Models Predicted Fully Developed Flow

Many had Much "Shallower" Decrease of Density With Height (less dense at bottom, more dense at top)

## RADIAL MASS FLUX (489 kg/s-m$^2$ & 3 Gas Velocities)

Data Show Dependency on U, But Several Models Showed No Dependency On U

For FCC, Many Models Do Not Predict That Solids Go Up at the Wall (they actually do)

For FCC, Data Have a "Hump" at about 0.7 R

Several Models Actually Predict This

## RADIAL DENSITY

Several Models an Overly Very Sharp Increase in Density at the Wall

## CONCLUSIONS

**Models are not Sophisticated Enough Yet to be Used to Predict All of the Hydrodynamics in a CFB**

**However, Some Predict Trends Relatively Well (for Both FCC and Sand**

**Most Have Been Developed to Predict the Hydrodynamics of One Material (i.e., Sand or Catalyst)**

**Not Much Data in Literature at High Mass Fluxes (where FCC risers operate). Therefore, it was Understandable that Models Predicted Trends at High Mass Flux Poorly.**

# MOST SUCCESSFUL MODELS

## GROUP II:

1. Chaouki et al

2. Pugsley and Berruti

## GROUP III:

1. Gidaspow