

**THE PERFORMANCE OF
MULTIPLE IMPELLER SYSTEMS
IN SOLIDS SUSPENSION**

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**1996 Annual AIChE Meeting
Industrial Mixing and Scaleup
Chicago, Illinois
November 13, 1996**

ACKNOWLEDGEMENTS

- ▶ James Nordmeyer
- ▶ Eric Janz
- ▶ Andrea Michaud
- ▶ Michael Hicks

TOPICS

- ▶ Just-suspended speed
- ▶ High solids loadings
- ▶ Solids distribution
- ▶ Tickler impellers

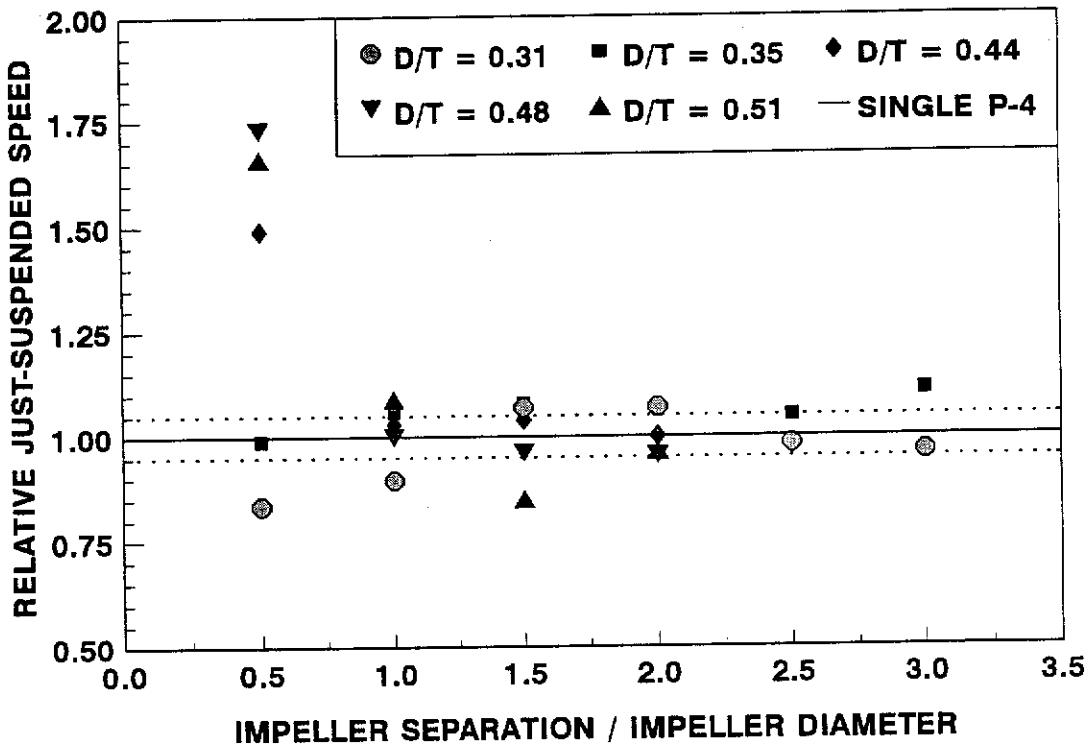
JUST-SUSPENDED SPEED

It is commonly accepted that the just-suspended speed of a dual impeller system is the same as that of a single impeller

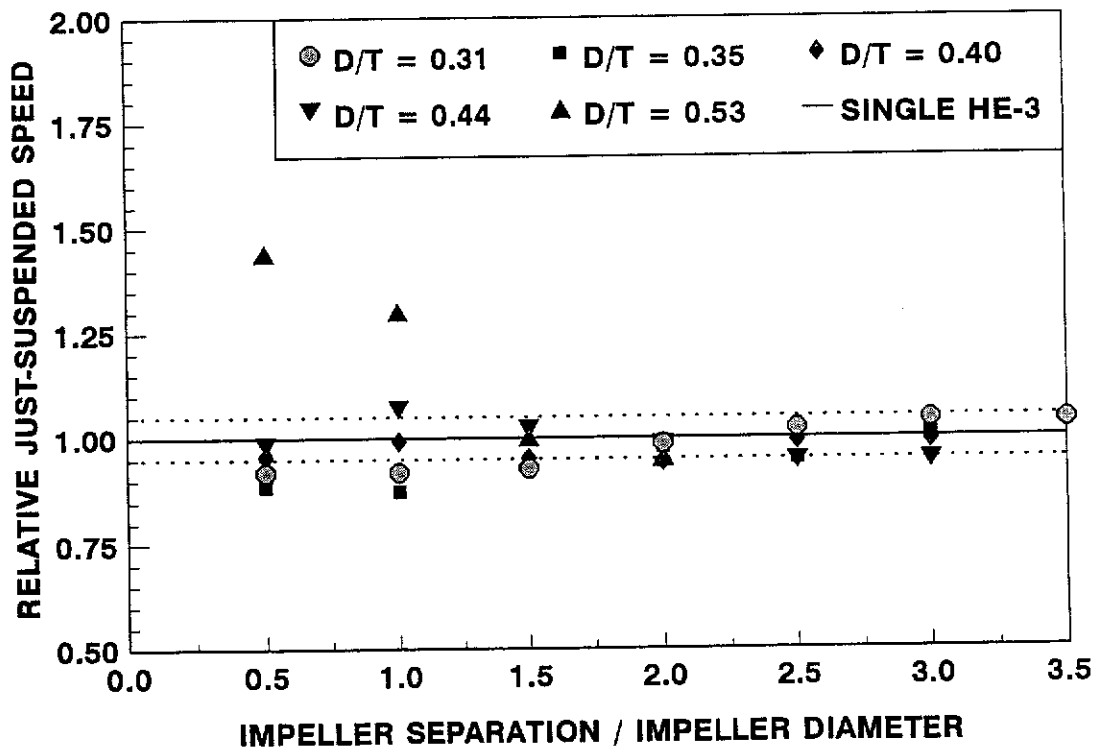
JUST-SUSPENDED SPEED EXPERIMENTAL SYSTEM

- ▶ P-4 and HE-3 impellers
- ▶ $T = 11.4$ inches (0.29 m) (flat bottom)
- ▶ Various D/T and S/D , $C(1)/T = 0.25$,
 $Z/T = 1.75$
- ▶ Ion exchange resin in water
- ▶ Solids loading of ten weight percent (based on square batch geometry)

EFFECT OF IMPELLER SEPARATION ON DUAL P-4 JUST-SUSPENDED SPEED



EFFECT OF IMPELLER SEPARATION ON DUAL HE-3 JUST-SUSPENDED SPEED



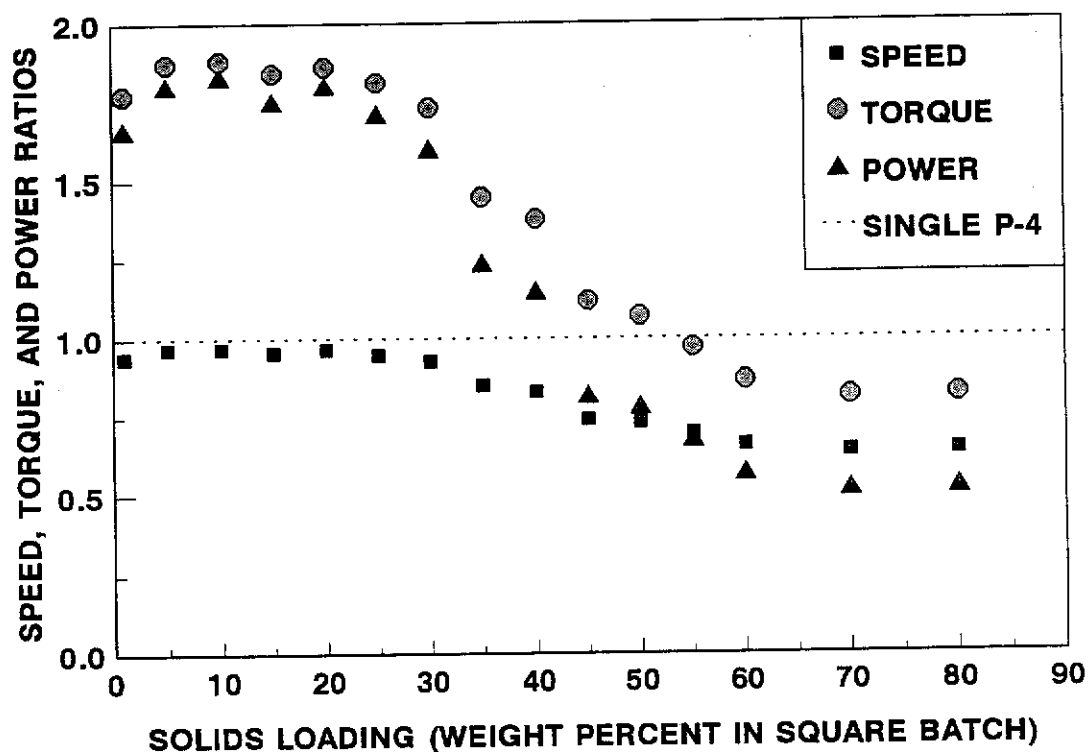
HIGH SOLIDS LOADINGS

Little experimental data
has been taken with dual
impeller systems at high
solids loadings

HIGH SOLIDS LOADINGS EXPERIMENTAL SYSTEM

- ▶ Single and dual P-4 impellers
- ▶ $T = 11.4$ inches (0.29 m) (flat bottom)
- ▶ $D/T = 0.35$, $C(1)/T = 0.25$, $C(2)/T = 1$,
 $Z/T = 1.5$
- ▶ Ion exchange resin in water
- ▶ Various solids loadings (all based
on square batch geometry)

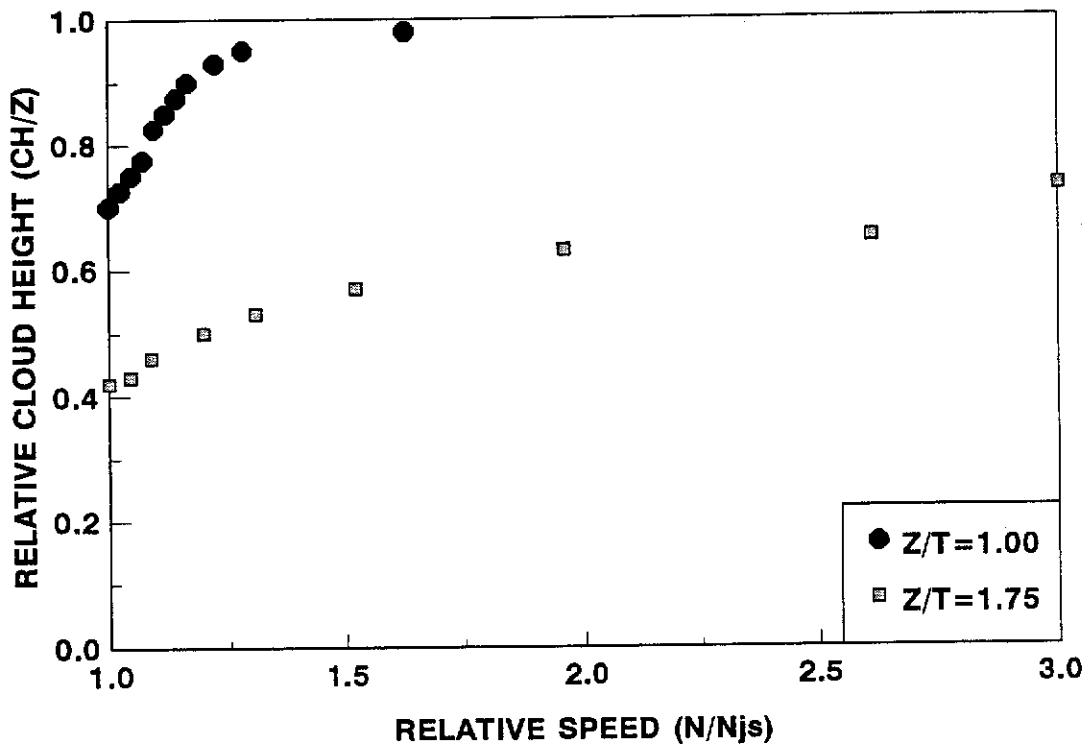
COMPARISON OF SINGLE AND DUAL P-4 IMPELLERS AT JUST-SUSPENDED CONDITIONS



SOLIDS DISTRIBUTION

Multiple impellers are often required to provide adequate solids distribution throughout tall vessels

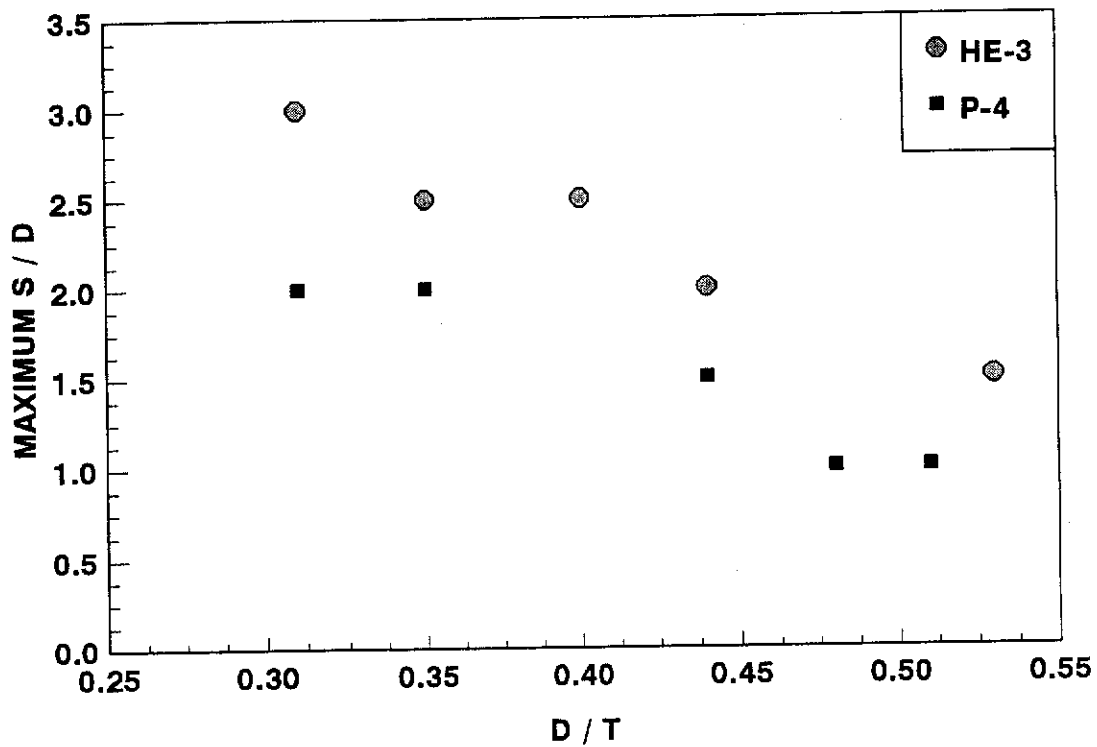
CLOUD HEIGHT PRODUCED BY A SINGLE HE-3 IMPELLER



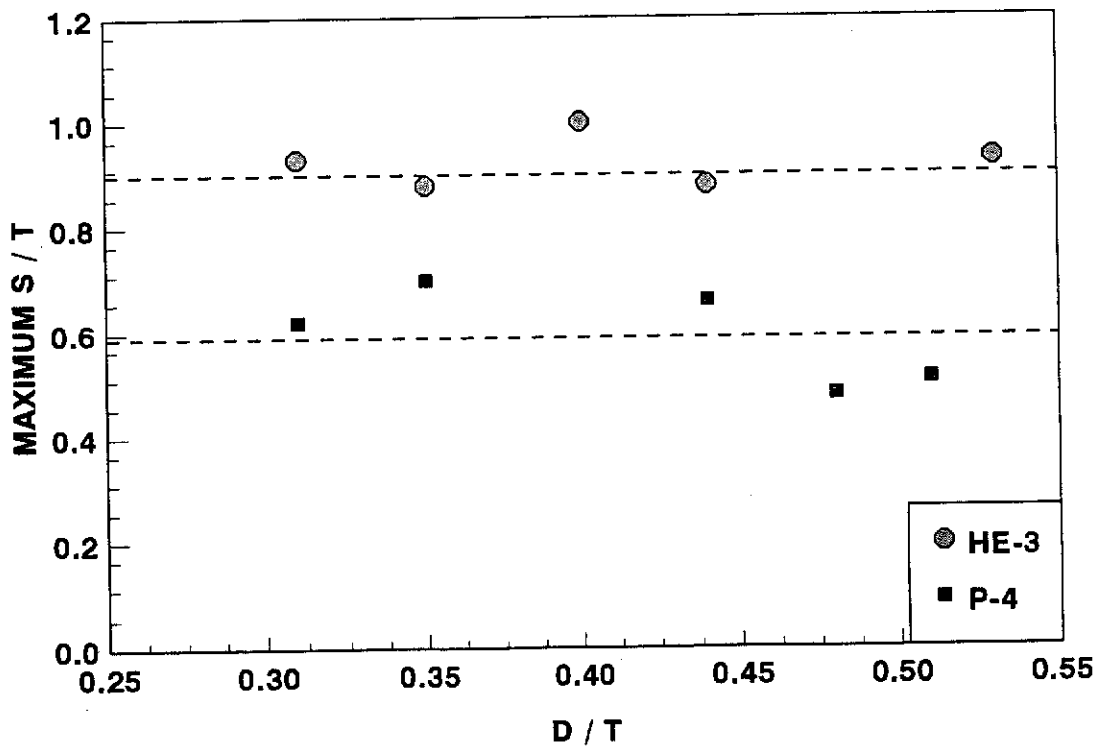
SOLIDS DISTRIBUTION EXPERIMENTAL SYSTEM

- ▶ Dual P-4 and HE-3 impellers
- ▶ $T = 11.4$ inches (0.29 m) (flat bottom)
- ▶ Various impeller diameters and separations
- ▶ $C(1)/T = 0.25$, $Z/T = 1.75$
- ▶ Ion exchange resin in water
- ▶ Solids loading of ten weight percent (based on square batch geometry)

MAXIMUM IMPELLER SEPARATION FOR GOOD SOLIDS DISTRIBUTION



MAXIMUM IMPELLER SEPARATION FOR GOOD SOLIDS DISTRIBUTION



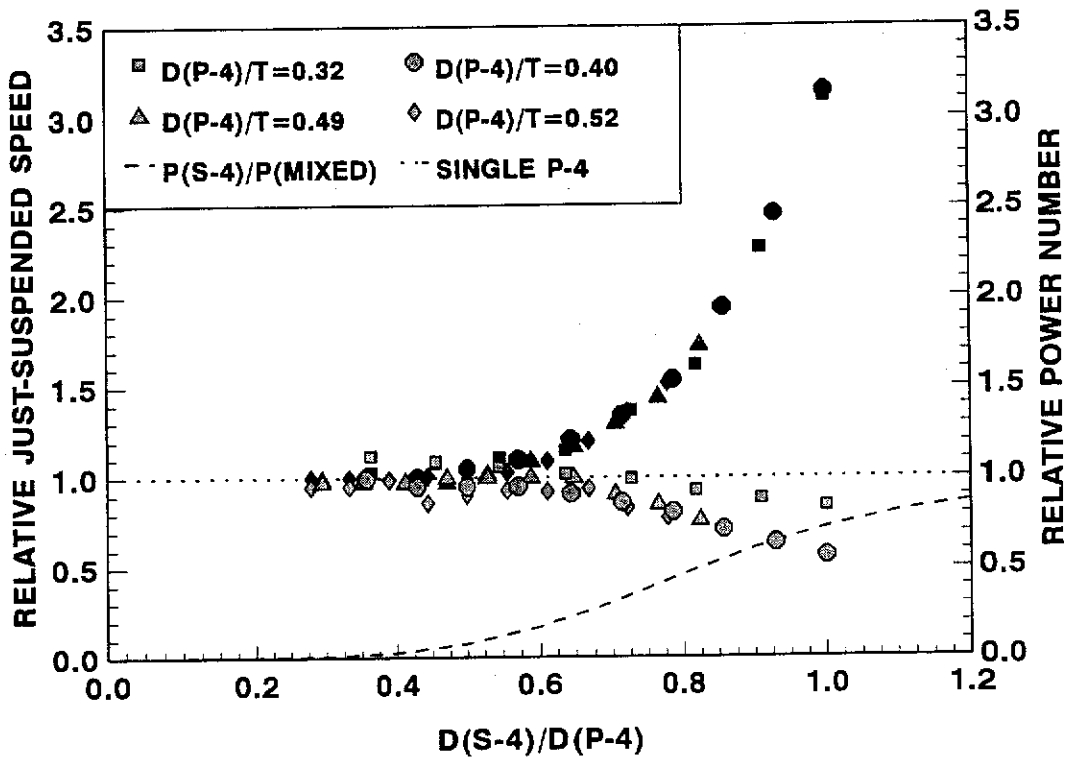
TICKLER IMPELLER

A small impeller that is placed below the primary solids suspension impeller to provide minimal agitation during periods of low liquid level

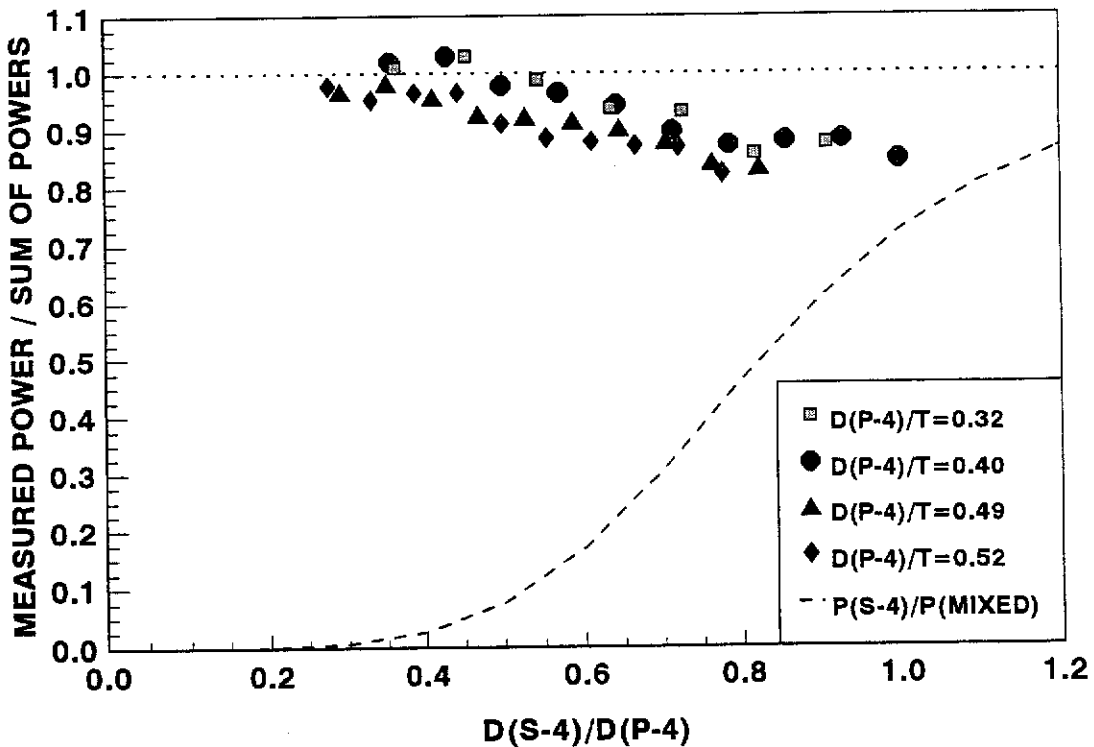
TICKLER EXPERIMENTAL SYSTEM

- ▶ Upper P-4 impeller with lower S-4 impeller
- ▶ $T = 17.4$ inches (0.44 m) (flat bottom)
- ▶ Variable impeller diameters
- ▶ $C(P-4)/T = 0.25$ $C(S-4)/T = 0.05$
- ▶ Square batch geometry ($Z/T = 1$)
- ▶ Acrylic solid in water
- ▶ Solids loading of ten weight percent

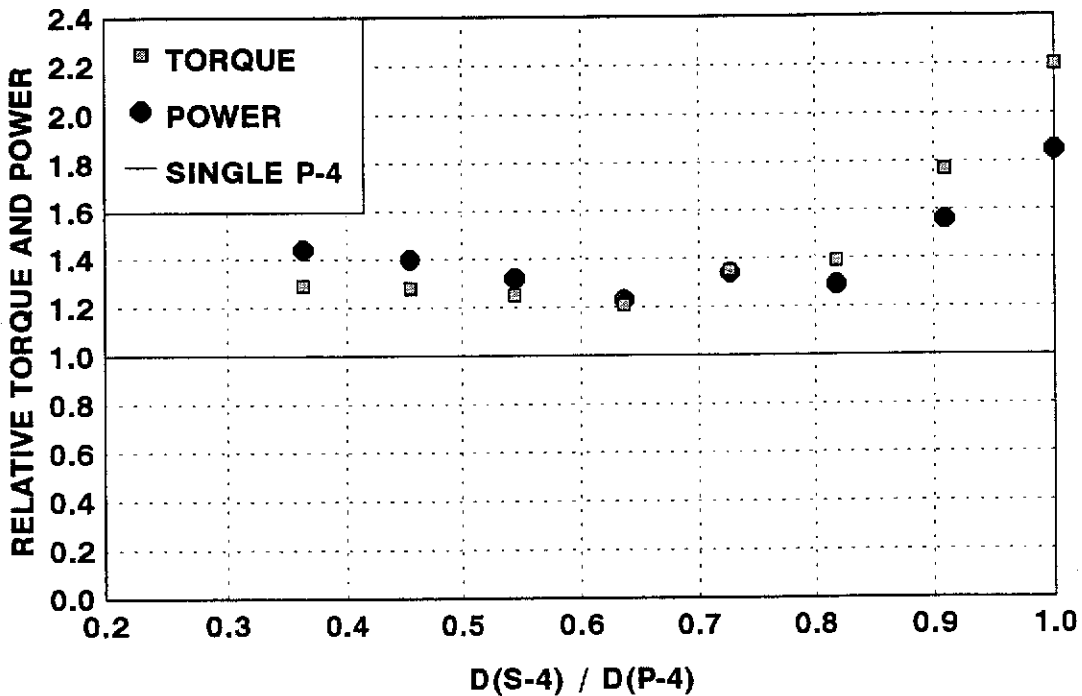
RELATIVE JUST-SUSPENDED SPEEDS AND POWER NUMBERS OF MIXED S-4/P-4 IMPELLER SYSTEMS



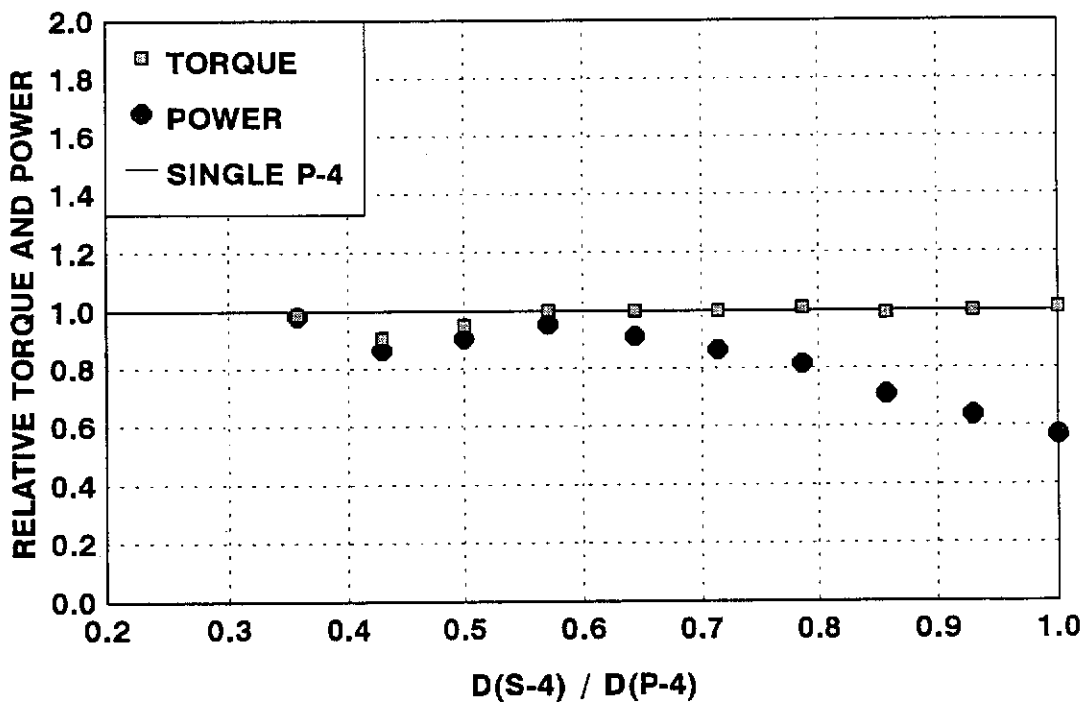
POWER DRAW OF MIXED S-4/P-4 IMPELLER SYSTEMS



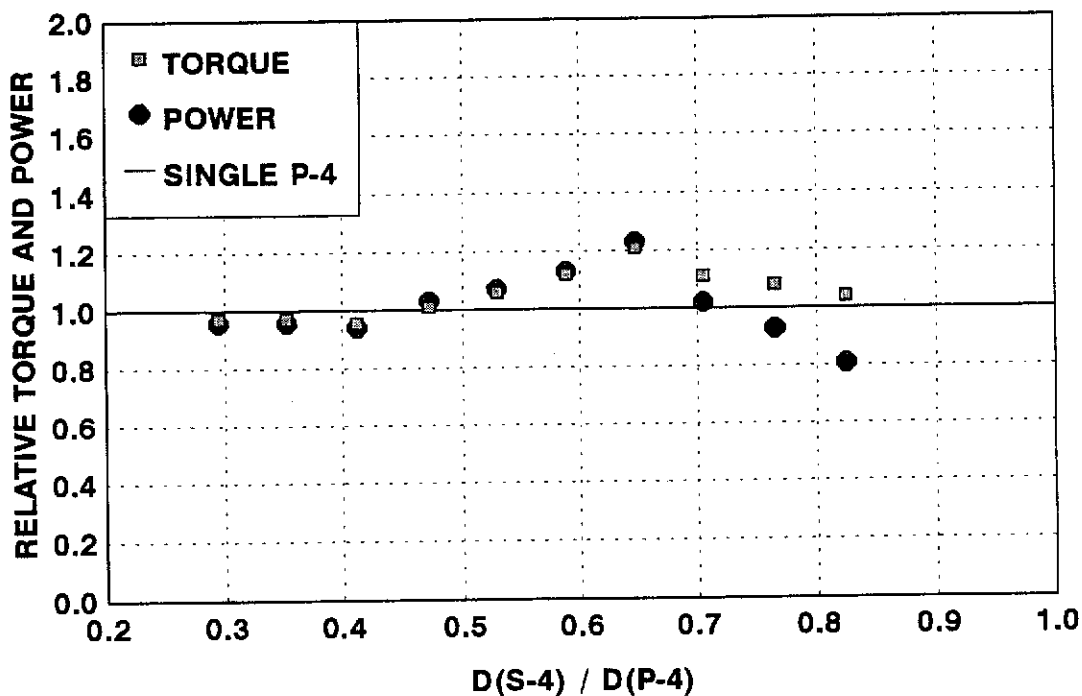
JUST-SUSPENDED TORQUE AND POWER OF A MIXED S-4/P-4 IMPELLER SYSTEM $D(P-4)/T = 0.32$



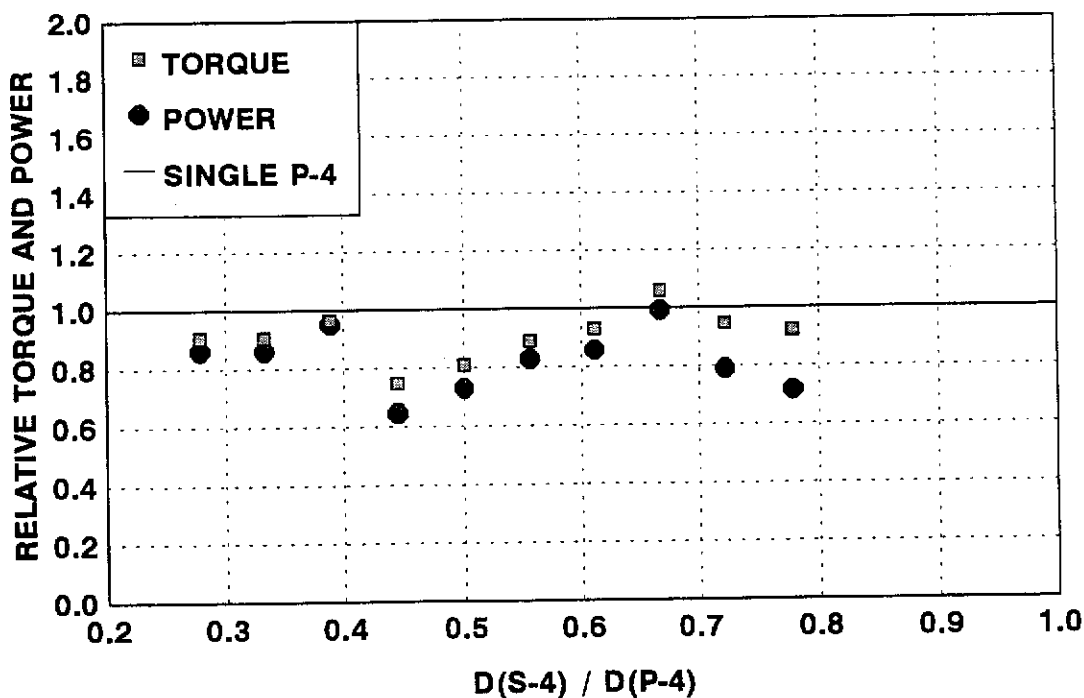
JUST-SUSPENDED TORQUE AND POWER OF A MIXED S-4/P-4 IMPELLER SYSTEM $D(P-4)/T = 0.40$



JUST-SUSPENDED TORQUE AND POWER OF A MIXED S-4/P-4 IMPELLER SYSTEM $D(P-4)/T = 0.49$



JUST-SUSPENDED TORQUE AND POWER OF A MIXED S-4/P-4 IMPELLER SYSTEM $D(P-4)/T = 0.52$



CONCLUSIONS

- ▶ Close impeller spacings can influence the just-suspended speeds of dual impeller systems
- ▶ Dual impeller systems can be more efficient than single impellers in solids suspension at high solids loadings

CONCLUSIONS

- ▶ A maximum impeller separation of sixty percent of the tank diameter ($0.6 T$) is recommended for good solids distribution with the P-4 impeller; ninety percent ($0.9 T$) is recommended for the HE-3 impeller
- ▶ Tickler impellers can influence just-suspended speed, torque, and power; however, generalizations are difficult