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Predicting Mixing Parameters in a Double Coaxial Mixer: An Artificial Neural Network Approach

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INTRODUCTION & AIM

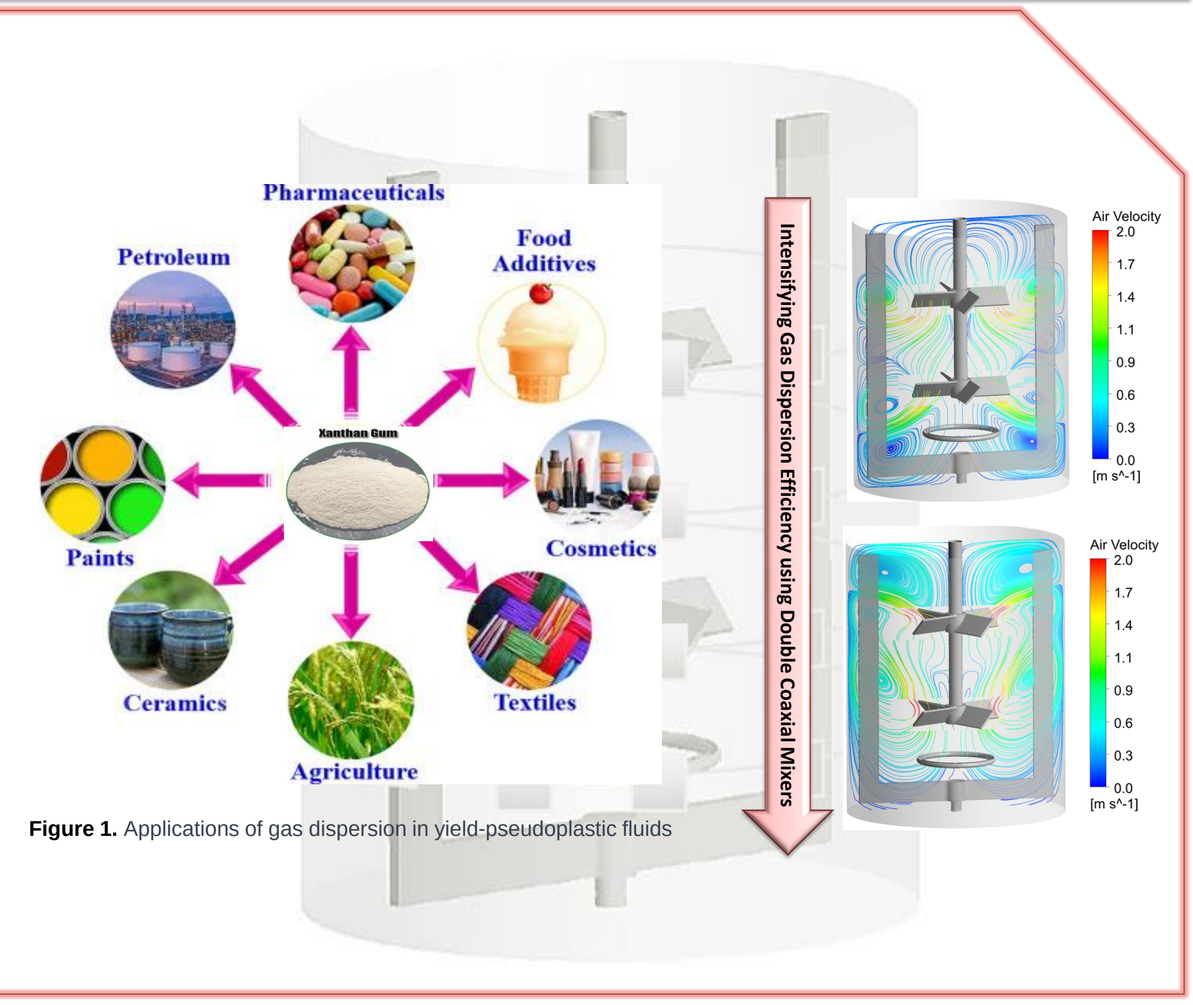


Figure 1. Applications of gas dispersion in yield-pseudoplastic fluids

METHOD

Experimental Set-up

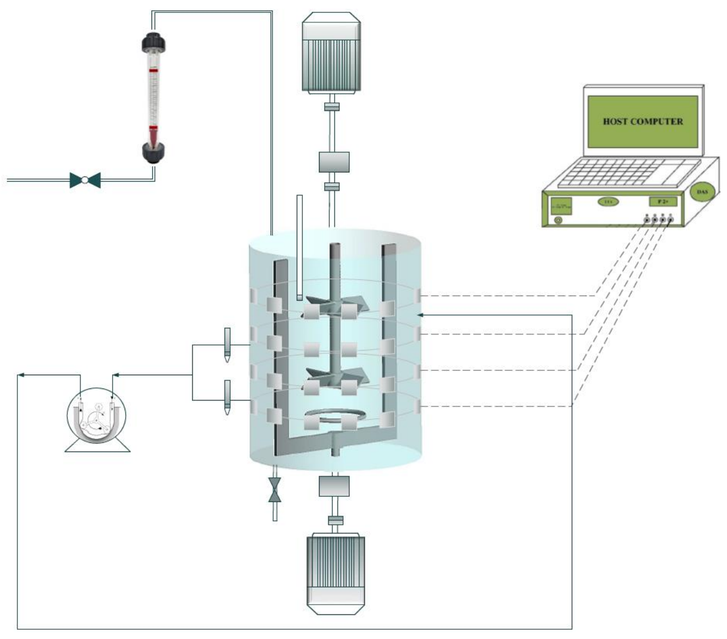
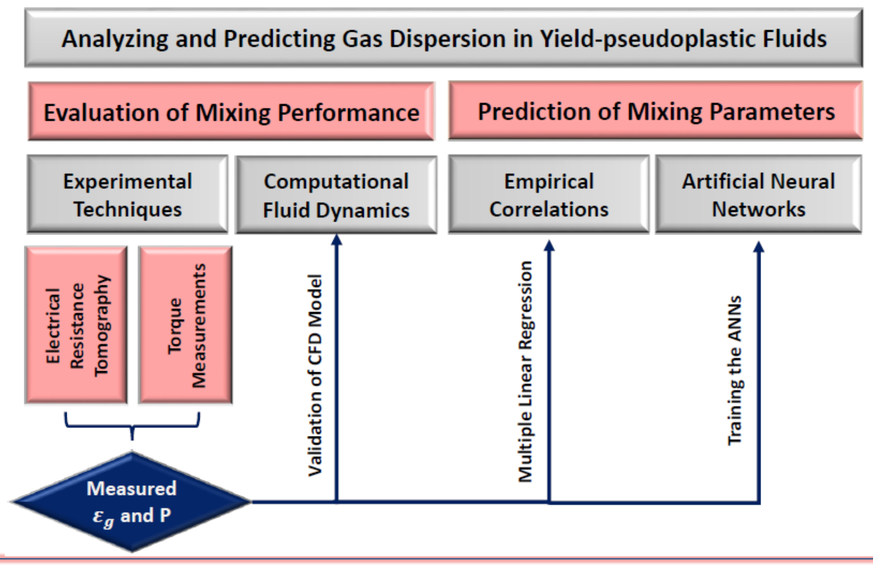


Figure 2. Schematic Diagram of the Experimental Set-up

Methodologies



RESULTS & DISCUSSION

Experimental Results

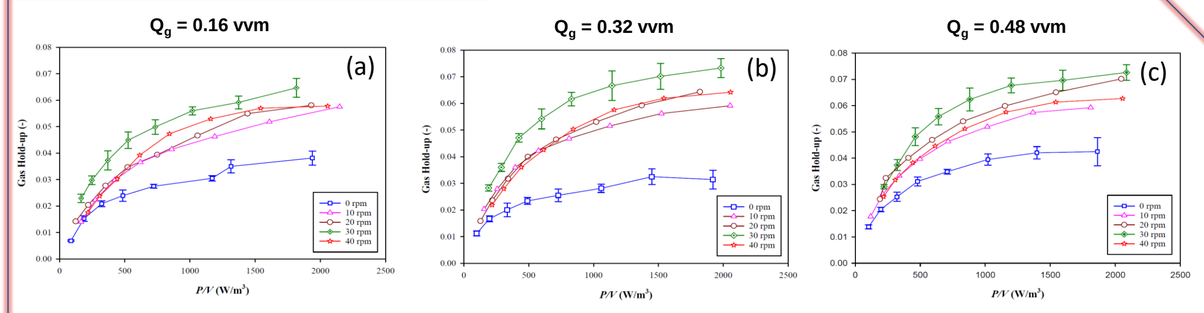


Figure 3. Experimental gas hold-up versus specific power consumption for at varying central impeller and anchor speeds (N_c = 150-500 rpm, N_a = 0-40 rpm) in three rates of aeration

Artificial Neural Networks (ANNs)

- 360 data points
- MATLAB 2022
- Feed-Forward ANNs
- Training subset: 70%
- Validation subset:15%
- Test subset:15%

	Parameter	Range
Input layers	$N_c(rpm)$	150-500
	$N_a(rpm)$	0-40
	$Q_g(L/min)$	20-40
	μ_{app} (Pa.s)	0.219-0.860
Output layer	ε_g	0.0068-0.0929

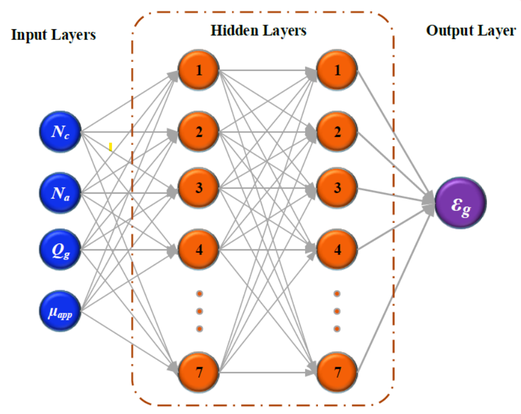


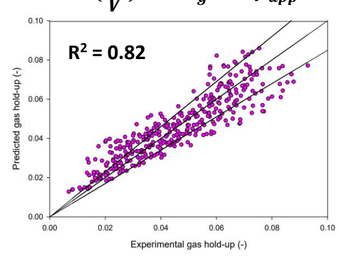
Figure 4. Structure of ANNs Model

Optimized ANN Structure:
- **Hidden Layer Sizes: 7**
- **Learning Rate: 0.01**

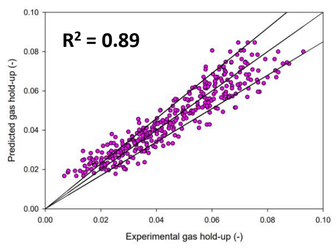
Prediction Results

Figure 4. Predicted vs. Experimental Gas Hold-ups

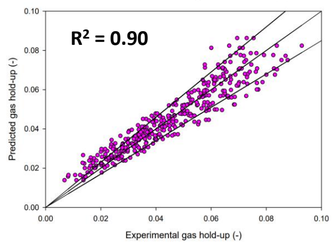
$$\varepsilon_g = 1.023\,(\frac{P_g}{V})^{0.642}\,u_g{}^{0.969}\,\mu_{app}{}^{0.507}N_R{}^{-0.119}$$



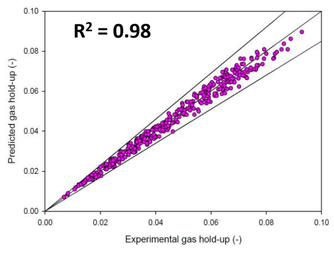
$$\varepsilon_g = 1.046\,N_{eq}{}^{1.269}\,u_g{}^{0.629}\,\mu_{app}{}^{0.483}N_R{}^{-0.183}$$



$$\varepsilon_g = 1.106\,(N_cD_c)^{1.552}\,u_g{}^{0.313}\,\mu_{app}{}^{0.589}N_R{}^{-0.160}$$



ANNs Model [4-7-7-1]



CONCLUSION

- Empirical correlations incorporating tip speed (N_cD_c), superficial gas velocity (u_g), apparent viscosity (μ_{app}), and speed ratio (N_R) were developed to predict gas hold-up with the highest accuracy.
- The ANN model demonstrated superior predictive capabilities with a R^2 of 0.98 and accurately estimated gas hold-up within ±15% of the ideal prediction.

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