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Progress Report

A NEW APPROACH IN ULTRAPURIFICATION OF COAL BY SELECTIVE FLOCCULATION

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SUMMARY

A relatively pure sample of coal and coal pyrite (free of clays) was provided form the Coal Research Resource Center at VPI, Blacksburgh, VA. The samples have been prepared and single mineral flocculation tests are in progress to confirm the selectivity achieved with the previously evaluated flocculents.

The mathematical/computational model was used to predict the effect of process parameters such as feed composition and polymer dosage on the yield and selectivity. It is determined that improvement in selectivity can be achieved by controlling the dosage of not so selective flocculents.

Further screening of potential selective flocculents will continue. Also FT-IR and heat of adsorption measurements and planned to better understand the parameters which control the floc properties.

INTRODUCTION

In the previous report it was shown that coal and coal pyrite samples, obtained from the DOE, contained an appreciable amount of kaolinite and other mineral matter. It was not clear if the polymers, which had exhibited selectivity in single mineral flocculation tests, adsorbed on the samples because of the associated minerals. Therefore, it was imperative to re-examine the single mineral selectivity and evaluate adsorption parameters using a pure (or purer) samples of coal and coal pyrite.

A small amount of clean coal and coal pyrite samples were obtained from the Coal Research Resource Center at Virginia Tech.

Sample Preparation

The coal and coal pyrite lumps were passed through a Chipmunk Jaw crusher followed by a pulverizer to reduce the size. This materials was sieved to -270 mesh and the larger particles were passed through the pulverizer again.

The -270 mesh fraction was comminuted to -400 mesh using a ceramic wet ball mill and the coal sample was stored as a wet slurry under Argon atmosphere to minimize oxidation.

Characterization

The particle size analysis of coal and coal pyrite samples, using HORIBA particle size analyzer are given in Figures 1-3. The d_{50} of coal and coal pyrite are approximately 5.0 μm and 0.81 μm respectively. For the proximate and ultimate analysis of coal and coal

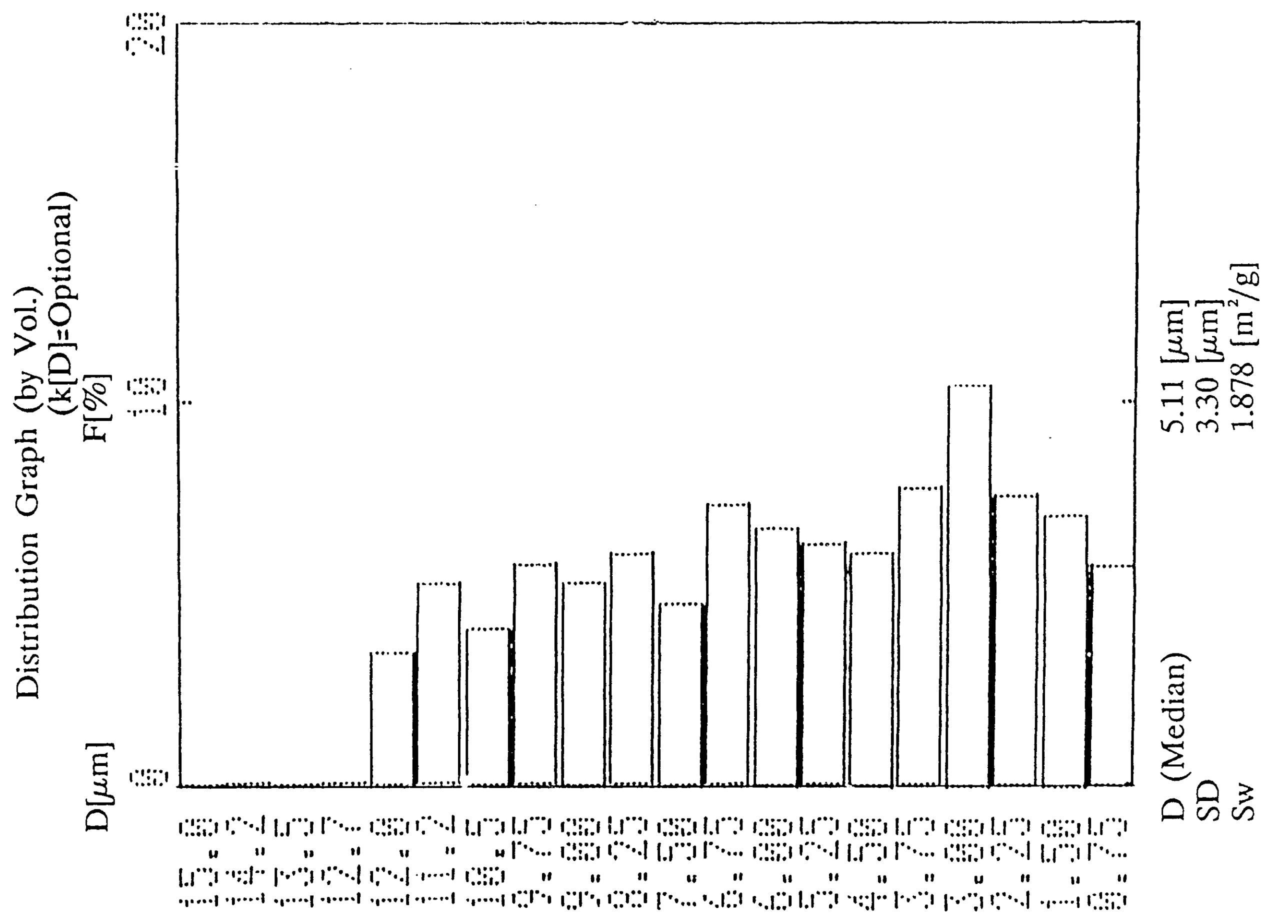

Figure 1. Particle Size Distribution of Coal

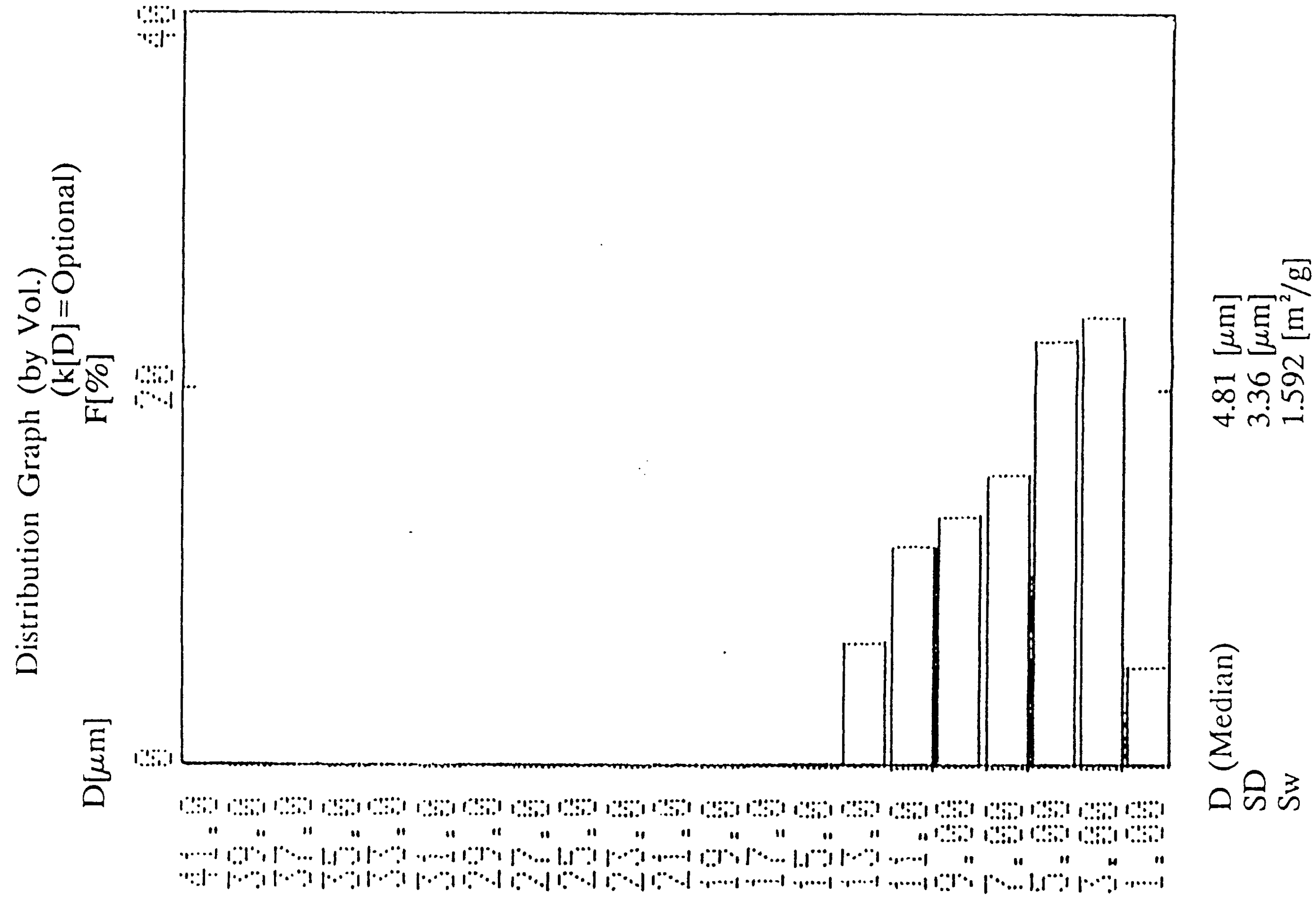

Figure 2. Particle Size Distribution of Coal

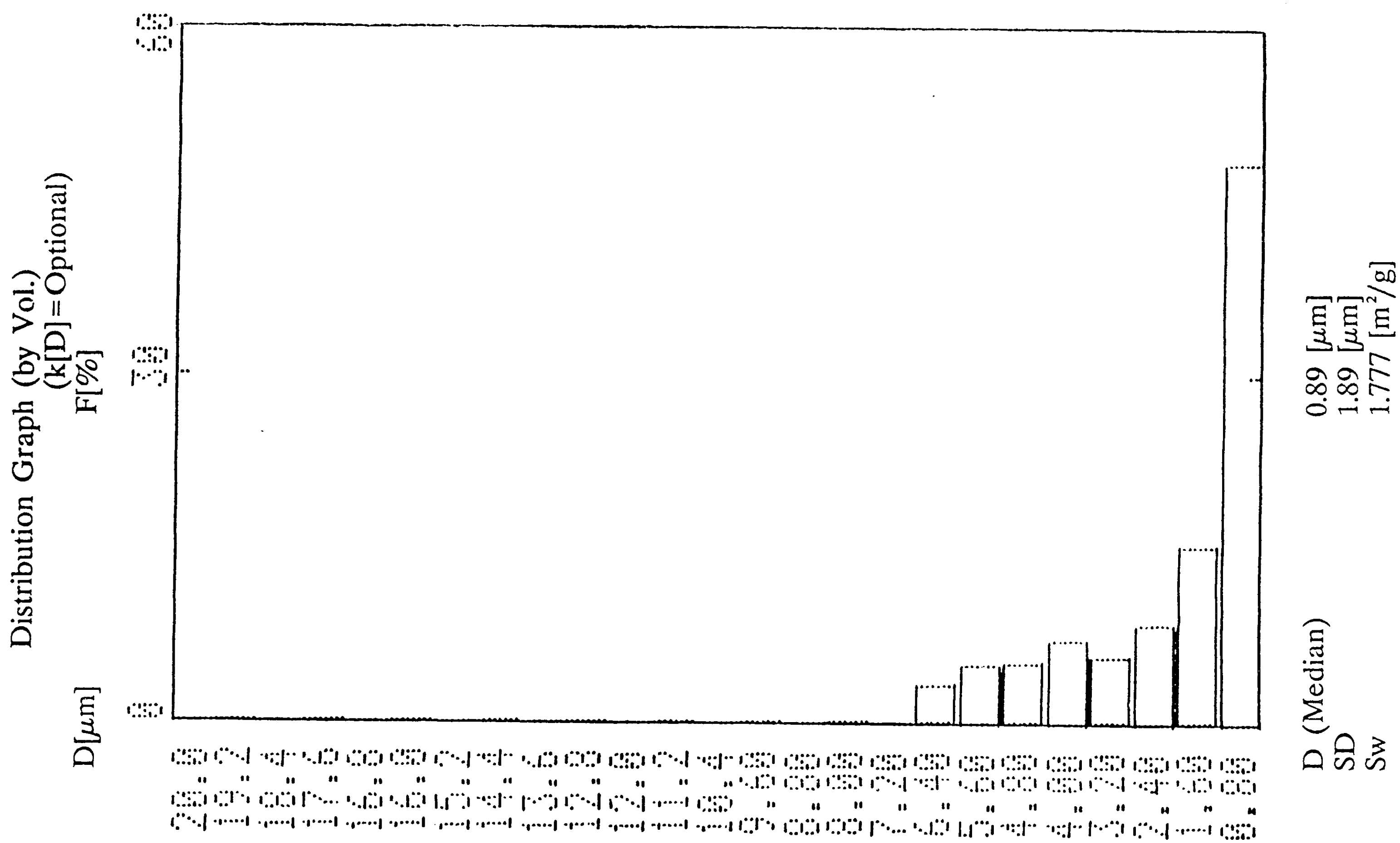

Figure 3. Particle Size Distribution of Coal Pyrite

pyrite, the samples have been sent to the Commercial Testing and Engineering company, Birmingham, Alabama.

Single Mineral Tests

A number of polymer and dispersant combinations are being tested in the laboratory. With the new coal and coal pyrite samples. Visual inspection of the slurry after introduction of the polymer is done to assess the nature and size of the flocs formed. As previously reported, the settling criteria for selection of polymer is not quite accurate since on using SF 362, no settling of coal is observed, however, flocs were definitely formed as indicated by visual inspection of the slurry.

The results with a few polymers tested so far are given in Table 1. Evaluation of other polymers as selective flocculents is in progress. WCL 762/Darvan C seems to have shown single mineral selectivity. Tests will be conducted for mixed mineral for this particular case.

MODEL PREDICTION

The computational model was used to simulate the effect of various process parameters on different values of Φ_R (Φ coal pyrite/Φ coal) on the selectivity index and recovery. The parameters studied were:

I. Effect of Feed Composition: The selectivity Index at lower Φ_R values shown in Figure 4, decreases as the amount of active component in the feed increases. However, at higher values of Φ_R, the S.I. remains unchanged as a function of feed composition. The recovery at higher Φ_R values also remains unchanged but at

Table 1.

POLYMERS TESTED USING DARVAN C .185 g/l

Polymer	Coal	Pyrite
SF 16*		
.01 kg/t	No flocs	No. flocs
.1 kg/t	Small flocs	
1 kg/t	Large flocculation rapid settling	Large flocs
SF 107		
0.1 kg/t	No observable flocculation	No flocs
1 kg/t	Small size flocs slow settling	Medium flocs settled rapidly
SF 127		
0.1 kg/t	No flocs	No observable flocs
1 kg/t	Large flocs. Rapid settling	Medium to large flocs. Rapid settling
WCL -762		
.01 kg/t	No observable flocs	No observable flocs
1 kg/t	Very small if any flocs	No observable flocs
10 kg/t	Very big flocs	No flocs

* Also tested with sodium meta-phosphate as a dispersant at the same concentration achieving the same results.

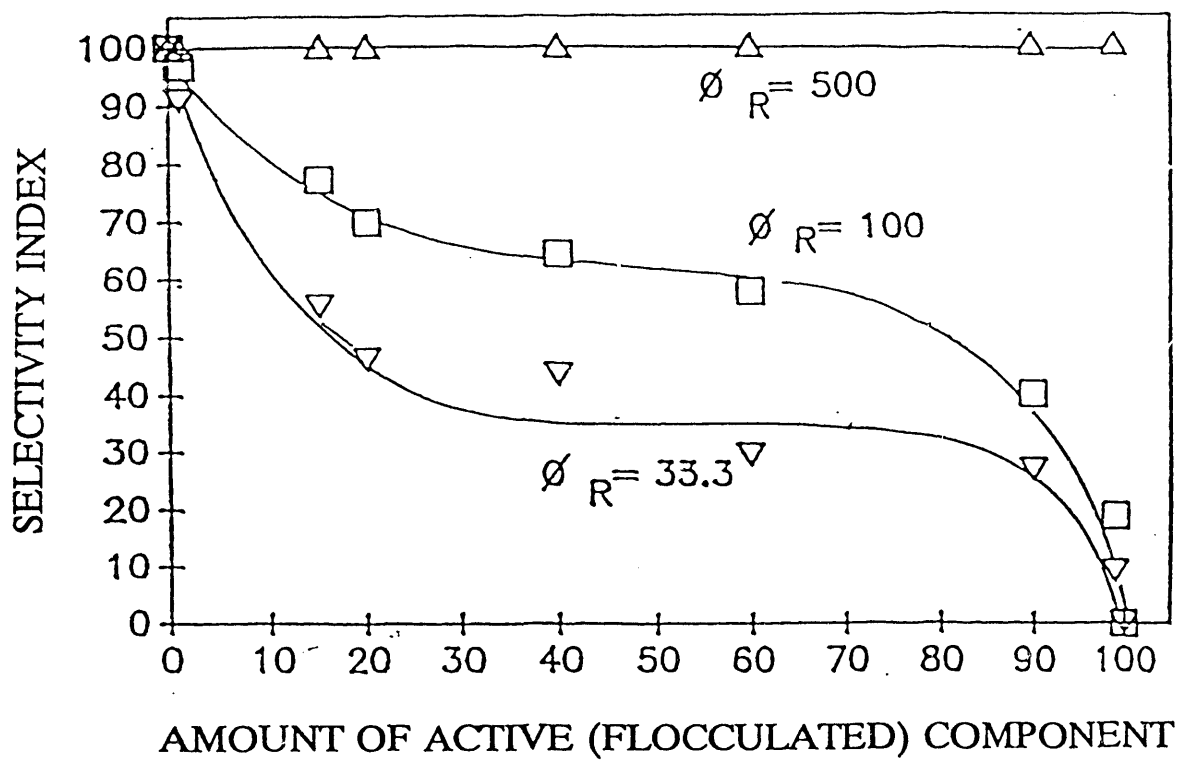

Figure 4. Effect of Pulp Density On Selectivity Index (-) and Recovery (---)

lower Φ_R exhibits a minimum of around 60% of the active component (Figure 5). At lower Φ_R the loss of Selectivity Index is due to heteroflocculation.

II. Effect of Polymer Dosage: At lower θ (fractional surface coverage) of the inactive or inert component, a number of collisions between active inactive particles would be unsuccessful because these collisions would take place between the bare sites on the floc surface (unoccupied polymer sites). However, the success rate of active and inert particle collisions is not affected by the value of θ of inactive particles which leads to less heteroflocculation and therefore, higher selectivity as illustrated in Figure 6. The increased recovery at lower Φ_R can be attributed to the formation of a less number of flocs of active particles. These trends are in agreement with the experimental results of Kogan, et al.

III. Effect of Pulp Density

The S.I. and recovery remains constant for a wide range of pulp density (Figure 7). Kogan et al showed that for the coal ash forming materials system there is no appreciable difference in recovery and S.I. for slurries of more than 5 wt. %.

To obtain a higher Selectivity Index, it is once again emphasized that high values of Φ_R are required. However, by properly controlling polymer dosage even at low values of Φ_R, high S.I. may be obtained (Figure 6).

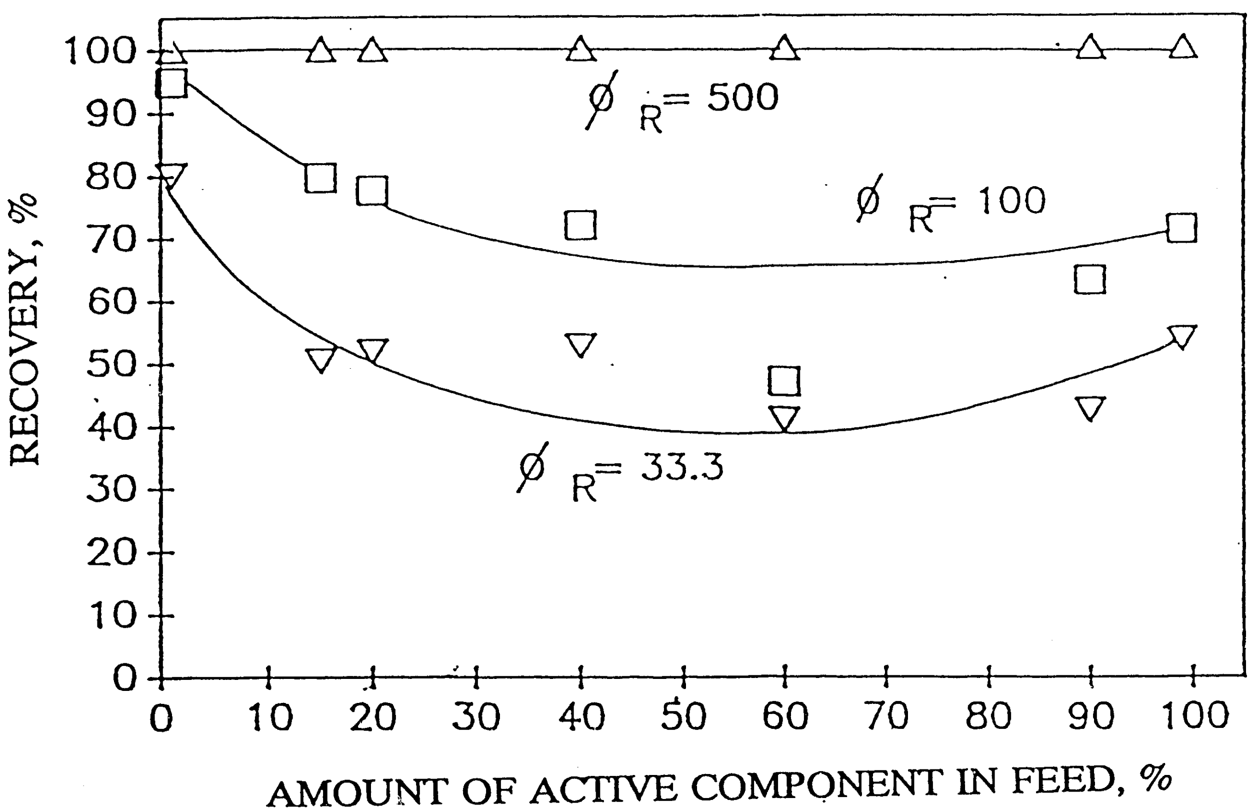

Figure 5. Effect of Feed Composition On Selectivity Index

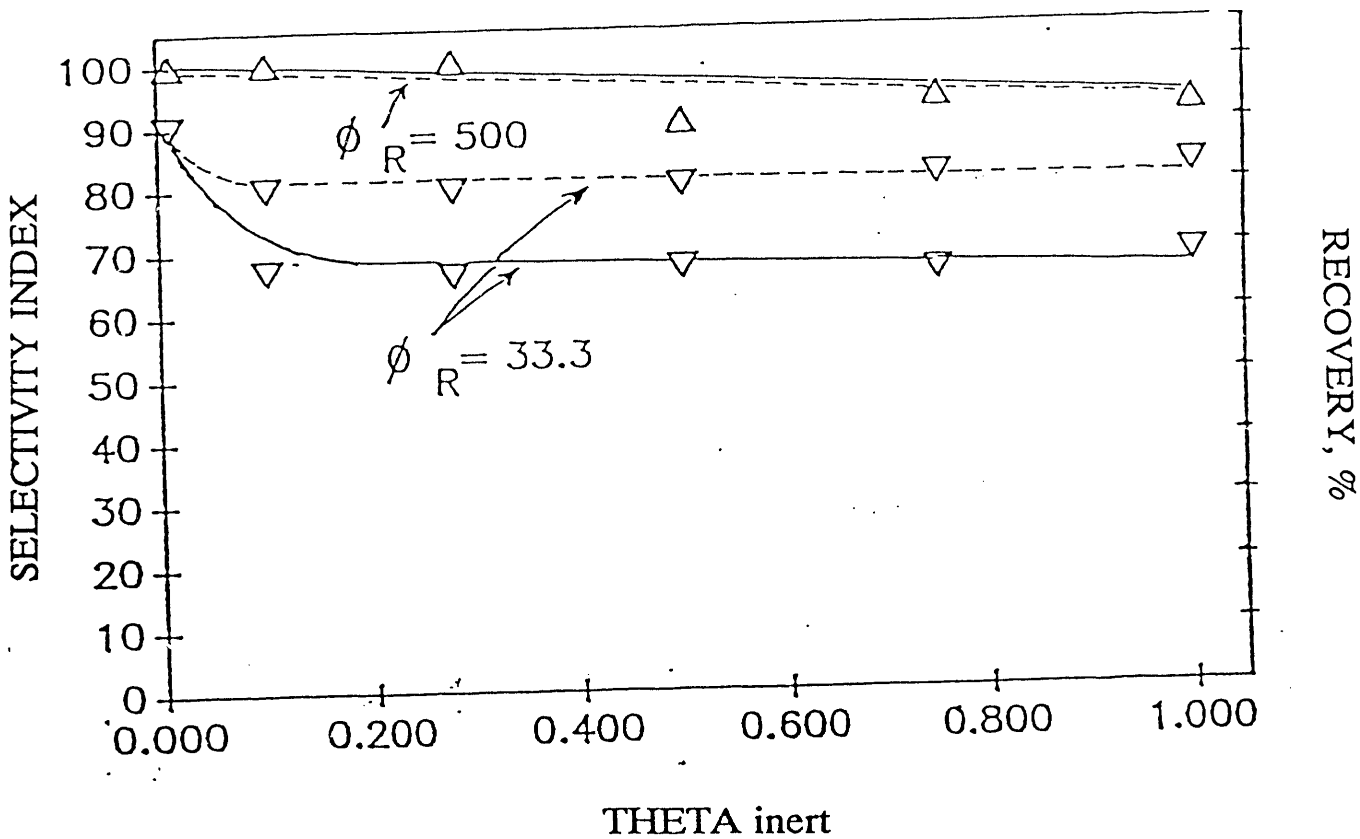

Figure 6. Effect of θ_{inert} On Selectivity Index (-) and Recovery (---)

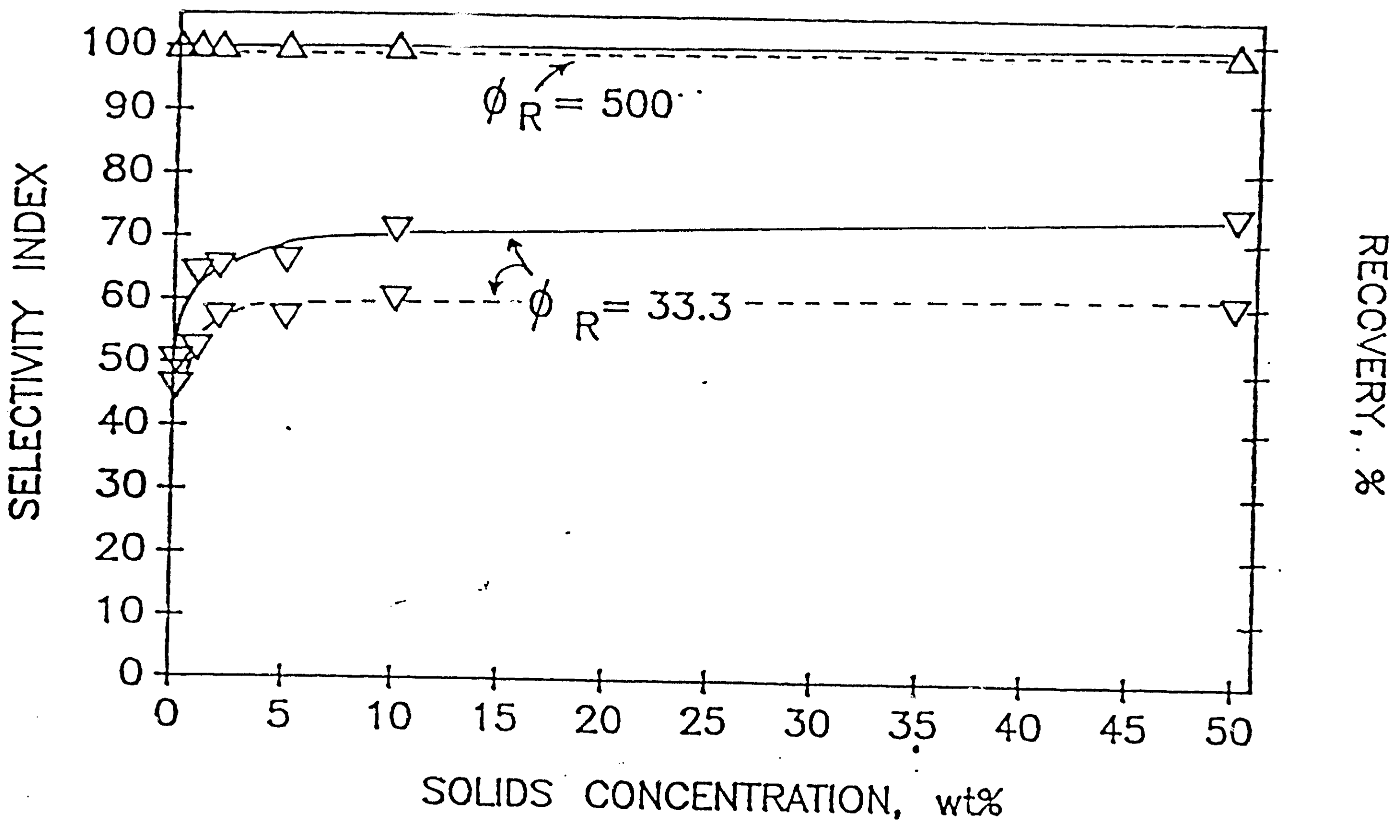

Figure 7. Effect of Feed Composition on Recovery

Future Work

In the future, a proper screening of more polymer/dispersant systems would be carried out by single mineral flocculation tests. After selecting the polymer, adsorption parameters would be determined to check the amount of selectivity achievable.

Also FT-IR analysis and evaluation of heat of adsorption of the polymer on the solids would be carried out. This would give an indication of the conformation of the polymer on the surface, and hence floc properties. A better understanding of the parameters which control floc properties, can lead to separation even if the polymer adsorption is not highly selective.

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