A Novel Ultrasonic Dynamic Drainage Tester

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Water Removal in Papermaking

Solids Content

Fiber Water Content (kg/kg)
Cost of Water Removal

Relative cost to remove a given quantity of water:

<table>
<thead>
<tr>
<th></th>
<th>Former</th>
<th>Presses</th>
<th>Dryers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$1</td>
<td>$58</td>
<td>$220</td>
</tr>
</tbody>
</table>
Conventional Drainage Tester

Canadian Standard Freeness Tester:

Excellent tool for pulp quality control
Dynamic Drainage Jar

A very useful device for determining first pass retention.
Modified Dynamic Drainage Jar

Dynamic Drainage Analyzer:

A simple test, but no turbulence during drainage
Effect of Mixing on Drainage in Modified DDJ

- No mixing: 14.1s
- Mixing at 400rpm: 17.0s
- Mixing at 1000 rpm: 38.1s
Fines Distribution of a Sheet Formed in a DDJ Under Continuous Mixing

![Graph showing fines distribution across thickness and wire side to top side.]

Fines Content (%) vs Thickness (mm)
Other Drainage Testers

Moving Belt Drainage Tester
Pulsed Drainage Device

...
Ultrasonic Dynamic Drainage Tester

- Ultrasound Horn
- Screen
- Impeller
- Vacuum Gauge
- Vacuum Pump
- Balance
- Data Processing
Ultrasonic Filtration Screen

Ultrasonic processor

Filtration screen

Ultrasonic filtration screen
Screen Unblocking and Deflocculation by Ultrasound in Standard Retention Test

![Graph showing the effect of ultrasound on fines retention. The graph compares different conditions: Control, Control + Chitosan, With ultrasound, and Ultrasound + Chitosan. The x-axis represents the impeller rotating speed (rpm), and the y-axis represents fines retention (%). The graph illustrates the improvement in fines retention across different conditions as the impeller speed increases.]
Drainage Profiles of a Newsprint Furnish At 400 rpm with Mat Formation

- No mixing, 14.1s
- Ultrasound, 11.5s
- Mixing + Ultrasound, 15.9s
- Mixing, 17.0s
## Drainage and Retention with Chitosan
At 400 rpm with Mat Formation

<table>
<thead>
<tr>
<th>Sample</th>
<th>No Mixing</th>
<th>Mixing at 400 rpm</th>
<th>Ultrasound</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Drainage Time (s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulp Alone</td>
<td>14.1</td>
<td>17.0</td>
<td>11.5</td>
</tr>
<tr>
<td>Pulp + Chitosan</td>
<td>12.3</td>
<td>14.1</td>
<td>11.8</td>
</tr>
<tr>
<td></td>
<td>Fines Retention (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulp Alone</td>
<td>77.6</td>
<td>79.7</td>
<td>64.1</td>
</tr>
<tr>
<td>Pulp + Chitosan</td>
<td>88.6</td>
<td>87.3</td>
<td>80.9</td>
</tr>
<tr>
<td>Increase in Retention</td>
<td>11.0</td>
<td>7.6</td>
<td>16.8</td>
</tr>
</tbody>
</table>
Drainage Profiles of a Newsprint Furnish At 1000 rpm with Mat Formation

![Graph showing the impact of ultrasound and mixing on drainage profiles.

- Ultrasound, 10.0s: 53.6%
- No mixing, 11.7s: 69.3%
- Mixing, 38.1s: 68.9%
- Ultrasound + Mixing, 10.7s: 30.9%]
Retention Is Changed by Ultrasound Intensity

![Graph showing the relationship between fines retention and ultrasound amplitude. The graph compares TMP and TMP + Chitosan.](image-url)
Pressure Profile under Various Turbulence Conditions

- Ultrasound
- Ultrasound & mixing at 1000 rpm
- No turbulence
- Mixing at 1000 rpm

Pressure (kPa) vs. Time (sec)
Drainage vs. Pressure and Retention

- Fines Retention $= 0.4505$
- Equilibrium Vacuum $R^2 = 0.7587$
Fines Distribution of a Sheet Formed with Ultrasound

With Ultrasound

Under Continuous Mixing
Drainage Mechanism with Ultrasound

Before starting drainage test

Dewatering under mixing

Dewatering under ultrasound
Conclusions

• The turbulence induced by impellor in a conventional DDJ increases filtration resistance enormously.

• Ultrasound can
  ✓ Deflocculate fiber suspension
  ✓ Unblocking forming wire
  ✓ Enlarge dewatering channel in the web

• The Ultrasonic DDJ could be very useful laboratory tool to determine drainage under dynamic conditions
  ✓ Drainage profile
  ✓ Vacuum profile
  ✓ Retention
Acknowledgements

- T. Owston
  ✓ Initial experimental work
- C. Castro
  ✓ Data processing program
- G. Dorris, G. Laivins, T. Owston & M. Drainville
  ✓ Filtrate weight and pressure monitoring
- I. Tihanyi & N. Vignola
  ✓ Vessel and accessory manufacturing
- M. Laleg, J. Jong, I. Vadeiko, T. Owston and S. Middleton
  ✓ Valuable discussion
- NSERC IPS program