REMOVAL OF ACETOCHLOR AND METOLACHLOR BY ADSORPTION PROCESS

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**Pesticides**

**Definition:** USEPA defines the pesticides as chemical substances used for controlling and repelling of pests.

**Spectrum of Pesticides**
- Insecticides
- Herbicides
- Fungicides
- Rodenticides

Pesticides:
- **carcinogenic, mutagenic, and teratogenic** in nature,
- significantly toxic due to their ability to **bioaccumulate** in organism tissue and migrate to higher organisms.
Pesticides Consumption in the World

Pesticides are widely used in:
- Agriculture, industry, forestry, and households.
- Total pesticide use is 4.2 million tons, and 2.7 kg/ha of pesticide is applied for cultivated area.

Of the total consumption:
- 47.5% herbicides,
- 29.5% insecticides,
- 17.5% fungicides,
- 5.5% others.

According to the European Commission (EC) database for pesticides, there are 1472 types of pesticides including active substances, safeners, and synergists and only 453 of which are approved.
Acetochlor and metolachlor are two pesticides used most frequently and detected at the highest concentration in surface waters worldwide.

The aim of this study is to investigate the removal performances of acetochlor and metolachlor by adsorption process using of 4 different activated carbon
Material and Methods

<table>
<thead>
<tr>
<th>Acetochlor</th>
<th>Metolachlor</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Acetochlor Structure" /></td>
<td><img src="image2.png" alt="Metolachlor Structure" /></td>
</tr>
</tbody>
</table>

Activated Carbon:
1) AC Puriss,
2) Norit SX F Cat,
3) Norit SX Ultra
4) Norit CA1

Experimental Procedure:
1. Kinetic tests: 2.5 mg/L TOC, 500 µg/L pesticides, 300 mg/L AC, 2-96 hr
2. Isotherm tests: 2.5 mg/L TOC, 500 µg/L pesticides, 10-1000 mg/L AC, 72 hr

Pesticides Analysis:
1. Acetochlor: HPLC, DLLME extraction, 70/30 ACN/W, 1 ml/min, 210 nm.
2. Metolachlor: HPLC, DLLME extraction, 80/20 ACN/W, 1.2 ml/min, 230 nm.
# RESULTS

<table>
<thead>
<tr>
<th></th>
<th>Flowrate (mL/min)</th>
<th>Oven Temp. (°C)</th>
<th>Solvent Ratio</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetochlor</td>
<td>1.00</td>
<td>40</td>
<td>70/30</td>
<td>0.9974</td>
</tr>
<tr>
<td>Metalochlor</td>
<td>1.20</td>
<td>50</td>
<td>80/20</td>
<td>0.9983</td>
</tr>
</tbody>
</table>

### Acetochlor

**Regression Equation:**

$$y = 0.0458x$$

**$R^2$:** 0.9983

### Metalochlor

**Regression Equation:**

$$y = 0.1019x$$

**$R^2$:** 0.9974
<table>
<thead>
<tr>
<th>Adsorbent</th>
<th>$q_e$ (exp) (mg/g)</th>
<th>$k_1$ (g/mg.h)</th>
<th>$q_e$ (cal) (mg/g)</th>
<th>$R^2$</th>
<th>$k_2$ (g/mg.h)</th>
<th>$q_e$ (cal) (mg/g)</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norit SX Ultra</td>
<td>6.87</td>
<td>0.007</td>
<td>2.88</td>
<td>0.47</td>
<td>0.386</td>
<td>6.82</td>
<td>0.99</td>
</tr>
<tr>
<td>Norit CA</td>
<td>5.66</td>
<td>0.013</td>
<td>3.13</td>
<td>0.89</td>
<td>0.192</td>
<td>5.55</td>
<td>0.99</td>
</tr>
<tr>
<td>AC Puriss</td>
<td>5.52</td>
<td>0.017</td>
<td>3.63</td>
<td>0.79</td>
<td>0.131</td>
<td>6.40</td>
<td>0.99</td>
</tr>
<tr>
<td>Norit SX F Cat</td>
<td>7.42</td>
<td>0.013</td>
<td>4.93</td>
<td>0.59</td>
<td>0.198</td>
<td>7.35</td>
<td>0.99</td>
</tr>
</tbody>
</table>
### Modified Freundlich Isotherm

The Modified Freundlich isotherm is used to describe the sorption of pollutants onto solid surfaces. The equation is given by:

\[ q_e = K_F \left( \frac{C_e}{M} \right)^{1/n} \]

Where:
- \( q_e \) is the amount of pollutant adsorbed per unit mass of adsorbent (mg/g)
- \( C_e \) is the equilibrium concentration of the pollutant in the solution (mg/L)
- \( K_F \) is the Freundlich constant (L/kg)
- \( n \) is the Freundlich exponent
- \( M \) is the mass of the adsorbent (g)

### Results

<table>
<thead>
<tr>
<th>Adsorbent Type</th>
<th>( q_{e,exp} ) (mg/g)</th>
<th>( K_F )</th>
<th>( n )</th>
<th>( R^2 )</th>
<th>( q_{e,exp} ) (mg/g)</th>
<th>( K_F )</th>
<th>( n )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norit SX F Cat</td>
<td>85.6</td>
<td>2.62</td>
<td>1.5</td>
<td>0.98</td>
<td>84.3</td>
<td>1.36</td>
<td>1.31</td>
<td>0.99</td>
</tr>
<tr>
<td>AC Puriss</td>
<td>102.5</td>
<td>2.68</td>
<td>1.37</td>
<td>0.98</td>
<td>106.7</td>
<td>1.91</td>
<td>1.27</td>
<td>0.99</td>
</tr>
<tr>
<td>Norit SX Ultra</td>
<td>69.2</td>
<td>1.89</td>
<td>1.48</td>
<td>0.99</td>
<td>95.2</td>
<td>1.82</td>
<td>1.3</td>
<td>0.98</td>
</tr>
<tr>
<td>Norit CA1</td>
<td>52.7</td>
<td>1.45</td>
<td>1.63</td>
<td>0.95</td>
<td>50.3</td>
<td>1.28</td>
<td>1.56</td>
<td>0.97</td>
</tr>
</tbody>
</table>

**Note:** The red highlight indicates the adsorbent type with the highest \( R^2 \) value for both Acetochlor and Metolachlor.
SUMMARY

- Adsorbents obeyed the Pseudo second order kinetic rate
- Modified Freundlich Isotherm was applied for adsorption capacity estimation
- AC Puriss provided the highest adsorption capacity:
  - ✔ 102.5 mg/g for acetochlor
  - ✔ 106.7 mg/g for metolachlor
- Acetochlor was removed with > 90% at higher than 200 mg/L adsorbent dosages.
- Metolachlor was almost completely (>99%) removed by all adsorbents even in low dosages.
ACKNOWLEDGEMENT

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Thank you very much for your interests

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