## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Chapter 1</th>
<th>INTRODUCTION</th>
<th>Pg. No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fig. 1.1</td>
<td>(A) and (B) illustrate the process of Osmosis, (C) Reverse Osmosis</td>
<td>19</td>
</tr>
<tr>
<td>Fig. 1.2</td>
<td>Pictorial diagram of water treatment through membrane filtration</td>
<td>19</td>
</tr>
<tr>
<td>Fig. 1.3</td>
<td>Distinction between physical and chemical adsorption process</td>
<td>27</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 2</th>
<th>LITERATURE SURVEY</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fig. 2.1</td>
<td>Effect of cutting fluid on the height of micro-irregularities on the machined surface</td>
<td>41</td>
</tr>
<tr>
<td>Fig. 2.2</td>
<td>Effect of cutting fluid on the chip contraction</td>
<td>41</td>
</tr>
<tr>
<td>Fig. 2.3</td>
<td>Dependence of force $F_Z$ on the uncut chip thickness in machining steel 20, at $v = 6.5$ m/min with the application of various cutting fluid</td>
<td>42</td>
</tr>
<tr>
<td>Fig. 2.4</td>
<td>Relationship between tool face wear and time of operation: 1- Dry; 2- using emulsion cutting fluid</td>
<td>42</td>
</tr>
<tr>
<td>Fig. 2.5</td>
<td>Effect of various types of cutting fluid on drill life</td>
<td>43</td>
</tr>
<tr>
<td>Fig. 2.6</td>
<td>Effect of various types of cutting fluid on the cutting speed / tool life</td>
<td>43</td>
</tr>
<tr>
<td>Fig. 2.7</td>
<td>Effect of types of lubricant on the cutting speed/tool life relationship for the turning operation</td>
<td>44</td>
</tr>
<tr>
<td>Fig. 2.8</td>
<td>Effect of types of lubricant on the cutting speed/tool life relationship obtained when turning steel</td>
<td>44</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 3</th>
<th>RESEARCH METHODOLOGY / MATERIAL AND METHODS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fig 3.1</td>
<td>X-Ray diffraction pattern of PGAC</td>
<td>71</td>
</tr>
<tr>
<td>Fig 3.2</td>
<td>X-Ray diffraction pattern of metal PSAC</td>
<td>72</td>
</tr>
<tr>
<td>Fig 3.3</td>
<td>X-Ray diffraction pattern of DMAC</td>
<td>73</td>
</tr>
<tr>
<td>Fig 3.4</td>
<td>X-Ray diffraction pattern of metal cutting oil loaded PGAC</td>
<td>74</td>
</tr>
<tr>
<td>Fig 3.5</td>
<td>X-Ray diffraction pattern of metal cutting oil loaded PSAC</td>
<td>74</td>
</tr>
<tr>
<td>Fig 3.6</td>
<td>X-Ray diffraction pattern of metal cutting oil loaded DMAC</td>
<td>75</td>
</tr>
<tr>
<td>Fig 3.7</td>
<td>FTIR Spectrum of raw Pomegranate Peel of particle size 100µm</td>
<td>77</td>
</tr>
<tr>
<td>Fig 3.8</td>
<td>FTIR Spectrum of Pomegranate peel Activated Carbon</td>
<td>78</td>
</tr>
<tr>
<td>Fig 3.9</td>
<td>FTIR Spectrum of PSAC adsorbent</td>
<td>78</td>
</tr>
<tr>
<td>Fig 3.10</td>
<td>FTIR Spectrum of DMAC adsorbent</td>
<td>79</td>
</tr>
<tr>
<td>Fig 3.11</td>
<td>FTIR of metal cutting oil loaded PGAC adsorbent</td>
<td>79</td>
</tr>
<tr>
<td>Fig 3.12</td>
<td>FTIR of metal cutting oil loaded PSAC adsorbent</td>
<td>80</td>
</tr>
<tr>
<td>Fig 3.13</td>
<td>FTIR of metal cutting oil loaded DMAC adsorbent</td>
<td>81</td>
</tr>
<tr>
<td>Fig 3.14</td>
<td>SEM image of PGAC adsorbent</td>
<td>82</td>
</tr>
<tr>
<td>Fig 3.15</td>
<td>SEM image of PSAC adsorbent</td>
<td>83</td>
</tr>
<tr>
<td>Fig 3.16</td>
<td>SEM image of DMAC adsorbent</td>
<td>84</td>
</tr>
<tr>
<td>Fig 3.17</td>
<td>SEM image of PGAC with adsorbed metal cutting oil</td>
<td>85</td>
</tr>
<tr>
<td>Fig 3.18</td>
<td>SEM image of PSAC with adsorbed metal cutting oil</td>
<td>86</td>
</tr>
<tr>
<td>Fig 3.19</td>
<td>SEM image of DMAC with adsorbed metal cutting oil</td>
<td>87</td>
</tr>
<tr>
<td>Fig 3.20</td>
<td>Different pattern of continuous adsorption process for wastewater</td>
<td>89</td>
</tr>
<tr>
<td>Fig 3.21</td>
<td>Flow diagram of Continuous adsorption process within the fixed bed column</td>
<td>91</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>Fig 3.22</td>
<td>Flow diagram of experimental set up of fixed bed adsorption system</td>
<td>92</td>
</tr>
</tbody>
</table>

**Chapter 4 RESULT AND DISCUSSION**

| Fig 4.1 | (a) & (b) Column hold up and breakthrough curve for the adsorption of metal cutting oil on PGAC at initial conc. Co=0.5% with bed height H=35mm and flow rate D=50ml/min. | 97 |
| Fig 4.2 | (a) & (b) Column hold up and breakthrough curve for the adsorption of metal cutting oil on PSAC at initial conc. Co=1.5% with bed height H=92mm and flow rate D=35ml/min. | 98 |
| Fig 4.3 | (a) & (b). Column hold up and breakthrough curve for the adsorption of metal cutting oil on DMAC at initial conc. Co=1.0% with bed height H=92mm and flow rate D=35ml/min. | 98 |
| Fig 4.4 | Effect of varying concentration of metal cutting O/W emulsion at a fixed flow rate D=25ml/min, bed length H of PGAC adsorbent=35mm and T=25ºC. | 104 |
| Fig 4.5 | Effect of varying adsorbent amount (column/ bed length H of PGAC adsorbent) of metal cutting O/W emulsion at a fixed influent concentration C_o= 0.5%, flow rate D=25ml/min. and T=25ºC. | 104 |
| Fig 4.6 | Effect of varying flow rate of O/W emulsion on the adsorption of metal cutting oil on PGAC adsorbent at a fixed influent concentration C_o= 0.5%, H=35mm and T=25ºC. | 105 |
| Fig 4.7 | Effect of varying concentration of metal cutting O/W emulsion at a fixed flow rate D=35ml/min, bed length H of PSAC adsorbent=40mm and T=25ºC. | 106 |
| Fig 4.8 | Effect of varying adsorbent amount (column/ bed length H of PSAC adsorbent) of metal cutting O/W emulsion at a fixed influent concentration C_o= 1.5%, flow rate D=35ml/min. and T=25ºC. | 107 |
| Fig 4.9 | Effect of varying flow rate of O/W emulsion on the adsorption of metal cutting oil on PSAC adsorbent at a fixed influent concentration C_o= 1.5%, H=40mm and T=25ºC. | 108 |
| Fig 4.10 | Effect of varying concentration of metal cutting O/W emulsion at a fixed flow rate D=35ml/min, bed length H of PSAC adsorbent=92mm and T=25ºC. | 109 |
| Fig 4.11 | Effect of varying adsorbent amount (column/ bed length H of DMAC adsorbent) of metal cutting O/W emulsion at a fixed influent concentration C_o= 1.0%, flow rate D=35ml/min. and T=25ºC. | 110 |
| Fig 4.12 | Effect of varying flow rate of O/W emulsion on the adsorption of metal cutting oil on DMAC adsorbent at a fixed influent concentration C_o= 1.0%, H=40mm and T=25ºC. | 111 |
| Fig 4.12(a) | Effect of pH on sorption capacity of adsorbents PGAC, PSAC and DMAC at influent concentration C_o= 1% of metal cutting oil | 112 |
| FIG 4.13 | Langmuir isotherm for PGAC-metal cutting oil system | 116 |
| FIG 4.14 | Langmuir isotherm for PSAC-metal cutting oil system | 116 |
| FIG 4.15 | Langmuir isotherm for DMAC-metal cutting oil system | 117 |
| FIG 4.16 | Freundlich isotherm for PGAC-metal cutting oil system | 118 |
| FIG 4.17 | Freundlich isotherm for PSAC-metal cutting oil system | 119 |
| FIG 4.18 | Freundlich isotherm for DMAC-metal cutting oil system | 120 |
| FIG 4.19 | Breakthrough curves of adsorption of metal cutting fluids onto the adsorbents (PGAC, PSAC, DMAC) at oil/water emulsion concentration Co=1%, column bed height H=40mm with emulsion flow rate D=35ml/min. at pH 8 and T=25ºC | 122 |
| FIG 4.20 | Thermal gravimetric analysis of the Pumpkin seed waste activated carbon (PSAC) before adsorption | 125 |
| FIG 4.21 | Thermal gravimetric analysis of the Pumpkin seed waste activated carbon (PSAC) after adsorption of metal cutting oil | 125 |
| FIG 4.22 | (a) Plots of Coats and Redfern Method for PSAC before adsorption in first zone of temperature 30º-100ºC. (b) Plots of Coats and Redfern Method for PSAC before adsorption in next zone of temperature 380º-980ºC | 128 129 |
| FIG 4.23 | (a) Plots of Coats and Redfern Method for PSAC after adsorption in first zone of temperature 30º-100ºC. (b) Plots of Coats and Redfern Method for PSAC after adsorption in next zone of temperature 250º-980ºC. | 129 130 |