CHAPTER 6

CONCLUSION

This work investigates the energy conservation through efficiency improvement in an induction motor by Die-cast Copper Rotor (DCR) Technology. The possibility of the efficiency improvement for the three phase, low voltage, squirrel-cage induction motor between the ratings from 0.37 kW to 11 kW is verified by numerical calculation using Matlab 7 and also by experimentation. In a 2.2 kW (3 HP) squirrel cage motor with DCR, produces an efficiency more than 3 % points that of the same motor with Die-cast Aluminium Rotor (DAR). Based on the experimental tests a summary of the average performance variations of the motors between the range 0.5 HP - 5 HP with DCR in comparison with DAR are shown in Table 6.1. While understanding the comparison of performance it is to be noted that, the motors are tested with DCR and conventional DAR without any change in the rotor slot configuration and rotor stamping stacks.

Table 6.1 Comparison of various performance parameters between DCR and DAR

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Variation Factor</th>
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<tbody>
<tr>
<td>Reduction in slip</td>
<td>2%</td>
</tr>
<tr>
<td>Increase in starting current</td>
<td>10%</td>
</tr>
<tr>
<td>Decrease in starting torque</td>
<td>17%</td>
</tr>
<tr>
<td>Improvement in Efficiency</td>
<td>2.8%</td>
</tr>
<tr>
<td>Decrease in Temperature</td>
<td>7.5°C.</td>
</tr>
<tr>
<td>Decrease in Full load Current</td>
<td>4%</td>
</tr>
<tr>
<td>Chance in Full load p.f</td>
<td>Negligible.</td>
</tr>
</tbody>
</table>
By merely changing the DAR with DCR without any other design modifications, it is observed that an average efficiency improvement of 2.5% between the ratings from 0.37 kW to 11 kW is achieved.

The possible efficiency improvement and cost saving opportunities of the submersible pumpsets are also studied. By decreasing the core length and increasing the efficiency of submersible motor using DCR technology, the overall efficiency enrichment is achieved. By reducing the stack length of DCR, the various electrical parameters including the low voltage performance are measured and compared with the existing Copper Fabricated Rotor (CFR) in a range between (3 – 10) HP, 3 phase wet type water cooled induction motors in accordance with IS 9283.

The overall performance of submersible pumpsets is also practically verified in accordance with IS 8034. The cost comparison between the existing CFR and DCR’s are also reported and found that by merely replacing CFR with reduced core length DCR, about 15% of the initial cost without sacrificing the overall efficiency of the pumpset can be saved as indicated by IS 8034.

The experimental result shows that, with M47 stamping material the development of cost effective DCR motor model with 170 mm core length would give the overall efficiency of about 51%, which means an improvement of 10% over conventional CFR submersible pumpset with 205 mm core length at 10% of lower cost. Thus, it has been demonstrated that 25% of energy could be saved in the pumping operations by this newly developed pumpset, which costs only 90% of the cost of CFR pumpset. By using reduced core length “PRIME” grade lamination the cost effective pumpset was developed.
During this process, the overall efficiency level of the pumpset is kept within the level stated by IS 8034:2002.

A new slot design is also proposed instead of conventional slot design for accommodating copper conductors for stator and rotor for increasing the starting torque of the DCR motor. The possible efficiency improvements are checked with three varieties of laminations (M47, Prime and LC) in both motor and pump sides. Due to the adoption of proposed slot design with M47 lamination in the existing CFR motor, efficiency of the submersible motor increases by 4% - 5% and hence, the overall efficiency of the submersible pumpset also increases. The increase in overall efficiency of the submersible pumpset of about 1% to 1.5% more than CFR motor is arrived in DCR motor with new slot geometry. In addition to increase in efficiency, there is also an increase in the starting torque of DCR motor with new lamination compared to the CFR motor. Apart from new slot configuration with M47 lamination, the diffuser and impeller materials are changed from Cast Iron (CI) to Noryl material and then further improvement in overall efficiency (minimum of 3% more) is possible. If proper attention is given to limit the various losses such as Hydraulic losses, Leakage losses, Mechanical losses and Disc friction losses in submersible pumpset, then further more enrichment in overall efficiency of submersible pumpsets are possible.

By the tests on agricultural pumps the following conclusions are arrived at:

1. DCR pumps can be used for increased heads while compared to the average pumps
2. DCR pump of same dimension can be used for superior pump range.
3. By using DCR pump, the dimension of the existing pump can be minimized.
The following observations could be made from the experiences of design and manufacture of DCR-LT Induction motors.

- The cost increase in converting standard aluminium rotor motors to Eff1 level motors by using DCR without any other design change except changes in stator winding is about 15 to 20%.

- Continuous process industries like textile mills, chemical industries, Effluent Treatment plants etc., operating 24 hours a day accepts the increase in cost as this could be got back within 6 months of operation.

- The other industries operating 8/12 hours a day are reluctant to absorb the incremental cost of higher efficiency DCR motors.

- To be able to supply to this category of market and to satisfy all range of customers it is necessary to modify the design of stator configuration, body size, frame size etc., which will make the cost of DCR’s equal to or less than standard DAR motors.

- It will be a great boon to the user industries as well as society at large when the energy efficiency and energy conservation is improved at affordable cost.

Apart from energy savings, the DCR motor also reduces the production of greenhouse gases and pushes down the total environmental cost of electricity generation. Therefore, the adoption of these motors can give immense benefits to the user, as well as to the country and the global environment.
6.1 FUTURE RESEARCH

This work can be extended further in number of ways and some of them are as follows:

- In this thesis, the reduction in starting torque in DCR motor is roughly 20% with respect to the DAR motor. The starting torque can be increased in a DCR motor by using double cages instead of single cage.

- The decrease in starting torque in DCR motor can be increased exactly by designing the various parameter values in the equivalent circuit of an induction motor. By using any one of the optimization techniques like Genetic Algorithm (GA), Ant Colony optimization, Hybrid Techniques etc., these values will be optimized easily.

- Because of the reduction in starting torque in DCR motor, the task of efficiency improvement in a single phase induction motor is quite complex. But, this problem can be overcome in a Capacitor-start Capacitor-run induction motor. The existing winding design of this motor can be modified suitably so that, the starting torque of the machine will improve.

- In this thesis, the overall efficiency improvement and cost effective manufacturing of submersible pumpset using DCR technology is achieved by improving the efficiency of submersible motor. By giving proper attention to limit the various losses such as Hydraulic losses, Leakage losses, Mechanical losses and Disc friction losses in submersible pump, further more enrichment in overall efficiency of submersible pumpsets are possible along with reduced cost.