“Indian Motor Policies – Status Report”

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Energy Conservation Act, 2001

- Bureau of Energy Efficiency was formed under the Energy Conservation Act, 2001 with the aim to reduce energy consumption by three major actions
  - Designated consumers and activities concerning energy audits and implementation of economically viable measures to reduce norms of energy consumption,
  - energy conservation building codes for new commercial buildings,
  - standards and labeling
- standards and labeling provides for
  - Specifying and enforcing minimum energy performance standards for equipment and appliances prohibiting manufacture, sale, and import of products not meeting the minimum standards
  - Direct display of labels on specified appliances

Indian motor market analysis

- Industry accounts for 40% of electrical energy consumption.
- 70% of electricity consumed in industry is for motive purposes
- LT squirrel cage (LTSC) induction motors are widely used in the country.
- 95-96% of the LTSC motor population is less than 15kW rating (covering from 63 to 160 frame sizes). Around 2 million motors were manufactured in this range in 2004. (source: IEEMA production statistics & AFF Fergusson survey February, 2006)
- This accounts for about 60% of motive electricity consumed in the industry.

Evolvement of Indian Standards for electric motors

- IS 12615 covers the requirements and performance of energy efficient, 3 phase squirrel cage induction motor in 2, 4, 6 and 8 poles for all frame sizes up to 315 L for continuous duty (S1) operation at rated voltage and frequency of 415 volts, 50 Hz. All performance values are subject to tolerance specified in IS 325. In preparing the revision assistance has been derived from IEC 60034 – 1, IEC 60034 – 2, IEC 60038 and IEC 60050 (411).
- IS 325: 1996 provides specifications for three phase induction motors
- IS: 4029 – 1967, reaffirmed 2002, prescribes methods for conducting and reporting the tests for three phase induction motors.

[1]Tests carried out by BEE

- It was decided to conduct the studies on the fast moving ranges of 2.2 kW and 3.7 kW, 4 pole motors with EFF 2 efficiency levels.
- Samples were procured from the cross section of the supply chain and tested at NABL accredited laboratories for their performance and material testing. The sample size included 28 numbers each for both the ratings.
- The test results for efficiency indicated that about 70% of both 2.2 and 3.7 kW samples conform to EFF 2. 30 % of the samples did not conform to EFF 2 standards.
- Following performance testing, motors were then stripped for assessment of constructional features, and the quantity and quality (composition) of active materials (steel, copper, aluminum).
- Specific iron loss of stator core was measured.

[1] The test and analysis for arriving at minimum energy performance for motors were carried out by PPP between GTZ, BEE, Thyssen Krupp Electrical Steel, and International Copper Promotion Council of (India).

Analysis of test results

- Active materials represent the biggest component of motor cost, typically 45-50 %.
- The analysis suggests that efficiency improvement of Non-EFF 2 class motors to EFF 2 levels will require the following steps roughly in the order indicated:
  - reduce core loss through use of electrical steel
  - reduce rotor copper loss though use of more aluminum, and use of (electrical) steel with thinner laminations and uniform thickness of laminations
  - optimize air gap to reduce slip (Non-EFF 2, Non-Electrical steel motors have higher air gap)
  - reduce stator copper loss through use of more copper consistent with and corresponding to use of electrical steel
  - reduce friction and windage loss through use of better bearings and fan improvement.

Impact on manufacture

- Design of motor and active materials costs are a trade off since lower cost of non-electrical steel is offset by use of greater quantity of steel and use of greater amount of copper which costs about 5 times more than steel.
- Contrary to what is generally believed, manufacture of more efficient motors will not lead to substantial increase in cost of active materials. A possible reason for this surprising finding could be that the motors may have been designed at some time in the past, and the quantity of active materials and other design aspects would have been determined based on the rates prevailing at that time. However, costs of metals have changed considerably over time, and copper prices particularly have shown a sharp upward trend, resulting in the present situation being markedly different.
- Thus the only costs that would be incurred by motor manufacturers would be the fixed costs for changes in equipment and fixtures, etc. apart from some relatively small increase in material costs for bearings, fan, etc. Being capital costs, these investments would be recoverable over an extended period of time and over the entire production volume, and hence would lead to only a small increase in the production cost of motors.

Efficiency Improvement Benefits, Motors < 15 kW

Efficiency level	Units	EFF 2(-)[1]	EFF 2[2]
Savings	%	0.5	1.67
Energy savings, first year	GWh/yr	27.7	92.6
Cost savings, first year	[3]Rs millions/yr	138	463
Cumulative energy savings, 10 years	GWh	1,618	5,409
NPV, cumulative cost savings, 10 years	Rs millions	5,420	18,110

[1] Conforming to EFF 2 levels but taking advantage of measurement tolerances

[2] Conforming to EFF 2 levels without considering measurement tolerances

3] 1 Euro = 60 Rupees

Recommendation for Minimum Energy Performance Standard (MEPS)

- Two options were considered for minimum energy performance standard for motors are EFF 2 with and without measurement tolerance
- The PPP for motors recommended that efficiency corresponding to EFF 2 level but without any lower tolerance be adopted as the minimum energy performance standard for motors.
- PPP in arriving at the recommendation for minimum energy performance standards considered the following:
  - Cost of materials for compliance would be marginal for both to EFF 2(-) MEPS level or EFF 2 MEPS levels.
  - The savings that would be realised for EFF 2 MEPS level are much greater than for EFF 2(-) MEPS levels.
  - The increase in savings would be greater than the increase in cost incurred by manufacturers for EFF 2 MEPS levels compared to EFF 2(-) MEPS. Thus, the ratio of benefits to costs would be higher.

BEE Technical committee meetings

- The question of efficiency levels, tolerances and testing standards developments at International Electro technical Commission (IEC) relating to upgrading IEC 34-2 part related to measurement of efficiency and the draft IEC standard 61972 (2002-11) were discussed in the BEE technical committees.
- Since India has 400 small motor manufacturers, it may not be feasible for immediate implementation as it involves different procedure and instruments of higher accuracy involving higher costs for setting up the test procedure.
- While the EFF 2 levels of efficiency without recourse to measurement tolerances would be a win - win situation from cost benefit analysis, apart from material changes, it would call for design changes, jigs, dies and tools which would require more time and costs.
- It was consciously decided that India will go ahead with EFF 2 levels for MEPS and adopt the earlier version of IEC 34-2 in the initial stages. That will allow manufacturers to get suitable equipments and experience with the new method.
- Indian manufacturers will have to carry out own R and D to find out real additional load losses on their own products and ways to reduce them. Indian manufacturers are mentally reconciling to the position that procedures similar to IEC 61972 will have to be followed in the long run if they have to compete.