PREMIUM EFFICIENCY MOTORS AND MARKET PENETRATION POLICY

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Abstract
This paper illustrates the induced enormous energy saving potential, permitted by using high-efficiency motors. Furthermore, the most important barriers to larger high-efficiency motors utilization are identified, and some incentives recommendations are given to overcome identified impediments. The authors consider that there is a strong case not only for putting in place obligatory level standards for the energy efficiency of electric motors and drives, but enhance incentives policies for larger market penetration. The US Energy Policy Act and the Canadian Energy Efficient Act, along with the implementation of NEMA Premium efficiency levels, have lead to North American leadership on motor efficiency implementation. Meanwhile North America is not on the leading edge for energy saving and conservation, motor efficiency is an exception that should be at least maintained.

Keywords: energy savings, high efficiency motors

I. ENERGY, CLIMATE CHANGE AND ELECTRICITY

According to last report intergovernmental Panel on Climate Change IPCC [1], the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. Moreover, nevertheless the e-mail scientists polemic, there is no doubt that discernible human influences now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes and wind patterns [1]. Stabilizing atmospheric carbon dioxide concentrations at twice the level of pre-industrial times is likely to require emissions reductions up to 90 % below current levels by 2100. Clearly, reductions of this magnitude can be achieved only by taking action globally and across all sectors of the economy. The electricity sector will undoubtedly need to assume a major share of the weight, according to its contribution to overall emissions.
According to [2, 3, 4…], industry accounts for more 40 % of the world 18 000 BkWh (billion kilowatt hours) electricity consumption. Within the industrial sector, motor driven systems account for approximately 60% to 65% of the electricity consumed by North American and European Union industries. Implementing high efficiency motor driven systems, or improving existing ones, could save up to 200 BkWh of electricity per year. This would significantly reduce the need for new power plants. It would also reduce the production of greenhouse gases and push down the total environmental cost of electricity generation.

The worldwide electric motors above 1 hp can be estimated to be more 300 million units. Typically, one-third of the electrical energy use in the commercial sector and two-thirds of the industrial sector feed the electrical motors. Moreover, the low voltage squirrel cage induction motor constitutes the industry workhorse. In particular industrial sector such as the Canadian petroleum and paper industry, the share of the energy used by electrical motors can reach 90%. Since induction motors are the largest electrical energy user, even small efficiency improvements will result in very large energy savings and contribute to reduce greenhouse gas emissions. Furthermore, the declining resources combined with environmental global warming concerns and with increasing energy prices make energy efficiency an imperative objective.

II. MEPS AND MOTOR CLASSIFICATION

There are many different worldwide definitions for energy efficient motors, as uuntil these last years, there was no consensus on what really represents an energy efficient motor. Technical barriers include non harmonized testing standards and efficiency classification. Recently 2008 international harmonized standard for efficiency classes IEC60034-30 can contribute to lowering barriers in high efficient motors generalization. The key mandatory instrument is minimum energy performance standards (MEPS).

On October 1992, US Congress voted law, Energy Policy Act EPAct, which mandates strict energy efficiency standards for electrical appliances and equipment, including electric motors. EPAct requires that the general purpose electric motors meet the higher nominal efficiency requirements defined in the table of National manufacturer association NEMA Standard, and the implementation of the motor MEPS went into effect in 1997. The Canadian Standard association developed a Canadian standard in 1993, and updated it in 1998. CAN/CSA C-390 set the requirement for minimum efficiency for new motors made or sold in Canada at the same value as the NEMA energy-efficient level.

In 2002, NEMA and Consortium for energy efficiency CEE established a voluntary NEMA Premium level of efficiency, and the manufacturers began the next step in evolution with the implementation on voluntary basis MEPS NEMA Premium efficiency motors. The evolution of MEPS based on NEMA Premium is now moving from voluntary basis to legislated regulation, as the law implementation is awaited on December 2010. Moreover, seven motor types (namely U-frame, Design C, footless, close-coupled pump, vertical solid shaft, eight poles, and motors with all low voltages) not previously covered are added .Later, a classification scheme was introduced that categorizes motors into three efficiency classes: premium efficiency (established since 2002 as voluntary program), EPAct (established in accordance with 1992 Energy Policy Act as mandatory program), and pre-EPAct (established as banned standard motors).

In Europe, the European committee of manufacturers of electrical machines and power electronics CEMEP has classified 2 & 4 pole 1-90 kW motors into three levels: high (EFF1), improved (EFF2), and standard efficiency (EFF3). The CEMEP classification has induced substantial EFF3 motors reduction and EFF2 market share promotion. Nevertheless, EFF1 market part is still modest. Meanwhile, European Union is considering prohibiting the sale of motors that don't meet EFF2 criteria in the near future.

BRIC countries (Brazil-Russia-India-China) motors and motor driven equipment are still relatively less efficient. For example, the efficiency of over 80 % Chinese motors is 2-5 % lower than international advanced ones. Chinese scientists consider that if efficiency of motor systems could be raised to the North American level, then 150 BKwh of electricity would be saved each year. But China is making progress, by formulating a number of policies, laws and regulations on energy conservation. Beginning this 2010 year, the efficiency of newly added motors should reach international first-rate level.

Newly 2008 harmonized standard for energy efficiency class 60034-30-2008 follow International electro technical commission protocol IEC and defines four induction motor efficiency classes:

- Super Premium efficiency IE4
- Premium efficiency IE3
- High efficiency IE2
- Standard efficiency IE1

It's manifest that, nowadays, Premium efficiency IE3 is the most efficient motor. Super Premium efficiency IE4 is a future new generation motor. It is awaited that in average, the losses reduction of IE4 should be 15 % compared to IE3.

Efficiency Class	IEC	USA/Canada	CEMEP	China
Super Premium efficiency	IE4	-	-	-
Premium efficiency	IE3	NEMA Premium	-	-
High efficiency	IE2	EPAct	EFF1	Class 1
Standard efficiency	IE1	-	EFF2	Class 2
Below standard efficiency	-	-	EFF3	Class 2

III. LIFE CYCLE COST PREMIUM MOTORS

An electric motor is somewhat cheap to buy, but expensive to run. A 3 hp Premium efficiency motor functioning 6 000 hours per year consumes about 1000 $ of electricity at $0.07/kWh. The purchase price for such a motor is about 500 $ and over the motor's 15-year life, the acquisition price represents only 3 % of the lifetime costs, while the cost of electricity accounts for 97 %. Finally, a 2 % increase in Premium motor efficiency over EFF1 translates in energy savings over that time nearly twice the cost difference. In addition, with a larger motor, the saving potential will be larger, and therefore payback periods would be shortened. In the 100 Hp motor case, the acquisition price represents only 1 % of the lifetime costs, while the cost of electricity accounts for 99 %!!!

The average life cycle of the small power motors is of the order of 15 years, i.e. the equivalent of the an average car range. The fundamental difference is in the fact that during this period, the cost of the electricity will represent 97 % of the cost of useful life cycle of the electric motor, while for the car motor, it represents only 10 %. Moreover, the car's internal combustion motors can rarely overcome 50 % efficiency, with an enormous negative impact to be paid in environmental pollution. We can deduct from this fact that the improvement of 1 % of the motor efficiency will have the same impact as the reduction of the 10 % gas consumption car.

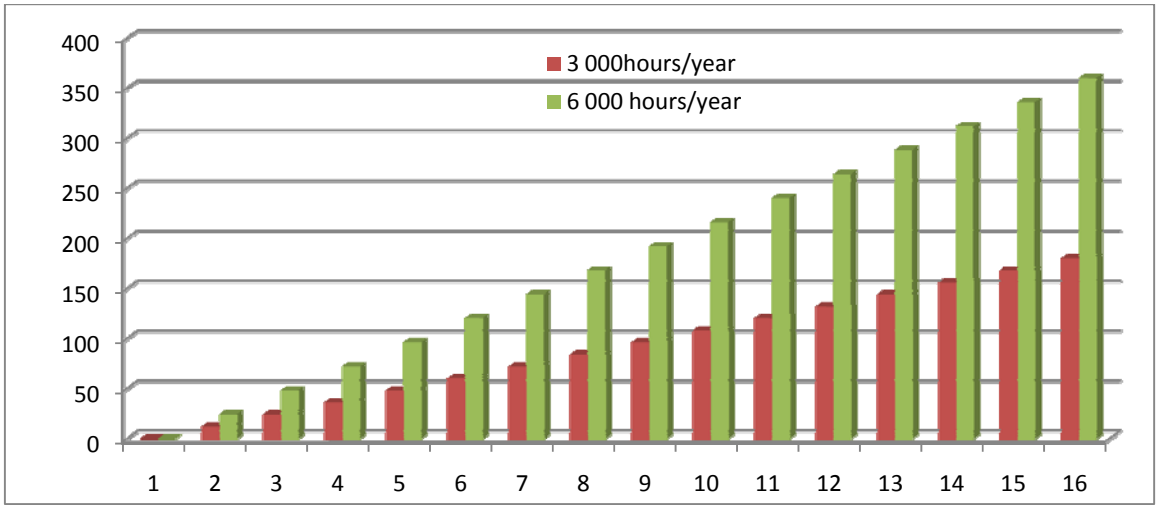

Fig.1. saving in energy costs in $

Moreover, the Canadian electricity costs are presently up two times cheaper than elsewhere, and high electricity prices reduce payback period. In addition, some Canadian utility companies and public agencies like Hydro Québec in Québec offer rebate programs to encourage customers to upgrade their standard motors to Premium efficiency. For motors from 1 to 75 hp, this program allows 600 $/hp to the customer and 150 $/hp to the distributor for each saved hp. Unfortunately, as a consequence of the lack of energy saving importance, the purchase of a new motor, as well as the rewinding of defective standard-efficiency motors, the choice of the motor is often driven by short term investment considerations, not on the cost of the electricity which can be saved.

The first law for energy efficient motors is the Energy Policy Act (EPAct) which mandates strict energy efficiency standards for electrical appliances and equipment. This law was first adopted in USA and became effective in Canada with the adoption of Standard CAN/CSA-C390-98. Today more than 75 % of the motors sold in North America are Premium efficiency and EPAct machines. This clearly indicates the positive effect of the energy law. In light of the above, and taking into consideration the very slow market transformation with just voluntary incentive, it's time to go ahead by promoting Premium efficiency motors as standard as soon as possible. There is no doubt that the appropriate legislation is the

best way of achieving that goal. Only the latest energy efficient motor technologies should be manufactured and used. In general terms, North America is not on the leading edge for energy saving and conservation. Motor efficiency is an exception that should be at least maintained.

IV. BARRIERS TO HIGH EFFICIENCY MOTORS MARKET PENETRATION

Despite the colossal energy saving potential and financial incentives programs, many companies are still reticent to invest in energy-efficiency motors and drive equipments. The reasons why the well-known potential for energy saving energy is not exploited have been investigated, and the authors have identified the reasons why this potential is not yet fully exploited [21]. The Grand paradox is that cost effective measures are not taken because of several no logical barriers. So, the most important barriers to high efficiency motors promotion are:

- The energy costs are relatively so small that energy efficiency improvement isn't taken into consideration,
- Lower priority of energy savings importance, when other factors such as availability service, reliability, and first costs are of premium importance,
- Industry reluctance to change what, a priori, is a good functioning system,
- Doubt about success of energy efficiency programs, or the discount rates used to justify energy efficiency programs are too low,
- Downtime replacement cost look like peanuts, but shutdown time to install new equipment is expensive, and many companies don't support this inconvenient,
- Reduced budget often makes reducing energy consumption as « poor parent », inducing a lack of encouragement to make a decision,
- Implementing making-decision responsibility is often shared, with many internal conflicting pressures and divergence, and ultimate choice don't always belongs engineers, who are energy savings aware.
- Distributors regularly represent two or more motor manufacturers and they can advantage products from the manufacturer that offers the highest discount rather than high-efficiency ones,
- Usual predisposition to use stocked old motors rather than purchase high efficiency ones,
- It is not economically pragmatic to change a motor until it fails,
- Penchant to have the failed motor repaired rather than replaced by high efficiency ones,
- Degradation efficiency of repaired motor cannot be simply illustrated,
- Annual running hours are not sufficiently high to induce satisfactory payback,
- In addition, some companies invoke specific barriers like harmonic generation, induced earlier insulation and bearing failure, complicated...

V. INCENTIVE POLICIES TO OVERCOME BARRIERS

Experience of many energy saving initiatives around the world shows that the most successful programs are based on a combination of technical and promotional information, educational tools and financial incentives. If technicians & engineers would be trained in system design integration and least lifecycle cost as a goal, no doubt that the problem of inefficient industrial equipment should be solved.

Consequently, to overcome the identified obstacles need a combination of the following measures:

- Premium priority: For the companies, the energy saving status has to arrive at legislative endorsement, like is the case for safety, and quality insurance
- Incentive programs: to reinforce energy savings promotion politics, much higher discount rates should be used to evaluate the cost-effectiveness of energy efficiency policies, programs or measures. Effective rebates are the most effective way to improve the penetration of energy efficient motors

- Highlighted information and diffusion: this information must be of practical value, and sufficiently demonstrative with real pilot projects
- Environmental concern: It's necessary to reinforce ecological policy criteria and support environmental friendly companies. This follows the principle that the saved energy is the most environmentally friendly one. A particularly promising concept is the emissions trading scheme, which could be enable companies to claim emissions credits for investments that reduce energy consumption
- Legislation: to legislate against recalcitrant, as it's time to impose to market the approach of the « carrot and the stick », where the carrot represents the incentives, and the stick stands for refractory.

The authors strongly believe in the need to enhance policy measures aimed at reducing the demand for energy and the resultant environmental impact. We therefore welcome the increased interest in energy conservation in Canada. The accumulated experience clearly show that putting in place obligatory level standards for the energy efficiency of electric motors is not sufficient, as it is mandatory to enhance incentives policies for market penetration. The carbon savings from this measure have the potential to make a significant contribution to Canadian emissions target reduction.

VI. CONCLUSION

In the future sustainable energy mix, a key role will be reserved for electricity, as GHG emissions reduction in this sector has to be drastically reduced. In this option, obvious conclusion is that large market penetration Premium motors needs a complex approach with a combination of financial incentives and mandatory legal actions, as industry doesn't invest according to least life cycle costs.
The US Energy Policy Act and the Canadian Energy Efficient Act, along with the implementation of NEMA Premium efficiency levels, have lead to North American leadership on motor efficiency implementation. In general terms, North America is not on the leading edge for energy saving and conservation. Motor efficiency is an exception that should be at least maintained.

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