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SPECIFICATION OF ENERGY CONSUMPTION AND ENERGY LABELING OF SINGLE PHASE ELECTRICAL MOTORS

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Abstract- In this paper energy efficiency and energy labeling in single phase electromotor is illustrated. Residential sector consume about 40% of electricity can be produced from power plant. The estimates show that more than 50 percent from of residential sector is allocated to single phase electromotors. Nowadays, home appliances such as washing machines, evaporative cooler, gas cooler, chillers are the significant part of electricity consumption in the residential and commercial sector. Based on law that approved by parliament, the government must be reduced energy intensity in home sector, so that energy labeling in home appliances are defined. In this paper, we concentrate on the most important devices that have very influence in electrical consumption. The single phase electromotors are the essential part of home appliances. We define energy labeling and minimum energy performance in these electromotor and divided electromotrs by application.

Keywords: Single Phase, Electromotors, Energy Labeling, Energy Efficiency, Standard.

I. INTRODUCTION

Figure 1 shows that energy saving strategy in OECD country. As can be seen, the most important home appliances such as dish washers, cooling system, washing machines have single phase eletromotors, approaching to high efficient home appliances; it is possible by consideration using high efficient electromotor. So that single phase electromotor marked by every company. In Iran, energy labeling is endorsement for product and every company has to install energy labeling. Energy labeling for single phase electromotor by application is the first time is define in the world.

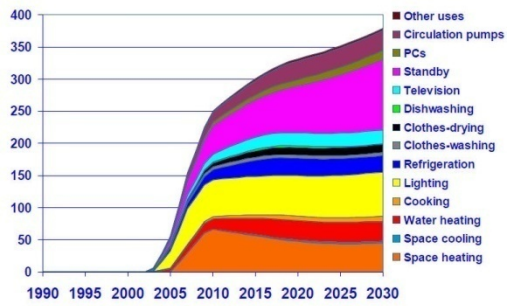

Figure 1. Important saving potential for all end uses, e.g. OECD Europe

II. OBJECTIVE AND SCOPE

This paper illustrates minimum energy performance and energy labeling in single phase electromotors by application. For each power output and application energy ranking is defined. Standard of single phase induction electric motors uses four categories according to the classification subclass descriptions are:

A. Squirrel cage rotor induction motors used in automatic washing machines with a nominal output power far greater than or equal spicy 40 W;

B. Fan motors include shaded pole nominal output power 2 W to 70 W (two poles and four poles) and the broken phase with nominal output power up to 5-200 W;

C. Cooler engines with nominal output power 70 W to 700 W (1/8 hp to 3/4 hp);

D. Industrial engines polarization (0.09 kW to 2.2 kW), four poles (0.06 kW to 2.2 kW) and six poles (0.12 kW to 0.75 kW).

The following electro scope of this standard are:

1. Fan coil electro
2. Electro torch
3. Electro circulation pump
4. Electro gas cooler
5. Universal electro
6. Electro pumps water (coolers and washing)
7. Electro semi-automatic washing machine

III. TERMS AND DEFINITIONS

In addition to this standard definitions and terminology in the Iranian National Standard No. 3772-1, the following words and expressions are used:

- Electric nominal values:

Nominal amounts of electric current and voltage contain nominal, rate(s) nominal, nominal power output and other profile (according to the Iranian National Standard No. 1-3772) for the conditions specified by the manufacturer to determine and work on electric profile plug is inserted.

- Times nominal:

It consist of maximum load specified for electric causes electric nominal 04/0 profile in their work.

- Energy efficiency:

Term nominal yields a ratio of electric power to the total nominal output is the input power is expressed in terms of percentage.

- Power factor:

An alternating current electric power factor is simply the ratio of nominal output power (kW) Nominal apparent power output (kVA).

- Nominal speed:

Nominal rate of speed electromotor electromotore include under voltage, frequency and its nominal power.

- Electric four categories:

The standard criteria to determine the single phase induction electric motors energy consumption, according to their applications in industry and public use into four categories washing machine electro, electro technology, industrial electro cooler and are classified. Energy labels for each of these categories are defined separately. In Table 1 the nominal electric power output range, according to the classification specified.

Table 1. Classification of single phase electromotor based on output power and application

Cooler electro	Industrial electro			Fan electro		Electro semi-automatic washing machine (high speed)
	6 poles	4 poles	2 poles	Split phase	Shaded pole (2&4 poles)	
$70 \leq p \leq 700$	$120 \leq p \leq 750$	$60 \leq p \leq 2200$	$90 \leq p \leq 2200$	$5 \leq p \leq 200$	$2 \leq p \leq 70$	$p \geq 40$

IV. CRITERIA AND SPECIFICATIONS OF ENERGY CONSUMPTION AND LABEL ENERGY EFFICIENCY

The standard input output method is used to determine efficiency. Under this method, electric dynamometer under load by the nominal voltage is placed. Dynamometer, according to the nominal electric power output (which is determined by the manufacturer) is set so that the output equivalent to the electric load is applied. In this case the input power is measured by appropriate measuring devices.

Energy efficiency is simply the ratio of nominal output power (declared by the manufacturer in electro plate profile) to the input power (which is assisted dynamometer measurements). Energy efficiency is expressed in terms of percentage.

$$\eta\% = \frac{P_2}{P_1} \times 100 \quad (1)$$

Classification based on single phase induction motors energy efficiency energy efficiency achieved for each of four categories determined by the electro single phase (Table 1) is performed as follows:

Note carefully measuring instruments in accordance with Iran's national standard number is 3772-1.

A. Classification of Washing Machines Electromotors

Efficiency of these electromotors have three options, the first is the average energy efficiency in the low and high speed and the second only in high speed and finally in low speed can be measured. Energy ranking is from A (highest yields) to E (lowest efficiency) (Tables 2-4).

Table 2. The first classification of washing machines electro motors based on efficiency for low and high speed

Energy ranking (%)					Output power (W)
E	D	C	B	A	
$18 \leq \eta < 21$	$21 \leq \eta < 24$	$24 \leq \eta < 27$	$27 \leq \eta < 30$	$30 \geq \eta$	$40 \leq p \leq 100$
$19 \leq \eta < 22$	$22 \leq \eta < 25$	$25 \leq \eta < 28$	$28 \leq \eta < 31$	$31 \geq \eta$	$100 < p \leq 160$
$27 \leq \eta < 30$	$30 \leq \eta < 33$	$33 \leq \eta < 36$	$36 \leq \eta < 39$	$39 \geq \eta$	$160 < p \leq 220$
$30 \leq \eta < 33$	$33 \leq \eta < 36$	$36 \leq \eta < 39$	$39 \leq \eta < 42$	$42 \geq \eta$	$220 < p \leq 280$
$31 \leq \eta < 34$	$34 \leq \eta < 37$	$37 \leq \eta < 40$	$40 \leq \eta < 43$	$43 \geq \eta$	$280 < p \leq 340$
$32 \leq \eta < 35$	$35 \leq \eta < 38$	$38 \leq \eta < 41$	$41 \leq \eta < 44$	$44 \geq \eta$	$340 < p \leq 400$
$33 \leq \eta < 36$	$36 \leq \eta < 39$	$39 \leq \eta < 42$	$42 \leq \eta < 45$	$45 \geq \eta$	$p > 400$

Table 3. The second classification of washing machines electro motors based on efficiency for high speed

Energy ranking (%)					Output power (W)
E	D	C	B	A	
$25 \leq \eta < 28$	$28 \leq \eta < 31$	$31 \leq \eta < 34$	$34 \leq \eta < 37$	$37 \leq \eta$	$40 \leq p \leq 100$
$26 \leq \eta < 29$	$29 \leq \eta < 32$	$32 \leq \eta < 35$	$35 \leq \eta < 38$	$38 \leq \eta$	$100 < p \leq 160$
$41 \leq \eta < 44$	$44 \leq \eta < 47$	$47 \leq \eta < 50$	$50 \leq \eta < 53$	$53 \leq \eta$	$160 < p \leq 220$
$42 \leq \eta < 45$	$45 \leq \eta < 48$	$48 \leq \eta < 51$	$51 \leq \eta < 54$	$54 \leq \eta$	$220 < p \leq 280$
$43 \leq \eta < 46$	$46 \leq \eta < 49$	$49 \leq \eta < 52$	$52 \leq \eta < 55$	$55 \leq \eta$	$280 < p \leq 340$
$44 \leq \eta < 47$	$47 \leq \eta < 50$	$50 \leq \eta < 53$	$53 \leq \eta < 56$	$56 \leq \eta$	$340 < p \leq 400$
$45 \leq \eta < 48$	$48 \leq \eta < 51$	$51 \leq \eta < 54$	$54 \leq \eta < 57$	$57 \leq \eta$	$400 < p$

Table 4. The third classification of washing machines electro motors based on efficiency for low speed

Energy ranking (%)					Output power (W)
E	D	C	B	A	
$14 \leq \eta < 16$	$16 \leq \eta < 18$	$18 \leq \eta < 20$	$20 \leq \eta < 22$	$22 \leq \eta$	$40 \leq p \leq 100$
$16 \leq \eta < 18$	$18 \leq \eta < 20$	$20 \leq \eta < 22$	$22 \leq \eta < 24$	$24 \leq \eta$	$100 < p \leq 160$
$20 \leq \eta < 22$	$22 \leq \eta < 24$	$24 \leq \eta < 26$	$26 \leq \eta < 28$	$28 \leq \eta$	$160 < p \leq 220$
$21 \leq \eta < 23$	$23 \leq \eta < 25$	$25 \leq \eta < 27$	$27 \leq \eta < 29$	$29 \leq \eta$	$220 < p \leq 280$
$22 \leq \eta < 24$	$24 \leq \eta < 26$	$26 \leq \eta < 28$	$28 \leq \eta < 30$	$30 \leq \eta$	$280 < p \leq 340$
$23 \leq \eta < 25$	$25 \leq \eta < 27$	$27 \leq \eta < 29$	$29 \leq \eta < 31$	$31 \leq \eta$	$340 < p \leq 400$
$24 \leq \eta < 26$	$26 \leq \eta < 28$	$28 \leq \eta < 30$	$30 \leq \eta < 32$	$32 \leq \eta$	$400 < p$

B. Classification of Fans Electrometers

Electro technology for home use, commercial and industrial fans are used on. These generally two types of electric poles and split phase are broken according to those who have different energy efficiencies. Electro technology based on energy efficiency) η (is calculated according to Tables 5 and 6 are grouped the Energy Efficiency from A (highest yields) to E (lowest efficiency).

Table 5. Classification of fans electromotor, shaded pole, 2 and 4 poles

Energy ranking (%)					Output power (W)
E	D	C	B	A	
$9 \leq \eta < 11$	$11 \leq \eta < 13$	$13 \leq \eta < 15$	$15 \leq \eta < 17$	$17 \leq \eta$	$2 \leq p \leq 5$
$12 \leq \eta < 14$	$14 \leq \eta < 16$	$16 \leq \eta < 18$	$18 \leq \eta < 20$	$20 \leq \eta$	$5 < p \leq 10$
$18 \leq \eta < 20$	$20 \leq \eta < 22$	$22 \leq \eta < 24$	$24 \leq \eta < 26$	$26 \leq \eta$	$10 < p \leq 20$
$27 \leq \eta < 29$	$29 \leq \eta < 31$	$31 \leq \eta < 33$	$33 \leq \eta < 35$	$35 \leq \eta$	$20 < p \leq 30$
$30 \leq \eta < 34$	$34 \leq \eta < 38$	$38 \leq \eta < 42$	$42 \leq \eta < 45$	$45 \leq \eta$	$30 < p \leq 70$

Table 6. Classification of fan electrometers-split phase

Energy ranking (%)					Output power (W)
E	D	C	B	A	
$43 \le \eta < 46$	$46 \le \eta < 49$	$49 \le \eta < 52$	$52 \le \eta < 55$	$55 \le \eta$	$5 \le p \le 200$

C. Classification of Industrial Electrometers

Electro industrial centers generally used in commercial and industrial accommodation. Grouping efficiency for energy, industrial electro according to their nominal power output and the number of terminals are classified into three categories .Industrial motors based on energy efficiency) η (is calculated, are grouped according to Table 7 as the Energy Efficiency A (highest yields) to E (lowest efficiency).

Table 7. Classification of industrial electro motors (2 poles)

Energy ranking (%)					Nominal power (kW)
E	D	C	B	A	
$45 \le \eta < 49$	$49 \le \eta < 53$	$53 \le \eta < 57$	$57 \le \eta < 61$	$61 \le \eta$	0.09
$48 \le \eta < 52$	$52 \le \eta < 56$	$56 \le \eta < 60$	$60 \le \eta < 64$	$64 \le \eta$	0.12
$51 \le \eta < 55$	$55 \le \eta < 59$	$59 \le \eta < 63$	$63 \le \eta < 67$	$67 \le \eta$	0.18
$54 \le \eta < 58$	$58 \le \eta < 62$	$62 \le \eta < 66$	$66 \le \eta < 70$	$70 \le \eta$	0.25
$57 \le \eta < 61$	$61 \le \eta < 65$	$65 \le \eta < 69$	$69 \le \eta < 73$	$73 \le \eta$	0.37
$60 \le \eta < 64$	$64 \le \eta < 68$	$68 \le \eta < 72$	$72 \le \eta < 76$	$76 \le \eta$	0.55
$61 \le \eta < 63$	$63 \le \eta < 69$	$69 \le \eta < 73$	$73 \le \eta < 77$	$77 \le \eta$	0.75
$63 \le \eta < 67$	$67 \le \eta < 71$	$71 \le \eta < 75$	$75 \le \eta < 79$	$79 \le \eta$	1.1
$66 \le \eta < 70$	$70 \le \eta < 74$	$74 \le \eta < 78$	$78 \le \eta < 82$	$82 \le \eta$	1.5
$69 \le \eta < 73$	$73 \le \eta < 77$	$77 \le \eta < 81$	$81 \le \eta < 85$	$85 \le \eta$	2.2

Table 8. Classification of industrial electro motor (4 poles)

Energy ranking (%)					Nominal power (W)
E	D	C	B	A	
$31 \le \eta < 35$	$35 \le \eta < 39$	$39 \le \eta < 43$	$43 \le \eta < 47$	$47 \le \eta$	0.06
$34 \le \eta < 38$	$38 \le \eta < 42$	$42 \le \eta < 46$	$46 \le \eta < 50$	$50 \le \eta$	0.09
$41 \le \eta < 45$	$45 \le \eta < 49$	$49 \le \eta < 53$	$53 \le \eta < 57$	$57 \le \eta$	0.12
$48 \le \eta < 52$	$52 \le \eta < 56$	$56 \le \eta < 60$	$60 \le \eta < 64$	$64 \le \eta$	0.18
$51 \le \eta < 55$	$55 \le \eta < 59$	$59 \le \eta < 63$	$63 \le \eta < 67$	$67 \le \eta$	0.25
$53 \le \eta < 57$	$57 \le \eta < 61$	$61 \le \eta < 65$	$65 \le \eta < 69$	$69 \le \eta$	0.37
$56 \le \eta < 60$	$60 \le \eta < 64$	$64 \le \eta < 68$	$68 \le \eta < 72$	$72 \le \eta$	0.55
$59 \le \eta < 63$	$63 \le \eta < 67$	$67 \le \eta < 71$	$71 \le \eta < 75$	$75 \le \eta$	0.75
$64 \le \eta < 68$	$68 \le \eta < 72$	$72 \le \eta < 76$	$76 \le \eta < 80$	$80 \le \eta$	1.1
$66 \le \eta < 70$	$70 \le \eta < 74$	$74 \le \eta < 78$	$78 \le \eta < 82$	$82 \le \eta$	1.5
$67 \le \eta < 71$	$71 \le \eta < 75$	$75 \le \eta < 79$	$79 \le \eta < 83$	$83 \le \eta$	2.2

Table 9. Classification of industrial electro motor (6 poles)

Energy ranking (%)					Nominal power (W)
E	D	C	B	A	
$41 \le \eta < 45$	$45 \le \eta < 49$	$49 \le \eta < 53$	$53 \le \eta < 57$	$57 \le \eta$	0.12
$48 \le \eta < 52$	$52 \le \eta < 56$	$56 \le \eta < 60$	$60 \le \eta < 64$	$64 \le \eta$	0.18
$51 \le \eta < 55$	$55 \le \eta < 59$	$59 \le \eta < 63$	$63 \le \eta < 67$	$67 \le \eta$	0.25
$53 \le \eta < 57$	$57 \le \eta < 61$	$61 \le \eta < 65$	$65 \le \eta < 69$	$69 \le \eta$	0.37
$56 \le \eta < 60$	$60 \le \eta < 64$	$64 \le \eta < 68$	$68 \le \eta < 72$	$72 \le \eta$	0.55
$59 \le \eta < 63$	$63 \le \eta < 67$	$67 \le \eta < 71$	$71 \le \eta < 75$	$75 \le \eta$	0.75

D. Classification of Evaporative Cooler Electromotors

Two-speed electromotors are generally cooler. Classified according to their efficiency these engines take place at high speed.

Note - Cooler engines efficiency in terms of low rate coefficient (K) of the nominal yield is considered high speed. The coefficient value will be obtained According to experimental results, coefficient K for the two-speed electro changed using the poles with 0.72 and the split winding method are using the equivalent of 0.6 is considered

Two-speed electro cooler their high speed based on energy efficiency), η (are grouped according to Table 10. For single-speed electro cooler, three percent is added to the Table 10 values (Table 11) according to energy efficiency classification of A (highest yields) to E (lowest efficiency).

Table 10. Classification of evaporative cooler electro motors (two-speed)

Energy ranking (%)					Output power	
E	D	C	B	A	(W)	(hp)
$30 \le \eta < 35$	$35 \le \eta < 40$	$40 \le \eta < 45$	$45 \le \eta < 50$	$50 \le \eta$	$70 \le p \le 100$	1/8
$33 \le \eta < 38$	$38 \le \eta < 43$	$43 \le \eta < 48$	$48 \le \eta < 52$	$52 \le \eta$	$100 < p \le 180$	1/6
$36 \le \eta < 42$	$42 \le \eta < 47$	$47 \le \eta < 52$	$52 \le \eta < 57$	$57 \le \eta$	$180 < p \le 230$	1/4
$48 \le \eta < 51$	$51 \le \eta < 55$	$55 \le \eta < 60$	$60 \le \eta < 65$	$65 \le \eta$	$230 < p \le 320$	1/3
$48 \le \eta < 51$	$51 \le \eta < 55$	$55 \le \eta < 60$	$60 \le \eta < 65$	$69 \le \eta$	$320 < p \le 500$	1/2
$53 \le \eta < 58$	$58 \le \eta < 63$	$63 \le \eta < 68$	$68 \le \eta < 73$	$73 \le \eta$	$500 \le p \le 700$	3/4

Table 11. Classification of evaporative cooler electro motors (one-speed)

Energy ranking (%)					output power	
E	D	C	B	A	(W)	(hp)
$30.9 \le \eta < 36$	$36 \le \eta < 41.2$	$41.2 \le \eta < 46.3$	$46.3 \le \eta < 51.5$	$51.5 \le \eta$	$70 \le p \le 100$	1/8
$33.9 \le \eta < 39.1$	$39.1 \le \eta < 44.2$	$44.2 \le \eta < 49.4$	$49.4 \le \eta < 53.5$	$53.5 \le \eta$	$100 < p \le 180$	1/6
$37 \le \eta < 43.2$	$48.4 \le \eta < 53.5$	$48.4 \le \eta < 53.5$	$53.5 \le \eta < 58.7$	$58.7 \le \eta$	$180 < p \le 230$	1/4
$49.4 \le \eta < 52.5$	$52.5 \le \eta < 56.6$	$56.6 \le \eta < 61.8$	$61.8 \le \eta < 66.9$	$66.9 \le \eta$	$230 < p \le 320$	1/3
$50.4 \le \eta < 55.6$	$55.6 \le \eta < 60.7$	$60.7 \le \eta < 65.9$	$65.9 \le \eta < 71$	$71 \le \eta$	$320 < p \le 500$	1/2
$54.5 \le \eta < 59.7$	$59.7 \le \eta < 64.8$	$64.8 \le \eta < 70$	$70 \le \eta < 75.1$	$75.1 \le \eta$	$500 \le p \le 700$	3/4

Energy labels, sheet containing information on standards and technical specifications on each product are energy. Also in the energy label single phase induction electric motors, electric energy efficiency criteria in the accepted standard is to compare (form 1 to 8 refer).

Single phase induction electric motors in the energy label should be placed on it or is attached. Tags should be easily visible. Items contained in the label Must meet the following 1 to 8 depending on the application of single phase induction electric motors energy label is inserted:

1. Energy Standard Mark (the mark only for electro production is used domestically, and not on imported electro energy labels to be inserted);
2. The term "electric energy consumption labels" (in the dotted type, such as electric washing machines, industrial, fan or air conditioner is mentioned);
3. Energy efficiency;
4. W output power nominal terms or kW;

5. Nominal power factor;
6. Nominal high and low speed on multi-speed motors (depending on RPM);
7. Numeric value in energy efficiency and nominal power output for multi-speed electro high level of energy efficiency and lower the nominal rate;
8. Name of the manufacturer or trademark;
9. Model name or attribute type;
10. The phrase "in accordance with National Standards No. 7874".

V. CONCLUSIONS

It is conclude that, improving energy efficiency in single phase electromors have directly relationship with home appliances, if we improve only one grade of local product. The estimates show that 1000 MW in power installation can be reduces. The cost for 1 kW including generation, transmission and distribution is 1500 U$ in Iran based on thermal power plant. So that energy saving particularly in single phase electromotors is the biggest power plant and world can be saved.

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BIOGRAPHY

Reza Effatnejad is the Ph.D. in electrical engineering. Power and energy is the field of his study. Labeling in home appliances was the first of his activity. He is an expert in energy auditing in industry. He is an assistant professor of Electrical Engineering Department in Islamic Azad University, Karaj Branch, Iran. He has carried out a number of research projects and has published over 40 international scientific papers and three books in thefields of Energy Management, Energy Efficiency, Energy Conservation in Industry and Building Sectors, Combined Heat and Power (CHP) and Renewable Energy.