Energy Conservation

In Consumer Applications Through Fractional Horse Power Motors Driven by Electronic Controls

Electric motor is the workhorse of prime moving in industries and in household applications for over a decade. DC motors, Induction motors and Universal motors have been mainly used for various applications. These classic motors developed before the advent of electronics are designed to operate at constant-speed directly from readily available, utility main AC power usually with relatively little regard towards efficiency.

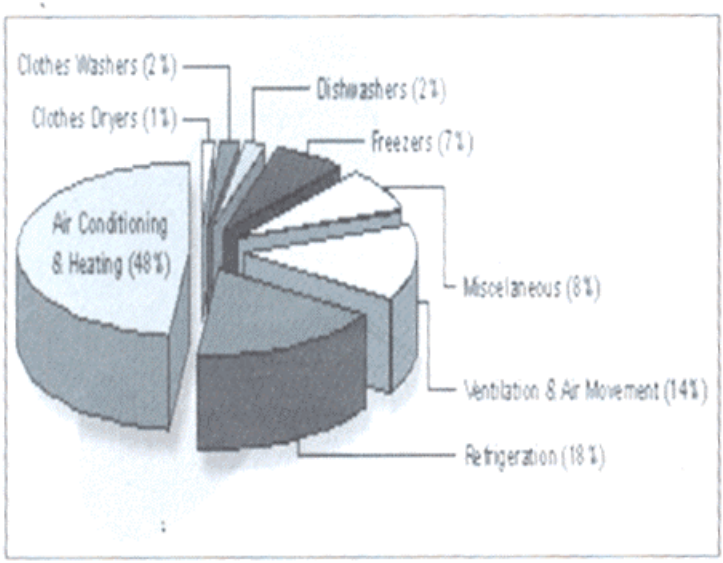

Fig 1: US Household Motor Energy Consumption (courtesy "Xtreme energy" website)

The single-phase induction motors drive most of these applications. This efficiency of these motors depending on the rating, could be, lowest 25% (table fans, ceiling fans, small exhaust fans, a/c blower motors etc) to highest 65% (pumps, blower motors in larger air-conditioners etc). The volume of such motors used in each country is very huge. Therefore even if a small improvement in the efficiency of the motors driving these applications is effected, it will have a large impact on the energy it can save. The Fig 1 shows how motors in various applications in US consume the electric energy. This consumption pattern would be similar almost in every country. The chart shows that the maximum energy consumer is in HVAC (66%) and general air moving applications 14%. As mentioned earlier in these applications single-phase induction motors are used.

Industry has long desired adjustable-speed drives (ASDs) to improve its products and processes, and has understood that large potential energy-savings and superior process control is available if ASDs are used instead of constant-speed motors. However, the lack of an easy, practical way to vary the supply voltage or frequency being applied to an electric motor in order to control its speed limited the use of ASDs through the first 60 years of the 20th century. Even after more reliable, less expensive transistorized EMDs (Electronic Motor Drives) began to spread throughout industry in the 1980s, the large investment already made in constant-speed product and process designs, the inertia inherent in many traditional industries, and the sensitivity to price and reliability inherent in high-volume consumer applications served to hold back the widespread use of EMDs in household appliance applications well into the 1990s.

During the later half of the last century there has been lot of concern about the depletion of fossil fuel, global warming and need for energy conservation. This has lead to movements around the world for energy conservation. One of the largest consumers of energy is “electric motor” and that too single-phase induction motors, used in household appliances. Energy efficiency improvements in prime movers of these applications can lead to high-energy saving/conservation. The potential is much huger if ASDs are used in all such applications mentioned above. For a country like India where the consumerism is growing at a high speed there is a huge potential for using ASDs in various applications for saving energy and bringing down the burden on national and state governments on spending on power generation.

Since the 1990s, the industry has been increasingly impacted by government regulations mandating greater energy-efficiency and reduced environmental emissions (eg. EMI/ RFI, harmonics) and by heightened consumer demands for lower energy costs, betters performance, reduced acoustic noise and more convenience features. Most, if not all, of these requirements, as it turns out can be met by the use of electronically driven motors. This has lead to development of various newer types of electronically controlled motors of which the most promising have been the following.

- DC brushless drive (BLDC),

Table I

Drive	% η	Control	Noise	Tq / Wt
BLDC	Highest	Simple Voltage control	Lowest	Highest
SRM	Medium	Simple Voltage control	Highest	Medium
CIM/ AC VFD	Lowest	Involved v/f control	Medium	Lowest

- Switched Reluctance Drive (SRM).
- Controlled Induction Motor (CIM) or ac variable frequency drive (AC VFD).

The table I give in brief, the comparative features of each of these drives.
Currently, appliance manufacturers in Europe, Japan and Asia are favoring the use of BLDC motors for refrigerator and air-conditioner compressor because of their higher efficiency (in comparison to AC induction motors) and their lower motor and EMD costs (in comparison to PMAC motors and drives). In Japan, BLDC inverter drives are displacing AC VFD for air-conditioner compressor applications as well.

In clothes washer applications, PMAC drive are being favored for frontloading drum applications in Europe and in Japan for their better low-speed direct-drive performance, although AC VFD vector control drives are in the running. In North America both SR and BLDC drives are being used in frontloading washers.

Another potential problem of using ASDs is that it pollutes the power quality by introducing harmonics in to the power system. ASD manufacturers in Japan and the west take this into account while deciding the application.

A clear trend is emerging in today’s major appliance industry for lower energy, high efficiency motors. Electronically driven motors, the majority of which will be of the BLDC type will soon replace constant-speed single-phase induction motor and variable-speed universal motor drive designs.

The motor technology in India, realising the potential benefits should soon move towards the energy efficient electronic motors at a faster pace.

Reference Book:
IEEMA Journal (Energy Conservation Week 14-21 Dec., 2004)
Energy Conservation Special Issue