DESIGN OF ELEVATOR FOR ENERGY SAVING

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ABSTRACT
It has proved that the saving of electrical energy is much more economical than generating the same energy. If this principle is extended to the elevator field in India where, more than 60,000 elevators are running, with the addition of 10,000 every year the energy saving; even if achieved as a small percentage can be quite substantial.

0. INTRODUCTION

Energy saving can be obtained by:

1. By designing elevators from an energy saving point of view and by using the latest energy saving techniques and devices.

2. By effective and efficient maintenance of elevators to maintain smooth running and by avoiding unnecessary increased friction in moving parts.

3. By proper operational management i.e. by avoiding under utilisation of elevator capacity, such as empty trips in both or either direction, etc.

To calculate the energy saving and to design energy efficient elevators it is necessary to identify, the major energy consuming equipment in elevators as mentioned below:

a. Driving motor.
b. Main contactors
c. Electromagnetic brake.
d. Retiring camp.
e. Auxiliary relays such as floor relays.
f. Transformer.

Let us study these one by one.

1. DRIVING MOTOR

Here we have to study energy consumption during starting and running separately. During starting the current is 4 to 5 times the full load current, but the duration is very small i.e. let us say 0.5 s (10 cycles) for a number of starts of say 20 per hour and a full load current of 7 A for 3.75 kilowatts.

The energy saving can be achieved by limiting the starting current to a minimum level preferably equal to full load quantum. Nowadays this is possible by using latest electronic technology of soft start, soft stop and variable frequency and variable voltage control for A.C. induction motors. This method gives a saving to the extent of 35 % with the additional advantage of better ride comfort for the passengers.

Other considerations for reducing energy consumption can be indicated such as the use of high torque motors instead of a high capacity motor and using power factor improvement techniques.

2. ELECTROMAGNETIC BRAKE

The electromagnetic brake consumes energy in the pulling force requirement for opening the brake. This requires energy to the extent of (0.4 X 110 V) 44 watts. This energy consumption is found to be reduced by 5% if the gap between the liner and the brake drum is uniform and as small as possible. This can be achieved by precise mechanical design with CNC (Computer Numerical Control) machines. Also by using dynamic braking the energy consumption can be reduced.

3. MAIN CONTACTORS

The main contactor consumes 8.5 VA for each operating coil. This consumption of 17 VA for two contactors (out of three, two contactors will always be in operation under running conditions). These contactors can be easily replaced by solid state contactors which brings down the consumption to 0.015 VA only.

4. AUXILIARY RELAYS

Auxiliary relays used for various functions such as the floor relay, which consumes energy to the extent of 8 VA per relay can be brought down using thyristor switching to the extend of 0.01 VA.

5. RETIRING CAMP

Precision mechanical design of 'R' Camp found to be helpful for reducing pulling force of 'R' camp coil and hence saving of energy to the extent of 5%.

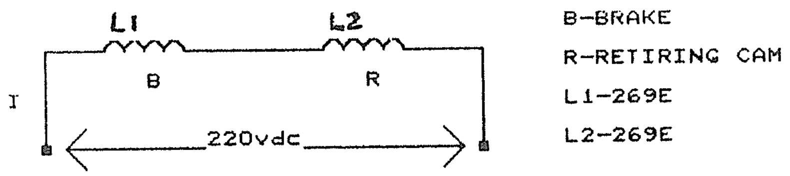
6. TRANSFORMER

Transformers consume energy for:

a. Secondary loading of brake Coil, R-camp etc.
b. Secondary loading of Aux.relays, indicators etc.
c. Transformer loss (self consumption)
(fixed Iron loss + variable copper loss.)

By eliminating the transformer we can reduce transformer losses. This can be achieved by using a single phase supply. The retiring Cam and Brake is connected in series instead of parallel operation. Simple circuits are designed for this purpose, where the supply is rectified directly and fed to the Brake coil & 'R'- camp in series which saves substantial energy.

Diagram is indicated below:



CIRCUIT DIGRAM OF SERIES OPERATED
BRAKE & R - CAM

7. WIRING

Wiring consumes energy due to the I^2R losses in the wire. In designing the use of computer networking, PLCs using serial communication can reduce the number of wires from 40 to 10 reducing the energy consumption in wiring. This reduction was to the extent of 5 %. The added advantage is the reduction in labour costs during the installation of the lift and quicker fault detection during maintenance.

8. CAGE

The load on the motor is due to the weight of the car and counter weight. It is also observed that by using tough & light material for manufacturing the cage, savings are achieved. Fibre glass bodies can be used, which result in a reduction of the counterweight & motor capacity.

9. OTHER METHODS TO SAVE ENERGY

1. Use of Feather Touch Switches in Hall Call Units and Car Call Units.

2. Use of roller guides instead of conventional guides.

3. Use of LEDs instead of conventional bulbs for indication circuits.

4. Use of electronic choke for tube lights inside the car.

All above methods were tried on two identical elevators in Nagpur, India. The passenger elevator was selected served G +4 floors, with a capacity of five persons & both were installed during the same time span. The details of power saving by then above methods are recorded as indicated in the table.

10. CONCLUSION

The above will indicate that substantial saving can be achieved by:

a. Proper selection of equipments.
b. Use of latest electronic techniques.
c. Use of low consumption electronic devices.
d. Proper management of elevator operation for maximum utility of its capacity by system programming.

BIOGRAPHICAL DETAILS

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TYPE	Power circuit components			Control circuit components			Mechanical components		Other	Remarks
	Motor	Transformer	Main contactor	Indication	Wiring	Floor relay	Brake	Retiring camp	alternative material	Total VA.
CONVENTIONAL	Rating. 5H.P/3.75Kw Imax=7.5 A V=415 V freq=50Hz	primary:415V sec: 110V /4A rating=440VA	Coil voltage:55 V Coil resistance:356E Ciol current :155mA rating :8.5 VA. total rating :8.5X2 =17 VA.	resistive lamp V :12V I :250 mA rating:3VA	no. of wire :40 floor height :3.5 mtrs. length of wire 3.5 X 6 = 21mtrs. total length = 21 X 40 =840 mtrs. losses =Length X I*2 X R= 0.84 X O.55 X 0.4 =0.185watt	Coil voltage:110V Coil resistance:1.5K Coil current :70mA. rating =7.7VA.	Coil voltage 110V Coil Resistance 269E Coil current :409 mA Rating:45VA	Coil voltage 110V Coil resistance 169 E Coil current :650 mA rating :71.5VA		144.2
STATIC	Rating. 5H.P/3.75Kw Imax=7.5 A V=415 V freq=10 to 50Hz keeping V/F constant. using VVVF method.	primary:220V sec: 12 /0.5A rating=6 VA	optically isolated solid state relay . operating volatge:1.5V current : 10mA total rating :1.5X.01 =0.015 VA.	Use of LED's V = 1.5V I =10 mA. total rating: 0.015VA	no. of wire :7 floor height :3.5 mtrs. length of wire 3.5 X 6 = 21mtrs. total length = 21 X 7 =147 mtrs. losses =Length X I*2 X R= 0.147 X O.105 X 0.4 =0.0062watt	Use of SCR. Vg= 5 V I = 2 mA rating =0.01 VA	Brake and retiring cam both are operated in series. Total coil voltage : 220 V Total Resistance = 269 + 269 = 538 E. Total current = 409 mA. rating = 90 VA.		Use of fibre glass cage. instead of wooden cage.	90.04

The total energy saving of 37.5 % using static controller over the conventional type.