Column published in the June 2003 issue of the Industrial Product Finder, page 206.

Harshwardhan Gupta's Design Tips–8

Saving on Energy

Energy-saving is like sex in India – everybody wants to do it, but each has his own peculiar ideas, and in the process, lot of energy gets wasted. Why you are laughing? You are just not taking seriously anything I am telling!

But, seriously, how many of us realize that if we keep on going like the way we do, our own grandchildren will have ZERO conventional energy sources – thermal power and automobile fuel – left in the whole World? So where do we start?

Saving begins at home. The biggest culprit is not the staircase light, but the water heater. In most houses, unknown to the average householder, the water heater accounts for more than half of the power bill. Do invest in a solar heater. If the flame from the gas burner is reaching the rim of the utensil on fire, you are definitely wasting LPG.

And in the office? Quite obvious: Change the old incandescent lamps to fluorescent ones. Switch off all lights and appliances when not required, blah blah... But why are the lights and the fans required in the first place? What is not obvious is the need to clean up those grimy glass windowpanes and open the curtains; thus making maximum use of natural light. Yes, I know it is very difficult to clean the glass-panes from outside, but do get it done. Keep the UPS battery in good shape – else it will constantly consume power and keep boiling. The filters of air-conditioners often get choked very soon in dusty India, and make them even more energy-inefficient. They need to be cleaned every week, not every year.

The concept of a lights-always-on office comes from the West – which are actually not western but northern countries. In these countries, it is cloudy almost all year round. In winter there is insufficient light even to drive on the roads, and daylight hours are very short – in Sweden in December, you drive to office at dawn, and come back at dusk after 8 hours. And we naively follow their office design even when we in India are blessed with so much natural daylight all year long.

Do tell your architect to design your next office as a low energy building. If he does not know how to, go to someone who knows how and ask him to show you his past such work. Ceiling-level ventilators – an old-fashioned idea now – can take out the hot inside air by slow natural convection and reduce the need for air-conditioning and fans.

On the road? The usual: Pool the cars, use public transport, switch of the engine at signals… Again, there are many lesser-known methods: Drive in the highest gear possible – if the car will move smoothly, say, in third gear, don't run in second gear in a given situation. Learn to make minimum use of braking by any method, whether by brakes or by gear shifting – in other words, learn to drive defensively and gently. Don't race the engine after starting (like many drivers of old Fiats habitually do). Don't race the engine ever, actually. The modern MPFI engines don't need to be raced. Get those trucks and LCVs you are responsible for repaired and running efficiently, educate their drivers and give them fuel-saving incentives. For that matter, do that with your chauffeur too.

And at the factory? Compressors are often the biggest culprits, and stopping all air leaks (see last month's Design Tips) will bring your energy bill down. Very old motors are largely very inefficient and changing (plus downsizing) them with new motors will usually pay off within a year. Use burners that are more efficient. Black smoke always means incomplete combustion. In plain words, that black cloud coming out of your factory is your own money drifting away in the air.

If it is a machine tool, use a well-sharpened, smoother-cutting tool, and you will immediately save power. Power saving in a machine-shop is usually completely ignored, but a few weeks of investigation with an energy meter connected in series with the incoming line to monitor individual machine tools will immediately throw up the culprits. I know this is unheard of, but if you want to save on your power bill, invest in a portable power meter, or hire it for a few weeks. Check what

operations consume what power and what action reduces that figure.

Get a proper Energy Audit done from qualified people. Know that all wasted energy appears as heat somewhere or the other, and a lot of electrical and mechanical energy makes very little heat. If you are a big consumer of energy, ask them to use infrared cameras to locate "hot-spots" of energy leakages as heat. Leaking compressed air will show up as cold spots, not hot. The Energy Audit is not a bureaucratic exercise, or just hot air! Do take it seriously and do a merciless job, without office politics. Remember that you are actually benefiting your own grandchildren!

How can the design office contribute? Charity begins at home, they say; and energy saving begins at the design office. Why blame the state government for the power crisis, when the demand is going up partly because of inefficient and wasteful use. So, what do I have to say to my fellow machine designers? Plenty!

Are you quite sure that machine needs a 3 HP motor? I can safely bet with you that it will peacefully run with a ½ HP motor. I know I will win 80% of the time. Yes, I know that a motor consumes power proportional to the load, but there is something called part-load efficiency and fan losses; and at every start and stop – energy loss due to higher inertia of the heavier motor plus drive. So, use a smaller motor, and save money in the drives too. If you are using a heavier motor just because it is starting a large inertial load, then use a soft-start and a smaller motor instead.

I was once called in to solve a problem of large motors of a hammer mill getting burnt out. The mill originally had a 25HP motor, which burned out, so a 35HP motor was put in its place. That burned out too. Then a 50HP one died, and then an incredible 75HP was about to meet the same fate, when I was called in. The motor was running as hot as a ready *chapatti ka tava*. The cause was not overloading at all! The outlet of the cooling fan (the place where the air blows out from the fan cowling to flow through the cooling fins) would get progressively choked with the sticky dust flying all over from the hammer mill. The necessary cooling action would progressively reduce, and finally stop altogether – so the burnouts. What is the moral of this story?

Do avoid high reduction-ratio worm gear drives if they are constantly running under heavy load. You are constantly losing energy in their gross inefficiency. Replace them with multi-stage helical reducers. If the reduction-ratio is in single digits, use a series of timing belts instead of worm or helical boxes. Avoid sliding bearings, and keep rolling bearings in good shape. Avoid friction, basically.

Take a h-a-r-d look at the air cylinders you have used in your design. Make their bores and strokes as small as you can (see last month's Design Tips). Stop all leaks. Keep air tubing from the valves to the cylinders as short as you can – tubing length before the valve does not matter. Don't oversize hydraulics either, and use proper unloading valves. Design the hydraulic system in such a way that it uses minimum energy. Servomotors can often replace hydraulics and consume much less energy.

Saving material and weight also indirectly saves energy, as raw materials need much energy to be produced. No gram or watt or joule is too small to ignore. Save every bit of energy and material – that's the mark of a good designer!

Time travel is definitely possible. We just have to keep on wasting energy – and by 2050 A.D., we would be back in 2050 B.C.

Next Month: Tolerances

The author is a graduate of IIT Bombay in Mechanical Engineering. He has been designing machines since 1976. He founded Neubauplan Machine Design Studio, an independent consulting machine-design firm in 1981 in Pune. He can be reached at harsh@neubauplan.com or through his website at www.neubauplan.com