The Energy Efficiency of the ELF Series

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While much of focus of the ELectroForce Series of test instruments is directed at their performance, precision and durability, they also represent an extremely energy efficient alternative to conventional servohydraulic test systems. The electromagnetic linear motor of the ELectroForce generates linear force using a direct energy conversion, representing an advantage over traditional servohydraulics, which require several energy conversions (electrical to mechanical, mechanical to fluid power, and fluid power to mechanical) to power the system.

When at idle, the ELF 3200 and ELF 3400 linear motors draw only 10W and 23W respectively. This is the energy required to light a typical night light. Servohydraulic test systems use much more energy at idle requiring a minimum of 0.75 HP or 560 watts. This about the energy required to run three garage door openers continuously. The idle energy is used to generate a continuous high pressure supply of hydraulic oil that is used to compensate for leakage in the servovalve.

At full load and frequency, factoring in energy lost to motor coil heating and any amplifier inefficiency, the ELF 3200 and ELF 3400 draw about 116W and 1300W* respectively. The total amount of energy required to operate the ELF 3200 at full operating capacity is a fraction of what traditional servohydraulic test systems require to run at idle. While the ELF 3400 draws more power than an idling servohydraulic test system, the inefficiencies of the older hydraulic technology quickly multiply as those systems are put to work.

For example, to operate at a pk-pk deflection of 13mm and 100Hz, the ELF 3200 and 3400 require only about 60W and 100W of power respectively. This is the power required to light a typical light bulb. There are very few servohydraulic test systems that can achieve this frequency and amplitude since it requires a special high performance servovalve and 75HP (56KW) hydraulic power supply! By the way, 75HP will push two automobiles along the freeway at 80 mph.

Not all test applications require high displacement and frequency. More typical test applications have an applied load with small displacement. Here are some examples:

ELF 3200 Application: 200N (40 lb) applied sinusoidal load at 30 Hz and 3mm pk-pk deflection. The ELF 3200 power draw is 150W versus 3700W (10kN Actuator, 21 LPM, 14Mpa hydraulic power supply) for the traditional servohydraulic test system.

ELF 3400 Application: 2500N (500 lb) applied sinusoidal load at 50Hz and 5mm pk-pk deflection. The ELF 3400 power draw is 1000W versus 7400W required (15kN Actuator, 25LPM, 21Mpa hydraulic power supply) for the traditional servohydraulic test system.

One final caveat: Most of the energy required to operate both ELectroForce and servohydraulic test systems must be dissipated as heat since very little of it is absorbed by the specimen. To prevent a temperature increase in the surrounding area, you need to carry the heat away from the test system.

The heat generated by ELectroForce instruments is small enough to be picked up by the lab air conditioning system. Servohydraulic systems generate substantially more heat and usually require a water-oil heat exchanger. Tap water is circulated through the heat exchanger and either dumped to a drain or cooled using a chiller system. The first approach is often considered wasteful and not allowed in many areas. In the second approach, the energy required to operate the chiller is about equivalent to the hydraulic power rating.

ELectroForce Series instruments operate on a fraction of the energy required for servohydraulic test systems. In these times of rising energy costs and limited water supplies, the ELectroForce Series represent a refreshing alternative to servohydraulic testing technologies.

• *For a full efficiency analysis report, please contact an EnduraTEC Sales Representative.*

A note from the U.S. Department of Energy's Energy Information Administration:

The Rising Costs of Electricity

From the Energy Information Administration/Monthly Energy Review June 2001
http://www.eia.doe.gov/emeu/mer/prices.html

"The average price of electricity sold by electric utilities to **all ultimate consumers** in the United States in January 2001 was 6.89 cents per kilowatt-hour, **10 percent higher than the January 2000 mean price**.

The price of electricity sold to **commercial consumers** averaged 7.60 cents per kilowatt-hour in January 2001, **12 percent higher than the January 2000 price**.

The price of electricity sold to **industrial users** in January 2001 averaged 4.96 cents per kilowatt-hour, **20 percent higher than the price 1 year earlier**."

("Beginning with January 1986, new series of national average price estimates were based on a statistically derived sample of both publicly and privately owned electric utilities. Previously, average price estimates were derived from selected privately owned electric utilities and were not national averages".)