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All-electric presses ride high-growth surge

BY STEPHEN MOORE

IPF in Tokyo demonstrated that the latest electric injection machines have the performance and economics to win a big share in small machines.

The heightened interest in all-electric injection machines was clearly illustrated at IPF '99, Japan's triennial plastics exposition in Tokyo in September, where a myriad of all-electric machinery was on display. Moreover, the show confirmed in no uncertain terms that Japanese suppliers believe all-electric technology will soon capture the majority of the small-machine market.

As price differentials with hydraulics continue to shrink, and benefits such as faster cycle times, enhanced repeatability, and precision are emphasized, machine suppliers feel that at least those processors in high-electricity-cost regions should have no reason not to switch (Jun MP, 58; MPI, 52). One kWh of electricity costs ¥21 (\$0.20) in Japan, compared to an estimated ¥9

(\$0.09) in Germany and ¥7 (\$0.07) in the U.S.

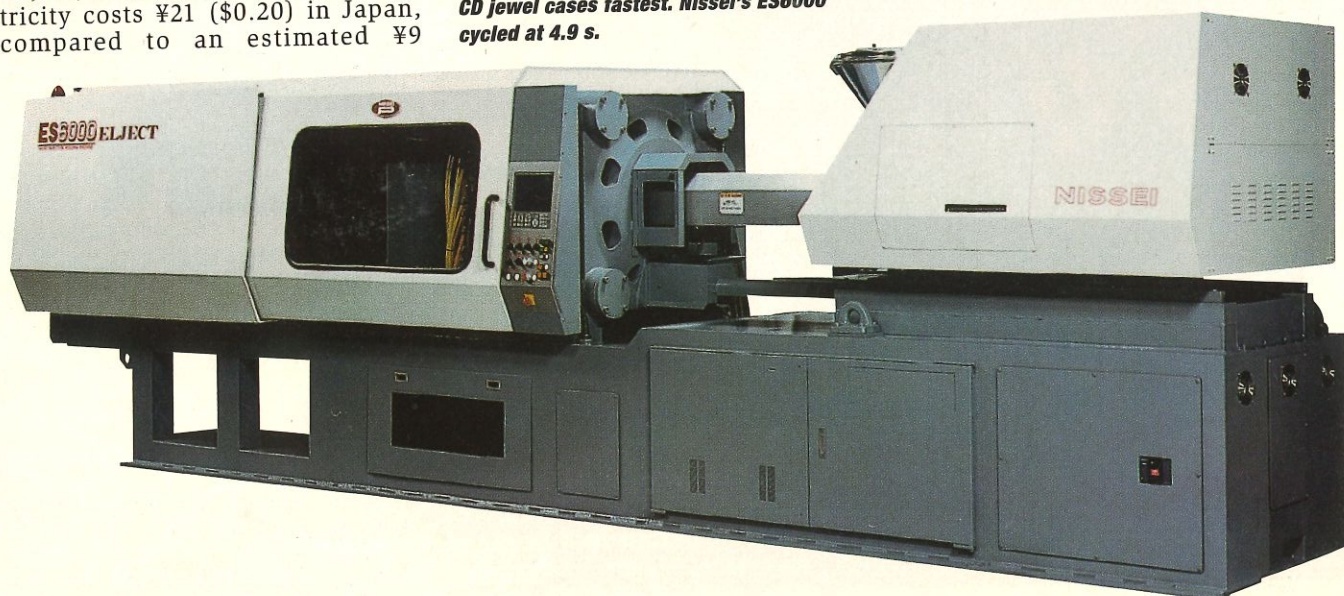
Others, however, see the current wave of all-electric machines as a marketing ploy to re-ignite a stagnant Japanese domestic market. "The processing industry is saturated with a manufacturing base of hydraulic machines that can do the job effectively, and can continue doing so for some time to come," says one injection machine supplier requesting anonymity. "The current sales push in all-electrics, when coupled with pressure from major customers in the electronics industry who see all-electrics as green

Machine makers were engaged in a speed battle at IPF to see which could mold CD jewel cases fastest. Nissei's ES6000 cycled at 4.9 s.

machines, is resulting in processors prematurely replacing perfectly good hydraulic machines." Nevertheless, all-electrics are becoming a permanent fixture in many molding operations.

Dr. Yoshiharu Inaba, vp. of all-electric pioneer Fanuc Ltd., ◀272▶ is confident that the current surge in processor interest will transform into an unstoppable tide in select areas. "We estimate that all-electric machines will capture 80% of the sub-200-tonne machine market in Japan within two to three years, up from 50%." Inaba claims all-electrics are now cheaper than hydraulic machines with servo-valve accumulators.

Tsukasa Yoda, president of Nissei Plastic Industrial Co. Ltd., ◀273▶ Nagano, Japan, is more conservative, predicting all-electrics might gain half of the small-machine market in five years. "We still have work to do to bring electric machine



1000-tonne-plus range due to lack of suitably priced large servo motors.

Toshiba Machine Corp., ◀283▶ Tokyo, is taking the hybrid approach for machines 450 tonnes and larger. It unveiled the wide-platen IS450 GSW II, with an AC servo for screw rotation and an induction-motor inverter control for the fixed-displacement pump drive motor. Inverter control supplies only the amount of oil required, netting an energy savings of up to 30%.

Sodick ◀284▶ has taken the hybrid route for its Tuparl EH series of plunger-type machines. Debuting two years ago, the Ishikawa-based supplier has added 180- and 200-

tonne presses. Electric drives are employed for mold opening/closing and screw rotation. At IPF, a 40-tonne press molded an 80-pin connector with 0.5-mm pitch. At Sodick, hybrids account for 50% of total shipments, and machine cost is equivalent to hydraulics.

One supplier which has not jumped on the all-electric bandwagon is Kawaguchi Ltd., ◀285▶ Shimizu, Japan. "We showed an all-electric at IPF to prove we're capable of making such units, but our latest hydraulics can achieve the required precision and only use one-third the energy of hydraulics with constant-delivery pumps," says

Sean Ohata, manager of the foreign trade department. Kawaguchi's KEX series uses digital hydraulic feedback control, and reportedly consumes half the power of typical variable-displacement pump units.

All-electrics can also boost productivity in thermoset processing, says Matsuda Seisakusho Co., ◀286▶ Kuki, Japan. More accurate control of platen position enables flash reduction of 20 to 30%. Matsuda debuted a 75-tonne all-electric. ◻

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A compact, low-cost electric direct clamp

Virtually all commercially available electric injection machines use toggle clamping. One major reason is that it has proven impossible to design a direct-drive system at reasonable cost.

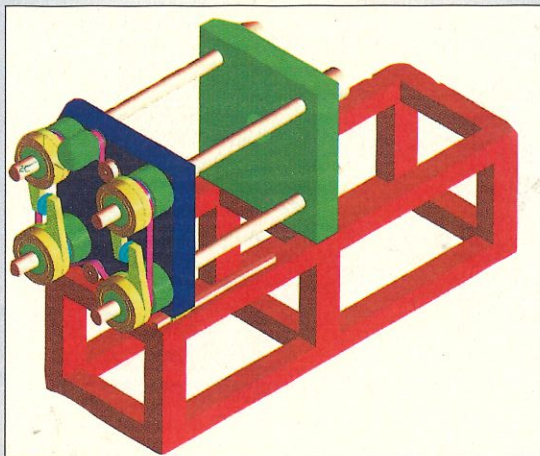
The prototype Nissei machine seen at the IPF show in Tokyo used two 45-kW motors to provide just 800 kN of clamp force; on a toggle clamp, one such motor would be sufficient for an 8000-kN machine. Toggles in themselves have numerous benefits, but they are far from ideal for use on electric machines because they are inherently a complicated way of converting the rotary motion of the motor into linear motion of the clamp.

Amir Ziv-Av, head of Ziv-Av Engineering, ◀287▶ Or-Yehuda, Israel, (the holder of the tiebar-less patent behind the Billion two-tiebar machine first seen at K'95 and relaunched in a modified version this month) reckons he has solved the problem with a design – still to be built – that should actually be no more expensive than a hydraulic machine while sacrificing nothing in terms of speed and accuracy.

The "electro-mechanical" machine uses new satellite roller screws made by Rollvis, Geneva. The principle is similar to that used in planetary extruders. It provides an area around 10 times greater than a conventional ball screw to apply pressure – and thus provides 10 times the clamp force, but without the bulk. A 2000-kN machine would need a single motor no larger

than 5 kW on the clamp side. Energy efficiency would be higher than any machine on the market.

Ziv-Av points out that a key feature of the toggle system is the long distance between the pivots on the moving platen that ensures platen parallelism. This led him to devise a two-platen direct clamp unit with four satellite roller screws at the ends of the tiebars. The screws are fixed



Ziv-Av design for electric direct clamp uses far less power than other competing designs.

and the nuts, belt- or chain-driven by a single motor, and connected to the moving platen via bearings, rotate around them. The platen moves on two linear bearings.

The second benefit of the toggle is that it provides the ideal combination of a fast-closing motion with low force, followed by high force over a short distance. So in the Ziv-Av design, clamp-up is done by rotating arms. These are disconnected from

the nuts during the closing stroke, but are re-engaged by a multidisc clutch for clamp-up. The arms are arranged in counter-facing pairs to ensure uniform force on all tiebars.

Ziv-Av says a two-platen, 2000-kN unit could be made around 1.8 m shorter than its three-platen counterpart. And, unlike other two-platen hydraulic machines now on the market, there would also be good access to the nozzle, since there would be no cylinders fixed to the injection side of the fixed platen: all the mechanisms are on the back of the moving platen.

Plus, by using the satellite roller screw, "you can get all the clamp force you need with tiebars of regular cross sections, or maybe slightly larger," he says.

The screw rotates about 2000 r/min – more than sufficient for high-speed closing. With a thread lead of about 30 mm, linear velocity is 1 m/s.

The relatively high cost of the satellite roller screws is negated by the reduction in mechanical parts elsewhere on the clamp unit, Ziv-Av claims. Furthermore, of those parts that remain, there are more that are the same, thus reducing machining costs. He says that applied to small, two-tiebar machines, the mechanism would actually be cheaper than a regular toggle – and this calculation is based on "very conservative" cost estimates from Rollvis.

Ziv-Av has a U.S. patent pending on the design. The system is suitable for machines up to 2000 kN. –Peter Mapleston