

MACHINE DESIGN

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Reinventing the industrial shock absorber

Adjustable shock absorbers are widely used because they provide an economical way to decelerate loads, prevent impact damage, dampen noise, and increase equipment speeds. They're also simple to apply. One need only approximate the correct size shock from a few different models and then tune it on the machine for best performance. But ever since William J. Chorkey patented the first adjustable industrial shock absorber in 1963, there have been relatively few major innovations.

One was the introduction of self-compensating shock absorbers in the 1970s. These devices operate across a relatively wide range of input conditions without the need for adjustment. Compared with adjustable shocks, however, self-compensating units have slightly lower energy ratings and require more models to cover a given range.

Other styles were introduced over the years to accommodate specific markets, including crane bumpers, stacker-crane shocks, and soft-contact and heavy-duty units. Nonetheless, adjustable versions remain the "bread-and-butter" shocks of industrial automation.

This increasingly presents a problem for today's users. Competitive pressures demand machines that run faster and maximize throughput which, in turn, requires shocks with higher cycle rates and wider operating ranges. At the same time, there is a trend toward smaller, lighter equipment and lower costs. So simply specifying a larger shock is often not an option. Despite the fact that shock-absorber manufacturers have continuously refined their products, the nearly 40-yr-old design has nonetheless been pushed to its practical limits.

Ace Controls Inc., Farmington Hills, Mich., addressed this problem by fundamentally redesigning the basic industrial shock absorber. The resulting range of products, called the Magnum Group, features 50% more energy capacity without increasing size or cost. At the same time, Ace managed to maintain interchangeability with existing models and build in user-friendly features such as a fully threaded body, an integral stop pad, and adjustability from either end.

Designing a shock with higher energy ratings is straightforward, but it also presents sizable challenges because of a limited number of options available to increase energy-absorption capacity. In a shock, energy capacity, E , is determined by $E = FS$, where F = force and S = stroke. To ensure interchangeability, the stroke of each shock had to match an existing model, so designers could only manipulate force.

In the case of a shock absorber, $F = PA$, where P = pressure and A = area. Because existing shocks already operate at 8,000 to 12,000 psi, the best approach was to increase the piston diameter and area, rather than



ACE Magnum Group shock absorbers, which include adjustable and self-compensating models, offer up to 3.9 times the effective weight capacity of standard models without increasing size or cost.

pushing operating pressures beyond recommended limits.

Not surprisingly, a larger piston, inner tube, and metering tube consumed valuable space inside the shock absorber. Additional volume was lost as a direct result of the goal to create a fully threaded body, which eliminated an oversized midsection that housed the closed-cell foam accumulator.

Accumulators are a key element in shock-absorber performance. When the piston strokes, the foam accumulator collapses to accommodate the

displaced oil. Typically, foam compression should be on the order of 20 to 25%.

The most expedient method to recover the lost volume was to hollow out other internal parts of the system and fill them with foam. Unfortunately, the best results with this method compressed the foam from 40 to 45%. These prototypes failed under test due to deterioration of the closed-cell foam.

Another option was to use a less-dense foam, but past experience had shown that thinner cell walls combined with high compression caused premature failures. Changing from foam to a small bladder accumulator solved the problem. While foam averages 46% solid material by volume, the bladder design, in comparison, averages only 13%. The bladder accumulator made better use of the available volume, solving the dilemma of fitting a larger piston in the same-size housing.

Energy ratings for Magnum Group shock absorbers range from 1,350 to 54,000 lb-in./cycle. This extensive range lets design engineers specify shock absorbers with higher safety factors within the same package. In some cases designers can specify smaller sizes at a lower cost. Applications include packaging machinery, conveyors, robots, and bottling equipment, or anywhere motion control is necessary. ■

Information for this article was provided by Mike Ferkany of ACE Controls Inc., Farmington Hills, Mich.

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