

# Specifying a Solenoid

When specifying a solenoid, it is essential to set down realistic specifications and to keep the traditional “safety margins” to a minimum. In today’s cost competitive market, it is imperative that the solenoid user have a working knowledge of the solenoid he/she is about to specify, or work closely with someone who does. This article will address some of the design criteria that is often neglected, but is essential in the initial stages of “designing in” a solenoid for a particular application.

All too often, we at Deltrol Controls have become involved at too late a stage in the solenoid design. As a result of this “late start,” problems include the redesigning of the customer’s housing or mechanism to accommodate a larger solenoid to accomplish the required job. This unnecessary cost could have been prevented through earlier design considerations.

A solenoid is a specially designed electro-magnetic device used to convert electrical energy into mechanical action. Since a significant amount of the electrical energy supplied to the solenoid is dissipated as heat, the temperature of the solenoid will rise until a stabilized temperature is reached.

As a result of the temperature rise, the solenoid coil resistance will increase, which will in turn reduce the current draw resulting in lower available push or pull force. Heat rise resulting in power loss is one of many mistakes made in the initial stages of “designing in” a solenoid for a particular application. If the solenoid is designed to do a certain amount of work at a given stroke, and the effects of coil self-heating and high ambient temperature are neglected, difficulties are bound to arise. Consequently, the maximum allowable coil temperature rise and maximum ambient temperature must be known because they dictate the duty cycle.

The ambient temperature is a function of the surrounding conditions and must be known. The coil temperature rise, in many cases, is determined by the allowable physical size of the unit, the amount of work to be done (a known load to be moved a known distance), the coil “on” time and cycle rate, and the thermal conductivity of the device that the solenoid is mounted to.

As previously stated, as the coil temperature and/or ambient temperature go up, the solenoid pull or push force goes down. It is advantageous to keep the coil temperature and ambient temperature to a minimum. In fact, regulatory agencies such as U.L. and C.S.A. have strict allowable total temperature limitations based on the application and the product end use.

A continuous duty coil (on 100% of the time) will provide less force for a given size than the force available from an intermittent duty coil (on a fraction of the time), simply because the continuous duty coil must continuously dissipate the lost heat energy without any time to cool. As a result, the force available decreases. However, there are choices. One

could specify a solenoid large enough to provide the force needed on a continuous basis, or if the application permits intermittent operation, one could use a smaller, stronger coil with a specified on and off time. The choice of a smaller solenoid could decrease the cost of the unit.

When “designing in” a solenoid for a particular application, the following steps should be taken:

- 1) Determine the magnitude of the load to be pushed or pulled.
- 2) Determine the stroke length this pushing or pulling will require (keeping the stroke to a minimum will minimize current draw, coil heating and will maximize life).

*(The data referred to in items 1 and 2 will yield the force-stroke requirements.)*

- 3) Determine the required duty cycle in terms of time “on” vs. time “off.” Continuous duty implies that the coil is energized continuously. Intermittent duty implies that the coil is energized for short intervals and off for periods long enough to allow the winding to cool. Whenever possible, heat sinks should be used for maximum heat dissipation.
- 4) Determine the maximum ambient temperature to which this solenoid will be exposed. (In some cases an allowance must be made for the additional heat generated by the solenoid.)
- 5) Determine the voltage variations to which the solenoid will be exposed. It is advisable to keep voltage variations to a minimum because the solenoid must be designed to withstand the heating effect of maximum voltage and yet develop the required force at the minimum voltage. Large voltage variations could require an “overdesigned” unit which would increase the cost unnecessarily.
- 6) The solenoid should be mounted in a vertical position if possible. Vertical plunger movement minimizes wear between the plunger and coil bobbin. The actual load should be in line relative to the plunger bore as much as possible to maximize performance and life.
- 7) Determine the maximum allowable physical solenoid size.
- 8) Wherever possible, quick-connect terminals should be utilized to keep the cost of the solenoid to a minimum. Lead wires are also available where quick-connect terminals are not feasible.
- 9) Most solenoids can be operated with either AC or DC voltage. When using AC voltage, the designer should be aware that the solenoid will draw substantially more current

during pull in and will have a tendency to buzz when energized.

- 10) The mounting of the solenoid is determined by the type of solenoid construction used. Typically, the C&D frame solenoids are manufactured with tapped holes in their frames so that they can be fastened to a surface. The tubular solenoids are typically manufactured with threaded bushings and are supplied with lock washers and hex nuts. When determining how the solenoid will be mounted, the designer should be careful not to design a blind assembly.

Items 1 through 10 include criteria that must be addressed. With this data, solenoid design engineers can create the right solenoid to meet your requirements. Preferred components, used wherever possible, will allow Deltrol controls to supply your solenoid at the lowest possible cost.

Other considerations may be addressed as the design project approaches completion. As an aid in this process, Deltrol Controls has developed a Solenoid Application Sheet (page 65) which covers the main points addressed in the design process.

In the final analysis, of course, direct interface between customer and supplier is the most valuable communication of all. The engineering and sales staff at Deltrol Controls are ready to work with you to solve your design needs. We look forward to your call.

## SOLENOID DESCRIPTIONS



**“C” Frame Solenoids:** This category of solenoids is designed primarily for volume application (appliances, vending machines, valve operators, etc.) where low cost is essential. Many of the types listed incorporate molded coils as a standard feature. Long operational life (in the millions of cycles) can be expected in most applications because of the low friction, high wear capabilities of the plastic plunger guides which are provided. Residual magnetism characteristics are kept to a minimum by using high quality magnetic iron in the frames, plungers and backstops.



**“D” Frame Solenoids:** This group of solenoids is the “standard” of the industry for high quality applications (business machines, tape decks, industrial controls, recorders, etc.) Molded coils are standard on some types and available without premium on others. High permeability iron is used exclusively providing fast, reliable operation and negligible residual magnetism. Hard finish on plungers and low friction metal or plastic guides promote long, reliable life expectancy. “D” frame construction provides excellent magnetic characteristics for high operating efficiency, particularly in D.C. applications.



**“ME” Solenoids:** For D.C. applications only. Designed to provide greatest possible force in limited space. Solenoids are completely metal enclosed and are highly resistant to shock, vibration and moisture. All units available in “pull” or “push” types as standard. Stock types incorporate Class B temperature rated insulation. Plunger guides are wear resistant brass or stainless steel. Low plunger mass and high magnetic power provides fast, accurate response. Easy mounting with threaded bushings and hardware provided.