Movable cores and side-actions are commonly used on injection molds to make complex geometries possible. While details are more complicated than described here, some simple calculations provide worst-case estimates for proper sizing.

Force on the Core

Before determining the requirements of the side-action, calculating force on the core is essential. Seal offs, core length and other factors notwithstanding, the designer can simply use maximum projected area and injection pressure to calculate core force.

- Maximum Projected Area (C) in square inches is found by sectioning the core at the largest point exposed to plastic.
- Maximum Injection Pressure (P) is nozzle pressure in psi (hydraulic ram injection pressure x 10).
- Core Force (F) = P x C.
 For 20,000 psi and a 2" dia. pin:
 F = (20,000 psi)(3.14 sq.in.) = 62,800 lbs.

Side-Action Options

The following side-action options are possible:

- 1) Cam Pin with Heel-no preload
- 2) Cylinder with Heel-no preload
- 3) Cylinder Only-large
- 4) Side-Action System-small

While methods 1 and 2 use heel blocks to final position the core, flex and compression is often a problem. More robust preloading methods 3 (with pressure) and 4 (without pressure), eliminate these issues, but require the ability to calculate core and cylinder forces.

Cylinder Basics

Cylinder Push/Extend Force (M) and Cylinder Pull/Retract Force (N) is calculated as follows:

M = H x [(3.14xB})/4]

 $N = H \ge [(3.14xB)/4 - (3.14xR2)/4]$

- H = Hydraulic supply pressure (psi)
- B= Bore diameter of cylinder (in.)
- R= Rod diameter of cylinder (in.)

Note for pull, rod area subtracts from the piston area. Retract Force is critical when considering friction from material shrinkage.

Cylinder Sizing

 Standard Cylinders: If the machine cylinder hydraulic pressure is known (and available during injection), minimum bore size is:
 B = SQRT[(4 x F)/(H x 3.14)]

For 2" dia. core and H = 1,500 psi: B = SQRT[(4 x 62,800)/(1,500 x 3.14)] = 7.3 inches (8" bore cylinder)

For other injection pressures and core area, see Chart 1.

 Nonstandard Cylinders: Preloading side-action cylinders generate the large output forces of large bore cylinders in a smaller bore package. A typical preload side-action system produces 60,000 lbs of output force with a bore diameter of two inches, and total outside diameter of five inches, easily fitting inside bore of the eight-inch standard cylinder in the example. Nonstandard cylinders may also maintain output force with zero psi hydraulic pressure.

Cylinder calculations provide good first look comparisons when considering the most suitable side-action option early in the mold design.