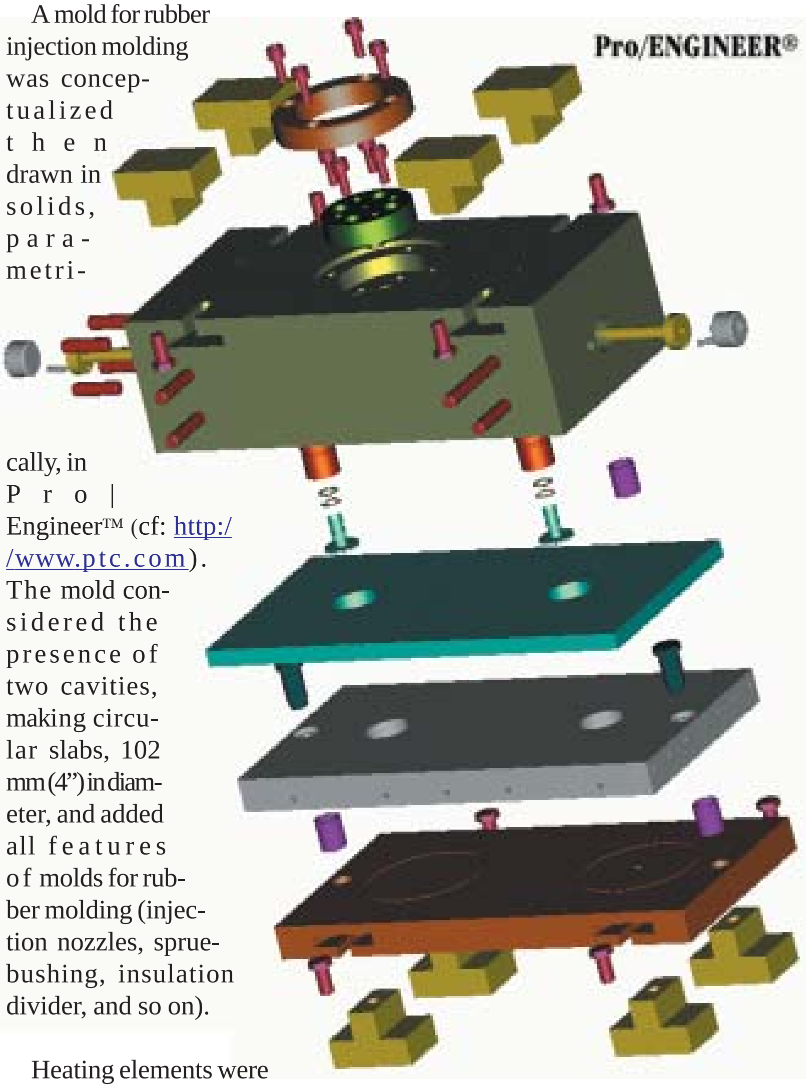
# Thermal Analysis of Cold Manifold Mold

*Corex Design Group* called on WIDL to shade light, as to thermodynamics within cold manifold molds, for rubber injection molding. The idea was to try various insulation materials, to separate cavity plates from the manifold, and potentially eliminate water-cooling (which would simply the process, drastically). The concern was premature curing of rubber in runners and nozzles, while waiting to be injected in cavities.

A mold for rubber injection molding was conceptualized then drawn in solids, parametrically, in Pro|Engineer™ (cf: [http://www.ptc.com](http://www.ptc.com)). The mold considered the presence of two cavities, making circular slabs, 102 mm (4") in diameter, and added all features of molds for rubber molding (injection nozzles, sprue-bushing, insulation divider, and so on).

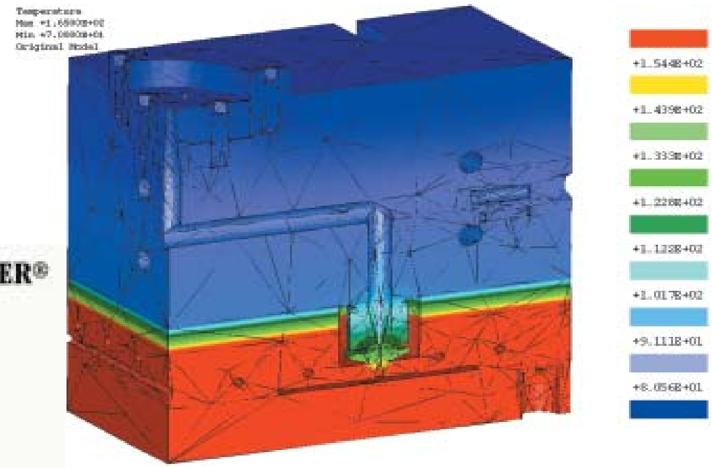



Assembly of 2-cavity mold to inject rubber

Heating elements were drawn as a grid, along with isobars, to even the temperature, at WIDL. Thermal properties of P20 steel were considered along with those of typical insulation boards. Isobars were modeled as super conductive materials (10 times better than steel).

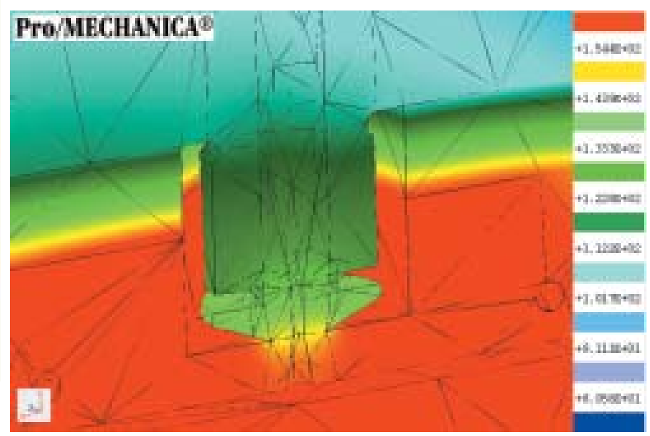
The top and bottom surfaces of the mold were attached to platens of a press, at T-slots; the remaining two surfaces were allowed to exchange heat through convection, with the ambient. Water was varied in speed, by changing forced-convection parameters; some cases eliminated water circulation (no cooling to the manifold). Thermal (conduction and convection) properties of three rubber formulations (natural rubber, EPDM, and silicone) were considered, each of high and low durometers (40 and 70 Shore A). Still, due to symmetry, only a quarter-mold was modeled, with adiabatic conditions at the cutting planes.

Temperatures were highest at the nozzles. Water was found to cool these than the manifold. Eliminating cooling channels raised temperatures beyond the processing window of the compounds selected in the study. The nozzles modeled, ended in double funnels, to break the curing rubber at the tips.

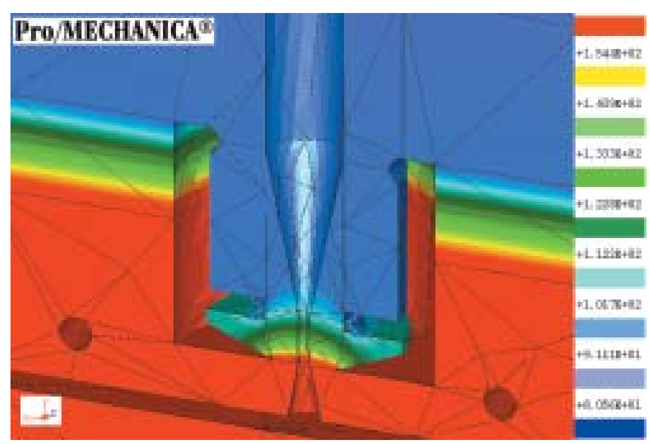


*Temperatures in water-cooled mold (1/4 model)*

Alternative designs and materials for nozzles tried at WIDL held the hot zone local to the contact with the cavity plate. Still, a super isolation material was yet to find, to attempt at eliminating forced (water) cooling. Typically, mechanical strength and thermal resistance compete with one another: a porous material helps trap air in a still condition, but then, it cannot take load without deflecting.




*Distribution of temperatures in non-cooled nozzles*




*Distribution of temperatures with alternative nozzles*