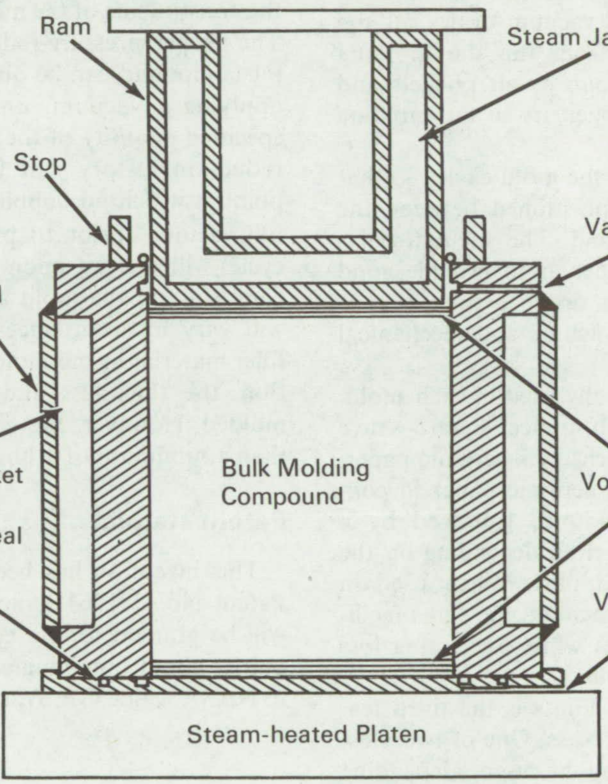
NASA TECH BRIEF

Improved Compression Molding Process



The problem:

To develop a method for compression molding, to a full range of densities, certain thermosetting, high-bulk-factor, ablative plastic molding compounds. The molding compounds consist of microsized particles in spherical and multilateral shapes. The molded parts are required to be reproducible, homogeneous, and free of residual stresses.

Abalative compounds molded by the conventional compression-molding process exhibited certain undesirable effects in the finished parts. These effects were identified as pockets of entrapped air, stratification of molding compound constituents, residual stresses and cracks caused by material separation and the uneven distribution of resin, and inhibition of molding cure caused by locked-in volatiles. Stratification resulted from turbulence generated by the compression and subsequent venting of air from the molding material. In addition to inhibiting molding cure, the locked-in volatiles generated internal pressures which would tend to rupture the molded part.

(continued overleaf)

The solution:

Modification of the conventional compression-molding process in three major respects: (1) application of a vacuum to the mold during the molding cycle, (2) use of a volatile sink, and (3) exercising precise control of the mold closure limits. Parts produced by the modified molding process are strong, homogeneous, free of residual stresses, and have improved ablative characteristics.

How it's done:

As shown in the figure, the mold assembly is equipped with O-ring seals. The seals permit the application of a continuous, leak-free vacuum of 5.0 mm of mercury to the charged and closed mold throughout the entire molding cycle. The mold cavity is made large enough so that when the seals are engaged, it will accommodate the required amount of molding compound in bulk form. The vacuum draws off the air and vaporized volatiles from the the molding compound, thus eliminating voids or air pockets and thereby ensuring greater homogeneity in the molding compound.

Vacuum ports are located in the mold cavity so that the volatile sinks are always positioned between the ports and the molding compound. The vacuum ports are constructed in such a manner as to provide good support to the volatile sinks, in order to prevent rupture of the sinks while under vacuum and mechanical pressure.

Two volatile sinks are normally used in each mold. Each sink consists of 13-mil, 10-ounce, square-weave fiberglass cloth, and a 0.080-inch-thick ceramic paper. A sink consists of one sheet of ceramic paper in contact with the molding compound, followed by a number of layers of fiberglass cloth depending on the total thickness of the finished part. When used in conjunction with the applied vacuum, the sinks facilitate the evacuation of volatiles while preventing loss of resins in the molding compound.

Control of the mold closure limits is the third feature of the vacuum molding process. One of two closure-limit control methods may be used, depending upon whether a high- or low-density part is to be molded. In molding high-density parts, the charged mold is closed to a predetermined height indicated on the molding-press piston, or ram. This height is maintained by either increasing or decreasing pressure as the part cures. The second method consists of closing the mold against rigid, prelocated stops such as those shown in the figure. This method is preferred when molding parts with densities of 60 pounds per cubic foot or less, because of the difficulty in maintaining the proper ram position at the required low pressure.

Beginning with the application of vacuum to the charged, closed, and sealed mold cavity, the pressure-reduction rate must be slow enough to prevent undue agitation, or bubbling of the heated molding compound. Bubbling will occur when the pressure-reduction rate within the mold cavity exceeds by too great an amount the slower evacuation, or bleed-off of air contained in the bulk compound. The occurrence of bubbling will have a detrimental effect in that it causes the constituents of the molding compound to separate. The proper pressure-reduction rate of a given molding compound can be quite accurately determined by applying a vacuum, under visual conditions, to a specified quantity of the compound. A time-pressure-reduction history can then be established for the point at which no bubbling occurs. Dwell time under full vacuum (prior to proceeding with the molding cycle) will depend upon the size of the mold cavity. Cure time in the mold as well as the post-cure time will vary in accordance with the type of resin and filler material in the molding compound and, in addition, the thickness and density of the part being molded. However, the cure time will seldom be less than a minimum of 1 hour per inch of part thickness.

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3317641), and royalty-free license rights will be granted for its commercial development. Inquiries about obtaining a license should be addressed to NASA, Code GP, Washington, D.C., 20546.

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