INTRODUCTION

Under the worldwide campaign to "save resources and energy," automobiles have been improved by reducing weight and increasing fuel efficiency. In Japan the use of urethane bumpers which meet these objectives has been steadily increasing. However, the manufacture of polypropylene bumpers as a substitute is also increasing, due to cheaper starting materials. The RIM urethane technology is very well suited to the production of parts that are large in size and complicated in shape. The problems with moldability arise when parts are made thinner, larger and when cycle time is reduced. These problems connected with moldability can be solved to some extent by optimization of the molding conditions, by better mold design and by selection of a better urethane system. However, the development of a new urethane system requires many experimental trials to optimize it because of the many variables involved, such as catalysts, isocyanates, polyols, blowing agents, temperature of starting materials, etc. At the present time there are only a few papers in literature discussing problems associated with the moldability of RIM systems. In this paper, computer techniques suitable for the optimization of physical properties and moldability of RIM systems will be discussed.

PROBLEMS IN URETHANE BUMPER PRODUCTION

One of the major problems in RIM bumper production are the molding problems that are associated with the product thickness. Figure 1 shows the density contours of the urethane bumper drawn by the computer. As can be seen from this figure, the contour lines of
0.01 g/cm\(^3\) steps are very closely arranged together in the case of a thinner type of bumper, especially at the corners where the density becomes so low that it is difficult to make a good product.

Figure 2 shows the typical molding defects in bumper production:

1. **Sink Marks.** The poor flowability causing high density near the gate generates uneven surfaces in striped or round shapes which are called sink marks. The sink marks become round when there are cases like chip spots of the releasing agent. The reason for the occurrence of sink marks is unclear, but they can easily be caused by high density and closely arranged high density distribution. The local difference of the conversion of liquid injection seems to cause this phenomena.

2. **Loose Skins or Flow Marks.** A less reactive urethane system brings about loose skins or peeling of the surface near the gate or at the corner, causing stains on the mold. The flow marks are the radial loose skins near the film gate. This can easily be caused when the shape of the film gate is not adequate. The loose skins are often seen when the reactivity is poor. These phenomena are generally caused more often in ethylene glycol-based systems than in 1,4-butanediol-based systems.