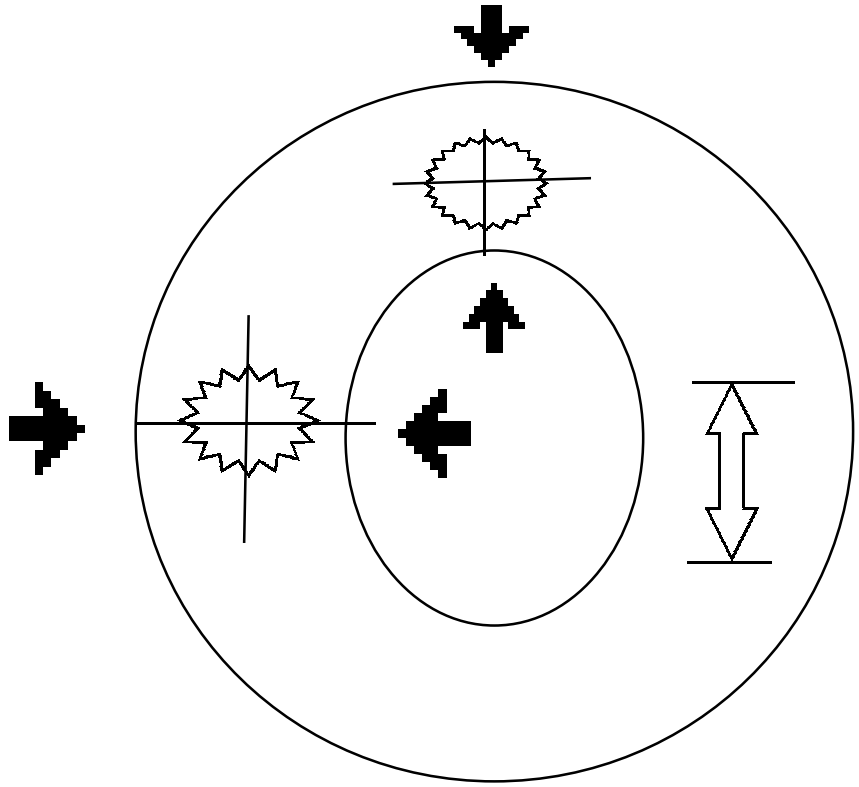
Chapter VII.

Special Tests

Chapter VII. A

Mold Shrinkage of Various Elastomers



Mold Shrinkage of Rubber Compounds

It is becoming increasingly difficult, with the number of compounds that are available to the trade, to be able to design a mold with any semblance of accuracy due to the lack of presenting a clear idea of what direction to take in regard to mold shrinkage. Early laboratory work performed that covered a lot of the problems and this report has been taken and applied to present day compounds. The following will present the data that applies and this in turn should help in future mold design.

This work is intended to bring together pertinent facts concerning the shrinkage of molded rubber goods and summarize the laboratory work completed on neoprene, natural rubber and nitrile compounds.

According to Juve and Beatty*, there are several factors affecting shrinkage:

1. The principle reason for shrinkage is the thermal contraction resulting from cooling from the temperature of vulcanization to room temperature. Partly counteracting this is the increase in dimensions of the mold cavity from heating from room temperature to vulcanizing temperature. A generally accepted figure for the coefficient of volume expansion for a high gum mix is $6.6 \times 10^{-6}/^{O}C$.
2. A second factor affecting shrinkage is the change in volume resulting from vulcanization. Shrinkage due to vulcanization for a 3-part sulphur stock has been found to be about .0009 inch/inch. Thus for a compound stock this would be reduced in proportion to the volume of rubber present.
3. Other factors affecting the shrinkage are the grain direction; i.e., parallel to and across the direction of the grain. This shrinkage is large along the direction of the grain and small across the grain.

Fibrous materials such as cotton linters produce many complicating factors. Processing stocks with these materials will orient the fiber and often give much greater shrinkage perpendicular to the fiber than along the fiber.

*** Reprint from Rubber World, October 1954 - "Shrinkage of Mold Cured Elastomer Composition" by: A. E. Juve and J. R. Beatty.**

Metal parts also have some effect. Where the thickness of the rubber on the metal part is thin, the difference in shrinkage is large and thus produces considerable stress in the rubber portion. As the rubber portion becomes thicker, the shrinkage becomes less and the difference less.

All test work was performed in a mold with center pins varying in diameter from 1" to 5" and an outside diameter constant at 6". Height was also constant at 2". Only the 1", 3" and 5" I.D. pieces were made on each trial to reduce the time involved. Compounds from the factory were selected with varying elastomer content and each piece allowed to stand over night before being measured. Simple devices for measuring was used with the greatest possible accuracy and these measurements converted to percent shrinkage. Preforms were constructed in a manner simulating that in the plant, which gives shrinkage values with the grain along O.D. and I.D. measurements and across the grain on thickness measurements.

Outside diameters and inside diameters showed a fair degree of accuracy, whereas thickness measurements were somewhat erratic because of mold closure.

Curves have been laid out for each polymer, plotting the percent shrinkage against the percent of organic material plus elastomer by volume. These curves are shown as Figures 1, 2, 3, 4, 5 and 6 (attached).

Table I has also been attached giving the volume percent elastomer plus organic material for the current factory compounds.

To interpret the charts, use the values for the O.D. and the 5" X 6" piece to arrive at the normal linear shrinkage for the stock. This would apply to thin walled pieces, rings, etc. For pieces containing thicker walls, use those values given for 3" or 1" I.D. pieces or that cylinder conforming closest to the piece.

For example, to find the shrinkage on the lip of a 6" X 3" piston rubber using 20-001-80,

first obtain the proper volume percent elastomer from Table I; then using the 3" X 6" curve on Figure 3, you find the shrinkage on the O.D. to be 0.57% or .0057 inches/inch.

With the attached charts, the mold designer should be able to proceed with a greater degree of accuracy in determining mold dimensions for a finished piece. These charts, however, are accurate only for solid rubber pieces and adjustment should be made for those having wires or inserts. Also, variation may occur in compounds having an excess of ester type plasticizer or in HiSill compounds.

TABLE I

Compound	% Elast. + Org.
10-003-60	77.2 %
10-003-75	72.6 %
10-003-85	64.6 %
20-003-70	72.0 %
20-004-70	72.2 %
20-001-80	56.7 %
20-005-80	65.5 %
20-001-90	49.7 %
30-002-45	85.9 %
30-001-65	78.5 %
60-001-65	70.6 %
60-003-80	79.3 %

FIGURE 1
VOLUME % ELASTOMER VS ID % SHRINKAGE
CONSTANT THICKNESS ID & OD
NEOPRENE - BLACK FILLED

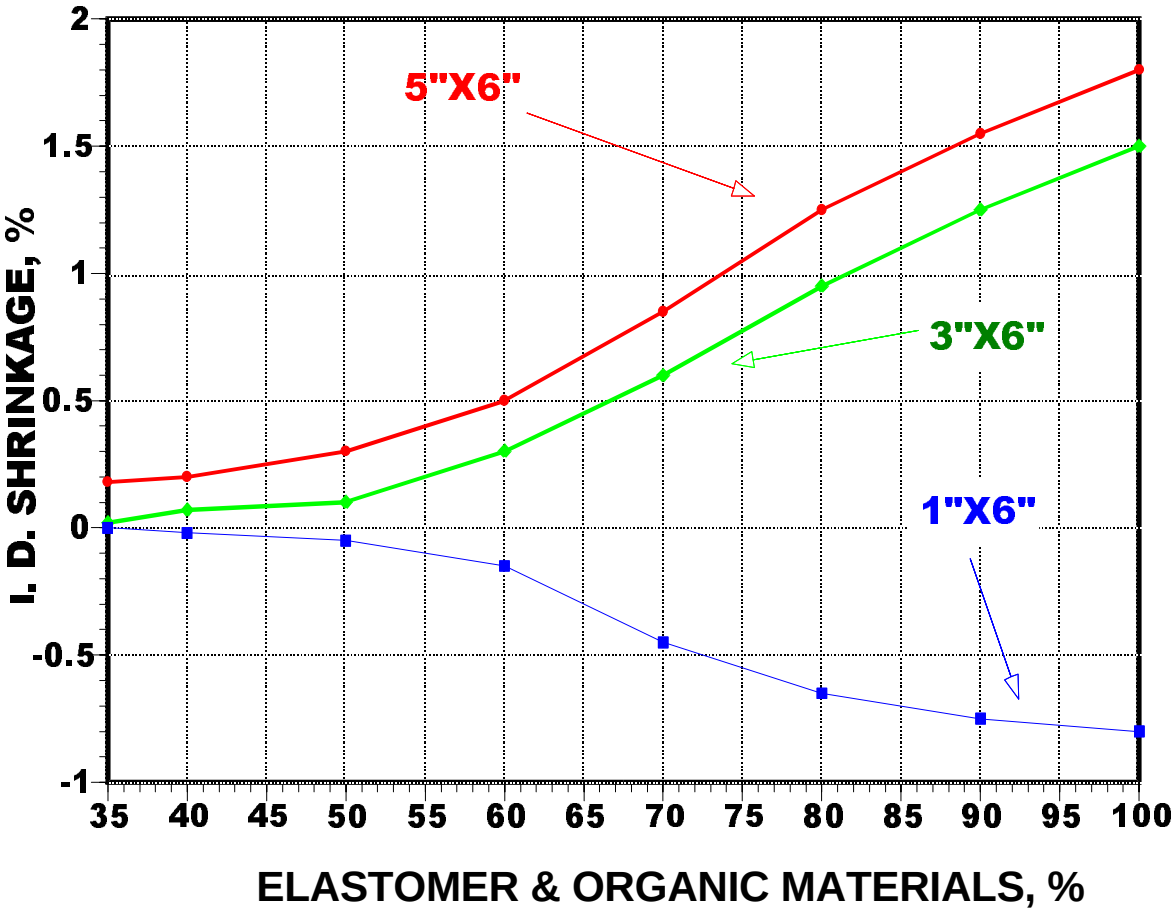


FIGURE 2
VOLUME % ELASTOMER VSOD % SHRINKAGE
CONSTANT THICKNESS ID & OD

NEOPRENE BLACK FILLED

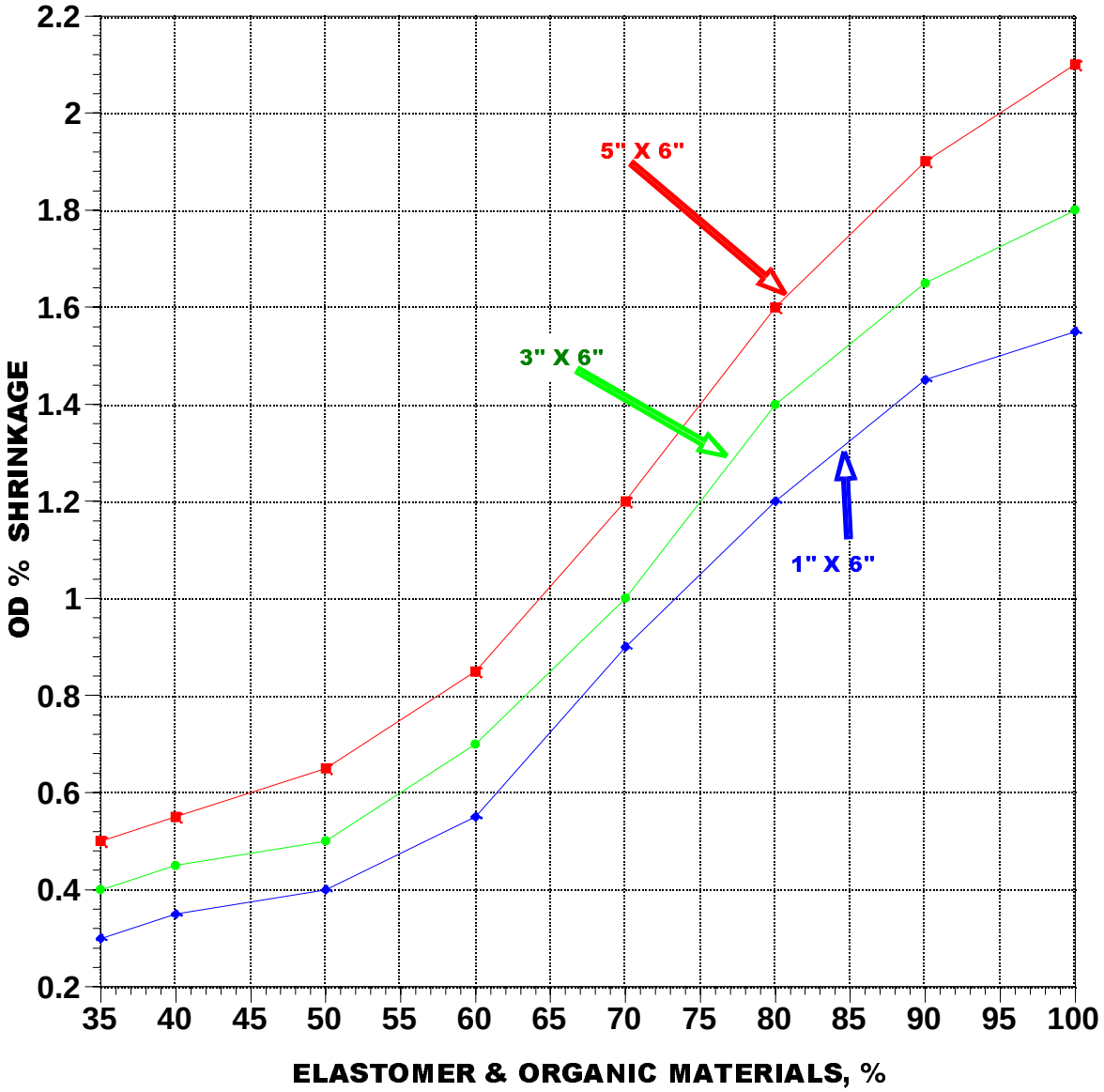


FIGURE 3
VOLUME % ELASTOMER VS OD % SHRINKAGE
CONSTANT THICKNESS - ID X OD

NATURAL RUBBER - BLACK FILLED

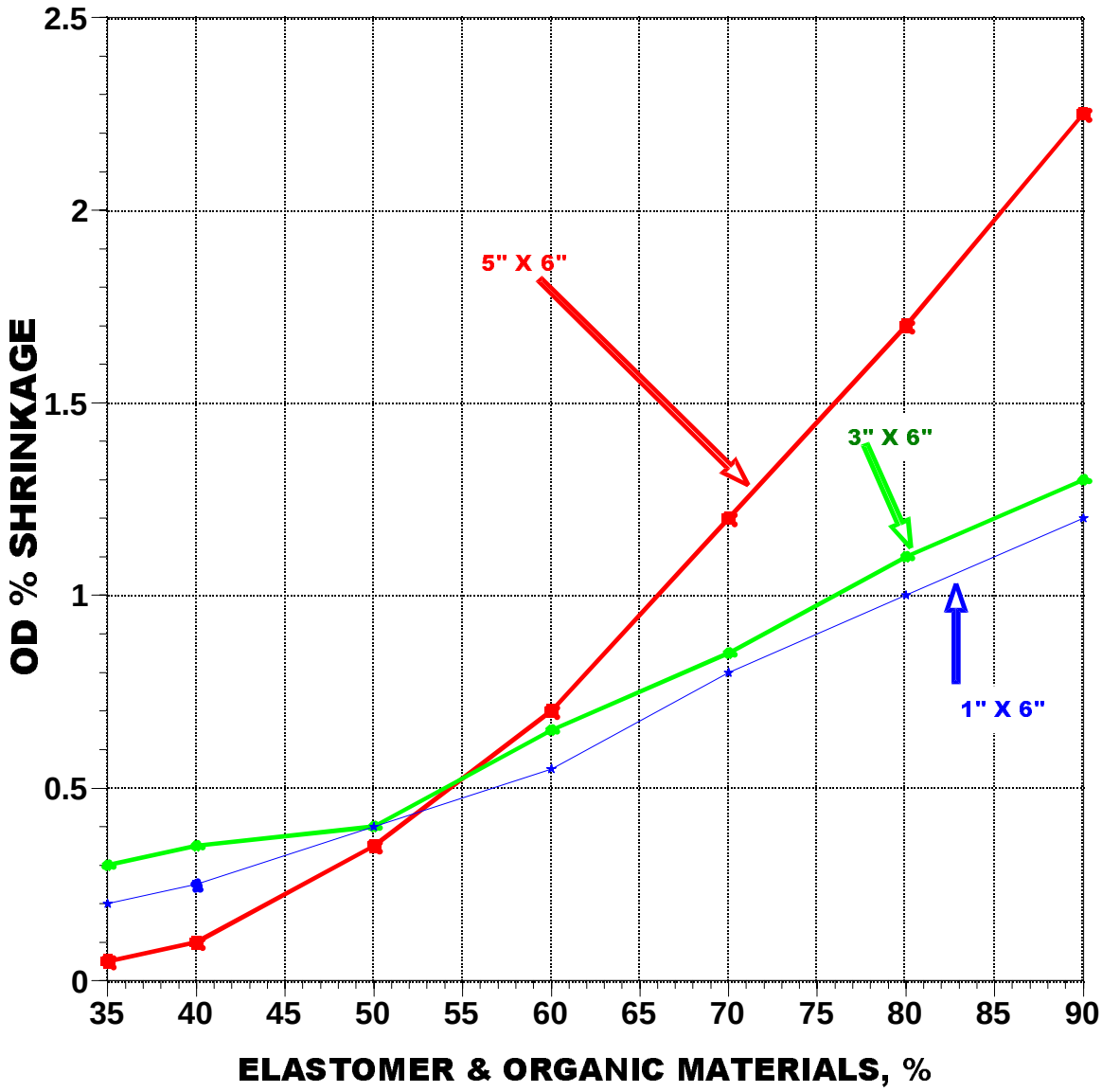


FIGURE 4
VOLUME % ELASTOMER VS ID % SHRINKAGE
CONSTANT THICKNESS - ID $ OD

NATURAL RUBBER (POLYISOPRENE) - BLACK FILLED

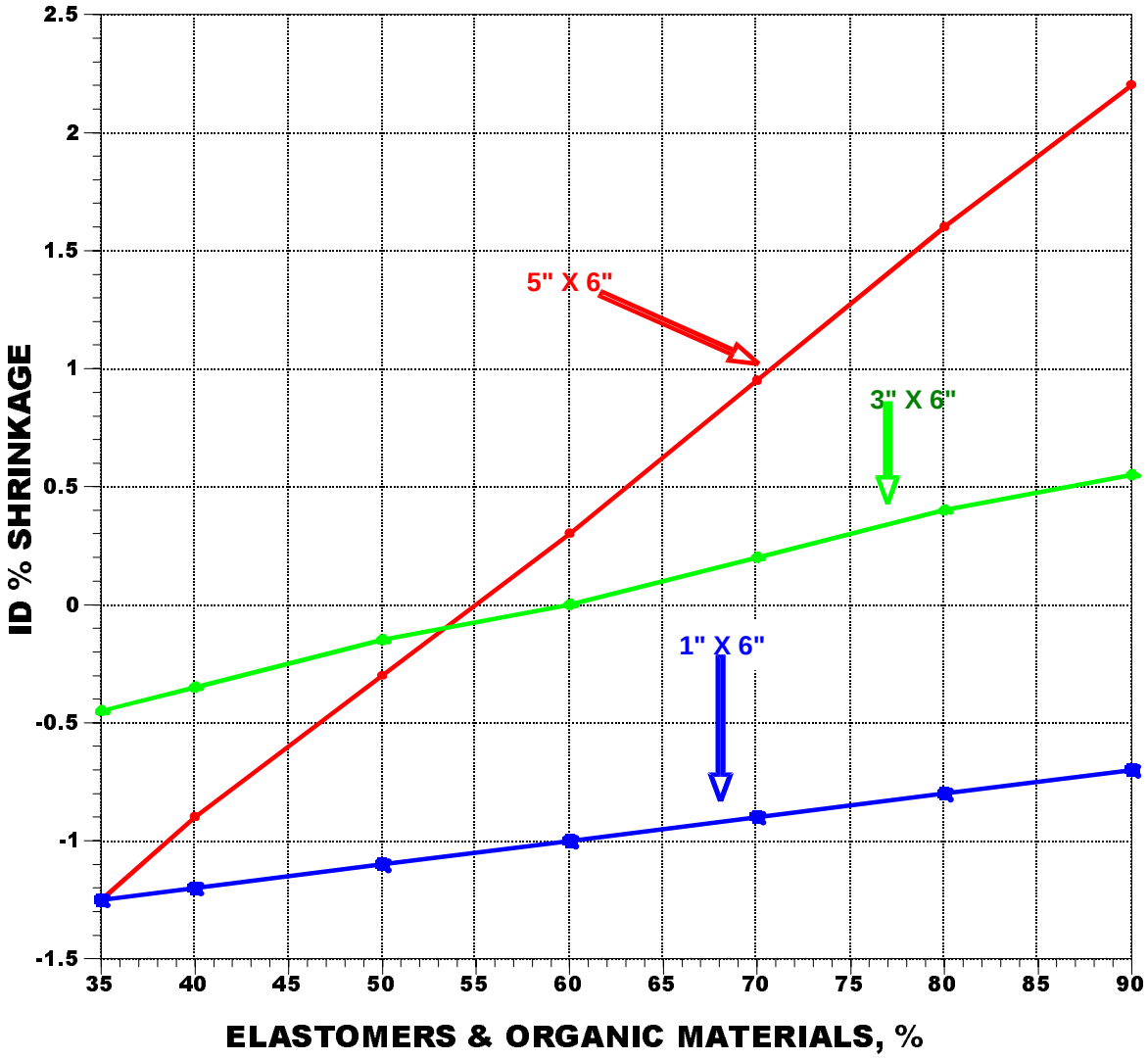


FIGURE 5
VOLUME % ELASTOMER VS OD % SHRINKAGE
CONSTANT THICKNESS - OD & ID
NITRILE - BLACK FILLED

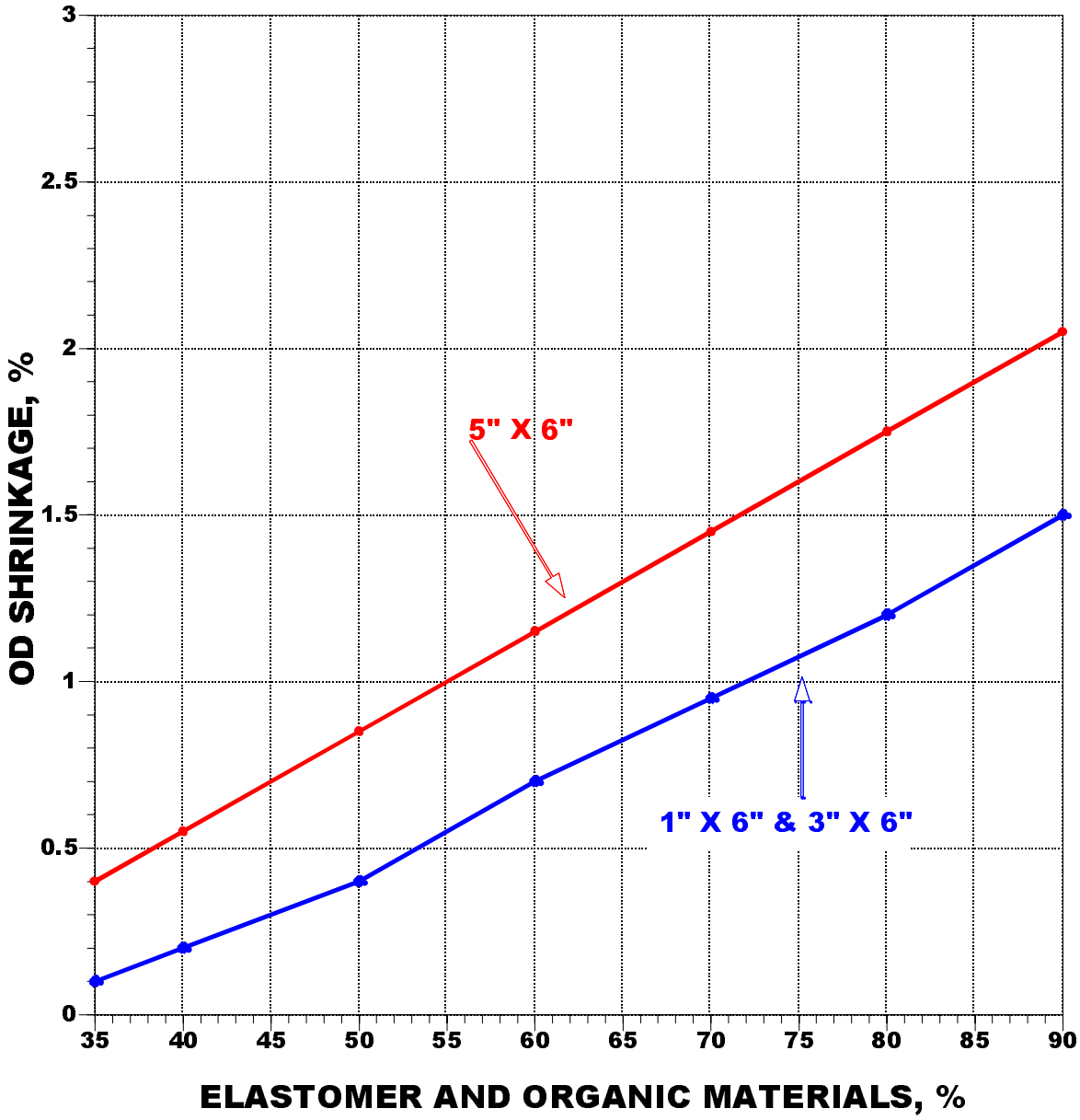
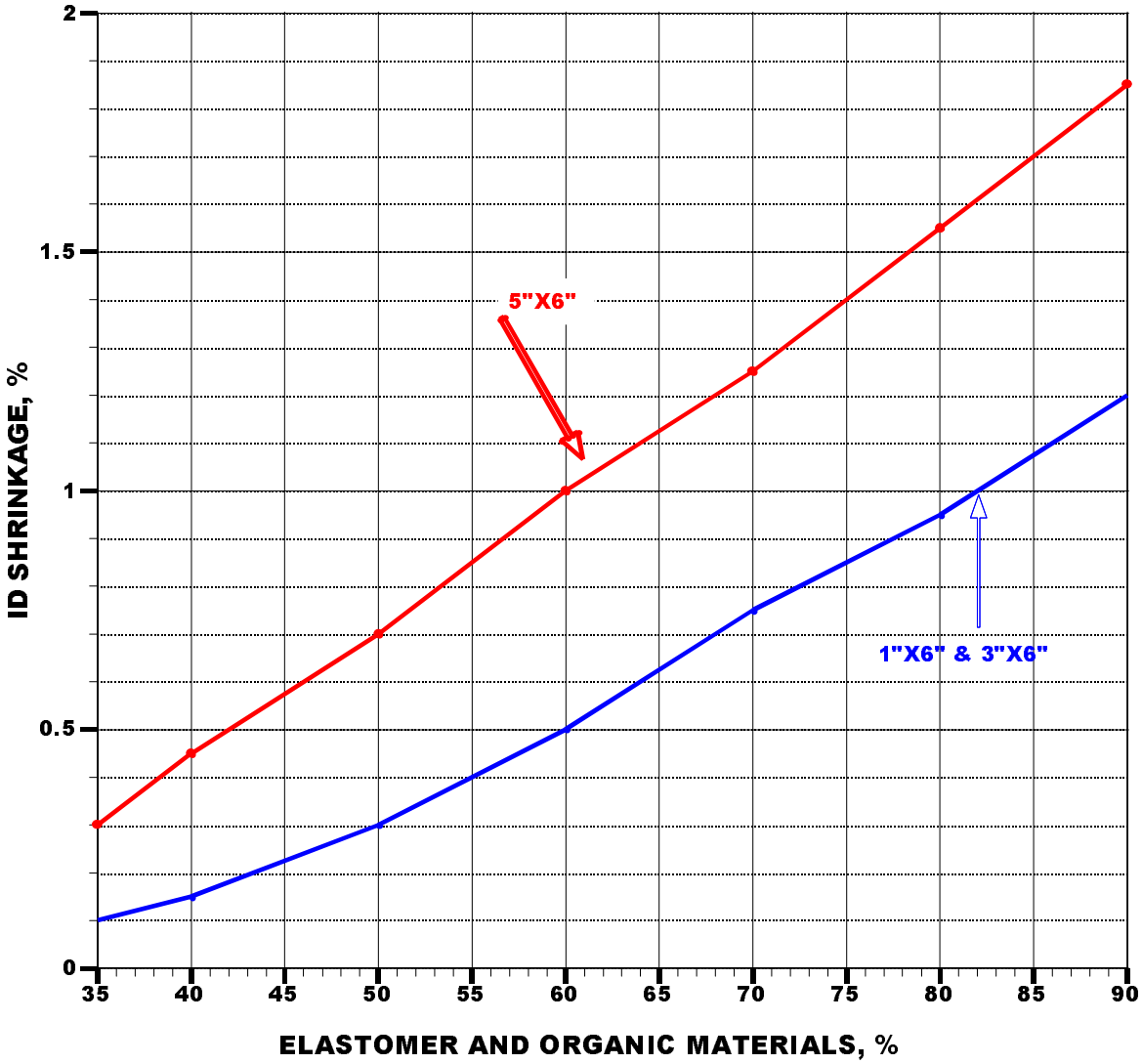


FIGURE 6
VOLUME % ELASTOMER VS ID % SHRINKAGE
CONSTANT THICKNESS - ID & OD
NITRILE - BLACK FILLED



Are you a manager or a blob?

You can call yourself a real manager if you are:

Outspoken. You are willing to state your case and stand up for what you believe. You may also be getting into trouble with your bosses for your stands.

Attuned. You have a sense of what's going on around you, not only in the company, but in the real socio-economic world outside, too.

Creative. You have the ability to spot a new way of doing things that may pay off big for your company.

Dedicated. You thrive on work. You realize money comes with success so you pay attention to the job at hand.

Future-oriented. You know where you're going and how to get there.

Accountable. You take the responsibility for your failures as well as your successes.

Flexible. You are able to adapt to new ways of doing business and willing to try something new.

Healthy. You do not fight with yourself, have a healthy outlook on life, and don't have a drinking problem.

Politically wise. You don't play politics to somebody else's disadvantage and are able to transcend personality conflicts.

Realistic. You live and work one day at a time.

A risk-taker. You are not afraid to play your hunches. You consider set goals to be a minimum.

You can call yourself a blob if you are:

None of the above.