3” Back Water Valve Project

Background, Scope and Objective

Review CAD drawings and 3D model for the product.
Make product design recommendations to improve cost/performance.
Conduct Mold Flow analysis and analyze results.
Make tooling recommendations including tool steel, gating, ejection, cooling etc.
Make process recommendations.

Material specified is Rigid PVC, Geon M1000 White from Poly One Corporation.

Analysis

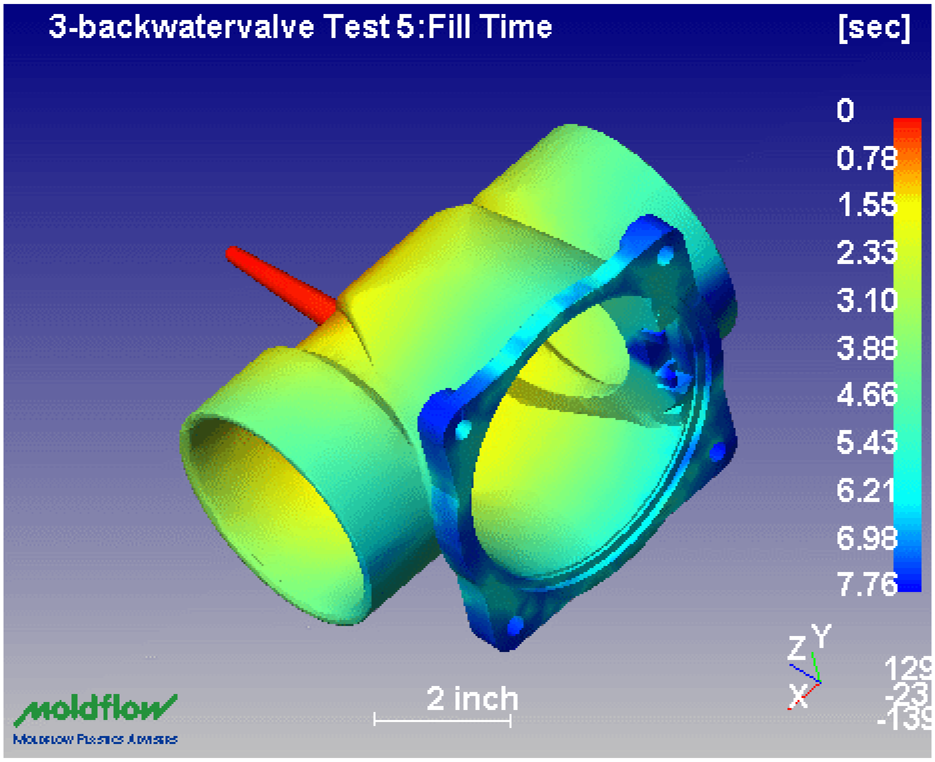
The supplied model was thoroughly scrutinized by our team and Moldflow analysis using Moldflow software along with FEA analysis using Cosmos were conducted. The part was reviewed from product design, processibility, and tooling design.

Results:

Moldflow analysis was conducted using a single cavity mold with direct sprue gating into the part. Several iterations were carried out to establish optimum location of the sprue gate in order to achieve the most balanced flow into the cavity along with uniform pressure drop and flow front temperature. Special attention was given to reducing knit lines and keeping the melt hot to obtain strong knit lines.

Plastic Flow: The fill pattern shows how the part fills, and help to understand how weld lines and air traps will form.
This part filled very uniformly and showed the formation of knit lines as expected.

Fill Time: The results of this analysis show the path of the plastic through the part. The fill time analysis uses a range of colors that will indicate the regions first filled (colored red) through the last region to fill (colored blue). Fill time results determine if all flow paths fill at the same time, (balanced flow) hesitation and over-packing.
The results showed that the filling pattern for Back Water Valve is fairly uniform without any hesitation effect. The part should be filled in less than 8 seconds.



Confidence of Fill: The results of this analysis help determine whether the part will fill with a high level of confidence and also indicate the areas of low confidence of fill. The analysis simulates the molding parameters at the normal processing range for the material selected from the database.
The Confidence of Fill analysis showed a very high degree of confidence of fill indicating that there should not be any problems filling this part at a relatively low injection and packing pressure.

Injection pressure: The result displays injection pressure when the selected point was filled. The result uses a range of colors to indicate the highest pressure (colored red) thorough the region of the lowest pressure (colored blue). The results can be used to implement other parameter changes to improve filling such as, higher or lower injection pressure, moving gate location, changes to the parts geometry, of possible selection of a different polymer.
The injection pressure required to fill this part is well within the range of the molding equipment.

Pressure Drop: Polymer melt flows from high pressure areas to low pressure areas. The results of this analysis display the pressure drop through the cavity. The pressure drop test uses a range of color to indicate the region of lowest pressure colored blue) through the region of the highest pressure drop (colored red). Ideally, the pressure drop should be uniform from the injection location to the last point of to fill.
Analysis of this part showed a very uniform pressure drop as indicated by the colors showing 80% of the part being filled uniformly at very low pressure drop differential. The pressure drop is high in the flange area as expected and should not pose any concern.

Flow Front temperature: The ideal filling pattern has the melt reaching every extremity of the cavity simultaneously, with the constant melt-front velocity throughout the process. Otherwise local over-packing may arise within the part. The flow front temperature uses a range of colors to indicate the region of the lowest temperature (colored blue) through the highest temperature region (colored red).
The part analyzed shows only a few degree variation in flow front temperature.

Weld (Knit) Lines

Only Weld Lines showing are the ones around the holes which are expected. Based on the flow front temperature and fill time, it appears that weld line strength should be very high and should cause no concern.

Air Trap

Majority of the air bubbles are in the area last to fill and with proper venting they should not cause any problems.

Product Design Observations

Overall design of the 3" Back Water Valve looks very sound. Wall thicknesses look uniform, and the part has adequate radius in all critical areas.

<u>Tooling Recommendations</u>

Mold Steel: 420 Stainless Steel core and cavity inserts for high volume production.
Either H13 or P20 tool steel with electroless nickel or chrome plating is appropriate for producing 150,000 to over 1,000,000 parts. The plating, which protects the steel, may need to be replaced occasionally.

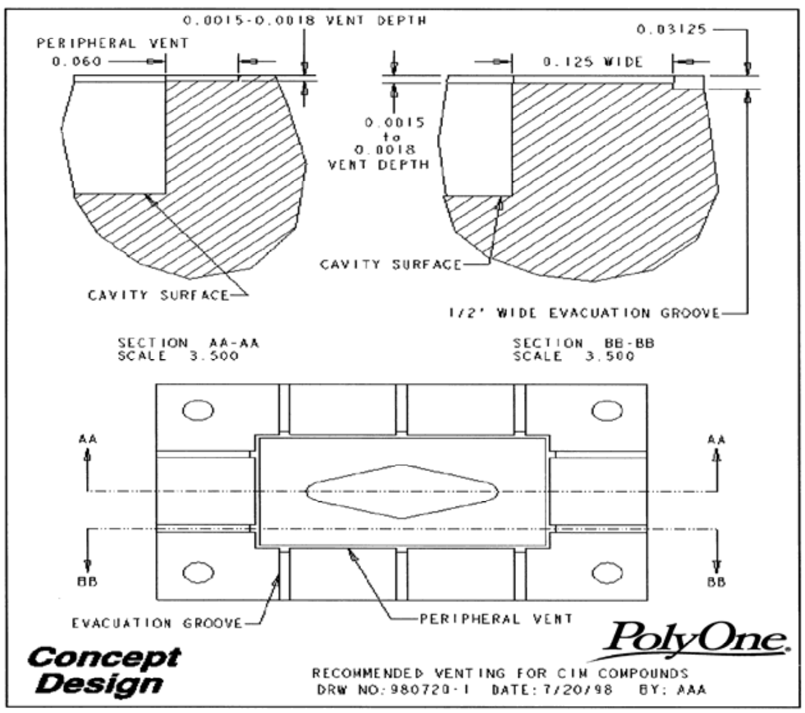
Gating: Direct Sprue gate in exact location as shown in the Moldflow analysis. This is very important since this location allows the most balanced filling of the part.

For a Sprue Gate

Average Wall Thickness in (mm)	Part Weight ounces (grams)	Sprue Diameter in (mm)
0.100 (2.54)	10 (284) or less	0.281 (7.14)
0.125 (3.18)	16 (454) or less	0.281 (7.14)
0.125 (3.18)	16 - 32 (454 - 908)	0.375 (9.53)
0.125 (3.18)	32 - 48 (908 - 1362)	0.438 (11.13)
0.140 (3.56)	32 (908) or less	0.375 (9.53)

Table 7a. Mold design parameters for sprue gates

Cavity Venting Diagram



Process Recommendations

Machine Size:

Screw: Low compression screw is preferred. However, if you plan to use Geon M 1000 grade of PVC, you can get by with general purpose screw with 3:1 compression ratio.

Check Ring: Free-flowing sliding check rings with ample clearance under the check ring are strongly recommended. The clearance under the check ring should be

1 to 1-1/2 times the exit depth of the screw. This is the least restrictive screw tip that achieves complete shutoff during injection. Complete shutoff is important because it prevents backflow and delivers the full, steady injection pressure.

Nozzle: Nozzle length of one to six inch is suggested. Long reach nozzles should be avoided at all costs.

Barrel Capacity: A shot weight which uses 50% to 70% of the barrel capacity is desirable for molding rigid PVC.

Barrel Temperatures:

Sample Temperature Profile Chart

Press Size (tons)	**Rear Zone** (feed)	**Middle Zone** (compression)	**Front Zone** (metering)	**Nozzle**
75 - 150	370°F (188°C)	370°F (188°C)	370°F (188°C)	370°F (188°C)
175 - 350	340°F (171°C)	350°F (177°C)	350°F (177°C)	360°F (182°C)
375 - 500	340°F (171°C)	345°F (174°C)	345°F (174°C)	360°F (182°C)
550 - 1000	340°F (171°C)	345°F (174°C)	345°F (174°C)	360°F (182°C)
1100 - 2500	320°F (160°C)	320°F (160°C)	320°F (160°C)	350°F (177°C)

Optional barrel profiles of "Flat" or "Reverse" can also be used effectively.

Melt temperature:

Melt Temperature

The ideal melt temperature range for Geon® Vinyl Rigid Molding Compounds is 390°F to 410°F (200°C-210°C). The temperature is measured by taking an "air shot" and measuring the temperature of the melt with a calibrated needle probe pyrometer. In addition, the melt should look smooth and glossy. A dull-looking melt indicates too low a temperature. A rough surface melt indicates too hot a melt or moisture in the compound.

Back Pressure: 75 to 150 psi

Screw RPM: 30 to 50 rpm

Injection Speed: 1 inch per second

Mold temperature: 70 to 90° F