Arnite® AV2 370 /B

Machinery, tooling and processing guidelines for injection moulding Brake Booster Valve Bodies

- Machinery
- Tooling
  - Tool construction
  - Tool modification
- Processing
  - Material handling
  - Machine settings

a DSM Guide

Unlimited. DSM

Machinery

Machinery

Arnite® AV2 370 /B can easily be processed on standard injection moulding machines. However, DSM recommends the use of modern, electronically controlled machines for this precision part.

Cylinder

For optimal processing of Arnite® AV2 370 /B, the residence time of the material in the cylinder should be minimized. If the material is properly dried, the residence time in the cylinder can be up to 10 minutes. The size of the machine and cylinder diameter should therefore be such that the product weight is within a range of approximately 40 to 70 % of the maximum shot capacity. The minimum required effective injection pressure is 2000 bar (29000 PSI). The heating elements should allow for precise and constant temperature control, to avoid large differences in melt temperature. To obtain good product quality, a fast injection speed should be used.

Screw

The geometry of the screw determines the transport behavior and the degree of plasticization of the granules. Standard, three-zone, screws with an L/D ratio from 20 to 23 and a thread depth ratio of approximately 1:2 yield excellent results. To avoid backflow of the melt during injection and holding pressure, the screw should be equipped with a non-return (check)valve.

Nozzle

Arnite® AV2 370 /B should be processed on decompression-controlled machines with an open nozzle. Employing a short nozzle, having a channel diameter of 12 mm and a 4 mm bore with land length 10 to 15 mm, will enable minimal frictional heat and pressure loss.

Tooling

Tool construction

Weld lines will be present where there are cross channels at multiple sections. The resulting glass fiber orientation will lead to shrinkage differences. As a result, the cylinder will turn into an elliptical tube. This part of the tool core should be as inexpensive and as simple as possible, so that the modifications can be done cost effectively. Therefore, tooling should be constructed in such a way as to enable the easy replacement of mold parts that have to be corrected (modular mould construction).

Venting

Insufficient venting leads to burn spots at the ends of flow paths, poor surface appearance, poor local mechanical strength and dimensional inconsistency. Special attention should therefore be given to effective mould venting. Vents should be located on parting lines, slide cores and at the end of the flow paths (3 x 0.02 mm).

Tool modification

Considerations before starting the mould modification process

Prior to making adaptations to production tooling, to correct for dimensional problems, concentricity and/or length and diameter tolerances, please consider the following:

- Tooling must first be fully production capable (i.e. the tool must have proven ability to run consistently, under typical production conditions).
- Tool surface temperature must be at least 140°C/284°F (measured on the surface of the tool), which is the minimum crystallisation temperature for Arnite® AV2 370 /B.

Tooling

Tool modification (continued)

- Adequate cooling capacity must be available to bring the polymer from melt temperature (290°C/554°F) down to tool temperature (140°C/283°F). To ensure cycle time efficiency, a cooling channel diameter of 10 mm is required for pressurized water devices and 12 mm for oil heating devices.

- Machines settings should remain constant and verified frequently.

- Machine settings should not be changed after tooling corrections have been carried out as this could have an adverse effect on part dimensions. This implies that this part of the development should only be performed on the machine for production. It is extremely important to carry out these actions carefully and deliberately.

Production and measurement of reference samples

- As soon as the machine/tool combination is determined and the process is consistent and acceptable for production (between 50 and 60 seconds cycle time), 150 shots should be taken and consecutively labelled. The first 50 shots should be discarded and complete dimensions of the remaining 100 parts taken. The measurement statistics taken from these parts should serve as the reference for tooling corrections.

- To correct for “out-of-roundness” problems on the tube section, several dimensions must be checked. The tube diameter should be measured at 10 mm intervals along the tube. The diameter should be measured at least 6 times (each 30 degrees) at each point along the tube. The resulting corrections will lead to an “out-of-round” core that will produce a round part.

Calculation of the correction factor

- Reference sample dimensional statistics will provide the required correction factor for tool adaptations. It is realistic to expect that diameter tolerances, per batch, of ± 0.05 mm can be maintained.

- To account for batch to batch variability, 0.05 mm must be added to dimensional tolerances. Additionally, 0.05-0.10 mm should be added to account for mould and machine variability. Total acceptance tolerances in standard production should therefore be 0.15 - 0.2 mm.

- Shrinkage of Arnite® AV2 370 /B for brake boosters can be approximated as 1.2% (diameter) and 0.4% (length).

Processing

Material handling

To avoid moisture pick-up or condensation on granules, store materials on the shop floor at least 12 hours prior to use, to allow for temperature equilibrium. Additionally, open bags just prior to usage and immediately reseal any open packages.

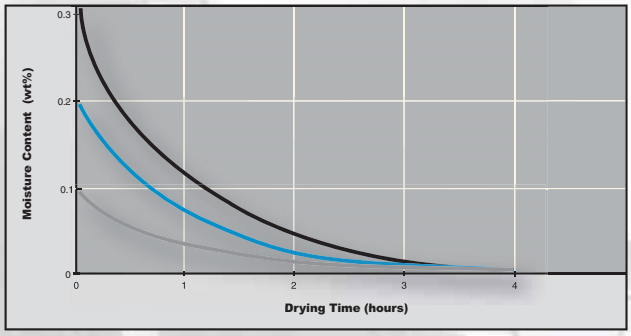
Use a desiccant dryer or an ambient air hopper dryer with a minimum residence time of 2 hours and a maximum of 4 hours. In a loaded dryer the air capacity must be at least 3m^3/kg granules/hour, and the temperature in the hopper must be checked regularly and maintained between 110°C/230°F and 120°C/248°F (Dew point -30°C/-22°F).

The moisture content will stabilize in the hopper-dryer at a level between 0.004 and 0.008%, which will lead to the best results in moulded components. Never use granules with measured moisture contents higher than 0.008%.

Table 1. Drying conditions.

Drying time	[hours]	2-4
Temperature	[°C] [°F]	110 - 120 230 - 248
Remarks	* Desiccant dryers with a dew point of -30°C (-22°F), and predried air dryers are used to dry Arnite. * To prevent material discoloration while using air dryers, temperature settings of >120°C (>248°F) should be avoided.	

Figure 1. Drying time in dehumidifying dryers. Air temperature 120°C/248°F with dew point under -20°C/-4°F.



Water absorbtion

Table 2. Rate of moisture absorption.
Time needed to reach maximum moisture content (>0.008%) in Arnite® AV2 370 /B. Initial moisture content 0.005% (= 50 ppm).

Ambient Temperature 23°C (74°F)			
Relative Humidity	**20%**	**50%**	**90%**
Saturation level (ppm/min)	0.6	5	20
Expected time (minutes) to reach moisture content of 0.008%	50	6	1.5

Processing

Machine settings

Injection pressure (hydraulic)		Injection time	Holding pressure (hydraulic)
Mould	120-150 bar 1740-2175 PSI	2-3 sec	35-60 bar 508-870 PSI

Cooling time (plasticizing time)	Decompression	Remark
15-20 sec	Just enough to prevent nozzle drool	Be sure that plasticizing is constant and consistent. Back pressure >10 bar / 145 PSI

	Mould	Melt	Nozzle	Front	Center	Rear	
AV2 370 /B	140	285-295	285-295	285	280	280	°C
	284	545-563	545-563	545	536	536	°F
Recommended screw rotation					0.3 m/sec (max 0.5 m/sec)		

The optimum performance and consistency of moulded specimens can only be assured when the moulding machine is running “on-cycle.” Every time the machine has been “off cycle” or restarted, the first 10 shots must be discarded. Once the optimum settings have been checked and are OK for production, it is very important to limit further changes to an absolute minimum.

Europe
The Netherlands

DSM Engineering Plastics
Poststraat 1
P.O. Box 43
6130 AA Sittard
Tel. +31 46 47 70075
Fax +31 46 47 70101

USA
North America

DSM Engineering Plastics
P.O. Box 3333
2267 West Mill Road
Evansville, IN 47732-3333
Tel. +1 812 435 7500
Fax +1 812 435 7702

Asia Pacific

DSM Engineering Plastics Asia Pacific
11F, The Headquarters Building
No. 168 Middle Xi Zang Road
Shanghai 200001
China
Tel. +86 21 6141 8188
Fax +86 21 6141 7010

DSM Engineering Plastics

www.dsmep.com - www.arnite.com

Trouble shooting

Shrinkage voids/sink marks

Cause	Solution/check
Shrinkage voids caused by excessive wall thickness.	• Increase shot size and consequently the weight of the article (check weight).
Holding-pressure too low or not effective in compensating for shrinkage.	• Increase the holding-pressure and/or • Increase the holding-time. • Check the gate(s) for blockage (contamination). • Check the dimensions of the gate(s). Note: If necessary, enlarge the gate(s).
Injection speed/pressure incorrect.	• Increase the injection speed.
Excessive shrinkage due to high polymer temperature.	• Decrease the cylinder temperature.

Air bubble or hole in the part

Cause	Solution/check
Injection speed too high at the transition from thin to thick walled sections.	• Decrease injection speed.
Inadequate mould venting.	• Increase venting possibilities (parting plane, bosses, ejector pins). • Check for blockage in the mould vents.

Periodic gloss differences:

often occur as rings around the gate or at the end of the flow path

Cause	Solution/check
Polymer temperature too low at melt front.	• Increase injection speed. • Increase cylinder temperature. • Increase nozzle temperature. • Increase hot runner temperature. • Increase back pressure. • Adjust screw speed.

Silver streaks on the surface from the gate(s) forward

Cause	Solution/check
Moisture in or on the granulate.	• Avoid condensation on granulate. Note: Don't bring the material out of a cooler (storage) area immediately prior to processing. • Dry the granulate.
Air trapped during plasticizing.	• Decrease decompression. • Increase back pressure.