GE
Plastics

Valox*

PBT/PET/PC resin

performance featured product guide

GE imagination at work

Valox PBT/PET/PC Resin

Developed in 1970 by GE Plastics, Valox* resin has become a very popular brand of PBT. With manufacturing and compounding facilities around the globe, GE Plastics has continued to introduce new products and blends with enhanced performance.

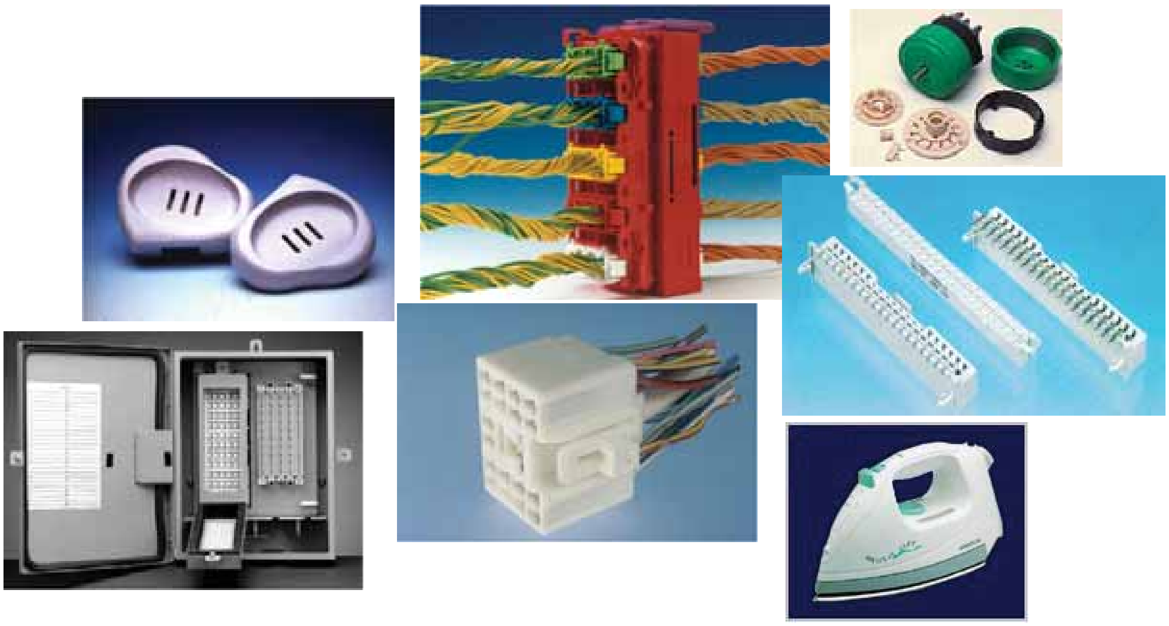
Manufacturing Locations

Whether you're a small business that designs, engineers and manufactures in one location or a multinational corporation that develops in one pole and manufactures in another, GE Plastics is ready to support your success.

Content

1. Introduction

Valox PBT/PET/PC Resin



Valox resin can help make customer applications safe and reliable.

- Long-term heat resistance
- Dielectric properties
- Chemical resistant
- Stiffness and strength
- Dimensional stability
- Creep resistant
- Impact resistant

With value added features to meet extreme weather conditions, stringent safety regulations and complex part design.

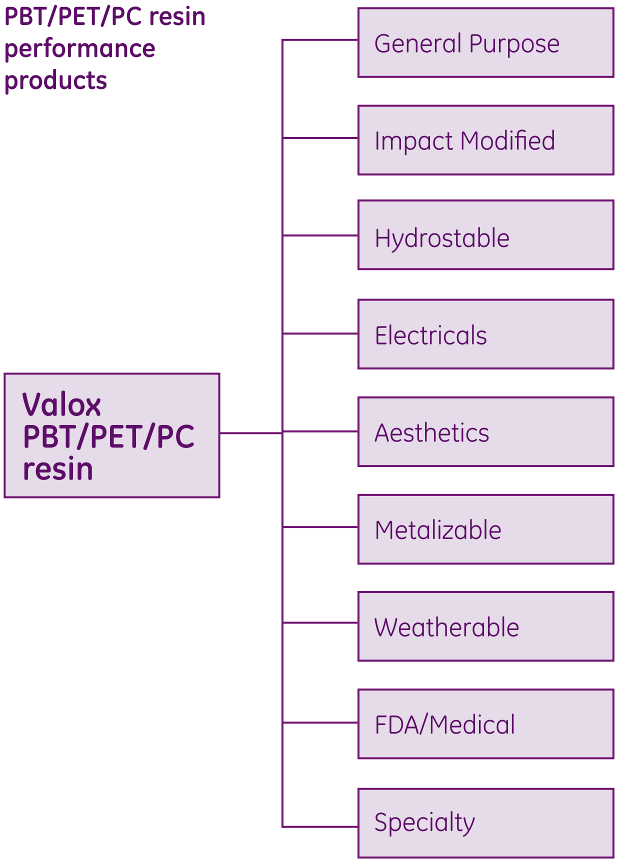
Valox Polyester Resin

This family of resin includes PBT (polybutylene terephthalate), PET (polyethylene terephthalate) and polyesters blended with polycarbonate.

These resin can be modified to offer exceptional performance in a wide variety of demanding applications.

Also included are a large number of general purpose and specialty grades for specialty performance applications.

Table 1: Valox PBT/PET/PC resin performance products



All the grades are designed to offer an excellent balance of physical, electrical, chemical and aesthetic properties to meet a wide range of applications.

Valox PBT/PET polyester resin and blends with polycarbonate resin offer processing flexibility, enhanced quality and productivity. The product line includes grades for injection molding, extrusion, blow molding and structural foam. It also includes a full line of flame retardant grades to meet UL regulations.

Typical property profiles of Valox resin include high dielectric strength, high heat resistance, excellent resistance to many common chemicals and good barrier resistance.

Processing characteristics include excellent flow, fast cycle times and excellent blow molding performance with designated grades.

Aesthetic options include high gloss capability and incorporation of visual effects.

The Valox resin portfolio is constantly modified to meet demanding applications in industries such as:

- Electrical and lighting
- Automotive
- Telecommunication
- Medical
- Food
- Appliances
- Business machines
- Textiles

2. General purpose Valox resin

General purpose grades of Valox resin include a wide variety of standard and flame retardant versions in both unfilled and glass filled grades.

Potential application benefits:

- Excellent balance of properties
- Enhanced flow
- Impact modified

Potential processing benefits:

- Wide and robust processing window
- Fast cycle times
- Lower drying temperatures
- Maintains performance with recycle

Product compliance:

- Long history
- Strong agency approval
- Global availability/local fulfillment
- Largest portfolio
- Valox 420SEO resin – a global benchmark
- Flame retardant grades meet UL, CSA, IEC and EN standards

Potential applications:

- Automotive underhood (connectors, sensors)
- Industrial sensor and connector applications
- Applications where heat and humidity are a challenge

Table 2 – Typical general purpose Valox resin grades

325	Unfilled non-FR general purpose grade
310SEO	Unfilled FR general purpose grade, passes UL 94 V0 at 0.70 mm
4022	20% glass filled non-FR general purpose grade
420	30% glass filled non-FR general purpose grade
457	7% glass filled FR general purpose grade, passes UL 94 V0 at 0.70 mm
451E	20% glass filled FR general purpose grade, passes UL 94 V0 at 0.70 mm
420SEO	30% glass filled FR general purpose grade, passes UL 94 V0 at 0.70 mm

3. Impact modified Valox resin

GE Plastics is an industry leader in material blend technology. Our Valox resin product line takes advantage of this expertise to provide unique combinations of chemical resistance coupled with improved impact performance. High impact is a differentiator offering higher value application.

Potential application benefits:

- Low temperature impact to -40°C
- Most unfilled flame retardant
- Impact resistance coupled with weatherability

Potential processing benefits:

- Excellent flow/thinwall

Product compliance:

- Flame retardant grades meet UL, CSA, IEC and EN standards

Potential applications:

- Sports and leisure snowmobile parts
- IT cabinets
- Connectors
- MCB, MCCB
- Industrial plugs and sockets

**Table 3 –
Typical impact modified Valox resin grades**

337	Unfilled non-FR impact modified grade with an excellent impact resistance at low temperature
357, 357M, 357X, 357XM, 357P, 357XP	Unfilled impact modified FR grade, passes V0 at 0.70 mm. Available with easy flow and mold release
365	Unfilled FR impact modified with good chemical resistance and dimensionally stable grade
PDR4926	18% glass filled PBT grade, impact modified FR, passes UL 94 V0 at 0.75 mm
VIC4311	30% glass filled, excellent impact modified
VIC4320N	30% glass filled, impact modified
VIC4350	33% glass filled PBT FR, passes UL 94 V0
VX3608C	Unfilled PBT/PC impact modified blend with FR, UL 94 V0 at 1.6 mm

4. Hydrostable Valox resin

Valox resin hydrostable grades provide enhanced retention of physical properties when exposed to extreme heat and humidity. They provide unparalleled performance in hot/humid environments.

Potential application benefits:
- Improved property retention in heat/humidity
- High flow to fill complex molds
- Impact modified for enhanced toughness

Potential processing benefits:
- High flow to fill complex molds
- Fast cycling
- Lower drying temperatures
- Maintains performance with recycle

Product compliance:
- Passes USCAR up to Class IV protocol

Potential applications:
- Automotive underhood (connectors, sensors)
- Industrial sensor and connector applications
- Applications where heat and humidity are a challenge
- Buffer tubes for fiber optics
- Specialty fibers

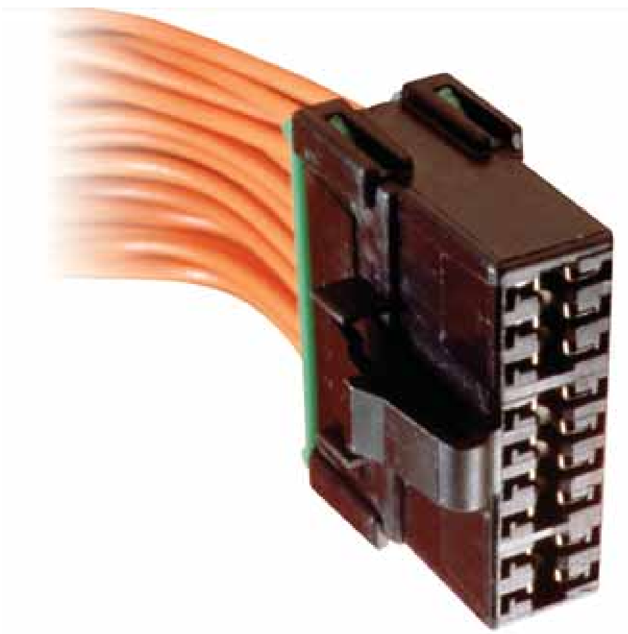
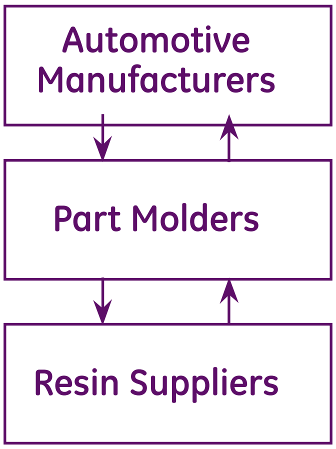


Table 4 – Typical hydrostable Valox resin grades

HR326	Unfilled high viscosity PBT with enhanced hydrostability and improved chemical resistance
HR326HV	Unfilled high viscosity PBT (higher than HR326) with enhanced hydrostability and improved chemical resistance
HR426	30% glass filled PBT with enhanced hydrostability and excellent mechanical properties
K3501	Unfilled heat stabilized PBT with mold release, impact modified and improved hydrostability
K4530	15% glass filled PBT grade with enhanced hydrostability and flow
K4560	30% glass filled PBT grade, impact modified with enhanced hydrostability and flow
V3100HR	Unfilled high viscosity PBT grade with enhanced hydrostability
V4860HR	30% glass filled FR PBT grade with enhanced hydrostability and impact, passes UL 94 at 0.80 mm
VX4015	15% glass filled PBT injection molding PBT grade with enhanced hydrostability

USCAR (United States Council for Automotive Research), a Consortium of Domestic (US) Automotive Manufacturers, is the umbrella organization of DaimlerChrysler, Ford and General Motors, which was formed in 1992 to further strengthen the technology base of the domestic auto industry through cooperative research.



5 year bumper-to-bumper warranty
10 year bumper-to-bumper warranty
Requires data under accelerated conditions

Standard Tests developed by USCAR
USCAR Class II, III, IV Part tests under accelerated conditions

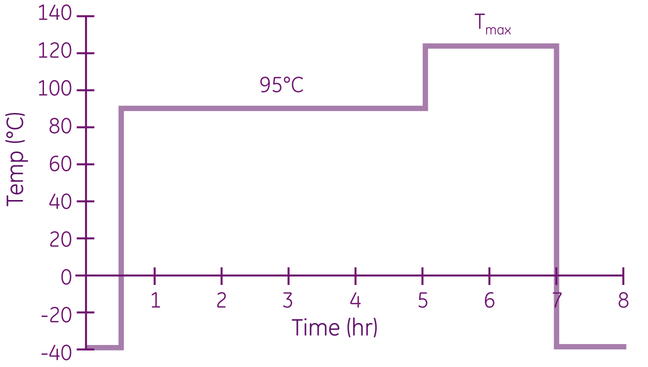
ASTM, ISO-tests after heat/humidity aging Use the same protocol as USCAR Class II, III, IV Internal Test methods

– e.g., Autoclave

Dry Heat Aging Actual end use parts are tested as per USCAR Class categories for 6 weeks

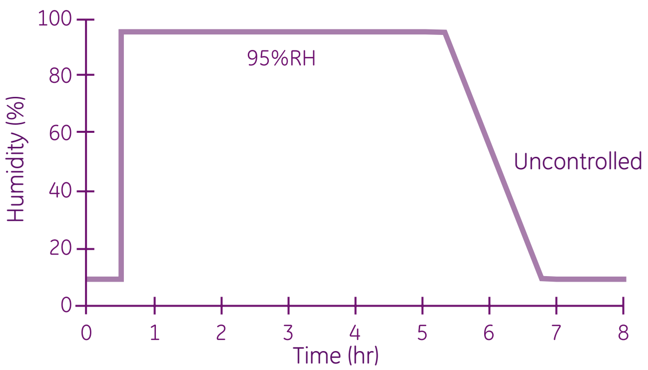
Humidity/Heat Cycle – Part Test

- 1 cycle = 8 hrs.
- Parts must pass 40 cycles



Categories
Standardization of terminal systems

Category 0	0.64 mm Terminal System
Category 1	1.0 mm Terminal System
Category 2	1.5 mm Terminal System
Category 3	2.8 mm Terminal System
Category 4	6.4 mm Terminal System



Classes
Environmental performance requirements

Class 1	85°C Ambient Temp.
Class 2	105°C Ambient Temp.
Class 3	125°C Ambient Temp.
Class 4	155°C Ambient Temp.

Heat Aging for 1008 hours
Heat and Humidity Cycling for 40 cycles
Full Listing of Chemical Exposures

5. Electrical Valox resin

The Valox resin portfolio has grades for electrical industries that meet high RTI and GWIT application standards. They offer heat and color stability, provide adhesion to epoxy, allow laser marking on custom colors and are flame retardant.

Potential application benefits:

- Better hydrostability vs. PA
- Electrical performance high CTI/GWIT
- High heat, color stability
- Thinwall design with dimensional stability

Potential processing benefits:

- Cycle time
- Excellent flow with minimum warpage
- Laser marking

Product compliance:

- UL listing 1446
- UL 94 V0 FR

Potential applications:

- Coil bobbins
- E-motors
- High CTI/GWIT applications
- Circuit breaker housings
- Lamp holders
- Terminal blocks for energy meters
- Indoor electrical enclosure

Table 5 – Typical electrical Valox resin grades

467	30% glass filled PBT/PC blend FR grade, impact modified
771	30% glass/mineral filled FR grade, passes UL 94 VO at 0.75 mm and CTI Class 0, 600 Volts
4521, 4521B	20% glass filled FR grade with enhanced flow, passes UL VO-0.75 mm and CTI Class 2
553	30% glass filled PBT/PC blend with an excellent dimensional stability and FR, passes UL 94 VO-0.86 mm
732E	30% glass/mineral filled with excellent thermal stability, low warpage and enhanced flow
735	40% glass/mineral filled PBT/PET blend, impact modified
745	29% mineral filled PBT/PC blend with an excellent dimensional stability and impact
V8560	30% glass filled FR PBT/PET blend with enhanced heat stability and mold release
V9561	30% glass filled PET FR grade, passes UL 94 at VO-0.80 mm
VX3603C	Unfilled PBT FR grade, passes UL 94 at 0.75 mm and CTI 275 V

6. Aesthetics

6.1 Color stable Valox resin

Valox resin aesthetics grades can improve the value of your product without compromising its functional requirements. These grades provide a more appealing look and product differentiation at the marketplace.

Color stable Valox resin

Potential application benefits:

- High gloss with color stability
- Good mechanical and chemical properties
- Increased strength, stiffness and heat resistance vs. unreinforced grades
- Excellent surface finish

Potential processing benefits:

- High flow, faster cycle times
- Robust processing window
- System cost reduction by eliminating secondary operations like painting

Product compliance:

- UL 94 V-0 grades

Potential applications:

- Household appliance components
- Consumer products
- Hot air gun assemblies, industrial guns

Table 6.1 –
Typical aesthetics Valox resin grades – color stable

815	15% glass filled PBT/PET blend with improved surface appearance
815F	15% glass filled PBT/PET blend with improved surface appearance
830	30% glass filled PBT/PET blend with improved surface appearance
830EI, 830M, 830R, 830X	30% glass filled PBT/PET blend with improved surface appearance and enhanced flow, impact modified, mold release or low cost
855	15% glass filled PBT/PET blend with improved surface appearance and FR, passes UL 94 VO at 1.50 mm
865	30% glass filled PBT/PET blend with improved surface appearance and FR, passes UL 94 VO at 1.70 mm
CS8115, CS8115U	15% glass filled PBT/PET blend with improved surface appearance and enhanced heat aging color stability and weatherability
CS815	15% glass filled PBT/PET blend with high surface gloss and improved heat aging color stability
CS860	30% glass filled PBT/PET blend with good surface appearance, passes UL 94 VO at .750 mm and improved heat aging color stability
V4280	15% glass filled PBT/PET blend with enhanced surface appearance and high modulus
V9260CS	30% glass filled PET grade with enhanced color stability
V9540CS	20% glass filled FR high heat PET grade with enhanced color stability
VX8016	15% glass/mineral filled PBT/PET blend with enhanced surface appearance
VX8532	30% glass filled non-blooming FR PBT/PET grade with enhanced surface appearance and ultrasonic weldability

6. Aesthetics

6.2 Heavy Valox resin for aesthetic applications

A unique, high density PBT material that combines the inherent characteristics of PBT with the advantages of high levels of mineral reinforcement.

Heavy Valox resin is a highly filled PBT resin, based on a unique property combination of:

- High thermal performance (up to 250')
- Chemical resistance (many domestic cleaners and urea)
- Dimensional stability
- High density (1.85 gr/ cm^3)
- FDA and BGA approval
- Quality feel and high quality surface
- Incoloring and visual effect capability
- Surface renewal ability

This unique combination of properties offers new added value for applications which require aesthetics.

Heavy Valox resin provides the following added value features:

- Aesthetics (color, visual effects like metallic and granite looks)
- Quality feel (stone-like feel and weight)
- Performance (thermal, hot/cold shock performance)
- Renewal ability (surface can be softly sanded to renew)
- Plating performance (metal look and feel)

Heavy Valox resin is an excellent candidate in these segments:

- Bathroom equipment and appliances (shower trays, sinks, urinals, soap trays, toothbrush bodies, toilet seats, etc.)
- Housings for electronic/electric equipment requiring aesthetics (speaker boxes, remote controls, knobs/ switches for stereo equipment, housings, handles for kitchen appliances)
- The fashion industry (buttons, beads for trendy jewelry, etc.)

Heavy Valox resin can provide added value and system cost advantages versus competitive materials, such as:

- Thermosets
- Ceramics
- Stainless steel or enameled steel

The downside of these competitive materials is their flexibility in shape, integration, visual effect, cycle time and tooling cost (ceramics), and recycle problems.

Recent commercial examples:

- Trendy sources for coffee cups
- Waterless urinal with metallic sparkle effect for a "granite look"
- Speaker box housings

Reasons for choosing heavy Valox resin are: aesthetic look and feel like ceramic or stone, chemical resistance against domestic cleaners and urea, flexibility in color and effects, and flexibility in design freedom. Ideal choice for bathroom applications like the urinal where staining can occur. The unique property of renewability is a key differentiator. This means that if a stain does occur on the surface it can easily be polished away by means of a standard commercial (green/yellow) washing pad.

The heavy Valox resin key commercial grades available:

- 7062
- 7062X 30% glass filled
- Color: most colors (non-bright) are possible
- Visual effects like "Stone," "Metallic" and "Glow in the Dark" are possible
- Color and visual effects should be discussed with the product manager

Table 6.2 – Typical aesthetics Valox resin grades – heavy Valox (Enduran*) resin

7062	38% mineral filled PBT/PET blend with high dimensional stability and excellent surface appearance
7065	63% mineral filled, PBT/PET blend with high dimensional stability and excellent surface appearance
7085	67% glass/mineral filled PBT/PET blend with good surface finish
7322	37% mineral filled PBT/PET/PC blend with improved surface appearance and UV stability
7062HP	38% mineral filled PBT/PET blend with excellent dimensional stability and surface appearance
7062X	45% glass/mineral filled PBT with excellent dimensional stability and surface appearance

Table 6.3 – Typical heavy Valox resin product data

		7062	7062X
Density (gr/cm^3)	ISO 1183	1.85	1.85
Tensile strength (Mpa)	ISO 527	60	105
Tensile Modulus (Mpa)	ISO 527	4500	8200
Izod Impact (un KJ/m^2)	ISO 180/1U	27	33
MVR (265°C/1.2kg)		30	20
Vicat (B/120°C)	ISO 306	187	218
Scratch resistance	DIN 53799	Moderate/Fair	
Abrasion resistance	Taber	110 mg	
Hot pan test	DIN 53799, part 4.9	250°C	
Cigarette burn test	ISO 4586-2, part 18	No destruction to surface (Class 2)	
Hot cold test shock	ANSI 2124.2, part 6.3.2	Pass 1000 cycles, no visual damage	
Chemical resistance	ANSI Z124.6	Pass all chemicals, repairable cigarette stain	

Table 6.4 – Heavy Valox resin performance versus competition

Material	Scratch Resistance	Abrasion Resistance	Heat Resistance	Impact Resistance	Water Resistance	Chemical Resistance	Processability	Quality Appearance
SMC thermoset coated	++	0	+	0	+	+	–	+
Polypropylene filled	––	––	––	++	++	++	++	0
Lexan*	–	0	–	++	0	–	++	+
PMMA filled minerals	0	0	+	–	–	0	––	++
Heavy Valox 7062X	0	+	+	+	+	+	+	++

Scale: –– poor – moderate 0 fair + good ++ excellent

6. Aesthetics

6.3 Visual*fx** Valox resin

GE can design and supply tailor-made Visual*fx* Valox resin from our wide range of patented technology to help meet your complex part geometry for a flow line, free end product. We can also assist you with our technical experience.

New Ideas – Concept – Design – Visual*fx* Valox resin – Win in the marketplace Value proposition

Application benefits:
- Product differentiation
- Quality feel/quality look
- Cost out – no secondary operations
- Mechanical performance

Applications:
- Automotive bezels
- Automotive front grille
- Household
- Bathroom accessories, urinal pot and lid
- Cosmetics jars and lids
- Door handles, mirrors, roof racks

**Table 6.5 –
Typical aesthetics Valox resin grades –
Visual*fx* Valox resin**

FXV310SK	Unfilled PBT injection molding grade with Visual*fx* pigment for automotive bezel applications or front grilles

7. Metalizable Valox resin

Metalizable Valox resin grades provide exceptional results for use in base coated headlight bezels or direct metalization applications.

Potential application benefits:

- Thinwall/low part weight due to high flow
- Excellent dimensional stability
- Visual*fx* resin options available

Potential processing benefits:

- Low cycle times
- Reduced injection pressures
- Anti-static to maintain dust-free surface (EH7020HF)

Product compliance:

- Global production capability
- In-house evaluation at processing centers

Potential applications:

- Headlight bezels
- Tail-light reflectors requiring high heat performance
- High mount stop light reflectors
- DLV3000 – indoor down light reflectors

Table 7 –
Typical metalization Valox resin grades

DLV3000	Metalizable PBT with higher heat resistance
DLV3100	Metalizable antistatic PBT with higher heat resistance
EH7020HF	20% talc filled metalizable PBT with enhanced flow for automotive applications

8. Weatherable Valox resin

The Valox resin weatherable products retain their physical properties and flammability performance while they meet extreme outdoor weather conditions. They are also available in custom colors for product differentiation in the marketplace.

Potential application benefits:

- UL F1 and F2 rating
- Custom color
- Chemical resistance
- High impact
- Low warpage

Potential processing benefits:

- Ultrasonic welding
- Good flow for large parts
- Laser marking

Product compliance:

- UL 746C
- UL 94

Potential applications:

- Outdoor cabinets
- Network interface devices
- Outdoor application where F1 rating is specified

Table 8 –
Typical weatherable Valox resin grades

364	Unfilled PBT+PC blend FR grade
3706	Unfilled PBT/PC FR blend, impact modified and good weatherability, passes V0 at 1.50 mm
357U, 357XU	Unfilled PBT/PC impact modified FR grade, passes V0 at 0.63 mm with an enhanced UV stability
3607U	Enhanced UV-stabilized, FR, injection molding grade, offering excellent weatherability
553U	30% glass filled PBT/PC blend with an excellent dimensional and UV stability, passes UL 94 V0-0.86 mm
8032U	30% glass filled PBT/PET blend with an excellent surface finish and weatherability
8032UX	30% glass filled PBT/PET blend has excellent surface finish and improved weatherability v/s 8032U
815UX	15% glass filled PBT/PET blend with improved surface appearance and UV stability
830U	30% glass filled PBT/PET blend with improved surface appearance and UV stability
V3900WX	Unfilled PBT/PC FR grade, passes UL 94 at 1.5 mm. UV-stabilized F1 rated grade, passes UL 746C (F1) weatherability performance
VX4920	20% glass filled nucleated PBT/ASA blend with excellent mechanical properties, dimensional stability and weatherability
VX4930	30% glass filled nucleated PBT/ASA blend with excellent mechanical properties, dimensional stability and weatherability
VX8015U	15% glass filled PBT/PET blend with improved surface appearance and excellent UV stability

9. FDA (food contact) and healthcare Valox resin

These Valox resin grades are excellent candidates to meet the stringent requirements in healthcare due to their chemical resistance, high heat resistance, gas and moisture barrier capabilities and ability to withstand sterilization by gamma and e-beams radiation.

Potential application benefits:

- Barrier capabilities and chemical resistance
- High heat resistance
- Low water absorption
- Food contact
- Surface finish/gloss

Potential processing benefits:

- High flow, easy processibility
- Recyclability
- Surface finish, no secondary processing

Product compliance:

- Comply with FDA food contact regulations

Potential applications:

- Food contact and cosmetic packaging
- Medical and dental instrument
- Housing and handles
- Clamps and valves
- Complex injection molded shoulder inserts for toothpaste tubes
- Co-extruded lids for yogurt pots

Table 9 –
Typical FDA/medical Valox resin grades

215HPR	PBT resin with mold release complies with FDA regulations/biocompatible
260HPR	Unfilled PBT grade with mold release and compliant with food contact regulations according to 90/128/EEC
312C	Unfilled PBT with mold release and food contact compliant
420HP	30% glass filled, excellent strength, stiffness and dimensional stability, FDA and biocompatible

10. Specialty Valox resin

Valox resin specialty grades include structural foam for large parts and weight reduction, as well as PBT Ionomers to be used as additives for other engineering plastics.

Structural foam

Potential application benefits:

- Low stress for improved structural performance
- Improved chemical resistance due to reduced stress
- Excellent dimensional stability

Potential applications:

- Air conditioning drain pans
- Electrical/mechanical/telecommunication housings
- Support brackets
- Call box

Table 10.1 – Typical structural foam Valox resin grades

FV620	30% glass filled FR V-0, foam grade
FV650	30% glass filled non-FR
Blowing agent is Valox FVC 60/65	

PBT ionomers

Carpet fiber additive (Valox V2205 resin) application benefits:

- Improved stain resistance for pre-colored PA 6/6 carpet fibers

Potential applications:

- Carpet fiber additive

Table 10.2 – Typical PBT ionomers Valox resin grades

V2205	PBT ionomer

11. Laser marking on Valox resin

GE has developed laser marking capabilities, offering a wide range of Valox resin grades. In today's mass production environment, laser marking is an easy, quick, permanent and economical option for printing on your end product.

Laser

LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. Laser can be used for various applications and technologies.

Benefits

Bar codes, safety information and all other combinations of numerical, alphabetic and graphic forms are regularly produced on a variety of applications for marking. The help of lasers contributes significantly to reduce production and part cost.

Typical benefits in using laser marking are:

- Durability of the image
- Flexibility because of use of fully automated digital computer systems
- No surface contact allowing complex geometries and irregular surfaces
- Speed allowing up to 2000 mm/sec or 200 characters/sec
- Cleanliness and better for the environment as no solvents or inks are applied

Laser systems

A given laser provides very high local energy input onto the surface of the material to be marked resulting in local degradation or chemical reaction, which in its turn causes color changes.

The laser systems use the technique of engraving or the technique of using a mask with the specified image. The latter is not used that widely because of less flexibility.

Three different kinds of systems are presently available and applied on the market:

- TEA-CO_2 laser: Long wavelength of 10.600 nm resulting in reduced resolution, it is the least expensive and is mainly used with the mask technology
- Nd-YAG laser: Available in long wavelength of 1064 nm and/or short wavelength of 532 nm, offering much higher image resolution then the CO_2 lasers. The YAG laser is the most commonly used laser for laser marking and is in the mid- price range
- Excimer lasers (UV): Available in very short wavelengths of 193 ~ 351nm and therefore offering the highest available image resolution at the highest price range.

Laser settings

The polymer used, the application, and applied equipment and settings determine the optimum laser marking effect. The main variables on the equipment are writing speed and consumed power/ amperage.

GE Plastics offers technical assistance to assess the optimum settings and material support to strive for the the highest required image resolution at the highest writing speed and lowest amperage. For more guidance please contact your local GE Plastics representative.

11. Laser marking on Valox resin

Laser marking effects

Many thermoplastic materials can be laser marked, in dark as well as light or bright colors. We usually refer to these effects as:

- **Light–on-dark**
  Showing a light mark on a dark surface
- **Dark-on–light**
  Showing a dark image on a light surface
- **Color–on–color**
  Showing a distinctive colored mark on a colored surface

Various effects can be achieved when thermoplastic parts are being laser marked with a laser system. The main effects are:

- Foaming: Resulting in a "light-on-dark" effect
- Carbonization: Resulting in a "dark-on-light" effect
- Bleaching: Resulting in a "color-on-color" effect and lighter color
- Ablation: Resulting in a "night and day" effect

Foaming

The plastic material is heated locally by the laser beam, which forms gas pockets. As a result the material starts to foam and leaves a foamed light mark. Very high contrast can be obtained in particular on dark or black surfaces. As the mark is partly on top of the surface it generally leads to a somewhat reduced wear resistance.

Carbonization

The high local heating by the laser beam causes very local carbonization of the polymer matrix, leaving a black/brownish dark mark on the surface. The effect is best seen on light colored materials. Excessive local heating/carbonization can affect the mechanical properties of the matrix. Achieving optimum settings is required.

Bleaching

Bleaching of the polymer surface locally, by the laser beam, induces a superficial color change. As the surface is hardly damaged with no unwanted side effects, this is the most desirable effect. Limited plastic/pigment combinations can be bleached. In general the contrast of the mark is lower than the other effects/techniques available.

Ablation

During ablation various (paint) layers can be selectively removed from the surface locally by the laser beam. This leads to one or more colored markings on the part's surface. In most cases the "night and day" effect is generated this way. A transparent plastic is painted dark and the paint is subsequently removed by the laser beam in the desired design, so the marking can be seen.

General influences on the effect

The selection of the applied polymer matrix in relation to the application and the marking contributes the most to the final effect. It is polymer specific as to how well the beam energy is absorbed and dissipated through the material, resulting in a significant laser marking effect (see Table 11.1).

The influence of additives on the quality of the image:
Glass fibers – minimal effect
Minerals – minimal effect
Flame retardants – significant effect
Stabilizers – minimal effect
Carbon black – significant effect
Pigments – significant effect

Excellent results

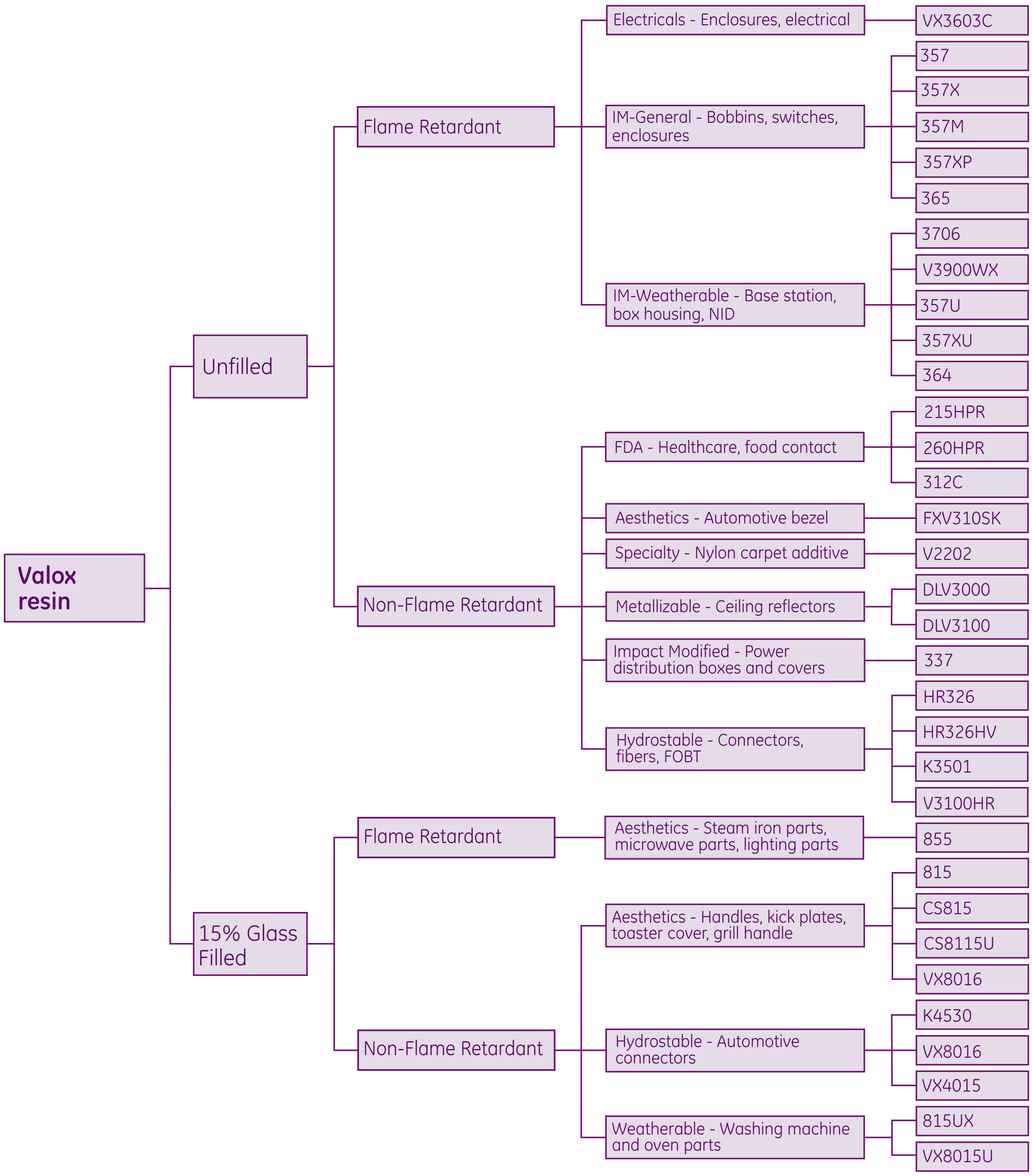
To achieve excellent results, GE Plastics can offer the following support and service:

- Match color of customer request (www.colormatch.com)
- Select matrix – pigment combination for optimal contrast (contact your GE sales representative)
- Test and evaluate color plaques on contrast, and define optimum settings (contact your GE sales representative)
- Develop new materials with new effects and higher efficiency (contact your GE sales representative)

Table 11.1 – Key laser marking grades

	Grade – Color	
Material Matrix	Dark-on-Light	Light-on-Dark
PBT	325ML-54058LM	325-BK2B050L
PBT-FR	VX3603-44012LM	
PBT-GF		4031-BK2108L 420
PBT-GF-FR	451E-GN5B021L 420SEO-8233	451E-GY1B125L 420SEO-GY1B126L
PBT-PC-GF	508-WH4B201L	
PBT-PC-GF-FR	553-BL1962L	553-BK1C052L
PBT-PC-IM-GF-FR	467-GN5B021L	467-GY1B125L
PBT-ASA-GF		VX4930-BK2125L
PBT-PET-GF		815-BK1C012L
PBT-PET-IM-GF-MF	771-1001	735-BK1066L
PET-GF		9215Z/V9235
PET-GF-FR	EXVX1135/V9561	

12. Valox resin product tree



- **Valox resin**
  - 20% Glass Filled
    - Flame Retardant
      - Electricals - Electrical components
        - 4521B
    - Non-Flame Retardant
      - Weatherable - Automotive connectors
        - VX4920
  - 30% Glass Filled
    - Flame Retardant
      - Aesthetics
        - CS860
        - 865
        - VX8532
      - Electricals - Connectors, mirco switches, component housings
        - V8560
        - V9561
        - 553
      - Hydrostable - Connectors for UTH
        - V4860HR
        - K4660
    - Non-Flame Retardant
      - FDA - Medical, bowls, plates
        - 420HP
      - Aesthetics - Iron skirt, appliance housings, handles
        - 830
        - 830R
        - V9260CS
        - 830X
      - Weatherable - Heat pump housing, bracket
        - VX4930
        - 8032U
        - 8032UX
        - 830U
      - Impact Modified - Ignition coil
        - VIC4320N
      - Hydrostable - Automotive connectors, sensors, brake module
        - K4560
  - Glass and Mineral Filled
    - Flame Retardant
      - Electricals - Enclosures and housings, ciruit protection, MCB/MCCB/ELCB
        - 771
    - Non-Flame Retardant
      - Metallizable - Automotive Bezel
        - EH7020HF
      - Aesthetics - Bath/kitchen counter, furniture, mirror bracket
        - 7062
        - 7062X
        - 7065
        - 7085
        - 7322
        - V4280
      - Electricals - Oven grills, adaptor rings
        - 732E
        - 735
        - 745

13. Valox resin product information

Grade	MFG. Location	Heat		Impact		Modulus	
	A = Americas E = Europe P = Pacific	**ISO 306** Vicat B/ 50 in °C	**ASTM D 648** HDT in °C, 0.45MPa (1.82MPa), 6.4mm	**ISO 180/1A** Notched Izod in kJ/m² at 23°C/-30°C	**ASTM D 256** Notched Izod in J/m at 23°C/-30°C	**ISO 178** Flexural in MPa	**ASTM D 790** Flexural in MPa
General Purpose (See page 6)							
325	A	175	154	6/6	5	2300	2345
310SEO	A	165	162	5/3	3	2600	2620
4022	E,P	210		7/6		6000	
420	A	215	215	5/5	8	8500	7586
457	A	190	204	6/5	3	3500	3513
451E	A	200	212	6/5	4	6500	5515
420SEO	A	205	212	8/7	7	9500	7586
Impact Modified (See page 7)							
337	A		98	8	870		1790
357	A, E, P		137		534		2060
357M	A		137		534		2060
357X	E	145		45		2000	
357XM	E		137		534		2060
357P	P		137		534		2060
357XP	E, P	145		45/10		2000	
365	A, P		129		640		2240
PDR4926	P		198		7		5221
VIC4311	A, P	175	205	12	137	6180	6080
VIC4320N	E	210		9		6000	
VIC4350	P				13	8490	
VX3608C	E	130		50		1800	
Hydrostable (See page 8)							
HR326	A, E	180	148	5/4	53	2500	2410
HR326HV	A		148		53		2410
HR426	A		218		90		6890
K3501	A			8	89	2020	2080
K4530	A				58	0	4640
K4560	A				96		6200
V3100HR	A		148		53		2410
V4860HR	A, E, P	176		10/8	90	7870	6740
VX4015	E	200		12/8		4200	

Flame Characteristics	CTI		RTI – UL 746B			Grade
UL 94 Flammability Rating @ Thickness (mm)	IEC 60112 Unit: V	UL 746A, PLC Code	Electric	Mechanical with Impact	Mechanical w/o impact	
HB @ 1.5	600	0	120	120	140	325
V0 @ 0.71	175	3	120	120	140	310SEO
HB @ 0.8	250					4022
HB @ 0.8	300	0	140	140	140	420
V0 @ 0.71	175	3	120	120	140	457
V0 @ 0.71	175	3	120	120	140	451E
V0 @ 0.71	175	3	130	130	140	420SEO
						337
			120	120	140	357
V0 @ 0.63		2	120	120	140	357M
V0 @ 0.8	225		120	120	140	357X
V0 @ 0.8		2	120	120	140	357XM
V0 @ 0.8		2	120	120	140	357P
V0 @ 0.8	225		120	120	140	357XP
			105	105	105	365
V0 @ 0.75						PDR4926
						VIC4311
						VIC4320N
V0 @ 1.5						VIC4350
V2 @ 1.6	225					VX3608C
HB @ 1.6	600	0				HR326
						HR326HV
V0 @ 0.76		1	140	140	140	HR426
						K3501
						K4530
						K4560
						V3100HR
V0 @ 0.8						V4860HR
	300					VX4015

13. Valox resin product information

Grade	MFG. Location	Heat		Impact		Modulus	
	A = Americas E = Europe P = Pacific	**ISO 306** Vicat B/ 50 in °C	**ASTM D 648** HDT in °C, 0.45MPa (1.82MPa), 6.4mm	**ISO 180/1A** Notched Izod in kJ/m^2 at 23°C/-30°C	**ASTM D 256** Notched Izod in J/m at 23°C/-30°C	**ISO 178** Flexural in MPa	**ASTM D 790** Flexural in MPa
Electrical (See page 10)							
467	E, P	155		7/6	7600		
771	A, E, P	180	217	5/5	42	8500	5860
4521	E, P	205		6		7400	
4521B	E	205		6/5		7400	
553	A, E, P	170	204	7/7	8	8000	6899
732E	A		215		101		6890
735	A, E, P	173	215	5/4	74	9000	8270
745	A, E, P	138	160		80	3400	3440
V8560	E	200		7		8000	
V9561	E	225		7		10750	
VX3603C	E	180		4		2750	
Aesthetics – Color Stable (See page 11)							
815	A, E, P	185	210	6/5	37	5200	4480
815F	E	200				5000	
830	A, E, P	200	221	9/8	80	9000	6890
830EI, 830M	P		221		80		6890
830R	P		192		80		6890
830X	E	175		5/5		7000	
855	A, E, P	190	204	6/6	53	5000	4820
865	A, E, P	200	212	7/6	80	8000	7580
CS8115	A		157		37		5000
CS8115U	A, P		157		37		5000
CS815	A				48		5170
CS860	A, P		212		80		8270
V4280	A		215		10		10690
V9260CS	E					9800	
V9540CS	E					8500	
VX8016	E			4		4250	
VX8532	E	200				9500	
Aesthetics – Heavy (See page 12)							
7062, 7062HP	A, E	175		3		3900	
7065	A, E		193		2		5397
7085	E		204		8		3445
7322	A		160		8		2689
7062X	E	200		5		7400	
Aesthetics – Visual*fx* (See page 14)							
FXV310SK	E	185		5		2750	

Flame Characteristics	**CTI**		**RTI – UL 746B**			**Grade**
UL 94 Flammability Rating @ Thickness (mm)	IEC 60112 Unit: V	UL 746A, PLC Code	Electric	Mechanical with Impact	Mechanical w/o impact	
V0 @ 1.5			130	120	140	467
V0 @ 0.8	600	0	140	125	140	771
V0 @ 0.8	275		130	130	130	4521
V0 @ 0.8	275					4521B
V0 @ 0.9	225	3	125	110	125	553
						732E
HB @ 0.8		2	140	140	140	735
HB @ 1.5			105	105	105	745
						V8560
V0 @ 0.8	200					V9561
V0 @ 0.75	275					VX3603C
HB @ 1.5	325	2	125	110	125	815
HB @ 1.6	325	2				815F
HB @ 1.5	325	2	120		120	830
		2	120		120	830EI, 830M
			120		120	830R
HB @ 1.5						830X
V0 @ 1.5	225	3	125	110	125	855
V0 @ 1.5	225	3	110	110	110	865
						CS8115
						CS8115U
						CS815
V0 @ 0.76		3	130	130	140	CS860
						V4280
V0 @ 0.8						V9260CS
	175					V9540CS
	200					VX8016
V0 @ 1.6	200					VX8532
HB @ 1.5	475					7062, 7062HP
HB @ 1.49			75	75	75	7065
HB @ 1.49	600	0	75	75	75	7085
HB @ 1.49		1	120	120	125	7322
HB @ 1.5						7062X
	600					FXV310SK

13. Valox resin product information

Grade	MFG. Location	Heat		Impact		Modulus	
	A = Americas E = Europe P = Pacific	**ISO 306** Vicat B/ 50 in °C	**ASTM D 648** HDT in °C, 0.45MPa (1.82MPa), 6.4mm	**ISO 180/1A** Notched Izod in kJ/m² at 23°C/-30°C	**ASTM D 256** Notched Izod in J/m at 23°C/-30°C	**ISO 178** Flexural in MPa	**ASTM D 790** Flexural in MPa
Metalizable (See page 15)							
DLV3000	P				25		2410
DLV3100	P				25		2330
EH7020HF	A, E, P		70		27	4710	
Weatherable (See page 16)							
364	A				747		1860
3706	A						1990
357U	A, P		137		534		2060
357XU	E	145		45/10		2000	
3607U	E	125		50/20		2050	
553U			204		8		6899
8032U	E	202		9/8		8500	
8032UX	E	202		9		8500	
815UX	E	200		6/5		4700	
830U	P		220		88		
V3900WX	A, P	121		41	800	2130	2200
VX4920	E	158		6		6000	
VX4930	E	176		7		8500	
VX8015U	E	200		6/5		5000	
FDA/Medical (See page 17)							
215HPR	A		154		53		2340
260HPR	E	175		5		2300	
312C	E	175		3		2400	
420HP	A		215		85		7580
Specialty (See page 18)							
FV620	A, P		201				7655
FV650	A, P		209		9		7684
V2205	A						

Flame Characteristics	CTI		RTI – UL 746B			Grade
UL 94 Flammability Rating @ Thickness (mm)	IEC 60112 Unit: V	UL 746A, PLC Code	Electric	Mechanical with Impact	Mechanical w/o impact	
						DLV3000
						DLV3100
						EH7020HF
			75	75	75	364
V0 @ 1.49			100	85	100	3706
V0 @ 0.63		2	120	120	140	357U
V0 @ 0.8	225		120	120	140	357XU
V1 @ 3.0	225		80	80	80	3607U
V0 @ 0.86		3	125	110	125	553U
HB @ 1.6						8032U
						8032UX
HB @ 1.5	300					815UX
						830U
5VA @ 3.0			75	75	75	V3900WX
HB @ 1.6	450					VX4920
HB @ 0.8	500					VX4930
HB @ 1.6	325					VX8015U
						215HPR
HB @ 1.5	600	0	75		75	260HPR
HB @ 1.5	600	0				312C
						420HP
V0 @ 3.91		3	75	75	75	FV620
						FV650
						V2205

14. Mold design

Mold Materials

Steel selection in tooling for Valox resin can be as critical to the performance of an application as the selection of the resin for the molded product. Just as resin are formulated to meet performance requirements in plastics applications, steels are alloyed to meet specific performance requirements in use.

Some applications may require a mold steel with high hardness and wear resistance for parting line durability, while others will require a mold steel with higher toughness for resistance to mechanical fatigue. In general, steels delivering higher hardness and wear resistance properties are those that tend to be more brittle, and in almost all cases, a steel with greater toughness will deliver some reduction in resistance to steel-to-steel wear (adhesive wear) and abrasive resistance to resin containing glass fibers or mineral fillers.

Prototype Tooling

Soft, lower-cost molds serve a valuable function by providing preproduction parts for marketing studies, manufacturing assembly requirements and dimensional capabilities, and by giving the designer an opportunity to evaluate some unusual function.

All casting and plating processes require a model which will be faithfully reproduced. The quality and durability of prototype tooling depends on the process. Some molds may produce fewer than 100 pieces, whereas others may function for many thousands of pieces. The cost and timing of the project may be the deciding factor in which method is used.

Some important molding information can also be gained which can be later translated to the production mold. Some common forms of producing prototype molds are as follows:

Conventional Machining Materials
- Steel (unhardened)
- Aluminum
- Brass

Casting Process
- Kirksite† - a metal casting material
- Aluminum
- Plastics, epoxies

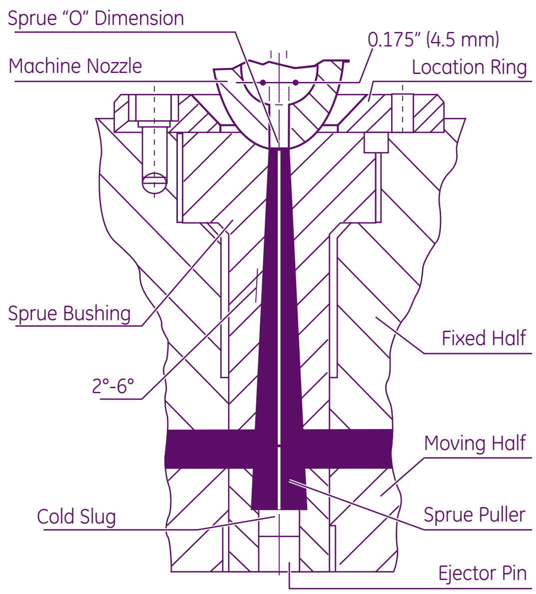
Liquid Plating Process
- Intricate shells can be nickel-plated on a master. These are later backed up and inserted into a mold frame.

Flame Spraying
- Flame spray metals can quickly produce a 1/8 inch (3.16 mm) thick shell which is further backed up and placed into a regular frame. A variety of metals which come in wire form can be utilized into the process.

Sprues and Runners

It is suggested that a cold-slug well be provided at the base of the sprue to receive the cold material first emerging from the nozzle. Well diameter should typically be equal to the largest diameter of the sprue, with depth 1-1/2 times this diameter. Wells should also be furnished in the runner system by extending the runner at least 1-1/2 times the runner diameter beyond every 90° turn. See Figure 14.1 below.

Figure 14.1 – Sprue Design



† Trademark of NL Industries

Cold Sprues

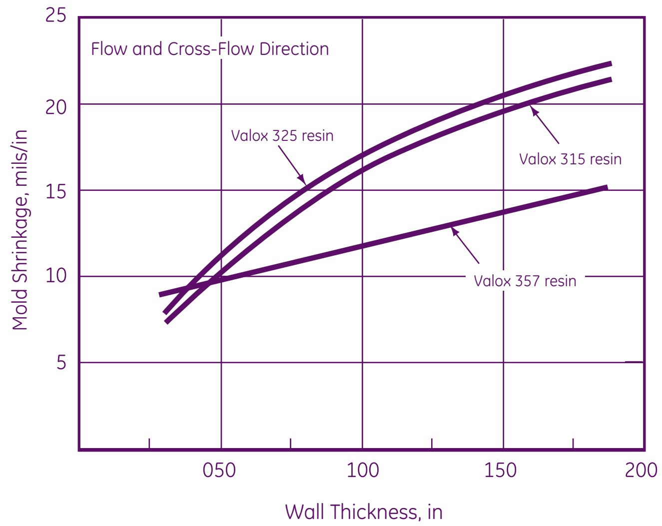
A standard sprue bushing of 1/2 or 3/4 inch (12.7 or 19.05 mm) taper per foot should have a minimum "O" dimension of 7/32 inch (5.56 mm) diameter. The diameter of the sprue at the parting line should be equal to, or slightly larger than, the runner diameter. An oversized sprue diameter at the runner intersection may result in a longer molding cycle. The sprue bushing should have a 1/32 to 1/16 inch (0.79 to 1.59 mm) radius at the runner intersection. A reverse-tapered or "dovetailed" cold well can act as a sprue puller at the runner intersection.

Shrinkage vs. Wall Thickness

The wall thickness of a part is the most significant variable affecting mold shrinkage. Thicker wall sections shrink more than thinner parts. Figures 14.2 through 14.9 depict the effects of wall thickness on mold shrinkage of five Valox resin families.

These curves represent shrinkage that can be expected when processing Valox engineering thermoplastics resin at the standard conditions suggested. *Part geometry and varying processing conditions can affect shrinkage. Prototype tests in part geometry will provide the most reliable data for a particular application.* Additional information on shrinkage can be obtained from GE Plastics Technical Services in Pittsfield, MA, at (800) 845-0600.

Figure 14.2 – Profile: Valox 300 resin grades – mold shrinkage vs. wall thickness†



† Nominal values normally ±0.002" due to variance in processing.

Figure 14.3 – Profile: Valox 508 and 553 resin grades – mold shrinkage vs. wall thickness†

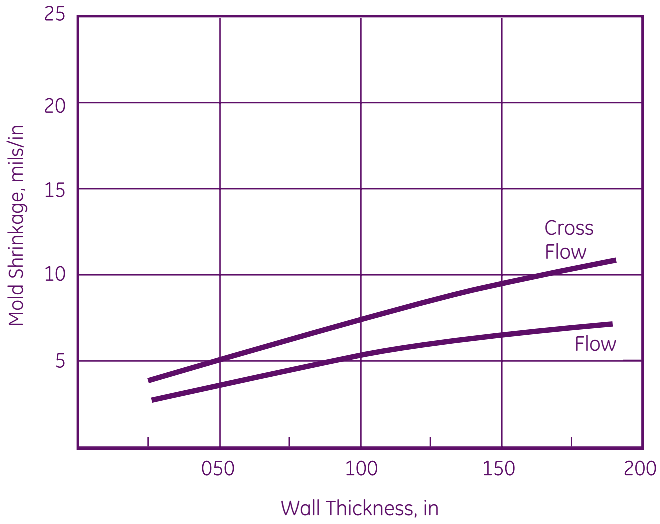
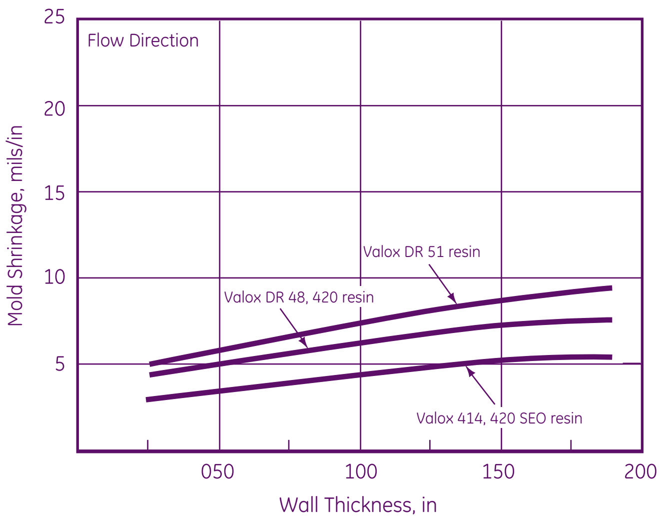


Figure 14.4 – Profile: Valox glass-filled resin – mold shrinkage vs. wall thickness†



14. Mold design

Figure 14.5 – Profile: Valox glass-filled resin – mold shrinkage vs. wall thickness†

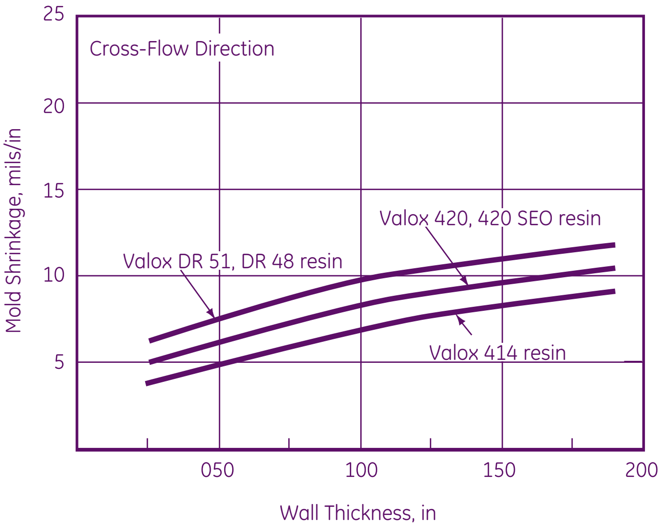


Figure 14.8 – Profile: Valox 800 resin grades – mold shrinkage vs. wall thickness†

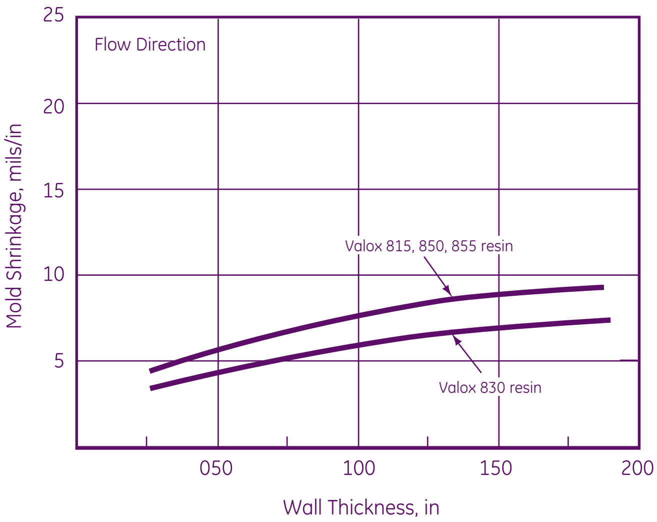


Figure 14.6 – Profile: Valox 700 resin grades – mold shrinkage vs. wall thickness†

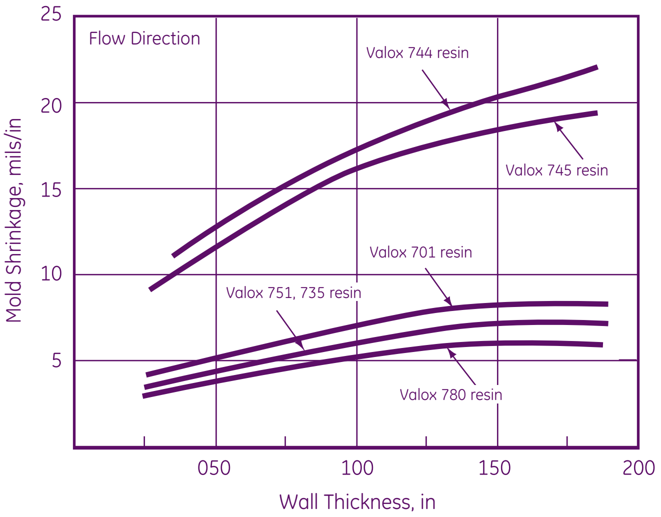


Figure 14.9 – Profile: Valox 800 resin grades – mold shrinkage vs. wall thickness†

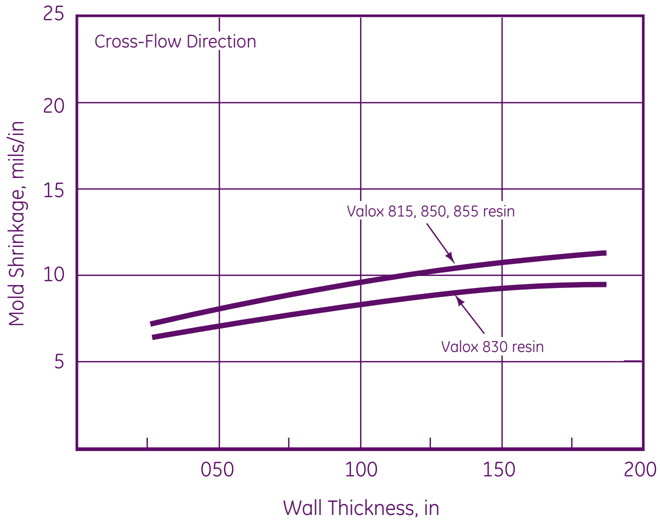
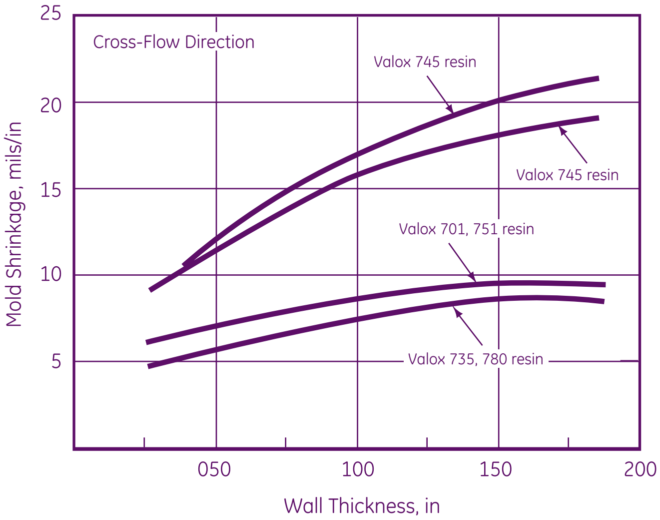


Figure 14.7 – Profile: Valox 700 resin grades – mold shrinkage vs. wall thickness†



† Nominal values normally ±0.002" due to variance in processing.

15. Equipment

Machine Selection

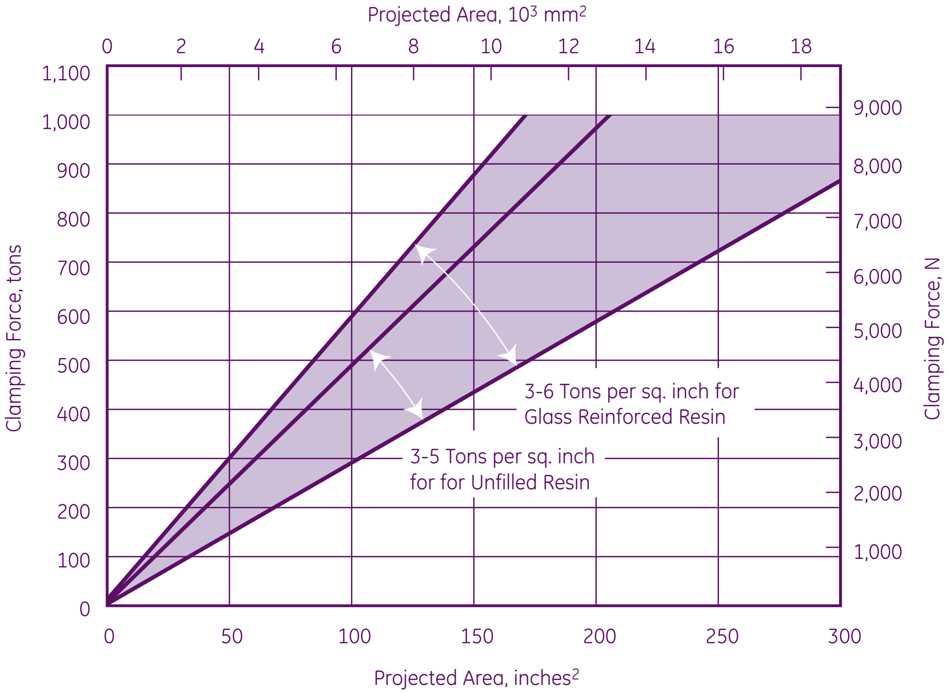
When determining the size of equipment to be used for molding a particular Valox resin part, total shot weight and total projected area are the two basic factors to be considered.

Optimum results are generally obtained when the total shot weight (all cavities plus runners and sprues) is equal to 30 to 80% of the machine capacity. Very small shots in a large barrel machine may create unnecessarily long resin residence times which may lead to resin degradation.

If it is necessary to mold at the high end of the temperature range, reduced residence time is usually required to reduce the possibility of material heat degradation. Therefore, for higher temperature molding requirements, it is suggested that the minimum shot size be greater than 60% of the machine capacity.

Once the total projected area of the complete shot (all cavity and runner areas subjected to injection pressure) has been determined, 3 to 5 tons of clamp force should be provided for each square inch of projected area to reduce flashing. See Figure 15.1 below.

Figure 15.1 – Clamping force for Valox resin



15. Equipment

Drying Parameters

Valox resin will absorb a small amount of water from the atmosphere after compounding and prior to processing. The amount absorbed will depend on environmental conditions, and may vary from 0.10 to 0.25%, depending on the temperature and humidity of the storage area.

In order to enhance performance of molded parts and to reduce the possibility of degradation, all grades of Valox resin must be dried before processing. Resin should be dried until the moisture level is less than 0.02%, typically 3 to 4 hours at 250°F (121°C) (other drying parameters may apply to specialty resin).

When using oven dryers, the resin should be spread in trays to a depth of approximately 1 inch (25.3 mm). For large pellet size (regrind) or glass filled materials, the residence time should be increased to 4 to 6 hours. Figure 15.2 shows a typical drying curve for Valox resin compounds. To avoid excessive heat history, it is suggested that the material be dried no longer than 48 hours.

The hopper and any open areas of the feed mechanism should be covered to protect the dried pellets from room atmosphere. If a hopper dryer is not available, only a sufficient quantity of dried, heated Valox pellets should be removed from the oven and placed in the hopper at one time. The length of exposure to ambient atmosphere which the dried resin can withstand before a potentially harmful amount of moisture is absorbed can range from 15 minutes to several hours depending on relative humidity.

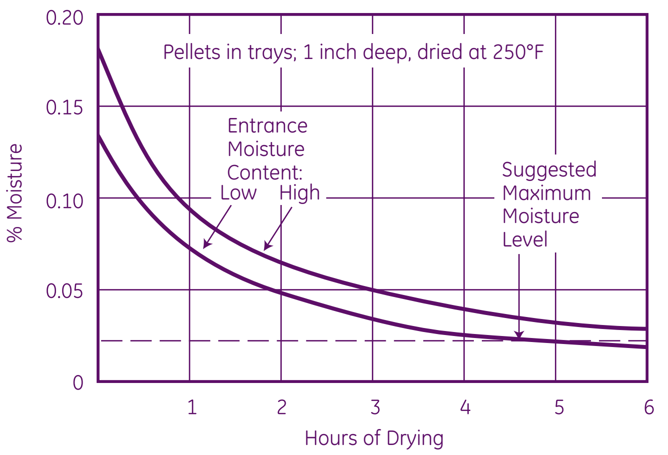
Where hopper dryers are available, oven drying can also be helpful to dry a quantity of resin for start-up. After start-up, a hopper of sufficient volume to maintain the resin for a 3 to 4 hours minimum at 250°F (121°C) is required. The hopper dryer should be preheated to the suggested drying temperature before the pellets are loaded in. Air entering the hopper should be at 250°F (121°C) and have a flow of 1.0 CFM for every pound per hour of use.

Drying Specialty Resin

Other drying parameters may apply to more recently developed Valox resin grades, either in their virgin state or as regrind.

Prior to running new Valox resin, refer to data sheets or contact a GE representative to confirm that suggested processing procedures are known. Call Product Support at (800) 845-0600 to request product literature or for technical information.

Figure 15.2 – Representative drying curves for standard Valox resin grades



16. Molding conditions

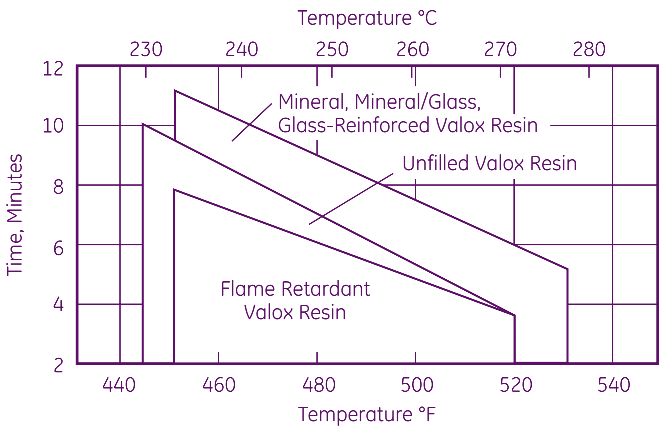
Control over processing conditions is critical to the economical production of quality parts. Fast cycles and low reject rates are both important in successful processing.
For typical processing parameters of Valox resin compounds, see Table 16.1.

Melt Temperature

Like the majority of thermoplastic molding materials, Valox resin are sensitive to prolonged exposure to heat. Long residence times and excessive melt temperatures should be avoided. A relatively small increase in screw speed (RPM) can result in a dramatic increase in melt temperature with no change in controller set point. It is suggested that melt temperatures be measured using hand-held pyrometers. These measures should be taken on the thermoplastic melts after the machine is on cycle.

A useful guide to time/temperature relationships is shown in the area molding diagram (Figure 16.1). In general, serious loss of properties or gas build-up is expected to occur when operating within the limits indicated. Valox resin, like other engineered thermoplastics, should not be left at elevated temperatures for prolonged periods of time without occasional purging.

Figure 16.1 – Residence time/temperature area molding diagram



Mold Temperature

Valox resin's rapid crystallization rate and other crystalline characteristics allow a wide range of mold temperatures without significant effects on physical properties.

The usual range for processing unreinforced Valox grades is from 120 to 180°F (38 to 60°C); higher temperatures will typically give the surface a very smooth, glossy appearance. The aesthetic appeal of surfaces molded in reinforced Valox resin can be enhanced by the use of fast fill rates, higher injection pressures and mold temperatures in the 150 to 225°F (66 to 107°C) range. Operating molds in this temperature range can also be used to improve flow, knitline strength and surface finish in reinforced resin.

When using reinforced Valox resin, mold temperatures higher than 150°F (66°C) and the maximum permissible ram speed are suggested to help achieve a high-gloss surface. All component parts of an assembly should be molded at the same mold temperature to assure color consistency when molding at temperatures over 150°F (66°C) (see Table 16.1).

16. Molding conditions

Typical Processing Parameters

Table 16.1 – Typical injection molding processing parameters for Valox resin.

		310 310SEO	325 325ML 327 337	357 364 365		420 420SEO 508 553	815 830 855 865 DR48 DR51	730 732E 735 736 745 771 780		HR326 HR426	
Processing Parameters	**Units**	**(min.)**	**(max.)**	**(min.)**	**(max.)**	**(min.)**	**(max.)**	**(min.)**	**(max.)**	**(min.)**	**(max.)**
Drying Temperature	°F(°C)	–	250(121)	–	250(121)	–	250(121)	–	250(121)	140(60)	170(77)
Drying Time (Normal)	h	3	4	3	4	3	4	3	4	4	5
Drying Time (Max.)	h	–	12	–	12	–	12	–	12	–	8
Maximum Moisture	%	–	0.02	–	0.02	–	0.02	–	0.02	–	0.05
Melt Temperature	°F(°C)	470(243)	500(260)	480(249)	510(266)	480(249)	510(266)	490(254)	530(277)	480(249)	510(266)
Nozzle	°F(°C)	460(238)	490(254)	470(243)	500(260)	470(243)	500(260)	490(254)	520(271)	470(243)	500(260)
Front Zone	°F(°C)	470(243)	500(260)	480(249)	510(266)	480(249)	510(266)	490(254)	510(266)	480(249)	510(266)
Middle Zone	°F(°C)	460(238)	490(254)	470(243)	500(260)	470(243)	500(260)	480(249)	500(260)	470(243)	500(260)
Rear Zone	°F(°C)	450(232)	480(249)	460(238)	490(254)	460(238)	490(254)	470(243)	490(254)	460(238)	490(254)
Mold Temperature	°F(°C)	120(49)	170(77)	120(49)	170(77)	150(66)	190(88)	150(66)	200(93)	150(66)	190(88)
Back Pressure	psi(MPa)	50(0.3)	100(0.7)	50(0.3)	100(0.7)	50(0.3)	100(0.7)	50(0.3)	100(0.7)	50(0.3)	100(0.7)
Screw Speed	rpm	50	100	50	100	50	80	50	80	50	80
Shot to Cylinder Size	%	40	80	40	80	40	80	40	80	40	80
Clamp Tonnage	tons/in^2	3	5	3	5	3	6	3	6	3	6
Vent Depth	in	0.0005	0.0010	0.0005	0.0015	0.0005	0.0015	0.0005	0.0015	0.0005	0.0015

Screw Speed

Screw speeds (RPM) should be adjusted to permit screw rotation during the entire cooling cycle without delaying the overall cycle (Figure 16.2). Low screw speeds will help reduce glass fiber damage during plastication when molding reinforced grades.

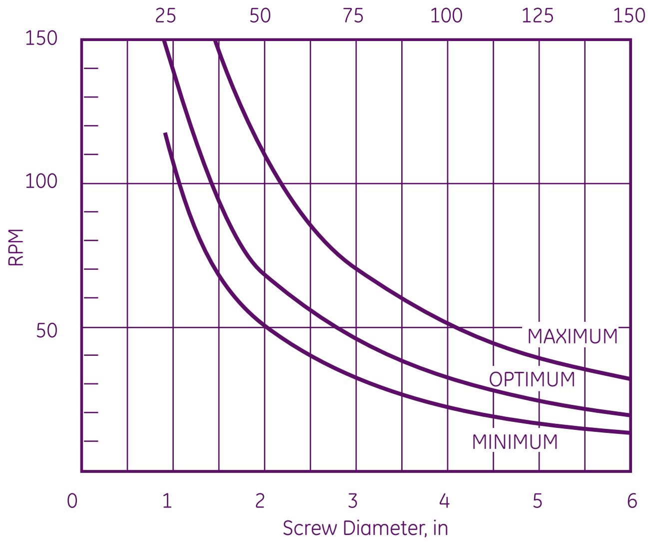
Suggested screw speed is dependent on screw diameter. Optimum linear velocity of screw O.D. is 8 inches (202.4 mm) per second. RPM = screw diameter × π divided into the optimum linear velocity of 8 inches (202.4 mm) per second × 60. For example, for a 3 inch (76.2 mm) diameter screw: 3 (screw Dia.) × 3.1416 = 9.4248 divided into 8 inches (202.4 mm) per second (optimum linear velocity) × 60 = 51 RPM.

Back Pressure

A back pressure of 50 to 100 psi (0.17 to 0.34 MPa) is suggested to ensure a homogeneous melt and consistent shot size. Higher back pressures used to improve melt mixing result in higher melt temperatures.

When molding reinforced grades, low back pressure will help reduce glass fiber damage during plastication.

Figure 16.2 – Screw speed suggestions for Valox resin



Shot Size

The suggested shot size is 30 to 80% of the machine capacity. For blended grades where color control is critical, it is suggested the shot size be as close to 60% of machine capacity as possible in order to reduce residence times.

Ram Speed

When selecting injection speed, careful consideration must be given to adequate mold venting, resin melt temperature and injection pressure, along with the potential for jetting.

The fastest fill speed possible generally provides longer flow, fills thinner wall sections and creates better surface finish. In thick parts, slow fill helps reduce voids. Valox resin require a fast fill to help prevent premature freeze-off. Thin-wall sections below 0.06 inch (1.52 mm) require fast ram speeds in order to fill the cavity and enhance knitline strength. The fill rate of thick sections may be reduced to aid packing when filling through restricted gates.

Programmed injection is suggested for parts with small gates (pin gates and subgates). A slow injection rate can be used at the start to reduce shear, jetting and burning of the material.

Injection Pressure

The actual injection pressure will depend on variables such as melt temperature, mold temperature, part geometry, wall thickness, flow length and other mold and equipment considerations. Generally, the lowest pressures which provide the desired properties, appearance and molding cycle are preferred.

Valox resin flow relatively easily, however, medium to high injection pressure may be required to fill intricate part configurations or thin walls. Normal injection pressures are 8,000 to 10,000 psi (55 to 69 MPa) for unreinforced grades or 10,000 to 18,000 psi (69 to 124 MPa) for reinforced or filled grades.

16. Molding conditions

Holding pressures from 60 to 80% of the injection pressure are usually adequate for normal requirements.

Due to the speed at which Valox resin crystallizes, thin-walled parts with small gates may require only moderate holding pressure. However, thick sections with large gates will typically require high holding pressures and longer holding times.

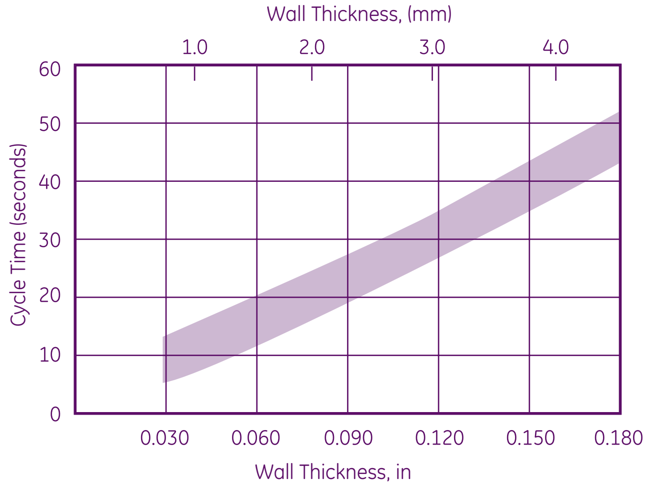
Cushion

The use of a small cushion (1/8 inch [3.18 mm] suggested) reduces material residence time in the barrel and helps accommodate machine variations.

Cycle Time

Cycle time is primarily dependent on part thickness, therefore thin sections from 0.03 inch to 0.06 inch (0.76 to 1.52 mm) usually give overall cycles of about 10 to 18 seconds, while thicker sections of up to 0.15 inch (3.81 mm) can usually be molded in about 40 seconds. Specific cycle time is dictated by part and mold design. The fastest possible ram travel time is best for most parts. The thickest wall section of the part normally sets the cycle time. Figure 16.3 illustrates the overall cycle time prediction as a function of wall thickness. A runner/sprue section could exceed the part wall thickness and extend cycle times shown in Figure 16.3. This should be a consideration before the tool is built, as well as during actual molding.

Figure 16.3– Typical cycle time vs. wall thickness for Valox resin



Effect of Wall Thickness on Flow Length

Valox resin flow relatively easily because of the low melt viscosity of PBT; however, the fast crystallization of PBT resin limits flow capability. Variables affecting mold flow length include wall thickness, mold temperature, injection pressure, melt temperature and material composition. For example Valox resin flow longer in thicker sections versus thin sections. And, unreinforced resin usually flow farther than glass-reinforced resin at similar pressure.

Figures 16.4 through 16.8 show flow properties of different Valox resin as a function of wall thickness.

It should be emphasized that increasing melt temperature has minimal effect on flow length. In general, melt temperatures should be kept below 510°F (266°C) to prevent thermal degradation.

Figure 16.4 – Flow length vs. wall thickness Valox 300 resin grades

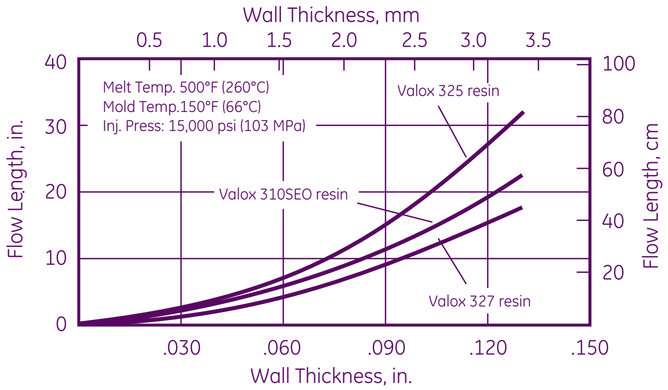


Figure 16.5 – Flow length vs. wall thickness Valox 400 resin grades

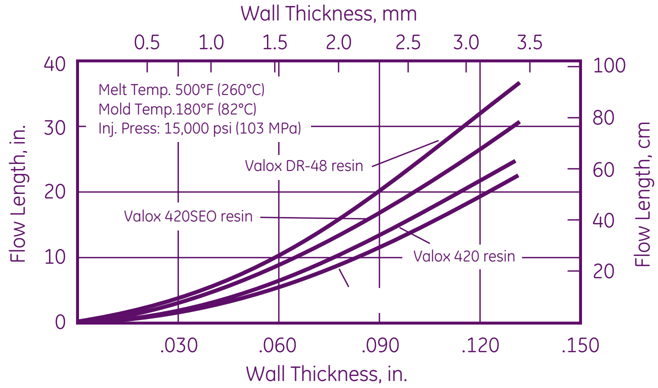


Figure 16.6 – Flow length vs. wall thickness Valox 700 resin grades

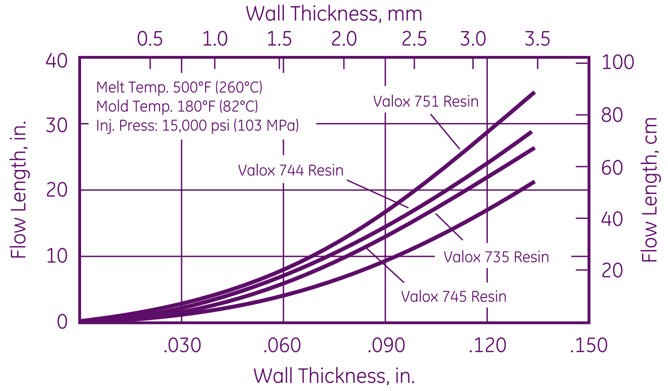


Figure 16.7 – Flow length vs. wall thickness Valox 800 resin grades

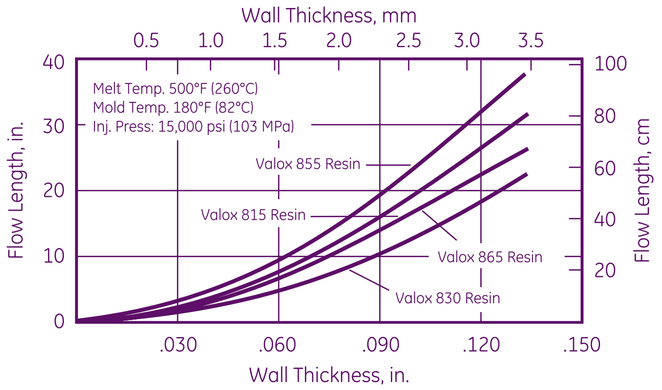
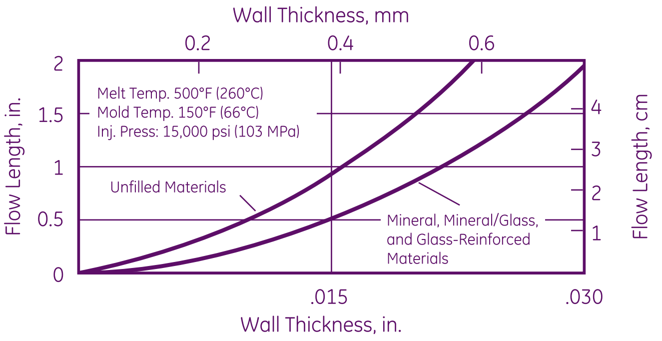


Figure 16.8 – Thin wall flow of Valox resin



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