ANNEALING OF PLASTICS

Annealing of plastics is a heating of a polymeric part to below it's glass transition temperature in order to relieve the internal stresses introduced into the part during its fabrication (molding, cooling after molding, machining, welding)

In order to mold a plastic it is soften by heating and then forced into a cavity where it cools down and shrinks. Non-uniform flowing of the soft plastic and non-uniform and relatively fast cooling result in a formation of internal stresses, which may cause dimensional distortion of the part and even cracking.

Machining of the molded parts introduces additional internal stresses particularly if an improperly designed tool is used or if the plastic part is locally overheated due to excessive cutting and feed speeds.

Drilling deep holes, uneven thickness reduction and screw thread cutting are the machining operations producing internal stresses, which should be reduced by annealing.

Some polymers (e.g. polycarbonate, polysolfone) are more susceptible to internal stress formation.

Technology of plastics annealing

General annealing process includes the following stages:

- ⊡ Placing the plastic part in an annealing oven.
- ⊡ Heating the part to the annealing temperature at a controlled rate. The heating rate is commonly not greater than 50-100 ºF/hour (~30-60 ºC/hour).
- ⊡ Holding the part at the annealing temperature for 2-4 hours per inch of thickness (except Polyamide-imide (PAI), which is held for 3-10 days at the annealing temperature).
- ⊡ Cooling the part to the ambient temperature at a rate not exceeding 10-50 ºF/hour (~6-30 ºC/hour)

There are three technique for annealing of plastics:

- ⊡ **Batch annealing**. This is the most common annealing method. The process is performed in a batch oven with forced convection. The plastic parts are placed on the shelves/racks. The

main disadvantages of the method are: batch type (non-continuous) process and a longer annealing operation due to the restricted air flow.

- **Conveyorized Forced Hot Air Annealing (CFHA)**. CFHA is a continuous annealing process in which the plastic parts are placed on the conveyor belt moving through a long tube like oven with forced hot air convection. The heating process is much faster than in a batch oven. Additionally the continuous character of the technique is preferable for the industrial implementation.

- **Infrared annealing (IR)**. IR annealing also utilizes a continuous oven but heating method is different. The plastic parts are heated not by hot air (like in CFHA) but the energy transmitted by infrared radiation. This is the fastest heating method. However heating is not always uniform: shadowed portions of the part heat up slower.

Annealing temperatures for plastics

Plastic material	Annealing temperature	
	ºF	ºC
ABS	200	93
Acrilic	180	82
Delrin	320	160
Polyethylene Terephtalate (PET)	350	177
High Density Polyethylene (HDPE)	250	121
Polyvinylidene fluoride (PVDF)	275	135
Nylon 6	300	149
PEEK	375	191
Polycarbonate (PC)	275	135
Low Density Polyethylene (LDPE)	175	79
Polyethylene UHMW	220	104
Polypropylene	185	85
Polysterene	170	77
Polyamide-imide (PAI)	500	260
Polysulfone	330	166

Source : http://www.substech.com/dokuwiki/doku.php?id=annealing_of_plastics