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INJECTION MOULDING PLASTIC GEARS

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Key words: injection moulding, plastic gears, thermoplastic materials,

Abstract: The paper present specific problems of mould construction, gate location and properties of termoplastics used in injection moulding process.

Plastic gears displace metal gears in a lot of industrial and automotive application. Plastic gears can be produced similarly with metal gears or by injection moulding.

Injection moulding process is more economical for long series of fabrication. In the same time plastic gears present a lot of advantages:

- low cost, of injection moulding process,
- low weight, result low inertia,
- capability to absorb vibration, due the elastic properties,
- low coefficient of friction,
- very good corrosion resistance,
- need an minimum lubrication,

And the following disadvantages:

- low load capacity, due the stress properties,
- dimensional instabilities, due the coefficient of thermal expansion and moisture absorption,
- reduced capability to work at high temperature, less 100°C,
- are affected by chemical agents and lubricants,
- cannot be moulded to the accuracy like metal gears,
- injection moulding process produce internal stress and warpage,

The location of gate on the gear surface is the most important thinks in mould construction. If the gate is build like in figure 1 the melt is injected in one point, flow to fill the cavity of mould and create a welding line opposite the gate. If the melt is less fluid, in welding point, in time, appears strength limitation.

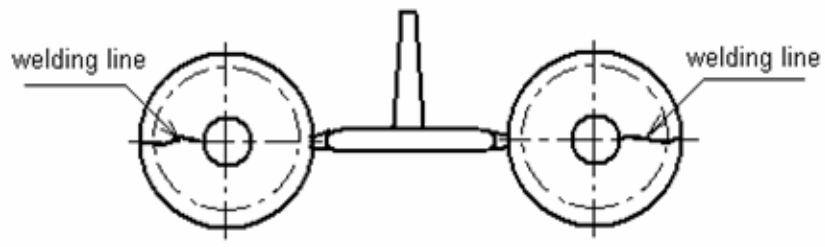

Fig.1. Point injection gate.

To avoid this problem is possible to build diaphragm gate or multiple point gate like in figure 2.

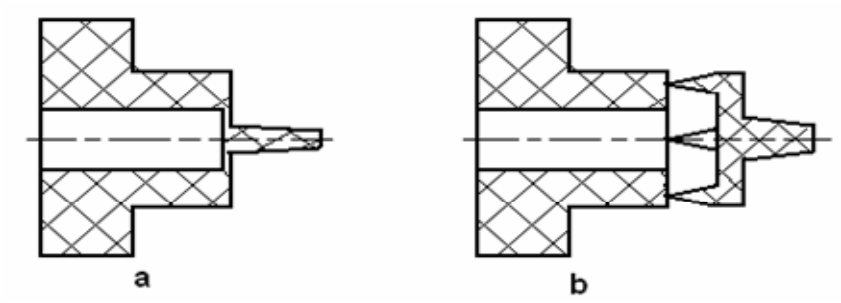

Fig. 2, Injection gate. a- diaphragm gate, b- multiple point gate,

Mould construction could be with 1, 2 or 3 separation plans.

Moulds with one separation plan are using for plastics gear with point injection gate, with 2, 4 or 6 mould cavity.

For diaphragm and multiple point gate are using construction with two or three separation plans. In figure 3 a.b.c. is present an injection mould with three separation plans.

When the mould is open the tear bars draw the intermediary plate and ejected the gear, runners and the gate.

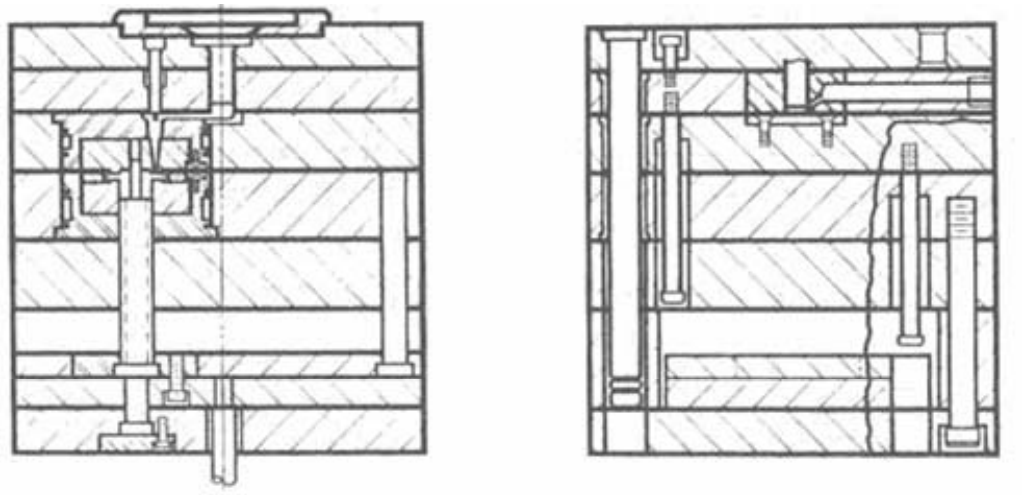

Fig.3.a. Closed mould.

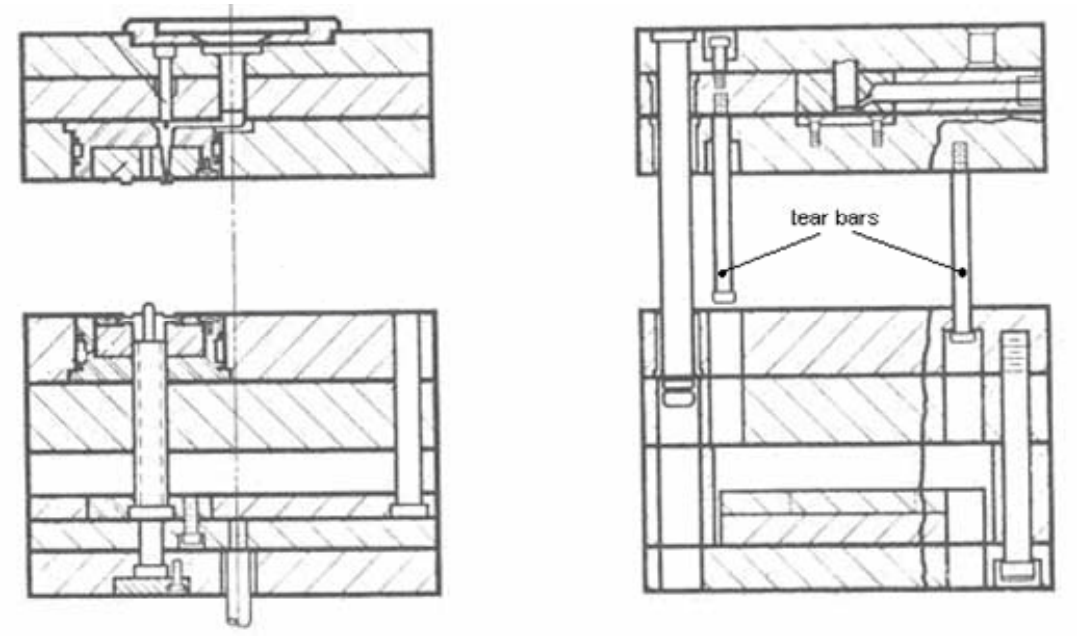

Fig.3.b. Intermediate open mould.

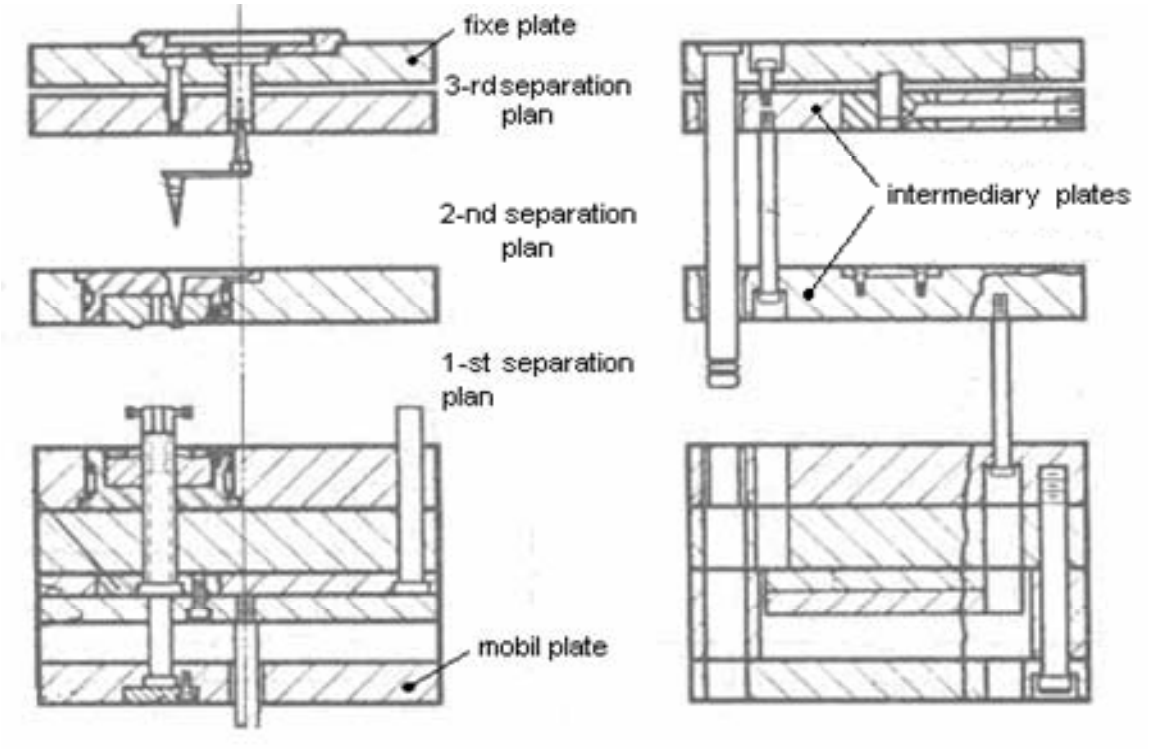

Fig. 3.c. Open mould.

Thermoplastics materials for gears are choosing function of physical and mechanical properties, regard to strength, rigidity, dimensional stability, lubrication, moisture absortion, etc.

In tables 1 and 2 are present physical and mechanical properties of the most representative plastic materials used for gears.[2],[3].

Table 1

Property	ABS	POM 30%glass	PA6.6	PA6.6. 30%glass	PA 6.10
Dimensional stability					
Coef. thermal expansion [$°C^{-1}$]	$7…15.10^{-5}$	10…15	5…14	2…3	6…10
H_2O absortion/24 h [%]	0,05…1,8	0,15…0,5	1…3	0,8…1,1	0,4…0,6
Shrinkage [%]	0,7…1,6	1,8…2,5	0,7…3	0,5	1…1,3
Physical properties					
Density [g/cm^3]	1,02…1,21	1,41…1,42	1,13…1,15	1,37	1,09…1,1
Glass transition temperature[°C]	90…102	50…60	55…58	50…60	55…60
Service temperature					
Fragile temperature [°C]	-25…-40	-40	-80…-65	-55	-60
HDT@1,8 MPa [°C]	88…100	110…130	65…105	130	80…85
Mechanical properties					
Flexural modulus [GPa]	1,6…2,4	2,8…3,7	0,8…3	5…8	1…2
Hardness Shore D	100	80…95	80…95	80…95	60…85
Strength at break [MPa]	29,8…43	60…70	50…95	100…125	50…65
Strength at yield [MPa]	29,6…48	54…78	45…85	100…125	50…65

Table 2

Property	PS 30% glass	PS high imp.	PSU 30% glass	PVC	POM
Dimensional stability					
Coef. thermal expansion [$°C^{-1}$]	3,5	5…20	2…3	2…4	10…15
H_2O absortion/24 h [%]	0,005…0,3	0,05…0,15	0,3…0,4	0,01…0,2	0,15…0,5
Shrinkage [%]	0,2	0,2…0,8	0,1…0,6	0,1…0,2	1,8…2,5
Physical properties					
Density [g/cm^3]	1,25	1,03…1,06	1,4…1,5	1,45…1,5	1,41…1,42
Glass transition temperature[°C]	90…120	89…92	100	60…100	60
Service temperature					
Fragile temperature [°C]		-40…-20	-20	-10	-40
HDT@1,8 MPa [°C]	77…122	75…80	175…185	75…80	110…136
Mechanical properties					
Flexural modulus [GPa]	10	1,5…3	7…8,5	4,5…7	2,8…3,7
Hardness Shore D	80…90	60…75	95	85…90	80…95
Strength at break [MPa]	70	20…40	100…105	60…90	60…70
Strength at yield [MPa]	70	20…40	100…125	60…90	54…78

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