Exercise subject: Injection moulding

1. Exercise objectives:
- theoretical: studying the injection moulding as a method of processing of polymer materials;
- practical: learning the injection moulding machine handling and determining the injection parameters:
  - injection parameters optimization;
  - assessing the quality of moulded parts for various cooling times and temperatures;
  - shrinkage process assessment - longitudinal, lateral and thickness.

2. Theoretical issues:
injection moulding process, thermoplastic injection moulding methods, course of injection moulding cycle, types of injection moulding machines, injection moulds design.

3. Literature:
1) Crawford R.J. : „Plastics Engineering", Butterworth-Heinemann 1998.
2) Ram A.: "Fundamentals of Polymer Engineering", Plenum Press, New York 1997.
3) Vegt A.K.: "From polymers to plastics", DUP Blue Print, Delf 2002.
4) Rosato D.: "Injection Molding Handbook", Kluwer Academic Publishers, Massachusetts 2000.

4. Experimental part:
a) injection moulding machine start - up and operation

CAUTION!! START – UP AND OPERATION OF THE MACHINE ONLY BY THE LECTURER!!!

CAUTION!! DO NOT TOUCH ANY MOVING PARTS OF THE MACHINE WHILE CLOSING AND OPENING THE MOULD!!!

CAUTION!! DO NOT TOUCH THE MOVING PARTS OF THE MACHINE DURING INJECTING AND PLASTYFYING PROCESS OF THE PLASTIC. MANIPULATING IN THE HOPPER DURING PISTON MOVING IS HIGHLY FORBIDDEN. DO NOT TOUCH THE INJECTION MOULDING MACHINE CYLINDER AND THE MOULD AREA.

CAUTION!! OPERATE THE INJECTION MOULDING MACHINE ONLY WHEN THE SAFETY NET OF THE WORKING SYSTEM OF THE MACHINE IS CLOSED!!!

b) Exercise execution:

I. Optimization of injection parameters: prepare a few moulded pieces of a specified plastic, while adjusting the following: 1- the temperature of the heating system; 2 – injection time and pressure in the [s] until the moulded piece is ready.

II. Prepare a ten of moldings of polypropylene and polypropylene with glass fiber (5 and 10 %wt). Determine the effect of adding glass fiber on: 1 - part weight; 2 - longitudinal shrinkage (S_l).

5. Results reporting:

Describe the exercise performance, prepare a summary of the results of the measurements in tables, according to the enclosed examples, prepare relevant graphs, carry out a discussion about the results and draw conclusions.

6. Safety rules:

I. **All tests and measurements involved in the exercise must be carried out in accordance with the lecturer's instructions**

II. **Always wear safety glasses while operating the injection moulding machine!!!**

III. **Data sheets of the substances must be read before starting the exercise (see the attachment).**

IV. **Take particular caution while:**

- **CLOSING AND OPENING OF THE MOULD – DO NOT TOUCH ANY MOVING PARTS OF THE MACHINE!!!**

- **INJECTION AND WITHDRAWAL OF THE SCREW – DO NOT TOUCH THE MOVING PARTS. MANIPULATING IN THE HOPPER DURING THE SCREW MOVEMENT IS FORBIDDEN. DO NOT TOUCH THE INJECTION MOULDING MACHINE CYLINDER AND THE MOULD AREA.**

7. Attachments:

a) Safety data sheet: polypropylene Moplen HP456J.
b) Safety data sheet: Battenfeld Plus 35.

RESULTS SUMMARY - TABLES

I. Set–up parameters

Injection unit	Value	Unit
Temperature		ºC
Injection pressure		bar
Injection time		s
Follow up pressure		bar
Follow up time		s
Injection mould temperature		ºC
Cooling time		s

II. Measurement values of the dumbbells

NO.	PRODUCT	WEIGHT [g]	LENGTH [mm]
1.	pure polypropylene		
2.			
3.			
4.			
5.			
1.	composites 5 wt% GF + 95 wt% PP		
2.			
3.			
4.			
5.			
1.	composites 10 wt% GF + 90 wt% PP		
2.			
3.			
4.			
5.			

Calculate the processing shrinkage (longitudinal shrinkage) from the equation:

$$S_l = \frac{l_0 - l_1}{l_0} \cdot 100\%$$

l_0 - mould cavity length = 159,00 [mm]

Charts:

Please make graphs: weight = f(filler content, wt%) and S_l = f(filler content, wt%)

Please include mean values and standard deviation.