TÜRK LOYDU

TENTATIVE RULES FOR POLYETHYLENE CRAFTS

2014

This latest edition incorporates all rule changes. The latest revisions are shown with a vertical line. The section title is framed if the section is revised completely. Changes after the publication of the rule are written in red colour.

Unless otherwise specified, these Rules apply to crafts for which the date of contract for construction is on or after 15th of May 2014. New rules or amendments entering into force after the date of contract for construction are to be applied if required by those rules. See Rule Change Notices on TL website for details.

"General Terms and Conditions" of the respective latest edition will be applicable (see Rules for Classification and Surveys).

If there is a difference between the rules in English and in Turkish, the rule in English is to be considered as valid. This publication is available in print and electronic pdf version. Once downloaded, this document will become UNCONTROLLED. Please check the website below for the valid version.

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Contents

A. GENERAL **1-**1
1. Purpose
2. Scope

B. MATERIAL PROPERTIES OF POLYETHYLENE **1-**1
1. General Requirements
2. Documentation
3. Properties of Polyethylene

C. STRUCTURAL DESIGN **1-**2
1. General
2. Rotation moulding of polyethylene boats
3. Boat construction
4. Structural Requirements

A. GENERAL

1. Purpose

This tentative Additional Rule has been developed to meet industrial requirements regarding the use of polyethylene as structural material in boats. For all other requirements, Chapter 9 - TL Rules for Construction and Classification of Yachts (Chapter 9) is to be applied except Section 3-Hull Construction-Wood, Section 4-Hull Construction-GRP, Section 5-Hull Construction-Steel, and Section 6-Hull Construction-Aluminium. However, Türk Loydu, if finds justified, also reserves the right to modify the application of Yacht Rules or to apply alternative measures.

2. Scope

The classification aims at providing an appropriate safety level for the special service crafts, their intended application and design limitations. The technical and safety standards prescribed are considered adequate for Commercial craft with overall lengths in the approximate range 6 to 24 m and with speedup to 45 knots. Craft with lengths and/or maximum speed other than indicated may be classed upon special consideration.

B. MATERIAL PROPERTIES OF POLYETHYLENE

1. General requirements

1.1 The approval is given to the manufacturer who produces the raw material at the final stage before boat production. For rotational moulding the approval is granted to the granulate/ powder manufacturer. For thermoforming of sheets the approval is granted to the sheet manufacturer.

1.2 Ageing properties shall be verified on sheet material with pigments etc. which shall be used in the production.

1.3 The content of pigments shall not exceed 4% and are to be evenly distributed in the material. Any detrimental effect on the strength of the material shall be recorded.

1.4 The impact strength of the material at low temperatures is approved in relation to the fracture character at pendulum notch impact testing. Brittle fracture at temperatures above 0°C shall not be accepted. If the transition between tough and brittle fracture occurs between 0°C and -20°C, the following statement shall be entered on the boat's class certificate:

The impact strength of the plastic material is reduced at low temperatures. The craft is not recommended to be used in cold temperatures.

1.5 The ability of the material to withstand heating by sunlight is subject to approval on the basis of the reduction in the material stiffness between 20°C and 65°C. A reduction in the shear modulus of the material greater than 80% shall not be accepted.

If the reduction is between 30% and 80%, the following statement shall be entered on the boat's class certificate:

The material softens at high temperatures and may be permanently deformed by long term loading at high temperatures.

2. Documentation

2.1 Table 1 and 2 (for LDPE and MDPE) and Table 3 (for HDPE) specify requirements for properties and documentation.

2.2 The test specimens shall be taken from the material which is used in production, but the material shall not be weakened due to the manufacturing process.

2.3 The approval shall state the manufacturing process for which the material is approved.

3. Properties of polyethylene

3.1 LDPE and MDPE Polyethylene shall comply with the requirements given in Table 2. Properties of HDPE Polyethylene are given on Table 3. The test specimens shall be taken from material manufactured in accordance with a method representative for the boat production.

C. STRUCTURAL DESIGN

1. General

1.1. Premises

1.1.1 Premises for manufacturing of boats of poyethylene shall be suitable for the production process applied.

1.1.2 Uncontrollable draughts must be avoided in the vicinity of the production machinery and in cooling rooms.

1.1.3 Premises and production machinery shall be arranged to avoid risk of pollution by oil spill, dust etc.

1.2 Marking of produced boats

1.2.1 The boat is to have a durably fitted plate or similar which clearly states the structural material of the boat.

1.2.2 The boat manufacturer shall supply the following with each boat: information on the boat's presupposed use, directions for maintenance and repair as well as information on substances which may have detrimental effects on the boat's structural material.

2. Rotation moulding of polyethylene boats

2.1 Moulding condition

2.1.1 Release compositions applied to the mould are not to have any detrimental effects on the boat material, e.g. stress cracking.

2.1.2 Regenerated raw material will not be accepted for use in hulls manufactured by rotation moulding.

2.1.3 The rotation procedure shall be the same for moulding of all boats of the same type.

2.1.4 The weight quantity of powder in the mould is not to be less than 1% below the specified value.

Table 1 Properties and documentation of LDPE and MDPE

Properties	***Test method***	***Results to be given for information except where noted. * Also required by delivery***
Tensile properties	ISO/DIS 527-1985 (Test specimen type 2, 5 - 50 mm/min.)	Curve at 20°C and 65°C
Shear modulus	ISO 537-1980 (torsion pendulum)	Curve for temperature range -20°C - 65°C
Shear strength	ASTM D-792	
Creep	ISO/R 899-1981 (carried out on at least 3 stress levels and 2 test pieces per level)	Isochronous stress-deformation diagram for 1000, 100, 10, 1 and 0.1 hours at 20°C and 65°C
Fatigue	Fatigue test carried out with constant stress or deformation amplitude	Curves up to at least 100.000 loading cycles at 20°C
Hardness	ISO 868-1985 (Shore D)	Given at 20°C, read after 15 seconds
Falling weight impact	ASTM D 3029-72 (method A). The radius of the drop hammer's striking surface is to be 12.5 mm	Fracture energy by visible crack as fracture criterion, given at 0°C and at 20°C and with relevant material thickness
Pendulum impact	With V-notch 45° in accordance with ISO 180-1982. For particularly flexible materials an alternative test method (tensile impact	Fracture energy at 0°C as well as a description of fracture type The notch impact strength is only stated for non-aged
Ageing	ISO 179-1982 (Charpy) without notch: Natural ageing DIN 53386, item 6.1. Accelerated ageing: DIN 53387	Plotted fracture energy for aged materials as a function of logarithmic time. The time is normally to cover 48 months natural ageing or 5 000 hours accelerated ageing. A shorter time can be approved if the ageing process is clarified at an earlier stage
Fuel resistance	Stressed material submerged in normal engine fuel	Description of surface cracking
Melt index	ISO 1133-1981 COND 18	To be given for polyethylene
Chemical resistance	ISO 175-1981	List of chemicals which may damage the material
Density	ISO 1183-1983 (Method D)	To be given for polyethylene *
Oxygen index	ASTM D 2863-1977	Value *
Flexural Properties	ASTM D-790	
Compressive strength	ASTM D-695	

Table 2 Properties of LDPE and MDPE

Property	***Requirement LDPE***	***Requirement MDPE***	***Unit***	***Comments***
Density	< 0.930	0.930 - 0.945	g/cm^3	
Melt index	Stated value ±1.0 Though max. 3.5	As LDPE	g/10 min.	
Tensile yield stress	min. 7.5 min. 4.5	min 13.0 min 8.0	N/mm^2 N/mm^2	At 20°C At 65°C
Elasticity modulus in tensile yield	min. 180	min. 350	N/mm^2	At 20°C
Tensile creep strength	max. 2.5 at stress 2.0	2.0 at stress 3.0	% N/mm^2	Deformation after 100 hours at 20°C
Flexural Strength	8-15	20	N/mm^2	
Flexural Modulus	250	500	N/mm^2	
Compresive Strength	9.6	15	N/mm^2	
Shear Strength	8	12	N/mm^2	
Hardness	Stated value ±3	As LDPE	Shore D	Tested at 20°C and read after 15 sec.
Impact strength (drop test without notch)	min. 15	min. 15	J/mm thickness	Freely supported test piece 0°C
Notch impact strength (pendulum test with notch)	Not brittle fracture	Not brittle fracture	Visual	Required only for boats with single skins 0°C
Pore contents	max. 15 max. 20	As LDPE As LDPE	% of thickness % of thickness	In structural parts In the boat elsewhere
Impact tensile strength of aged material	Not brittle fracture min. fracture energy 1.0 J/cm^3	As LDPE J/cm^2	Visual	Aged material corresponding to 4 years of natural ageing, tested at 0°C and with a test speed 2 x 10^5 %/mm

Table 3 Properties of HDPE

Property	Properties of HDPE	Unit	Test Method
Density	0.946 to 0.972	g/cm^3	ASTM D-792
Melt Mass Flow Rate	0.030 to 10 (190°C/2.16 kg)	g/10 min	ISO 1133
Tensile Yield Stress	min 17	N/mm^2	ASTM D-638
Tensile Break Stress	min 14	N/mm^2	ASTM D-638
Ultimate Tensile Stress	min 24	N/mm^2	ASTM D-638
Tensile Elongation at Yield	1.0 to 27	%	ASTM D-638
Tensile Elongation at Break	10 to 1500	%	ASTM D-638
Tensile Creep Modulus	292 (After 1000 hrs)	N/mm^2	ISO 899-1
Compressive Stress	20	N/mm^2	ASTM D-695
Shear Strength	18	N/mm^2	ASTM D-792
Flexural Strength	40	N/mm^2	ASTM D-790
Flexural Modulus	750	N/mm^2	ASTM D-790
Hardness	as LDPE **(1)**	Shore D	
Impact strength (drop test without notch)	as LDPE **(1)**	J/mm thickness	
Notch impact strength (pendulum test with notch)	as LDPE **(1)**	Visual	
Pore contents	as LDPE **(1)**	% of thickness	
Impact tensile strength of aged material	as LDPE **(1)**	Visual	
Viscosity Number (Reduced Viscosity)	157.8 to 398.3	ml/g	ISO 1628
Water Absorption	0.010 to 0.017 % (24 hrs)		ASTM D570

(1) *Test method, results and comments of referred material shall be applied as indicated on Tables 1 and 2.*

Note: *The information contained at the table above stated at 23 °C is typical values intended for reference and comparison purposes only. Above mentioned values to be used for design calculations are also to be agreed by* ***TL.***

2.1.5 The temperature shall be automatically controlled. The temperature and its specified permissible variations will be subject to approval in each case, on the basis of the limitations of the raw material properties. The temperature at each measuring point is not to vary by more than +5°C for each moulding process.

2.1.6 The sintering time and the after-sintering time is stipulated on the basis of thickness measurements on the boat type in question to ensure that an even distribution of material in the mould is obtained. The process time is not to vary by more than + 1 minute from the approved time. Any welding together of inner and outer mould is to be approved in each separate case.

2.1.7 The cooling-down process is to be the same for each boat of the same type, and will be stipulated on the basis of the sintering temperature, boat type and raw material, so that deformations in the material are avoided.

2.1.8 If alterations are made in the manufacturing method, **TL** is to be informed for considering whether special tests will be required to check the material quality.

2.2 Moulded boats

2.2.1 The material in the finished moulded boats is to be without any visible surface flaws of significance to the boat's service. Surfaces and cross sections are not to show any sign of either insufficient fusion of the powder particles or thermal degradation of the material.

2.2.2 Pores or air bubbles must not be so numerous or of such size that the material properties are significantly reduced. The amount and size allowed shall be stipulated for each type of material.

2.2.3 The material in the moulded boats is to comply with the requirements to minimum mechanical properties specified for the raw material in question.

2.2.4 Completed boats must not have significant deformations, and all welded joints are to be tight.

2.3 Internal control

2.3.1 The boat manufacturer shall keep a journal of the raw material supplier's certificate data, and store samples from each material delivery.

2.3.2 The boat manufacturer is to record the following process data for each individual boat:

- weighed quantity of powder
- temperature
- sintering and after-sintering time
- cooling-down time.

2.3.3 Each boat shall also to be visually checked for surface flaws and tightness of welded joints.

2.3.4 Each boat shall be marked with its production number, which also shall identify the mould in which the boat has been manufactured. The marking is to be made in a durable way.

2.3.5 Thickness measurements shall normally be carried out on boats that are cut into several sections. Such measurements shall be carried out on one out of 200 boats manufactured in each mould.

3. Boat construction

3.1 Design

3.1.1 Material properties given in the tables for scantling calculation purposes as a reference. Those properties are to be validated by material test results.

3.1.2 The design of the boat shall be suitable for the manufacturing process and the raw material being used.

3.1.3 When forming boats of polyethylene, it is to be taken into consideration that the mechanical properties of the material vary with the temperature and the duration of the loading.

3.1.4 Hard points in the structure are as far as practicable to be avoided. Stiffening is to be evenly distributed over the hull, to the extent this is practicable.

3.1.5 The design is to be such that sufficient hull stiffness is obtained. Large flat surfaces are to be avoided as far as practicable.

3.2 Assembly

3.2.1 No materials built into the boat must have detrimental effects on the other materials applied.

3.2.2 The skins in double hulled constructions and in sandwich constructions shall be watertight. Screws or bushings in the skins must also be watertight.

3.2.3 Where exposed, the connection between inner and outer skin shall be watertight.

3.3 Rule thickness

3.3.1 Rule thickness is the value stated in item C.4.

3.3.2 A measured thickness is regarded as satisfactory when the average of the values measured at 20 points is not less than the rule thickness and if none of the values measured at the individual points is more than 15% below rule thickness.

3.3.3 Local reinforcements that are welded or glued to the hull, may upon special consideration be regarded as part of the skin thickness.

4. Structural Requirements

4.1 Manufacturing

4.1.1 Requirements to moulding time, temperatures and cooling time are determined based on quantity of powder used and the rotation speed, on the background of inspection of complete moulded boats.

4.1.2 Raw materials should be approved in accordance with Subsection B.

4.1.3 If the boat manufacturer is to grind granulate to powder, the grinding and sieving equipment are first to be approved by **TL**.

4.1.4 A pigment of approved type and in the approved quantity is to be added to the powder. During or after the grinding the powder is to be sifted through a mesh of not more than 800 microns.

4.1.5 Material moulded in accordance with the boat manufacturer’s actual procedure shall at least have properties as given in Table 1 and Table 2 or Table 3.

4.2 Scantlings - LDPE, MDPE and HDPE

4.2.1 Scantling values obtained by direct calculation methods shall not be less than 80% of those stated in relevant ampirical formula given in these Tentative Rules.

4.2.2 Hull Thickness

4.2.2.1 The thickness of the outer hull bottom and side shall not be less than:

$$t_y = ks\sqrt{\frac{PF}{L\ 6.7}}(14 + 3.6\ L)\ \ mm$$

where

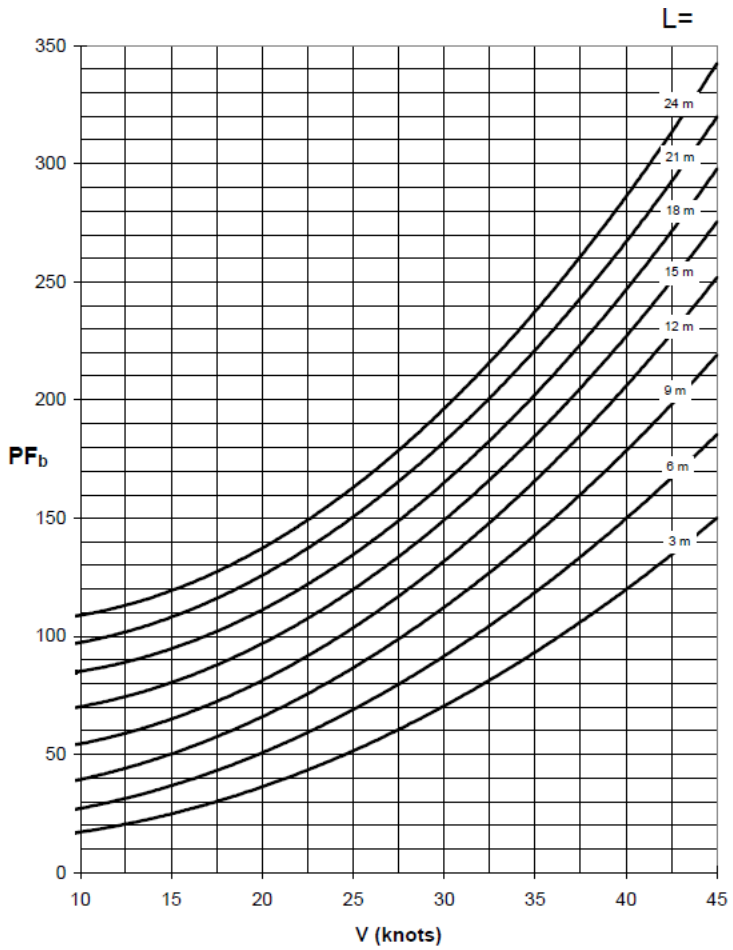
k = 1.0 for LDPE

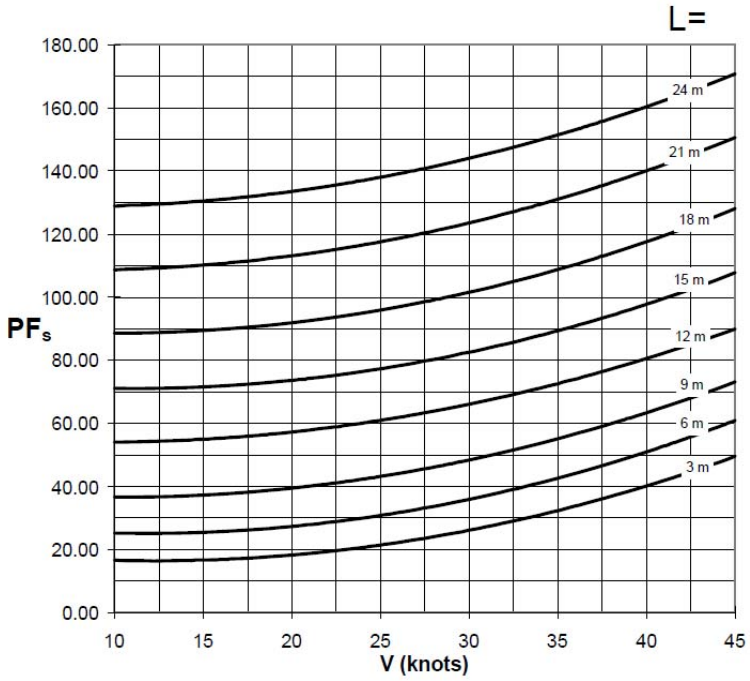
k = 0.85 for MDPE

k = 0.72 for HDPE

s = stiffener spacing in meter

PF = pressure factor for bottom, respectively side (PFb and PFs), taken from the figures in below:





4.2.2.2 The thickness of the inner hull is not to be less than:

t_i = 0.8 ty mm

4.2.2.3 Rotation moulded boats should have a hull weight of at least k x 45 kg. The boat should be stiffened in such a way that keel, bottom or side shell are not to be deformed or deplaced by normal load without reducing the usage of the boat.

4.2.2.4 Proper stiffness shall be provided and demonstrated to TL. For this purpose direct calculation methods may be utilised.

4.2.2.5 Scantling of stiffeners is to be adequate with intended service of craft and to withstand loads to which the craft may encounter. For this purpose direct calculations are to be submitted to Türk Loydu attached to plans.

The scantlings of primary and secondary stiffenining members are to be determined by direct calculation where the craft is of unusual design, form or proportions.

4.2.2.6 Transom for engine mounting is normally to be stiffened over its full breadth. Scantlings based on practical testing with simulated loads from the engine may be accepted.

4.3 Surveillance of the production

4.3.1 Moulding time, temperature, density and melt index of the materials shall be recorded.

4.3.2 The inner surfaces and weldings are to be visually inspected and the hull thicknesses measured by cutting various sections of the boat.