INTERNATIONAL STANDARD

ISO 15546

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Petroleum and natural gas industries — Aluminium alloy drill pipe

Industries du pétrole et du gaz naturel — Tige de forage en alliage d'aluminium

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15546 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*.

This second edition cancels and replaces the first edition (ISO 15546:2002), of which it constitutes a minor revision.

Introduction

Users of this International Standard need to be aware that further or differing requirements could be needed for individual applications. This International Standard is not intended to inhibit a manufacturer from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application — particularly applicable where there is innovative or developing technology. Where an alternative is offered, the manufacturer will need to identify any variations from this International Standard and provide details.

This International Standard includes requirements of various nature. These are identified by the use of certain verbal forms:

— “shall” is used to indicate that a provision is mandatory;

— “should” is used to indicate that a provision is not mandatory, but recommended as good practice;

— “may” is used to indicate that a provision is optional.

Petroleum and natural gas industries — Aluminium alloy drill pipe

1 Scope

This International Standard specifies the technical delivery condition, manufacturing process, material requirements, configuration and dimensions, and verification and inspection procedures for aluminium alloy drill pipes with or without attached steel tool joints for use in drilling and production operations in the petroleum and natural gas industries.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2566-1, *Steel — Conversion of elongation values — Part 1: Carbon and low alloy steels*

ISO 6892, *Metallic materials — Tensile testing at ambient temperature*

ISO 9303, *Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes — Full peripheral ultrasonic testing for the detection of longitudinal imperfections*

ISO 10424-2, *Petroleum and natural gas industries — Rotary drilling equipment — Part 2: Threading and gauging of rotary shouldered thread connections*

ISO 11484, *Steel tubes for pressure purposes — Qualification and certification of non-destructive testing (NDT) personnel*

ISO 11960:2004, *Petroleum and natural gas industries — Steel pipes for use as casing or tubing for wells*

ASTM[1)] A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM G1, *Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens*

ASTM G44, *Standard Practice for Exposure of Metals and Alloys by Alternate Immersion in Neutral 3,5 % Sodium Chloride Solution*

Manual on Statistical Planning and Analysis for Fatigue Experiments — STP-588, ASTM

1) ASTM International, 100 Bar Harbor Drive, West Conshohocken, PA 19428-2959, USA.

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
defect
imperfection of sufficient magnitude to warrant rejection of the product based on the criteria defined in this International Standard

3.1.2
drill pipe
seamless pipe used to rotate the drill bit and circulate the drilling mud, pipes being coupled together by means of tool joints

3.1.3
heat
metal produced by a single cycle of a batch melting process

3.1.4
imperfection
discontinuity in the product wall or on the product surface that can be detected by a NDE method as given in ISO 11960:2004, Table C.62 or Table E.62

3.1.5
lot
lengths of pipe with the same specified dimensions and grade, heat treated as part of a continuous operation (or batch), and which are of a single heat or from different heats grouped according to documented procedure

NOTE The documented procedure will ensure that the appropriate requirements of this International Standard are met.

3.1.6
manufacturer
firm, company or corporation responsible for marking the product

NOTE Marking by the manufacturer warrants that the product conforms to this International Standard, and it is the manufacturer who is responsible for compliance with all of its applicable provisions.

3.1.7
pipe mill
firm, company or corporation that operates pipe-making facilities

3.1.8
processor
firm, company or corporation that operates facilities capable of cutting the threads and assembly of the pipe with the tool joints

3.1.9
seamless pipe
wrought tubular product made without a welded seam, manufactured by hot working and, if necessary, by subsequent cold finishing of the tubular product to produce the desired shape, dimensions and properties

3.2 Symbols

The following symbols are used in this International Standard.

D	Pipe body outside diameter, expressed in millimetres
D_1	Outside diameter of upset end, expressed in millimetres
D_2	Diameter, thread end groove in the pipe end plane, expressed in millimetres
D_3	Pipe end outside diameter, expressed in millimetres
D_4	Pipe thread outside diameter in the end plane, expressed in millimetres
D_5	Pipe diameter at the thread run-out, expressed in millimetres
D_6	Pipe diameter in the estimated plane, expressed in millimetres
D_{pt}	Outside diameter of protector thickening, expressed in millimetres
D_s	Tool joint bevel diameter, expressed in millimetres
D_{se}	Tool joint elevator bevel diameter, expressed in millimetres
D_{sp}	Pin bevel diameter, expressed in millimetres
D_{tj}	Tool joint outside diameter, expressed in millimetres
d	Inside diameter, expressed in millimetres
d_1	Inside diameter of the pipe upset end, expressed in millimetres
d_2	Pipe thread inside diameter in the plane of reference, expressed in millimetres
d_3	Tool joint tapered bore diameter in the plane of the end, expressed in millimetres
d_4	Tool joint tapered bore diameter in the seal estimated plane, expressed in millimetres
d_5	Tool joint thread inside diameter in the plane of reference, expressed in millimetres
d_6	Tool joint thread inside diameter in the end plane, expressed in millimetres
d_7	Bevel diameter at the tool joint thrust inner step, expressed in millimetres
d_8	Inside bevel diameter at the pipe thrust end, expressed in millimetres
d_{tp}	Tool joint pin inside diameter, expressed in millimetres
d_{tb}	Tool joint box inside diameter, expressed in millimetres
f	Hydrostatic pressure test factor
L_1	Length of upset end, expressed in millimetres
L_2	Length of upset end transition zone, expressed in millimetres
L_3	Length of protector thickening, expressed in millimetres
L_4	Length of protector thickening transition zone, expressed in millimetres
L_5	Distance between the pipe end and the end of the processed tapered surface of the stabilizing groove, expressed in millimetres

l Distance from tool joint end plane to inside shoulder face, expressed in millimetres

l_p Pipe length without tool joint, expressed in metres (the distance between the pipe ends)

l_{pj} Pipe length with tool joint, expressed in metres (the distance between the tool joint box face and pin shoulder)

l_{tb} Tool joint box length, expressed in millimetres

l_{tp} Tool joint pin length, expressed in millimetres

p Standard hydrostatic test pressure, expressed in megapascals

t Wall thickness of pipe body, expressed in millimetres

t_1 Wall thickness of upset end, expressed in millimetres

$\sigma_{y,min}$ Specified minimum yield strength, expressed in megapascals

4 Information to be supplied by purchaser

4.1 In placing orders for drill pipe without threads, with threads but without tool joints, or with tool joints attached, the purchaser shall specify the following on the purchase order:

a) reference to this International Standard (i.e. ISO 15546);

b) quantity;

c) internal upset, external upset, external or internal upset and protector thickening (see Tables 4 to 7);

d) drill pipe delivery condition (see 5.4 and Clause 14);

e) outside diameter (see Tables 4 to 7);

f) wall thickness (see Tables 4 to 7);

g) material group (see Table 1);

h) length (see 7.2, Table 3);

i) delivery date and shipping instructions;

j) inspection by purchaser (see Annex A);

k) alternatives of tool joints (see Figure 7).

4.2 The purchaser should also state on the purchase order any requirements concerning the following stipulations, which are at the option of the purchaser:

a) pipe coatings (see 7.9);

b) marking requirements (see Clause 11);

c) non-destructive inspection (see 10.4);

d) corrosion rate test for Group IV chemistry (see Table 1);

e) test certificates (see 13.1);

f) alloy system (see Table 1).

5 Process of manufacture and delivery condition

5.1 General

Drill pipe furnished to this International Standard shall be made by the seamless process.

5.2 Heat treatment

Drill pipes shall be heat-treated by solution heat treatment followed by artificial or natural ageing. The aluminium pipe shall not be subjected to cold working after the final heat-treatment process, except for that which is incidental to normal straightening or threading operations.

The temperature and time requirements for the solution and ageing heat-treatment cycles shall be determined in accordance with the manufacturer's documented practice. Actual furnace temperatures and transfer timing shall be documented in order to verify that each heat-treatment lot meets the manufacturer's documented requirements.

5.3 Traceability

The manufacturer shall establish and follow procedures for maintaining heat or lot identity or both until all required heat/lot tests have been performed and conformance with specification requirements has been verified.

5.4 Delivery condition

Aluminium alloy drill pipes are normally supplied as

a) plain end pipe (with external or internal upsets but without threads),

b) threaded pipe (with external or internal upsets but without tool joints), or

c) with tool joints attached (with external or internal upsets).

6 Material requirements

6.1 Material groups

Materials for aluminium alloy drill pipes after heat treatment are divided into the following four material groups that shall be in accordance with Table 1:

— **Group I**, without additional requirements for high strength or corrosion resistance;

— **Group II**, with improved strength;

— **Group III**, with high-temperature mechanical properties;

— **Group IV**, with improved corrosion resistance.

Table 1 — Material requirements for aluminium alloy drill pipes

Characteristic[a]	Unit	Requirements			
		Material group I	Material group II	Material group III	Material group IV
Alloy system		Al-Cu-Mg	Al-Zn-Mg	Al-Cu-Mg-Si-Fe	Al-Zn-Mg
Yield strength, min. (0,2 % offset method)	MPa	325	480	340	350
Tensile strength, min.	MPa	460	530	410	400
Elongation, min.	%	12	7	8	9
Operational temperature, max.	°C	160	120	220	160
Corrosion rate in 3,5 % sodium chloride solution, max.	g/(m^{2}h)	—	—	—	0,08
It is permitted to use an alternative aluminium alloy system, provided there is purchaser agreement and that it conforms to the requirements of one of the four material group categories. The manufacturer shall have a documented procedure that demonstrates the minimum yield strength that can be achieved at the maximum operational temperature defined in Table 1. Mechanical testing shall be in accordance with ISO 6892. It is necessary that users be aware that the yield strength at ambient temperature can be reduced by up to 30 % at the maximum operational temperature for exposure times greater than 500 h.					
[a] The mechanical properties of the alloys given in this table are for a test temperature of 21 °C ± 3 °C.					

6.2 Metallographic examination

Each heat treatment lot sample shall undergo metallographic examination. The macrostructure shall be homogeneous, without cracks, pits, laminations, shrinkage cavities, surface tears or sponginess. The microstructure shall not contain porosities or grain boundary eutectic melting resulting from solution heat treatment.

For terminology relating to microstructure examination, see ASTM B917 and ASTM B918.

6.3 Chemical composition

Chemical analysis shall be undertaken on each heat. The residual lead content shall be limited to 0,005 % by mass for all material groups.

6.4 Steel tool joints

Material for steel tool joints shall be in accordance with Table 2.