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Energy efficiency of industrial trucks — Test methods —

Part 1: General

Efficacité énergétique des chariots de manutention — Méthodes d'essai —

Partie 1: Généralités

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 110, *Industrial trucks*, Subcommittee SC 5, *Sustainability*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This document is intended to be used in conjunction with ISO 23308-2 and/or ISO 23308-3.

A list of all parts in the ISO 23308 series can be found on the ISO website.

Introduction

The ISO 23308 series deals with the energy efficiency of industrial trucks including batteries and battery chargers.

This document contains the procedures to determine the efficiency of trucks, traction batteries and battery chargers. The other parts provide a specific test cycle for different truck types.

NOTE The test cycles are based on the VDI 2198 guideline. This guideline is widely accepted by industry and is used to measure the energy consumption of electric industrial trucks and internal combustion (IC) industrial trucks. The guideline has been in place since 1996 and it is used broadly. This approach provides for the evaluation of the energy efficiency of trucks by comparison.

The content of this document is of relevance for the following stakeholder groups:

— machine manufacturers (small, medium and large enterprises);

— market surveillance authorities;

— machine users (small, medium and large enterprises);

— service providers, e.g. for consulting activities.

The stakeholder groups above have been given the opportunity to take part in the drafting process of this document. The machines concerned are indicated in the scope of this document.

Energy efficiency of industrial trucks — Test methods —

Part 1: General

1 Scope

This document specifies general test criteria and requirements to measure the energy consumption for self-propelled industrial trucks (hereinafter referred to as trucks) during operation. For electric trucks, the efficiency of the battery and the battery charger is included.

The truck specific requirements in ISO 23308-2 and ISO 23308-3 take precedence over the respective requirements of ISO 23308-1.

This document is applicable to the in-use phase of the product life cycle.

It applies to the following truck types according to ISO 5053-1:

— counterbalance lift truck;

— articulated counterbalance lift truck;

— reach truck (with retractable mast or fork arm carriage);

— straddle truck;

— pallet-stacking truck;

— pallet truck;

— platform and stillage truck;

— pallet truck end controlled;

— order-picking truck;

— centre-controlled order-picking truck;

— towing, pushing tractor and burden carrier;

— towing and stacking tractor;

— side-loading truck (one side only);

— variable-reach container handler;

— counterbalance container handler;

— lateral-stacking truck (both sides);

— lateral-stacking truck (three sides);

— multi-directional lift truck.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 3691-1:2011, *Industrial trucks — Safety requirements and verification — Part 1: Self-propelled industrial trucks, other than driverless trucks, variable-reach trucks and burden-carrier trucks*

ISO 3691-2:2016, *Industrial trucks — Safety requirements and verification — Part 2: Self-propelled variable-reach trucks*

ISO 5053-1, *Industrial trucks — Terminology and classification — Part 1: Types of industrial trucks*

ISO 15500-1, *Road vehicles — Compressed natural gas (CNG) fuel system components — Part 1: General requirements and definitions*

ISO 23308 (all parts), *Energy efficiency of Industrial trucks — Test methods*

IEC 60254-1, *Lead acid traction batteries — Part 1: General requirements and methods of tests*

IEC 62620:2014, *Secondary cells and batteries containing alkaline or other non-acid electrolytes — Secondary lithium cells and batteries for use in industrial applications*

EN 589, *Automotive fuels — LPG — Requirements and test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5053-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
battery
electrical power source consisting of battery cells, connectors of cells, battery controller (if applicable, e.g. controller for Li-Ion batteries) and battery enclosure that is ready to use in a truck

3.2
battery state of charge
measured capacity (in Ampere hours [Ah]) of the battery divided by the maximum rated capacity [Ah], expressed as a percentage

3.3
carbon dioxide equivalent
CDE
quantity that describes, for a given mixture and amount of greenhouse gas, the amount of CO_2 that would have the same global warming potential (GWP)

3.4
charging factor
ratio between amount of Ah recharged into the battery and the prior discharged amount of Ah from the battery

Note 1 to entry: Typically, the charge factor for lead acid batteries is in the range of 1,02 to 1,25.

3.5
power battery factor
PBF
factor that gives the ratio between the battery capacity and the electrical power taken from the battery

3.6
synthetic discharge cycle
typical battery discharge profile that mirrors the actual energy consumption of electric trucks during a test cycle

4 Test conditions

4.1 General

The following test conditions ensure that the measurement of power consumption is performed in a similar and comparable way.

4.2 Test equipment

4.2.1 Test area

The test area shall be a flat and smooth area with a hard, clean and dry surface made of concrete, asphalt or equivalent. The test course shall have no more than 2 % slope in any direction of travel.

4.2.2 Test track

For truck type specific information, see the relevant part of the ISO 23308 series.

4.2.3 Test load and / or towing capacity

Unless it is otherwise stated in the specific part of the ISO 23308 series, the test load shall be equal to 70 % of the rated load and standard load centre distance of the truck, in accordance with ISO 3691-1:2011, A.2, or ISO 3691-2:2016, A.1 and A.3.

Tractors shall tow with a force according to 70 % of the rated drawbar pull, as defined in ISO 3691-1:2011, A.3.

Burden-carriers shall be laden with 70 % of the maximum payload, as defined by the manufacturer.

4.3 Truck conditions

The truck to be tested shall be a sample that is representative of series production. For all parts of the truck, with effect to the energy consumption, a run-in time of up to 100 h is permissible. The run-in time shall be documented.

The truck to be tested shall be in a safe and functional state. All equipment attached shall be in accordance to the specification of the manufacturer of the truck.

The set-up of the truck (e.g. software parameters) shall be available as per the manufacturer's specification. This requirement means that the truck performance as specified is achievable (e.g. driving and lifting speed, acceleration) and all software settings are commercially available to the customer.

NOTE For instance, the test driver can adapt the maximum driving speed to achieve the number of cycles per hour.

The test truck shall be fitted with new tyres (maximum 10 % of tread wear) which shall comply with the specifications of the manufacturer of the truck. Pneumatic tyres shall be inflated to their correct pressure specified by the truck manufacturer or by default from the tire manufacturer.

The fuel tanks of internal combustion engine trucks shall be filled to the maximum specified level prior to the warm up period. All other tanks shall be filled to their correct operating levels, if applicable.

If the test is to be performed on a sample that is representative for a range of trucks with the same rated capacity but different lift heights, the test shall be carried out on the truck with the specification according to ISO 3691-1:2011, A.2.1. For trucks covered by ISO 3691-2, the specific requirements of the applicable part of the ISO 23308 series shall apply.

For trucks covered by ISO 3691-1, the specified lift height shall be at least the standard lift height according to ISO 3691-1:2011, A.2.2. The truck's specified lift height shall allow the measurement procedures as defined in the specific part of the ISO 23308 series.

If the test is to be performed on a sample that is representative for a range of trucks with the same rated capacity and the lift height is lower than the lift height that is specified in ISO 3691-1:2011, A.2.1 and A.2.2, the test shall be carried out on the truck with the greatest lift height.

If the test is to be performed on a sample representative of a range of electric trucks with the option of different battery capacities, the test shall be carried out on the truck with the standard battery/ batteries according to the data sheet of the manufacturer.

4.4 Environmental conditions

The measurement shall be carried out at an environmental temperature range between 5 °C and 35 °C.

The truck in test configuration shall be at operating temperature.

A minimum warm-up period of 10 min is required for the laden truck, before the test starts.

4.5 Truck maintenance

IC-trucks with emissions control systems that can require cleaning or regeneration of the emission control device shall remain within manufacturer recommended parameters throughout the test. It is allowed to block automatic regenerating of the emission control device during the test.

Engines with other emissions control systems utilizing additional reagents/materials shall remain within the parameters recommended by the manufacturer throughout the test.

4.6 Battery condition

Battery efficiencies are influenced by many factors, e.g. cell technology, cell type, cell design and geometry. Therefore, the battery efficiency as stated in 6.2.2 is representative for the tested battery type/battery manufacturer.

If the battery technology requires any energy consuming auxiliary device, e.g. battery management system, controller, cooling or heating, this shall be included in the test.

The battery shall be charged to the rated capacity prior to the respective test. When tests require discharging to the rated minimum capacity of the battery, this shall be determined by one of the following methods.

a) Lead-acid batteries voltage: the battery is discharged if the voltage is less than or equal to 1,6 V/cell (according to IEC 60254-1 for discharge current I1).

b) Lead-acid rated capacity: the battery is discharged if 80 % of the rated capacity is taken from the battery during the test. Recuperation may be considered by calculating with 75 % of the recuperated current over time.

c) Other technologies: discharge criteria are defined by the battery manufacturer. This criterion shall be consistent with all other specification provided with the battery type, e.g. identical life time and

