

1. Purpose and Scope

This product specification covers the demands on quality which apply to solid tungsten carbide plungers for high pressure compressors in regard to material, processing procedure and delivery condition. The relevant applicable standards are referred to herein. Standards of particular importance, e. g. the evaluation criteria of non-destruction tests (NDT), are additionally detailed described.

2. Reference Standards

- ISO 3312 (sintered metal materials and hardmetals: determination of Young's modulus)
- ISO 3326 (hardmetals: determination of (the magnetization) coercivity)
- ISO 3327 (hardmetals: determination of transverse rupture strength)
- ISO 3369 (impermeable sintered metal materials and hardmetals: determination of density)
- ISO 3878 (hardmetals: vickers hardness test)
- ISO 4499 (hardmetals: metallographic determination of microstructure)
- ISO 4505 (hardmetals: metallographic determination of porosity and uncombined carbon)
- ISO 4506 (hardmetals: compression test)
- ISO 9001 (quality management systems: requirements)
- DIN EN 10204 (metallic products: types of inspection documents)
- DIN EN 1330 (non-destructive testing (NDT))
- DIN EN 9712 (non-destructive testing: qualification and certification of NDT personnel)

Further regulations are set by internal standard operating procedures (SOP) and work instructions. The latest revision status is valid.

3. Material

Solid tungsten carbide plungers for high pressure compressors are manufactured in grade V20 or grade V25. Their physical and chemical properties fall within the ranges as specified in the related data sheets. The powder mixture is made of virgin raw material.

4. Product Monitoring

4.1 Primary and Intermediate Product

Powder batch sample – The production of hard metal at TRIBO Hartstoff GmbH is batch managed. Every new prepared powder mixture (batch) is analyzed for chemical composition as well as its physical and metallographic properties are determined by a sintered sample. For a release to production the batch must comply the criteria set out in the specification fully.

Plungersample – Powder mixtures to be used for plungers have to fulfill more stringent quality requirements. An additional sintered sample is made from every plunger batch to evaluate the processing behavior (grinding and polishing). The polished surface is thoroughly inspected.

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Titel

Quality Specification for High Pressure Compressor Plungers

Wafer – In order to be able to determine and check the material properties of the sintered product as well, a sample is cut off the preform and sintered together with it in the same furnace cycle. A part of this sample is archived as reserve for possible further tests.

4.2 Final Product

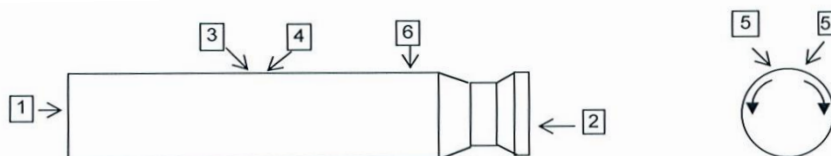
4.2.1 Non-destruction Test (NDT)

The non-destruction material testing of finished plunger is performed by an independent material testing agency, whose staff is trained and certified in accordance with DIN EN 9712. This agency carries out the tests according EN 1330 on the basis of their specific test instruction and valuation guideline. Customer requests with regard to acceptance terms of the regular test as well as to additional test are taken into account.

Test methods:

- Penetration test (PT)
- Ultrasonic test (UT)
- Eddy current test (ET)
- Visual test (VT).

Scope of testing – In accordance with the varying stress during operation first priority is given to the inspection of the polished running surface. UT, PT and VT additionally comprise the inspection of the front sides, PT and VT further include the non-polished plunger head:



Accept and reject criteria running surface – Processing traces are permissible, provided they have the usual depth (not indication PT). Defects $\geq 0,125$ mm are not permitted. Shallow pores and other flat surface defects are conditionally permitted:

- Defects $\geq 0,125$ mm are not allowed.
- Max. 5 defects $< 0,125$ mm per 1000 cm^2 running surface are permissible, of which no more than 3 defects are allowed to be $> 0,075$ mm.
- The minimum allowed space between 2 defects $\geq 0,075$ mm is 20 mm.

documentation – The found defects were recorded with photography by size (max extension on surface) and location. The location is defined by the distance from front side B (plunger head) and the position to the zero mark in terms of degrees viewing from side B to side A.

4.2.2 Dimensional and Visual Inspection

Directly following NDT the plunger is made ready for transport or storage by wrapping in a multilayered corrosion protection package. The packaging and the foregoing dimensional inspection are carried out by at least two staff members. During the packaging a final visual inspections is conducted (“four-eyes-principle”). The procedure for packaging is laid down in the packaging instruction. Customer specifications are taking into account.

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5. Product Identification

Plungers are identified according to the applicable drawing. In the event of absence of a drawing specification or a customer request in this regard all plungers are identified through a material-saving and material-friendly procedure with data listed below. The location for these markings is within the non-polished cylindrical surface of the plunger (piston holder area) or on a front side, and it constitutes the zero mark as necessary for recording the location of defects as per section 4.2.

- Purchase order no
- Plunger no. (allocated by TRIBO)
- Zero mark
- TRIBO Logo

6. Dokumentation

All test results are handed over to the customer in the form of acceptance test certificates and measurements protocols bound to a folder (Plunger file). All samples and related documents are retained and kept available for at least 10 years at TRIBO.

The plunger file consists of:

- Acceptance test certificate 3.1
- Measurement protocols (dimensions, roughness, geometric tolerances)
- NDT certificates
- Optional: certificates for customer-specific tests
- Optional: records and material certificates for additional material, e. g. steel.

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