

无损检测 渗透检测 第1部分：总则

1 范围

本文件规定了使用白光或UV-A(波长为365 nm)源检测被检材料表面开口不连续(如裂纹、重皮、折叠、气孔和未熔合等)的渗透检测方法。该方法主要用于金属材料,但也能用于其他非多孔性且对渗透材料呈惰性的材料。被检材料的实例包括铸件、锻件、焊缝、陶瓷等。

本文件规定了检测过程与控制要求,但不包括验收准则。本文件不涉及个别检测系统特定应用的适用性信息,也不涉及检测设备的要求。

注1: 确定和监测渗透检测产品的基本性能方法,见ISO 3452-2和ISO 3452-3。

注2: 本文件使用的术语“不连续”包括了所有尚未进行可接受或不可接受验收评定的显示。

注3: CEN/TR 16638给出了使用光化蓝光进行渗透检测的方法。

1 Scope

This document specifies a method of penetrant testing used to detect discontinuities, e.g. cracks, laps, folds, porosity and lack of fusion, which are open to the surface of the material to be tested using white light or UV-A (365 nm) radiation. It is mainly applied to metallic materials, but can also be performed on other materials, provided that they are inert to the test media and not excessively porous (castings, forgings, welds, ceramics, etc.)

This document also includes requirements for process and control testing, but is not intended to be used for acceptance criteria. It gives neither information relating to the suitability of individual test systems for specific applications nor requirements for test equipment.

NOTE 1 Methods for determining and monitoring the essential properties of penetrant testing products to be used are specified in ISO 3452-2 and ISO 3452-3.

NOTE 2 The term "discontinuity" is used in this document in the sense that no evaluation concerning acceptability or non-acceptability is included.

NOTE 3 CEN/TR 16638 addresses penetrant testing using actinic blue light.

2 规范性引用文件

下列文件中的内容通过文中的规范性引用而构成本文件必不可少的条款。其中,注日期的引用文件,仅该日期对应的版本适用于本文件;不注日期的引用文件,其最新版本(包括所有的修改单)适用于本文件。

ISO 3059 无损检测 渗透检测和磁粉检测 观察条件 (Non-destructive testing—Penetrant testing and magnetic particle testing—Viewing conditions)

注: GB/T 5097-2020 无损检测 渗透检测和磁粉检测 观察条件 (ISO 3059:2012, IDT)

ISO 3452-2 无损检测 渗透检测 第2部分: 渗透材料的检验 (Non-destructive testing—Penetrant testing — Part 2: Testing of penetrant materials)

注: GB/T 18851.2-XXXX 无损检测 渗透检测 第2部分: 渗透材料的检验 (ISO 3452-2:2021, IDT)

ISO 3452-3 无损检测 渗透检测 第3部分: 参考试块 (Non-destructive testing—Penetrant testing—Part 3: Reference test blocks)

注：GB/T 18851.3-2008 无损检测 渗透检测 第3部分：参考试块（ISO 3452-3:1998, IDT）

ISO 3452-4 无损检测 渗透检测 第4部分：设备（Non-destructive testing—Penetrant testing—Part 4: Equipment）

注：GB/T 18851.4-2005 无损检测 渗透检测 第4部分：设备（ISO 3452-4:1998, IDT）

ISO 3452-5 无损检测 渗透检测 第5部分：温度高于50℃的渗透检测（Non-destructive testing—Penetrant testing—Part 5: Penetrant testing at temperatures higher than 50 degrees C）

注：GB/T 18851.5-2014 无损检测 渗透检测 第5部分：温度高于50℃的渗透检测（ISO 3452-5:2008, MOD）

ISO 3452-6 无损检测 渗透检测 第6部分：温度低于10℃的渗透检测（Non-destructive testing—Penetrant testing—Part 6: Penetrant testing at temperatures lower than 10 degrees C）

注：GB/T 18851.6-2014 无损检测 渗透检测 第6部分：温度低于10℃的渗透检测（ISO 3452-6:2008, MOD）

ISO 12706 无损检测 渗透检测 术语（Non-destructive testing—Penetrant testing—Vocabulary）

注：GB/T 12604.3-2013 无损检测 术语 渗透检测（ISO 12706:2009, IDT）

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 3059, *Non-destructive testing — Penetrant testing and magnetic particle testing — Viewing conditions*

ISO 3452-2, *Non-destructive testing — Penetrant testing — Part 2: Testing of penetrant materials*

ISO 3452-3, *Non-destructive testing — Penetrant testing — Part 3: Reference test blocks*

ISO 3452-4, *Non-destructive testing — Penetrant testing — Part 4: Equipment*

ISO 3452-5, *Non-destructive testing — Penetrant testing — Part 5: Penetrant testing at temperatures higher than 50 degrees C*

ISO 3452-6, *Non-destructive testing — Penetrant testing — Part 6: Penetrant testing at temperatures lower than 10 degrees C*

ISO 12706, *Non-destructive testing — Penetrant testing — Vocabulary*

3 术语和定义

ISO 12706 界定的术语和定义适用于本文件。

4 安全警示

渗透检测经常使用有害、易燃和/或挥发性的材料，因此应关注相关安全法规（如光辐射法规）。

宜避免皮肤或粘膜长期或反复地接触这些材料。工作区域应按相关法规的要求，有足够的通风，且远离热源、电火花和无遮蔽的明火。

应按制造商提供的说明书使用渗透检测材料和设备。

紫外线（UV-A）源应始终处于良好状态。

应确保渗透检测安全实施。

4 Safety precautions

As penetrant inspection techniques often require the use of harmful, flammable and/or volatile materials, safety regulations (e.g. optical radiation legislation) shall be taken into account.

Prolonged or repeated contact of these materials with the skin or any mucous membrane should be avoided. Working areas shall be adequately ventilated and sited away from sources of heat, sparks or naked flames, taking into account all applicable safety regulations.

The penetrant testing products and equipment shall be used with care and always in compliance with the instructions supplied by the manufacturer.

UV-A sources shall always be maintained in a good condition.

Care shall be taken to ensure the safe implementation of the method.

5 总体要求

5.1 人员

检测应由熟练的、经过培训和资格鉴定的人员实施,如适用,应由雇主或雇主委托的检测机构任命有能力的人员负责监督。为证明人员具备相应的资格,宜根据ISO 9712 或各方同意的体系进行资格鉴定和认证。除另有约定外,渗透检测人员,应由雇主任命有能力的监督人员(3级或同等能力)进行操作授权。

5 General principles

5.1 Personnel

Testing shall be carried out by proficient, suitably trained and qualified personnel and, where applicable, shall be supervised by competent personnel nominated by the employer or, by delegation of the employer to the inspection company in charge of testing. To demonstrate appropriate qualification, it is recommended that personnel be certified according to ISO 9712 or an equivalent formalized system. Penetrant testing operations, unless otherwise agreed, shall be authorized by a competent supervisory individual (Level 3 or equivalent) approved by the employer.

5.2 方法概要

渗透检测前,被检表面应进行清洗和干燥。然后将适当的渗透剂施加在检测区域,使其渗入被检表面上开口不连续内。经适当的渗透时间之后,去除表面多余的渗透剂,再施加显像剂,吸出渗入和滞留在不连续内的渗透剂,获得一个清晰、易见和放大的不连续显示。

宜规定无损检测的协调性,优先进行渗透检测,避免污染物堵塞开口不连续。如果渗透检测在其他无损检测方法后进行实施,则在施加渗透剂之前,应仔细清洗被检表面,去除污染物。

5.2 Description of the method

Prior to penetrant testing, the surface to be inspected shall be clean and dry. Suitable penetrant is then applied to the test area and enter discontinuities open to the surface. After the appropriate penetration time has elapsed, the excess penetrant is removed from the surface and the developer applied. The developer absorbs the penetrant that has entered and remains in the discontinuities and may give a clearly visible enhanced indication of the discontinuity.

Should complementary non-destructive testing (NDT) be required, it is preferable that the penetrant inspection be performed first, so as not to introduce contaminants into open discontinuities. If penetrant inspection is used following another NDT technique or method, the surface shall be cleaned carefully to remove contaminants before application.

5.3 操作顺序

渗透过程应是连续的,各阶段之间不应存在不必要的延迟。如果过程中发生不满足工艺参数的情况,被检表面应进行重新清洗和再次渗透。

通常的检测过程为:

- a) 准备和预清洗(见 8.2);
- b) 施加渗透剂(见 8.4);
- c) 去除多余渗透剂(见 8.5);
- d) 施加显像剂(见 8.6);
- e) 观察(见 8.7);
- f) 后清洗和防腐保护(见 8.8)。

检测过程应按附录 A 进行。

5.3 Process sequence

The penetrant process shall be continuous with no undue delays between the stages. If process parameters are not met, surfaces shall be cleaned and reprocessed.

Testing generally proceeds through the following stages:

- a) preparation and precleaning (see [8.2](#));
- b) application of penetrant (see [8.4](#));
- c) excess penetrant removal (see [8.5](#));
- d) application of developer (see [8.6](#));
- e) inspection (see [8.7](#));
- f) postcleaning and corrosion protection (see [8.8](#)).

The process shall be as given in [Annex A](#).

5.4 设备

渗透检测所用设备与被检件的数目、尺寸、重量和形状有关。设备应符合ISO 3452-4的规定。

5.4 Equipment

The equipment used for carrying out penetrant testing depends on the number, size, weight and shape of the parts to be tested. The equipment shall be as specified in ISO 3452-4.

5.5 有效性

渗透检测的有效性与诸多因素有关,包括以下因素:

- a) 渗透材料和检测设备的类型;
- b) 表面准备与状况;
- c) 被检材料和预期的不连续;
- d) 被检表面的温度;
- e) 渗透和显像时间;
- f) 观察条件等。

应按附录B规定的方法实施过程控制检验,以证实使用了正确的检测参数。

5.5 Effectiveness

The effectiveness of the penetrant testing depends upon many factors, including

- a) types of penetrant materials and testing equipment;
- b) surface preparation and condition;
- c) material under examination and expected discontinuities;
- d) temperature of the test surface;
- e) penetration and development time;
- f) viewing conditions.

Control checks shall be carried out to demonstrate that the correct testing parameters are used in accordance with [Annex B](#).

6 产品、灵敏度和名称

6.1 产品族

渗透检测存在多种检测系统。应根据应用需求，选择合适的渗透系统和产品族。多种因素对过程的有效性和灵敏度都有影响，如表面粗糙度和条件、被检材料的尺寸和形状、以及产品族的灵敏度等级。例如，在粗糙表面上使用高灵敏度渗透剂可能比使用低灵敏度渗透剂的检测灵敏度低。

产品族是渗透剂、去除剂（方法A除外）和显像剂等3种渗透材料的组合。产品族可由制造商、用户或检测机构定义。渗透检测材料不一定来自同一制造商，但应按ISO 3452-2规定的方法进行型式检验。

6 Products, sensitivity and designation

6.1 Product family

Various test systems exist in penetrant testing. The penetrant system and the product family shall be selected according to the application. Various factors have an impact on the effectiveness and sensitivity of the process, e.g. the surface roughness and condition, size and shape of the parts to be tested and the sensitivity level of the product family. For example, using a high sensitivity penetrant on a rough surface may result in a less sensitive test than using a lower sensitive penetrant.

A product family is understood as a combination of the following penetrant testing materials: penetrant, excess penetrant remover (except method A) and developer. A product family may be defined by the manufacturer, user or inspection authority and the testing materials do not necessarily have to be from the same manufacturer, but shall be type tested in accordance with ISO 3452-2.

6.2 检测产品

检测产品见表1。

6.2 Testing products

The products used for testing are given in [Table 1](#).

表1 检测产品/程序

渗透剂		去除剂		显像剂	
类型	种类	方法	种类	方式	种类

I	荧光	A	水	a	干粉
II	着色	B	亲油性乳化剂	b	水溶性
III	两用（荧光和着色）	C	溶剂	c	水悬浮
		D	亲水性乳化剂	d	溶剂型(非水, 适用于 I 型)
		E ^a	水和溶剂	e	溶剂型(非水, 适用于 II 型和 III 型)
				f	特殊应用
g ^b	无显像剂(仅适用于 I 型)				
注：对于特殊场合所用的渗透检测产品，必须使用符合可燃性、硫、卤素和钠含量以及其他污染物特定要求的渗透检验产品，见ISO 3452-2。					
^a 方法E涉及到两种产品的使用，即水和溶剂。符合方法A的渗透材料也被认为符合方法E。					
^b 方式g规定的显像时间见8.6.1。					

Table 1 — Testing products/procedures

Penetrant		Excess penetrant remover		Developer	
Type	Denomination	Method	Denomination	Form	Denomination
I	Fluorescent	A	Water	a	Dry
II	Colour contrast	B	Lipophilic emulsifier	b	Water-soluble
III	Dual purpose (fluorescent and colour contrast)	C	Solvent	c	Water-suspendable
		D	Hydrophilic emulsifier	d	Solvent-based (non-aqueous for type I)
		E ^a	Water and solvent	e	Solvent-based (non-aqueous for Types II and III)
				f	Special application
g ^b	No developer (type I only)				

NOTE For specific cases, it is necessary to use penetrant testing products complying with particular requirements with regards to flammability, sulfur, halogen and sodium content and other contaminants. See ISO 3452-2.

^a Method E relates to the use of two products, both water and solvent. Penetrant materials qualified for method A are also considered qualified for method E.

^b For form g, development time is required, see [8.6.1](#).

6.3 灵敏度

产品族的灵敏度等级，应按ISO 3452-2规定的方法进行。通过使用特定的产品族，可达到不同的灵敏度等级。渗透剂基线灵敏度和产品族灵敏度按ISO 3452-2规定的方法进行。

6.3 Sensitivity

Sensitivity levels shall be determined according to ISO 3452-2. By using specific product families, different sensitivity levels may be achieved. ISO 3452-2 describes penetrant baseline sensitivity and product family sensitivity.

6.4 名称

渗透检测用产品族给出包含检测产品类型、方法和方式的名称，以及按ISO 3452-2规定的方法进行检测所得到的灵敏度等级的显示图。

示例：当渗透检测系统采用 ISO 3452-1 和 ISO 3452-2 时，某一产品族包括了荧光渗透剂(I)、作为去除剂的水(A)、干粉显像剂(a)和2级系统灵敏度，则此产品族的名称表示为ISO 3452-2, IAa 2级。

6.4 Designation

The product family to be used for penetrant testing is given a designation comprising the type, the method and the form for the testing products, and a figure which indicates the sensitivity level achieved by testing according to ISO 3452-2.

EXAMPLE A product family comprising a fluorescent penetrant (I), water as the excess penetrant remover (A), and a dry-powder developer (a), and having a system sensitivity of level 2 gives the following penetrant testing system designation when using ISO 3452-1 and ISO 3452-2: product family ISO 3452-2, IAa Level 2.

7 相容性

7.1 总体要求

渗透检测产品应与被检材料和工件的预期用途相容。

7.2 渗透检测产品的相容性

发生流失损耗时，应继续使用相同的产品。该产品可来自不同批次。

7 Compatibility

7.1 General

The penetrant testing products shall be compatible with each other and the material to be tested. The use for which the part or parts is designed shall also be considered.

7.2 Compatibility of penetrant testing products

Drag-out losses shall be replaced with the same product, which may be from a different batch.

7.3 渗透检测材料与被检件的相容性

7.3.1 多数情况下，在使用前能按 ISO 3452-2 规定的腐蚀试验方法进行产品的相容性评价。

7.3.2 检测前应使用所选渗透检测产品检测被检表面的湿润性。当渗透剂应用过程中(例如自动化系统)被检件不可见时，在检测前应通过检测有代表性的被检件，目视判断渗透剂在被检表面的润湿性。

7.3 Compatibility of penetrant testing products and the material to be tested

7.3.1 In most cases the compatibility can be assessed prior to use by means of the corrosion tests detailed in ISO 3452-2.

7.3.2 The wettability of the test surface using the selected penetrant testing product shall be established before testing. When parts are not visible during penetrant application (e.g. automated systems), the wettability of the penetrant on the test surface shall be visually checked before testing on a representative sample.

7.3.3 渗透检测材料会对某些非金属材料的化学或物理性能产生不利影响，因此在检测由这些材料制造的部件和包括这些材料的组件之前，应先确定它们的相容性。

7.3.3 The chemical or physical properties of some non-metallic materials can be adversely affected by the penetrant testing products; their compatibility shall be established before inspecting parts manufactured from, and assemblies that include, such materials.

7.3.4 在可能发生污染的情况下，应确保渗透检测产品不对燃料、润滑油、液压油等产生有害影响。

7.3.5 在过氧化火箭燃料、易爆容器(包括所有与其相连的易爆推进器、发动机或燃烧室材料等)、液氧设备或核反应装置等相关工件上使用渗透检测材料,其相容性应有特殊要求。

7.3.4 In situations where contamination can occur, it is essential to ensure that the penetrant testing products do not have a deleterious effect on fuels, lubricants, hydraulic fluids, etc.

7.3.5 For parts associated with peroxide rocket fuel, explosive stores (these include all items containing explosive propellant, initiating or pyrotechnic materials), oxygen equipment or nuclear applications, the compatibility of penetrant testing products shall be given special consideration.

8 检测工艺规程

8.1 书面检测工艺规程

所有检测都应按经批准的书面检测工艺规程进行。书面检测工艺规程或专门编制,或包括在相关产品标准中。书面检测工艺规程应包括检测的所有相关参数,如温度、时间、压力等。制定书面检测工艺规程时应关注产品制造商的建议。

8 Test procedure

8.1 Written test procedure

All testing shall be performed in accordance with an approved written documentation, either specifically prepared or included in the relevant product standard. The written test procedure shall also include all relevant parameters for testing, e.g. temperatures, times, pressures. When generating test procedures, the product manufacturer's recommendations shall be taken into account.

8.2 预清洗

8.2.1 总体要求

应去除诸如污垢、铁锈、油、油脂或油漆等污染物。如有必要,使用机械或化学的方法,或两者的组合。预清洗应确保被检表面无残留物,以便渗透剂渗入任一不连续内。清洗区域应足够大,以防止来自实际被检表面附近区域的干扰。

8.2 Precleaning

8.2.1 General

Contaminants such as scale, rust, oil, grease, paint and water shall be removed — if necessary using mechanical or chemical methods, or a combination of these. Precleaning shall ensure that the test surface is free from residues and that it allows the penetrant to enter any discontinuity. The cleaned area shall be large enough to prevent interference from areas adjacent to the actual test surface.

8.2.2 机械预清洗

应使用诸如刷、擦、磨、喷、高压爆破(水或冰丸)等适当方法去除污垢、熔渣、铁锈等。这些方法从表面去除污染物,但通常无法去除表面不连续的内污染物。在任何情况下,应确保不连续性不被塑料变形遮蔽或研磨材料堵塞。如有必要,在随后的表面浸蚀处理后,应适当进行冲洗和干燥,以确保不连续表面开口。

8.2.2 Mechanical precleaning

Scale, slag, rust, etc. shall be removed using suitable methods such as brushing, rubbing, abrasion, blasting or high-pressure blasting (water or ice pellets). These methods remove contaminants from the surface and generally are incapable of removing contaminants from within surface discontinuities. In all cases care shall be taken to ensure that the discontinuities are not masked by plastic deformation or clogging from abrasive materials. If necessary to ensure that discontinuities are open to the surface, subsequent etching treatment shall be carried out, followed by adequate rinsing and drying.

8.2.3 化学预清洗

化学预清洗应使用适当的化学清洗剂，以去除诸如油脂、油、油漆或浸蚀材料等残留物。

化学预清洗过程产生的残留物，能与渗透剂产生反应并由此导致其灵敏度下降。因此，在清洗过程后，应使用适当的清洁方法去除被检表面的化学清洗剂。

8.2.3 Chemical precleaning

Chemical precleaning shall be carried out, using suitable chemical cleaning agents, to remove residues such as grease, oil, paint or etching materials.

Residues from chemical precleaning processes can react with a penetrant and greatly reduce its sensitivity. Therefore, chemical agents shall be removed from the surface under examination, after the cleaning process, using suitable cleaning methods.

8.2.4 干燥

作为预清洗的最后工序，被检件应彻底地干燥，以使不连续内没有滞留任何水分或溶剂。

8.2.4 Drying

As the final stage of precleaning, the parts to be tested shall be thoroughly dried, so that neither water nor solvent remains on the test surface and in the discontinuities.

8.3 温度

除干燥过程（8.2.4）外，被检件、被检表面和环境温度应在10℃~50℃之间。宜避免温度快速变化导致被检表面凝结干扰检测。

当温度低于10℃或高于50℃时，应按ISO 3452-5或ISO 3452-6规定的方法检测，如适用。

8.3 Temperature

The testing materials, the test surface and the ambient temperature shall be within the range from 10 °C to 50 °C, except for the drying process (8.2.4). Rapid temperature changes can cause condensation, which may interfere with the process and should be avoided.

For temperatures outside the range from 10 °C to 50 °C, inspection shall be carried out in accordance with ISO 3452-5 or ISO 3452-6, as applicable.

8.4 施加渗透剂

8.4.1 施加的方法

渗透剂能采用喷、刷、浇、浸等方法进行施加。

在整个渗透时间内，应确保被检表面始终保持充分的润湿。

8.4 Application of penetrant

8.4.1 Methods of application

Penetrant can be applied to the part to be tested by spraying, brushing, flooding, dipping or immersion. Penetrant shall remain on the test surface throughout the entire penetration time.

8.4.2 渗透时间

适当的渗透时间，与渗透剂的性能、施加时的温度、被检件的材料和欲检的不连续等有关。

渗透时间应在5 min~60 min之间，不应少于制造商推荐的达到所需灵敏度的时间。渗透时间应在书面检测工艺规程中规定。

8.4.2 Penetration time

The appropriate penetration time depends on the properties of the penetrant, the application temperature, the material of the part to be tested and the discontinuities to be detected.

The penetration time shall be between 5 min and 60 min and shall not be less than the manufacturer's recommended time for the required sensitivity. The penetration time shall be defined in the written test procedure.

8.5 多余渗透剂的去除

8.5.1 总体要求

去除过量的渗透剂时应确保保留不连续内的渗透剂。

8.5 Excess penetrant removal

8.5.1 General

The excess penetrant removal shall be such that penetrant remains in the discontinuities.

8.5.2 水

使用水去除时，应采用擦、浸或喷的方式。不应过度清洗，如使用高压喷雾、过长时间或过度机械动作。使用擦拭去除时，应先使用合适的清洁无绒布或吸水纸去除多余的渗透剂，然后用润湿的清洁无绒布进行擦拭。

8.5.2 Water

When water is used for removal it shall be applied by wiping, immersion or spray. Care shall be exercised to avoid overwashing for example by the use of high-pressure spray, excessive time or excessive mechanical action. When wiping is used, excess penetrant shall be removed first by using a suitable clean lint-free cloth or absorbent paper and subsequently by cleaning with a clean lint-free cloth lightly moistened with water.

8.5.3 溶剂

多余的渗透剂应首先使用合适的干净无绒布或吸水纸去除，然后使用蘸有溶剂的清洁无绒布。任何其他去除技术应得到合同各方的同意，尤其是将溶剂去除剂直接喷射在被检件上。

8.5.3 Solvents

Excess penetrant shall be removed first by using a suitable clean lint-free cloth or absorbent paper and subsequently by using a clean lint-free cloth lightly moistened with solvent. Any other removal technique shall be technically approved for adequacy and agreed by the contracting parties, particularly when the solvent remover is sprayed directly onto the part to be tested.

8.5.4 乳化剂

8.5.4.1 亲水性(水可稀释)

施加的乳化剂,应使得后乳化型渗透剂变为可水洗,以便于从被检表面上去除。为了去除被检表面上大部分多余渗透剂,以及在后续施加亲水性乳化剂时产生出均匀的效果,施加乳化剂之前,宜进行水洗。

应采用浸没或起泡设备施加乳化剂。乳化剂浓度和接触时间应由用户通过预试验来确定。乳化剂接触时间不应超过预试验确定的时间。乳化后应按8.5.2进行最后的水洗。

8.5.4 Emulsifier

8.5.4.1 Hydrophilic (water-dilutable)

To allow the post-emulsifiable penetrant to be removed from the test surface, it shall be rendered water-rinsable by application of an emulsifier. Before the application of the emulsifier, a water wash shall be performed in order to remove the bulk of the excess penetrant from the test surface and facilitate a uniform action of the hydrophilic emulsifier that will be applied subsequently.

The emulsifier shall be applied by immersion or by foam equipment. The concentration and the contact time of the emulsifier shall be determined by the user through pre-tests. After emulsification, a final wash shall be carried out in accordance with [8.5.2](#).

8.5.4.2 亲油性(油基)

施加的乳化剂,应使得后乳化型渗透剂变为可水洗,以便于从被检表面上去除。乳化剂只能采用浸没技术施加。乳化剂接触时间应由用户按制造商的说明书通过预试验来确定。

接触时间应充足,在后续水洗时能去除被检表面多余渗透剂即可。乳化时间不应过长。乳化后应按8.5.2进行水洗。

8.5.4.2 Lipophilic (oil-based)

To allow the post-emulsifiable penetrant to be removed from the test surface, it shall be rendered water-rinsable by application of an emulsifier. This can only be done by immersion. The emulsifier contact time shall be evaluated by the user through pre-tests according to the manufacturer's instructions.

This time shall be sufficient to allow only the excess penetrant to be removed from the test surface during the subsequent water wash. The emulsifying time given by the manufacturer shall not be exceeded. Immediately after emulsification, a water wash shall be carried out in accordance with [8.5.2](#).

8.5.5 水和溶剂

首先应使用水去除多余的水洗型渗透剂(见8.5.2)。随后应使用干净的无绒毛布沾少许溶剂进行清除。

8.5.5 Water and solvent

First, the excess water-washable penetrant shall be removed using water (see [8.5.2](#)). Subsequently the surface shall be wiped with a clean lint-free cloth, lightly moistened with solvent.

8.5.6 多余渗透剂去除效果检查

从被检表面去除多余渗透剂时，应检查被检表面是否有影响判定的渗透剂残留。
应按ISO 3059规定的方法正确地去多余渗透剂。

8.5.6 Excess penetrant removal check

During excess penetrant removal, the test surface shall be checked for penetrant residues that may affect interpretation.

Excess penetrant removal shall be carried out under the conditions specified in ISO 3059 to confirm correct removal.

8.5.7 去除多余渗透剂后的干燥

为便于快速干燥多余水分，应去除被检件上的任何水滴和积水。

除采用水基显像剂外，被检表面应在去除多余渗透剂之后，采用以下方法之一尽快进行干燥：

- a) 用清洁、干燥、无绒毛的布擦；
- b) 热水浸泡后在环境温度下蒸发；
- c) 升高温度蒸发；
- d) 循环空气；
- e) a)~d)所列方法的组合。

如使用压缩空气，应确保气体清洁干净且不会造成已经渗入的渗透剂回流。宜使用最大压力200kPa (2bar)的气源，喷嘴与被检表面距离约300mm或更远。

如果使用强制空气循环或干燥机进行干燥，干燥温度不应超过70℃。干燥时不应导致表面温度高于50℃。

干燥被检件的方法应确保已进入不连续内的渗透剂不被干燥。

8.5.7 Drying after excess penetrant removal

In order to facilitate rapid drying of excess water, any droplets and puddles of water shall be removed from the part.

Except when using water-based developer, the test surface shall be dried as quickly as possible after excess penetrant removal, using one of the following methods:

- a) wiping with a clean, dry, lint-free cloth;
- b) evaporation at ambient temperature after hot water dip;
- c) evaporation at elevated temperature;
- d) forced air circulation;
- e) a combination of methods a) to d).

If compressed air is used, particular care shall be taken to ensure that it is clean and does not affect any penetrant bleed-back that may already have started. It is recommended that a maximum pressure of 200 kPa (2 bar) is used and a distance of around 300 mm or more is allowed between the nozzle and the test surface.

If forced air circulation or a drier is used for drying, the air temperature shall not exceed 70 °C. The drying time shall not lead to a surface temperature higher than 50 °C.

The method of drying the part to be tested shall be carried out such that the penetrant remaining in the discontinuities does not dry.

8.6 施加显像剂

8.6.1 总体要求

使用期间的显像剂应保持均匀状态，并应均匀地施加到被检表面上。

施加显像剂应在去除多余渗透剂后尽快进行。

使用带有可水洗渗透剂的水基显像剂时不应从不连续内去除渗透剂。

显像时间应在书面的检测工艺规程中规定。显像时间应根据应用情况决定。显像时间不应小于10min。

显像时间始于以下情形：

- 干显像剂刚施加完成后；
- 湿显像剂施加完成并干燥后；
- 未使用显像剂时，被检表面干燥后。

8.6 Developing

8.6.1 General

The developer shall be maintained in a uniform condition during use and shall be evenly applied to the test surface.

The application of the developer shall be carried out as soon as possible after the removal of excess penetrant.

Care shall be exercised when using water-based developers with water-washable penetrants to avoid removing further penetrant from the discontinuities.

The development time shall be defined in the written test procedure. The development times shall be selected according to the application. The development time shall not be less than 10 min.

The development time begins

- immediately after application, when dry developer is applied,
- immediately after drying of the developer layer, when a wet developer is applied, or
- immediately after drying of the test surface, when no developer is used.

8.6.2 干粉

干粉显像剂仅可与荧光渗透剂一起使用。此类显像剂应采用喷粉、静电喷射、聚束枪、流化床或喷粉舱等技术均匀地施加到被检表面上。应使被检表面形成一薄层覆盖，不允许出现局部堆积。

8.6.2 Dry developer

Dry developer may only be used with fluorescent penetrants. The developer shall be uniformly applied to the test surface by one of the following techniques: dust storm, electrostatic spraying, flock gun, fluidized bed or storm cabinet. The test surface shall be thinly covered by the developer; local agglomerations are not permitted.

8.6.3 水悬浮显像剂

应按批准的工艺规程，通过浸没在搅动的悬浮液中使用适当的设备喷射来施加此类显像剂，形成一均匀薄层。此类显像剂的浸没时间和温度，应由用户按制造商的使用说明书，通过预试验评估确定。只要确保得到最适宜的结果，浸没时间应最短。

被检件应采用蒸发和(或)使用循环空气烘箱进行干燥。

8.6.3 Water-suspendable developer

A thin, uniform application of the developer shall be carried out by immersion in agitated suspension or by spraying with suitable equipment in accordance with the approved procedure. The immersion time and temperature of the developer shall be determined by the user through pre-tests according to the manufacturer's instructions. The immersion time shall be as short as possible to ensure optimum results.

The part shall be dried by evaporation and/or by the use of a forced-air circulation.

8.6.4 溶剂型显像剂

应通过喷射均匀地施加此类显像剂。显像剂喷雾稍微润湿被检表面,并形成一均匀薄层。

8.6.4 Solvent-based developer

The developer shall be applied by spraying uniformly. The spray shall be such that the developer arrives slightly wet on the surface, giving a thin, uniform layer.

8.6.5 水溶性显像剂

应按批准的工艺规程,通过浸没或使用适当的设备喷射来施加此类显像剂,形成一均匀薄层。此类显像剂的浸没时间和温度,应由用户按制造商的使用说明书通过预试验评估确定。只要确保得到最适宜的结果,浸没时间宜尽可能短。

被检件应采用蒸发和(或)使用循环空气烘箱进行干燥。

8.6.5 Water soluble developer

A uniform application of the developer shall be carried out by immersion or by spraying with suitable equipment in accordance with the approved procedure. The immersion time and temperature of the developer shall be determined by the user through pre-tests according to the manufacturer's instructions. The immersion time should be as short as possible to ensure an optimum result.

The part shall be dried by evaporation and/or by the use of a drying oven.

8.6.6 特殊应用的水基型或溶剂型显像剂(如可剥离显像剂)

当渗透检测过程中所显现出的显示需要记录时,宜采用如下工艺规程:

- 用清洁、干燥、无绒毛的布擦去显像剂;
- 以任何方便的方法施加相同的渗透剂,然后按与最初完全相同的过程进行操作,直至施加显像剂;
- 被检件在去除多余渗透剂和干燥之后,按制造商推荐的方法施加可剥离显像剂;
- 当推荐的显像时间结束后,剥下显像剂覆盖层。与被检件直接接触的覆盖层呈现有显示。

8.6.6 Water- or solvent-based for special application (e.g. peelable developer)

When an indication that needs to be recorded is shown with the penetrant inspection process the following steps should be used:

- Wipe off the developer with a clean, dry, lint-free cloth.
- Apply the same penetrant by any convenient means, then follow exactly the same process as initially used, up to application of the developer.
- After excess penetrant removal and drying of the part, apply the peelable developer as recommended by the manufacturer.
- When the recommended development time has elapsed, carefully peel off the developer coating. Indication(s) appear(s) on the face of the coating in direct contact with the part.

8.6.7 无显像剂（只适用类型 I）

应仅在合同各方达成具体协议的情况下，在无显像剂的情况下进行渗透检测。灵敏度也应基于所使用渗透剂基线灵敏度，由合同各方商定。

8.6.7 No developer (type I only)

Penetrant testing without a developer shall only be performed with specific agreement between contracting parties. The sensitivity shall also be agreed on by the contracting parties and may be based on the baseline sensitivity of the penetrant used.

8.7 观察

8.7.1 总体要求

渗透检测产生的显示可提供关于不连续的形状、深度和尺寸的信息。在某些情况下，可在干显像剂施加完成或湿显像剂干燥后，就立即进行首次观察，这有助于更好地评定显示。

宜注意区分真显示和伪显示，如划痕或厚度变化。操作人员应进行必要的检测和观察，以确定并在可能的情况下消除造成伪显示的因素。

所有不能确定是否为伪显示的应分为线性或非线性，并按产品标准要求进行记录。

显像时间结束，应立即进行观察。

最终评定和显示尺寸测量应在显像时间结束时进行。

能借助放大镜或镜子等辅助设备进行检查。

通过擦拭技术(见8.7.3)进行的评估可有助于观察。

8.7 Inspection

8.7.1 General

Indications produced by the penetrant method may provide limited information on the shape, depth and dimension of discontinuities. In some cases, it may be advantageous to carry out the first examination just after the application of the developer or as soon as the developer is dry. This facilitates a better evaluation of indications.

Care should be taken to differentiate between true indications and spurious or false indications, such as scratches or changes of section. The operator shall carry out any necessary testing and observations to identify and, if possible, to eliminate the reason for such false indications.

All indications which cannot be confidently discounted as false shall be classified as linear or non-linear and shall be recorded as required by the product standard.

Inspection shall be carried out when the development time has elapsed.

The final evaluation and the indication sizing shall be performed at the end of the development time.

Inspection aids such as magnification instruments or mirrors can be used.

Assessment by the wipe-off technique (see [8.7.3](#)) may assist the inspection.

8.7.2 观察条件

观察条件应符合ISO 3059的规定。此外，对于荧光技术，应让检测人员的眼睛在观察区域有足够的适应黑暗，在观察开始前至少需要1分钟。

8.7.2 Viewing conditions

Viewing conditions shall conform to ISO 3059. Additionally, for fluorescent techniques, sufficient time shall be allowed for the operator's eyes to become dark-adapted in the inspection area, at least 1 min before inspection commences.

8.7.3 擦拭技术

该技术用于辅助评定引起显示的不连续的性质，包括去除初始显示，然后进行进一步显像的过程。该技术不应用于弥补一般观察过程中清除不足等不规范操作。具体的过程可是合同各方具体协商的要求，也可包括在相关的验收条款中。除非另有约定，否则不应重复此过程。如果显示没有进一步拓展，这不应成为评定一个显示是否是伪显示的唯一证据，但可用来证明最初的解释是正确的(如水渍或表面污染)，或允许检测人员通过观察显示在重新显像期间的生成来获得更多信息。

以下为擦拭过程：

- a) 用沾有快干溶剂的干净的、无绒毛的棉签擦拭出现显示的检测面，去除检测面的显示。如果存在不连续，显示将再次出现；
- b) 在观察条件下检查该区域，以确保渗透剂被完全去除；
- c) 继续喷涂显像剂——形成薄层的湿溶剂型(非水性)显像剂，在材料接触后几乎立即干燥的区域应用，除非另有约定；
- d) 喷完显像剂后立即观察该区域；
- e) 每隔一段时间观察一次，完成 10min 显像时间后再次观察。

8.7.3 Wipe-off technique

This technique is used to assist in the assessment of the nature of a discontinuity causing an indication and consists of the removal of the initial indication followed by a further development process. It shall not be used to remedy general inspection process irregularities such as inadequate removal. The exact process may be the subject of a specific agreement between the contracting parties or included within relevant acceptance criteria. Unless otherwise agreed, repeating the procedure is not permitted. Where no indication redevelops, this shall not be the sole evidence for assessing an indication as spurious or non-relevant but can be used to demonstrate that the initial interpretation is correct (e.g. water mark or surface contamination) or to allow the inspector to obtain additional beneficial information by witnessing the growth of the indication during the redevelopment time.

The process is as follows:

- a) using a small, clean, lint-free swab lightly moistened with fast-drying solvent, wipe across the surface where the indication is present to remove that indication in a manner that further bleed out will occur if a discontinuity is present;
- b) view the area under inspection conditions to ensure the penetrant materials have been completely removed;
- c) apply further developer — use a light coating of wet solvent-based (non-aqueous) developer, applied from a distance where the material dries almost immediately on contact, unless otherwise agreed;
- d) inspect the area immediately after the application of the developer;
- e) inspect again at intervals and at the final development time of 10 min.

8.7.4 记录

可采用任何适当的方法实施记录，如书面描述、草图、剥离技术或照片。

8.7.4 Recording

Recording may be done by any adequate method, e.g. written description, sketch, peel technique or photograph.

8.8 后清洗和防腐保护

8.8.1 后清洗

检测后，渗透检测产品可能有害于后续加工、检测或使用功能的情况下，应对被检件进行后清洗。

8.8 Post cleaning and corrosion protection

8.8.1 Post cleaning

After final inspection, post cleaning of the part is necessary only in those cases where the penetrant testing products can interfere with subsequent processing, testing or service requirements.

8.8.2 防腐保护

如要求，应对被检件做适当的腐蚀防护。

8.8.2 Corrosion protection

If required, a suitable corrosion protection shall be applied.

8.9 重新检测

若需重新检测，如不能明确地评定显示，则应从预清洗开始，重复整个检测工艺规程。

如有必要，检测工艺规程应选择更为有利的检测条件。不允许使用不同类型的渗透剂或来自不同供应商的同一类型的渗透剂。

8.9 Retesting

If retesting is necessary, e.g. because no unambiguous evaluation of indications is possible, the entire test procedure, starting with the precleaning, shall be repeated.

If necessary, more favourable test conditions shall be chosen for this procedure. The use of a different type of penetrant or a penetrant of the same type from a different manufacturer is not allowed.

9 检测报告

检测报告应包含以下内容：

- a) 被检件的信息：
 - 1) 名称；
 - 2) 尺寸；
 - 3) 材料；
 - 4) 表面状况；
 - 5) 生产阶段。

9 Test report

The test report shall contain the following information, in reference to this document:

- a) information on the part tested:
 - 1) designation;
 - 2) dimensions;
 - 3) material;
 - 4) surface condition;
 - 5) production stage;

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