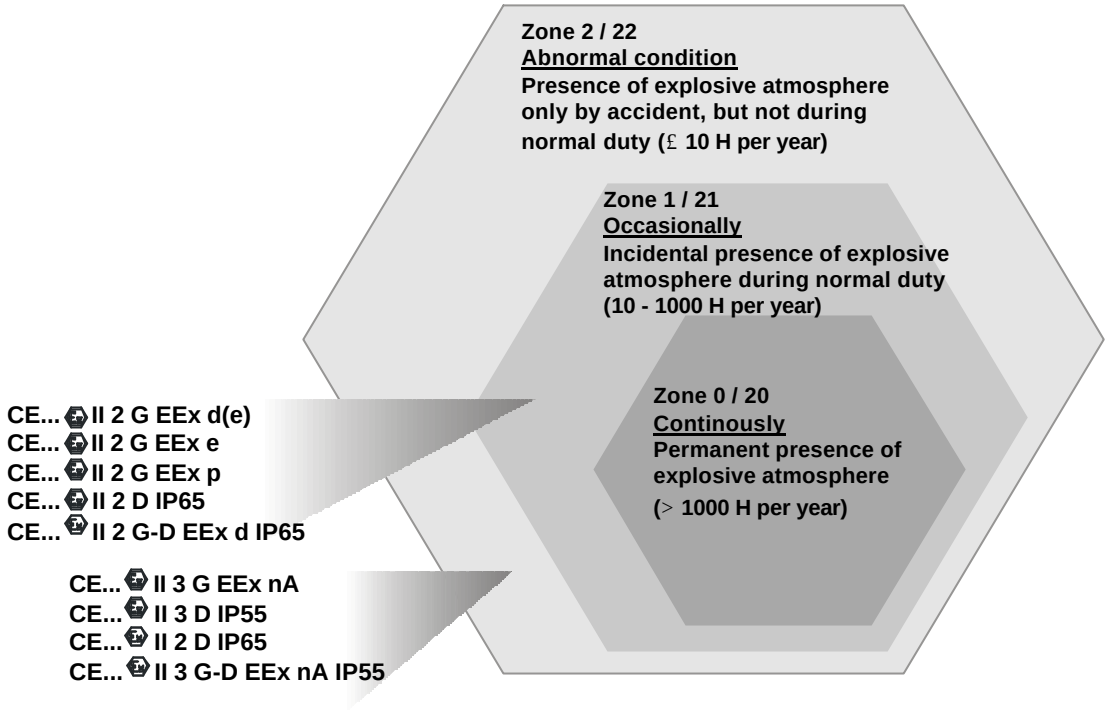
Hazardous areas

Hazardous areas worldwide are classified by zone, according to the risk posed by explosive gas or dust in the atmosphere.



Classification of hazardous locations

The definition of areas according to the presence of atmosphere are set up in EN 1127-1 or IEC 60079-0.

Explosive atmosphere	**Permanent presence**	**Incidental presence** (normal operation conditions)	**Accidental presence** (abnormal operation conditions)
IEC (International) CENELEC (Europe)	**Zone 0** (gas) **Zone 20** (dust)	**Zone 1** (gas) **Zone 21** (dust)	**Zone 2** (gas) **Zone 22** (dust)
Note: In certain countries EEx d and EEx e motors are also used in Zone 2.			

July 2003; all equipment both electrical and non-electrical put on the market in hazardous areas shall comply with:

European Directive 94/9/EC (ATEX)

Motors in accordance with ATEX directive comply with:

- Low Voltage Directive 73/23/EEC amended by 93/68/EEC (Voltage supply less than 1000V)
- EMC Directive 89/336/EEC amended by 92/31/EEC and 93/68/EEC
- Machinery Directive 98/37/EEC (Certificate of Incorporation)

Key words of ATEX Directive:

- **Free movement in the EU territory** is ensured for any products complying with ATEX directive.
- **EHSR**s: Essential Health and Safety Requirements needed for products used in potentially explosive atmospheres with detailed demands of manufacturer.
- **1st of July 2003**: The European Union has decided not to extend the transition period for the new standard relating to equipment for use in potentially explosive atmospheres, ATEX, beyond 1st of July 2003.
- **Article 14**: Previous Directives 76/117/EEC, 79/198/EEC and 82/130/EEC will expire on 1st of July 2003.
- **All national standards** which are in conflict with the directive will be withdrawn.

In addition to the above, all ABB's motor production units are certified to ISO 9001 and ISO 14000.

Marking temperatures, gas groups and hazardous areas

To ensure equipment can be safety used in potentially explosive atmospheres, the hazardous areas where the equipment is installed must be known. Temperature class of equipment must be compared with the spontaneous ignition temperature of the gas mixtures concerned and its gas group must be known in specific cases (e.g. flame proof protection).

Categories or classification

The ATEX Directive has introduced the concept of "Categories" which is a way of expressing the capability of equipment respecting the EHSR needs for versus the Zone where the equipment is installed.

Category 1	according to Annex 1 of ATEX used in Zone 0 or Zone 20
Category 2	according to Annex 1 of ATEX used in Zone 1 or Zone 21
Category 3	according to Annex 1 of ATEX used in Zone 2 or Zone 22

Classification

	Category equipment	Inflammable substances	Level of protection	Fault protection	Comparison with present practice and IEC
Equipment group I (mines)	**M1**	Methane, dust	Very high level	2 types of protection or 2 independent faults	Group I
	M2	Methane, dust	High level	1 type of protection Normal operation	Group I
Equipment group II (surface)	**1**	Gas, vapours, mist, dust	Very high level	2 types of protection or 2 independent faults	Group II Z0 (gas) / Z20 (dust)
	2	Gas, vapours, mist, dust	High level	1 type of protection Habitual frequent malfunction	Group II Z1 (gas) / Z21 (dust)
	3	Gas, vapours, mist, dust	Normal	Required level of protection	Group II Z2 (gas) / Z22 (dust)

Temperature classes

Temperature class	Ignition temperature for the gas/vapor °C	Max. permitted temperature equipment °C
T1	> 450	450
T2	> 300 < 450	300
T3	> 200 < 300	200
T4	> 135 < 200	135
T5	> 100 < 135	100
T6	> 85 < 100	85

Grouping of electrical apparatus

Group I	Apparatus for coal mines susceptible to firedamp
Group II	Apparatus for explosive atmospheres other than mines; surface industries
IIA, IIB, IIC	Group II is subdivided for EEx d and EEx i -equipment according to the severity of the environment. IIC is the highest rating; a motor from one of the higher categories can also be used in a lower category environment.

Marking of equipment

CE marking

Identification of the notified body responsible for the approval. 0081 is the identification number of LCIE

The European Commission mark for Ex products

Motor grouping: **II** for surface industry (I for mines)

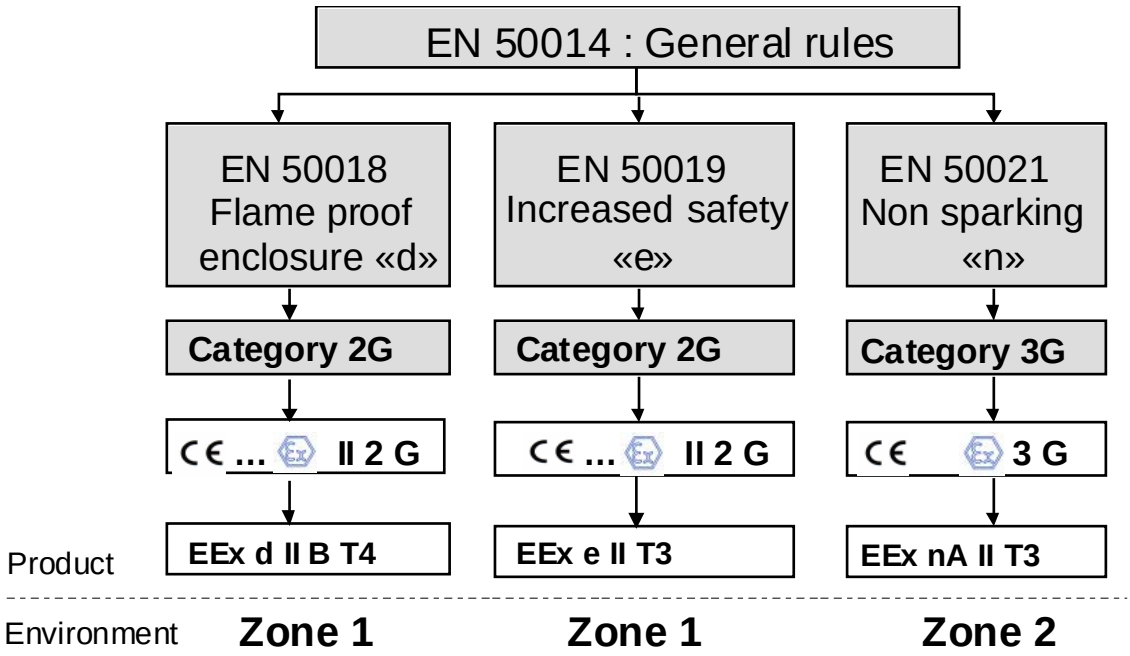
Equipment category: **2** allowed for Zone 1 or Zone 21 (**1** for Zone 0 or 20, **3** for Zone 2 or 22)

Atmosphere surrounding the motor: **G** for explosive gas (**D** for dust)

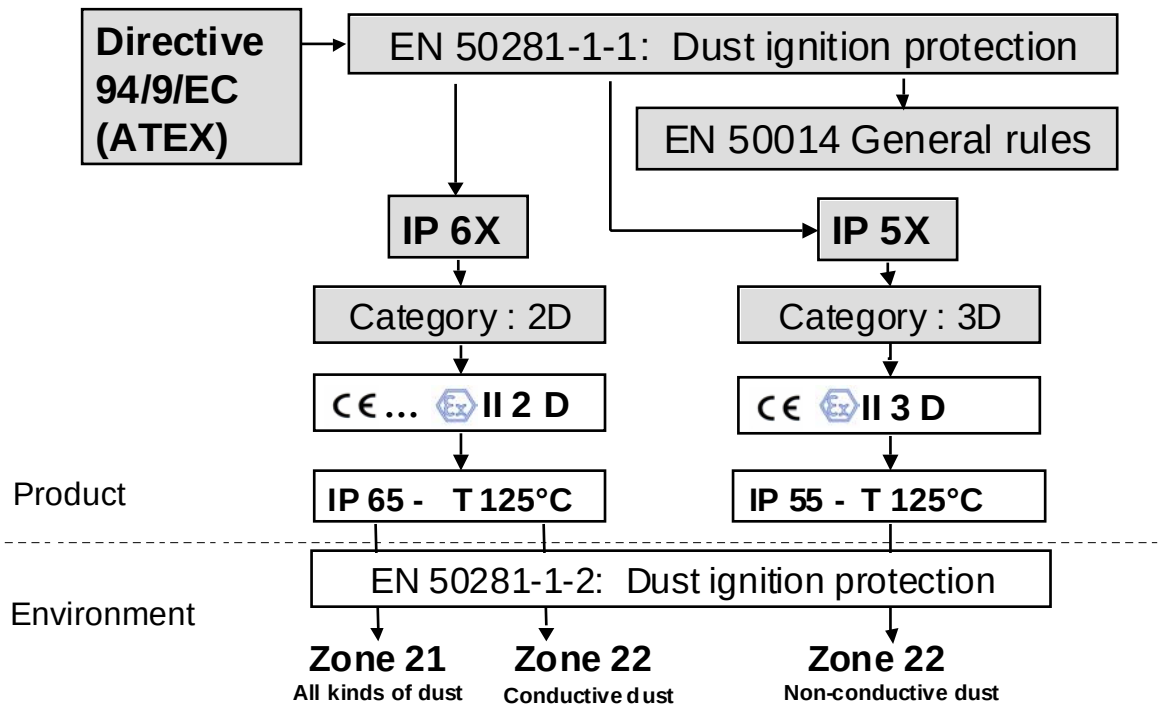
Additional marking specifying the type of protection of motor

Selection of products for hazardous areas

EN Standard for Group II: Gas environments



EN Standard for Group II: Dust environments



Dust Ignition protection in hazardous areas

Combustible dusts is hazardous as it can form potentially explosive atmospheres when dispersed in the air. Furthermore, layers of combustible dust may ignite and act as ignition source for an explosive atmosphere.

Hazardous areas with dust can be found in a variety of industries such as:

- agriculture
- chemicals
- plastics
- stock holding

Selection and installation of electrical equipment
To ensure equipment can be safely used in hazardous areas with dust, the following procedure should be considered before selecting a product:

1. Type of dust:
- Will a cloud of dust be present around the product or
- will a layer of dust build up on the product and if so, what will be the maximum thickness of the layer between two cleaning/maintenance periods?

2. Characteristics of the dust:
- Is the dust electrically conductive or non-conductive?

3. Ignition temperature of the dust:
- T_{Cl}: Ignition temperature of dust in a "cloud" or
- T_{5mm}: Ignition temperature of a 5 mm dust layer

Selection and installation of product: EN 50 281-1-2

Equipment category	Category 1 (Zone 21)	Category 2 (Zone 21 and conductive dust)	Category 3 (Zone 22 and non-conductve dust)
Minimum protection for equipment	not applicable	IP 6X	IP 5X

Marking temperature

Type of dust	Ignition temperature	Maximum surface temperature of motor	Marking temperature of equipment T°C
Cloud	T_{Cl}	2/3 x T_{Cl}	T°C ≤ 2/3 x T_{Cl}
Layer up to 5 mm	T_{5mm}	T_{5mm} - 75 K	T°C ≤ (T_{5mm} - 75 K)

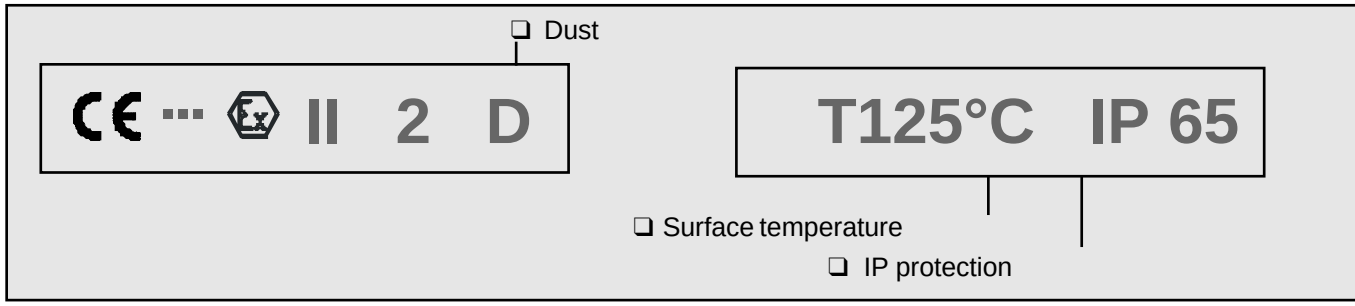
T_{5mm} is the ignition temperature of 5 mm layer of dust

Note: In case of dust layer above 5 mm; please consult ABB.

Substances (examples)

Dust	Wheat	Barley	Corn	Turniprape	Sunflower	Sugar	Lignite	Sulphur
T_{Cl} (cloud)	420°C	450°C	400°C	480°C	490°C	350°C	450°C	190°C
T_{5mm} (5mm)	200°C	205°C	250°C	230°C	220°C	220°C	200°C	220°C

Marking of equipment



General about hazardous areas

Standards

Motors for hazardous areas comply with the following international standards:
- IEC publications 60079-0 (2000-06) and 60079-15 (2001-02); 61241-1-1 (1999-06)
- European standards (latest edition) EN 50014, EN 50016, EN 50018, EN 50019, EN 50021 and EN 50281-1-1
- British standards BS 5000 Part 16

Preamble

In hazardous areas, it is the utmost importance to ensure the safe use of electrical apparatus. To this end, many countries have regulations concerning both the design and use of such apparatus. These regulations are becoming increasingly harmonized within the framework of IEC recommendations and European Standards.

The hazard may be due to an explosive atmosphere composed of a mixture of gas, vapors or dusts with air. This chapter only deals with safety in explosive gas atmospheres for which European Standards exist.

Flameproof enclosure EEx d and EEx de

The motor enclosure shall be designed in such a way that no internal explosion can be transmitted to the explosive atmosphere surrounding the motor. The enclosure must withstand, without damage, any pressure levels caused by an internal explosion. The shape, length and gap of part assembly joints, at shaft opening, cable entries, etc., shall be designed to allow for throttling and cooling of hot gases escaping outside. The standards emphasize the impact of an explosive atmosphere (for instance, explosion pressure) over constructional requirements of such apparatus.

Work on assembly devices of enclosure component parts is only permitted using prescribed tools. Cable entries must meet the requirements of this type of protection.

The temperature of the motor's external enclosure should not exceed the self-ignition temperature of the explosive atmosphere of the installation area during normal operation. For this reason, rated output depends on this rated maximum temperature for the considered area.

No motor device outside the flameproof enclosure (e.g., ventilation) shall be a potential source of sparks, arcs or dangerous overheating.

Variants combining two types of protection usually combine ”d” and ”e” protection. The most commonly used and recognized by the CENELEC European Standards is the EEx de variant. The motor is designed with an EEx d flameproof enclosure, while the terminal box features an EEx e increased safety protection. Such design combines the superior safety degree of the ”d” type of protection with the less stringent electrical connection requirements of increased safety motors.

Motors featuring dual protection are seldom encountered - such as an increased safety motor with a flameproof enclosure designated EEx e + EEx d in European Standards.

Alleinschutz – thermistors as sole protection (optional)

The flameproof motors from ABB, frame sizes 80 to 400, have been certified for thermistors as sole protection against overload. This construction, "Alleinschutz", is available as an option, see variant codes.

"Alleinschutz“ is a term that defines the certification of flameproof motor and protection device together. The certificate confirms that thermistors and relays will switch off the motor in case of overheating before the temperature of the motor's external enclosure exceeds the temperature marking stamped on the rating plate.

Each motor ordered with thermistors as sole protection will be tested, with locked rotor, up to the point where the thermistors trigger the relay to turn off the motor. At the triggering temperature, the motor has to be within the certified temperature class.

The relay is included in the certificate, which means that only approved relays can be used for "Alleinschutz“.

Please note that sizes 315 to 400 require special technical solutions, consult ABB.

Increased safety design, EEx e

The design of this motor type prevents the occurrence of sparks, arcs or hot spots in service (including starting and locked rotor situation), that could reach the self-ignition temperature of the surrounding, potentially explosive atmosphere, in all inner and outer parts of the machine.

This is ensured by applying constructional or dimensional provisions that mainly concern:

– specified minimum values for creepage distances and clearances
– use of tracking-proof isolating materials
– suppression of sharp angles where static electrical loads could build-up
– ensuring electrical and mechanical assemblies are tightly secured
– minimum backlash values between stationary and rotating parts (e.g., air gap, ventilation, etc.)
– temperature-rise limits, taking into account locked rotor, normal operation, accidental mechanical stalling of machine under the most adverse thermal conditions, i.e. when thermal equilibrium of machine is reached while in service.

Temperature rise limits are to be considered for two operating aspects; one for normal operating conditions and the other under accidental stalling conditions.

Temperature rise limits under normal operating conditions

The expected electrical lifespan of a motor depends on its temperature rise for a given insulation class, and on the motor winding temperature, in operation, which is not homogeneous with hot spots appearing.

For these reasons, a safety margin of 10 K is allowed for between windings temperature rise at rated output, as measured by the change of resistance method, and the maximum temperature rise permitted by the winding insulation class.

Temperature rise limits during short circuit under accidental stalling conditions

Should the machine stall while in operation, a short-circuit current nearly equal to the starting current will develop, and stator and rotor winding temperatures will rise rapidly (see figure 1).

To prevent this temperature value from exceeding the temperature level below which the apparatus should not cause the spontaneous ignition of an explosive atmosphere, protection devices must trip within a specified time (t_E). This tripping time depends on the short-circuit current level or the short-circuit current to rated current ratio (I_A/I_N). Figures 2 and 3 show, for commonly used protection devices, the limiting ratio between short-circuit current inrush I_A/I_N and rotor stalling time t_E, according to the EN and VIK.

This type of protection is inappropriate for commutator machines or brake-motors which, by principle, are capable of producing arcs, sparks or hot spots.

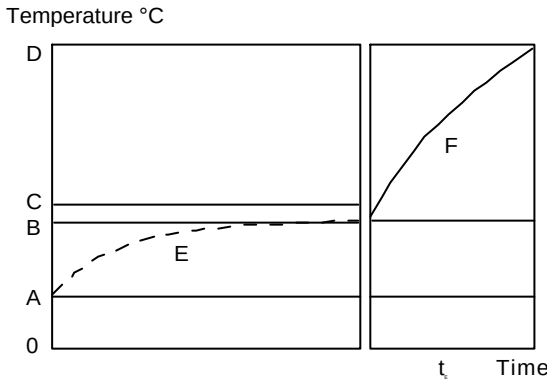


Figure 1.
O = temperature 0°C
A = Max. ambient temperature, reference 40°C
B = Temperature at rated load
C = Max temperature as permitted by the insul. class
D = Max limit temperature as set by the nature of the potentially explosive atmosphere
E = Temperature-rise curve of motor at rated output
F = Temp. rise curve under stalled rotor conditions
t_E = stalled rotor time

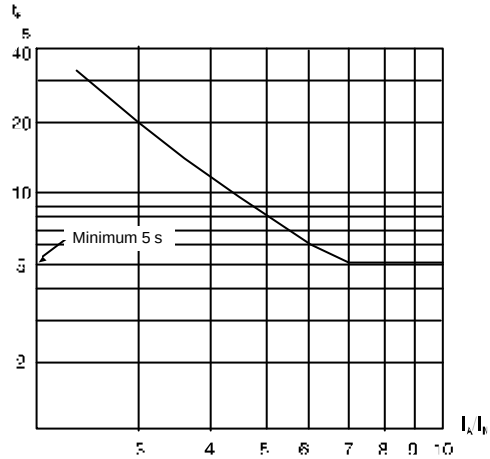


Figure 2. Min. value of time t_E as a function of I_A/I_N ***acc. to EN 50019.***

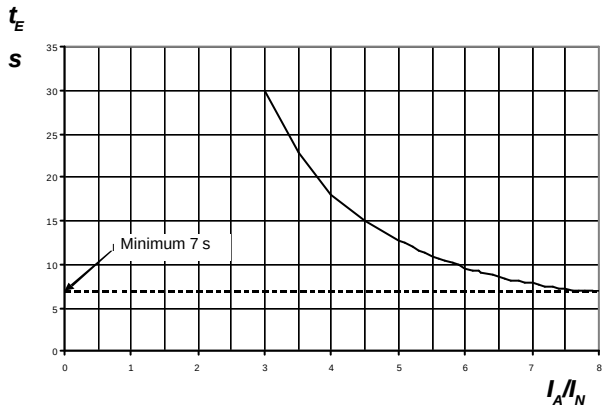


Figure 3. Min. value of time t_E as a function of I_A/I_N ***acc. to VIK.***

Non-sparking design, EEx nA, Ex nA, Ex N

This type of protection is allowed to be used in the hazardous area corresponding to zone 2.

This design is also known as 'Non-sparking' type as the motor must be designed in such a way that no sparks can occur in normal operation, and used within the ratings specified by the manufacturer, which excludes thermal requirements due to starting or accidental stalling.

Yet, EHRS's (Essential Health and Safety Requirements) stated in ATEX Directive for products installed in zone 2 have introduced new requirements on the motor design compared to previous technical report IEC 79-15 (1987) used for Zone 2. These new requirements make the motor safer against the risk of spark during the start-up.

However, along with the ATEX -directive, the national standards will be withdrawn and supersided by the ATEX directive 94/9/EC and the EN standards. Thus the new British standard for non-sparking is BS-EN 50021.

EEx nA motors are not flameproof motors. They have no flamepath, and thus the enclosure groups A, B and C have no relevance. The letter "A" stands for non-sparking equipment according to EN 50021.

After 1st of July, 2003 it will not be allowed to put on the market any motor according to IEC 79-15 in hazardous area corresponding to zone 2 in Europe.

The requirements of IEC 60079-15 are identical to the requirements of EN 50021, which proves that although CENELEC and IEC operate at two different levels, their action has a strong mutual impact in the electrotechnical field around the world.

Dual certification

EEx nA motors in cast iron frame can also be used for Dust -applications. Following combinations are possible:

CI sizes 71..315	EEx nA II T3 for zone 2	DIP T125°C, IP55 for zone 22
CI sizes 160..315	EEx nA II T3 for zone 2	DIP T125°C, IP65 for zone 21

These features are possible due to the IP protection. The gases penetrate this protection, and thus the inside surface temperature class is T3 (200°C). The ingress of dust, however, is prevented and the dust determines the outside surface temperature class: T 125°C.