PAUL GOTHE BOCHUM

PAUL GOTHE – GMBH

Manual for Pyrometer

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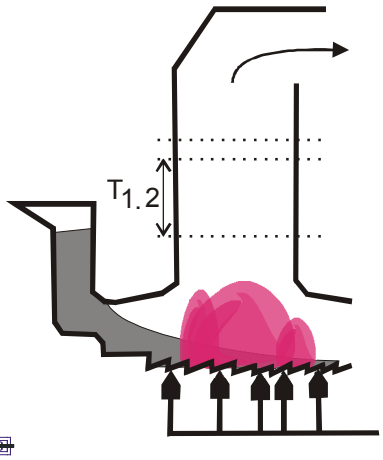
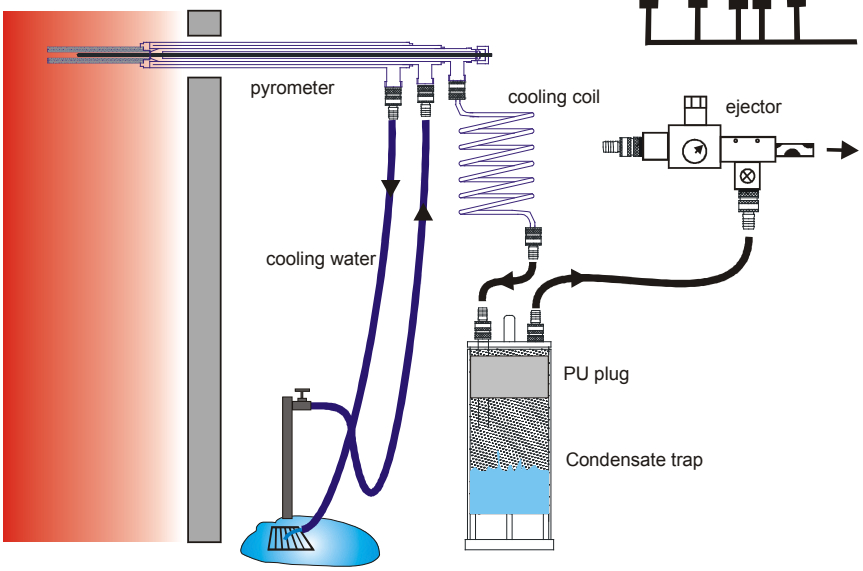
Suction pyrometer

For the determination of the temperature in the fire chamber (like demanded for the singularly test at chamber installations according to the emission act) is only interesting the convective part of the heat and not the radiation-heat. Suction pyrometer can use for such determination. The thermocouple is in the front area of the suction pyrometer and shielded by ceramic-bodies to protect the thermocouple against the IR-radiation from the fire-combustion chamber. The hot exhaust gas will be sucked over the thermocouple. The suction pyrometer can be cooled by cooling water circuit. The sucked gas with the pyrometer can use for the measurement of the oxygen rate by an analyser.



Example sampling system:



Important note for the use of the suction pyrometer within high temperature area!

In order to bring the cooling water into contact with the entire external tube and to prevent the building of bubbles, a complete filling of the suction tube with cooling water is necessary. This is achieved by filling the pyrometer exactly according to the hint in this manual. The water supply is fixed to the rear connecting piece (the cooling water first led to the internal tube and later to the external tube) and filled with water. The degassing is performed by the output tube connection. Finally, absolutely move the suction tube up and down at its ends so that all air can escape.

Absolutely consider:

Before inserting the suction tube into hot gases, the water cooling must be started up with a sufficient quantity of water (approx. 20 1/min).

On the side of the water inflow there should be used at least a 3/4" pressure resistant hose to ensure the necessary quantity of water. In order to avoid a bending of the exit-water-hose and thus a backwater (of the warmed water), on the side of the water outflow there must likewise be used a 3/4" pressure resistant hose with free outlet. To reduce the water flow use the valve only at the water inlet!

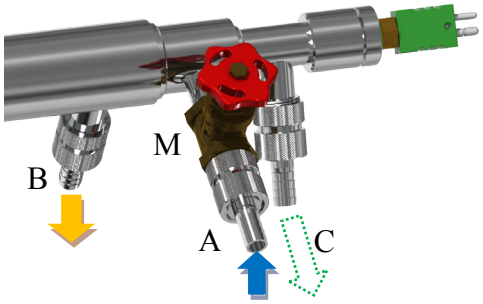
If any air in the tube (bubbles, blister) and the tube is fixed in hot gases, over-heating can happen at this position and can burst the tube.

Respect: Titanium may not be heated over 400°C.

Exit Pyrometer:

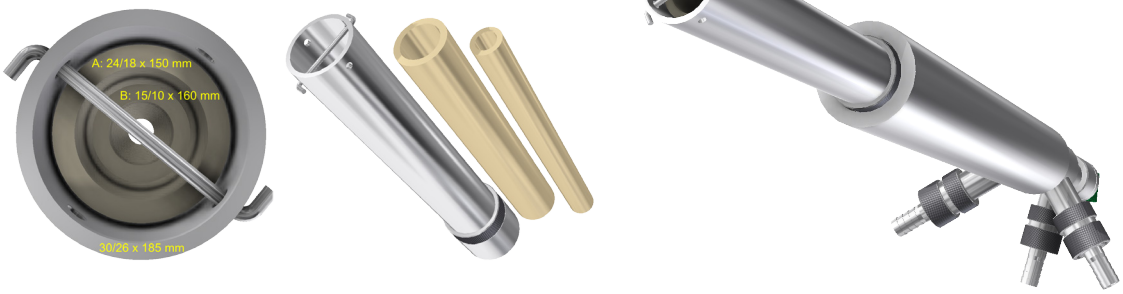
Installation of the shut-off valve for the water cooling only at the water inlet: A: Water inlet / B: Water outlet / M: Valve.

Last fast coupling is for the gas suction (C).

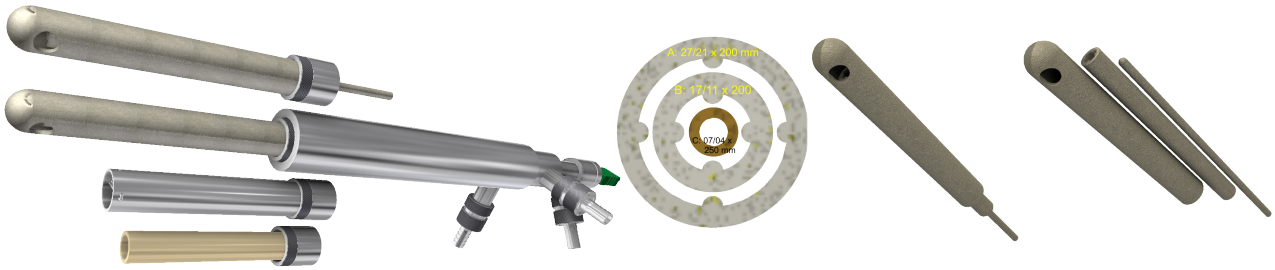


Assembling the VDI ceramics with steel protection tube

In case of the version with stainless steel protection shields from 1.4841 place both ceramics in the settings for the ceramics and use the shearing pin to fix the ceramics and bend him. This pin is from special steel and can use up to 1200°C.



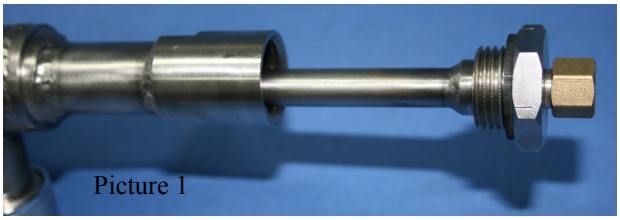
Assembling VDI / IFRF Version with bayonet:



The ceramic-tubes must fix with the special cement into the bayonet, processing see further below. Screw the bayonet into the pyrometer and insert the thermocouple from the back.

Cleaning and remove of the inner tube for the thermocouple

The inner-tube can screw out easily at the exit of the pyrometer (picture 1). Now the tube can clean for the suction from inside with brushes (picture 2).

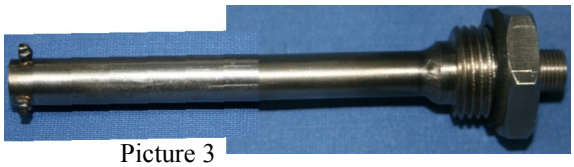


Picture 1

The inner-tube for the thermocouple has centring pins at the front, so that it can be shoving easy in very long pyrometer (picture 3).

Caution: For pipes > 1.5 m, the thread of the inner tube can only be screwed on and loosened if the pyrometer is held vertically!

Picture 2



Picture 3

Pay attention to the bending if use long pyrometer:

Bending:

total-length [mm]	free-hanging length [mm]		total-weight [kg] empty / with water		bending [mm]	
	Titan	stainless steel	Titan	stainless steel	Titan	stainless steel
2000	1000	1000	4 / 9	6 / 11	8	100
3000	2000	2000	7 / 12	10 / 15	50	180
4000	3000	3000	8 / 15	13 / 20	75	260
5000	4000	-	10 / 17	-	100	-
6000	5000	-	12 / 20	-	200	-

Necessary suction rate for the pyrometer like VDI-Version:

So that the suction rate has no influence on the temperature-measurement, a suction rate of at least 80 m/s should be at the thermocouple. Here a few calculation examples:

[v: gas velocity at the thermocouple, V: required sucked gas volume flow, at ambient temperature at Ejector]

v [m/s]	pyrometer: 1000°C ejector: 30°C m³/h	pyrometer: 1200°C ejector: 30°C m³/h	pyrometer: 1600°C ejector: 30°C m³/h
80	4,5	3,9	3,1

Necessary suction rate for the pyrometer like IFRF-Version:

[v: gas velocity at the thermocouple, V: required sucked gas volume flow, at ambient temperature at Ejector]

v [m/s]	pyrometer: 1000°C ejector: 30°C m³/h	pyrometer: 1200°C ejector: 30°C m³/h	pyrometer: 1600°C ejector: 30°C m³/h
80	3,8	3,3	2,6

Drying tower as condensate trap

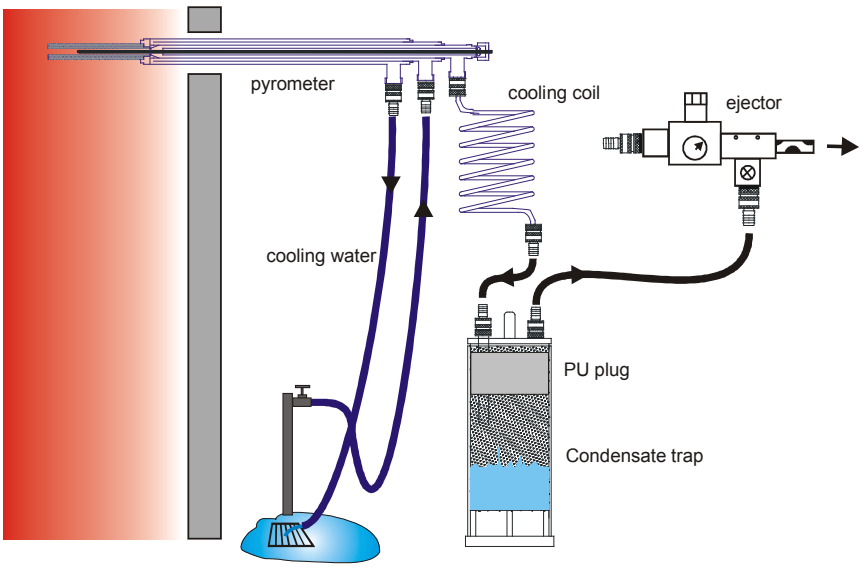
Entry tube A

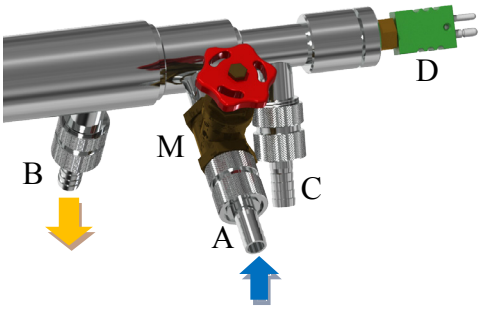
Foam B

Exit tube C

Closing cap D

Construction of the sampling line:





The hose with the cooling water must connect with the rear water connection of the pyrometer (A). The hose for the drainage must connect with the front connection of the pyrometer (B). Fill the pyrometer with water according to the manual. Use the shut-off valve (M) only at the water inlet.

Connect the suction hose with the rear small coupling (C). In case of high gas temperatures and short pyrometers should use a cooling coil which is directly connected behind the suction tube to protect the suction hose. The suction hose must connect with the condensate trap (drying tower) to catch all condensate. The exit from the condensate trap must connect with the ejector. The manual from the ejector show you how to connect the ejector.

The thermocouple must be inserted from the rear of the pyrometer and fixed with the union nut (D).

Before you insert the pyrometer into the hot gases must run the cooling water (shut-off valve must be open). Please check the water flow! Regulate the water flow only at the water inlet, never at the water outlet. Be sure that inside the pyrometer is no high water pressure. Now can insert the pyrometer. Start the suction and wait until the temperature is constant. The temperature should not increase if a higher suction is selected. Control the suction rate to be sure it is enough, maybe use a flowmeter to control the suction rate.

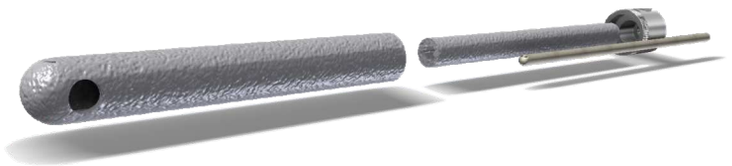
Close the water flow not before you take off the pyrometer!

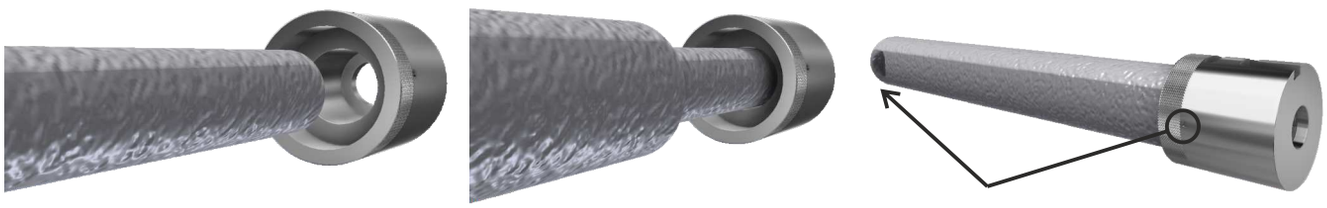
Attention!

Nevertheless, despite of the water cooling the pyrometer has very hot parts! Risk of burning! Use the pyrometer only with appropriate protective equipment and only with well-trained staff!

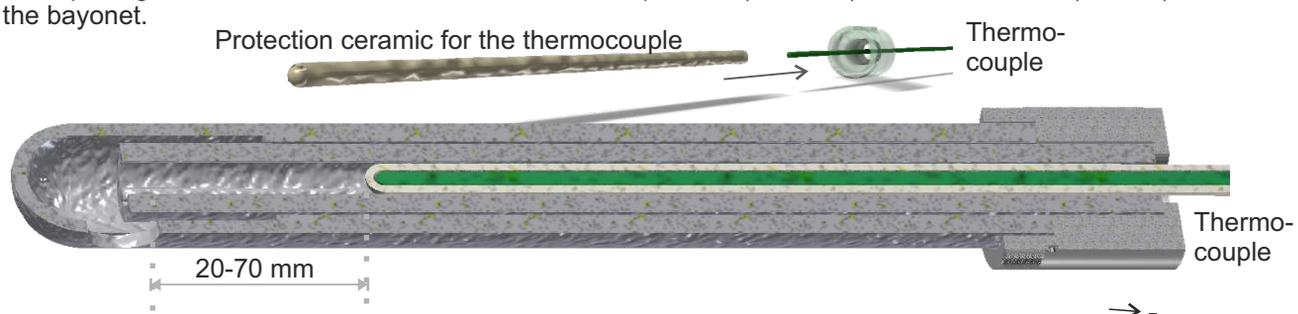
Mounting instructions IFRF Version

The IFRF-Version consists of three ceramics, one protection ceramic tube for the thermocouple, one middle and one outer ceramic and one bayonet.





Place at first the inner ceramic into the bayonet with the cement and after that the outer ceramic with cement. The opening of the outer ceramic must have the same position (direction) as the small hole (marker) in the bayonet.

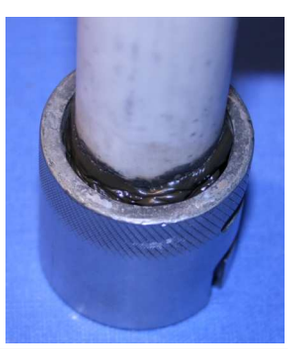


Final Mounting: Shove the protection ceramic over the thermocouple and after it the bayonet with the ceramics. Fix the bayonet with the ceramics in the front of the pyrometer. Turn the bayonet in the way that the pin will be ending at the end of the groove.

Ceramics ready for use in 10 minutes

Stir cement and lubricate the ceramics 1-2 mm thick.

Insert first the inner, subsequently the outer ceramic. Position hot fan against the steel part: ~3 min at 100°C, ~5 min at 500°C.



	Datum	Name
Erstellt		Grodten
Kontr.		

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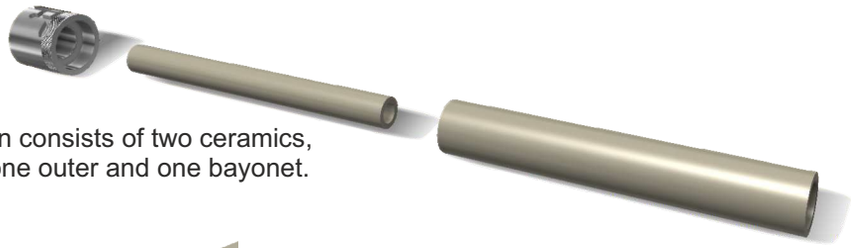
Zeichnungs-Nr.:

Installation IFRF Version

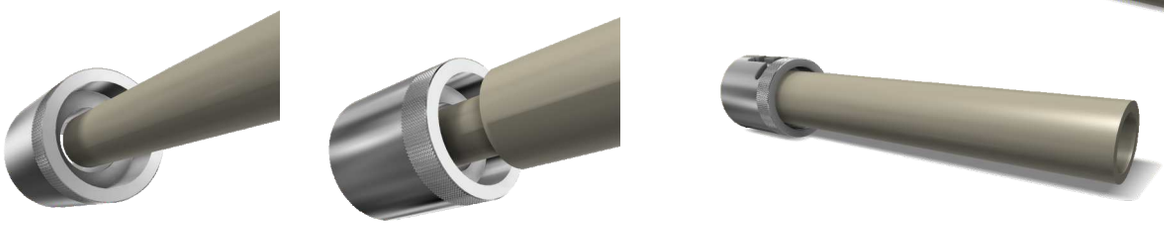
1

A 4

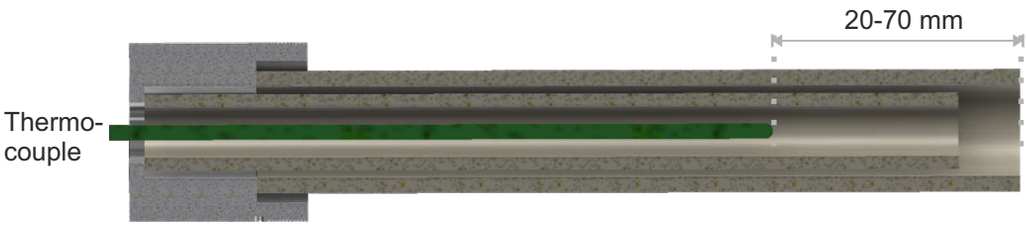
Mounting instructions
VDI Version



The VDI-Version consists of two ceramics,
one inner and one outer and one bayonet.



Place at first the inner ceramic into the bayonet with the cement and after that the outer ceramic with cement.

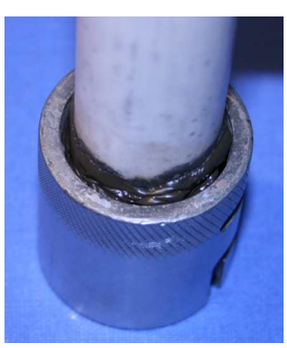


At the end place the bayonet with the ceramics in the front of the pyrometer. Turn the bayonet in the way that the pin will be ending at the end of the groove.

Ceramics ready for use in 10 minutes

Stir cement and
lubricate the
ceramics
1-2 mm thick.

Insert first the inner,
subsequently
the outer ceramic.
Position hot fan against
the steel part:
~3 min at 100°C,
~5 min at 500°C.



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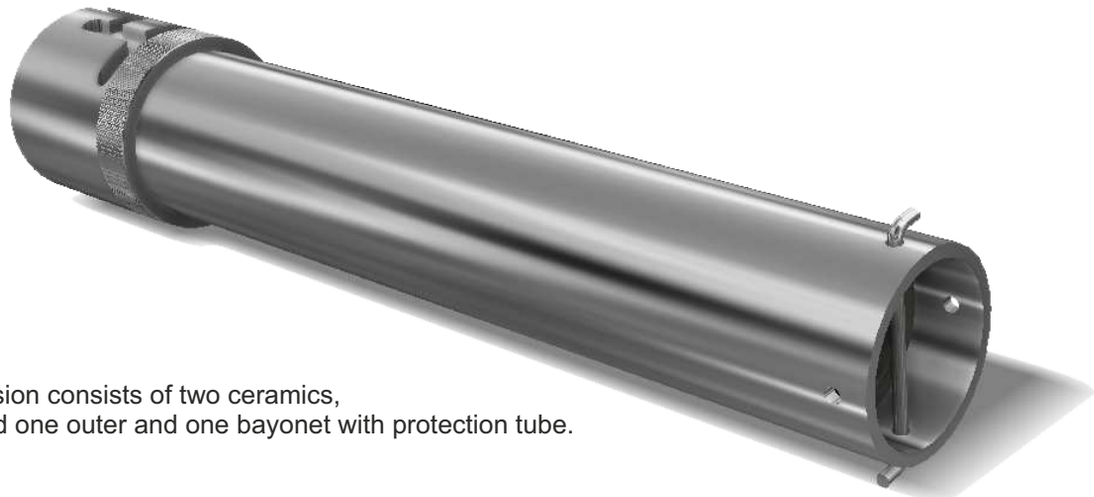
Montage / Installation VDI Version

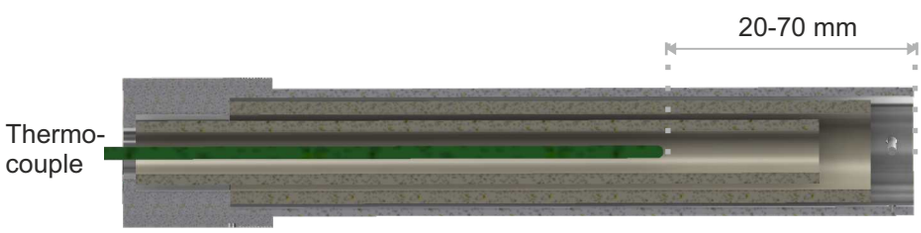
1

A 4

Mounting instructions VDI Version with protection tube



The VDI-Version consists of two ceramics,
one inner and one outer and one bayonet with protection tube.



At the end place the bayonet with the ceramics in the front of the pyrometer. Turn the bayonet in the way that the pin will be ending at the end of the groove.

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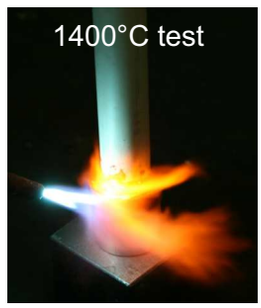
1

A 4

Remove the cement



To remove the ceramics, use a hammer to loose the cement.
Several light shocks will be sufficient.

Cement can remove by scraping.

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remove cement

Be/Rd

Important note for the use of the suction pyrometer within high temperature area !

In order to bring the cooling water into contact with the entire external tube and to prevent the building of bubbles, the complete filling of the suction tube with cooling water is necessary.

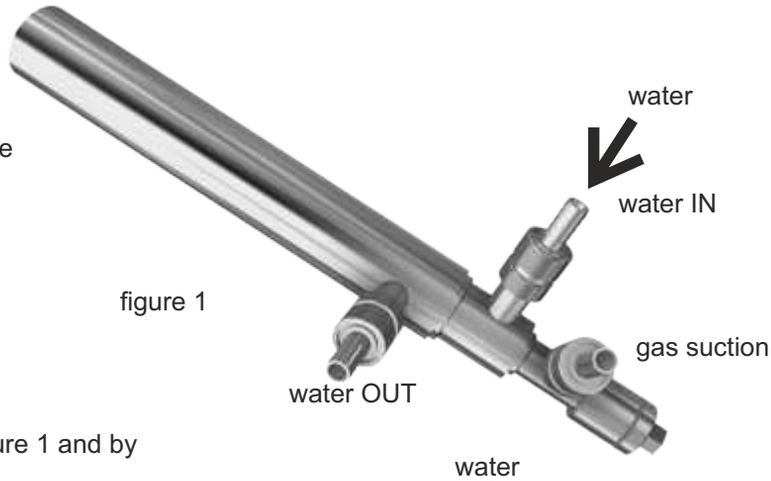

figure 1

This is achieved by holding the tube like in figure 1 and by filling the water in the port for the internal tube (IN), hold the front for the ceramics up.

When the water flow outside the output for the external tube (OUT), move the pyrometer like figure 2, side with the thermocouple up and be sure that all air comes out.

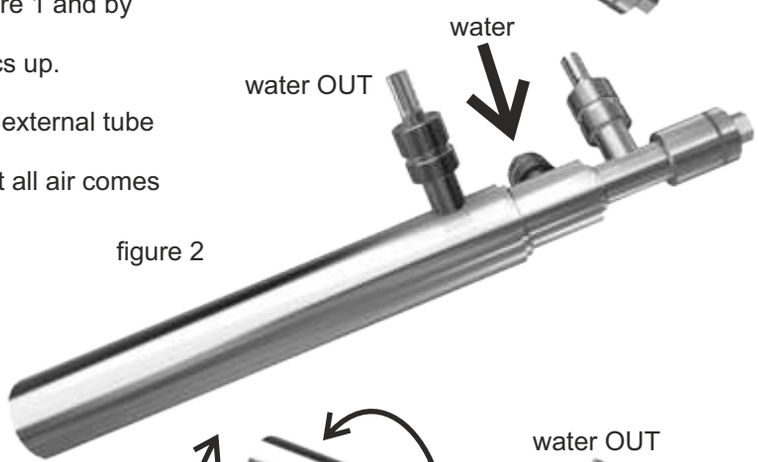

figure 2

The water supply is fixed to the back connecting piece (the cooling water is first led to the internal tube) and filled with water. The deareation is performed by the output tube connection. Finally, absolutely move the suction tube up and down at its ends so that all air can escape, see figure 3.

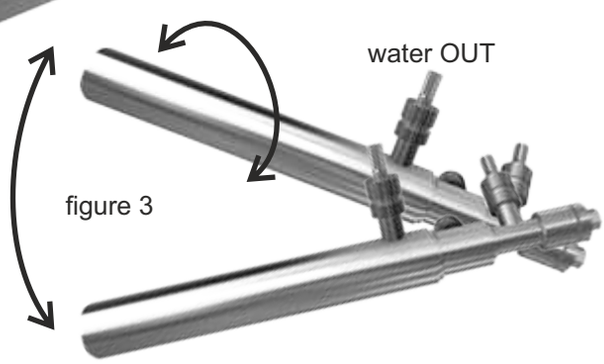

figure 3

Absolutely consider:

Before inserting the suction tube into hot gases, the water cooling must be started up with a sufficient quantity of water (approx. 20 1/min).

On the side of the water inflow there should be used at least a 3/4 " pressure resistant hose to ensure the necessary quantity of water. In order to avoid a bending of the exit-water-hose and thus a backwater (of the warmed water), on the side of the water outflow there must likewise be used a 3/4 " pressure resistant hose with free outlet.

If an air-blister is existing and the tube is fixed in hot gases, a over-heating can happen at this position and can burst the tube.

Respect Titanium may not be heated over 400°C.

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Zeichnungs-Nr.:

Info-Pyrometer water filling

Be/Rd

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CE

Hints Suction Pyrometer

Gas Temperature Measurement Equipment

When a bare thermocouple is introduced into a flame for the measurement of gas temperature, errors arise due to the radiative exchange between the thermocouple and its surroundings. In the standard suction pyrometers a Platinum-Rhodium (type S for use up to 1650 °C) or Nickel-Chromium Nickel (type K for use up to 1200 °C) thermocouple, protected from chemical attack by a sintered alumina sheath, is surrounded by two concentric radiation shields. The gases are drawn between the shields and over the sheath with high velocity (> 80 m/s) so that the equilibrium thermocouple temperature is nearly that of the gases without the need for correction. The gases are normally sucked in a dynamic position through a hole drilled at the side of the outer shield with the end of the shield closed with a cement plug.

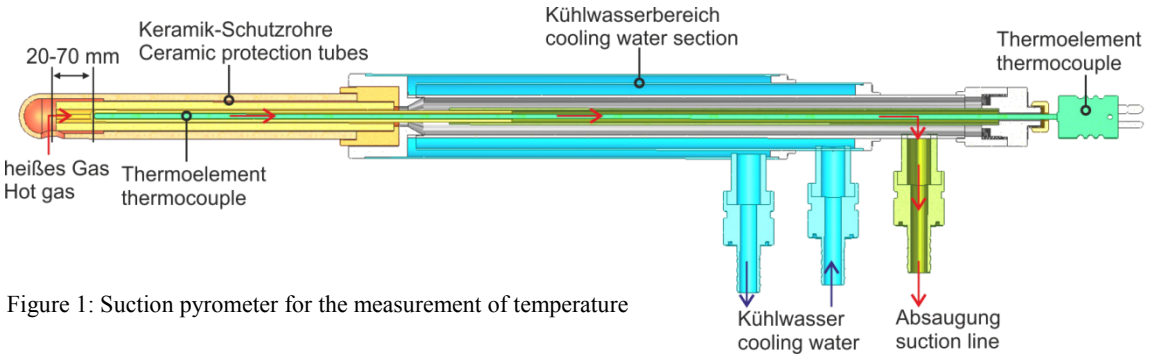

Figure 1: Suction pyrometer for the measurement of temperature

Pt-PtRh 10% (ANSI type S) thermocouples in combination with a silimanite shield have a recommended temperature range up to 1650 °C. Pt-Rh 30% (ANSI Type B) thermocouples and alumina shield are adopted for higher temperatures with a range up to 1800 °C. All these elements are easily replaceable. The response time of the instrument depends upon the size of the shields and the suction velocity. From ambient to 1600 °C and with a suction velocity of 150 m/s the time to achieve equilibrium is of the order of 5-8 min., and for subsequent temperatures changes of 100 °C, about 3-4 min.

Ejectors can use for the suction pyrometers. These devices use expansion of compressed air (or steam) to produce the proper suction rate. The recommended set-up of the equipment is shown below:

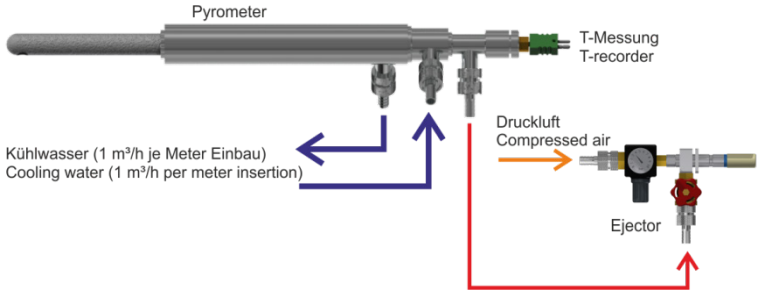

Figure 2: Suggested scheme for use of the suction pyrometer