

2 temperature instrumentation

2. temperature

2.3. thermowells

2.3.1. general information

about thermowells

145

2.3.2. thermowell executions

built up wells

$\frac{1}{2}$ " x $\frac{1}{2}$ "

BDTW11

152

$\frac{1}{2}$ " x $\frac{3}{4}$ "

BDTW12

152

$\frac{1}{2}$ " x 1"

BDTW13

152

bar stock stepped shank

$\frac{1}{2}$ " x $\frac{1}{2}$ "

BDTW31

152

$\frac{1}{2}$ " x $\frac{3}{4}$ "

BDTW32

152

$\frac{1}{2}$ " x 1"

BDTW33

152

bar stock tapered shank

$\frac{1}{2}$ " x $\frac{1}{2}$ "

BDTW51

152

$\frac{1}{2}$ " x $\frac{3}{4}$ "

BDTW52

152

$\frac{1}{2}$ " x 1"

BDTW53

152

bar stock straight shank

$\frac{1}{2}$ " x $\frac{1}{2}$ "

BDTW71

152

$\frac{1}{2}$ " x $\frac{3}{4}$ "

BDTW72

152

$\frac{1}{2}$ " x 1"

BDTW73

152

built up flanged wells

150-300#

BDTW81

153

flanged bar stock stepped shank

150-900#

BDTW91

153

flanged bar stock tapered shank

150-2500#

BDTW101

153

flanged bar stock straight shank

150-2500#

BDTW111

153

flanged bar stock tapered shank, Vanstone

1" - 1 $\frac{1}{2}$ "

BDTW40

153

bar stock tapered shank, weld in

$\frac{1}{2}$ " x weld in

BDTW60

153

flanged bar stock straight shank, tri-clamp

$\frac{1}{2}$ " x 1 $\frac{1}{2}$ " - 2" - 2 $\frac{1}{2}$ " tri-clamp

BDTW50

154

flanged bar stock straight shank, Tuchenhagen

Tuchenhagen flanges

BDTW55

154

flanged bar stock straight shank, S38.100

dn25/dn50

SFB

154

flanged forged bar stock tapered shank, S38.100

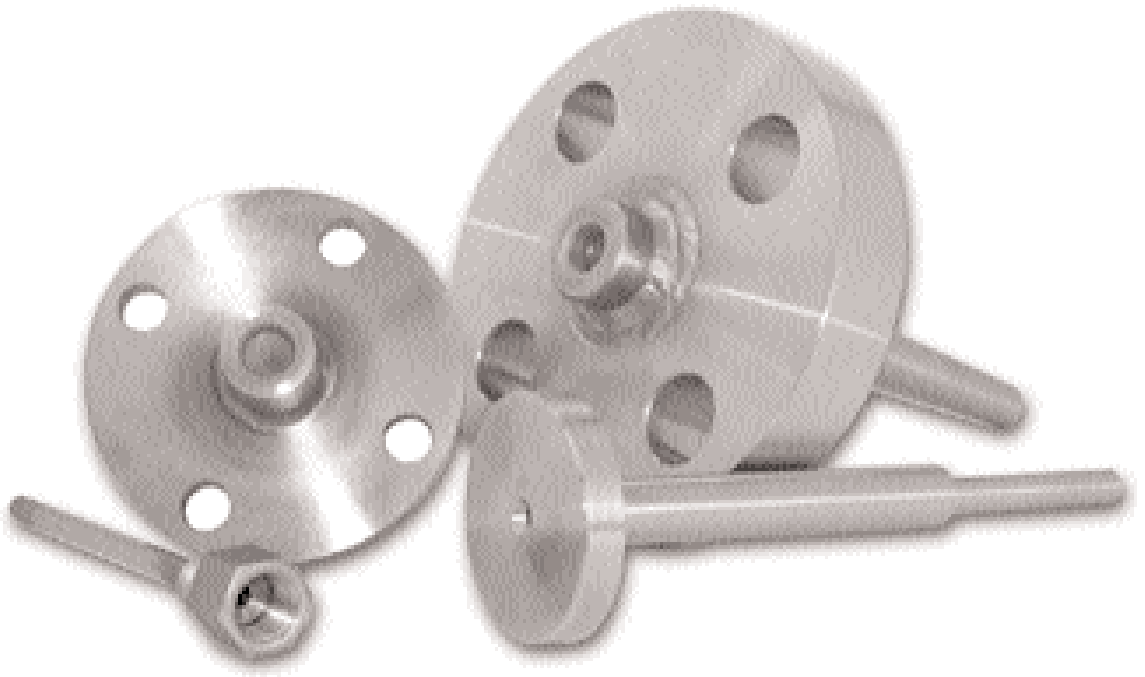
dn25/dn50

SFF

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instrumentation index

thermowells



thermowells

Thermowells from Badotherm are precision components manufactured to the highest standards from barstock, forgings or fabricated material to serve as protection devices for primary sensing elements like bimetal thermometers, gasfilled thermometers, thermocouples and thermo elements. A wide range of possible products are available.

Conditions of pressure, temperature and corrosion resistance governs the size, shape and selection of materials to ensure optimum dependability, system response and accuracy of the instruments involved. Proper temperature element protection starts with the selection of the thermowell or protection tube. Conditions that influence the selection include the temperature, pressure, flow velocity, pipe size, insertion length and the process environment and medium.

A variety of materials and process connections are available for both thermowells and protection tubes. All metallic wells are constructed in strict compliance with ASTM and ANSI specifications. For higher temperatures ceramic protection tubes are available.

Fluid flowing by a thermowell forms a turbulent wake that has a defined frequency. The thermowell must have adequate rigidity so that its natural frequency is greater than the wake frequency. Badotherm will help you to design your thermowell around the required process conditions. Badotherm's complete family of barstock, flanged and fabricated wells and protection tubes can provide safe and reliable protection for any process environment.

Badotherm's three kind of thermowells are defined;

barstock thermowell, made from solid material

- ▶ ■ barstock with parallel shank type BDTW71 (flanged BDTW111)
- ▶ ■ barstock with tapered shank type BDTW51 (flanged BDTW101)
- ▶ ■ barstock with stepped shank type BDTW31 (flanged BDTW91)
- ▶ ■ barstock weld-in, tapered shank type BDTW60 (DIN 43763)
- ▶ ■ barstock tri-clamp straight shank type BDTW50
- ▶ ■ barstock with tapered shank for cover flanges type SFB
- ▶ ■ barstock with tapered shank type Van Stone
- ▶ ■ barstock with straight shank type Tuchenhausen

fabricated thermowell, made from several components welded together

- ▶ ■ fabricated with parallel shank type BDTW11 (flanged BDTW81)

forged thermowell, made from a forging

- ▶ ■ flanged forged thermowell type SFF

All thermowells are also available with lagging extensions.

Dimensional drawing of our thermowells can be found on the internet www.badotherm.com

important information

instrument connection

Instrument connections may be male or female with NPT, BSP or other threads.

process connection

Connection to the pipe or vessel may be done by means of thread, flange or weld.

threaded connection

Using standard tapered or parallel pipe threads for simplicity is popular, generally for low pressure applications.

flanged connection

All sizes and ratings are available to ANSI, DIN, BS, JIS standards.

weld in connection

Weld in thermowells are normally used where process pressure and velocities are too great for flanged and threaded executions, or where long term inexpensive connections are required.

immersion profile

The profile should take account of the fluid flow characteristics, strength of the thermowell and immersion length.

bore

Selected to suit primary sensing element, ensure ease of removal and minimize the amount of free air space around the instrument stem, thus providing optimum response time. In general the outside diameter and bore of the thermowell should be such that the minimum wall thickness is 3 mm.

immersion length

The immersion length should be calculated to ensure that the sensing element has sufficient immersion into the process medium to give accurate reading. To ensure optimum results and freedom from outside influences, thermowell tip should be located at the point which equates with the lower portion of the centre third of the pipe line. In high velocity applications, wake frequency effects must also be considered.

surface finish

Thermowells are supplied as standard with fine machined surfaces. Other surfaces are on request like polished surface etc.

special coatings

To increase corrosion and abrasion resistance it is recommended to go for a special coating. Options of coatings include satellite, tungsten, carbide, tantalum, zirconium and PTFE.

heat treatment

Thermowells may be heat treated to client's requirement.

flange and thermowell materials

AISI 316 Best corrosion resistance of the austenitic stainless steel due to the addition of molybdenum, widely used in chemical processing, offers a useful resistance to H₂S. As with AISI 304, a low carbon grade, AISI 316L is available for welded applications. Maximum temperature 900 °C.

AISI 321 Similar properties to AISI 304, except that this grade is titanium stabilized to prevent intergranular corrosion.

AISI 304 Low cost corrosion resistant material, used extensively in food, beverage and chemical processing where good corrosion resistance is required. A low carbon grade AISI 304L is available which can be welded without impairing its corrosion resistance. Maximum temperature 900 °C.

AISI 310 Heat resistant material, which can be used up to 1150 °C with useful resistance in sulphur bearing atmospheres. Corrosion resistance is slightly better than AISI 304, but not as good as AISI 316. Can be welded but with caution.

AISI 446 Ferritic stainless steel with excellent resistance to sulphurous atmospheres at high temperatures, however due to its low strength at high temperature, thermowells should be mounted vertically. Used in heat treatment processes, iron and steel furnaces, gas production plant and it has some useful resistance to molten lead. Good corrosion resistance to nitric acid, sulphuric acid and most alkalis gives it some limited use in chemical plants. Maximum temperature 1150 °C.

carbon steel Low cost materials with little corrosion resistance. Used in low temperature and stress applications where the measured medium protects it from corrosion, oils, petroleum, tars etc. Maximum temperature 530 °C.

duplex stainless steel These grades combine high strength with excellent corrosion resistance, especially to chloride stress corrosion cracking, however a tendency to brittleness limits their use to approx 315 °C. Under zero use is also restricted to approx 50 °C because of brittleness due to the ferrite content. Main uses include offshore, chemical tanks, flue gas scrubbers and chimneys.

super duplex stainless steel Similar qualities and limitations to duplex grades as above. These grades are widely used to handle seawater and other brackish waters, marine pumps, oil and gas production and desalination plants are typical applications.

inconel® 600 A very widely used nickel-chromium-ion alloy with excellent high temperature strength and oxidation resistance, however it is very vulnerable to attack in sulphurous atmospheres above 500 °C. Good resistance to chloride-ion stress corrosion cracking and nitriding environments. Use extensively in chemical industries for its strength and corrosion resistance. Easily welded, can normally be used without post weld heat treatment. Maximum temperature 1210 °C.

inconel® 625 A nickel-chromium alloy with excellent resistance to pitting and crevice corrosion, unaffected by radiation embrittlement, widely used in aerospace applications and in marine environments. Good weldability, can be used as weld-in construction. Maximum temperature 1093 °C.

flange and thermowell materials

incoloy[®] 800 Superior to alloy 600 in sulphur, cyanide salts and neutral salts. Extensively used in steam/hydrocarbon reforming plants for pigtail piping, manifolds and waste heat boilers and in the internal components of secondary reformers. Widely used in heat treatment equipment and heater sheath material. Maximum temperature 1093 °C.

monel 400 Nickel-copper alloy with very good corrosion resistance, commonly used to handle seawater, hydrofluoric acid, sulphuric acid, hydrochloric acid and most alkalis. Typical applications include marine fixtures, chemical processing equipment, gasoline and watertanks, process vessels and piping and boiler feedwater heaters. Maximum temperature 538 °C.

hastelloy[®] C276 Nickel-molybdenum-chromium alloy with excellent corrosion resistance, especially in chlorinated environments. Widely used in chemical plants where it tolerates ferric and cupric chlorides, solvents, chlorine, formic acid, acetic acid, brine, wet chlorine gas and hypochlorite. Can be easily welded and maintains its properties in the welded construction. Maximum temperature 1093 °C.

hastelloy[®] C22 A nickel-chromium-molybdenum-tungsten alloy with outstanding resistance to pitting, crevice corrosion and stress corrosion cracking. It shows exceptional resistance to a wide range of chemical process environments, such as ferric and cupric chlorides, chlorine, hot contaminated solutions, formic and acetic acids and seawater or brine solutions. The material has superior weldability, and retains its properties as a welded construction.

haynes alloy 230 Excellent high temperature strength oxidation resistance and longterm thermal stability. Used in aerospace, chemical processing and high temperature heating applications. Recommended for use in nitriding environments. Maximum temperature 1149 °C.

haynes alloy 556 A multipurpose alloy which offers good resistance to sulphurising, carburizing and chlorine bearing atmospheres. Common applications include waste incinerators, petroleum processes where sulphur is present, chloride salt baths, exhaust gas probes, the alloy is one of very few that can survive in molten zinc, making it ideal for galvanizing processes. Maximum temperature 1093 °C.

titanium A lightweight material with good strength in the 150 to 470 °C range. Excellent resistance to oxidizing acids such as nitric or chromic, it is also resistant to inorganic chloride solutions, chlorinated organic compounds and moist chlorine gas. Its good resistance to seawater and salt spray, allows it to be used in off-shore installations. Can be welded with special precautions to protect from atmospheric contamination.

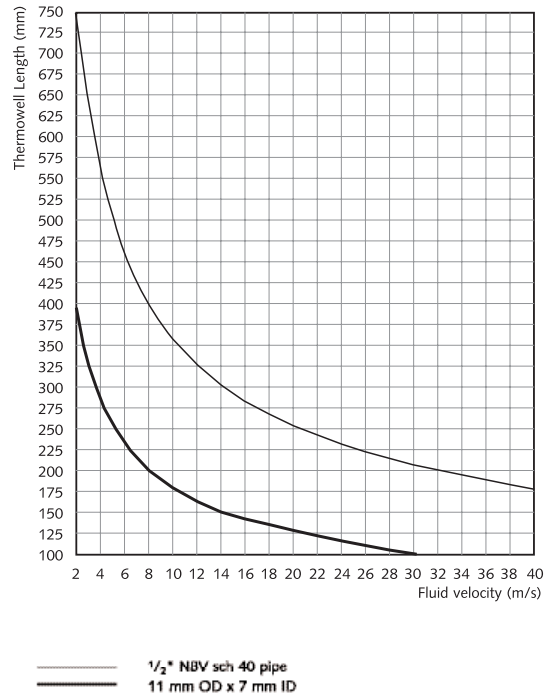
Badotherm thermowells and flanges can be made according customers requirement in different materials as mentioned above.

For a Wake frequency calculation you are required to fill in details as mentioned in our specification sheet. The test is based on the Performance Test Code, ASME/ANSI PTC 19.3.

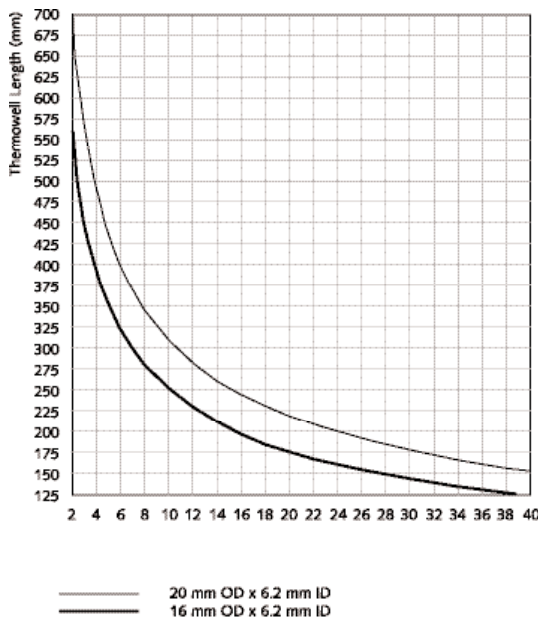
Incoloy, inconel and monel are trademarks of INCO alloys
Hastelloy is a trademark of Haynes International Inc.

To assist our clients in an immediate answer if a thermowell is suitable or not in the existing process, we enclose a number of graphs. The graphs show the maximum lengths possible for a given process velocity for a variety of popular thermowell designs. All graphs assume the well material to be AISI316, at an operating temperature of 20 °C. For different materials and process temperatures, a correction factor must be applied, as determined from the graph shown overleaf. These graphs are intended for guidance only, and if in any doubt, a formal calculation should be completed against extra cost.

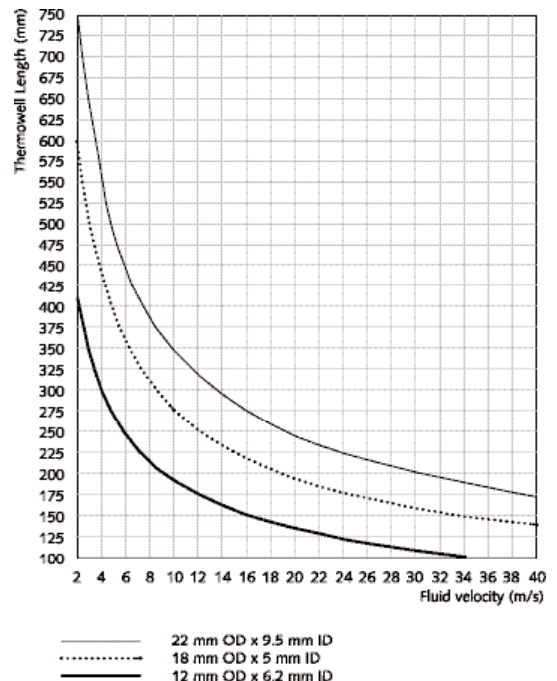
Type W11 build-up (fabricated) thermowells



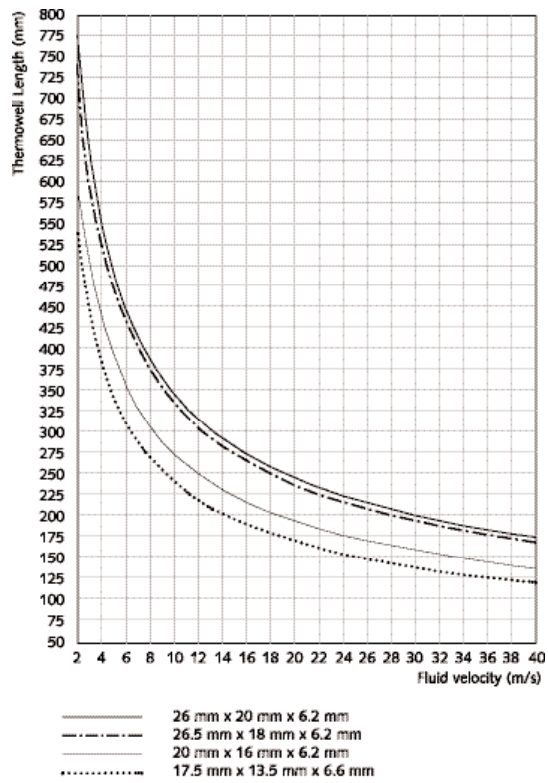
Type W71 solid bar stock parallel



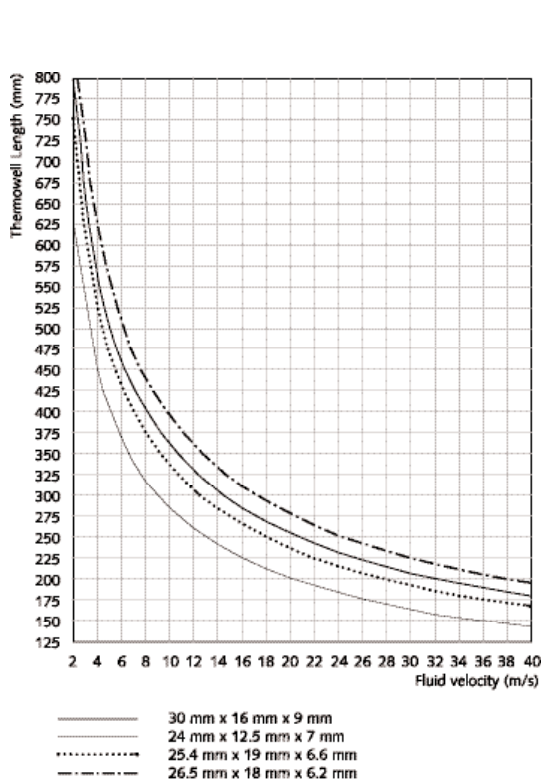
Type W40 Vanstone well



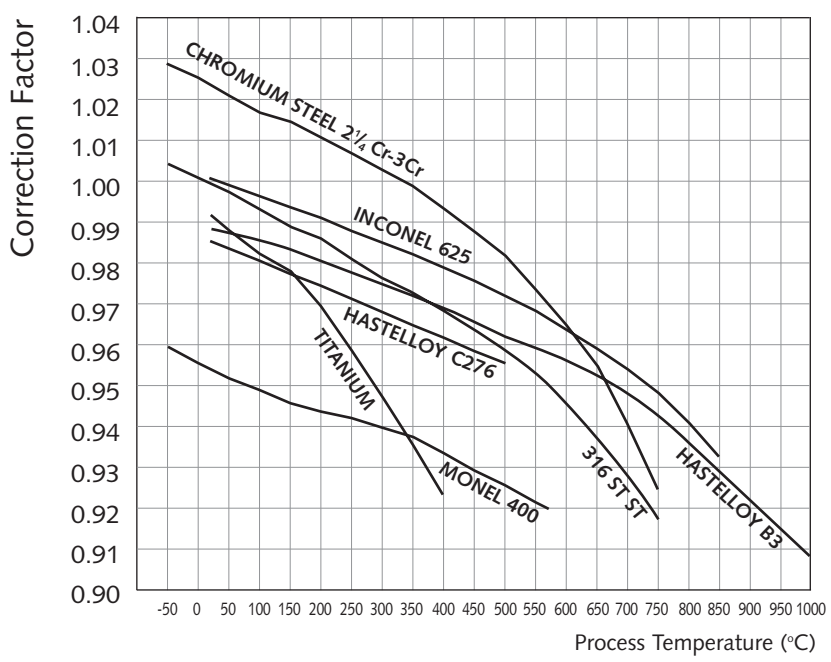
Type W51



Type W51



Material versus temperature correction factors

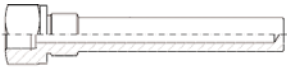
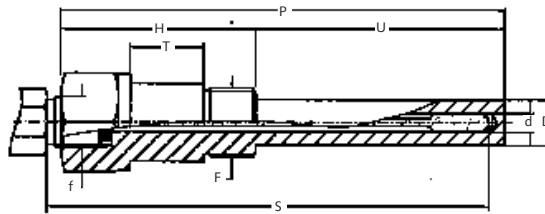




Badotherm thermowells are standard made out of stainless steel AISI316, but can also be manufactured in carbon steel, AISI304, AISI321, Duplex, Monel, Hastelloy C and others, see page 147 and 148.

When ordering please specify all dimensions as mentioned here under accurately.

d = inside diameter	P = total length well
D = outside diameter	f = instrument connection
G = taper end biggest diameter	F = process connection
U = insertion length	T = extension length
S = stem length instrument	H = total connection length



Type BDTW11 build-up (fabricated) straight shank, threaded

instrument connection 1/2" bsp / npt
 process connection 1/2" / 3/4" / 1" bsp / npt
 maximum 25 bar



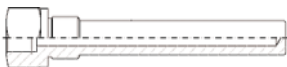
Type BDTW31 bar stock, stepped shank, threaded

instrument connection 1/2" bsp / npt
 process connection 1/2" / 3/4" / 1" bsp / npt
 maximum 100 bar



Type BDTW51 bar stock, tapered shank, threaded

instrument connection 1/2" bsp / npt
 process connection 1/2" / 3/4" / 1" bsp / npt
 maximum 400 bar (see pressure / temperature rating table page 154)

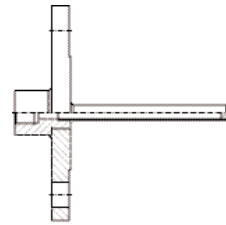


Type BDTW71 bar stock, straight shank, threaded

instrument connection 1/2" bsp / npt
 process connection 1/2" / 3/4" / 1" bsp / npt
 maximum 400 bar (see pressure / temperature rating table page 154)

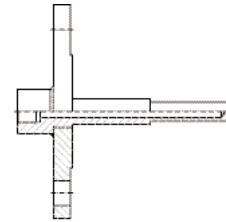
Type BDTW81 build-up (fabricated) straight shank, flanged

instrument connection 1/2" bsp / npt
 process connection ANSI / DIN / JIS flanges
 maximum 25 bar



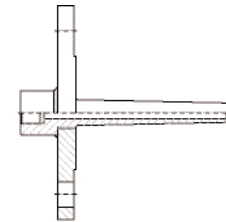
Type BDTW91 bar stock, stepped shank, flanged

instrument connection 1/2" bsp / npt
 process connection ANSI / DIN / JIS flanges
 maximum 100 bar



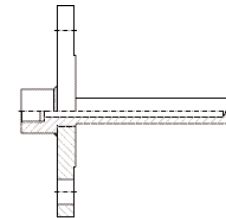
Type BDTW101 bar stock, tapered shank, flanged

instrument connection 1/2" bsp / npt
 process connection ANSI / DIN / JIS flanges
 maximum 400 bar



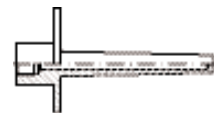
Type BDTW111 bar stock, straight shank, flanged

instrument connection 1/2" bsp / npt
 process connection ANSI / DIN / JIS flanges
 maximum 400 bar



Type BDTW40 bar stock, tapered shank, Vanstone

instrument connection 1/2" bsp / npt
 process connection flanged 1" / 1 1/2"



Type BDTW60 bar stock, tapered shank, weld-in

instrument connection 1/2" bsp / npt
 process connection weld-in





Type BDTW50 bar stock, straight shank, tri-clamp

instrument connection 1/2" bsp / npt
 process connection 1" / 1 1/2" / 2" / 2 1/2" tri-clamp



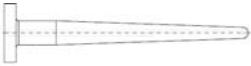
Type BDTW55 bar stock, straight shank, Tuchenhagen

instrument connection 1/2" bsp / npt
 process connection Tuchenhagen flanges



Type SFB bar stock, straight shank, cover flange

instrument connection cover flange
 process connection ANSI / DIN / JIS flanges



Type SFF forged, tapered shank, cover flange

instrument connection cover flange
 process connection ANSI / DIN / JIS flanges

thermowell pressure / temperature rating in BAR for model BDTW 51 / 71							
Material	Temperature in °C						
	20°C	100°C	200°C	300°C	400°C	500°C	650°C
Brass	350	295	70	-	-	-	-
Carbon steel	360	350	335	320	250	100	-
Aisi304	490	430	400	380	360	315	115
Aisi316	490	490	450	430	425	360	175
Monel	450	420	380	370	360	100	-