

## BW 型不锈钢波纹管(膨胀节)的安装选型要点

### The outline of the installation and selection of the BW stainless steel bellows

在工厂动力管网和城市集中供热管网中,使用不锈钢波纹管(膨胀节)比传统的补偿方法有明显优点,但工程管路设计受各方面客观环境的制约变得相当复杂,在不同的情况下,恰当的选用合适的波纹管膨胀节,对于管路的安全运行和节约资金是十分重要的。

一般波纹管膨胀节的选型可按以下程序进行:

1、根据实际管路情况,合理确定各段管线采用的波纹管膨胀节的形式和数量。直线管段一般采用轴向膨胀节; L 型管段、Z 型管段则采用单向铰链型、复式自由型和复式铰链型膨胀节; 而空间段则采用复式栏杆型和单、复式角向万向铰链型膨胀节。

2、根据使用介质温度选定材质,确定工作压力等级,并做出必要的修正。

3、计算各管段的位移量,确定波纹膨胀节的补偿量。管线的热胀冷缩所产生的伸缩量。计算公式如下:

$$\Delta X=CL(T_{\max}-T_{\min})$$

$\Delta X$ ——管线位移量(伸缩量)mm; C——管材膨胀系数mm/mOC;  $T_{\max}$ ——最高使用温度 OC;  $T_{\min}$ ——最低使用稳定 OC; 碳钢材料膨胀系数 C 为:

工作温度℃ working temperature	20-110	20-200	20-300	20-400	20-600
$\times 10^{-6}$	8.7- 11.1	8.5- 11.6	10.1- 12.2	11.5- 12.7	12.9- 13.2

4、设置固定支架:它的作用是将管线分段,设置固定点,保证波纹管膨胀节在两个固定支架之间管段正常工作。固定支架由分为主固

The outline of the installation and selection of the BW stainless steel bellows is evidently superior to conventional compensating method. However, the pipeline project is quite complex due to the restriction of all kinds of external condition. Under different circumstances, the right selection of bellows is very important to safe operation and economy. The selection of bellows can be carried on as following steps:  
1 According to the actual condition of pipeline, confirm the form and quantity of the bellows reasonably. Straight pipe sections fits axial expansion joint; L-tube sections, Z-tube sections fits one-way hinge type, double-free type and double-hinge-type expansion joint; While space segment fits double-fence type and single-angle, double-angle type universal joints to the expansion joint.

定支架和次固定支架。	2 Select the material and confirm the level
主固定支架承受管线内压力产生的盲板推力，在管线的盲板端、	of working pressure according to the
拐弯、变径、支管进出口及装有阀门处都应设置。主固定支架主要承	temperature of medium and make necessary
受三个力：	modification as well.
（1）盲板推力 $F_p=P \cdot A$ ；P——最高工作压力 MPa；A——波纹管	3 Calculate the displacement of every part to
有效面积 mm <sup>2</sup> ；（2）膨胀节位移时产生的刚度反力 $F_k=1/2 K \cdot e$ ；K—	confirm the compensating quantum. The
—刚度 N/mm <sup>2</sup> ；e——补偿量 mm；（3）摩擦反力 $F_f=9.8 \mu$	expanding or shrinking quantum of the
$(wL+wp)$ ； $\mu$ ——摩擦系数；W——每米管重 Kg/m；L——管线长度	pipeline caused by the temperature
m；wp——膨胀节重量 Kg。由于后二者（2）（3）相比盲板推力（1）	fluctuation can be calculated as follows:
小得多，一般可只粗略计算 $F_p$ 。	$\Delta X=CL (T_{max}-T_{min})$
次固定支架不承受管线内压力产生的盲板推力，只承受膨胀节刚度反	$\Delta X$ ——line displacement(volume expansion)
力和摩擦反力。	mm；C——pipe expansion coefficient mm/mOC；
5、按标准规定设置导向支架。	$T_{max}$ ——maximum service temperature OC； $T_{min}$
膨胀节的安装：	——minimum service temperature OC；expansion
为保证波纹管膨胀节在工作温度下处于良好的工作状态，减少管架受	coefficient of carbon steel materials:
力，安装前要进行预变形，凡属轴向膨胀节的轴向预变形量 $\Delta L$ 预由	4 Set up fixed bracket: it is used to divide
下式确定： $\Delta L_{预}=X (1/2)$	the pipeline, set up fixed point to ensure
X——轴向补偿量 mm； $T_e$ ——安装温度 OC； $T_{min}$ ——最低设计温度	the smooth operation of the corrugated
OC； $T_{max}$ ——最高设计温度 OC； $\Delta L_{预}$ 为正值，表示预拉伸量， $\Delta L$	compensator between the two brackets. The
预为负值，表示为预压缩量。	fixed bracket can be classified as primary
安装注意事项：	and secondary.
1、膨胀节安装前应先检查其规格型号与管道压力、直径、位移量等配	The primary bracket bear the blind plate
置要求是否符合。	thrust from the inner pipeline and it should
2、带内筒的膨胀节安装方向与介质流向要一致。铰链型产品转动平面	be set up at the blind plate end, turning,
与管道位移平面是否一致。	track, and in-out port and where is installed

3、需要“预紧”的膨胀节，去所用的辅助构件，螺栓、螺母等在安装完毕后需。

kind of force:

4、安装过程中，严禁用波纹管变形来调整管道安装误差。特别是法兰孔不对中时，可采用活套法兰和转动法兰，保证膨胀节处于自然状态，以患产生高压力，降低使用寿命。

(1) blind plate thrust  $F_p = P \cdot A$ ; P——highest working pressure MPa; A——effective area of

5、膨胀节所有活动元件一套有足够的活动空间，不得卡死。

bellows mm<sup>2</sup>; (2) the counterforce of the

6、安装轴向补偿器时，必须保证与管道的同心度。

rigidity caused by the expansion joint

7、当波纹管需安装在动力设备进出口时，宜采用减振型不锈钢波纹管或带内罩型波纹管。严禁拆除产品拉杆（作运输防变形用除外），在 N/mm<sup>2</sup>; e——compensation mm; (3) anti-压力较高时，需加强拉杆、支耳强度，并在波纹管近端设置足够强度

displacement  $F_k = 1/2 K \cdot e$ ; K——rigidity friction force  $F_f = 9.8 \mu (wL + wP)$ ;  $\mu$ ——

和刚度的主固定支架，在升压至工作压力后将两侧拉杆螺母调松至支耳 2~5mm 距离内。

friction coefficient; W——weight per meter pipe Kg/m; L——pipeline length m;  $w_p$ ——

8、当安装在伸缩缝其大位移补偿时，可加大波纹管长度或采用复式轴 expansion joint weight Kg. Since the latter 向型式：如 BW-FFL, BW-FL, BW-XL 等。当要求较高时，也可采用 BW- (2) (3) is much less than (1),  $F_p$  is a rough DJ 型、BW-WJ 型等加长型角向波纹补偿器和轴向型波纹补偿器组合串 calculation. The secondary fixed bracket can 联使用。 only bear the counterforce of the rigidity

9、膨胀节可用于高频低振幅振动系统。为避免与系统发生共振，膨胀 and anti-friction force but not blind plate 节的自振频率应小于系统频率或至少大于 1.5 倍系统频率。 thrust caused by pressure pipeline.

单式膨胀节轴向振动自振频率  $f_n = C_i K_x / W$  式中 W——波纹管 and 介质总 5 Set up the guide bracket according to 重量 kg;  $K_x$  ——波纹管轴向刚度 N/mm,  $C_i$ ——对于前五阶振型,  $C_i$  standards The installation of the expansion 取值见下表: joint:

波数 Wave number	C1	C2	C3	C4	C5
1	14.22				
2	15.3	28.8	37.17		
3	15.69	30.25	42.64	52.29	58.25
4	15.69	30.73	44.73	56.96	66.94

To make sure the expansion bellows are in good working condition under the working temperature and reduce the force of the bracket, pre-deformation should be performed before installation. Pre-axial deformation

5	15.78	31.06	45.7	59.22	71.12
6	15.78	31.22	46.18	60.34	73.38
7	15.78	31.38	46.5	61.14	74.99
8	15.78	31.38	46.82	61.47	75.79
9	15.78	31.38	46.82	61.95	76.43
≥10	15.78	31.38	46.98	62.12	76.91

单式膨胀节横向振动自振频率  $f_n=C_i \left( D_m/L_b \right) \sqrt{K_x/W}$

式中 W——波纹管和介质总重量 kg； $D_m$  ——波纹管平均直径 mm； $L_b$  ——波纹管的波纹长度 mm； $K_x$  ——波纹管轴向刚度 N/mm， $C_i$ ——对于前五阶振型， $C_i$  取值见下表：

C1	C2	C3	C4	C5
39.91	109.74	214.01	355.61	531.00

can be determined by following formula:  $\Delta L_{pre} = X \left( 1/2 \right)$   
 $X$ ——axial compensation mm； $T_e$ ——installation temperature $^{\circ}C$ ； $T_{min}$ ——Minimum design temperature $^{\circ}C$ ； $T_{max}$ ——the maximum design temperature $^{\circ}C$ ；Positive  $\Delta L$  预 means the volume of pre-tension while negative  $\Delta L$  预 means pre-compression.

Installation Notes:

- 1 Model specifications and configurations as pipeline pressure, diameter, and displacement should be checked before installation of expansion joint.
- 2 The direction of inside-tube expansion joint should be consistent with medium flow. Confirm the rotation planes of the hinge-type products are consistent with the displacement of the pipe.
- 3 Auxiliary components used to retighten the joint, such as bolt, nut, should be removed and installation.
- 4 Forbid to adjust pipeline installation error with bellows deformation. Especially when there are wrong holes in the flange, looped flange and rotating flange can be used to ensure the expansion joint is in a natural

state in case high pressure reduces the service life.

5 Make sure the enough space for all movable element of the expansion joint.

6 Guarantee the concentricity with the pipeline when installing the axial compensator.

7 When the bellows need to be installed in the access port of the power equipment.

Stainless steel bellows-type damping and cover-band-shaped bellows is recommended.

Forbid to remove pull rod (except in the use of transport and anti-deformation).When the pressure is high, the pull rod and Supporting ear should be Strengthened .Besides, the main fixed bracket with enough intensity and rigidity should be set near the bellows. When the pressure rises to working level, the nut on both sides of the pull rod should be loosened 2~5mm within the distance of the supporting ear.

8 When large displacement compensation is needed, the length of the Bellows can be increased or double-axial type can be used ,such as BW-FFL, BW-FL, BW-XL. Prolonged angular corrugated compensator, such as BW-

DJ, BW-WJ, and axial-type bellows compensator can be assembled and utilized in series when the requirement is high.

9 Expansion joint can be used in the high-frequency and low-amplitude vibration system. To avoid resonance with the system, the natural frequency of the joint should be less than system frequency or at least 1.5 times greater than the system frequency.

Natural frequency of axial vibration of single expansion joint  $f_n = C_i K_x / W$  Where  $W$ ——the total weight of medium and bellows kg;  $K_x$ ——axial rigidity of bellows N/mm,  $C_i$ ——for the first five-order vibration mode,  $C_i$  values in the table below:

Natural frequency of transverse vibration of single expansion joint  $f_n = C_i (D_m / L_b) K_x / W$  Where  $W$ ——the total weight of medium and bellows kg;  $D_m$ ——the average diameter of bellows mm  $L_b$ ——the length of the corrugated bellows mm ;  $K_x$ ——axial rigidity of bellows N/mm,  $C_i$ ——for the first five-order vibration mode,  $C_i$  values in the table below:

## 阻尼弹簧隔振器选用要点和安装方法

### Selecting methods of damp spring vibration absorber

#### 一、隔振器的静载荷与高度分四种类型

A、DMdeintofourtypes accordingtothe staticload

##### 1、零静载荷

andheight

隔振器处于自由状态，不承受任何 负载，称为零载荷。此时 1、Zero staticload

隔振器的高度  $H_0$ 。为弹簧自由高度、上下盖及防滑胶垫 厚度 111e stateinwhicbthevibrationabsorberisfree  
之和。 andhasnoload onis called zero

##### 2、顶压静载荷

staticload. Herethetotal height $H_0$ ofthe vibration

隔振器通过预压螺栓施加力于弹簧， 使弹簧压缩到一定高 absorberincludingtheheight offree spring,topbase  
度，预压螺栓施加 的力称为预压载荷，一般情况下隔振器 出COVer,endrubber skidproofmat.

厂时即为这一状态。预压载荷下隔振 器的高度称为预压高 度，记为  $H_1$ ， 则

##### 2、Toppresure staticload

The vibration absorber exerts aforce on the sp 皿 g by

$$H_1 = H_0 - F_1 / K \text{ cm}$$

the preliminary press bolt, then the sp 皿 g is

式中， $F_1$ —预压载荷 N

compressed to some extent. Heretheforceis

$K$ —隔振器静刚度 N / cm

calledas $F_1$ . preliminarypressloadN

##### 3、工作静载荷

Normallythevibrationabsorberisinthis

隔振器工作时所承受的实际载荷， 此时隔振器的高度记为  $H_2$ ， 则  $H_2 = H_1 - (F_2 - F_1) / K \text{ cm}$  式中， $F_2$ —

stateasitisproducted Heretheheight  $H_1$  is called

aspreliminary pressheight, then

工作静载荷 N

$$H = H_1 - F_2 / K \text{ cm}$$

在具体设计时，隔振器工作时实际 高度  $H_2$  可按上式计算。

Here $K$ static idnyofvibrationabsorber

##### 4、最大静载荷

##### 3、Working staticload

出于对强度及使用寿命等角度考虑， 隔振器在使用时所允许 承受的最大载荷。此时隔振器的高度为  $H_3$ ， 则

Working staticloadisthe actualloadmatthevibration

ahsorber cen bear whenitis worldng, Herethe height of

$$H_3 = H_0 - F_3 / K \text{ cm}$$

vibration absorber is  $H_2$

式中， $F_3$ —隔振器所能允许承受的最大载荷，在选用隔振器  $H = H_0 - F_2 / K = H_0 - (E - F_0) / K \text{ cm}$

时，工作载荷可选择在预压载荷  $F_1$  和最大载荷  $F_3$  之间，—And in the formula.  $F_2$  working smile load  $N$ .

般以宜选在中间值为好，中间值记  $F$ ，， 则  $F_2 = (F_3 - F_0) / 2 + F_1$  The actual height  $H$  of working vibration absorber can be calculated according to

## 二、隔振效率的简易计算

the formula mentioned above when it is carefully designed.

1、根据振动控制的有关标准确定隔振效率  $g$

4、Maximum static load permitted max mlm load that

2、忽略阻尼，则有振动传递率

the vibration absorber can bear when it is working in view

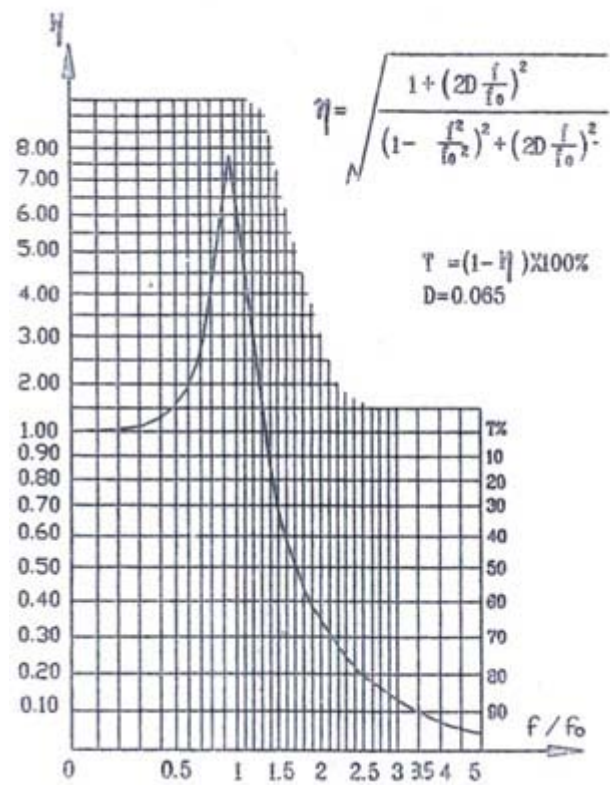
$T = 1 / [1 - (f / f_0)^2]^2$ —隔振效率  $\eta = (1 - T) \%$  于是由  $g$  可以确定  $f / f_0$  的大小，即频率比。式中， $f$ —扰力频率  $\text{Hz}$

of intensity, using life end so on. Here the height of also evibration absorber is  $H_3$ . end

$f_0$ —隔振系统固有频率  $\text{Hz}$  当考虑阻尼时，隔振效率略有下降，计算公式及图表如下：

$$H_3 = H - F_3 / K \text{ cm}$$

here,  $F_3$  permitted maim load,



传递力  $\eta$  及隔振效率  $T$  曲线图

The magnitude of working load can be any value between preliminary load  $F_1$  and maximum load  $F_3$ . Commonly the best choice is the middle value which is written as  $F_2$

$$F_2 = (F_3 - F_0) / 2 + F_1 \text{ N}$$

B、Simple calculation of isolating vibration

efficiency 1、Ascertain the isolating vibration

efficiency  $\eta$  according to corresponding standard of vibration control.

2、Neglect damp, vibration transfer efficiency

appears.  $T = 1 / [1 - (f / f_0)^2]^2$

Isolating vibration efficiency  $\eta = (1 - T)$  So the value of  $F / F_0$  which is frequency ratio can be confirmed by  $\eta$ ,

here  $f$  is disturbance frequency  $\text{Hz}$   $f_0$  is intrinsic frequency of the

## 3、频率计算

A、扰力频率：对于旋转设备，扰力频率  $f$  一般为  $f = n / 60$



Hz 式中，n 一机器每分钟转速 r / mi n systemHz Reckon in damp, isolating vibrailon

B、隔振系统固有频率 f0 对于弹簧隔振器 f。的计算方法有 efficiency descends shghfly, formulaandfigure

以下简易方法： fo=5 / 、厂\_矿 Hz 6=F2 / K cm 式中，6 一隔showasfollows:

振器工作时，弹簧压缩 量 cm K——隔振器静刚度 N / cm F，隔3、Frequency calculation

振器工作时承受的静载荷 N a. disturbfrequency: 0013~lvalueisF——n / 60Hz,

三、隔振器的选取 forrevolving inslirtmaents.

根据以上计算，选取隔振器遵守两 个原则： herennlpmofequipment. b

1、 隔振器工作时承受的静载荷在预压 载荷和最大载荷之间 intrinsicfrequencyofisolatingvibrailon systems

即可，宜选在中间 值附近。如被隔振机器设备扰力很大或 为 ‘ ordinary calculate method of ‘shows as follows,

冲击设备，则工作载荷选取点不要离 最大载荷太近。 fF5/6 Hz 6=FJKem

2、 隔振器的固有频率选择可根据二提 供的方法计算。一般 here 6 compressed magnitude of spring when working

情况下，应选择频 率比 f / f0=2. 5~4. 5，此时隔振效率 ern KstaticrigofthevibrationabsorberN / cm

在 80%~95%。 F2staticloadwhenworkingN C、Selecting method

3、阻尼比选择原则为 Obey two rulaswhen

1、对旋转设备和旋转往复设备，视转 速高低，阻尼比可在 selectingvibrationabsorberaccordingto the calculation

0. 03~0. 10 范围 选取，阻尼比不宜大于 0. 1 5。 as mentioned above:

2、对锻冲设备，阻尼比应在 0. 1 5~ 0. 30 范围内选取。 1、lll emagnitude of staticload can been any

安装方法 一、一般情况下，隔振器底座与基础之间不必用地 butitisappropriateto

脚螺栓连接。 be nearthemiddle value. Iftheisolatedin stmmnt

二、隔振器上部与机器设备底座或隔振台座之间是否采用螺栓acutely disturbs or is a kind ofimpulsive equipment,

连 接，可视具体情况确定。 the value of workingload shouldbe

1、当设备扰力不大时，则隔振器上部不必与设备固定。 selectedfarfromthemaximumload.

2、当动力设备扰力较大时，四个角的隔振器可与设备底座或 2、The calculationoftcan followsthemethodtwomentioned

隔 振台座固定，而中间几个隔振器不固定，以便移动其位 ab0VC,

置，达到 所有隔振器静态压缩量相同之目的。

## Installation

A、Under normal condition, the foot

connecting bolt need not to be used between the base of vibration absorber and the ground work of equipment

B、Top cover of vibration absorber can

be fixed with connecting bolt either on the base of equipment or on the vibration insulating pad

according to the real situation

1、Top cover need not be fixed on the equipment while the disturbing force of the power equipment is tiny.

2、When the disturbing force of the power

equipment is quiet great, the vibration absorber

on the four corners shall be fixed either on the base

of equipment or on the vibration insulating

pad. Other vibration absorbers in the middle

should not be fixed so they can be removed in

order to reach the aim that all the static compressed value

of the vibration absorber are the same

Under normal condition, frequency ratio is  $f/f_2$ . 5~

4. 5, here isolating vibration efficiency is about 80%~95%.

3、Selecting rules of damp ratio

1) The damp ratio is 0. 03~0. 10 according to the speed of rotation for the revolving instrument or

rect protator, and it is not suitable to exceed 0. 15

2) The damp ratio is 0. 15~0. 30 for forging and pressing equipments.