DESIGN DATA

Tech Data: G820

RIGID JOINTS

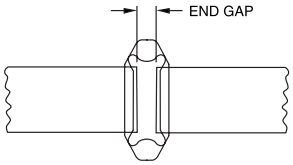
Grinnell® Rigid Couplings provide rigid gripping of the pipe. They are designed to bring the pipe ends closely together and the coupling clamps firmly onto the pipe OD and also into the bottom of the grooves. Because Rigid Couplings clamp around the entire pipe surface, they provide resistance to flexural and torsional loads and therefore permit longer spacing to ASME/ANSI B31.1 (Power Piping) and ASME/ANSI B39.1 (Building Services) requirements.

FLEXIBLE JOINTS

Grinnell Flexible Couplings act as an "expansion joint", allowing linear and angular movement of the pipe. They are designed with the coupling keys engaging the pipe without gripping on the bottom of the grooves, while still providing for a restrained mechanical joint. This is particularly useful to allow for pipe expansion / contraction and piping misalignment.

LINEAR MOVEMENT (Flexible Couplings)

For thermal expansion with flexible couplings, the pipe ends at each joint should be fully gapped to the maximum end gap. This can be accomplished by pressurizing the system and then anchoring the system.

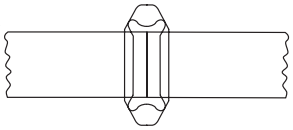


Pipe Ends Gapped for Expansion

For design purposes, the maximum pipe end gap should be reduced to account for field practices as follows:

End Gap Reduction	
Pipe Size Inches *mm*	Maximum Pipe End Gap *Reduction*
1¼ - 3 *42.4 - 88.9*	50%
4 - 24 *114.3 - 610.0*	25%

For thermal contraction with flexible couplings, the pipe ends at each joint should be fully butted. The system can then be anchored in place to prevent the pipe ends from opening up to the maximum end gap when pressurized.



Pipe Ends Butted for Contraction

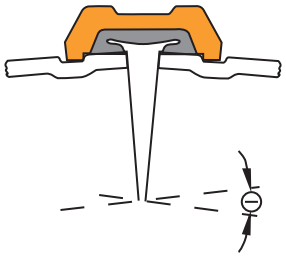
Therefore the following values should be used as available pipe end movements for Grinnell Figure 705, 707 and 716 Flexible Couplings:

Pipe End Movements		
Pipe Size Inches *mm*	Cut Grooved Inches *mm*	Roll Grooved* Inches *mm*
1¼ - 3 *42.4 - 88.9*	0 - 0.063 *0 - 1.6*	0 - 0.031 *0 - 0.8*
4 - 24 *114.3 - 610.0*	0 - 0.188 *0 - 2.4*	0 - 0.094 *0 - 2.4*

* Roll grooved joints provide ½ the available movement of cut grooved joints.

ANGULAR DEFLECTION

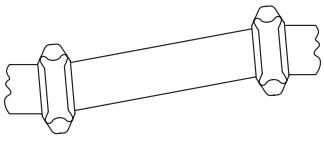
Grinnell® Flexible Couplings are capable of accommodating angular deflection.



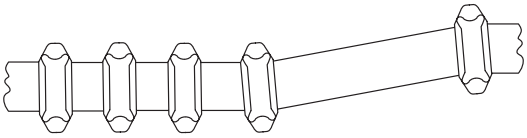
The deflection published is a maximum value. For design purposes the maximum deflection should be reduced to account for field practices as shown:

Deflection	
Pipe Size Inches *mm*	Maximum Pipe Deflection *Reduction*
1¼ - 3 *42.4 - 88.9*	50%
4 - 24 *114.3 - 610.0*	25%

Expansion / Contraction



Grinnell Flexible Couplings are capable of accommodating pipe thermal movements provided they are properly gapped and a sufficient quantity of flexible couplings are used. Note that flexible couplings will not accommodate both full maximum linear movement and the maximum available angular deflection concurrently at the same joint.



If it is desired to have both deflection and linear movement available, then the system should have sufficient flexible joints to accommodate the requirement.

DESIGN DATA

THERMAL MOVEMENT

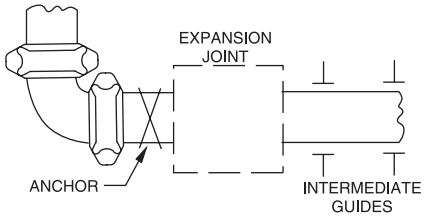
The following guidelines are similar to any expansion joint:

It is recommended that anchors be installed at changes of direction on the pipe lines to control the pipe movement. The thermal expansion / contraction in the piping system can be accommodated utilizing Grinnell® Flexible Couplings. In designing anchoring systems, it is suggested that the following be taken into consideration as a minimum:

- Pressure thrusts
- Frictional resistance of any guides or supports
- Centrifugal thrust due to velocity at changes of direction
- Activation force required to compress or expand a flexible coupling

Three methods are available as examples to accommodate thermal expansion/ contraction:

1) Design the system with rigid couplings and place expansion joints at the proper locations. Expansion joints may be a series of flexible grooved couplings of a sufficient quantity to accommodate the movement.



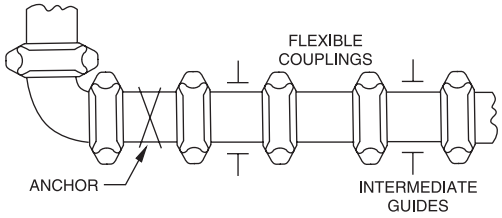
2) Design the system with flexible and/or rigid couplings and allow the pipe to move in directions desired, with the use of anchors and guides if so required. With this method, it is important to ensure that movement at branch connections, changes of direction, equipment hookup, etc., will not cause damage or harmful stresses.

Activation Force	
Pipe Size Inches *mm*	Activation Force Lbs. *N*
1¼ *42.4*	35 *156*
1½ *48.3*	45 *200*
2 *60.3*	70 *311*
2½ *73.0*	100 *645*
76.1mm	110 *489*
3 *88.9*	145 *645*
4 *114.3*	240 *1068*
5 *139.7, 141.3*	375 *1668*
165.1mm	500 *2224*
6 *168.3*	520 *2313*
8 *219.1*	880 *3914*
10 *273.0*	1365 *6072*
12 *323.9*	1915 *8518*

3) Design the system with flexible couplings utilizing the expansion/contraction capabilities of these products.

The following example illustrates this method:

- 6" Schedule 40 Steel Pipe, Roll Grooved, 150' long, anchored at each end.
- Maximum Temperature = 200°F
- Minimum Temperature = 40°F
- Install Temperature = 80°F



DESIGN DATA

THERMAL MOVEMENT

To calculate the number of couplings required in this example to compensate for the Thermal Expansion and Contraction of the pipe:

1) Thermal Contraction

Utilize the Thermal Expansion Table. Allowance for installation temperature to the minimum temperature, in this case 80°F to 40°F is calculated as:

80°F = 0.61" per 100'
40°F = 0.30" per 100'
Difference = 0.31" per 100'
For 150' of pipe = 0.31" x 1.5 = 0.47" per 150'

2) Thermal Expansion

Utilize the Thermal Expansion Table. Allowance for installation temperature to the minimum temperature, in this case 80°F to 200°F is calculated as:

200°F = 1.52" per 100'
80°F = 0.61" per 100'
Difference = 0.91" per 100'
For 150' of pipe = 0.91" x 1.5 = 1.36" per 150'

Thermal Expansion of Carbon Steel in Inches/100 Feet (Millimeters/30.5Meters) Between 0°F (-18°C) & Indicated Temperature

Temperature F° (C°)	Inches/100 Feet (mm/30.5M)
-40 (-40)	-0.30 (-7.62)
-30 (-34.4)	-0.23 (-5.84)
-20 (-28.9)	-0.15 (-3.81)
-10 (-23.3)	-0.08 (-2.03)
0 (-17.8)	0.00 (0.00)
10 (-12.2)	0.08 (2.03)
20 (-6.7)	0.15 (3.81)
30 (-1.1)	0.23 (5.84)
40 (4.4)	0.30 (7.62)
50 (10.0)	0.38 (9.65)
60 (15.6)	0.46 (11.68)
70 (21.1)	0.53 (13.46)
80 (26.7)	0.61 (15.50)
90 (32.2)	0.68 (17.27)
100 (37.8)	0.76 (19.30)
110 (43.3)	0.84 (21.34)
120 (48.9)	0.91 (23.11)
130 (54.4)	0.99 (25.15)
140 (60.0)	1.06 (26.92)
150 (65.6)	1.14 (28.96)
160 (71.1)	1.22 (30.99)
170 (76.7)	1.29 (32.77)
180 (82.2)	1.37 (34.80)
190 (87.8)	1.44 (36.58)
200 (93.3)	1.52 (38.61)
210 (98.9)	1.60 (40.64)
220 (104.4)	1.67 (42.42)
230 (110.0)	1.75 (44.45)

Mean Coef. of thermal expansion = 0.00000633 in/in/°F
Source: ASME B31.9

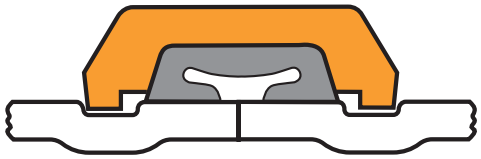
3) Couplings Required

Available linear movement for a 6" Figure 707 Flexible Couplings on roll grooved pipe = 0.094" per coupling.

a) Fully Butted Together for Contraction Only

Therefore the number of flexible Figure 707. Couplings required:

- 0.47" / 0.094" per coupling = 5.0
- Use 5 Figure 707 Couplings for pipe contraction



b) Fully Gapped Apart for Expansion Only

Therefore the number of flexible Figure 707. Couplings required:

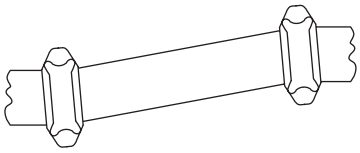
- 1.36" / 0.094" per coupling = 14.47
- Use 15 Figure 707 Couplings for pipe expansion

DESIGN DATA

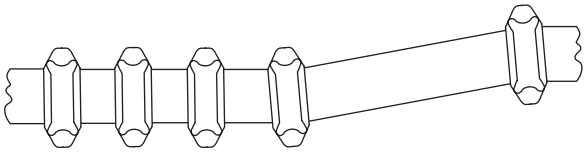
MISALIGNMENT AND DEFLECTION

Grinnell® flexible couplings provide for restrained joints and allow for deflection to aid where the pipe or equipments is misaligned.

Note that flexible couplings will not accommodate both full maximum linear movement and the maximum available angular deflection concurrently at the same joint.



If it is desired to have both deflection and linear movement available, then the system should have sufficient flexible joints to accommodate the requirement.

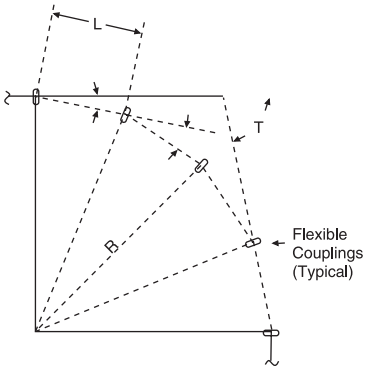


Flexible couplings are also useful in laying out curved piping systems.

$$R = \frac{L}{(2)\ (\text{Sin}\ \frac{\ominus}{2})}$$

$$L = (2)\ (R)\ (\text{Sin}\ \frac{\ominus}{2})$$

$$N = \frac{T}{\ominus}$$



R = Radius of curve

L = Pipe length

$\ominus$ = Deflection from centerline, in degrees, for each coupling (see table)

N = Number of flexible couplings needed

T = Total deflection, in degrees, required

Design Deflection for Roll Grooved Pipe

Deflection $\ominus$ (Roll Grooved Pipe)	
Pipe Size Inches *mm*	Figures 705 & *707*
1¼ *42.4*	1.08°
1½ *48.3*	0.94°
2 *60.3*	0.75°
2½ *73.0*	0.62°
76.1mm	0.60°
3 *88.9*	0.51°
4 *114.3*	1.19°
5 *139.7, 141.3*	0.97°
165.1mm	0.83°
6 *168.3*	0.81°
8 *219.1*	0.63°
10 *273.0*	0.50°
12 *323.9*	0.42°

Incorporates the recommended safety factor reduction for field practices (50% for sizes 1¼" - 3" and 25% for sizes 4" - 12").

DESIGN DATA

PIPE SUPPORT

All piping systems require that the support system accommodate the weight of the pipe, joint connections, fluid and other system components. In addition, consideration may be necessary in reducing stresses, accommodating thermal expansion or contraction, building settlement, seismic movement, etc. The following tables provide guidelines for grooved steel piping products without concentrated loads between supports.

Flexible Joints

For pipe runs when linear movement is accommodated by the flexible coupling:

Number of Hangers Per Pipe Length								
Pipe Size Inches *mm*	Pipe Length in Feet/*Meters*							
	10 *3.3*	12 *3.7*	15 *4.6*	22 *6.7*	25 *7.6*	30 *9.1*	35 *10.7*	40 *12.2*
	Avg. Hangers Per Pipe Length							
1 1/4 - 2 *42.4 - 60.3*	2	2	2	3	4	4	5	6
2 1/2 - 4 *73.0 - 114.3*	1	2	2	2	2	3	4	4
5 - 24 *139.7 - 609.6*	1	1	2	2	2	3	3	3

For pipe runs when linear movement is not required:

Distance Between Supports	
Nominal Size Inches *mm*	Maximum Distance Between Supports Feet *Meters*
1 1/4 - 1 1/2 *42.4 - 48.3*	12 *3.7*
2 - 8 *60.3 - 219.1*	15 *4.6*
10 - 12 *273.0 - 323.9*	16 *4.9*
14 - 16 *355.6 - 406.4*	18 *5.5*
18 - 24 *457.2 - 609.6*	20 *6.1*

Note: The requirements of ANSI, ASME or other code groups may require additional supports.

Rigid Joints

For pipe runs with rigid couplings:

Pipe Size Inches *mm*	Suggested Maximum Span Between Supports - Meters/Feet			
	Water Service		Air Service	
	I	II	I	II
1 1/4 *42.4*	7 *2.1*	11 *3.4*	9 *2.7*	11 *3.4*
1 1/2 *48.3*	7 *2.1*	12 *3.7*	9 *2.7*	13 *4.0*
2 *60.3*	10 *3.0*	13 *4.0*	13 *4.0*	15 *4.6*
2 1/2 *73.0*	11 *3.4*	14 *4.3*	14 *4.3*	16 *4.9*
76.1mm	11 *3.4*	14 *4.3*	14 *4.3*	16 *4.9*
3 *88.9*	12 *3.7*	15 *4.6*	15 *4.6*	17 *5.2*
4 *114.3*	14 *4.3*	17 *5.2*	17 *5.2*	21 *6.4*
5 *141.3*	16 *4.9*	19 *5.8*	20 *6.1*	24 *7.3*
165.1mm	17 *5.2*	20 *6.1*	21 *6.4*	25 *7.6*
6 *168.3*	17 *5.2*	20 *6.1*	21 *6.4*	25 *7.6*
8 *219.1*	19 *5.8*	21 *6.4*	24 *7.3*	28 *8.5*
10 *273.0*	19 *5.8*	21 *6.4*	24 *7.3*	31 *9.4*
12 *323.9*	23 *7.0*	21 *6.4*	30 *9.1*	33 *10.1*
14 *355.6*	23 *7.0*	21 *6.4*	30 *9.1*	33 *10.1*
16 *406.4*	27 *8.2*	21 *6.4*	35 *10.7*	33 *10.1*
18 *457.2*	27 *8.2*	21 *6.4*	35 *10.7*	33 *10.1*
20 *508.0*	30 *9.1*	21 *6.4*	39 *11.9*	33 *10.1*
24 *609.6*	32 *9.8*	21 *6.4*	42 *12.8*	33 *10.1*

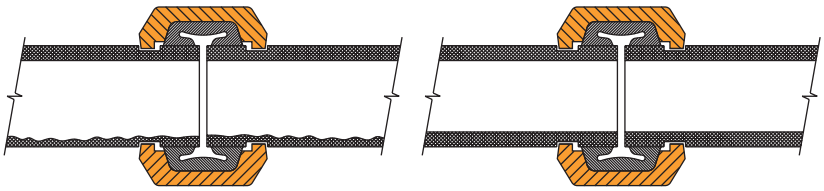
I - Spacing by ANSI B31.1 Power Piping Code
II - Spacing by ANSI B39.1 Building Piping Code

DESIGN DATA

ROTATIONAL MOVEMENT

Grinnell® flexible couplings are suitable for use in seismic as well as mining applications. The inherent capability of the flexible coupling to allow for linear movement, angular deflection, and rotational movement, make it an excellent choice for reducing stresses in a piping system and to increase pipe life in slurry applications.

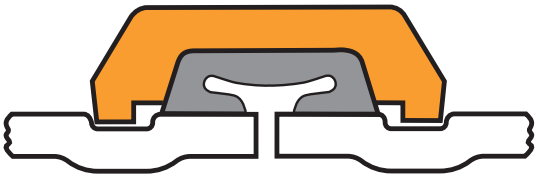
For mining applications where the pipe needs to be rotated, the system should be depressurized. The pipe couplings bolts/nuts can be loosened, pipe rotated and the bolts/nuts re-tightened and the system be put back in service.



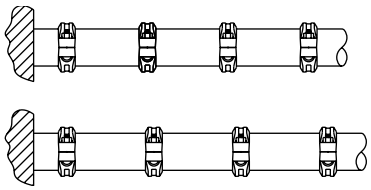
Even distribution of pipe wear can be achieved with this method on the inner service of the pipe.
Note: Precautions are necessary to monitor pipe wall thickness to evaluate pressure capability of the pipe with reduced wall.

LINEAR MOVEMENT

Flexible couplings are designed with the couplings keys engaging the pipe without gripping on the bottom of the groove while still providing for a restrained mechanical joint.



The inherent flexibility of the coupling must be considered when deciding on support arrangements for the piping system as movement can occur in more than one plane (linear movement, angular deflection and rotational movement).

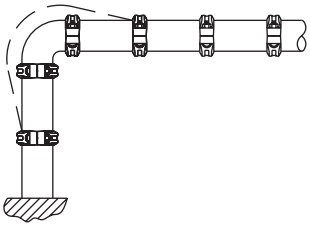


Upon system pressurization, each pipe end within the flexible couplings will expand to the maximum published value. The coupling keys make contact with the face of the groove and restrain the joint. In piping systems, this movement will be accumulative.

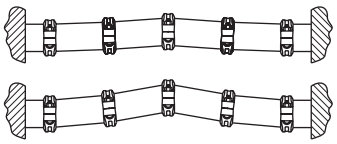
DESIGN DATA

ANGULAR MOVEMENT

System movement can be accommodated by providing for sufficient offset lengths. Temperature increases/decreases can further increase this movement.

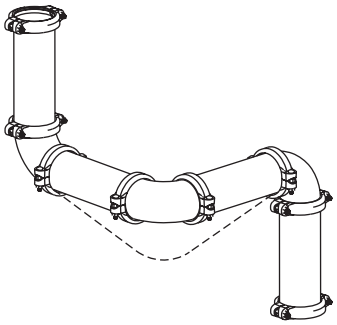


When systems are anchored with partially deflected joints, the system can move to the fully deflected condition upon pressurization resulting in the "snaking" of the piping system. Light weight hangers may not be suitable to prevent the lateral motion.



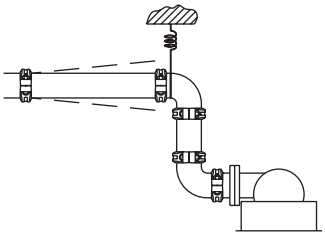
PIPE SUPPORT

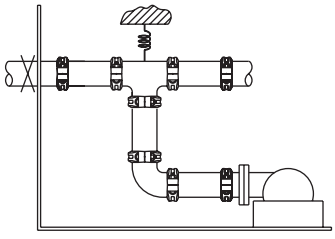
Pipe hanger positioning is important when considering pipe "sagging" due to the flexible nature of the piping system. Proper positioning of hangers near the elbow, for example, should be considered.

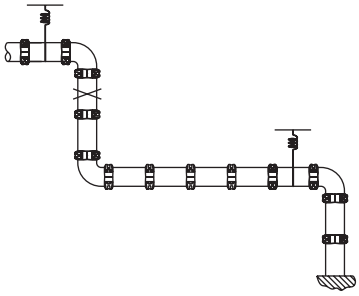


The use of spring hangers or other methods can be considered to accommodate vibrations. Base supports, pressure thrust anchors and pipe offsets can be used to direct pipe movement.

The use of rigid couplings can be considered to reduce the movement available with flexible couplings. Consideration to other methods of accommodation of pipe movements may be required.



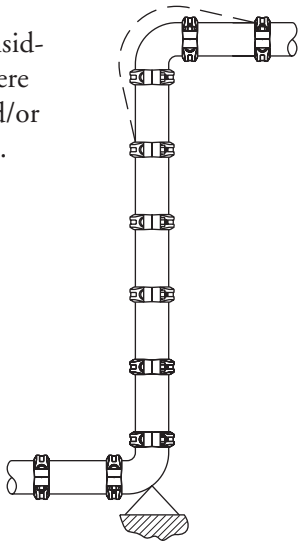


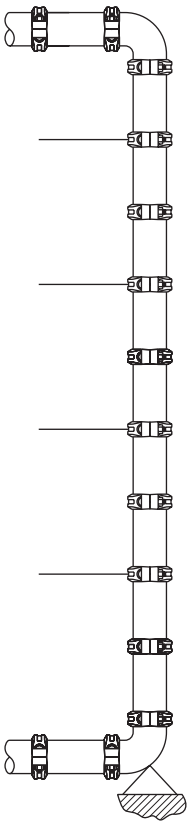


DESIGN DATA

VERTICAL PIPING

Risers comprised of rigid couplings can be considered similar to welded or flanged systems. Where thermal movement exists, expansion joints and/or flexible couplings with offsets may be required.





When using flexible couplings, the movement that occurs in long lengths of piping needs to be considered. Each joint can move up to the maximum pipe end separation published. This movement can accumulate and result in the growth of the piping system, for example, at the top. Offsets may be necessary.

Should the riser contain branch connections, the movement which occurs at these locations with flexible couplings, will also need to be considered.

One solution would be to anchor the vertical piping at appropriate locations to prevent movement which can cause stresses at the branches or equipment. The use of rigid couplings can be an advantage.

As always, good piping practice should prevail. It is the Designer's responsibility to select products suitable for the intended service and to ensure that pressure ratings and performance data is not exceeded. Never remove any piping component nor correct or modify any piping deficiencies without first depressurizing and draining the system. Material and gasket selection should be verified to be compatible for the specific application.