Tutorial on Reduction of Support Loads with Cold Spring using CAEPIPE

General

Cold spring (cut short or cut long) is used to reduce thermal forces on equipment connected to the piping system. When lengths of pipes are cut short or extended by design, they are pulled together or pushed apart to join them during installation, giving rise to a “cold-sprung” system.

Such an installation process (cold condition) obviously introduces stresses, which are relieved when the system starts up (hot condition). Note however, that the piping codes do not allow credit for any reduction in stresses due to cold spring since the displacement range is unaffected (similar to self-springing). But, codes allow reduction in support loads due to cold spring (which can be helpful at the equipment).

This feature should be used only with a proper understanding of the implications.

The intent of this tutorial is to provide a guideline on reducing the operating load on equipment connections by using the Cold Springs.

Tutorial

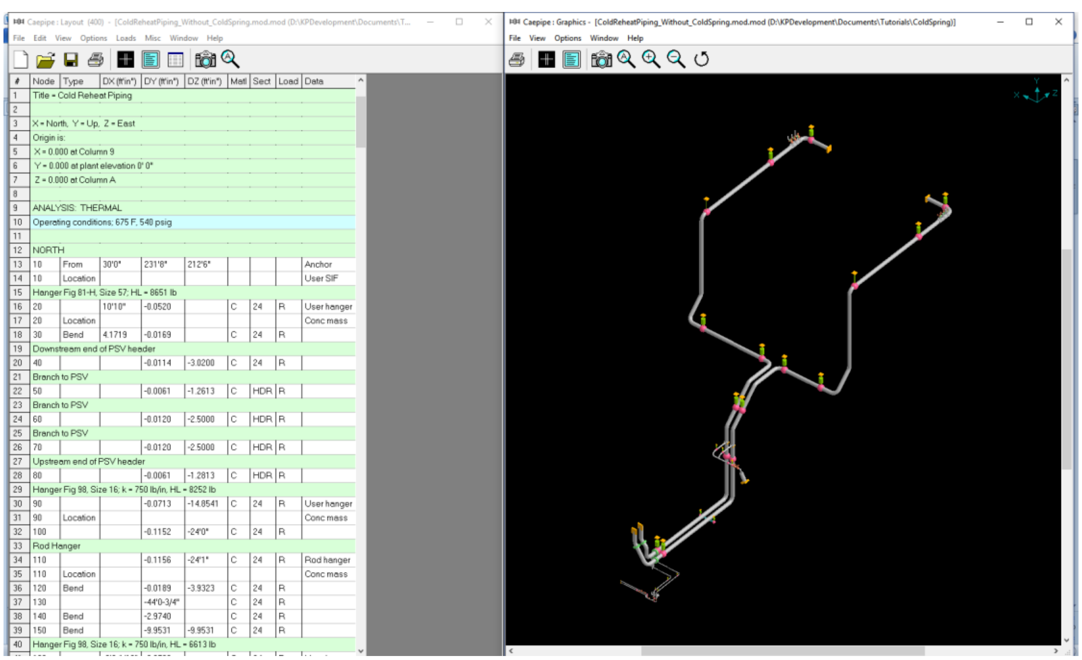
Step 1:

Attached are two sample CAEPIPE stress models of a Cold Reheat Piping system connecting the PSV Header to the Turbine Nozzles with and without Cold Spring.

Model 1: ColdReheatPiping_without_ColdSpring.mod

For this model, let us note the following.

1. Nodes 10 and 470 connect to PSV Headers.
2. Nodes 400 and 870 connect to Turbine Nozzles.
3. No Cold Springs (Cut Pipes) are used in the piping connecting to the Turbine Nozzles.



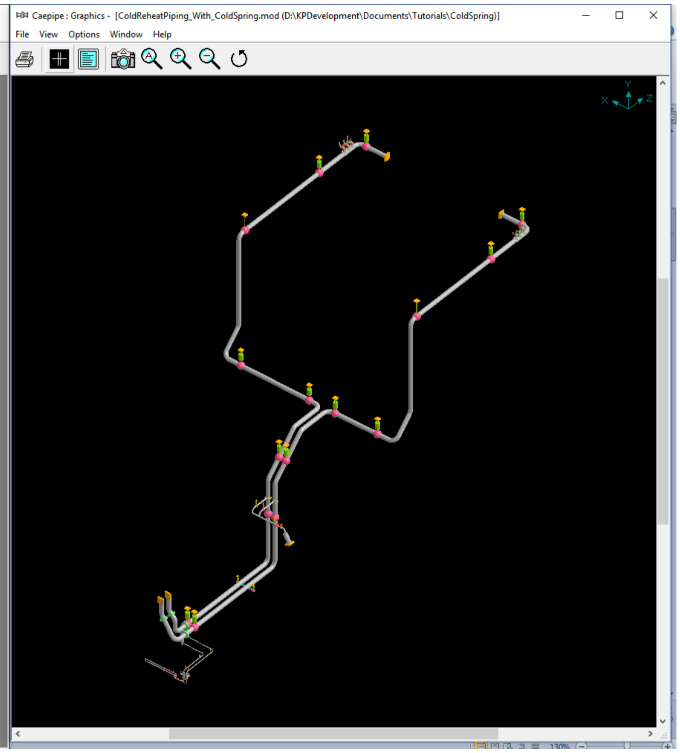
Model 2: ColdReheatPiping_with_ColdSpring.mod

This model is same as Model 1 except that two Cold Springs are added in the piping connecting to the Turbine Nozzles as given below.

1. A Cut Pipe between Nodes 400 & 410 which is cut short by 6.65 inch
2. A Cut Pipe between Nodes 860 & 870 which is cut short by 6.639 inch.

Caepipe : Layout (400) - [ColdReheatPiping_With_ColdSpring.mod (D:\KPDevelopment\Documents\Tutorials\C...

#	Node	Type	DX (ft'in")	DY (ft'in")	DZ (ft'in")	Matl	Sect	Load	Data
1	Title = Cold Reheat Piping								
2									
3	X = North, Y = Up, Z = East								
4	Origin is:								
5	X = 0.000 at Column 9								
6	Y = 0.000 at plant elevation 0' 0"								
7	Z = 0.000 at Column A								
8									
9	ANALYSIS: THERMAL								
10	Operating conditions; 675 F, 540 psig								
11									
12	NORTH								
13	10	From	30'0"	231'8"	212'6"				Anchor
14	10	Location							User SIF
15	Hanger Fig 81-H, Size 57; HL = 8651 lb								
16	20		10'10"	-0.0520		C	24	R	User hanger
17	20	Location							Conc mass
18	30	Bend	4.1719	-0.0169		C	24	R	
19	Downstream end of PSV header								
20	40			-0.0114	-3.0200	C	24	R	
21	Branch to PSV								
22	50			-0.0061	-1.2613	C	HDR	R	
23	Branch to PSV								
24	60			-0.0120	-2.5000	C	HDR	R	
25	Branch to PSV								
26	70			-0.0120	-2.5000	C	HDR	R	
27	Upstream end of PSV header								
28	80			-0.0061	-1.2813	C	HDR	R	
29	Hanger Fig 98, Size 16; k = 750 lb/in, HL = 8252 lb								
30	90			-0.0713	-14.8541	C	24	R	User hanger
31	90	Location							Conc mass
32	100			-0.1152	-24'0"	C	24	R	
33	Rod Hanger								
34	110			-0.1156	-24'1"	C	24	R	Rod hanger
35	110	Location							Conc mass
36	120	Bend		-0.0189	-3.9323	C	24	R	
37	130			-44'0-3/4"		C	24	R	
38	140	Bend		-2.9740		C	24	R	
39	150	Bend		-9.9531	-9.9531	C	24	R	
40	Hanger Fig 98, Size 16; k = 750 lb/in, HL = 6613 lb								



Caepipe : Cut pipes (2) - [ColdReheat...

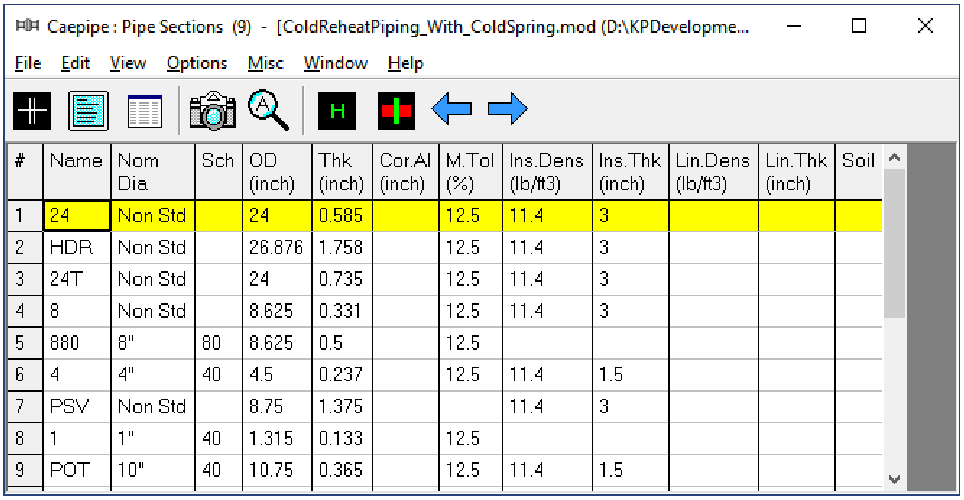
#	From	To	Cut (inch)	Type
1	410	400	6.65	Short
2	870	860	6.639	Short

Step 2:

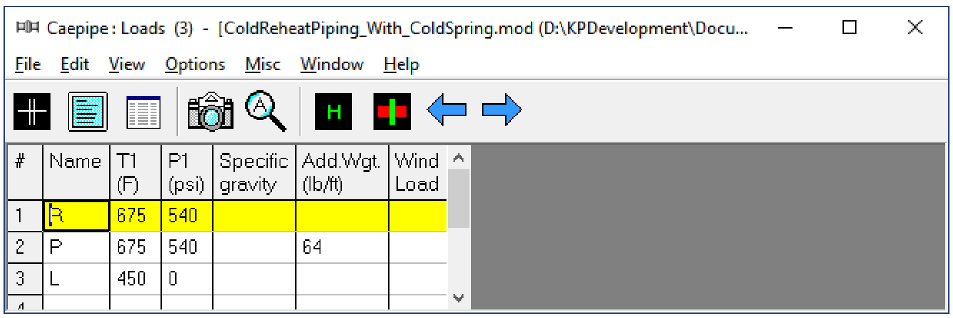
Material, Section and Load properties of the two models are identical. They are given below for reference.

Caepipe : Materials (3) - [ColdReheatPiping_With_ColdSpring.mod (D:\KPDevelopment\D...

#	Name	Description	Type	Density (lb/in3)	Nu	Joint factor	#	Temp (F)	E (psi)	Alpha (in/in/F)	Allowable (psi)
1	B	A106 Grade B	CS	0.283	0.3	1.00	1	70	29.5E+6	6.40E-6	17140
2	C	A106 Grade C	CS	0.283	0.3	1.00	2	700	25.5E+6	7.60E-6	16730
3	O	A106 Grade B	CS	0.0	0.3	1.00	3	720	25.2E+6	7.64E-6	16490
4							4				



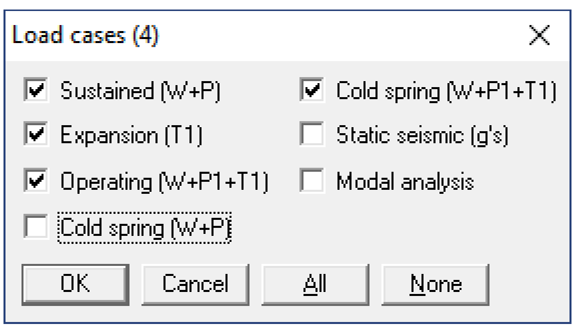
#	Name	Nom Dia	Sch	OD (inch)	Thk (inch)	Cor.Al (inch)	M.Tol (%)	Ins.Dens (lb/ft3)	Ins.Thk (inch)	Lin.Dens (lb/ft3)	Lin.Thk (inch)	Soil
1	24	Non Std		24	0.585		12.5	11.4	3			
2	HDR	Non Std		26.876	1.758		12.5	11.4	3			
3	24T	Non Std		24	0.735		12.5	11.4	3			
4	8	Non Std		8.625	0.331		12.5	11.4	3			
5	880	8"	80	8.625	0.5		12.5					
6	4	4"	40	4.5	0.237		12.5	11.4	1.5			
7	PSV	Non Std		8.75	1.375			11.4	3			
8	1	1"	40	1.315	0.133		12.5					
9	POT	10"	40	10.75	0.365		12.5	11.4	1.5			



#	Name	T1 (F)	P1 (psi)	Specific gravity	Add.Wgt. (lb/ft)	Wind Load
1	R	675	540			
2	P	675	540		64	
3	L	450	0			

Step 3:

When the Cold Spring (Cut Pipe) is defined in the stress model, Cold Spring load cases will appear automatically in the Loads menu (under Load cases).



For analysis, select the desired Cold Spring load cases from those shown. Please note, the Hanger selection procedure does not consider the cold spring since the selection is based on the first Operating (W+P1+T1) load case. However, if Cold Spring is used, the hanger loads for the Cold Spring load cases [for example, Cold Spring (W+P1+T1)] will include the effect of the Cold Spring.

Once the required load cases are selected, perform Analyses of both the models using CAEPIPE.

Step 4:

Caepipe : B31.1 (2014) Code compliance (Sorted stres...

File Results View Options Window Help

#	Sustained				Expansion			
	Node	SL (psi)	SH (psi)	SL/SH	Node	SE (psi)	SA (psi)	SE/SA
1	930	8089	16746	0.48	930	34842	34269	1.02
2	470	8340	19107	0.44	1070	21779	35327	0.62
3	10	8279	19107	0.43	1040	19699	37231	0.53
4	780	8084	19107	0.42	1020	17175	37542	0.46
5	1070	7030	16746	0.42	1030B	15467	38467	0.40
6	440	6634	16746	0.40	1030A	14478	38527	0.38
7	110	7298	19107	0.38	470	15061	40544	0.37
8	570	7137	19107	0.37	10	13882	40604	0.34
9	480	7077	19107	0.37	490A	13238	42615	0.31
10	20	7060	19107	0.37	1050	10988	37709	0.29
11	330	7001	19107	0.37	30A	12019	42638	0.28
12	790	6972	19107	0.36	1000	10252	37112	0.28
13	320	6963	19107	0.36	490B	11895	44647	0.27
14	120A	6822	19107	0.36	900	9438	37212	0.25

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File Results View Options Window Help

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Caepipe : B31.1 (2014) Code Compliance - [ColdReh...

File Results View Options Window Help

#	Node	Press. Allow. (psi)	Sustained			Expansion		
			SL (psi)	SH (psi)	SL/SH	SE (psi)	SA (psi)	SE/SA
1	10 20	540 815	8279 7059	19107 19107	0.43 0.37	13882 6327	40604 41824	0.34 0.15
2	20 30A	540 815	7060 6689	19107 19107	0.37 0.35	6327 6263	41823 42195	0.15 0.15
3	30A 30B	540 1024	6245 4377	19107 19107	0.33 0.23	12019 10670	42638 44506	0.28 0.24
4	30B 40	540 815	5395 5397	19107 19107	0.28 0.28	5576 5572	43488 43486	0.13 0.13
5	40 50	540 2187	1747 1837	19107 19107	0.09 0.10	1675 1600	47137 47047	0.04 0.03
6	50 60	540 2187	1842 2002	19107 19107	0.10 0.10	1600 1452	47041 46882	0.03 0.03
7	60 70	540 2187	2003 2083	19107 19107	0.10 0.11	1452 1304	46881 46800	0.03 0.03
8	70 80	540 2187	2084 2084	19107 19107	0.11 0.11	1304 1228	46800 46799	0.03 0.03

Caepipe : B31.1 (2014) Code Compliance - [ColdReh...

File Results View Options Window Help

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8	70 80	540 2187	2084 2084	19107 19107	0.11 0.11	1304 1228	46800 46799	0.03 0.03

From the Sorted Stresses and Cold Compliance results (shown above) obtained from the two models, it is noted that the stresses for Sustained and Expansion Load cases are identical between the two models.

This confirms the statement that the piping codes do not allow credit for any reduction in stresses due to cold spring since the displacement range is unaffected.

Step 5:

Caepipe : Support load summary for anchor at node 410 - [ColdReheatPiping_With_ColdSpring.res (D:\KPD...

File Results View Options Window Help

Load combination	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)	Displacements (global)		
							X (inch)	Y (inch)	Z (inch)
Sustained	-18	-1920	410	-7583	-2825	-5109	0.000	0.000	0.000
Cold spring1	5	67	574	-15240	7197	-18454	-0.220	-0.380	0.130
Maximum	5	67	574	-7583	7197	-5109	0.000	0.000	0.130
Minimum	-18	-1920	410	-15240	-2825	-18454	-0.220	-0.380	0.000
Allowables	0	0	0	0	0	0	0.000	0.000	0.000

Caepipe : Support load summary for anchor at node 410 - [ColdReheatPiping_Without_ColdSpring.mod.re...

File Results View Options Window Help

Load combination	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)	Displacements (global)		
							X (inch)	Y (inch)	Z (inch)
Sustained	-18	-1920	410	-7583	-2825	-5109	0.000	0.000	0.000
Operating1	66	-846	-2443	33635	-7518	-20243	-0.220	-0.380	0.130
Maximum	66	-846	410	33635	-2825	-5109	0.000	0.000	0.130
Minimum	-18	-1920	-2443	-7583	-7518	-20243	-0.220	-0.380	0.000
Allowables	0	0	0	0	0	0	0.000	0.000	0.000

Caepipe : Support load summary for anchor at node 870 - [ColdReheatPiping_With_ColdSpring.res (D:\KPD...

File Results View Options Window Help

Load combination	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)	Displacements (global)		
							X (inch)	Y (inch)	Z (inch)
Sustained	-35	-2331	51	-8049	701	-10990	0.000	0.000	0.000
Cold spring1	860	-596	1216	-28714	50469	-9047	-0.220	-0.380	-0.130
Maximum	860	-596	1216	-8049	50469	-9047	0.000	0.000	0.000
Minimum	-35	-2331	51	-28714	701	-10990	-0.220	-0.380	-0.130
Allowables	0	0	0	0	0	0	0.000	0.000	0.000

Caepipe : Support load summary for anchor at node 870 - [ColdReheatPiping_Without_ColdSpring.mod.re...

File Results View Options Window Help

Load combination	FX (lb)	FY (lb)	FZ (lb)	MX (ft-lb)	MY (ft-lb)	MZ (ft-lb)	Displacements (global)		
							X (inch)	Y (inch)	Z (inch)
Sustained	-35	-2331	51	-8049	701	-10990	0.000	0.000	0.000
Operating1	921	-1319	-3562	47726	14864	2397	-0.220	-0.380	-0.130
Maximum	921	-1319	51	47726	14864	2397	0.000	0.000	0.000
Minimum	-35	-2331	-3562	-8049	701	-10990	-0.220	-0.380	-0.130
Allowables	0	0	0	0	0	0	0.000	0.000	0.000

Now from the Support Load Summary results obtained from the two models (shown above), it is to be noted that the Support Loads for Cold Spring 1 [= Operating 1 (W+P1+T1) + Cold Spring] for the model with Cold Springs are considerably low compared to the Support Loads for Operating 1 (W+P1+T1) for the model without Cold Springs.

This effectively confirms that the operating load on equipment connections can be reduced using the Cold Springs.