SUPPORT ROD ANALYSIS OF PIPING HANGERS AND PIPING LOADS

by R.M. POTTER

INTRODUCTION

Many articles have been written on why high energy piping support loads are critical to the operating performance and safety of the piping system.

This paper will describe a method currently in use that will accurately measure the load that a hanger is applying to the pipe and will also measure the actual pipe load at the location of the hanger.

This method is performed while all components remain in place and can be carried out with the unit in the operating condition or in the cold shut-down condition.

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SUPPORT ROD ANALYSIS

Support rod analysis is a comprehensive term describing the process of determining the loading in various types of equipment supports, (IE. Boiler support rods, Suspended equipment, Piping hangers, Etc.)

This paper is directed to the various pipe support hangers found in the power and process industries whether the hangers are rigid, variable or constant load type.

The initial effort was in developing tools and techniques to meet the needs of the utilities in the United States that have moved toward more analysis of high energy piping systems to provide accurate load data to replace assumed data in piping analysis programs.

The technology transfers the active load in the support rod or hanger to a precision load monitoring system without changing the configuration or disturbing existing load distribution.

This allows the analysis to be performed on operating systems under actual hot conditions, as well as in the cold maintenance condition.

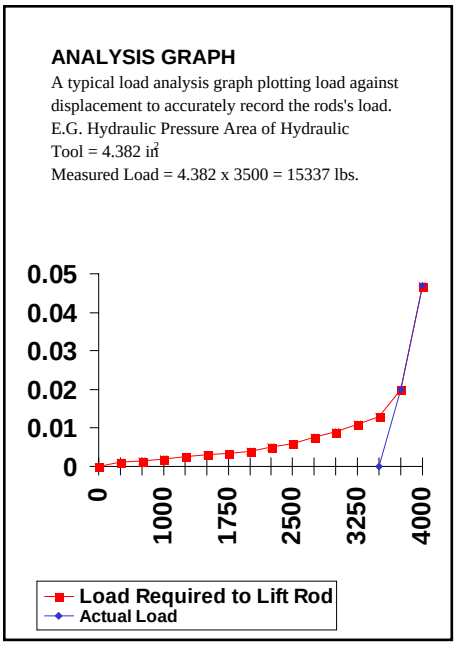

FIGURE 1 - LOAD ANALYSIS GRAPH

THERE ARE THREE LOADS TO BE CONSIDERED

1) **Hanger spring load:**
   The load being applied to the pipe by the spring mechanism while in its travel range.

2) **Pipe load:**
   The weight of the pipe at the hanger support point.

   To determine the pipe load while the spring mechanism is in the operating range, the mechanism must be locked-out by mechanical means while also maintaining its location.

3) **Bottomed-Out loads:**
   When a hanger has reached its full travel range (in this condition, the hanger has become a rigid support) it will induce stress as the piping system tries to continue moving downwards.

   The Bottomed-Out load can at worst exceed the design strength of the hanger or supporting structures.

EQUIPMENT

The system consists of specialized clamps and adapters designed by Richard Potter to work with hydraulic load cylinders.

The clamps and adapters form a beam onto which two hydraulic cylinders are then attached. Two cylinders are required to maintain balance and eliminate any outside moments.

The tooling design provides economic as well as engineering benefits in that the piping components remain in place. A sufficient number of hangers can be weighed per shift to offset the labor and mobilization costs and, most important, provide accurate and useful data on pipe support mechanism performance.

WEIGHING THE LOAD

The specialized tooling is attached to the support rod below the hanger support point and to the pipe clamp. The attachment point at the pipe clamp is the pin or bolt securing the support rod to the clamp.

The hydraulic cylinders are connected to a pump and calibrated gauge.

As pressure is applied, the load transfers into the clamping device and is monitored by gauge pressure. When the gauge pressure stabilizes, the transfer is complete and pressure is converted to load in pounds.

HANGER SPRING LOADS

On spring mechanisms, the load must be transferred to the measuring system, keeping the spring active within the system.

PIPE LOADS

Weighing the pipe load uses the same tooling and normally the same tooling set-up, as presented for spring mechanisms. The important difference being the need to lock out the active spring mechanism.

Hanger	Hanger Plate Load Stamp	Hanger Load Adj. % Setting	Actual Pipeload	Actual SPG. Load	Delta Percent		Elevation	
					+	-	MM	Inches
C19	5386	-15	474	4636		2	-9.4	-0.37
C20	11878	16	133358	13468		6.4	0.25	-1.10
C21	6406	4	5630	6624	15	-57.6	-2.26	-1.50
C22	7723	15	7728	7507		3	-28.0	-17.0
C23	5224	0	5961	5851		2	-38.0	-0.62
C24	8078	4	8390	8280		1	-43.7	2.87
C25	7466	8	7507	7397		1.5	-15.9	
C26	6633	10	*3864	6513			73.1	
C27	9808	12	10377	10543	1.5			
C28E	5986	4	6293	6070				
C28W	5986	7	6514	6348				
C28			12812	12420		3		
C29E	3986	16	4526	4250				
C26W	3986	14	4250	4140				
C29			8776	8390		4.3	-93.0	-3.60
C30E	N/A	N/A	9108	N/A				
C30W	N/A	N/A	8280	N/A				
C30			17388				-110.0	-4.3
**Totals			85286	85116	16.5	16.8		
NOTE: * HANGER IS PARTIALLY TOPPED OUT ** DOES NOT INCLUDE RIGID OR C26								

Hanger	Hanger Plate Load Stamp	Hanger Load Adj. % Setting	Actual Pipeload	Actual SPG. Load	Delta Percent		Elevation	
					+	-	MM	Inches
D1	6575	10	7346	7452	<1		56.4	2.20
D2	10931	9	12806	12364		3.3	-37.6	-1.48
D3	6670	0	6734	6624		-1.5	27.6	-1.08
D4	6426	0	**6624				-1.6	-0.06
D5	4465	0	**6072				-29.6	-1.18
D6	7017	2	7176	7286	1.5		-81.0	-3.18
D7	7490	4	7452	7507	<1		-58.6	-2.30
D8	7625	10	8170	8170	0	0	-5.1	-0.20
D9	6623	12	7065	7065	0	0	-15.1	-0.59
D10	9748	14	100046	10488	4			
D11E	5975	14	6513	6513				
D11W	5975	14	6513	6624				
D11			13026	13137	<1			
D12E	3972	14	4140	4305				
D12W	3972	14	4361	4471				
D12	7944		8501	8776	3		60.0	2.30
D13S	N/A	N/A	***8170	N/A				
D13W	N/A	N/A	***9384	N/A				
D13			17554			-41.0	-1.60	
**Totals			88372	88869	10.5	5		
NOTE: * DOES NOT INCLUDE RIGID (D13) OR D4 & D5 ** HANGER BOTTOMED OUT, LOAD = PIPE FORCE *** RIGID SUPPORT								

FIGUE 2
TYPICAL REPORT OF LOADS

The pipe load can be heavier or lighter that the supporting hanger, due to the pipe not being a free body but a beam.

For those hangers having built-in provisions, it is a somewhat simple process. Older hangers and other types that do not provide for locking (other than the pin provided for hydrostatic testing) must either be locked by some type of external clamp or by wielding a stop between the lever arm frame.

RIGID HANGER LOADS

It is important to note that rigid supports are found, at times, carrying loads exceeding the design strength of the components. On dual rod supports, rarely is the load evenly distributed between the two support rods.

HANGER LOAD ADJUSTMENTS

With the same tooling and measurement techniques it is now possible to adjust the applied load of the hanger(s) in the operating condition. I would like to caution that a sufficient piping load analysis be performed by qualified personnel prior to any random load adjustments.

CONCLUSIONS

The tolling procedures described provide the following benefits for piping industries.
1. To improve operating performance of the various components and support mechanisms.
2. To assist in problem solving.
3. To provide a margin of safety in knowing the piping system is operating as designed.
4. To eliminate the high labor costs associated with removing components for testing.