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DESIGN AND ANALYSIS OF GAS PIPE LINE IN LASER CUTTING

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ABSTRACT

Piping network design system has significant role in industrial sector to minimizing losses through designing effective and simplest network. Piping system is time consuming, complex and expensive effort process for construction and chemical plants. This project is to explore overview of piping network system design of laser cutting gas supply line, its requirements. ASME B31.3 design grade has elaborated with application. Concept of flexibility such as flexibility factor, stress intensification factor has discussed in detailed manner. Use of different piping analysis load cases overviewed for their effectiveness in this study.

Keywords- Piping, CAESAR II, Stress Analysis, ASME B31.3

INTRODUCTION

Lasers are used in many materials-processing applications: laser cutting, laser welding and surface treatment of metallic and non-metallic materials. Gas lasers and solid state-lasers are commonly used for these applications. Carbondioxide (CO2) gas lasers are the most frequently used for laser cutting of metals. In contrast, a variety of different laser types (including solid-state lasers) are being used for laser welding and surface treatment of metals. For laser welding, solid-state lasers are increasingly being used. Gas lasers such as CO2 or excimer require a gas mixture to generate a laser beam. Gas mixtures may vary depending on the type of laser. The purity of these mixes is critical to ensure best performance, efficiency and a higher return on investment. High-purity laser gases are supplied in gas cylinders, however there is no guarantee that the laser gas mixture in the resonator is of the same quality. Gas distribution systems and operators must be able to handle high-purity laser gases correctly in order to maintain the highest pure this document outlines the role of gases.

DESIGN PROCEDURE

The Methodology of design procedure is to find a piping configuration and size within the constraints, the design parameters which are safe and economical. The steps in pipeline design are as follows:

I. The determination of the problem, which includes:

- The characteristics of the fluid to be carried, including the flow rate and the allowable head loss;
- The location of the pipelines: its source and destination, and the terrain over which it will pass.
- Design code to be followed
- Material to be use

II. The determination of a preliminary pipe route, i.e. the shortest distance considering the constrains, the line length and static head difference

III. Pipe diameter based on allowable head loss and pressure design.

IV. Structural analysis :Pipe wall thickness Stress analysis

V. The stress analysis is performed in pipe configuration until compliance with the code is achieved

VI. Support and anchor design based on reaction found in the structural analysis.

(i) PIPING LAYOUT

The geometry of pipes, hollow tubes, cylinders, or whatever you prefer to call them is the subject of many varying interpretations. The aim of this section is to provide a general guide to the dimensions which are commonly referred to by those working with pipelines.

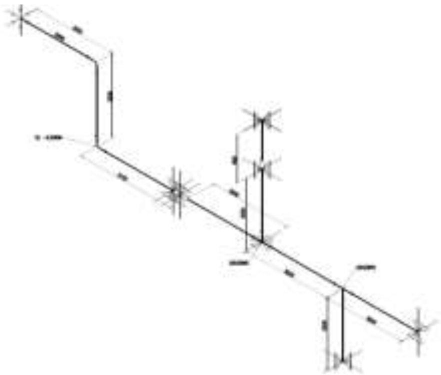
Given that there are numerous aspects of a pipe that might require measurement, there are many techniques and tools to carry out the measuring process itself. Some methods are basic and give rudimentary results, others are vastly more complex but can provide precise data about any given pipe dimension.

Pipe Material – Thin Sheet

Pipe Nominal Diameter – 2 to 3 mm

Operating Pressure – 20 bar

Operating Temperature – 90 to 130



(ii) PIPING STANDARDS AND PIPE CODE

This chapter discusses the associations involved in generating piping codes and material specifications. It provides description of various ASME pressure piping codes such as B31.1 Power Piping, B31.3 Process Piping, B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons, B31.5 Refrigeration Piping and Heat Transfer Components, B31.8 Gas Transmission and Distribution Piping Systems, B31.9 Building Services Piping and B31.11 Slurry Transportation Piping Systems. It also provides information on the associations involved in material specifications such as API - American Petroleum Institute Standards, ASTM – American Society of Testing Materials, ASME Piping Components Standards, American Welding Society (AWS), American Water Works Association (AWWA) and EN – E. The basic rules for piping engineering are ASME B31 codes. The important codes are:

ASME B31.1 - Power Piping

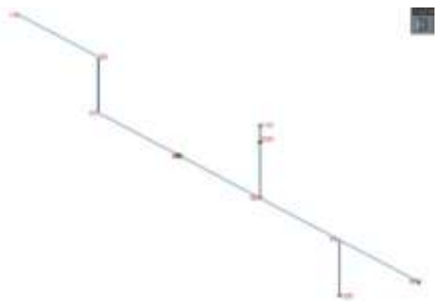
ASME B31.2 - Fuel Gas Piping

ASME B31.3 - Process Piping

ASME B31.4 - Liquid Piping

ASME B31.5 - Refrigeration Piping

Transportation European Standards.



(iii) METHODOLOGY

The methodology of the project is when you think about it, assist gas isn't the best name Assist gas sounds straightforward enough: It aids cutting via an exothermic reaction (with oxygen) and evacuates molten material. It's so straightforward that, according to sources, many new operators don't think to adjust it when they get a bad cut. They might simply slow the feed rate, which solves the problem, but it does increase cycle time and can negate the reason your shop invested in a laser in the first place: to cut a lot of parts extraordinarily quickly. The problem could have to do with assist gas pressure, which an operator can change easily at the controller; or flow rate, which depends on the nozzle orifice diameter. Or it could be that the focal point needs adjustment. Or the beam may not be centered in the nozzle. Or it could be a combination of everything.

- Pre-Processing
- Post Processing
- Solution

DISPLACEMENT ANALYSIS

Several cutting experiment were performed on stainless steel samples of various process and the pressure distributions were selected detail in order to analyze the Understanding and Future Opportunities, Composite Metal Pipes.

Node	DX mm.	DY mm.	DZ mm.	RX deg.	RY deg.	RZ deg.
10	-0.000	-0.000	-0.000	-0.0000	0.0000	-0.0000
18	0.603	-21.624	-0.000	-0.0000	0.0000	-0.3821
19	0.507	-21.884	-0.000	-0.0000	0.0000	-0.3462
20	0.280	-21.990	-0.000	-0.0000	-0.0000	-0.3096
28	-1.515	-22.376	-0.000	-0.0000	-0.0000	0.2199
29	-1.335	-22.308	-0.000	-0.0000	-0.0000	0.2847
30	-1.238	-22.087	-0.000	-0.0000	-0.0000	0.3488
40	-0.635	0.000	-0.000	-0.0000	-0.0000	0.0009
50	-0.615	-0.000	0.000	-0.0000	-0.0000	-0.0025
60	-0.000	-59.303	0.000	-0.0000	0.0000	-0.7412
70	0.614	-79.321	-0.000	-0.0000	0.0000	0.3987
80	1.228	-0.000	-0.000	-0.0000	-0.0000	2.1480
90	0.000	-58.894	-0.000	0.0000	0.0000	0.1651
100	-0.243	-58.874	0.000	0.0000	0.0000	0.1072
110	-0.000	-58.771	0.000	-0.0000	0.0000	-0.0942
120	0.000	-79.731	0.000	0.0000	0.0000	-0.2255

(iv) STRESS ANALYSIS

Hot lines must be routed properly. Provisions shall be taken so that when the temperature rises from ambient to an operating temperature, the thermal expansion of pipelines does not generate stresses too high for the pipes to withstand.

Node	***SLP KPa***	***F/A KPa***	***Bending KPa***	***Torsion KPa***	***SIF/Index In-Plane***	***SIF/Index Out-Plane***	***SIF/Index Torsion***	***SIF/Index Axial***	***Code KPa***
10	***4150.4***	***-18.8***	***46861.2***	***0.0***	***1.000***	***1.000***	***1.000***	***1.000***	***50992.8***
18	***4150.4***	***-18.8***	***16294.8***	***-0.0***	***1.000***	***1.000***	***1.000***	***1.000***	***20426.5***
18	***4150.4***	***-18.8***	***20595.0***	***0.0***	***1.264***	***1.053***	***1.000***	***1.000***	***24726.6***
19	***4150.4***	***33.6***	***21047.0***	***-0.0***	***1.264***	***1.053***	***1.000***	***1.000***	***25231.0***
19	***4150.4***	***33.6***	***21047.0***	***0.0***	***1.264***	***1.053***	***1.000***	***1.000***	***25231.0***
20	***4150.4***	***62.8***	***21319.4***	***-0.0***	***1.264***	***1.053***	***1.000***	***1.000***	***25532.6***
	4150.4	***-83.0***	***21002.***	***-0.0***	***1.000***	***1.000***	***1.000***	***1.000***	***25070.1***

Node	*SLP KPa*	*F/A KPa*	*Bending KPa*	*Torsion KPa*	*SIF/Index In-Plane*	*SIF/Index Out-Plane*	*SIF/Index Torsion*	*SIF/Index Axial*	*Code KPa*
28			*8*						
28	*4150.4*	*-83.0*	*37601.2*	*0.0*	*1.790*	*1.492*	*1.000*	*1.000*	*41668.6*
29	*4150.4*	*-74.4*	*37461.4*	*-0.0*	*1.790*	*1.492*	*1.000*	*1.000*	*41537.4*
29	*4150.4*	*-74.4*	*37461.4*	*0.0*	*1.790*	*1.492*	*1.000*	*1.000*	*41537.4*
30	*4150.4*	*-18.8*	*36782.2*	*0.0*	*1.790*	*1.492*	*1.000*	*1.000*	*40913.8*
30	*4150.4*	*-18.8*	*20545.3*	*-0.0*	*1.000*	*1.000*	*1.000*	*1.000*	*24676.9*
40	*4150.4*	*-18.8*	*49545.3*	*0.0*	*1.000*	*1.000*	*1.000*	*1.000*	*53676.9*
50	*4150.4*	*-18.8*	*125894.3*	*-0.0*	*1.000*	*1.000*	*1.000*	*1.000*	*130025.9*
60	*4150.4*	*-18.8*	*79116.7*	*0.0*	*1.000*	*1.000*	*1.000*	*1.000*	*83248.3*
60	*4150.4*	*-76.1*	*22057.2*	*-0.0*	*2.300*	*2.300*	*1.000*	*1.000*	*26131.4*
70	*4150.4*	*-76.1*	*47289.0*	*0.0*	*1.000*	*1.000*	*1.000*	*1.000*	*51363.3*
70	*4150.4*	*-0.0*	*149718.3*	*0.0*	*2.300*	*2.300*	*1.000*	*1.000*	*153868.6*
80	*4150.4*	*0.0*	*0.0*	*0.0*	*1.000*	*1.000*	*1.000*	*1.000*	*4150.4*
60	*4150.4*	*-190.3*	*204025.5*	*0.0*	*2.300*	*2.300*	*1.000*	*1.000*	*207985.5*
90	*4150.4*	*-35.7*	*27574.5*	*-0.0*	*1.000*	*1.000*	*1.000*	*1.000*	*31689.1*
90	*4150.4*	*-35.7*	*27574.5*	*0.0*	*1.000*	*1.000*	*1.000*	*1.000*	*31689.1*
100	*2991.9*	*-38.6*	*41468.5*	*0.0*	*1.000*	*1.000*	*1.000*	*1.000*	*44421.8*
	2991.9	*-38.6*	*41468.*	*0.0*	*1.000*	*1.000*	*1.000*	*1.000*	*44421.8*

Node	*SLP KPa*	*F/A KPa*	*Bending KPa*	*Torsion KPa*	*SIF/Index In-Plane*	*SIF/Index Out-Plane*	*SIF/Index Torsion*	*SIF/Index Axial*	*Code KPa*
100			*5*						
110	*2991.9*	*-0.0*	*0.0*	*0.0*	*1.000*	*1.000*	*1.000*	*1.000*	*2991.9*
70	*2991.9*	*154.4*	*73906.6*	*-0.0*	*2.300*	*2.300*	*1.000*	*1.000*	*77052.9*
120	*2991.9*	*-0.0*	*0.0*	*0.0*	*1.000*	*1.000*	*1.000*	*1.000*	*2991.9*

RESULT

There are many factors that must be considered when designing the industrial gas supply system. The supply system must be engineered along with the houseline piping and associated components to ensure that it operates safely, properly, and efficiently to meet the demanding laser requirements. Let Air Products put our experience in laser applications to work for you. We provide total solutions for your laser cutting requirements with equipment, technology and reliable gas supply. We have the expertise that comes from being a leading supplier to the industry around the world.

CONCLUSION

The laser cutting machine is a cutting technology of melting and gasifying surface material through focused energy generated by the use of laser specialties and focused lens. It features good cutting quality, high speed, various cutting material and. The following conclusions are drawn based on the experimental and analytical studies of oxygen-assisted CO2 laser cutting of carbon steel high efficiency.

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