Applications of Thin Wall Pipe In Oil Production

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ABSTRACT

Since its introduction to the oil and gas industry approximately five years ago, the consumption of line pipe in thinner than standard wall thicknesses has grown to the extent that now its utilization in oil and gas lines has become commonplace.

Within the last two years this thin-wall concept has grown to embrace oil well casing and tubing as well.

This paper will attempt to list some of the current applications of thin-wall pipe as well as the sizes and wall thicknesses available.

INTRODUCTION

This is an era of rising costs of both labor and material, low allowables and sharper competition. Most companies have been faced with the realization that to prosper, and in some cases to survive, it is imperative that they reduce, as much as possible, their operating costs, while still maintaining sound engineering practices. Naturally, the most logical place to start this soul-searching is with the original large capital outlays — in the case of the producer the well completion costs, and in the case of the pipe line operator the pipe laying costs.

In a majority of cases the results of these investigations have been most eye-opening, for many companies have discovered that many projects or wells in which so-called standard items were to be used would have been grossly overdesigned or that they could recover the same amount of oil and gas by decreasing the size combinations of casing and tubing or by utilizing some of the available lighter than standard wall items.

The term "thin-wall" when applied to pipe has come to mean a deviation from what has been classified as standard wall thickness. In the case of line pipe "thin-wall" applies generally to Schedule 40 and more particularly to wall thicknesses of .188 in. (3/16 in.) or less, while in casing and tubing this term has come to mean items having wall thicknesses less than those listed in API Bulletin 5C2 and API Standard 5A.

Actually, the term "thin-wall" is a misnomer when specific applications are considered. If one looks at each proposed pipe line project or well and determines what will most economically meet its design and safety requirements, then the item or items chosen become "standard" for the particular application. Any deviation from these items thus become either "thin" or "heavy".

This idea is basically the thin-wall concept, and, misnomer or not, the idea of designing a specific wall thickness for a specific application has gained wide acceptance in the oil and gas industry. And, as each day passes, this design theory is being used in more and more applications.

LINE PIPE

The majority of line pipe used in the oil field and gas gathering service falls in the 1 1/2 thru 8 in. nominal size range. It is in this range of sizes that the utilization of lighter walls has had the most effect.

The user now has a number of wall thicknesses to choose from, the most common of which are .083 in., .095 in., .109 in., .125 in., .156 in., and .188 in. Most sizes and wall thicknesses are available in four grades of steel: Grade B (35,000 psi minimum yield strength), 42,000 psi minimum yield, 46,000 psi minimum yield and 52,000 psi minimum yield strength.

In the final analysis — the pricing analysis — pipe is sold by the ton. Grade B pipe is sold at approximately $200 - $220 per ton; however, 52,000 psi minimum yield pipe has 50 per cent more strength than does Grade B; yet it is only approximately $6 a ton over the cost of Grade B. It is then obvious that great savings can be realized by utilizing a thinner wall in the higher strength material than by adding Grade B material to the wall thickness to achieve the same working pressure. And coupled with this saving on the cost of the pipe itself are the related savings brought about by having less weight to transport to the jobsite.

The majority of line pipe is manufactured to API 5L or API 5LX specifications. Although at present these specifications do not list line pipe manufactured from materials with yield strengths in excess of 35,000 psi in sizes below 6 5/8 in. OD or wall thicknesses less than .188 in., actual work is currently being done by an API task group, so it can be assumed that a forthcoming revision will include at least some of the lighter wall thicknesses in the X grades and most of the generally used sizes smaller than 6-5/8 in. OD.

CORROSION

Years ago it was common design practice to add wall thickness to line pipe for external corrosion allowance. This was a costly procedure, but it was necessary because the coatings available at that time would not guarantee long life from a corrosion standpoint.

However, external coatings and cathodic protection methods have improved to such a degree that this corrosion allowance is no longer necessary. The most economical wall thickness and steel grades can be used, together with these coatings and cathodic protection applications, with confidence that they will give long, corrosion free life.

The same applies for internal corrosion problems. The materials and application techniques for internally coating with cement or plastic have improved to the point where long life can be assured without adding steel to the wall thickness for protection against corrosion.

It is true, naturally, that if pipe is laid bare and a corrosive environment exists internally or externally the lighter walls will fail sooner than will the heavier walls. Soil exposure tests have shown that pit depth in a corrosive medium when plotted against time increases at a rapid rate during the first exposure period. The curve then levels off to a more gradual increase. Therefore, it is conceivable that the lighter walls would fail during this first exposure period prior to the levelling off portion of the curve. However, it is general practice with the majority of the users that, if a corrosive environment is anticipated and the service life of the line is to be of other than relatively short duration, the line will be coated regardless of the wall thicknesses used.

JOINING

Light wall line pipe is normally joined either by welding or some mechanical means. However, except in low pressure applications, joining by means of threads and couplings has not proven satisfactory for the lighter walls in this category because of the relatively high degradation of allowable working pressure required to make allowances for the steel removed from the wall thickness when cutting the threads.

Unlined line pipe is usually welded or, when portability is desired, connected by mechanical couplings. Wall thicknesses of .109 in. and lighter are normally butt welded by the acetylene method or electric arc welded by using a bell and spigot type joint. However, some contractors are quite capable of welding the lighter walls in the conventional way.

Pipe which has been internally coated, with cement or plastic, for corrosion can be joined by mechanical couplings or, in the case of cement lined pipe, welded by using asbestos or specially impregnated back up gaskets to protect the coating, at the joint, from the heat generated by welding.

Recently there have been two mechanical couplings developed specifically for use with internally lined pipe. These couplings incorporate seal rings to which the ends of the pipe are butted. This process isolates the corrosive fluids from contact with any pipe end areas which might have been damaged in handling.

OIL WELL TUBING

Within the last two years there have been developed a number of tubing items which incorporate an integral joint utilizing standard API thread forms rather than the more expensive high pressure type integral joint threads. These joints, coupled with the lighter wall thicknesses of tubing, offer an ideal combination for use in wells which present no extreme depth or pressure problems, and they have contributed substantially to the overall economics of slim hole completion methods, since this method has been applied generally to the medium depth wells.

These tubing items are available in 1 1/4 in. through 3 1/2 in. nominal sizes in standard and light walls and in steel grade of 50,000 psi minimum yield through N-80. The sizes most commonly used in the thinner walls are 1 1/4 in. and 1 1/2 in. with .125 in. wall thickness primarily for slim hole single and multiple completion applications.

Upon investigating the possible use of these thin wall tubing items, many operators discovered that they have been grossly over-designing certain wells. They have realized that they can recover the same amounts of oil and gas and save considerable capital outlay by reducing the size combinations of casing and tubing. Further, they may also reduce wall thickness on many tubing items to serve the same end. For example, a 5,000 ft single completion where normally 500 ft of 8 5/8 in. surface casing, 5,000 ft of 5 1/2 in. production casing and approximately 5,000 ft of 2 3/8 in. tubing would have been set. In this situation, drilling and tubular goods costs are approximately $39,000. On the other hand, by using the same footages of 6 5/8 in. surface casing, 2 7/8 in. production casing and 1 1/2 in. light wall integral joint tubing, the completion cost would be approximately $27,000 and thus yield a savings of $12,000 per well. And for multiple completions the savings can be even more pronounced. Recently a major oil company used this small pipe and light wall concept to complete a sextuple gas well. Three slim hole duals, each consisting of 1 1/2 in. .125 in. wall integral joint tubing set in 2 7/8 in. casing were clustered in one hole and six zones tapped at depths from 5400 ft to 6600 ft. Their cost for this completion was approximately $78,000 per well, but they estimated that to complete in the same sands by using conventional methods would have cost in excess of $300,000. Admittedly, this is an extreme case, but it does much to illustrate the potential savings offered by this technique of well completions when conditions warrant its use.

It is therefore well worth while to analyze each proposed well: depth, anticipated pressures, anticipated production volume, and probability that any trouble might be encountered in the process of drilling or completing the well. It can then be determined what tubing string or strings will be necessary to complete safely and to exploit prudently the producing formations. This determination is the keystone of the whole design process; thereafter, the sizes of production casing and surface casing and ultimately the size of drilling rig necessary to drill and complete the well can be determined. Where it is practicable, it can be seen that a reduction by just one size in all these can reduce the overall cost of the well considerably. If 1 1/2 in. instead of 2 3/8 in. production tubing can be used, if 3 1/2 or 4 1/2 in. instead of 5 1/2 in. production casing can be used, if 6 5/8 in. instead of 8 5/8 or 9 5/8 in. surface casing can be used the hole size can be reduced. This reduction then lowers the bit, mud and cementing costs, and possibly a smaller drilling rig can be utilized. And coupled with these savings are the reduced costs of primary cementing equipment, packers and wellhead equipment, and artificial lifting equipment when its use is necessary.

The tool and equipment manufacturers have been following, with much interest, this trend and have developed tools and equipment which allow the operator to complete the smaller sized wells in virtually the same manner as do their large size counterparts. These tools include complete lines of primary cementing equipment, single and multiple packers, sucker rods, bottom-hole pumps, gas lift valves, and swabs, as well as logging and perforating tools.

LIMITATIONS

Naturally, this small hole and light wall tubing technique has encountered problems which pose limitations. For instance, it cannot be used across the board in all areas or wells. Severe corrosive conditions, high fracturing volumes and/or pressures, large volumes of production, high production pressures and depths seem to be the major limiting factors restricting the use of this type of completion. However, continuously being developed and perfected are new methods and equipment which should allow its usage to be broadened.

CASING

Where maximum economy is desired in shallow wells above 6000 ft, there are available 2 7/8 in. OD and 3 1/2 in. OD casing in walls lighter than standard. The 2 7/8 in OD casing used primarily for tubingless completions, and single slim-hole completions is available in .156 in. wall thickness and .190 in. wall thickness and can be set to depths of approximately 5,000 and 6,000 ft respectively with a safety factor of 1.8 in tension. The 3 1/2 in. OD casing is available in .156 and .109 in. wall thicknesses and will set to depths of approximately 5,700 and 6,200 ft respectively with a safety factor of 1.8 in tension.

CONCLUSIONS

Considerable savings can be realized if the conditions of each pipe line project or well are investigated thoroughly and material selected specifically for the design conditions.

The concept of thin-wall line pipe in oil and gas transmission has come of age and has found a definite and useful place in the oil and gas industry. And, although relatively new, an extension of this concept — thin-wall oil well casing and tubing — has taken great strides in a surprisingly short time and is rapidly becoming a proven and economical measure to combat the ever increasing completion costs of oil and gas wells. And the oil tool and equipment manufacturers by developing tools and equipment to make its usage possible, have aided tremendously in its acceptance.

REFERENCES

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