Applications Of Air Balanced Pumping Units

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For most wells that have to be pumped, the conventional crank-type beam pumping unit meets all specifications and is lower in price and maintenance costs. However, in recent years a new unit has become increasingly popular because it has some advantages over the conventional unit. This is the Air Balanced Beam Pumping Unit, which differs from the conventional unit in that compressed air is used as a means of counter-balancing the load on the polished rod. In other respects the air balanced unit resembles the conventional unit in that it employs a speed reducer, cranks, pitmans, beam and samson post as used for many years on conventional units.

Air balanced units have the following advantages:

1. This unit is 40 percent lighter than comparable conventional unit.

2. This unit is 30 to 40 percent shorter than comparable conventional unit.

3. Counterbalance can be changed more easily than is possible on conventional units.

4. This unit may be furnished with an automatic counterbalance feature.

These units are ideal for test equipment because of their compactness, decreased weight, and ease of changing counterbalance effect. They are also ideal for setting on piling or substructures, or any installation where space is at a premium. Although their first cost is slightly more than conventional units of comparable size, the difference is offset, in many cases, by decreased cost for foundation and for transportation. Air balance units have most of the advantages of the crank-weight type beam units, except there is some maintenance involved in the air counterbalance system as compared to zero maintenance for the crank-weight system used in the conventional unit. The ease of changing counterbalance effect however, should justify the added maintenance in many applications.

Perhaps the most important advantage of the air balanced unit, insofar as the normal pumping well requirement is concerned, is the ease of changing counterbalance and the availability of "automatic counterbalancing." Recent studies of well pumping, consisting of analysis of dynamometer cards, reveal that over 95 percent of the wells checked were not counterbalanced within ten percent. This is not an alarming discovery if the pumping units had been selected, originally, with adequate margin of safety, but the results indicated that, in many cases, being only ten percent out-of-balance resulted in overloading of the gear box. Very few of the units checked were impossible to balance, that is, few required the purchase of more counterbalance weight, but the existing weights were improperly positioned on the cranks. This study indicated a definite need for the production on the cranks. This study indicated a definite need for the production personnel to check the counterbalance of all pumping units, to prevent overloading of the equipment. This unbalanced condition of the unit is, of course, reflected in the consumption of electric power, or fuel, by the prime mover. With the trend toward electric power and the increasing cost of natural gas, the economy of operation of the prime mover is gaining in importance. Consequently, with these factors taken into consideration, the operator must consider "ease of counterbalancing" as a factor in his choice of the type of pumping unit to buy. While the crank-type unit is not difficult to counterbalance, the fact remains that a "cut and try" system must be used, and the process is considerably more work than turning a valve, which is all that is necessary to change counterbalanc on the air balanced unit. This type unit is balanced, while running, by changing the air pressure, or an automatic counterbalancer is obtainable.

The automatic counterbalancer is an electrical device that bleeds off air if the unit becomes "over-balanced" and starts the air compressor to build up pressure if the unit becomes "under-balanced." Due to the cost of the mechanism, it is not recommended for ordinary well conditions, unless purchased electric power is being used and considerable saving can be effected. In most cases, the unit can be balanced manually, and the counterbalancer is not required. The device is available for use with either electric motor or gas engine as the prime mover.

In range of application, the air balanced unit approximates the wide range of the conventional unit, and sizes are selected in exactly the same manner. The air system costs about the same, regardless of unit size, so the air balanced unit is not offered in a size smaller than 80D (API). It is, however, offered in a larger size than the largest conventional unit. Since increasing the effective counterbalance available is just a matter of building a cylinder of larger diameter, a 16 ft. stroke air balance unit has recently been put on the market. This unit has a 912,000 inch-lb. gear box, 42,000 lb. beam, and 31,600 lbs. effective counterbalance. To offer such a unit in the crank-type version presents tremendous problems, particularly on counterbalance, and the resulting structure would weigh at least 90,000 lbs., as against 49,000 lbs. for the 16 ft. stroke air balanced unit.

As more and more wells of 7,000 ft. depth, and deeper, require pumping, there is a trend toward the use of longer strokes. Where the 320 size unit formerly used a 74" stroke, most units of this size are now sold with 84", 100", or 120" stroke. There is a sound reason for using the longer strokes. The deeper wells have more rod and tubing stretch, hence less net plunger travel for a given polished rod travel, so it may be necessary to go to the 100" stroke on a 9,000 ft. well to retain the same plunger travel that would have existed with a 74" stroke on a 5,000 ft. well. Also, it is true that a greater net plunger travel is needed, usually, on deep wells, because the rod string will not handle a large pump, so long plunger travel, plus a small pump, will be required to produce a reasonable volume of fluid.

These are good reasons for using longer strokes on units installed on deep wells, but the operator must remember that the increase in stroke length necessitates larger gear boxes, since the peak torque capacity needed in the gear box is directly proportional to the stroke length. Therefore, it is of the utmost importance to be sure of adequate gear box size when selecting a unit, whether conventional or air balanced, for pumping a deep well. At least 25 percent more capacity should be bought than is indicated by calculation or from weighing the well in question, or similar wells. This is a margin of safety, or "reserve capacity," which will insure long, trouble-free life for the pumping unit. As an example, the 320 size unit, with 74" stroke, operating at 90 percent load has 32,000 inch-lbs. "reserve" peak torque capacity and would be overloaded if allowed to get out-of-balance by 920 lbs. The same gear box, but with 120"' stroke, will be overloaded when allowed to get out-of-balance by only 565 lbs. This example shows how dangerous it is to select a gear "barely large enough" when using long-stroke units, and it points out the great importance of proper counterbalance at all times, when long strokes are employed. Many operators, upon experiencing rod trouble in pumping deep wells, go to longer strokes, slower speeds, and smaller pumps, which usually eliminates the rod trouble. They may be trading rod troube for unit trouble, however, if they do not realize the importance of "reserve capacity" in the gear box. Unfortunately, while the rod trouble makes itself apparent at once, the unit may not actually fail but just undergo undue wear, resulting in a short life. If the operator will recognize the importance of having at least 25 percent more peak torque capacity than is apparently needed, trouble and shortened unit life will be avoided.

The above applies to any type of beam pumping unit. The air balanced unit has two advantages which make it particularly adaptable for use on deep wells (over 7,000 feet):

1. Counterbalance is not dependent on the adding of more weights, hence greater counterbalance effect is available without increased expenditure. Hence, for large units with large amount of counterbalance effect, the air balanced unit may have a lower first cost than a comparable conventional unit.

2. Counterbalance may be changed without effort, or controlled automat-

ically, which is of greatest importance for long-stroke units on deep wells.

The modern air balanced beam-type pumping unit has many applications, particularly in pumping deep wells, and if proper selection is made initially, with adequate lubrication and maintenance given this mechanism, a long, trouble-free life can be expected.