

MACHINERY FOR DEEP WELL PUMPING PLANTS.

THERE is a wide variation in the results obtained in deep well pumping, and a great deal of it may justly be attributed to lack of proper data upon which the design of the plant is made. The selection of machinery naturally depends upon its suitability to produce the required results under the conditions which exist. Obviously there is a great necessity for studying all the factors entering into the problem of construction and operation of plant. We reproduce the following useful data from a paper on the subject read by Mr. D. A. Graham, assistant engineer, Dabney H. Maury Company, Chicago, at a recent meeting of the Illinois Society of Engineers and Surveyors.

Mr. Graham divides deep well pumping machinery into three general types, although there are additional divisions in some of these types. They are: air lift, reciprocating or plunger pumps, including one, two and three plunger machines, and rotary pumps, including turbine and propeller pumps. These types of machinery are all in common use and no detailed description is needed by those engaged in well work.

There are four general bases for comparing the several types of well pumping machinery mentioned above. These are: cost, efficiency, capacity and reliability.

The first cost may be easily ascertained from the machinery manufacturers and from the contractors bidding for the erection. As there are different forms, makes and grades of each class of machinery, it is difficult to give general comparative costs of the several types of pumping installations. The rotary turbine pump is probably the most expensive and the air lift the cheapest of the three. The reciprocating and the propeller pumps vary in cost between these two limits.

Efficiency is a more difficult matter to estimate, as unreliability or ignorance of bidders, uncertain or varying well conditions, improper erection and difficulty of testing combine to produce results different from those expected. In general it may be said that, of the best designs of the three types mentioned above, the plunger pump ranks first in efficiency, with rotary pumps second, and air lift generally a poor third.

If the wells are already drilled, the required quantity of water may determine the type of pumping machinery. With a given size of well, and average conditions, the air lift stands first in regard to amount of water that can be delivered, with the rotary pump second, and the plunger pump third.

From the standpoint of reliability the order of merit is again changed. The air-lift, with all of its moving parts above ground and easily accessible for inspection and repairs, is well in the lead, with reciprocating pump second and the rotary pump third, especially at lifts of 100 ft. or more.

The four general standards of comparison above stated are commonly recognized, and a comparison of each case can readily be made by reducing all these factors to the basis of annual cost, including operating expenses, interest and depreciation. There are a number of other factors, however, which cannot be stated in general terms, and which affect, not only the importance of the general characteristics of each type, but may dictate one type to the exclusion of all others from consideration.

The more important of these factors are: size of well, straightness of well, character of water, both chemical and

physical, pumping level of well and its probable fluctuations, number of units permitted, or the emergency reserve available, skill of the contractor who is to do the erecting, and the character of attendance and care the plant will receive after it is constructed.

For example, a turbine rotary pump cannot be successfully installed in a well smaller than 12 ins. in diameter, and the larger sizes produce the best results. A well so crooked as to cause a bend in rods or shaft of plunger or rotary pumps should never be used for these classes of machinery, except with a full knowledge of the breakdowns and repairs that are bound to result. Air lift is admirably adapted to crooked wells. Water high in sulphuric acid or carrying sand makes the use of either the plunger or turbine pump expensive, requiring heavy slow-corroding drop pipe.

The pumping level of a well at the capacity required is of prime importance in the selection of a pump. The pumping level usually varies widely for different rates of pumping, especially in the deeper sandstone wells. The statement of the water level in a well is meaningless unless the corresponding pumping rate is also given, although the rate of pumping is seldom given when data of this sort are requested from operating engineers. It is of utmost importance to know the pumping level before buying a pump, and a knowledge of the behavior of other wells in the territory is of great importance in estimating the probable changes which may be expected in the future.

The effect of varying water level is different in each class of machinery. In the air-lift the efficiency is largely dependent on securing the proper submergence of the air pipe. This should be about 60 per cent. for the best results. In installing an air-lift an estimate may be made in advance and the pipe readily raised or lowered after the tests are made until the desired point is reached. After the erector leaves, however, there is small chance for the adjustment of the air pipe by the station employees. They seldom have the necessary knowledge and it is rare that convenient means for measuring the pumping level are provided. Practically all well levels change with time and some vary rapidly, one instance of a drop of 70 ft. in one week being known to the writer. If a water level 100 ft. below the surface should drop to 120 ft., the air pipe, which had been 250 ft. below the surface, would have to be lowered 50 ft. If this were not done, the submergence would drop from 60 per cent. to 50 per cent., with a corresponding material loss of efficiency. The air lift, therefore, while easily adjusted within reasonable limits, is materially affected by changes in the water level, and it is probable that few of these plants maintain their best efficiencies very long after they are installed. Many tests of old air lift plants show efficiencies as low as 10 per cent. over all, while the manufacturer's guarantees now run to 30 and 40 per cent. This is due partly to changing water levels and partly to improvements in design.

The plunger pump also is affected materially by the original pumping level and its variations, although its reliability changes more than its efficiency. The rods, pump head and motive power must be designed for given loads. As long as the water level remains above the working barrel all goes well, as the entire machine is usually designed for a head equal to the depth the plungers are placed below the surface plus a constant surface pressure. If, however, the water level drops below or close to the barrel, trouble is sure to begin. The pump will take air, and breakage and loss of efficiency result. If the condition of the well permits, the barrel may be lowered, but the strain on all parts is thereby increased and trouble