Willard Says……

Really neat stuff you should know about hydraulic dredging.

The Discharge Pipeline—How Far Can a Pump Pump?

Sorry to say there is no simple answer. A valid analysis made with the goal of forecasting how far a dredge pump can pump must take into account the following variables:

Design variables:
- Pump efficiency.
- Available horsepower.
- Available pump speed
- Pipeline diameter.
- Static lift.
- Dredge Suitability.

Operating variables:
- Slurry density (Rate of production).
- Feed rate regulation.
- Velocity.
- Solids particle size & distribution.
- Availability of pumpable solids.

All of these factors influence a dredge pump's maximum pipeline "range". Some of them are design variables and others are operating variables. Design variables are those that were made constants by the choices made when specifying the dredge/pipeline/process plant.

Operating variables such as density, feed rate and velocity can be converted to constants by the effective use of instruments and controls.

Uncontrollable factors—availability of pumpable solids and particle size and distribution—are unique to each deposit and may vary widely. Hopefully, the dredge is equipped to deal with these factors and maintain a satisfactory rate of production. If not, a more effective digging device may need to be employed.

Table 1 shows the length of pipeline that can be expected for various sizes of pipe under various operating conditions.

<table>
<tr><th colspan="9">Table 1
Projected Pipeline Length w/ Various Slurry Densities</th></tr>
<tr><th>Pipe Size
Nominal Inches</th><th>HDPE SDR</th><th>Pipe I. D.
Inches</th><th>Density
% By Weight</th><th>Velo-city
FPS</th><th>Total Flow
GPH</th><th>Product -ion
TPH</th><th>Horse-Power</th><th>Pipeline Length
Feet</th></tr>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th><th>H</th><th>I</th></tr>
<tr><td rowspan="4">6</td><td rowspan="4">STL</td><td rowspan="4">6.0</td><td>20</td><td>10</td><td>881</td><td>50</td><td>99</td><td>1550</td></tr>
<tr><td>30</td><td>11</td><td>969</td><td>90</td><td>114</td><td>1075</td></tr>
<tr><td>40</td><td>12</td><td>1057</td><td>140</td><td>129</td><td>750</td></tr>
<tr><td>40</td><td>17</td><td>1497</td><td>200</td><td>161</td><td>375</td></tr>
<tr><td rowspan="4">8P</td><td rowspan="4">13.5</td><td rowspan="4">7.3</td><td>20</td><td>12</td><td>1565</td><td>90</td><td>183</td><td>1325</td></tr>
<tr><td>30</td><td>13</td><td>1695</td><td>155</td><td>208</td><td>950</td></tr>
<tr><td>40</td><td>14</td><td>1825</td><td>240</td><td>237</td><td>675</td></tr>
<tr><td>40</td><td>17</td><td>2217</td><td>300</td><td>256</td><td>450</td></tr>
<tr><td rowspan="4">8</td><td rowspan="4">STL</td><td rowspan="4">8.0</td><td>20</td><td>12</td><td>1879</td><td>110</td><td>220</td><td>1450</td></tr>
<tr><td>30</td><td>13</td><td>2036</td><td>190</td><td>253</td><td>1025</td></tr>
<tr><td>40</td><td>14</td><td>2192</td><td>290</td><td>284</td><td>750</td></tr>
<tr><td>40</td><td>17</td><td>2662</td><td>350</td><td>300</td><td>500</td></tr>
<tr><td rowspan="4">10P</td><td rowspan="4">13.5</td><td rowspan="4">9.2</td><td>20</td><td>12</td><td>2485</td><td>140</td><td>290</td><td>1675</td></tr>
<tr><td>30</td><td>13</td><td>2692</td><td>250</td><td>333</td><td>1175</td></tr>
<tr><td>40</td><td>14</td><td>2899</td><td>390</td><td>377</td><td>825</td></tr>
<tr><td>40</td><td>17</td><td>3521</td><td>475</td><td>406</td><td>575</td></tr>
<tr><td rowspan="4">10</td><td rowspan="4">STL</td><td rowspan="4">10.0</td><td>20</td><td>12</td><td>2936</td><td>165</td><td>342</td><td>1850</td></tr>
<tr><td>30</td><td>13</td><td>3181</td><td>290</td><td>392</td><td>1300</td></tr>
<tr><td>40</td><td>14</td><td>3425</td><td>450</td><td>445</td><td>900</td></tr>
<tr><td>40</td><td>17</td><td>4159</td><td>550</td><td>478</td><td>625</td></tr>
<tr><td rowspan="4">12P</td><td rowspan="4">15.5</td><td rowspan="4">11.1</td><td>20</td><td>12</td><td>3617</td><td>210</td><td>420</td><td>2000</td></tr>
<tr><td>30</td><td>13</td><td>3919</td><td>360</td><td>488</td><td>1425</td></tr>
<tr><td>40</td><td>14</td><td>4220</td><td>560</td><td>547</td><td>1000</td></tr>
<tr><td>40</td><td>17</td><td>5125</td><td>680</td><td>590</td><td>675</td></tr>
<tr><td rowspan="4">12
OR
14P</td><td rowspan="4">STL.
13.5</td><td rowspan="4">12.0</td><td>20</td><td>13</td><td>4580</td><td>260</td><td>537</td><td>1900</td></tr>
<tr><td>30</td><td>14</td><td>4933</td><td>450</td><td>611</td><td>1350</td></tr>
<tr><td>40</td><td>15</td><td>5285</td><td>700</td><td>684</td><td>950</td></tr>
<tr><td>40</td><td>17</td><td>5990</td><td>810</td><td>689</td><td>725</td></tr>
<tr><td rowspan="3">16P</td><td rowspan="3">13.5</td><td rowspan="3">13.6</td><td>20</td><td>14</td><td>6336</td><td>365</td><td>709</td><td>1850</td></tr>
<tr><td>30</td><td>15</td><td>6788</td><td>625</td><td>771</td><td>1350</td></tr>
<tr><td>40</td><td>17</td><td>7693</td><td>1025</td><td>891</td><td>850</td></tr>
<tr><td rowspan="3">16</td><td rowspan="3">STL</td><td rowspan="3">15.0</td><td>20</td><td>14</td><td>7707</td><td>450</td><td>855</td><td>2000</td></tr>
<tr><td>30</td><td>15</td><td>8258</td><td>750</td><td>939</td><td>1500</td></tr>
<tr><td>40</td><td>17</td><td>9359</td><td>1250</td><td>1084</td><td>925</td></tr>
<tr><td rowspan="3">18</td><td rowspan="3">STL</td><td rowspan="3">17.0</td><td>20</td><td>17</td><td>12020</td><td>700</td><td>1191</td><td>1575</td></tr>
<tr><td>30</td><td>19</td><td>13435</td><td>1250</td><td>1379</td><td>1250</td></tr>
<tr><td>40</td><td>21</td><td>14850</td><td>2000</td><td>1613</td><td>675</td></tr>
</table>

Column Key

Column A shows the nominal pipe size. The outside diameter (OD) of smaller size HDPE and steel pipes is larger than the actual OD. Note that 6″ pipe is 6.63″ OD, 8″ is 8.63″ OD, 10″ is 10.75″ OD and 12″ is 12.75″ OD. The actual OD of pipes that are 14″ and larger is the same as the nominal size.

Column B lists "STL" for steel pipe or an SDR number if it is HDPE plastic.

Column C shows the actual inside diameter of the pipe in inches.

Column D indicates the density of the slurry described on each row. Each row listing a density of 30 percent is boldfaced to emphasize that production at this density is a worthy goal. Values shown in these rows closely represent good dredge performance.

Column E indicates the velocity of the slurry in feet per second for each row. The ideal (target) velocity that must be maintained to move slurry through a pipeline is largely dependent on the slurry density and the size and size distribution of the solids particles in the slurry.

Column F shows slurry flow in gallons per minute. It is dependent on the inside diameter of the pipe and the velocity.

Column G is the rate of solids production in 2,000 lb. tons per hour. It is dependent on volume of slurry flow and the density of the slurry. Production is assumed to be uniform and uninterrupted, a condition that is rarely duplicated in actual operation.

Column H shows the horsepower required to maintain flow in the pipeline under the conditions described on each row.

Column I projects the lineal feet of pipeline through which the flow described on each row can be expected to flow when the pump is developing 220 feet of TDH.

Other factors

Static Lift. Assumed to be 40 feet for all calculations. A greater lift will decrease the length of pipe and a lower lift will enable an increase in pipe length.

Total Dynamic Head (TDH). Taken to be 220 feet because most dredge pumps can develop at least that amount of TDH. A portion of the TDH is utilized in the form of vacuum to raise solids from a depth of 40 feet to the pump inlet that is located at the surface of the water.

Particle Size & Distribution. The solids consist of 85 percent well-graded sand and the balance minus one-inch gravel. If the solids are finer the velocity can be slower and the pipeline length can be longer. Coarser solids may require a higher velocity, which will decrease the length of pipeline that can be served.

Pump Efficiency. The efficiency varies between 57 and 72 percent. Pump efficiency increases with velocity and density. Efficiency varies with pump make and model.

Relationships

The first and most important relationship is the one between the rate of production and the requirement that production be continuous. The production rates/pipeline lengths shown in Table 1 are possible only when the rate is continuous without "gaps" or "slugs". Most dredge operators can average the poor rate of twenty-percent solids by weight. A competent operator can achieve a thirty-percent average in a "good" deposit.

Difficulties arise when the average slurry density approaches forty-percent solids by weight. Such high densities require sophisticated controls and instruments such as Twinkle Co's CONVAC suction side stability system. The automation provided by this controller assures a continuous, regulated flow of solids into the dredge system and prevents chokeoff due to cave-ins.

Another important relationship is the effect that velocity has on pipeline length, production and horsepower. Target velocity is that velocity that is just faster than the critical velocity, which is the velocity at which solids commence to fall out of the flow and come to rest on the bottom of the pipe. Strive to determine and maintain flow at the target velocity.

It is assumed that the dredge system is adequate to the task of supplying sufficient solids and flows to obtain the listed rates of production and flow.

Total flow depends upon the pipe inside diameter and the velocity. The flows are listed to provide guidance in selection of process plant components.

ANALYSIS

The values listed in Table 1 were generated using a dredge production spreadsheet that has been refined through years of observing the performance of many dredge systems.

These theoretical projections provide some insight as to how a dredge system can be expected to perform under ideal conditions and to see how a change in one variable can affect dredge performance. *As such, the projected results shown do not constitute a warranty of performance of any kind*.

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