INTERMITTENT FLOW

98. In its early life, a flowing well usually flows *continuously.*

The period of continuous flow depends on:

the amount of energy or pressure stored in the ______________;

the care with which this stored-up ______________ is conserved.

99. Careful operation can conserve reservoir pressure to prolong the period of ______________ flow.

100. As fluid is produced from the reservoir, reservoir pressure (increases/decreases).

101. When the reservoir pressure and the well-bore pressure become nearly equal, flowing wells go through a stage of *intermittent* flow.

Most wells flow intermittently near the (beginning/ end) of their flowing life.

102. During intermittent flow, small changes in pressure in the well-bore and at the sand face, and small changes in the proportions of gas and liquid in the tubing, cause large fluctuations in the ____________ of flow from the well.

103. In intermittent flow, there are regularly alternating periods of gas flow and fluid flow, and sometimes periods of no ____________ at all.

104. In an intermittently flowing well, the regularly recurring peak of oil production is called a *head.*

Sometimes a little liquid flows between one ____________ and the next.

105. When reservoir pressure gets very low, the well may ____________ flowing completely between heads.

Annular Heading

106. Heading usually occurs when the bottom-hole pressure has fallen below the bubble point.

Then the pressure drop at the sand face releases the ____________ that has been dissolved in the reservoir fluid.

107. As fluid enters the well-bore from the reservoir, bubbles of ____________ may separate from the liquid and rise up into the tubing and annulus.

108. Gas that enters the annulus is trapped there.

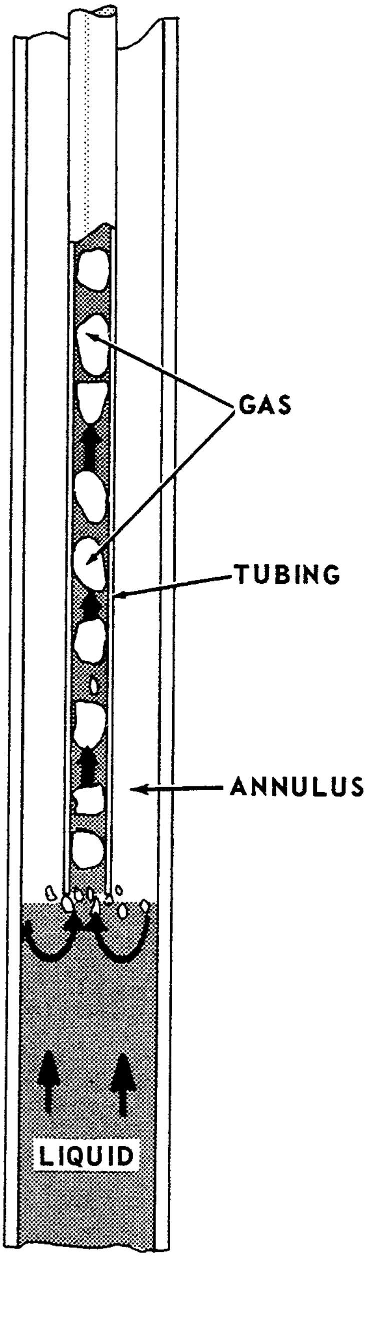
As gas enters the annulus, the pressure of the gas above the liquid in the annulus (increases/decreases).

109. This increased pressure forces the ____________ in the annulus down, and the annulus becomes completely filled with high-pressure ____________.

110. When no more gas can enter the annulus, then all the gas entering the well-bore must flow up the ____________ with the liquid.

111. The more gas there is in the tubing, the (higher/lower) the density of the fluid and the (more/less) hydrostatic pressure it exerts.

112. As tubing pressures get lower and lower, eventually the pressure of the gas in the annulus is higher than the pressure at the bottom of the tubing.



Then the liquid level in the annulus is forced to the bottom of the tubing, and high-pressure ___________ from the annulus blows around into the ___________.

113. As the *blowaround* gas lifts the fluid in the tubing it temporarily (increases/decreases) oil production.

114. When the pressures in the tubing and annulus have equalized, blowaround ____________.

115. Then production (increases/decreases) again.

116. If the small amount of gas still rising in the tubing is not enough to lift the oil to the surface, the well may ____________ flowing for a while.

117. The well may flow weakly or not at all while reservoir fluid gradually fills the well-bore.

As the well-bore begins to fill again, some of the fluid enters the tubing, and some rises up in the ____________.

118. Eventually, separated ____________ fills the annulus again.

119. Blowaround (occurs/cannot occur) again.

120. And again production temporarily (increases/decreases) during blowaround.

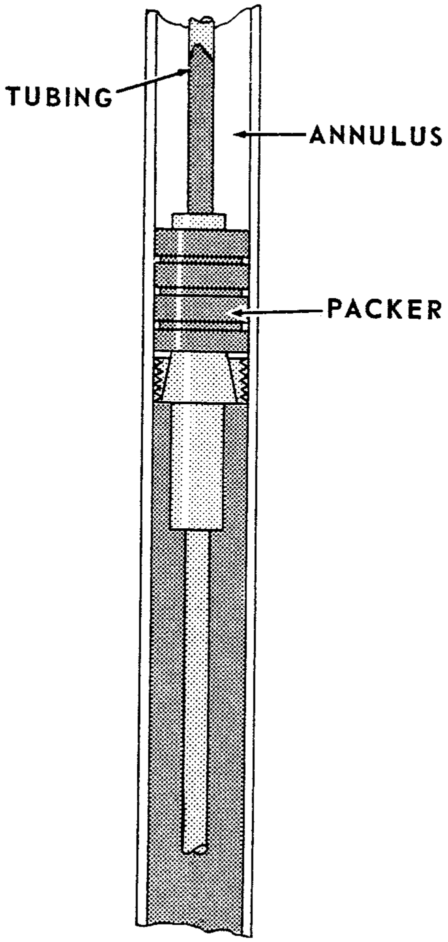
121. A heading well follows a regular pattern.

A heading well may flow rapidly for awhile, then its flow may continue slowly or may ____________ altogether.

122. Then the same pattern is repeated.

Accumulation of high-pressure gas above the fluid in the ____________ is one cause of heading.

123. Annular heading can be prevented by installing a packer.



A packer seals off the ____________ deep in the well, so that fluid cannot enter it.

Tubing Heading

124. Even when gas is not trapped in the annulus, most wells eventually begin to head when reservoir pressures get ____________ enough.

125. As tubing pressures decline, (oil/gas) begins to separate out and rise through the liquid.

126. (Oil/Gas) begins to flow slowly and drag against the tubing wall.

127. When velocity is low, gas bubbles begin to leave the liquid behind.

Pockets of gas get (larger and larger/smaller and smaller).

128. At the well head, a large pocket of ____________ leaves the tubing, followed by a heavy slug of ____________.

129. This flow is a "continuous heading," since a flow of ____________ alternates with a flow of ____________.

130. Eventually, the liquid slugs become too heavy for the gas to lift, and the liquid drops in the tubing.

A column of liquid builds up at the (top/bottom) of the well-bore.

131. More and more ____________ leaves the tubing.

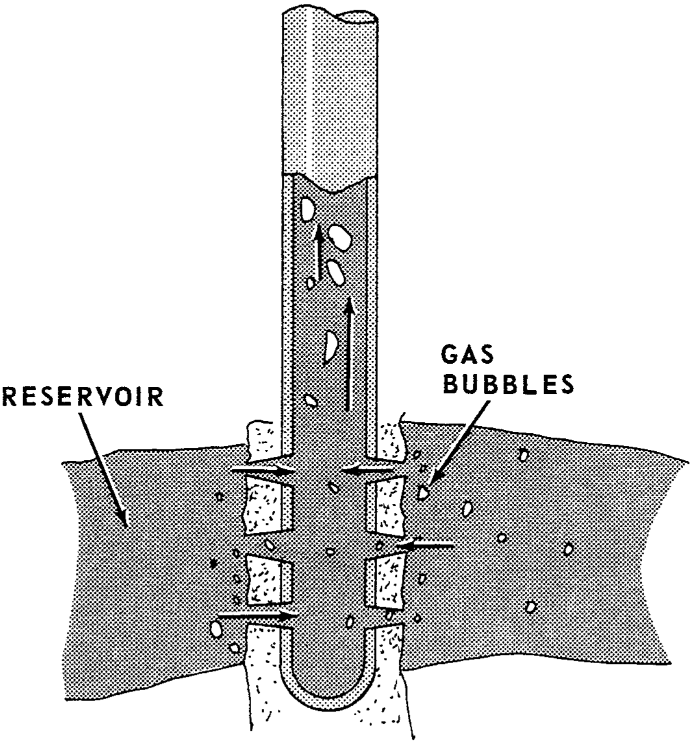
132. The fluid in the well-bore gets heavier and heavier.

Hydrostatic bottom-hole pressures (increase/decrease).

133. Flow into the well-bore (increases/decreases) and may ____________ altogether.

134. After flow into the well-bore stops, reservoir pressure gradually (increases/decreases) near the sand face.

135. Eventually, the pressure at the sand face builds up enough for flow into the well-bore to resume.



The reservoir fluid contains some separated ____________.

136. The pressure drop at the sand face releases still more ____________ as the fluid flows into the well-bore.

137. The gas in the well-bore (increases/decreases) hydrostatic bottom-hole pressures, and this causes fluid to enter the well-bore at a (higher/lower) rate.

138. (More and more/Less and less) gas enters the well-bore, and the well starts to ____________ again.

139. This kind of heading is sometimes called *tubing heading.*

In tubing heading, flow stops when heavy ____________ collect at well bottom.

140. Flow starts again when the reservoir pressure at the sand face builds up enough to release more ____________ into the well-bore.

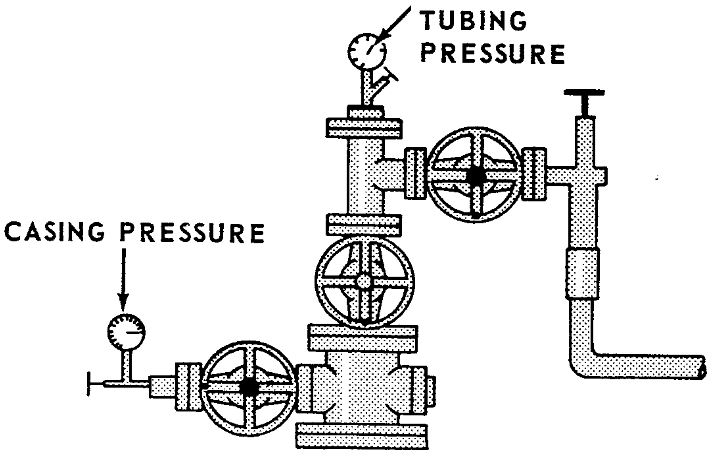
Patterns of Heading

141. Both annular heading and tubing heading follow regular patterns.

In annular heading, the time between heads is the time it takes for pressure to build up in the ____________.

142. In tubing heading, the time between heads is the time it takes for pressure to build up in the reservoir near the ____________ ____________.

143. Surface pressure gages show the pressures at the top of the tubing and annulus.



Before blowaround, casing pressure (increases/decreases).

144. *Tubing pressure* is at its highest during a head.

The peak in tubing pressure occurs when the gas forces the greatest amount of ____________ out of the tubing.

145. No matter where the gas comes from, tubing pressure rises and falls in the same cycle during heading.

In annular heading, tubing pressure is at its lowest (just before/during) blowaround.

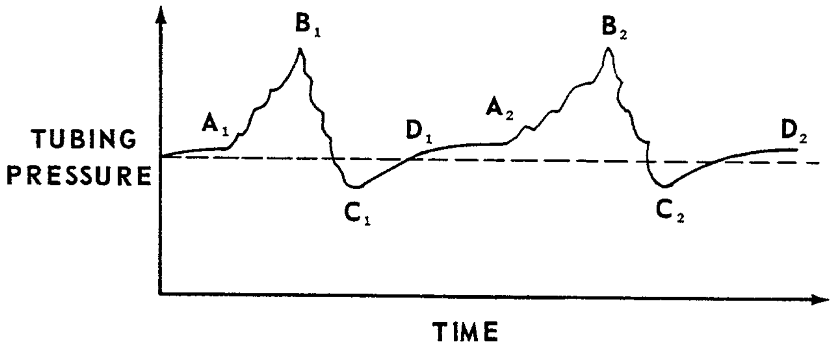
146. In tubing heading, tubing pressure is lowest when flow into the well-bore has ____________.

147. You can tell if a well is heading by reading the (casing/tubing) pressures.

148. In annular heading, the casing pressure (rises and falls/remains the same).

149. In tubing heading, the (casing/tubing) pressure may not change.

150. Here is a chart showing the tubing pressure of a well flowing by heads.



Heading is starting at points A_1 and A_2, where the tubing pressure starts to (increase/decrease).

151. The peak flow during the first head occurs at point ____________, and at point ____________ on the second head.

152. The tubing pressure curve is not smooth, because gas bubbles cause the pressure ____________ to fluctuate.

153. At the two point C's, all the gas and liquid has left the tubing, and tubing pressure has (fallen/risen).

154. From C to D, tubing pressure is rising again.

The ____________ is beginning to fill with fluids.

155. From D_1 to A_2, there is enough gas build-up to start another ____________.

156. In annular heading, casing pressure follows a different pattern of heading than tubing pressure.

Casing pressure is highest (just before/during/just after) blowaround.

157. Tubing pressure is highest ____________ blowaround.

158. In annular heading, as the tubing pressure rises the casing pressure is ____________.

159. Just before blowaround, the tubing pressure falls and the casing pressure is at its ____________.

160. After blowaround, both the casing and the tubing pressure are ____________; the two gages should show about the same ____________.

161. In wells with a packer, only (annular/tubing) heading can occur.

162. In a well with a packer, the casing pressure (rises and falls/remains the same) during heading.

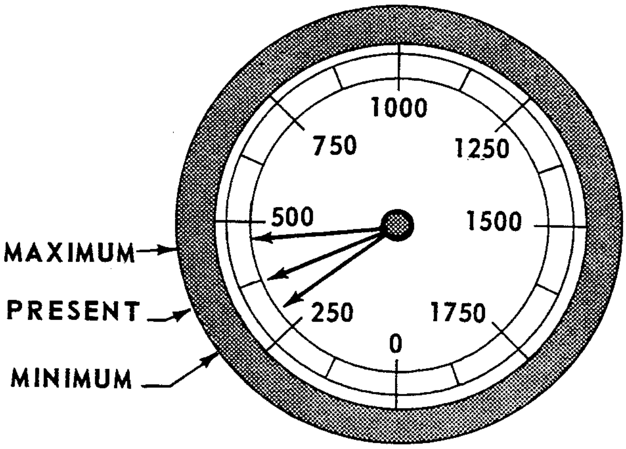
163. All heading affects the pressure on the tubing pressure gage.

The casing pressure gage is affected only by ____________ heading.

164. The pressure gages on a flowing well are usually read only once a day.

If tubing pressure changes from day to day, this may be a sign that the well is starting to produce by ____________.

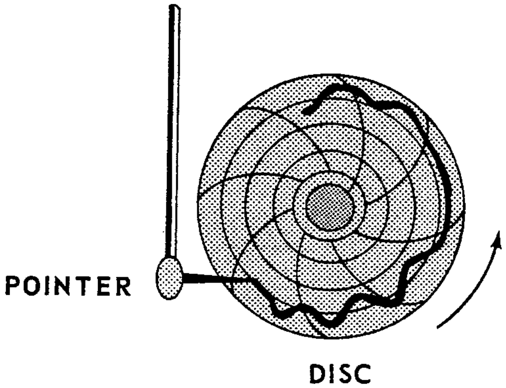
165. Some pressure gages record maximum and minimum pressures since the gage was last set.



If a well is heading, the maximum and minimum readings on the tubing pressure gage are (the same/widely different).

166. If the tubing pressure gage is equipped to record maximum and minimum pressures, the operator can tell at a glance whether or not a well is ____________.

167. This recording chart also shows up heading.



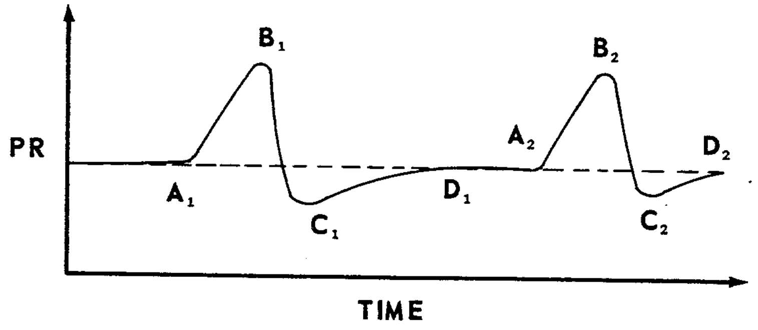
The chart records all ____________ in the tubing.

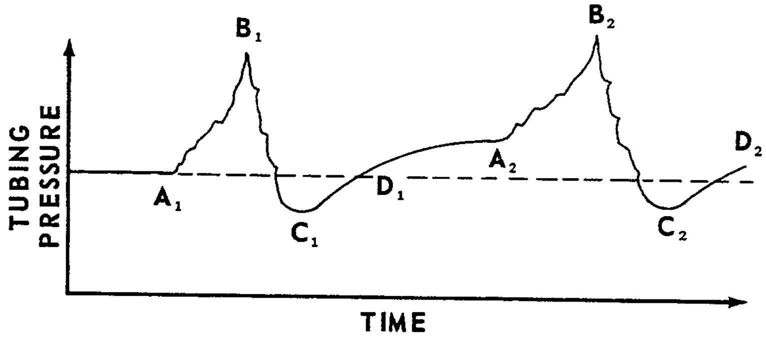
168. A glance at the chart on each visit tells the operator whether or not the well is ____________.

169. Heading may also be detected by changes in the sound the fluid makes as it flows through the valves and fittings at the well head.

The surge of gas and liquid makes a different ____________ than the steady flow of fluid.

170. The production rate (PR) curve of the well follows the tubing pressure curve.





The amount of oil produced hits a peak when tubing head pressure is ____________.

171. Immediately after the surge of oil and gas has left the tubing, tubing pressure (rises/falls), production decreases, and the flow may even stop.

172. When a well starts to head, its daily production falls off.

Often the *first* sign of heading in a well is a decline in daily ____________.

173. Heading may be detected by:

(an increase/a decrease) in daily production,

changes in the readings on the ____________ pressure gage, or

changes in the ____________ the fluid makes as it flows through well-head equipment.

174. Annular heading may also be detected by changes in the ____________ pressure gage.

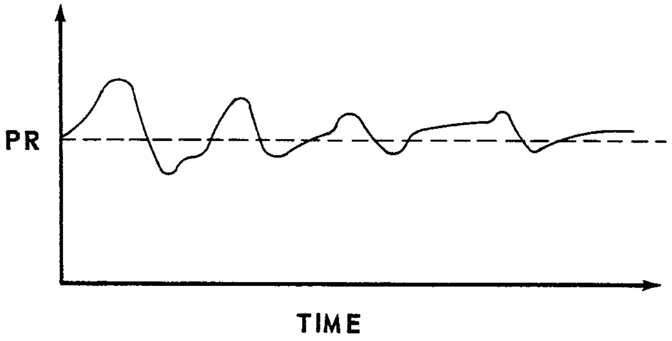
175. A heading well has its own characteristic *period of heading.*

The period of heading is the time from one ____________ to the next.

176. The period of heading may be as short as an hour or as long as a day.

When a well flows by heads, the period of ____________ usually remains about the same for a long period of time.

177. As production continues, the reservoir gradually loses pressure.



Eventually, the time between heads becomes (shorter/ longer).

178. As reservoir pressures decline, it takes ____________ time to build up enough pressure to start a heading.

179. As the time between heads grows longer, the total production of oil gradually (increases/decreases).

180. Eventually, there is no longer sufficient pressure to support either continuous or intermittent flow.

Artificial methods are then used to cause the well to ____________ again.

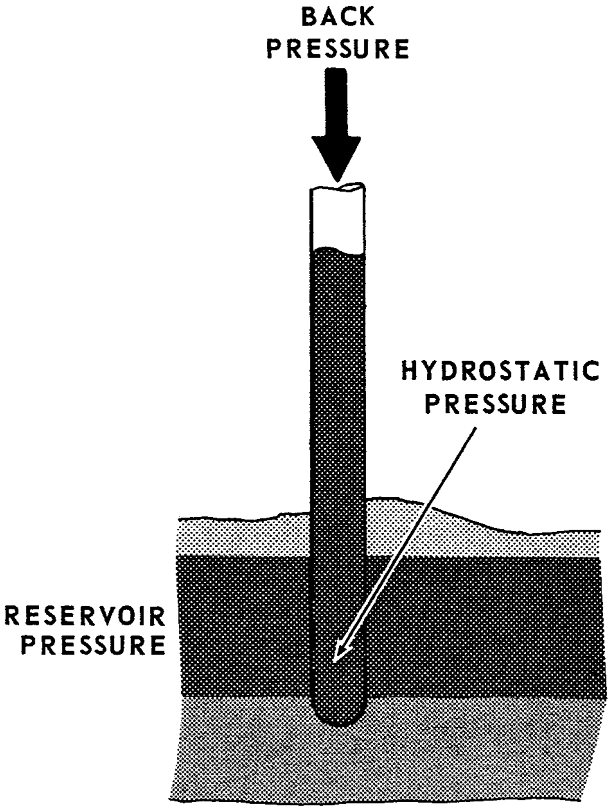
REVIEW AND SUMMARY

181. Flowing wells are produced from the ____________ of the fluids in the reservoir.

182. The pressure caused by the height and density of fluids in the well-bore is called ____________ pressure.

183. The pressure that forms upstream from a choke or other restriction is called __________ pressure.

184. The pressure drop across the sand face controls the rate of flow from the reservoir.



For the well to flow, reservoir pressure must be __________ than back pressure and hydrostatic BHP.

185. When hydrostatic BHP decreases, the flow rate across the sand face (increases/decreases).

186. Choking reduces the flow rate from the well by increasing the __________ pressure at well bottom.

187. Both back pressure and hydrostatic pressure tend to (cause/prevent) the separation of fluids in the well-bore.

188. But a bottom-hole choke can *cause* separation of gas in the tubing (upstream/downstream) from the choke.

189. Gas lifts more fluid when the well is in (slug/annular/mist) flow.

190. Heading is (continuous/intermittent) flow.

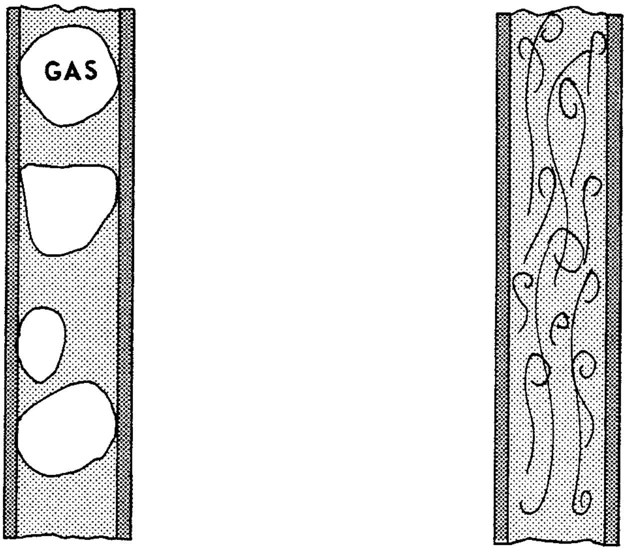
191. Annular heading is caused by blowaround gas from the ____________.

192. Tubing heading is caused by gas carried directly into the ____________ with the flowing liquids.

193. Flow from the well may ____________ completely between heads.

194. Intermittent flow occurs near the (beginning/end) of the flowing life of a well.

195. Here is a drawing of the flow patterns in two different well-bores.



A B

The fluids are *separating* in ____________.

196. Flow is *turbulent* in (A/B).

Flowing BHP is probably higher in (A/B).

197. Which well probably has a rising GOR? ____________.