Operating Principles

Since many of the advantages of the Baker Hughes tubing anchor catcher result from the elimination of breathing and buckling, it is well to review here the meaning of breathing and buckling.

Tubing Breathing

With the tubing hanging free, the bottom end of the tubing string moves up with the upstroke of the pump and down with the downstroke as the fluid column is alternately transferred between the standing valve and the traveling valve. On the downstroke the fluid load is against the standing valve, which temporarily places an additional load on the tubing string and causes it to stretch or "breathe" downward. On the upstroke the load is transferred from the tubing string is relieved of this temporary load, it contracts or "breathes" upward. Breathing of the tubing string often results in casing wear, coupling leakage, and tubing fatigue failures as well as a reduction of effective pump stroke and consequent loss of production.

Tubing Buckling

The phenomenon of tubing buckling (the tendency of tubing to bend because of internal pressure) occurs on the upstroke of the pump in an unanchored tubing string. The fluid load is supported by the sucker rods on the upstroke, and consequently there is insufficient tension in the tubing string to prevent it from being buckled by internal pressure. As the tubing buckles it rubs against the sucker rods which are held straight by the weight of the fluid load, causing excessive wear on both tubing and rods. The buckled tubing also makes contact with the casing ID, resulting in additional wear to both tubing and casing. Pumping efficiency is decreased because power input must be increased to compensate for the friction between the tubing and rods. Excessive pump wear may also occur, since the sucker rods are not properly aligned with the pump.

Calculations And Considerations Necessary Before Running The Tubing Anchor Catcher

In order to utilize the tubing anchor catcher to maximum advantage it is necessary to calculate and apply the correct amount of tension to the tubing string. Other calculations required are the selection of the proper shear-out value and the determination of maximum tensile loads on the tubing string. The recommended procedure for making these calculations is outlined in the paragraphs below. For sample calculations involving various assumed well conditions, refer to Tubing Anchor Calculations for Tension Anchors and Anchor Catchers Unit No. 1952 under Service Tools/Remedial Systems.

1. Determine initial tubing tension (FT)

   Initial tubing tension required to prevent breathing and buckling is determined from the "F" tables in the Tubing Anchor Calculation Unit. Use of the "F" tables is described in the sample calculations.

2. Convert initial tubing tension (FT) to inches of stretch at the surface

   It is good practice to apply initial tubing tension in inches of stretch rather than pounds of tension because of tubing to casing friction and possible inaccuracies in weight measurements. To convert pounds of tension to inches of stretch refer to "Stretch Charts" in the Tubing Anchor Calculation Unit, Unit No. 1952 under Service Tools/Remedial Systems.

   Because of unknown factors in well data it is advisable to apply a slight additional stretch above the calculated stress.

3. Select shear-out value

   Shear pins are installed in the anchor catcher to provide an emergency release in the event the tool will not release in the normal manner. Due to the reliable design of the releasing mechanism, it is a rare occurrence when the anchor catcher will not release in the normal manner. For this reason the tool is usually run with a high shear-out value to provide greater safety

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against accidental or premature shearing. Size 43 through 47 anchor catcher are shipped from the factory and run with ten [10] 5,000 lb shear pins for a total shear-out value of 50,000 lb. As many as twelve [12] 5,000 lb shear pins may be installed for a maximum shear-out of 60,000 lb. Sizes 49 through 53 are normally assembled with twelve [12] shear pins and may use up to sixteen [16]. There may be cases where it is desirable to reduce the shear-out value because of a corrosive condition, low strength tubing, etc. Knowing initial tubing tension (FT), the minimum total shear-out value can be taken from the Shear Pin Selection Table in the Tubing Anchor Calculation Unit. Use of the Table is shown in sample calculations.

4. Determine maximum tensile loads on the tubing string

   To prevent overloading and possible damage to the tubing string the maximum anticipated tensile loads should be determined and compared with the strength of the tubing string.

   a. First assume that the anchor catcher will release in the normal manner so that it is unnecessary to shear the emergency release to pull the tool.

      Minimum and maximum tensile loads under these conditions are discussed below:

   The absolute minimum tensile load on the top of the tubing string would occur when initial tubing tension (FT) is applied. This minimum load would equal the weight of the tubing string plus initial tubing tension (FT). Refer to sample calculations in the Tubing Anchor Calculation Unit.

   The maximum tensile load would occur when the weight of the rod string is also imposed on tubing. With the anchor catcher this could happen only after releasing the tool with the rods and pump in the hole.

   The resulting maximum tensile load would be the weight of the tubing plus the weight of the rods plus the fluid load in the tubing. For sample calculations,refer to the Tubing Anchor Calculation Unit.

   b. Next assume that the anchor catcher will not release in the normal manner so that it is necessary to shear the emergency release in order to pull the tool. The tensile load on the tubing required to shear out will be minimum of the weight of the tubing plus the shear value as considered below.

   If the rods, pump and standing valve are pulled from the well, the tensile pull required to shear out would equal the weight of the tubing plus the shear value of the tool. For sample calculations, refer to the Tubing Anchor Calculation Unit.

   Consider the case where the rods are pulled, but the tubing remains trapped full of fluid. In order to shear the emergency release it would be necessary to pull the weight of the tubing plus the weight of fluid inside the tubing plus the shear value of the anchor catcher. Refer to the tubing Anchor Calculation Unit for sample calculations.

   Consider a more extreme case where the rods and pump cannot be pulled, and the tubing is trapped full of fluid. In order to shear the emergency release it would be necessary to pull the weight of the tubing plus the weight of the rods and pump plus the weight of fluid in the tubing plus the shear value of the anchor catcher. Refer to the Tubing Anchor Calculation Unit for sample calculations.

The appropriate calculations of maximum tensile loads may indicate the tubing string to have inadequate tensile strength. This being the case there are certain alternatives that should be considered.

1. Higher strength tubing may be substituted at the upper portion of the string to provide the necessary strength.
2. Use the tubing of inadequate strength. It must be understood, however, that in the event of an emergency, it may be necessary to fish enough rods and tubing from the well to permit using an overshot and jars to shear out and retrieve the anchor catcher.

Anchoring With Less Than Specified Tension

There may be special cases where it is not possible or advisable to prestrain the tubing by the amount (FT) as determined from the "F" Tables due to poor condition of the tubing or in corrosive areas. In such cases it is recommended that (FT) be reduced by the fluid load on the rods to prevent the tool form transferring from cone to cone with each pump stroke.

The following formula should be used to determine the reduced initial tension (FT) to apply to the tubing for the special case referred to above:

$FT = FT - F_4$*

FT....from "F" Tables in the Tubing Anchor Calculation Unit F_4....from Table F_4*

F_4* Pump Fluid Load Table

Operating Fluid Level (ft)	Pump Plunger Size			
	1-1/4"	**1-1/2"**	**1-3/4"**	**2"**
1,000	615	885	1,200	1,570
2,000	1,230	1,770	2,400	3,140
3,000	1,845	2,655	3,600	4,710
4,000	2,460	3,540	4,800	6,280
5,000	3,075	4,425	6,000	7,850
6,000	3,690	5,310	7,200	9,420
7,000	4,305	6,195	8,400	10,990
8,000	4,920	7,080	9,600	12,560
9,000	5,535	7,965	10,800	14,130
10,000	6,150	8,850	12,000	15,700

Location of Anchor Catcher in Tubing String

It is good operating procedure to run the anchor catcher just below the pump. If for any reason the operator should desire to run it above the pump, the bore through the anchor catcher must be considered in relation to the OD of the pump.

When Running Anchor Catcher at a Distance Above The Pump

When the anchor catcher is run at some distance above the pump, the maximum allowable load below anchor must not exceed the maximums tabulated below. This load is a combination of the weight of the fluid inside the tubing (from the surface to the pump) and the tubing weight below the anchor catcher.

Maximum Allowable Load Below Anchor Catcher When Tool Is Run At A Distance Above Pump

Tool Size	Maximum Load (lb)
43	20,000
45	30,000
47	45,000
47 x 3.00	35,000
49, 51 and 53	60,000

Running Procedures

When Running at 8,000 feet or deeper:

Two [2] drag springs must be used in each slot (on all sizes except 43, 51 and 53) to ensure sufficient drag spring force to actuate tool.

Operating Instructions

NOTE: The drag springs should not be used as a carrying handle for this tool. Due to the leverage afforded by the springs being fastened at only one end, permanent distortion of the spring and possible serious difficulty in running-in can result.

Running-In

To prevent the slips from becoming dulled before reaching setting depth it is advisable to put a right-hand turn into the tubing every 5 or 10 stands while running in.

Setting

At the desired setting depth rotate the tubing to the left with hand tongs until the Slips contact the casing (approximately 5 to 8 turns). Maintain left-hand torque while alternately pulling strain and setting down weight several times to work all play out of the tool. During this slip setting operation the strain pulled should be at least equal to the final strain that will be applied; when the tubing is landed, and full tubing set-down weight should be applied. Release the tongs and continue working the tubing to remove any residual torque. Apply the required amount of tubing tension as determined form the calculations based on the "F" tables, adding tension considered appropriate as a safety margin.