Wellheads and Trees

- Simple to complex
- Seal Points and Control Points
- Basic use and intervention
Dual master valve tree – flow path is through wing valve. Swab valve is removed for a wireline run.

Operations on a tree with a dual master valve use the top valve. If a leak develops, a plug can be set in the profile at the tubing hanger and the lower master closed to give two barriers while the upper master valve is repaired.
Simple, older wellhead on a low pressure gas well allowing flow from tubing or annulus.
Remote actuated valve additions to an older tree.
A high pressure well head on a dry gas well
Casing Hangers

• Transfers part of the load of the casing string (any tubular string) to the wellhead. The actual weight is transferred to the string on which the wellhead flange is mounted.

• Two Types
  – Slip type
  – Mandrel type
Hangers

• Slip Type:
  – Used to suspend the casing in the slip bowl
  – The hanger may also incorporate seals to casing and annulus.

• Mandrel type thread to the casing
Casing Head

• Other names:
  – “A” section
  – Casing head
  – Starting head
  – Lower-most housing
  – Braden head
Welded, hydraulically formed or screwed to casing.

Centralizing and lock down screws.

Flange plate connection to upper spools.

Annular access port.
Casing Head

• The first piece of wellhead equipment installed.
• Most likely affixed to most outside, fully cemented casing string.
• Designed for universal use on all types and depths of wells.
Spools showing annular access ports and lockdown screws.
The wellhead flange attaches to the first cemented surface casing string designed to hold pressure.
Well flange attachment to the casing may be by welding, forming, threaded connection or set screws.
The second string of casing is run and the hanger is landed in the bowl.
Hanger set in the casing spool

Lock down screws engaged

Annular access port
The tubing spool follows.
The tubing is landed in the spool.
Lock down pins are engaged and the seal activated.
One or two full opening master valves come next.
Followed by the flow T or Cross.
The tree before adding control valves.
Completed Wellhead with choke and partly built left side of flow cross.
Wellhead with surface safety valve above the mechanical master valve and below the flow T.
Tubing hanger.

Note the lockdown screw and small seal isolating the tubing from the annulus. Other seals are above the hanger.

Note that the top part of the hanger is threaded to allow pickup of the tubing string.
Seal Assembly in the Wellhead

- Slips
- Ring Gasket
- Seals
Example of the base of a coiled tubing wellhead, showing flange groove.
Ring gasket still on master valve.

Carbide blast joint for annular frac.
Ring and groove types

Sealing rings are single use items. The metal-to-metal seal depends on deforming metal to the sealing surface of the spool groove.
A hanger flange showing:
- alignment/lockdown pins,
- slip bowl,
- annular access port
- seal elements
- “leak” investigation ports.
Lockdown screws and a tubing “donut”
Pressure Tests

• Before testing wellhead or BOP’s, consider the condition of the casing. Many older wells with low grade or poor quality casing can be damaged by a pressure test on a new wellhead.
TUBING HANGERS AND PACKOFFS

DESCRIPTION

Tubing hangers and packoffs are installed in the top bowl of a tubing head. Tubing hangers both suspend tubing and provide a primary annular seal between the tubing and production casing. Packoffs only provide a seal between the tubing and production casing; they do not suspend the tubing.

FUNCTIONS

- Tubing hangers suspend tubing and seal the annulus between the tubing and the production casing.
- Tubing hangers may also be utilized to set back pressure valves inside in order to seal the well bore.
- Packoffs allow tubing string manipulation for setting packers or displacing fluid while sealing the annulus between the tubing and the production casing.
Tubing hanger with pass thru for electric cable.
Hanger with a lock mechanism for subsea well.
Basic hanger, with tubing seal, lockdown, annular access and casing seal. The master valve is just above this unit.
Tubing hanger spool with annular access valves
Threaded Tree Caps – Standard Sizes

Basic Tree Cap
B-14-A

Dual Tree Caps
B-14-ADO
Develop One Side Only?

Valve instead of a blind flange on the left side would give better repair opportunities.
Develop both sides?

In high rate, high pressure, sensitive wells, or H2S wells, the second side may be a well saver!
Motor Operated Master Valve

Motor Operated Wing Valve

Manual Wing Valve

Choke to flow line
TMB = Twin Monobore Wellhead (Dual Wellhead)
Flanges

• Basic types
• Assembly and Inspection
• Seal types

Source: Woodco
Flanges with Ring Grooves, API Type 6B, for 5000 psi working pressure

<table>
<thead>
<tr>
<th>Nominal Size of Flange</th>
<th>Casing Size</th>
<th>Diameter of Flange</th>
<th>Diameter of Bolt Circle</th>
<th>Number of Bolts</th>
<th>Ring Type</th>
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Flange Assembly

• Clean the Ring Grooves and inspect for damage.
• Select a new Ring Gasket of the specified size and type.
• Place lubricated bolts in place and install nuts, lubricated on their back face, by hand.
• Tighten bolts by hand until nuts on both sides touch the backs of their respective flanges and have equal engagement on their stud bolts.
• Observe the stand-off between flanges for equal appearance all around, make any adjustment necessary to equalize the stand-off all around. Measure the standoff if visual inspection questionable.
• Tighten with proper wrenches to achieve equal stand-off.
Flange bolt tightening sequence – also check for equal gap.
Tightening

• Begin tightening by rotating nuts clockwise 1/2 turn, choosing one bolt first, then choosing the bolt 180° opposite second, then one at 90° and then the one 180° from that.

• Step over one nut from the first nut tightened (consistent clockwise or counter-clockwise) and continue the same pattern as with the first four.
6 BX Flanges

Those flanges for which API Spec. 6A specifies BX Ring Gaskets.

Made-up 6 BX Flanges -

6 BX flange raised faces shown in contact after assembly. In actual field situations any small gap present after achieving specified torque should appear uniform all around.

These flanges have raised faces that the design permits to meet or touch when the connecting bolts have reached the required torque.
6 B Flanges

• Those flanges for which API Spec. 6A specifies R or RX Ring Gaskets
• These flanges (usually without raised faces) have designs that leave a stand-off (gap) between the flanges after bolts have reached the required torque. See illustration.
• Select flange size to display stand-off between flanges using R and RX Gaskets in standard Ring Grooves.
6 B flanges must always stand apart after assembly.

Raised faces on 6 B flanges make the stand-off (gap) space difficult to measure accurately but field construction of a simple feeler gage will usually give a satisfactory approximation of the measurement.

This stand-off should appear uniform all around.
Drift Testing of Assembled Equipment

For 6 B or 6 BX flanges that have not been pulled fully face to face, non-uniformity of stand-off may prevent the passing of a Drift past the connection. See the exaggerated illustration:

Select full bore flange size to display Drift major diameter and length.

If the equipment bore has the minimum I.D. and the stand-off does not appear uniform (or the flange faces do not appear to run parallel), a passing drift may contact the wall of the connected piece of equipment and "bind" or "stick" instead of passing freely.
Assembly

- API Spec. 6A or Spec. 16A requires a drift test on each piece of flange equipment.
- When separate units of equipment require field assembly, the person(s) making the assembly may create an unexpected problem by not keeping any stand-off between flanges uniform all around. Rarely do field personnel have a drift gage available, so the best insurance against a stuck working tool comes from careful make-up of flange connections.
- Even if the job doesn't require close fitting tools, such tools may come into play should a well emergency occur.
Flange Assembly Learnings

• BOP stacks frequently experience Kelly wear on their I.D. because flange make-up lacked uniformity all around and all or a portion of the stack leaned from the vertical, allowing the Kelly to rub against the side leaning in.

• If operators do anticipate the need for running tools that have a small clearance with the I.D. of the BOP or Trees, then having a Drift Gage available and used at the make-up site will provide cheap insurance against later downtime.
A lock-ring type connection attaching the head to the casing. Attachment depends on the engagement of the bolts.
CHRISTMAS TREES

DESCRIPTION / FUNCTIONS

A christmas tree is an assembly of gate valves, chokes, and fittings which control the flow of oil or gas during production. Tree design will vary depending upon:

- Customer preference
- Well depth
- Well shut in pressure
- Tubing size
- Retained fluids produced
- Down hole completion procedures and hardware
- Projected profitability of the well
Never throttle with a gate valve! - washouts will ruin seal ability. Valves in series give repair opportunities.