MATERIALS AND CHEMICAL REAGENTS FOR OIL AND GAS PRODUCTION

LECTURE 4: Methods of wells operation and materials used in these processes

Lecture 4. Part 1.

Methods of wells operation

1. Gushing (flowing) – operation is performed only due to natural (reservoir pressure) forces.

2. Gaslift – operation is performed by natural forces and additional energy of compressed gas.

3. Artificial (pumping) – operation is performed by natural forces and additional energy of pumps.

Flowing well

1. Artesian flowing well: $P_{bh} > P_{sat}$, $P_{wh} > P_{sat}$.

P_{bh} is bottom hole pressure, Pa; P_{sat} is pressure of formation oil saturation, Pa; P_{wh} is well head pressure, Pa.

A pressure of formation oil saturation is a maximum pressure at which gas begins to liberate from oil at isothermal expansion of it under conditions of thermodynamic balance. (another definition: *by the pressure of saturation* is named the pressure after

insignificant decrease of which gas begins to liberate from oil).

2. Gaslift flowing well, with the beginning of gas separation inside the wellbore: $P_{bh} > P_{sat}$, $P_{wh} < P_{sat}$, ($P_{w.h.} = P_{g.s.} \leq 0.1 – 0.5$ MPa).

Indications (explanations) of P_{bh} , P_{sat} and P_{wh} are the same.

$P_{g.s.}$ is pressure in gathering system, Pa.

As a rule $P_{g.s.} = 0.1 – 0.5$ MPa.

As a rule we take $P_{wh} = P_{g.s.}$.

3. Gaslift flowing well, with the beginning of gas separation inside the reservoir: $P_{bh} < P_{sat}$, $P_{wh} < P_{sat}$.

Necessary condition for flowing well:

$$P_{bh} \geq \rho g H + \Delta P_{los} + P_{wh}$$

Equipment for flowing wells

1. Surface equipment: Christmas tree, manifold.

2. Subsurface (wellbore) equipment: tubing, packer (sometimes).

Christmas tree **is used for sealing the mouth of the flowing wells,**

lowering one or two tubing strings, providing the regulation of the technological operation mode of the well, measurement of surface and wellbore parameters, as well as performing various technological operations.

Christmas tree is used in flowing and gaslift oil and gas wells.

Christmas tree can be of three-way or cross-type.

Christmas tree:

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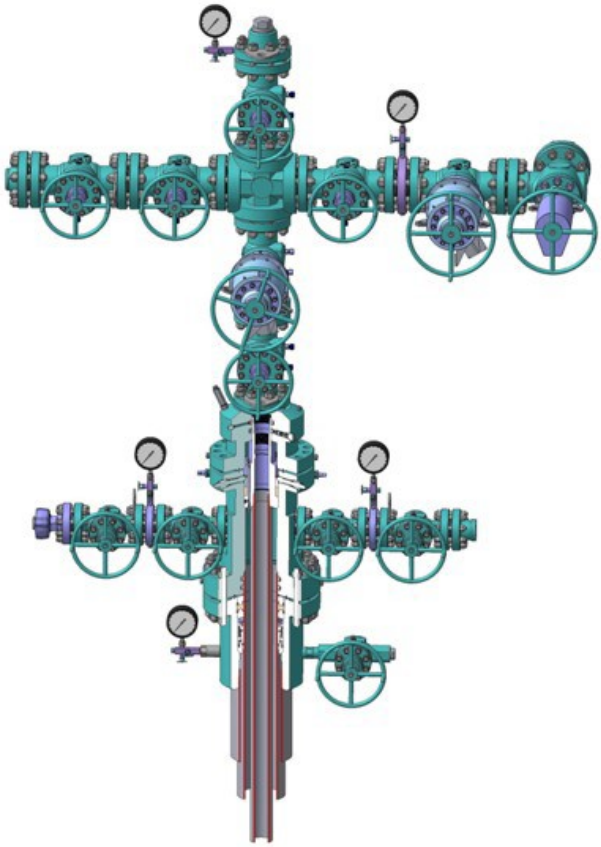
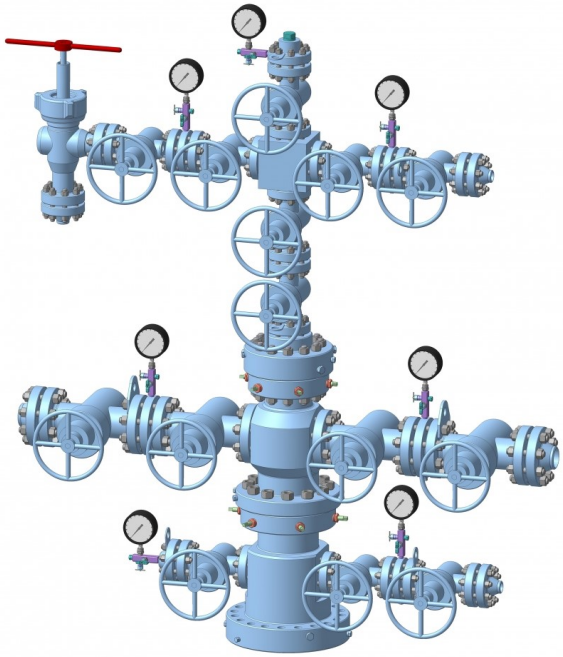
Christmas tree:





Cross-type Christmas tree is used in wells, which do not contain abrasive particles (sand) in their production fluid. It has smaller height, is simper in operation and is balanced.

Three-way Christmas tree besides the lower cross has a T-bend which allows to hang 2 tubing strings.

Christmas tree is installed on the landing head and consists of casing head and tree with shut-off and controlling valves.

Christmas tree can contain 1 or 2 T-bends. Double-deck Christmas tree is used in case of undesired production suspending. Christmas trees that are used for higher pressures (up to 105 MPa) each branch has 2 valves.

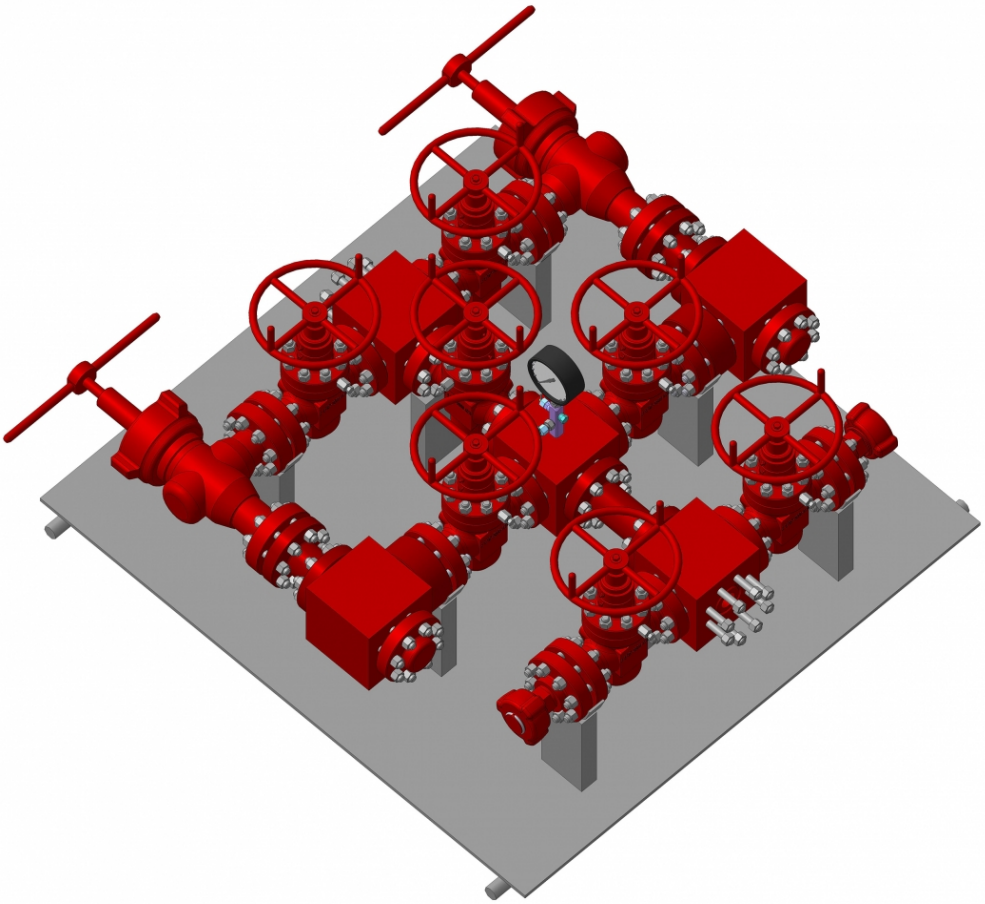
As a shut-off valves, straight through ball valves or forward shear locks may be used with pneumatic or automatic control.

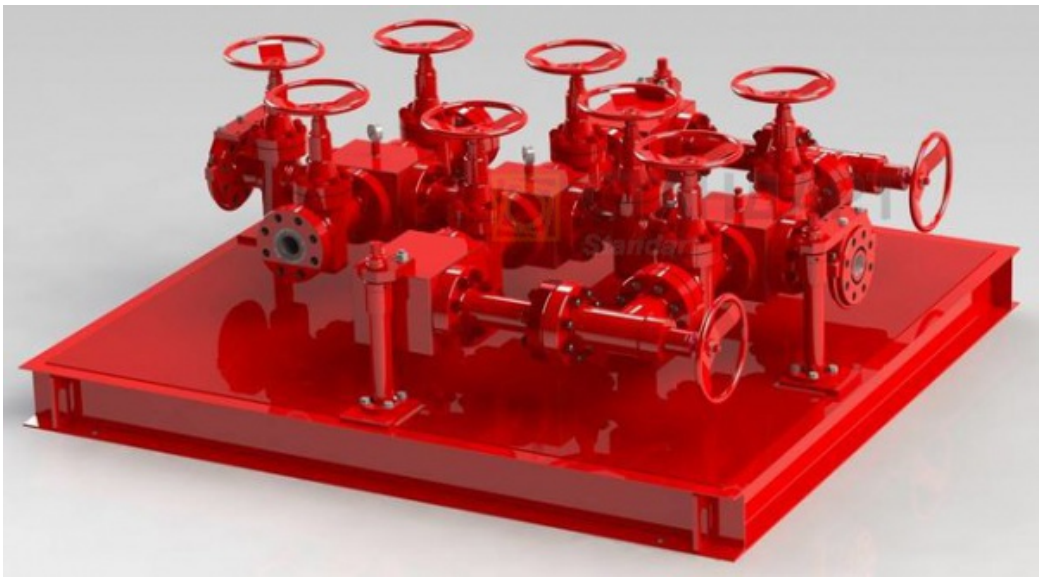
After shut-off valves, branch of the tree is equipped with throttles with different opening diameters (5 – 25 mm), which are determined experimentally during well testing. Wellhead and annulus pressure are measured by manometers.

Elbows of casing head have special openings for supplying corrosion and hydrates preventer agents into the annulus.

Manifolds **are used to connect Christmas tree with flowing pipelines that supply well production fluids to gathering measurement units. They provide connection between tubing and a pipeline, annulus with flare. Simple scheme of cross-type manifold only includes 1 flowing line: tubing with gathering measurement equipment.**

Manifold





Gaslift flowing wells

Condition for gaslift flowing:

In the process of wells operation, working conditions can worsen:

1) Increasing of water content in the production mixture, which causes increasing of pressure losses inside the tubing, greater bottomhole and wellhead pressures, reducing of production gas-liquid ratio *R* and eventually bigger minimal necessary specific flow rate of gas (*GLR*).

2) If the field is not developed using pressure maintenance methods or they are not effective, bottomhole and wellhead pressures can decrease (this causes increasing of minimal necessary specific flow rate of gas).

If the energy of dissolved gas is not enough to supply production fluid to the surface, than the necessary extra amount of gas is pumped inside the well from the ground. Such method of operation is called gaslift.

Condition for gaslift operation:

$$R + R_{ad} \geq GLR_{\min}$$

Gas is pumped with the help of a compressor. This kind of method is called compressor gaslift. Natural-pressure gaslift is present in case of high pressure gas layers or fields nearby (rarely applied).