Development of subsea separation system for multiphase pump

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We propose to introduce the vortex type separator of gas and hydrocyclone of water separation in traditional system of separation and redesign or improve the multiphase pump (MPP) for: minimizing the dimension and mass of the gas separator; collecting the sand in separate tank, enhancing the properties of screw material of the pump by decrease of hydro-abrasive wear. The mathematical model for proposed construction of separator is elaborated.

The ideal system of separation and pumping must ensure separate pumping of multiphase medium components (fluid-gas-water-solid, usually sand) from oil well and transport the material to 10 mile distance and more. This system must have high reliability with no failures within 10 years on the sea bed up to 4000 m depth. We consider equilibrium of droplet which is located in flow gas-liquid mixture, and the analytical expression to determine its limit radius.

For the experimental studies of separator an experimental pilot plant was designed and manufactured. Pilot installation performs the following functions:

1. Provision of research separator in conditions close to real (industrial);
2. Providing of modelling for different modes of separator;
3. Ensuring measurement of the test separator;
4. Ensuring the safety of personnel during the experimental studies.

In order to optimize the design of the separator and the inclusion of its original structural elements that improve the technical performance of the gas vortex separator (inertial) type the computer models of the separator that simulated real conditions of operation were carried out.

Separation and MPP may give same advantages: longer life of MPP, higher efficiencies. Some companies (FMC, Statoil) apply systems of separation and MPP. There are many possible configurations of systems: with separation of water and its injection into the well, periodical collection of sand and removal it on the platform, etc.

Our proposal is based on the application of hydrocyclone to remove sand to special rubber reservoir, which may be changed periodically after its filling by sand (Fig. 1.). Hydrocyclone may also separate water from fluid.

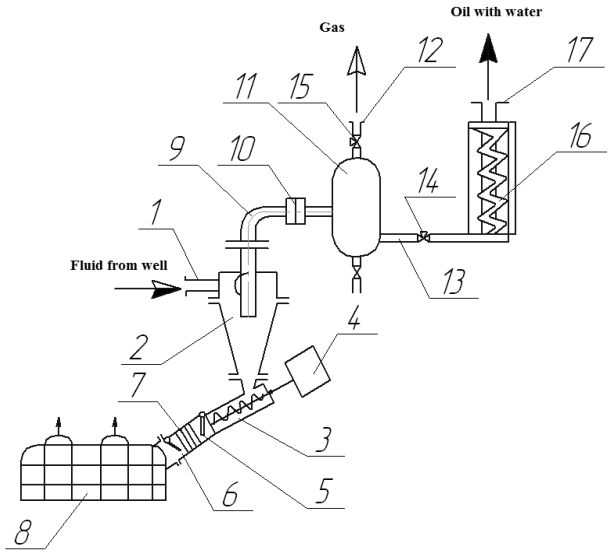

Fig. 1.: System of sand and gas separation before entering twin-screw pump 1 - pipe for reception of the fluid from the well, 2 - hydrocyclone unit for solids separating, 3 - screw for solids moving; 4 - screw drive mechanism, 5 - the valve of screw mechanism, 6-valve of rubber tank, 7 - mechanism to be able to transport solids to the surface, 8 - rubber reservoir, 9 - outlet of the fluid-gas mixture with solids; 10 - valve or shut-off unit, 11 - gas-liquid vortex -type separator, 12 – pipe for gas exit, 13 - pipe for displacement of purified liquid, 14, 15 - locking elements, 16 - twin-screw pump, 17 - pipe for exit of purified liquid product.

Vortex type gas separator may be used also for gas or for the sand separation. The new system of gas and sand separation with MPP is proposed. Gas after separator is directed to compressor and pumped to platform or FPSO by umbilacal. Sand is collected in sand tank.

New system of separation with multiphase pump is proposed. New type of vortex gas separator is proposed for use in this system. The mass and dimensions of new separator is 15 times less, than usual one.