CHE INC.

CHRISTOHOUSTON ENERGY INC.

MULTIPHASE DESANDING HYDROCYCLONES

Production of sand from oil & gas wells is a common difficulty for processing facilities, and is often caused by unconsolidated reservoirs, high production rates, or the failure of gravel packs and other sand control measures. Detrimental effects of sand production include mechanical damage (erosion) to chokes, flow lines, control valves, pumps and other equipment, reduced equipment capacity due to reduced residence time (in the case of separators) or due to partial blockage of pipelines, and high environmental discharge costs.
The main solutions to date have been to cut back oil & gas production rates to reduce the rate of sand produced, workover of wells to repair or install gravel packing or screens, or increased equipment maintenance which leads to reduced plant availability.

Cyclone manufacturers as well as a number of operators recognized the need for an alternative solution that actually enhances rather than restricts production. The Multiphase Desanding Hydrocyclone was thus developed to provide a compact solution for this application. These initial units were installed upstream of the production choke, thus termed "Wellhead Desanding Hydrocyclones". ESII furthered this technology for designing specific models to operate downstream of the choke. These units are termed "Wellstream Desanding Hydrocyclones". Both units operate in multiphase flow and are of similar design. The main difference in each is due to mechanical design requirements. A Wellhead Desanding Hydrocyclones is typically designed for 5,000-15,000 psi API, while a Wellstream Desanding Hydrocyclone is typically designed for 150# - 600# ASME.

The Multiphase Desanding Hydrocyclone offers a proven, compact, simple, cost reduced alternative to current techniques and allows higher sand free production rates while eliminating downhole sand control measures. The installation of a Multiphase Desanding Hydrocyclone will enhance production by increasing well rates and reducing process downtime. The robust design promotes installation of a Wellhead Desanding Hydrocyclone on almost any oil or gas well, as shown in Figure 1. Virtually all particulates debris such as formation sand, fracture (frac) sand, drilling chips, chalks, and scale, can be removed from production wells on-line.

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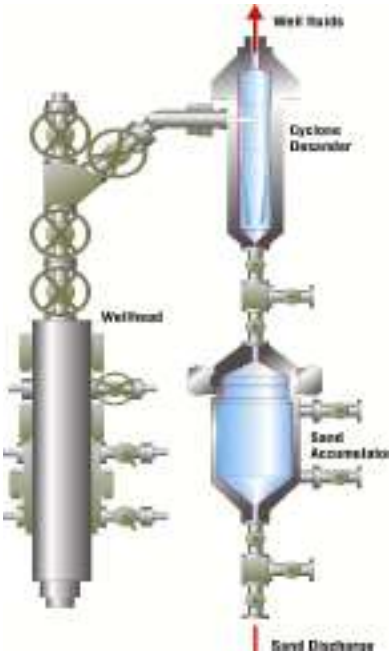

Figure 1 - Schematic of a Wellhead Desanding Hydrocyclone Installation

A serendipitous benefit of solids removal upstream of processing equipment is the cleanliness of the separated sand. Upon commissioning of the first commercial Wellhead Desanding Hydrocyclones, one of the major concerns was with solids handling. This concern was placated when the sand dumped from the accumulator was found to be relatively free of hydrocarbons. The reasons for the low hydrocarbon concentration on sand are twofold.

First, sand is typically water wet in the reservoir, and will remain so unless allowed to "cook" in production separators for extended periods between sand-jetting operations.

During retention in process vessels the sand is subjected to various interfacial modifying chemicals and processes that create an oil layer on the sand particle. Removing the sand ahead of the separators prevents oil adsorption. Second, the operation of a Multiphase Desanding Hydrocyclone unit ensures that the accumulator is pre-filled with clean (flushing) water after each purge cycle. This means that separated sand always sits in a "clean" water environment, but also that hydrocarbon well fluids are prevented from entering the accumulator and discharging with the sand. In field applications typical total hydrocarbon concentration on sand has measured to be typically less than 0.5% by weight. This is analogous to oil on drill cuttings can be directly discharged in many regions, providing the oil on solids concentration is less than 1% by weight.

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Under-Balanced Drilling

One of the biggest advances to oil well drilling in recent years is the increased use of underbalanced drilling. Traditional drilling involves the use of heavy brine or suspended mud based fluids to “kill” the well while the well hole is drilled. Killing the well means that the weight of the drilling fluid is sufficient to hold the hydrocarbons in the formation, such that they are not produced up the well bore. The well is in a “overbalanced” situation, with the downward weight of the drill fluid heavier than the upward pressure of the formation fluids. Underbalanced drilling involves using lower density drilling fluids, such that the formation can produce oil while the well is drilled.

During under-balanced drilling, the produced fluids present at the wellhead will be drilling fluid (brine or mud), produced fluids (oil, water, and gas), formation solids, and drill cuttings. The Wellhead Desanding Hydrocyclones is used to remove the formation debris, thus allowing the Produce fluids to be processed without the solids handling issues that may otherwise arise. The net result is that more and higher quality data can be achieved from the fluids, and from a drill stem test (DST). A typical system is shown in Figure 2.

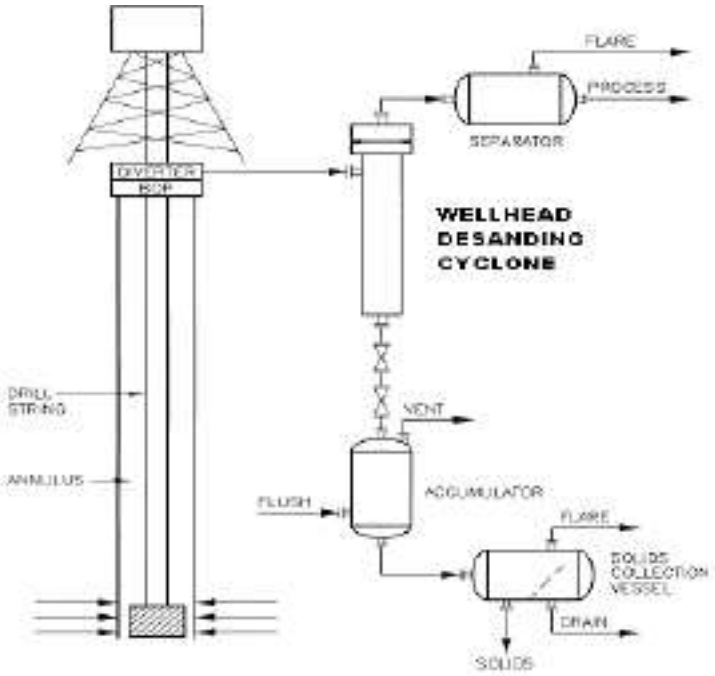

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Figure 2 - Schematic of an Underbalanced Drilling Operation

In normal drilling operations, the solids are removed from the drilling fluids with screen decks and shakers, which is an atmospheric operation. Open processing underbalanced drilling fluids poses many safety and environmental concern due to the presence of hydrocarbons. The Wellhead Desanding Hydrocyclone can remove these solids on-line, in a contained system to prevent any safety or environmental issues.

The location of the Wellhead Desanding Hydrocyclone at the wellhead environment does pose several process and safety issues, due to the extremely high operating pressure. Process design issues for underbalanced drilling applications are as follows.

1. The Wellhead Desanding Hydrocyclone is connected directly to the diverter, upstream of all process equipment.
2. A solids collection vessel is required to contain all solids purged from the accumulator. The purpose of the vessel is to provide a closed environment for the solids, in order to collect and flare any flashed gas, and drain off liquid hydrocarbons.
3. The Wellhead Desanding Hydrocyclone requires no control system to be applied the flowing well(s). The operating pressure drop is controlled by the volumetric throughput of fluids.
4. The accumulator purge sequence or purge may be manual or automatic. If manual
5. valve operation is chosen, then an interlock system is recommended. The interlock system requires a key box, to ensure valves are always operated in the correct prescribed sequence. Interlocking can also be provided for an automated system.
6. Activation of the purging sequence can be on a timed basis, the frequency of purging being defined by operational experience and optimization in the commissioning phase. It can also be activated by sand level measurement in the accumulator vessel.
7. Pressure indicators are located on each Wellhead Desanding Hydrocyclone vessel, each accumulator, and between each double block valve arrangement. Two pressure indicators are installed on each accumulator as a double check for accumulator

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pressure prior to emptying. In an automated system, a pressure switch is required on the accumulator to ensure the sand is removed only when the accumulator is vented.

8. Selection and installation of instrumentation must take into consideration the high sand content of the fluids being measured. For example, all pressure tapping should be taken off the top of horizontal lines. If there is potential for sand blocking the internal workings of pressure instruments, secondary fluid/bellows type flange connections should be considered.

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