COILED TUBING SURFACE EQUIPMENT

1- WELL CONTROL EQUIPMENT

Figure 1 shows typical well control equipment for CT operations, consisting of a BOP topped with a stripper (high pressure CT units have two strippers and additional BOP components). Both components must be rated for the maximum wellhead pressure (WHP) and temperature possible for the given operation. Also, each component must be compatible with any corrosive fluids that might be produced from the well or introduced as part of the CT operation.

Figure 1

Figure 2 shows a complete stackup of well control equipment for CT operations at WHP up to 15,000 psi.
Blowout Preventer (BOP)
A blowout preventer (BOP) contains wellbore pressure. Its main function is to prevent well fluids from escaping into the atmosphere. A CT BOP is designed specifically for CT operations.
A CT BOP consists of several pairs of rams. Each type of ram performs a specific function.
The number and type of ram pairs in a BOP are determined by the configuration of the BOP:
single, double, triple, quad, or quint. The standard CT BOP preventer is a quad.
The four rams, top to bottom, and their functions are:
1- Blind ram - seals the wellbore when the CT is out of the BOP
2- Shear ram - cuts the CT
3- Slip ram - supports the weight of CT hanging below it (some are bi-directional and prevent the CT from moving upward)
4- Pipe ram - seals around the hanging CT

Standard CT BOPs:
The standard CT BOP has two equalizing ports, one on each of the sealing rams. It also has a side outlet between the slip and shear rams. This side outlet can be used as a safety kill line.

Typical CT BOP Configurations

Stripper (Stuffing Box):(Fig 4)
The stripper (stuffing box) between the BOP and the injector head provides the primary operational seal between pressurized wellbore fluids and the surface environment. The stripper forms a dynamic seal around the CT during tripping and a static seal around the CT when it is stationary.
The sealing elements are similar in both stripper designs and consist of thick-walled elastomer cylinders split length-wise as in Figure 5. Stripper elements are composed of layers of different elastomers selected for their unique properties.
Usually, the WHP energizes the stripper seal by forcing a piston against one end of the elastomer cylinder. This axial force creates a pressure seal around the CT by compressing the stripper element between the CT and the surrounding pressure housing. The CT operator increases the axial force on the piston with hydraulic pressure from the power pack to increase the sealing force around the CT.

2- INJECTOR HEAD AND GUIDE ARCH:

Figure 6. Shows a typical CT injector head and a guide arch. The injector provides the following functions:
1- Apply dynamic axial force to the CT to control movement into or out of a well.
2- Supply enough traction to avoid slipping on the CT.
3- Apply static force to hold the CT when stopped.
4- Platform for weight and depth measurement sensors.

The guide arch is a static device that provides the following functions:
1- Support the CT above the injector head.
2- Provide a controlled radius of bending into/from the top of the injector head.
3- Withstand the reel back tension.
4- Accommodate the fleet angle due to spooling on/off the reel.

Fig 6
Wellhead Connections:

Rigging up pressure control equipment is a time consuming task. Working with the cranes and slings to lift the equipment and install it on the well can be dangerous. The hydraulic quick latch is a pressure control tool that makes the rigging process quicker and safer. The quick latch is normally the last connection made during the CT rig up.

1. Install the BOP and flow lines on the well head and mount the stripper to the injector.
2. Stab the CT into the stripper packer and make up the tools.
3. Pick up the injector, and use the quick latch to stab it onto the BOP stack.

Hydraconns

The hydraconn is designed to facilitate a secure connection between the CT BOP and stripper packer while providing an elevated level of personnel safety by minimizing the need for operator assistance during rig-up of the pressure control stack. The hydraconn incorporates a tapered seal bore that facilitates stabbing the connection with the injector. A safety latch, with a manual override and an indicator are included to prevent an unintentional release while operating with well pressure in the stack.
Quick Latch between the Stripper Packer and the Injector Head:

The injector connector is used as a tool to connect the pressure control equipment to the injector head. It is mounted above the stripper packer and is therefore a non-pressure containing device.

Hydraulic Releasing Connector:
the hydraulic releasing connector (HRC) is designed to facilitate the connection of the BOP and/or lift frame to the wellhead or drill pipe, making this procedure quick with increased operator safety.

![Hydraulic Releasing Connector](image1)

Unions:

Unions are a quick and easy method to attach pressure control equipment. Also known as quick unions, the unions have an elastomer seal for the well bore pressure. The seal is either on the box or pin connection depending on the type of union. The quick union is comprised of four components, which consist of the box end, pin end, union nut, and seal.

TUBING REEL:
The CT reel, is a storage device for the CT string. The reel's drive mechanism has only enough power to wrap/unwrap CT onto/off the drum.

Depth Measurement:
The tubing depth counter usually consists of a small “drive” wheel bearing against the CT and aligned to roll along its surface in the axial direction. Another wheel on the opposite side of the CT squeezes the CT between the two wheels. Due to friction between the “drive” wheel and CT, the wheel rotates as the CT passes by. A mechanical digital counter (like the odometer in a car) or encoder (electronic measurement), Figure 4.40, attached to the shaft of the wheel senses its revolutions. The digital display or data acquisition unit at the operator's console converts the wheel revolutions into linear distance the CT travels (depth). Slippage between the wheel and CT is a source of error in the depth measurement.
POWER UNITS:
A hydraulic power unit operates typical CT surface equipment. This unit must supply relatively high-volume, low-pressure hydraulic fluid to dynamic equipment like the injector head and reel and relatively low-volume, high-pressure hydraulic fluid to static devices like the stripper and BOP. Consequently, most CT unit power packs have several pumps powered by a diesel engine or electric motor.
CONTROL CAB AND OPERATOR’S CONSOLE:
The control cab or operator’s cab contains the console with the analog gauges, digital displays, and electrical and hydraulic controls necessary to operate the CT unit. The configuration of the cabin and console vary widely with manufacturer and each customer's specifications.

CT Unit Control Console (Stewart and Stevenson)

CT LIFTING FRAME:
A CT lifting frame is required when performing operations from a floating vessel where motion-compensation is required. The lifting frame is a high strength component in which the injector head and pressure control equipment is mounted inside the structure. The rig picks up the lifting frame in the traveling block. The traveling blocks on floating vessels are motion compensated by the use of an accumulator system, which allows the blocks to maintain at relatively steady pull while the rig heaves. These frames are generally rated to a capacity of at least 300 tons.