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THEME

Installation and Maintenance of Wellhead & X-Mas tree (Well ISB 302 Z TFT)

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Abstract:

The installation and maintenance of wellhead and X-mas tree equipment are essential for safe and efficient operations in the oil and gas industry. Wellhead and X-mas tree maintenance services include the inspection and maintenance of all existing sections, including casing head, casing spool, tubing head, and X-mas tree. The maintenance process involves physical and chemical property tests, bleeding off pressure, and flushing stuck valves

.Wellhead and X-mas tree equipment manufacturers, such as TechnipFMC, provide high-quality equipment that meets regulatory and safety requirements. These manufacturers offer API 6A certified equipment, ensuring the design, fabrication, and inspection are done in strict adherence to API 6A requirements

the installation and maintenance of wellhead and X-mas tree equipment require robust HSSE procedures, engineered support, and designs. Onsite installation and maintenance services are provided by companies like TechnipFMC, ensuring safe and efficient operations.

In summary, the installation and maintenance of wellhead and X-mas tree equipment are critical for safe and efficient operations in the oil and gas industry. High-quality equipment that meets regulatory and safety requirements is essential, and onsite installation and maintenance services ensure safe and efficient operations.

Résumé :

L'installation et l'entretien des têtes de puits et des arbres de Noël sont essentiels pour assurer la sécurité et l'efficacité des opérations dans l'industrie pétrolière et gazière. Les services d'entretien des têtes de puits et des arbres de Noël comprennent l'inspection et l'entretien de toutes les sections existantes, y compris la tête de tubage, la bobine de tubage, la tête de tubage et l'arbre de Noël. Le processus de maintenance comprend des tests de propriétés physiques et chimiques, la purge de la pression et le rinçage des vannes bloquées.

Les fabricants d'équipements de tête de puits et d'arbre de Noël, tels que TechnipFMC, fournissent des équipements de haute qualité qui répondent aux exigences réglementaires et de sécurité. Ces fabricants proposent des équipements certifiés API 6A, ce qui garantit que la conception, la fabrication et l'inspection sont effectuées dans le strict respect des exigences de l'API 6A.

l'installation et la maintenance des têtes de puits et de l'équipement de l'arbre de Noël nécessitent des procédures HSSE, un soutien technique et des conceptions solides. Les services d'installation et de maintenance sur site sont assurés par des sociétés comme TechnipFMC, ce qui garantit la sécurité et l'efficacité des opérations.

En résumé, l'installation et la maintenance des têtes de puits et des arbres de Noël sont essentielles pour assurer la sécurité et l'efficacité des opérations dans l'industrie pétrolière et gazière. Il est essentiel de disposer d'un équipement de haute qualité répondant aux exigences réglementaires et de sécurité, et les services d'installation et de maintenance sur site garantissent la sécurité et l'efficacité des opérations.

ملخص :

إن تركيب وصيانة معدات فوهات آلبار ومعدات شجرة إكس ماس ضرورية للعمليات آلمنة والفعالة في صناعة النفط والغاز .تشمل خدمات صيانة فوهة البئر وشجرة mas-Xفحص وصيانة جميع أألقسام الموجودة، بما في ذلك رأس الغالف، وبكرة الغالف، ورأس أألنبوب، وشجرة mas-X.

وتتضمن عملية الصيانة اختبارات الخصائص الفيزيائية والكيميائية، وتخفيف الضغط، وشطف الصمامات العالقة .توفر الشركات المصنعة لمعدات رأس البئر وشجرة عيد الميالد، مثل TechnipFMCمعدات عالية الجودة تلبي المتطلبات التنظيمية ومتطلبات السالمة.

تقدم هذه الشركات المصنعة معدات معتمدة من A6 APIمما يضمن أن يتم التصميم والتصنيع والفحص باالتزام الصارم بمتطلبات A6 API يتطلب تركيب وصيانة معدات فوهات آلبار ومعدات أألشجار mas-X إجراءات قوية للصحة والسالمة واألمن والبيئة والدعم الهندسي والتصميمات.

يتم توفير خدمات التركيب والصيانة في الموقع من قبل شركات مثل TechnipFMC، مما يضمن عمليات آمنة وفعالة .وباختصار، فإن تركيب وصيانة معدات فوهات آلبار ومعدات أألشجار السينية أمر بالغ أألهمية لعمليات آمنة وفعالة في صناعة النفط والغاز.

من الضروري توفير معدات عالية الجودة تلبي المتطلبات التنظيمية ومتطلبات السالمة، وتضمن خدمات التركيب والصيانة في الموقع عمليات آمنة وفعالة.

Dedication

I dedicate this modest work

To my dear mother, the first woman of my life, you represent for me the symbol of goodness par excellence, the source of tenderness and the example of dedication who never ceased to encourage me and pray for me. A mother does everything in her power to guide her children on the right path in life and studies. May God protect her.

To my dear father, the one who holds his name with great pride, and taught me that trust in Allah is key to success. You've waited so long for this moment, thank you for all love and support. Thank you for your positive feedbacks no matter what. All my gratitude and my respect to you. May GOD protect him.

To my loving grandma Ziri Aldjia

I would dedicate this work as well to:

My sisters: Chahrazad, Nour El Houda and Rahma

My little niece ″Tina″

My future wife

To each member of my extended family, my teachers and all my friends. Thank you all very much for your infinite support and encouragements.

And lastly, thank you Allah for your guidance, the strength and making my graduation came true.

Wahhab

Dedication

I dedicate this humble work to the light of my days, the flame of my heart, my life, and my happiness: my beloved mother. May God bless you with good health and a long life.

To the man of my life, my perfect example, my moral support and source of joy and happiness, the one who always sacrificed himself to see me succeed, may God bless you, my father.

To the people I would have liked to see here among you today, my dear brothers Riad and his wife Bouchra, Nasro, Ghanou, to my tenders sisters Feriel, Loubna and her Marie M'hammed and my beautiful niece Djouri

To the people who always helped and encouraged me, who were always by my side, and who accompanied me on my journey of higher studies, my kind brothers, friend and study colleagues

To my friends Wassim, Youba, Soufian, Rezki, Noureddine, Didine

Nour el islem

Dedication

I dedicate this modest work

To my dear parents (Rachedi Abdelhamid, Selfaoui Assia), who have always been by my side and supported me throughout my long years of study. As a token of my gratitude, may they find here the expression of my deepest gratitude for all their efforts and means to see me succeed in

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Abbreviations	Description
TFT	Tin Fouye Tabankort
LP	Low Pressure
Api 6A	American Petroleum Institute
PR	Performance Requirement
PSLs	Product Specification Levels
TD	Total Depth
LDS	Lockdown Screws
UH	Unihead
BOP	Blowout Preventer
CHH	Casing Head Housing
SBMS	Straight Bore Metal Seal
RCMS	Rough Casing Metal Seal
XEMS	Externally Energised Metal Seal
GV	Gate Valve
HY	Hydraulic
PN	Pneumatic
NPT	No Productive Time
BPV	Back Pressure Valve
RSOT	Running and Sting Off Tool
TTP	Tree Test Plug
PSI	Pounds Per Square Inch
TWC	Two Way Check Valve
ID	Inner Diameter
OD	Outer Diameter
FMC	Food Manufacturing Company

General introduction:

In the oil industry, drilling of oil wells and gas are the most difficult and labor intensive labor and require large capital investments Oil and gas well drilling technology demands the use of complex equipment and modern tools.Among the important petroleum equipment in production is the wellhead,is the main part of the most used well and its functionality must be constant throughout the life of the well. This is why the study of this equipment and knowledge of the equipment that makes it up is essential.

Wellheads and Christmas trees are essential components of subsea and onshore oil and gas installations. The wellhead is the structure located on the surface of an oil or gas well, while the Christmas tree is the set of valves and equipment installed at the top of the wellhead to control the flow of fluid coming from the well. Together, these elements play a crucial role in the production, safety and management of oil and gas wells.
The wellhead consists of three main parts:
a)- The casing head (casing head, casing
spool) b)- The tubing head
c)- The production head (X mas tree) or the Christmas tree
our work consists of studying and designing the installation of wellhead and x mas tree and the
maintenance this dissertation is divided into 3 chapters

- the first chapter we talk about the TFT region we give history of TFT field and geographical location and description and characteristic of the reservoir

-the second chapter we talk about wellhead design and x mas tree and equipment

- the third chapter case study of well(ISB 302 Z) it has a problem on the valves of x mas tree, we talk about dismantling and maintenance and assembly (installation).

Chaptre I

Generality of TFT zone

I -1 Introduction:

S O N A T R A C H, the flagship of the Algerian economy, embodies the essence of the hydrocarbon industry in the country and beyond. With a remarkable presence in various sectors, ranging from research to marketing, including pipeline transport and the transformation of hydrocarbons and their derivatives, SONATRACH stands out as a major player in energy on a global scale. Indeed, its activities extend far beyond national borders, embracing opportunities wherever they arise in the world. In addition to its leading role in the field of hydrocarbons, SONATRACH diversifies its portfolio by investing in strategic sectors such as electricity generation, new and renewable energies, and seawater desalination. Its influence goes far beyond national borders, making it not only the leading company on the African continent but also an essential force on the world stage. Ranked 12th among the world's oil companies, it ranks second among exporters of LNG and LPG and third among exporters of natural gas, thus demonstrating its significant weight in the international energy industry.

II -History of the TFT field:

II -1 Geographic location:

The Regional Directorate of TIN FOUYE TABANKORT, known as TFT, is an operational unit of the national company SONATRACH (Upstream Activity, Production Division). It is located in the northwest part of the Ilizi basin, more precisely 1300 km southeast of the capital, 500 km south east of Hassi Messaoud, and 260 km north west of In Amenas on national road N° 3. [1] [2]

Having the status of a sub-district falling under the district of In Amenas before the division intervened in 1976, which saw the birth of the Regional Directorate of TFT.

However, the TFT Region, composed of 2 sectors (north and south), occupies the 2nd region in oil production after that of Hassi Messaoud, as well as the development of gas in the partnership between SONATRACH, Total, and REPSOL makes TFT an important gas region.

Figure I-01: Geographical location of the TFT field

II -2 Development history:

The first discoveries in the region date from the beginning of the 1960s; the wells drilled were 51 in number, including 49 producers; the surface covered by the drilling did not cover more than 40% of the surface area of TFT; oil production in 1974 reached 2,634,000 tons. Until 1979, the TFT Region only had separation centers as installations of oil, storage tanks, and shipping pumps in both sectors (North and South), as well as medium-sized social infrastructures. [1] [2]

It experienced rapid development between 1980 and 1987, due to the decrease in reservoir pressure leading to the depletion of the energy of the reservoir. The project of maintaining pressure was introduced in 1980, and the results began to appear in 1984, when it produced 2,751,651 tons, 4,976,886 tons in 1991, 4,410,176 tons in 1994, and 3,504,200 tons in 1998. [1], [2]

In order to increase the recovery rate and recover the flared gases, another project entered service in 1987 with the construction of the gas processing plant. Currently, 400 wells of oil are drilled in the reservoir of the TFT deposit. Thus, several recovery techniques were used in the TFT region: primary recovery (eruptive well) and secondary recovery (gas lift, pressure maintenance by water injection, and electric pumping). [1], [2] With the creation and commissioning of pressure maintenance installations, namely:

*Two water production units and an injection station: in 1995, pressure maintenance was extended to the Amassak field by the construction of an injection station located in the center of TAM/E water production.

*Compound FG L stations

* 2 networks (North and South), each made up of a main station and a booster.

* An associated gas treatment and compression unit made up of two trains, each One is made up of two parts (BP and HP), a processing section, and a section for dehydration.

* A power plant made up of two turbogenerators of 18 MW each, which has been extended by the addition of a third 18 MW turbogenerator as part of the TFT gas project. At the beginning of 1996, the social infrastructure began to develop, with the creation of a new living base composed of:

- a VIP complex (2 villas, 16 studios, a restaurant, and a kitchen).
- a sports and leisure complex.
- a road network with a length of 186.1 km.
- an aerodrome with a tarmac runway, fenced and guarded, with a length of approximately 1700 meters.
- a telecommunications network composed of a digital center of 500 lines that interconnects to a fiber optic network. [1] [2]

II -3. Different TFT deposits:

The Tin FOUYE TABANKORT region covers an area of 4000 km2, and includes several deposits including: [1], [2]

Table I-01: The discovery and production of other deposits are summarized in this painting

The fields	Date of discovery	Date of commissioning
TIN FOUYE	1961	1963
HASSI MAZOLA NORTH	1958	1965
HASSI MAZOLA SOUTH	1963	1966
HASSI MAZOLA B	1966	1967
TFT ZONE 100	1966	1967
DJOUA	1966	1968
TFT Ordovicien	1967	1968
TFT ZONE EAST	1968	1968
TAMENJELT	1970	1974
AMMASSAK	1970	1974

Table I-02: Situation of Ordovician TFT wells 2020

Wells	Drilled	Open	Closed
Oil producer	233	96	137
Water injector	41	15	26
Water producer	22	19	03

- **TFT deposit:**

The TFT deposit discovered in 1967 and put into service in 1968, appears as a ring of oil, topped with a major gas cap, it represents 55% of the region's existing reserves of TFT. Having 117 wells, currently exploited in eruptive and partially in GL.

- **TIN FOUYE deposit:**

It is the first deposit discovered in 1961, put into service in 1963, it is located south of TFT it covers an area of 306 km2 and represents 22% of the region's existing reserves. The oil is present in the F6 unit of the Devonian (1300 m) and exploited by the gas-lift technique.

- **AMASSAK deposit:**

It is located 25 km northwest of the TFT deposit, it was discovered in 1970 and was put into operation. service in 1974. It represents 10% of the reserves in place in the TFT region, has 37 wells. The gas and oil reserves are located in unit 4-3 of the Ordovician (2000 m), for their exploitation we use the two techniques MP (1995) and gas lift .

❖ **DJOUA deposit:**

The DJOUA deposit is located 30 km south-east of TFT, it was discovered in 1966 and put in production in 1968, it produced oil mainly in the F6 tank (the C1 unit of the Devonian, 1500 m and AV-III and M1-X of the GOTHLANDIAN, 1600 m) by electric pumping.

❖ **TAMENDJLET deposit:**

The TAMENDJELT reservoir is located approximately 6 km northwest of TFT, it is discovered in 1970 and put into service in 1974. The oil from its F6 Devonian tank is exploited by gas-lift.

❖ **HASSI MAZOULA NORTH deposit:**

It was discovered in 1958 and put into production in 1965, it has 2 wells in operation. It produces by electrical pumping from tank F6.

❖ **HASSI MAZOULA SOUTH deposit:**

The HMZ-B deposit was discovered in 1963 and put into production in 1966, the number of wells in operation is 04. Currently, only the tank produces oil by pumping electric.

❖ **HASSI MAZOULA deposit (B):**

It was discovered in 1966 and put into service in 1967, its area is 4.4 km2 , the number of wells in exploitation is 04. Oil accumulations are produced by electric pumping.

II -4 Geology of the Illizi basin:

From a geological point of view the Illizi basin corresponds to a platform basin stable. The sedimentary cover with an average thickness of 300 m is essentially made up of Paleozoic deposits. The individualization of the basin took place at the end of the Silurian and during the Lower Devonian. [1] [2]

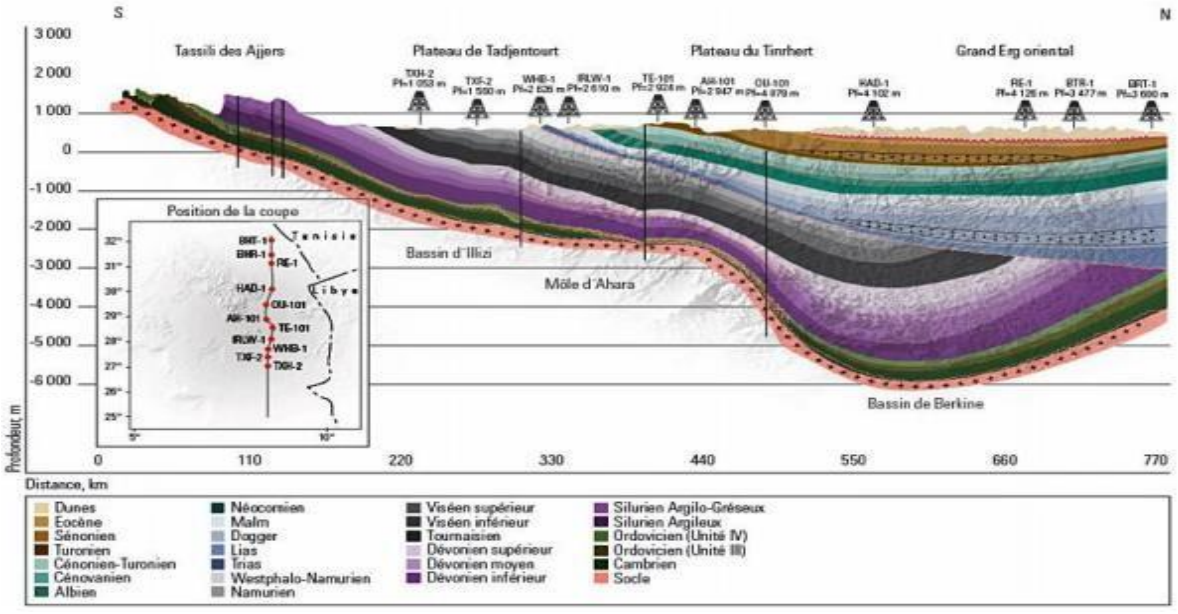


Figure I-02: South/north geological section of the Ilizi basin (S. Galeazzi & al., (2010)

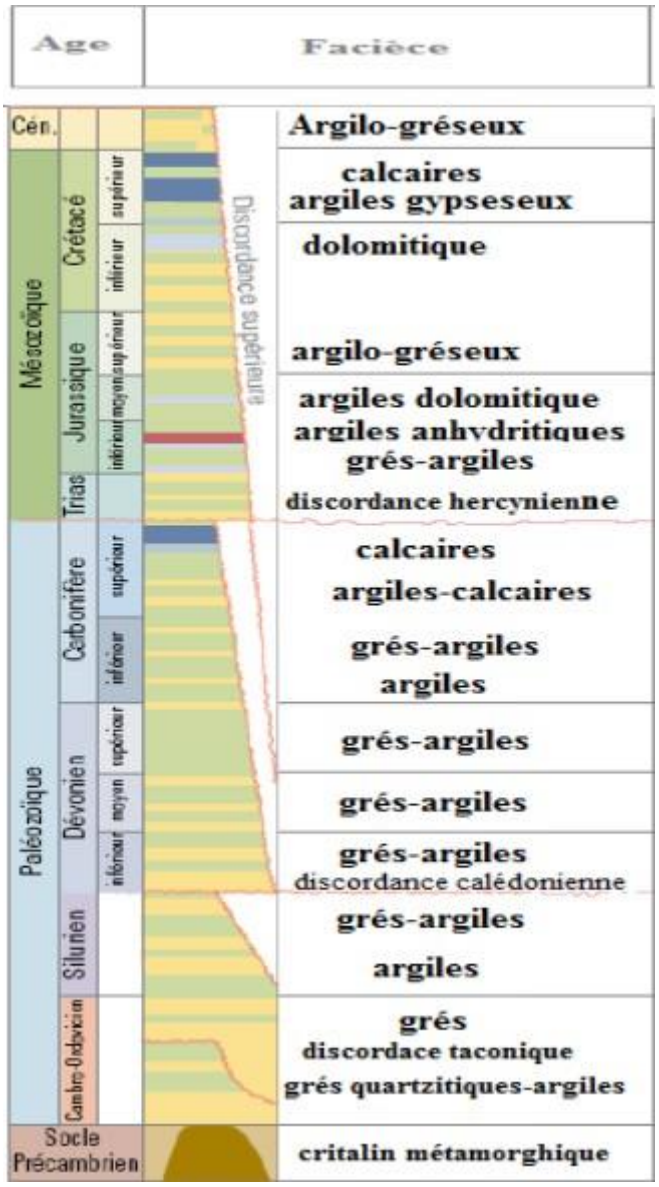


Figure I -03: Lithostratigraphic section of Illizi Basin (SONATRACH 2007)

Figure I-04: Lithostratigraphic table of the TFT basin (SONATACH 2020)

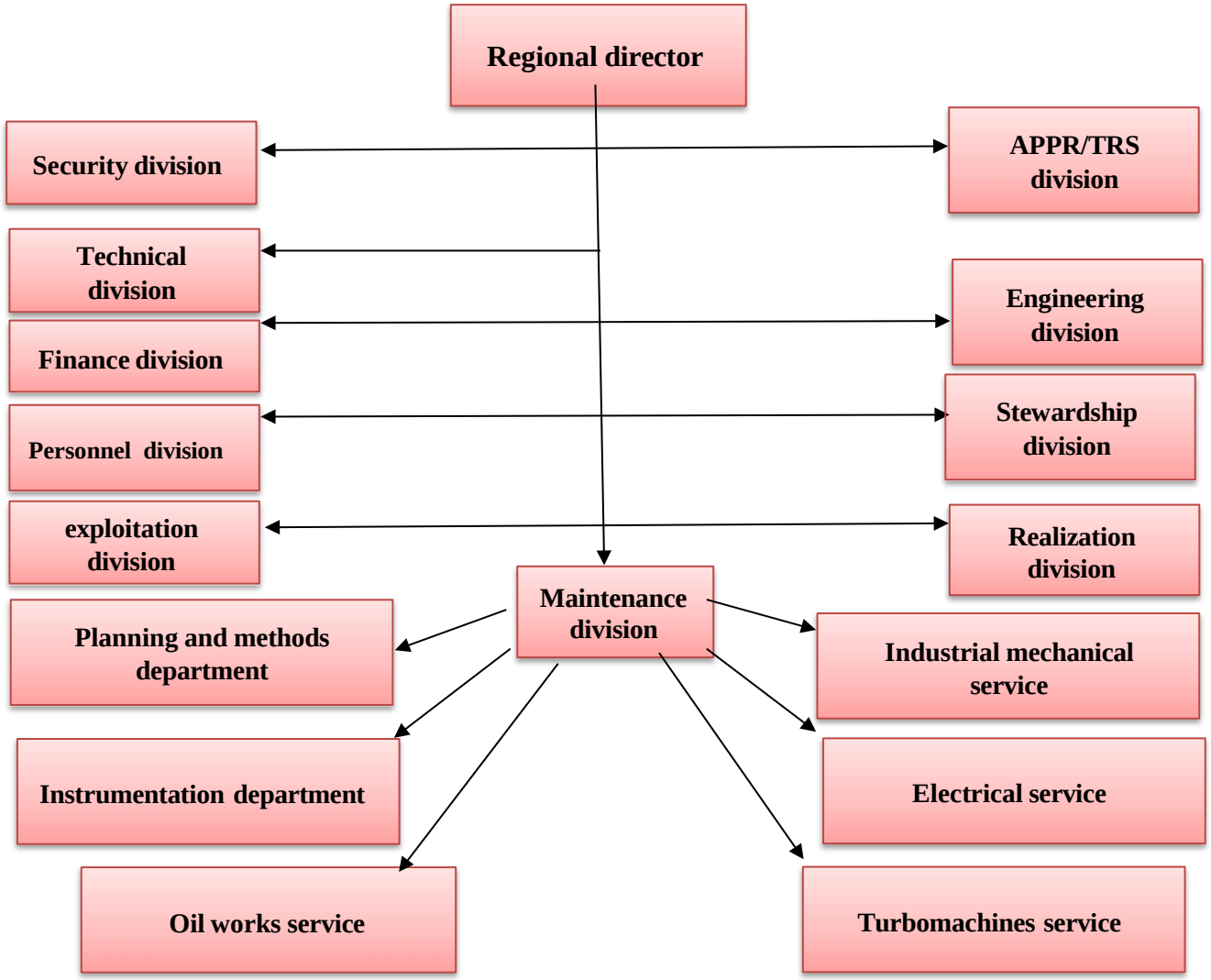
II -5 TFT regional management:

II -5.1 Presentation of the regional management of TFT:

The regional management of Tin FOUYE TABANKORT (TFT), is part of the division production of the SONATRACH company. It is responsible for the production of oil from the fields of TFT and the management of all the divisions attached to it. [1], [2]

We cite:

* Production Engineering Division
* Operations Division
* Maintenance Division
* Production Division
* Security Division
* Personnel Division
* Supply and Transport Division
* Stewardship Division
* Finance Division.



II -5.2 Different regional management divisions of TFT: [1], [2]

A- Engineering and production division:

This Division is responsible for monitoring production, it is provided with the services: Well intervention, geology, well techniques, production techniques, measurement.

B- Personnel division:

The role of this division is the management of human resources in the region. This division is composed of the following services:

Payroll management, social benefits, General administration, Personnel planning

C- Finance Division:

As soon as the scheduling service authorizer receives an invoice, he checks its compliance with usage, and established a voucher form, this form is required to faithfully reflect the amount and the details of the invoice, the authorizing officer transmits the said invoice to the finance division, which in turn will carry out its rigorous control and will proceed to the accounting, by establishing a ticket of settlement, which it transmits to the treasury

for payment, and composed of three services:

general accounting, analytical accounting and budget, treasury. [1], [2]

D- Stewardship Division:

The stewardship division is made up of three services:

Catering, accommodation, stewardship management

E- Supply and transport division:

This division is made up of the following five services:

Purchasing, Transport, Vehicle maintenance, Equipment, Inventory management

F- Production division:

This division is responsible for all civil engineering, electromechanical and maintenance works, on behalf of the TFT region. If necessary, it calls on other service companies (ENGCB, COSIDER, etc.) for the realization of new works, in this case, its role is limited to control and supervision of the work carried out by these companies. It has four services:

civil engineering - general maintenance - new works - electromechanical

G- Security division:

The security division is responsible for industrial security and safeguarding the industrial environment of all production and ancillary infrastructures in the region of TFT. The objectives sought by the division are to maintain production while reducing costs. accident risks, at an acceptable level, and minimizing the impacts of infrastructure on the environment. The security division is made up of two services and an environment unit. directly reporting to the head of the division: Prevention/intervention/Environment unit.

H- Operations division:

The operations division is responsible for the exploitation of oil, gas and water from the heads of wells until their shipment, it is responsible, among other things, for the management of surface installations following: [1], [2]

- Pipe line linking the producing wells to the separation centers
- Separation centers
- Storage centers (oil)
- Gas processing and compression plant combine
- Compression stations (gas lift closure)
- Water production and injection stations

The oil activity is spread over 300 wells and 20 separation centers adjoining the two northern sectors and South. For the North sector these are TFT and TAM. The South sector includes TFY, MAZOULA and DJOUA. Among the tasks accomplished by this division, we can cite the following:

- Opening and closing of wells
- Reports storage collection or shipping issues and anomalies
- Tests certain well parameters as part of a periodic program, such as:

Flow rates (oil, gas, water), pressures at the wellhead.

The division also carries out activities in the context of maintaining reservoir pressure, for example water production and injection as well as gas injection. The division also manages four compression stations, while ensuring the storage of crude oil whose total capacity is 72000 m3 (CPC TFT). The division verifies certain parameters and tests essential for reservoir monitoring such as testing oil and gas producing wells Such as GOR, water percentage, wellhead pressure. The division works in tandem with the security division, with the aim of ensuring the safety of personnel and property. [1], [2]

The organization chart of the Operations Division is made up of the following five departments:

North/South oil / Gas lift closure / Associated gas treatment unit / Pressure maintenance.

I - Maintenance division:

This division is responsible for the maintenance of equipment and various installations of all the TFT region. It has the following (06) services:

Turbomachine/industrial mechanics/industrial electricity/instrumentation/planning and method/oil works

The role of this division is to ensure the proper functioning of industrial equipment throughout the region, it is structured according to the following services:

***Method Service**: the Method Service plans equipment maintenance for all division services.

- Develops the schedule for equipment overhauls with the duration of the task
- forecast budgets, spare parts forecasts

The service is made up of three sections:

Turbomachine/industrial mechanics/instrumentation and electricity

***Industrial Mechanical Service:**

The service consists of three sections:

***Workshop Section:** takes care of the machining of parts and the renovation of rotating machines.

***South Sector Section**: this section has the task of intervention in the TAM oil, CPC sectors TFY, MAZOULA north and south.

***Northern Sector Section:** its role is intervention in separation centers From TFT, UTG, DJOUA and on generators, rotating machines throughout the region, as well as oil shipping pumps.

***Electrical Department:**

This service provides the following function:

- Transport of electrical energy to the stations and the life base Operation and maintenance of the 60kv and 5.5kv electrical network which are intended as follows: 60 kV to MP, GL, UTG, groups (TFT, TIFERNINE) and 5.5kv, to CPC, GCB.

- Maintenance of all electrical equipment in the region
- Development of specifications for electrical projects.

It is composed of: Power plant section/north electricity (TFT, UTG, MP)/south electricity (GL, TFY)

***Turbomachine service:**

It consists of the following sections:

- **Turbine section:** this section has the role of ensuring the maintenance and upkeep of the turbines at the levels of the CPC, electrical station, UTG.
- **UTG section:** ensures the maintenance and upkeep of the equipment of the two HP and BP trains with auxiliaries.
- **MP section:** takes care of the maintenance and upkeep of equipment at

TAM levels water, TFNE, CS2, AMASSAK.

- **GL section:** ensures the proper functioning of the stations: CPC, MF3, CTFNE, MF5.

***Petroleum Works Service:**

The main mission of the Petroleum Works department is to maintain equipment for surface installations of the production centers of the northern and southern sectors and stations (MP, FGL, UTG ...) as well as their control, measurement and safety instruments. [1], [2]

II -5.3 Description of UTGA:

With a processing capacity of 4.4 x 106 Sm3/J, the UTGA station is intended for the recovery of associated gases produced at the CS1, CS2, CS3, CS4 and CS5 separation centers.

These gases are collected by a collection network, then compressed, dried and treated while producing condensate. [1], [2]

II -5.3.1 Main elements of the UTGA station:

The main elements of the station are: [1], [2]

Manifold/Separators/Suction and discharge tanks/Separation pumps/Chillers/ Low pressure compressors/ Gas dryers/ Heaters/ Gas reboiler stripper/ HP compressors/ furnaces/ distillation column/ gas turbines

II -5.3.2 Description of the process:

The station (UTGA) located near the CS2 separation center has the function of compressing, to dehydrate and treat the associated gas. At the exit of the last compressor stage, the pressure gas reaches 80 bars in order to maintain sufficient injection pressure, for shipment by pipeline and at the head of various production wells. [1], [2]

A- Reception of associated gases:

The associated gases sent to the station are received by:

- A low pressure inlet separator for low pressure associated gases via of a BP collector. [1], [2]
- A high pressure inlet separator for HP gases via an HP collector.

These collected gases are sent to the LP and HP inlet separator for condensate separation.

B- Compression section:

Contains two compression trains (low pressure and high pressure)

* Low pressure gas compression section:

The received LP associated gases are sent to the low pressure compression section.

This compression section is made up of:

- a low-pressure gas compressor driven by an electric motor with its auxiliary facilities
- a Coolers
- two balloons

The received gas is compressed to the pressure equivalent to that of the HP associated gas at arrival, the gas is then cooled and decanted by the delivery tank (D-203A/B), then the gas will be mixed with the HP associated gas and sent to the compression boosting section. [1], [2]

*** Boosting and Recompression Compression Section:**

This section is made up of two compression units, each of which includes:

- Three compressors (two for boosting and one for recompression), which are driven by a gas turbine and auxiliary installations.
- Four balloons.
- Three coolers.

The HP gas emanating from the separation centers is introduced with the gas coming from the LP compressor in the H-P gas inlet separators (D-101) from where the gas is sent to two identical gas boosting trains. In each of these trains, the gas enters the first booster compressor (K-101A/B), the gas exits mixed with hot regeneration gas from the dehydration section and enters the second booster compressor (K-102A/B) after being cooled by the additional cooler.

The treated gas is compressed by the compressor (K-103A/B) to a pressure sufficient to be shipped from the station after being cooled. [1], [2]

C- Utilities:

*** Electrical energy:**

The station comprises facilities for receiving 60KV electricity from the network exterior and a substation for distribution is also equipped with an emergency generator 750KVA with diesel engine. [1], [2]

*** Air instrument and air service:**

The station includes an air production and distribution system to ensure instrument air supply and air service. The system consists of two air compressors driven by electric motors. [1], [2]

Conclusion:

In this chapter, we presented the geographical location of the TFT gas site, its production capacity and its reserves. We then dissected the development plan the different developments that have marked the gas industry in Algeria since its independence.

The Tin Fouye-Tabankort (TFT) field is one of the largest IOC-operated gas fields in Algeria, located in the prolific Illizi-Ghadames basin. Total and Repsol were awarded a production license in 1996 as part of SONATRACH's strategy to develop the gas sector, and TFT was an early key project in developing Algeria's LPG and condensate production. In 2023, SONATRACH, Total, and Repsol signed a new 25-year concession contract to extend the exploitation of the TFT field. The partners will carry out drilling and development investments to maintain the field's current production of over 80,000 barrels of oil equivalent per day for 6 more years. This agreement marks a new milestone in the strategic partnership between Total and SONATRACH in Algeria.

The TFT field is an important asset for Algeria's gas production and exports, particularly to Europe. The country's role as a reliable gas supplier has been highlighted by the recent energy market volatility. Algeria is positioning itself to maintain and expand its gas export capacity through new projects and partnerships like the TFT concession extension.

Chapitre II

Wellhead & X mas tree

Introduction:

The oil wellhead, also known as the wellhead or drillhead, is a crucial component of oil and gas operations. It is located on the surface of the well and acts as an interface between the well it self and the surface equipment. Its primary function is to control the flow of fluid (oil, gas, water) from the well, as well as provide an access point for drilling, completion and maintenance operations.

The wellhead is usually equipped with valves and control devices that help regulate the pressure and flow of fluids. It can also be equipped with safety devices, such as safety valves and relief valves, to prevent incidents such as oil spills or uncontrolled gas eruptions.

Additionally, the wellhead may house various sensors and measuring instruments used to monitor well conditions, such as pressure, temperature, and fluid composition. This data is essential to optimize production operations and ensure the safety of installations.

In summary, the oil wellhead plays a crucial role in the exploitation of oil and gas resources by ensuring safe and efficient control of the well, as well as providing essential data to optimize production operations.

1- Specification for Wellhead and Christmas Tree Equipment Api 6A:

API 6A is a crucial standard in the oil and gas industry that sets requirements for wellhead and tree equipment used in oil and gas wells. It covers various aspects such as performance, dimensional and functional interchangeability, design, materials, testing, inspection, welding, marking, handling, storing, shipment, and purchasing of equipment. The standard includes different Product Specification Levels (PSLs) that outline the minimum requirements for design, specification, qualification, temperature, process, inspection, and hydrostatic testing. API 6A also specifies different performance requirement levels (PR1 and PR2) with varying design validation procedures. Manufacturers producing API 6A compliant products must adhere to these standards to ensure the quality and safety of the equipment used in the industry [4]

1-1-The purpose of API 6A:

Api 6a serves as a critical standard in the oil and gas industry, specifically focusing on wellhead and tree equipment used in oil and gas wells. The purpose of API 6A is to establish requirements and recommendations for various aspects of this equipment, including performance, dimensional and functional interchangeability, design, materials, testing, inspection, welding, marking, handling, storing, shipment, and purchasing. This standard ensures the quality, safety, and reliability of the equipment used in the petroleum and natural gas industries by setting stringent guidelines that manufacturers must adhere to when producing wellhead and tree equipment. [4]

1-2 The impact of API 6A on the oil and gas industry :

API 6A has a significant impact on the oil and gas industry by ensuring safety, reliability, and standardization of wellhead and tree equipment used in oil and gas wells. This standard sets stringent requirements for performance, design, materials, testing, inspection, welding, marking, handling, and more aspects of the equipment. API 6A plays a crucial role in maintaining the quality and integrity of equipment used in petroleum and natural gas operations, ultimately contributing to the safety of workers, the environment, and the efficiency of oil and gas operations. Manufacturers must adhere to API 6A standards to produce equipment that

meets the industry's strict requirements, ensuring that the equipment is safe, reliable, and standardized for use in the oil and gas sector. [4]

I- Casing & Casing Programs :

Drilling a hole in the earth in the search for hydrocarbons involves the use of special drill equipment to both drill the hole and to run strings of casing. Casing is used to case the open hole to help keep it from caving in. This is especially important during the drilling of the well and later when total depth or "TD" is reached, to assure the oil and gas can be brought back to the surface.

Casing is large diameter steel pipe that is usually cemented into the hole to ensure a pressure tight connection to the oil and gas reservoir. Standard casing sized range from 4-½" to 20" in diameter.

Casing serves to:

- Prevent cave in or washout of the hole
- Prevent contamination of freshwater sands by fluids from lower zones;
- Exclude water from the producing formation
- Confine production to the well bore
- Provide a means of controlling the well pressure
- Permit installation of artificial lift equipment for producing the well
- Provide a flow path for produced fluids [5]

I-1- Types of Casing

During the course of drilling the well, casing is run and set at various intervals of hole depth. The number and size of casing strings will vary with each well and is determined by the drilling engineer as the well is being planned. There typically will be any where from 3 and up to 5 strings of casing run on a given well. Following we will discuss these types of casing strings: conductor; surface; intermediate; production; liner. [5]

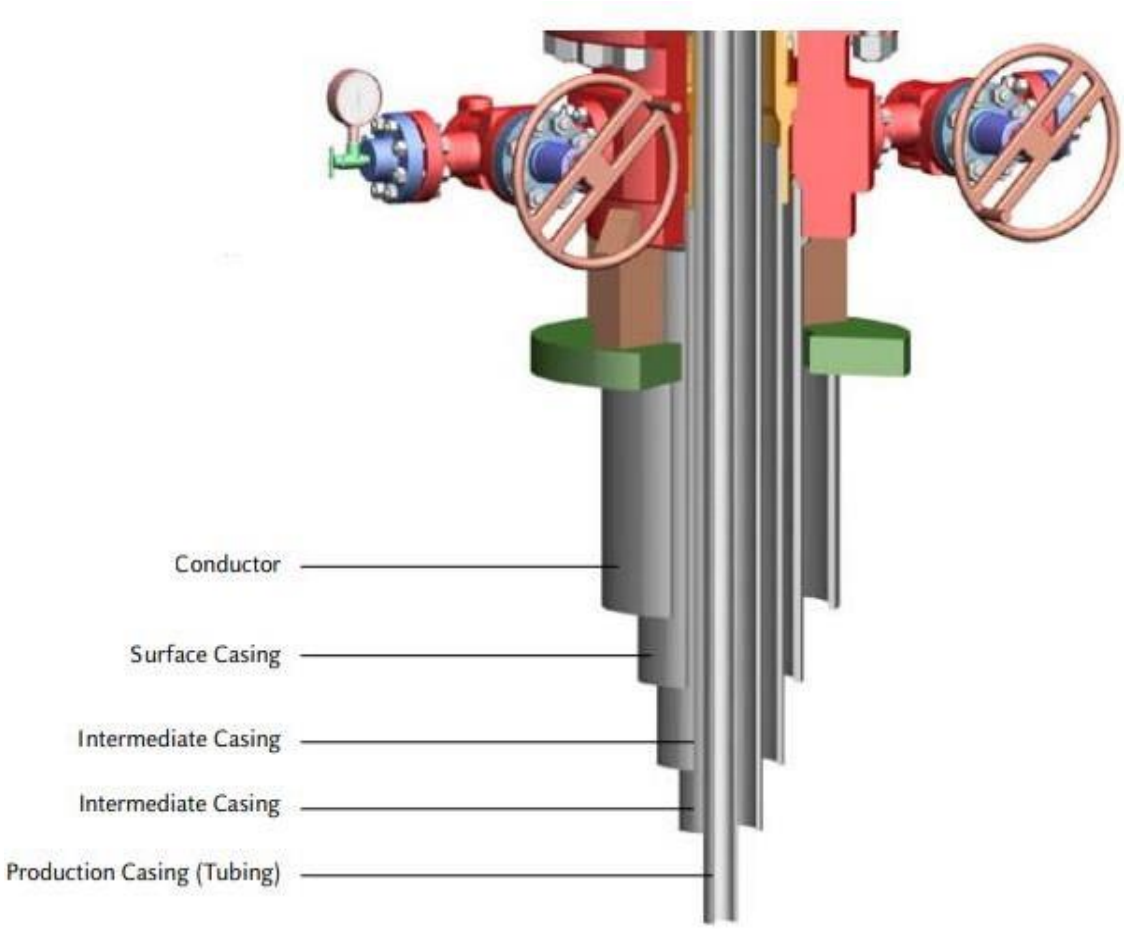


Figure II-01: Types of casings

❖ Conductor

A short string of pipe, usually 16" to 48" in diameter. Provides ground support for drilling operations. May extend 300 feet or more down. May be drilled for or driven in. Many times the "base plate" of the wellhead will sit on top of this string of pipe [5]

❖ Surface Casing

First string to be run inside the conductor and attached to the bottom of the lowermost wellhead component called the "casing head" or "starting head". May extend from 200' to more than 4000' depending upon circumstances at the surface. Usually will be engineered around the need to protect surface water sources or to isolate shallow gas deposits or both. [5]

❖ Intermediate Casing

May also be called protection casing and may be 5" to 13 3/8" in diameter. May be more than one intermediate string run depending upon down hole circumstances. Affords protection during drilling to isolate zones that may take mud from the hole as the well becomes deeper. Will usually be hung inside a casing spool and sealed off via special seals. [5]

- **Production Casing**

Sometimes referred to as the oil string, or long string. Isolates from undesirable fluids or gases and provides a means to protect the tubing and set a packer inside to create isolation between tubing OD and casing ID. [5]

- **Liner String**

A liner is a short string of casing used to case open hole below an existing string of casing. Extends from the bottom of that string into open hole with an overlap of approximately 100’ or more inside the previous larger string. [5]

I-2- Casing Properties

While the size of casing is important to us in the wellhead industry, there are other considerations that bear equal importance. When casing is run we need to know its weight per foot and the grade to be able to calculate the collapse pressures it will withstand. This is important information for us when we test the wellhead because the casing string will be exposed to certain test pressures after we install the equipment.

We also need to determine the drift diameter of the casing. This will tell us the diameters that the wellhead minimum id must be greater than to assure full opening into the casing. We also use information like tensile strength and pipe body yield to assure other wellhead associated members will function in a similar fashion as the casing. [5]

II- Definition of Wellhead

The wellhead is a structure located on the surface of a wellbore that serves as a connection point between the well and surface equipment. It is designed to control the flow of fluids (such as oil, gas and water) from the well and to provide safe access for drilling, completion and maintenance operations. The wellhead is equipped with valves, pressure control and safety devices, and sensors to monitor well conditions. Its role is crucial in oil and gas exploitation by ensuring safe and efficient operation of the well. [6]

II-1 Types of Wellhead:[6]

Table II-01: Types of Wellhead

System	Working pressure	Hanger/packoff retenion	Sealing technology	Nominal sizes	Temperature rating
Conventional	2000 psi thru 20000 psi	Lockscrew	Elastomer and rough casing metal seal (RCMS)	71/16″ thru 211/4″	-75° to 350°F
UH-1	5000,10000 psi	Lockscrew	Elastomer	11″,13-5/8″	-75° to 250°F
UH-2	5000,10000 psi	Internal latch	Elastomer	11″,13-5/8″	-20° to 250°F
UH-3	5000,10000 psi	Internal latch	Hybrid Pl-metal end cap	11″,13-5/8″	-75° to 350°F
UH-4	5000,10000 psi	Internal latch	Single metal to metal	135/8″ ,183/4″	-75° to 250°F
UH-5	5000,10000 psi, 15000 psi	Internal latch	Dual metal to metal	135/8″ ,183/4″	-75° to 400°F

1- Lockdown Screws:

Most Series tubing heads have a series of Lockdown Screws (LDS) in the top flange (unless customer or application requires otherwise). LDS have four functions:

- Actuate compression type hangers or packoff seals
- Lock the hanger or packoff down to prevent movement caused by thermal expansion of the tubing string during production
- Lock down the hanger in the event of annulus pressure
- Lock down temporary pressure isolation equipment, such as the patented Frac Isolation Sleeve during different stages of the completion phase of a well [6]

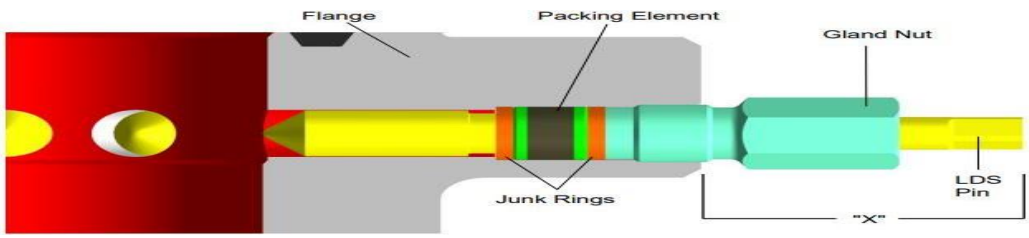


Figure II-02: Lockdown screws

2- Internal latch packoff

A significant design innovation in the UH-2 Unihead system is the internal latch packoff. The packoff uses an expanding latch ring retention mechanism, replacing lockdown screws.

The latch ring can be set and unset from the rig floor through the BOP stack, saving significant rig time compared to the lockdown screws system. Once engaged, the latch ring then becomes an independent load shoulder for the next hanger. Intermediate and production casing string packoffs are identical. Contingency packoffs are different, but use the same set of installation tools. We use a positive latch design that clearly indicates latch engagement and proper packoff installation. [7]

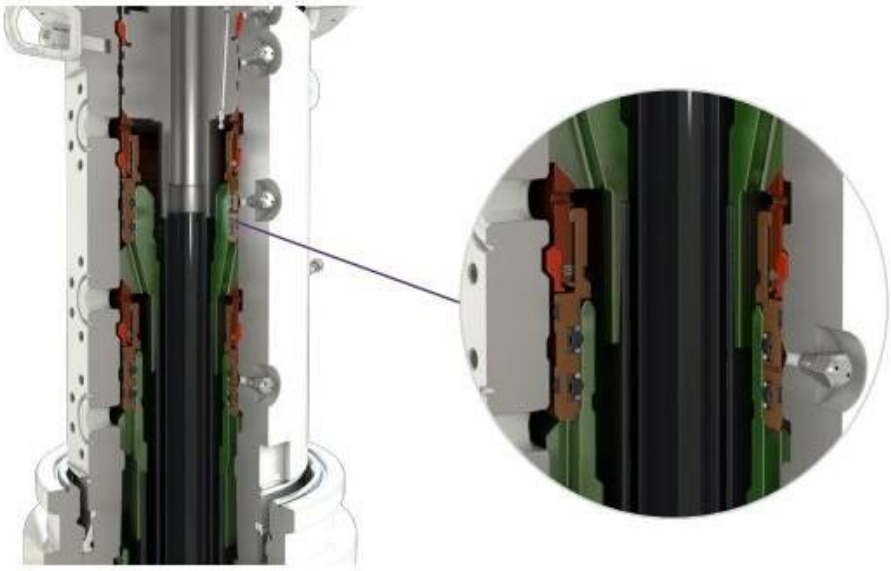


Figure II-03: Internal latch packoff

II-1-1 : Conventional Wellhead

Figure II-04: Conventional Wellhead

1- Base plates:

Base plates are often used for additional support when the weight suspended from the wellhead is high. The base plate may be an integral part (forged) or a separate piece attached with welded gussets or detachable assembly and positioned on the conductor or drive pipe. [6]

1-1 Functions:

- Provides means for temporary attachment to casing head
- Provides support for suspended weight in wellhead
- Provides means to transfer suspended weight in wellhead to conductor or drive pipe
- Provides access to weld the casing head to surface casing
- Provides means to center the casing head over base plate [6]

1-2 Features :

The split detachable base plate assembly is a base plate with integral vertical braces centralizing ring and tabs for connection to the casing head. The base plate assembly is attached to casing head with bolts and nuts. The base plate is not an integral part of the casing head so it can be easily detached from casing head. The detachable base plate provides the flexibility to use the same casing head with or without base plate depending on suspended weight in the wellhead. [6]

❖ **Bottom Connections:**

Each detachable base plate is designed for a range of conductor or drive pipe sizes. [6]

❖ **Top Connections:**

The top connection is designed to slip over the step at the bottom of casing head and to secure the base plate to casing head. [6]

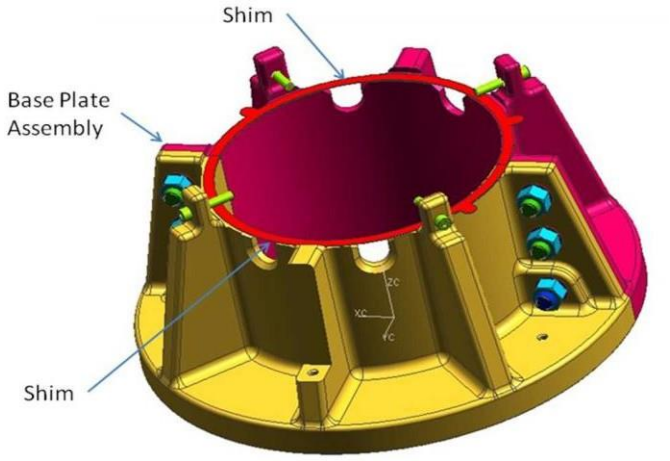


Figure II-05: Detachable Base Plate

2-Casing head:

2-1 Description and Function:

The casing head – also known as the "A" Section, Casing Head Housing (CHH), or a starter head – is the lowest part of the wellhead assembly and is almost always connected to the surface casing string. It supports the remaining parts of the wellhead and completion equipment

The casing head performs the following functions:

- Provides a means for attachment to the surface casing string.
- Allows for suspending and packing off of the next casing string (usually the first intermediate string).
- Supports the Blowout Preventers (BOP) while the hole is being drilled for the first intermediate string or the production casing string
- Provides outlets for fluid returns coming up the annulus and to monitor annulus pressure.
- Provides a means to test the BOP while drilling. [6]

Figure II-06: Casing Head Placement in a Wellhead Assembly

3-Casing spool:

Like a casing head, the casing spool has a top bowl that holds the casing hanger, which suspends a string of casing. Unlike a casing head, however, a casing spool also has a bottom prep with a packoff seal and a flange or clamp hub to connect it to the top of a casing head or previous spool. As many as four casing spools may stack on top of the other to hang intermediate and production casing strings. If a casing spool has full lockdown screws (LDS) it may also suspend tubing with a tubing hanger.

The functions of casing spools are as follows:

- Provides a load shoulder, in the top bowl, to support a casing hanger
- Provides a controlled bore, in the top bowl, for the casing hanger seal
- Provides a seal, in the bottom prep, to pack off the previous casing string, and isolate flange or hub seals and casing hanger seals from internal casing pressure
- Provides side outlets for fluid returns or fluid injection
- Provides a port for pressure-testing casing seals and flange connections
- Provides a means to support and test Blowout Preventers (BOP) while drilling [6]

Figure II-07: Casing spool

4-Casing hangers slips type :

In petroleum production, the casing hanger is that portion of a wellhead assembly which provides support for the casing string when it is lowered into the wellbore. It serves to ensure that the casing is properly located. When the casing string has been run into the wellbore it is hung off, or suspended, by a casing hanger, which rests on a landing shoulder inside the casing spool. Casing hangers must be designed to take the full weight of the casing, and provide a seal between the casing hanger and the spool.

Casing hangers have three functions:

- Suspend the casing load from a casing head or spool
- Center the casing string in the head or spool
- Provide a pressure-tight seal against the inside of the casing head or casing spool bowl to contain pressure in the annulus between its casing string and the previous string. In some cases, a separate seal ring or packoff bushing is necessary to provide the seal [8]

Figure II-08: Casing hanger and slips

The primary purpose of a casing hanger is to support and seal the casing strings within the wellhead. These casing strings are large-diameter pipes that are inserted into the wellbore during drilling and cemented in place. Casing hangers serve the following critical functions:

***Support:** Casing hangers support the weight of the casing strings, preventing them from collapsing or shifting within the wellbore. This ensures the structural integrity of the well.

***Sealing:** Casing hangers create a seal between the casing and the wellhead, preventing the escape of hydrocarbons and other fluids from the well. This is essential for safety and environmental protection.

***Isolation:** They isolate different sections of the wellbore, allowing for the injection of fluids, such as cement or drilling mud, and the production of hydrocarbons from specific reservoir zones. [8]

4-1 casing hanger C21:

The isolates the hanger from between-flange test pressure. This ring is used with C casing heads or spools that do not have lockdown screws and is installed after the casing has been cut.C Type H seal ring The features segmented slips with no annulus seal and is typically used for minimal casing loads. [8]

Figure II-09: casing hangers non-automatic c

4-2casing hanger C22:

GBI C22, or C-22, casing hangers are a wrap-around style with slip segments to bite into the casing. C22 provides an automatic Packoff seal energized by casing weight & lock screws and is recommended for medium casing load applications. [8]

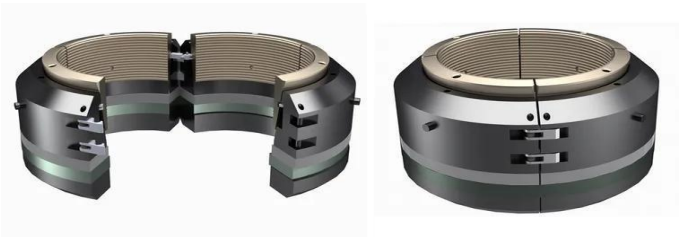


Figure II-10: casing hangers automatic

5-Tubing head:

The tubing head is the top spool on a surface wellhead assembly. It is installed on top of the casing spool that contains the last casing string (typically known as the production casing string), provides annulus access to the production casing string, and provides a seat and seal bore for the tubing hanger or packoff. After well completion, the surface tree installs on top of the tubing head using a tubing head adapter.

The tubing head performs the following functions:

- Provide a load shoulder inside the head to support tubing hangers and packoffs

- Provide a controlled seal surface bore against which the hanger or packoff can seal
- Provide a secondary annulus seal around the top of the previous casing string with their bottom prep packoffs
- Allow access to the annulus between the tubing string and the production casing
- Provide a means to support and test the Blowout Preventers (BOP) and frac equipment while completing the well [6]

Figure II-11: Tubing head

6- Tubing hanger:

Tubing hangers suspend the tubing and provide a primary annulus seal between the tubing and production casing. Packoffs only provide a seal between the tubing and production casing; they do not suspend the tubing. Both hangers and packoffs run through the blowout preventer (BOP) and land in the top bowl of the tubing head. Tubing hangers and packoffs are available for any type of tubing completion.

Tubing hangs and seals in four ways:

- Mandrel type tubing hanger
- Coupling type tubing hanger and packoff
- From the tubing head adapter
- From a coupling and/or mandrel inside a master bushing [9]

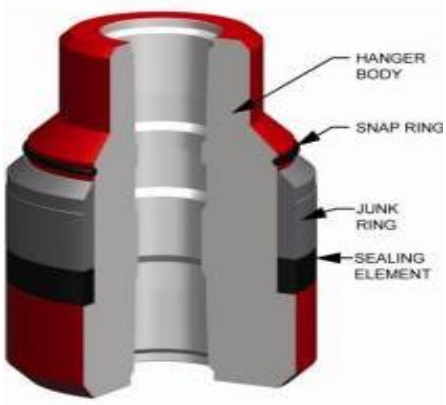


Figure II-12: Tubing hanger

7- Tubing Head Adapters:

7-1 Description and Function:

The tubing head adapter is the transition fitting between the surface tree and the tubing head. The bottom connection of the adapter matches the tubing head and the top connection of the adapter matches the tree. There are four basic types of adapters:

- Basic adapters
- Seal-bore adapters
- Tubing suspension adapters
- Coupling adapters [6]

7-2 Basic Adapters:

Basic tubing head adapters provide only a fitting for the tree. These adapters do not hang the tubing or provide a controlled seal bore.

Basic adapters have a slick bore and are used when the tubing suspends from the tubing hanger. They are for low pressure completions where the downhole line or tubing string manipulation is not necessary. The basic adapter normally installs with the tree, after running the tubing. [6]

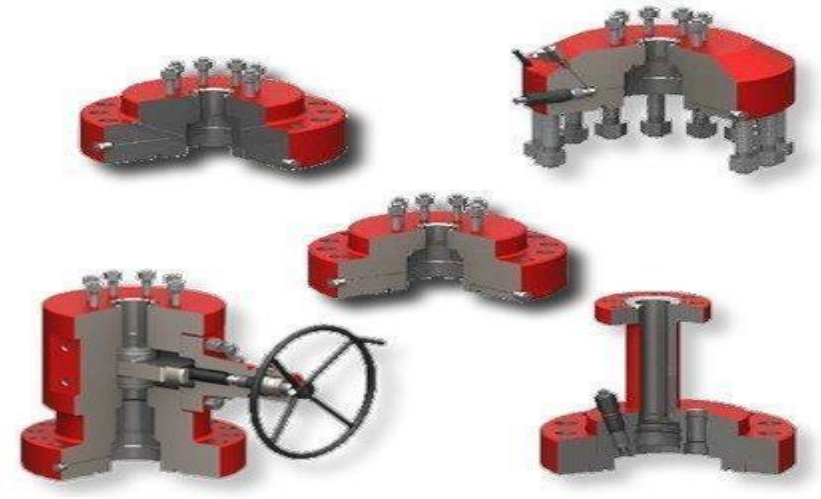


Figure II-13: Tubing Head Adapters

8-Ring Gasket:

Ring gaskets play a crucial role in the oil and gas industry by providing reliable seals for pipelines, flanges, and other connections, helping to prevent fluid and gas leaks. These gaskets, also known as ring joint gaskets or RTJ gaskets, are circular in shape with a hollow center, resembling a ring. They are designed to create a tight, secure, and leak-proof seal between flanges or other connecting surfaces under high compressive loads, making them ideal for applications where conventional gaskets may fail under extreme conditions. Ring joint gaskets are commonly used in industries such as oil and gas, chemical processing, power generation, and the petrochemical industry due to their ability to withstand high-pressure and high-temperature environments effectively. The materials used in ring gaskets, such as stainless steel, carbon steel, alloys like Inconel and Monel, soft iron, and duplex or super duplex, are carefully selected to ensure the gaskets' effectiveness in various applications. Different types of ring gaskets, including oval, octagonal, RX, BX, and SRX types, cater to specific needs and conditions, providing improved sealing performance in critical applications within the oil and gas industry, including those compliant with API 6A standards. [10]

Figure II-14: Ring Gasket

8-1 the advantages of using ring gaskets in oil and gas operations:

Ring gaskets offer several advantages when used in oil and gas operations, making them a preferred choice for sealing applications in high-pressure and high-temperature environments. Here are the advantages of using ring gaskets in oil and gas operations:

***High-Temperature and High-Pressure Resistance**: Ring gaskets are designed to withstand extreme temperatures and pressures commonly encountered in oil and gas operations, ensuring a reliable seal under challenging conditions.

***Effective Sealing Performance**: These gaskets provide a tight and secure seal between flanges or other connecting surfaces, minimizing the risk of leaks and ensuring the integrity of the system.

***Standardization and Compliance:** Ring gaskets, such as those manufactured according to API spec 6A standards, ensure compliance with industry regulations and standards, promoting safety and reliability in oil and gas equipment.

***Versatility:** Ring gaskets come in various types, such as oval, octagonal, RX, BX, and SRX, catering to different needs and applications within the oil and gas industry, providing versatility in sealing solutions.

***Material Selection:** Ring gaskets can be made from materials like stainless steel, carbon steel, Inconel, Monel, soft iron, and duplex or super duplex, allowing for customization based on specific operational requirements.

***Reliability and Durability:** These gaskets are known for their reliability and durability, ensuring long-lasting performance in demanding oil and gas environments, reducing the need for frequent replacements.

***Compatibility with Special Flanges**: Ring gaskets are always used in combination with special flanges that ensure a good seal, making them suitable for specific applications requiring unique sealing solutions.

By leveraging the advantages of ring gaskets in oil and gas operations, companies can enhance the safety, efficiency, and reliability of their equipment and systems, ultimately contributing to the overall success of their operations [10]

9- SBMS:

SBMS (Straight Bore Metal Seal) is a crucial sealing technology used in the oil and gas industry, specifically for ensuring gas-tight sealing between the tubing hanger neck and the Christmas tree. This metal-to-metal seal technology is designed to provide enhanced sealing performance in critical applications within wellhead systems. SBMS is part of the sealing technology offered by TechnipFMC, a company known for its expertise in developing reliable and robust seal technologies for various well conditions, ranging from low-pressure oil wells to high- pressure and high-temperature gas wells. SBMS, along with other metal-to-metal seal technologies like Rough Casing Metal Seal (RCMS) and Externally Energised Metal Seal (XEMS), undergoes fire testing to ensure its effectiveness and reliability in demanding oil and gas environments. These seal technologies are qualified in accordance with API 6A PR2F standards, demonstrating their compliance with industry regulations and their ability to deliver trouble-free seal integrity throughout the life of the well. [6]

Figure II-15: SBMS

III -X mas tree:

The X-mas tree, also known as the Christmas tree, is a complex set of equipment installed on the surface of an oil or gas well to control the flow of fluids (oil, gas, water) and allow the connection of production, injection or well control equipment.

Typically, it acts as an interface between the well and surface equipment, allowing operators to monitor and control the production process safely and efficiently.

In summary, the X-mas tree is an essential element of oil and gas installations, providing control and management of fluid flow in the well and facilitating production, injection and maintenance operations. [11]

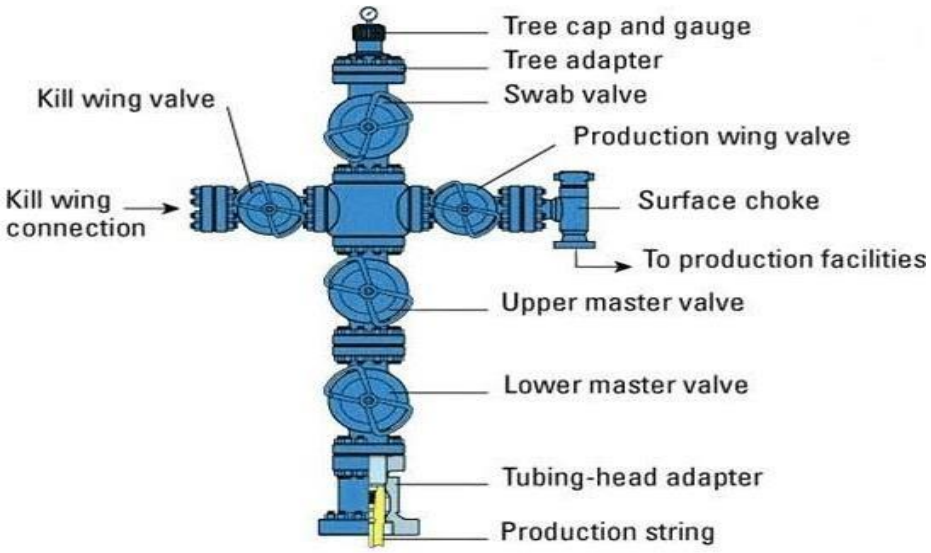


Figure II-16: X-mas tree

We have two types of X-mas tree : Frac X-mas tree and Production X-mas tree :

III -1 Frac X-mas tree:

The frac tree, whose major components are several frac gate valves and frac heads, is a crucial part of fracturing equipment.

Its main purpose is for the fracturing operation, which is controlled by the frac gate valve, through which multiple frac manifolds serve as the way into the frac head then down to the bottom of the well.

With techniques of the international advanced level, our frac tree is in parallel with the best choice.

For drilling and oil and gas outflow, the equipment of the wellhead and the Christmas tree are primarily used to monitor the surface pressure, regulate the oil (gas) and water flow and curb the volatile and toxic substance onto the surface and into the water. Besides, it is applicable to measure operations such as acidizing, fracturing, water injection, testing and so on [11]

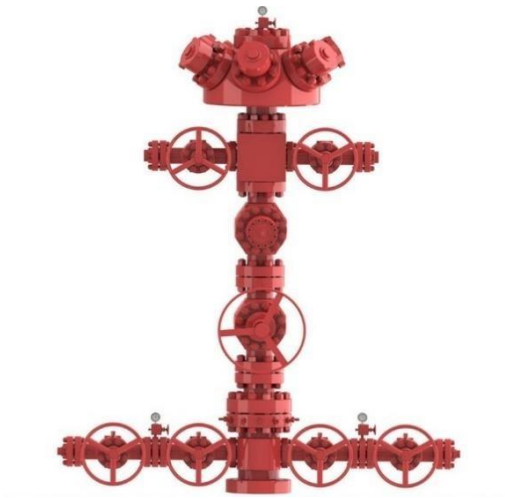


Figure II-17: Frac X mas tree

III -2 Production X mas tree:

III -2-1-Lower master valve

The lower master valve is a valve used to limit the amount of flow into the Christmas tree from the wellhead. It is manually operated in most cases and is held in a restricted, partially open position during production. [11]

III -2-2-Upper master valve

The upper master valve is a safety measure in case the lower master valve fails or if maintenance needs to be performed on the Christmas tree. It is often a remote-controlled valve and is automatically closed when the safety signal is given to prevent all flow to the Christmas tree. [11]

III -2-3-Kill wing valve

The kill wing valve is another hand-operated valve that is the connection point for injection. Fluids such as corrosion inhibitors, methanol, dewatering formulations, etc. can be injected through this valve. They are also known as side arm valves or secondary wing valves. [11]

III -2-4-Production wing valve + choke

The production wing valve, often located 180 degrees from the kill wing valve, is an automatically operated component that requires positive hydraulic pressure to remain open. It prevents injection/flow to the well during emergencies or maintenance and is often combined with a choke to control flow and pressure from the well. This choke is considered the 'tap' from which the fuel flows, so controlling the flow rate is very important for this component. [11]

III -2-5-Swab valve + cap and gauge

The swab valve is another manually operated valve that provides direct vertical access to the wellbore for well intervention. The T-cap and gauge are visual indicators of which valve is open; for example, if the kill wing valve is open and the swab valve is closed, the gauge should indicate 0 psi (no pressure), and if the production wing valve is open and the swab is open, the pressure should indicate the value specified by the well manufacturer. They can also include digital temperature valves and other monitoring systems to keep the well safe, since too many manual valves leave room for operator error. [11]

III -2-6- Gate Valve:

Gate valves are an on/off or positive shut off control devices that are used during drilling, completion, injection, and production of wells. By design, they will only operate in the fully open or the fully closed position. Gate valves are not chokes. They should never be used to throttle the flow of fluids under pressure.

Gate valves are positioned primarily in two places on conventional wellhead assemblies:

- In the wing position (side outlets) of casing heads, casing spools, or tubing heads.
- In a surface tree assembly.

Gate valves installed in the wing position of the lower sections of the wellhead assemblies are called annulus valves and gate valves installed on the upper sections of wellhead assemblies are called surface tree gate valves. [12]

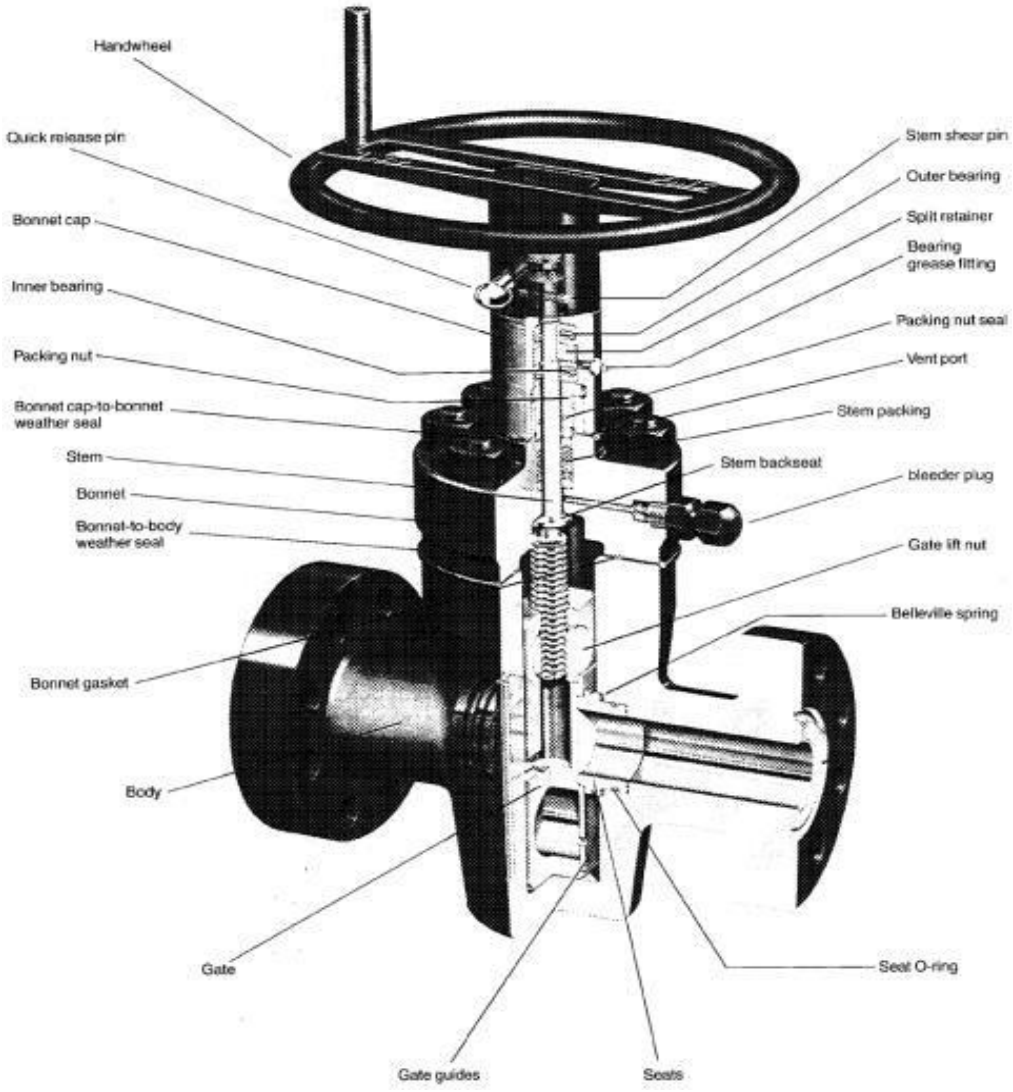


Figure II-18: Gate valve

There are several models of gate valve like M101/M120/M120+/M130/M130+ and each model has size, volume , turn to open and close , working pressure . [12]

III -2-7-Actuators:

The primary purpose of an actuator is to serve as a safety device which is used to shut in the well bore in the event of a catastrophic emergency.

*Fail Safe – Fail Close

*Rapid and complete valve closure in the event of the loss of control pressure

*Valve (Well Bore) pressure will close the actuator with the loss of control pressure

* Actuator springs shall be designed to assure complete closure with low or zero pressure in the valve body. [3]

III -2-7-1-HY – Hydraulic Actuators:

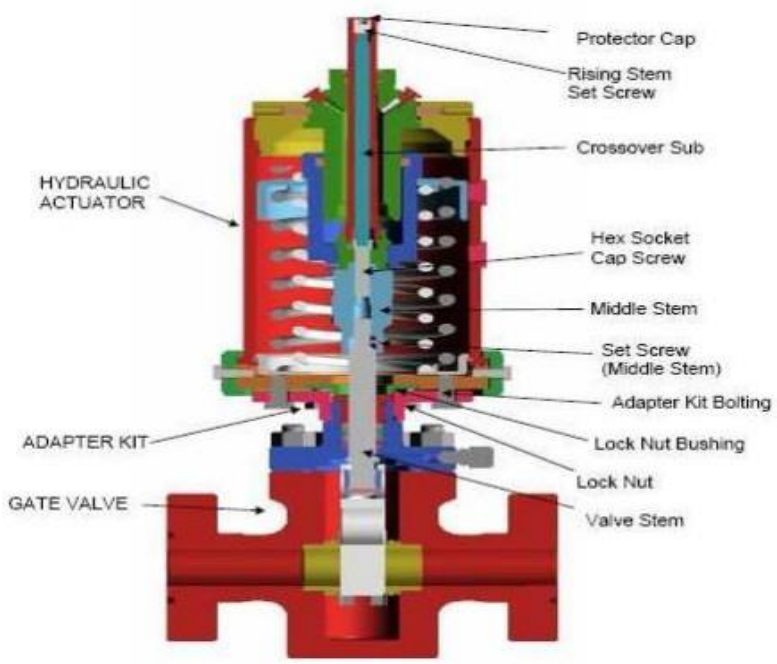


Figure II-19: HY Actuators

The HY Hydraulic Actuator is a ratio-piston-type actuator mounted on an "Adapted For" reverse acting gate valve designed to be "fail-safe and fail-close" which means the actuator will automatically close the valve in the event that hydraulic control pressure is lost.

The actuator operates using a closed hydraulic system completely independent of well fluids and pressure, and the actuator is opened when the force from the hydraulic control pressure overcomes the stem thrust and the drag force acting on the lower stem, gate and seats.

To meet the "Fail Safe – Fail Close" design requirement, the Adapted For valve stem is designed to have sufficient area so that the valve pressure acting on the cross sectional area of the valve stem will generate sufficient force to overcome the gate drag and packing friction to allow the stem to push the actuator closed. In the event that the valve has zero pressure in the bore, the actuator springs are designed to provide sufficient force to lift the weight of the gate and stem as well as overcome the packing friction to close the valve. [3]

III -2-7-2-PN – Pneumatic Piston Actuators

The PN Pneumatic Actuator is a ratio-piston-type actuator mounted on an "Adapted For" gate valve designed to be "fail-safe and fail-close". The PN actuator is operated by an air or gas source. When installed as part of a surface safety system, loss of pneumatic control pressure in the actuator cylinder will allow the well bore (valve working) pressure acting on the lower stem area to close the valve automatically. Additionally, the actuator springs are designed to provide enough closing force in the event that the valve working pressure is at or near zero. [3]

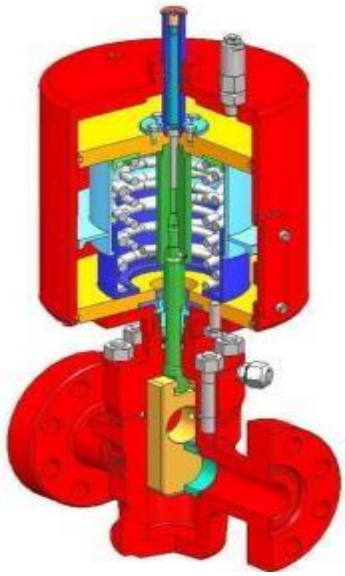


Figure II-20: PN Actuators

III -2-7-2-1Components of the Pneumatic Actuator

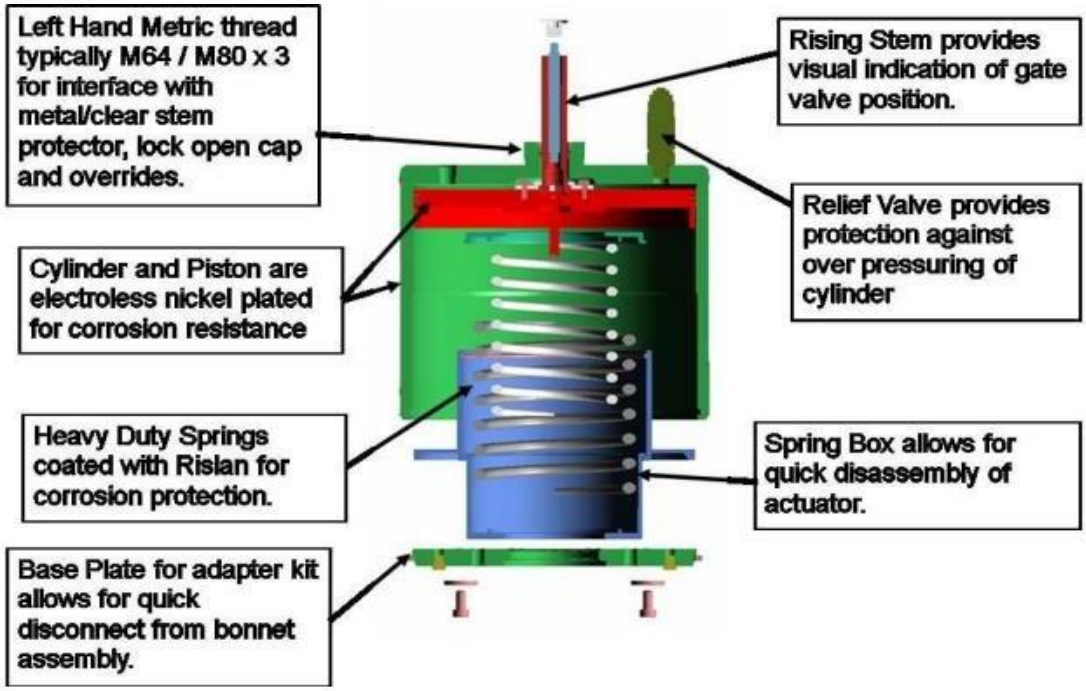


Figure II-21: Pneumatic Actuator Primary components

III -2-8-Cross:

The "cross" is a specific component of this Christmas tree. It is so named because of its cross shape when viewed from above. The cross is usually located at the top of the Christmas tree and is used to connect different parts of the Hole

***Structure:** The cross is generally made of sturdy steel to withstand the extreme conditions encountered in oil and gas operations. It is designed to support the loads and pressures associated with the operation of the well.

***Connections:** The cross has several ports or fittings for connecting the various equipment and pipes associated with the Christmas tree. These connections make it easy to control fluid flow and pressure.

***Operation:** The cross is essential for the delivery of fluids between the wellbore and surface equipment. It allows fluids to be directed to the appropriate pipes for subsequent treatment or storage.

***Maintenance:** Like any other oil and gas equipment, the cross requires regular maintenance to ensure its proper functioning. This may include visual inspections, pressure testing and repairs if necessary.

In summary, the cross is a vital component of the petroleum Christmas tree, facilitating the control and manipulation of fluids extracted from the wellbore. Its role is to provide a secure and reliable connection between the various equipment and pipes associated with oil and gas exploitation.[13]

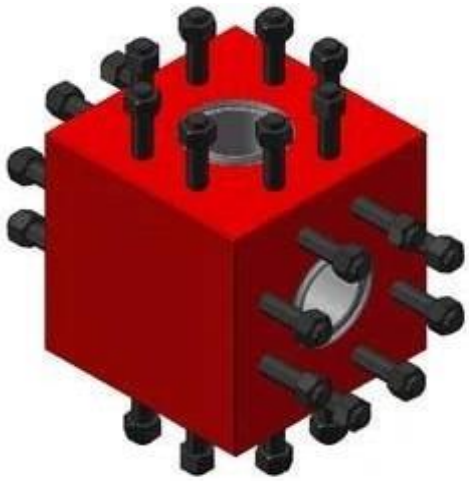


Figure II-22: Cross x-mass tree

IV -1 UH-1:

The UH-1 Drill-Thru Wellhead system provides time savings that dramatically reduce rig costs, allowing you to maximize the productivity of your drilling operation. The UH-1 wellhead maintains well control from the reduction of BOP nipple up and down times. It is commonly utilized for 13 5/8in surface, 9 5/8in intermediate, and 7 in production casing, with a compact design that addresses your sub- structure space constraints.

A UH-1 wellhead can consist of either two stages or three stages which will consist of a lower Unihead, either a Casing Head or Casing Spool, if the bore diameter needs to be reduced from the Casing Head used within the UH system, and one or two upper Uniheads.

Designed for quick and simple installation, the UH-1 wellhead allows you to make up 2-4 strings of casing without removing the BOP by having the same bore diameter throughout, optimizing rig time with the use of Mandrel Hangers and using the Packoffs to provide the next load shoulder for the following casing program. Though this wellhead is comprised of 2 or more drilling spools, they are made up as a single unit. This permits the drilling of two or more phases at the same time - saving 10 hours per stage.

It is common to use Mandrel Hangers when running Unihead systems. If the casing becomes stuck during installation an emergency plan is in place for the Unihead system. This is why the Unihead is made up of separate bodies to allow the Unihead to be split and run the contingency program by cutting the casing and using slip type hangers. UH-1 Drill-Thru Wellhead. [3] [14]

Figure II-23: UH-1

IV -1-1-Features:

- Basic Unihead Technology.
- Simple J slot Packoffs held in place with traditional lockdown screws.
- Utilizes the same lockdown screws to retain the Wear Bushing (Bowl Protector).
- Proprietary FS/S seals.
- Fluted Mandrel Casing Hangers with ACME running threads.
- Provides a means to support and test the BOP while drilling.
- Separate spools, made up as single unit permits drilling of two or more phases without removing the BOP [14]

IV - 1-2 Benefits:

- Reduces wellhead installation time:

For example; for 13 5/8in-10,000 psi installations, an average of 19 hours of rig time will be saved. That includes two drilling stages, meaning for wellheads requiring more than two phases, an additional ten hours per phase will be saved.

Table II-02: Example Comparison of Installation Time

Conventional Wellhead	Time (hrs)	UH-1 Drill-Thru Wellhead	Time (hrs)
Weld on 13 3/8in SOW Head, nipple up 13 5/8in BOP and DSA	12	Weld on 13 3/8in SOW Head, nipple up BOPs	10
Run and cement 9 5/8in casing, nipple down BOP & DSA, install Casing Spool	14	Run and cement 9 5/8in casing; no removal of BOPs or additional head installation	-
Run and hang 2 7/8in tubing, nipple down DSA & BOP	6	Run and hang 2 7/8in tubing, nipple down BOP	3
Nipple up 2 9/16in tree	3	Nipple up 2 9/16in tree	3
Total Installation Time	**35**	**Total Installation Time**	**16**

- Addresses substructure space constraint
- Maintains well control from the reduction of BOP nipple up and down times
- Improved safety. No need to work under suspended BOP stack except in emergency situations. [14]

IV -1-3- Mandrel hanger:

Mandrel hangers play a crucial role in the oil and gas industry, specifically in wellhead systems, by supporting the casing string when it is run into the wellbore. These hangers ensure that the casing is properly located and provide a seal between the casing hanger and the spool, contributing to the integrity and safety of the well. Mandrel hangers are designed to take the full weight of the casing string, allowing for the transfer of the casing string weight from the drilling rig to the load shoulder in a casing head or spool. They come in various types, such as slip-type and mandrel-type, with the mandrel type being threaded into the casing to provide superior well control when landing the hanger and improving the annular seal. Mandrel hangers are essential components in wellhead assemblies, ensuring the proper suspension and sealing of the casing string, and are designed, manufactured, and tested in accordance with API 6A standards to meet industry requirements for reliability and performance in oil and gas operations. [15]

1- the different types of mandrel hangers used in oil and gas operations :

In oil and gas operations, different types of mandrel hangers are utilized to support casing strings and ensure proper sealing within the wellhead systems. Here are the various types of mandrel hangers commonly used in oil and gas operations:

***Slip-Type Mandrel Hanger:** This is the conventional and most commonly used type of mandrel hanger. It is versatile and suitable for a wide range of well designs, providing reliable support for casing strings.

***Threaded Mandrel Hanger:** Threaded mandrel hangers secure the casing using threads, offering ease of installation and removal. They are known for their efficiency and simplicity in supporting casing strings.

***Metal-to-Metal Sealing Mandrel Hanger:** These hangers provide a robust metal-to-metal seal between the casing and the wellhead, ensuring high-pressure containment and reliable sealing performance in critical oil and gas applications.

***Custom Mandrel Hangers:** Custom mandrel hangers are designed to meet specific operational requirements and well configurations, offering tailored solutions for unique wellhead setups and challenging environments. Each type of mandrel hanger serves a specific purpose and is selected based on the operational needs, well conditions, and pressure requirements in oil and gas operations. These mandrel hangers play a vital role in supporting casing strings, providing sealing integrity, and ensuring the safe and efficient extraction of oil and gas resources from wells. [15]

Figure II-24: Mandrel Hanger

Figure II-25: Running tool of Mandrel Hanger

IV -1-4 Packoff mandrel hanger :

A packoff mandrel hanger is a component used in the oil and gas industry to suspend and support production tubing or casing in a wellbore, while also providing a seal at the interface between the tubing and the wellhead . The main purpose of the packoff mandrel hanger is to prevent fluid leakage between the tubing and the wellhead, which is essential to maintain the integrity of the well and to control the flow of produced fluids.

Concretely, the packoff mandrel hanger is designed with sealing elements, such as O-rings or metal gaskets, which ensure a hermetic seal between the tubes and the wellhead. This helps prevent oil, gas or water from leaking from the well to the outside environment, while also preventing the intrusion of contaminants or water into the well.

In summary, the purpose of the packoff mandrel hanger is to suspend and support the production tubing while providing an effective seal at the interface between the tubing and the wellhead, thereby ensuring safe and efficient operation of the oil well or gas. [15]

Figure II-26: Packoff

Figure II-27: Running tool of packoff

IV -1-5 Wear bushing (bowl protector)

The bowl protector, also called a wear sleeve or wear bushing, is installed in the top bowl of a casing head, casing spool, or tubing head during drilling and workover operations. It protects the load shoulder and critical sealing surfaces from wear and damage caused by the drill bit, drill pipe, and downhole tools. The bowl protectors are installed and retrieved with either a simple J-type running tool or a combination BOP test plug and running tool. They are usually installed immediately after the casing head, casing spool, or tubing head, that has been nippled up, and before drilling resumes. standard bowl protectors incorporate one of two methods to retain the bowl protector in the casing head or spool. One method is to use a dove tail elastomeric seal, called an L packing, to retain the wear bushing or wear bowl in the casing head or spool. Another method is to use Lockdown Screws (LDS) or Bowl Protector Type Screws (BPS) to secure the bowl protector in the head or spool.

We have three types of bowl protector; [16]

Figure 28: Long bowl protector

Figure 29: Intermediate bowl protector

Figure 30: Short bowl protector

Figure II-31: Running tool of bowl protector

IV -2 UH-2:

The UH-2 Drill-Through Unihead is a compact and unitised wellhead system that offers rig time savings, better well control and safer operations for rig crews.

The UH-2 Unihead system can be used as an alternative to our conventional spooled system or our UH-1 Unihead system. [3]

Figure II-32: UH-2

IV -2-1 Advantages:

-Offers internal latch packoffs and heavier load capacity

-Caters to single or twin stack BOPs and reduces BOP manipulation Saves up to 40 hours of rig time per well compared to conventional wellheads Improves pressure integrity with fewer through-wall penetrations [3]

Available with light or heavy casing programs:

Figure II- 33: Available with light or heavy casing programs

IV -2-2 UH-2 value proposition:

Low-cost Unihead option: same flexibility, safety and operating costs benefits of a Unihead at a lower cost Saves 40 hours of rig time compared to conventional system:

- Fast make up of starter head to Unihead
- Speedloc II clamp connection is used on the starter head and Unihead for drilling , with more time savings than API flanged connections
- Uses mandrel hangers, eliminating wait time on cement
- No lifting of BOPs to cut casing
- Field proven packoff
- installs and tests first time every time
- Efficient tooling to ensure smooth wellhead running

Safer than conventional wellheads due to fewer BOP manipulations working under suspended load to cut casing .

Globally standardised and field-tested UH-2 Unihead system Standardised global tool pool available near you [3]

IV -2-3 Features:

- Internal latch – no lockdown screws
- Independent load shoulders
- Fast makeup Speedloc clamps
- Fluted mandrel casing hangers Elastomeric packoffs using our seal technology
- Flexible design with standardised product across slim-hole and full-hole casing programs
- Onshore and offshore configurations Inbuilt safety features across UH-2 product range [3]

IV -2-4 UH-2 Sealing technology:

UH-2 Sealing technology TechnipFMC has a solid track record of investing in the development of new seal technologies. We continue to invest in metallic and non-metallic seal technology to handle all well conditions globally from low pressure oil wells to high pressure and high temperature gas wells. Our seal technologies have been designed to be reliable, robust and practical while delivering trouble-free seal integrity throughout the life of the well. Our seal capabilities cover 2,000 psi through 20,000 psi and temperatures from -75° F to 400° F.

The UH-2 product family offers a variety of non-metallic and metallic seal technologies covering a wide range of well conditions:

- S & FS Seals for machined and rough casing have been designed in-house using proprietary elastomer compounds (NBR, HNBR and FKM)
- Elastomer compounds have undergone stringent Rapid Gas Decompression testing per industry standards and our own internal test protocols
- Immersion testing has been carried out using various fluids to validate the suitability of the elastomer compounds for drilling and completion service
- Dovetail, L-Packing and compression packing for installation tooling
- Straight Bore Metal Seal (SBMS) for gas tight sealing between the tubing hanger neck and christmas tree
- Fire testing conducted on our metal-to-metal seals

Both metallic and non-metallic seals have been qualified in accordance with API6A PR2F. [3]

Figure II-34: FS Seal and S Seal

IV -2-5 Features and benefits Flexibility and reduced installation time

- Drilled with two-stack BOP (20¾-inch, 21¼-inch and 135/8-inch)
- 5,000 psi and 10,000 psi maximum working pressure
- 185/8-inch and 20-inch Sliploc and buttress starter heads, 20.140-inch and 18.595-inch
- Starter head upper connection 20¾-inch, 3000 psi API hub (compatible with Speedloc II clamp)

- Slim-hole and full-hole casing program options
- Basic system: 133/8-inch casing is threaded into the Unihead and run through the low pressure diverter with the Unihead.
- Medium system: 133/8-inch hanger runs through the diverter and lands in starter head, Unihead is then nippled up.
- Quick stab connected to starter head
- Fluted casing hangers runs through BOP, saving wait time on cement
- Emergency slip hangers available in the case of stuck casing
- Facilitates BOP test with short bowl protector left in place [3]

IV -2-6 Safety and reliability working to eliminate NPT

- Internal latch UH-2 packoff

– Eliminates lockdown screws, reducing leak paths

– Ensure safe installation through the BOP

– Creates independent load shoulders

– Fits all hanger sizes

– Uses proprietary FS and S elastomeric seals with integral non-extrusion rings

– Available as separate contingency packoffs

- Eliminates J-Slots on bowl protectors; Stab in/out design [3]

IV -3 Wear Bushing UH-2:

The Wear Bushing UH-2 is a specific type of wear bushing designed to safeguard seal areas in intermediate casing heads, casing spools, and tubing heads during drilling operations, ensuring the integrity of the seal areas (internal latch ring). [3]

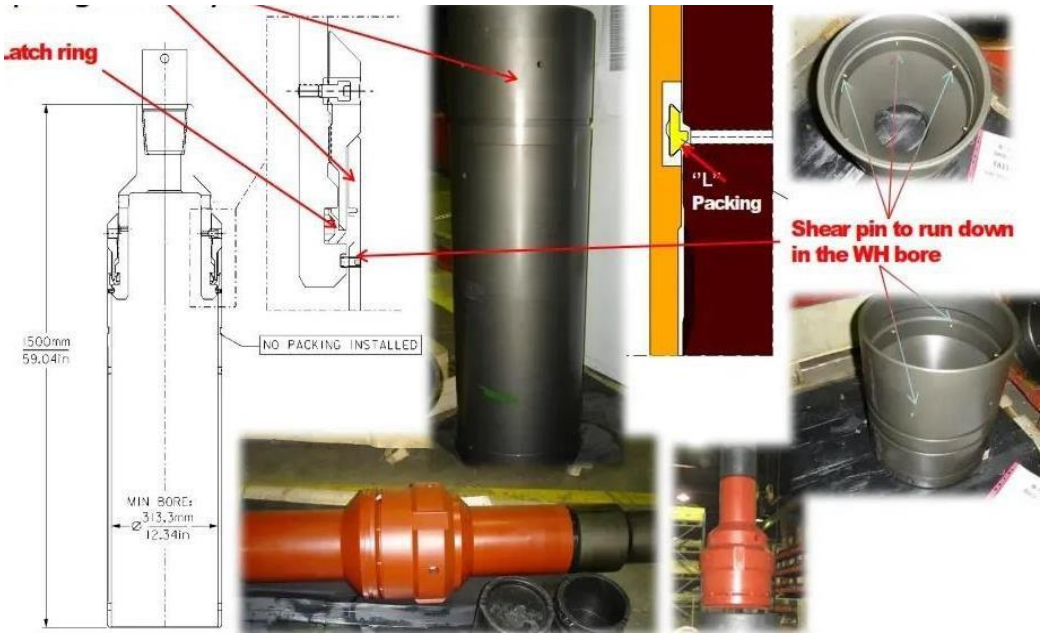


Figure II-35: Wear bushing UH-2

IV -4 Back Pressure Valve:

IV -4-1 ISA BPV description:

A Back Pressure Valve (BPV) seats in the tubing hanger or coupling to seal the well bore while the Blowout Preventer (BOP) is removed from the well and the tree is being installed. BPVs are also used to temporarily isolate the tree from the well pressure so that repairs can be made without having to kill the well.

BPVs are installed in four different ways. The method used depends on when the BPV is installed. The installation methods include:

- Manually on the Rig Floor
- Manually using sucker rods
- By hydraulic lubricator (ISA only)
- By wireline (ISA only) [3]

IV -4-2 ISA BPV:

The ISA BPV utilizes a shear pin release to provide positive indication that the expanding dogs are set and the BPV is securely installed. The ISA BPV has an internal stinger, or a rod and spring loaded check valve, which is used to check the well bore for pressure or to equalize pressure across the BPV. The internal stinger is designed to allow for all kill fluids to be pumped through it at a rate of 1 BBL per minute. The ISA BPV is run with the ISA- 100 RSOT and retrieved with the ISA-100 retrieval tool. [3]

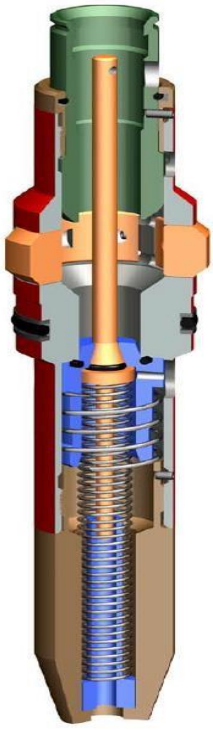


Figure II-36: BPV ISA

IV -4-3 ISA-100 Running and Sting Off Tool

The ISA-100 Running and Sting off Tool (RSOT) runs both the ISA BPV and the ISA-100 TTP and can be used to sting off or check the BPV for pressure.

The RSOT has one end threaded to accept either a 5/8" sucker rod or a hydraulic lubricator and the other end fits over the stinger in the BPV and is held in place by a shear pin. After the valve is secured in the hanger or coupling, the running tool is recovered by jarring up to shear the running tool pin and lifting straight up. This tool incorporates an indicator sleeve that is run in the down position to either assure the BPV has been properly set or to check for pressure prior to pulling a BPV with dry rods. The RSOT also includes a heavy duty centralizer/protector sleeve that protects the indicator sleeve during the running and sting off process. [6]

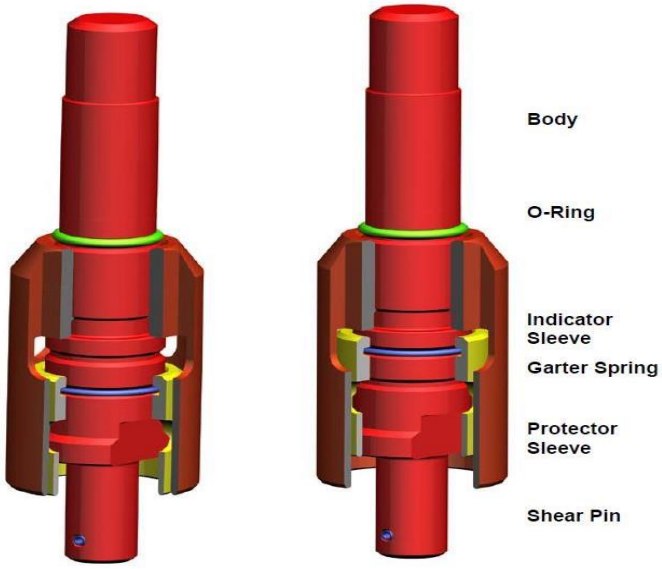


Figure II-37: RSOT – Indicator Sleeve in Down Position and Indicator Sleeve in Up Position

IV -4-4 ISA-100 Retrieval Tool

The ISA BPV and ISA-100 TTP are recovered from the tubing hanger or coupling using expanding retrieval tools. The ISA-100 Retrieval tool utilizes a spring loaded spear that engages into a mating groove in the mandrel of the BPV or TTP. When the retrieval tool is completely inserted into the BPV or TTP, the spear fingers expand and latch into the mandrel which enables tension to be applied to the mandrel to disengage the dogs in the BPV or TTP. Retrieval is accomplished by picking the tool straight up using either rods and jars or a lubricator. [6]

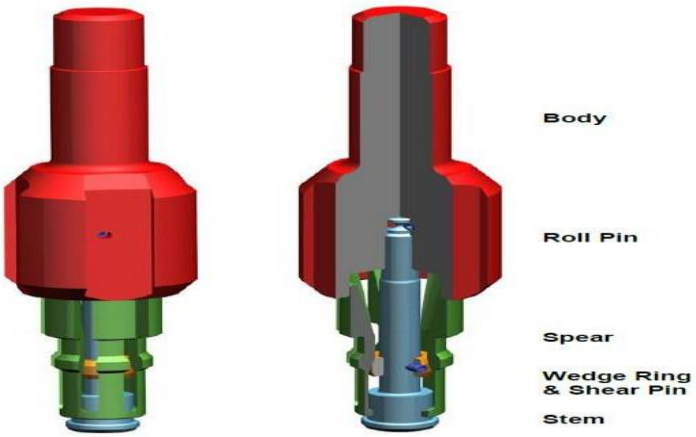


Figure II-38: ISA-100 Retrieval Tool

IV -4-5 ISA-100 Tree Test Plug (TTP)

The ISA-100 TTP uses a shear pin release to provide positive indication that the expanding dogs are set and the TTP is securely installed. An internal stinger is utilized in the ISA-100 to hold pressure from above rather than below. A number of substantial differences between the BPV and the TTP must be considered before running or retrieving the TTP.

The bottom of the spring housing is more open as opposed to the bottom of the ISA BPV which is more closed. The mandrel holds the stinger in the up and off-seated position to allow the stinger to work in conjunction with the mandrel upon setting. Pulling up on the mandrel will off-seat the stinger and when the mandrel is moved to the down position the stinger moves to the seated position. Parts from the ISA-100 TTP can not be interchanged with parts from the ISA BPV or the ISA TTP. Do not assume the dogs or mandrel will work on a comparably sized BPV.

The ISA-100 is ran and retrieved by hand, with rods and jars, using a hydraulic lubricator, or using a wireline, the same ways as a BPV. This tool is designed to test Surface Trees only. This tool is designed only to test surface trees. If well pressure is encountered while the BOP is being tests the personnel will not be able to pump through the TTP to kill the well. [6]

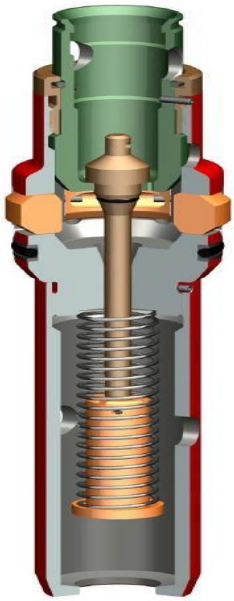


Figure II-39: Tree Test Plug

IV -5 Back pressure valve Type H and two way check valve:

BPVs are installed in different ways and the method used depends on when the BPV is installed. The installation methods include:

• Manually on the Rig Floor

• Manually using dry rods

• With PBMO Lubricator whenever pressure is present

A Two Way Check Valve is designed to plug the tubing in order to test the tree and should not be used to test BOP's. If pressure builds up below the TWC during testing there will be no way to kill the well, because you cannot pump through the TWC. [6]

IV -5-1Type H Back Pressure Valves, Two Way Check Valves, and Associated Tools:

1- Type H Threaded Style BPV:

The threaded style BPV incorporates internal running threads, external setting threads, and an internal stinger. This style valve must be rotated in a set of mating threads until it seats. The Type H BPV may not be set with wire line because it must be rotated to set.

The type H back pressure valve is a threaded style BPV that is designed to hold pressure from the well bore below the valve. Cameron rates this valve to 20,000 psi working pressure (WP). The internal threads in the upper body are right hand (RH) running threads that are used in conjunction with the running tool and retrieval tool. The external threads are acme style left hand (LH) threads and match the thread profile inside the corresponding tubing hanger.

An internal valve and spring assembly is designed to seal off well bore pressure, and to release and equalize well bore pressure across the valve when the poppet is off seated. The internal valve is designed to allow kill fluids to be pumped through the valve at a rate of up to 2 BBLS per minute. If this rate is exceeded the O-ring seal will be washed off or cut and the valve will not seal. The primary seal ring is located just above externally just above the male acme threads. [6]

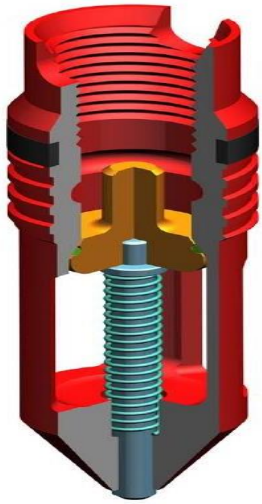


Figure II-40: Type H BPV

2- The Two Way Check Valve:

The Type H Two Way Check Valve is designed to plug the tubing in order to test the tree and to allow tubing pressure to bleed off before removing the plug. Cameron rates this valve to 15,000 psi. For 20,000 psi applications the HM style Two Way Check is to be utilized.

Both TWC valves utilize a plunger which seals on an upper seat to isolated tubing pressure from the Xmas tree bore. A lower seat is used to seal off pressure from above the TWC. The same running and retrieval tools are used to run both the Type H BPV and TWC. The TWC cannot be pumped through to kill or circulate the well. If tubing displacement is desired, the Type H BPV must be used first and then replaced with the TWC for testing of the tree. [6]

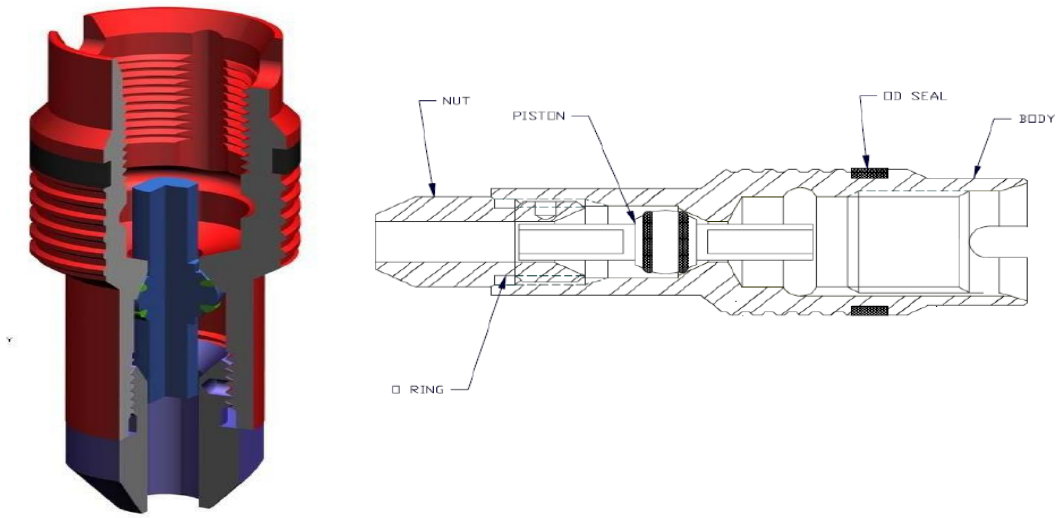


Figure II-41: Two Way Check Valve

3- Type H Running Tool

The Type H Running Tool is designed to be attached to the bottom of the polished rod of the PBMO lubricator. It is attached by driving a large pin through the socket on the bottom of the polished rod and the body of the running tool. The pin is then held in place by a set screw in the running tool that is tightened against the pin. A splined floating threaded ring assembly is incorporated into the lower tool body. The assembly is made up into the internal BPV and TWC running threads. A large torque pin is located just above the floating ring assembly. This used to transfer torque from the polished rod in the BPV or TWC when they are being installed into a tubing hanger. [6]

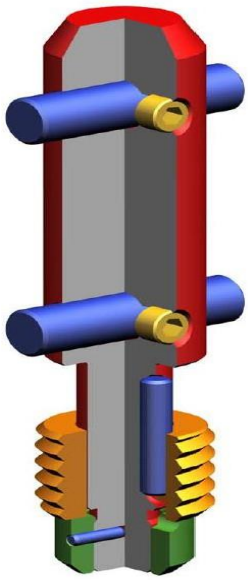


Figure II-42: Type H Running Tool

4- Type H Retrieval Tool:

The Type H Retrieval Tool is used to remove the Type H BPV and TWC from the threaded profile in the tubing hanger. It is attached to the socket on the bottom of the polished rod in the same manner as the running tool in the previous section. Drive a large pin through the socket on the bottom of the polished rod and the body of the running tool. The pin is held in place by a set screw in the running tool that is tightened against the pin. The threads on the bottom of the tool match the thread profile of the internal threads on the BPV and TWC. After the Retrieval Tool has been threaded into the BPV or TWC it is then rotated to the right (clockwise). This will remove the BPV or TWC from the tubing hanger and will retain it so that it can be removed from the well. [6]

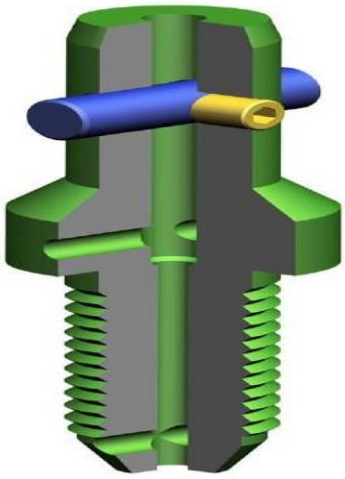


Figure II-43: Type H Retrieval Tool

The IS type BPV has been replaced by the ISA BPV. Only ISA types will be sent when new BPVs are ordered.

This section does not cover the old IS type BPV.

- Do not confuse the terminology ISA vs. ISA-100. The ISA-100 tooling designates the most recent designs for the TTP, RSOT, and retrieval tools.

V-Test of GV and X mas Tree:

Testing X-mas tree valves in the oil and gas industry is a crucial step in ensuring safe and efficient field operations. These valves, located at the wellhead, control fluid flow and play an essential role in regulating pressure and preventing leaks. Testing X-mas tree valves often involves rigorous procedures, such as pressure tests, closing and opening tests, as well as visual inspections for signs of damage or malfunction. The accuracy and reliability of these tests are essential to ensure worker safety and environmental protection during oil and gas extraction operations. [13]

Each valve has its own type and worker pressure, Look at the table below:

Table II-03: Procedure of test

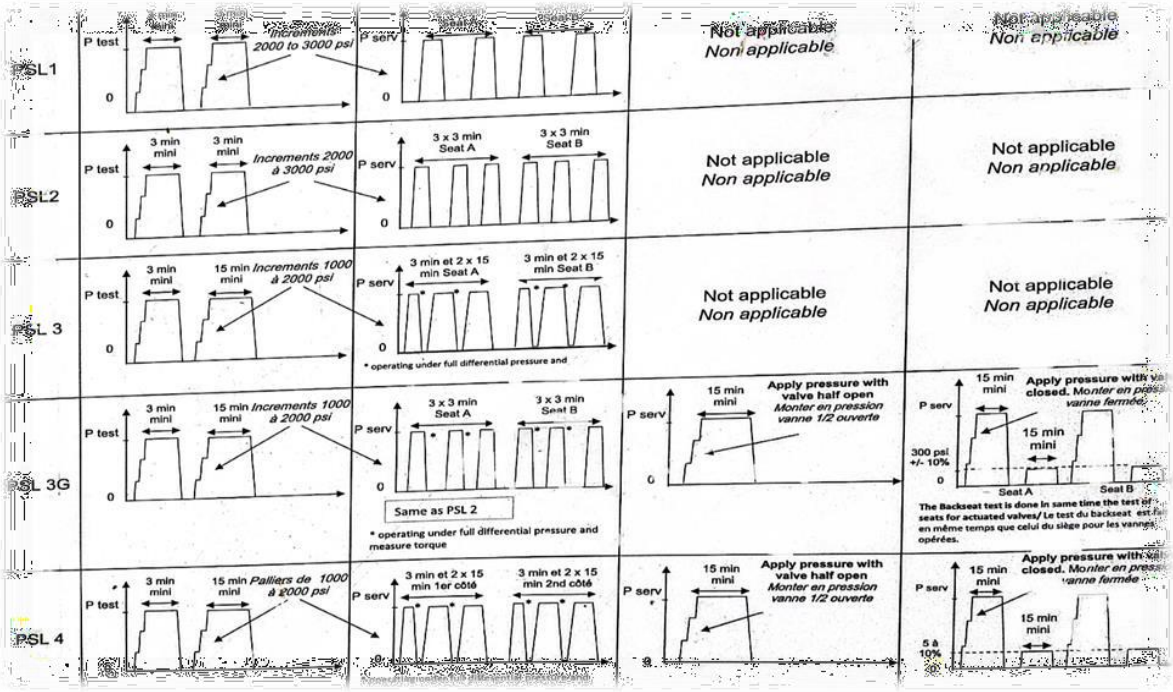


Table II-04: Allowable drop pressure (PSI)

	Allowable drop pressure PSI		Maximum initial pressure test
Test pressure (PSI)	**3 min. hold period**	**15 min. hold period**	
2000	5	25	2100
2250	6	28	2363
3000	8	38	3150
4000	10	50	4200
4500	12	56	4725
5000	13	63	5250
6000	15	75	6300
7000	18	88	7350
7500	19	94	7875
10000	25	125	10500

Conclusion:

In conclusion, the oil Christmas tree is an essential piece of equipment in the oil and gas industry, used at the top of drilling wells to control the flow of oil or gas. This set of equipment includes several components, such as valves, fittings and safety devices, which help regulate the pressure and flow of fluids coming from the well. Among these components, the "cross" occupies an important place by ensuring the connection and efficient distribution of fluids between the well and the surface equipment.

The Christmas tree is designed to withstand the rigorous environmental and operational conditions associated with oil and gas operations. Its design and maintenance are crucial to ensure operational safety and environmental protection. Additionally, it is often equipped with safety features to prevent accidents and potential leaks.

Overall, the oil Christmas tree plays a central role in hydrocarbon production, facilitating the control and efficient management of wells. Its proper use and maintenance is essential to ensure reliable and profitable oil and gas operations .

Chapitre III

Case study (Maintenance of Production Wing Valve) Well ISB 302 Z

In this chapter we will study the location of the well and the maintenance of the x mas tree (production wing valve) in TechnipFMC company

I- Introduction :

The Tihigaline area where the installation of the ISP 302 Z survey is proposed, is located in the block 226, Erg Issaouane II research perimeter, Illizi basin.

The ISP 302 Z drilling is part of the development of the Tihigaline North- west. It is planned to produce gas from the sandstones of the Ordovician reservoirs

The reservoir objective is the Cambro-Ordovician series composed of 3 large stratigraphic sets: a preglacial set (Units II and III), a set synglacial (Unit IV) and a postglacial group (Dalle M'Kratta "DMK")

The ISP 302 Z drilling is planned as a vertical well with a total planned depth of 2250m

MD (-1774.2m TVDSS). [1] [2]

II- Location :

The ISP 302 Z drilling is part of the Tihigaline North-West deposit, it was installed on the South-eastern part of the structure.

It is located 4,000km south of the ISP 301 Z well, 3km north of the AT19 well, 3km northwest of the AT-12 and 3 km southwest of the ISP 300 Z well

The ISP 302 Z borehole admits as geographical coordinates [1] [2]

Table III. 01: Geographic and UTM coordinate

Geographic coordinates	UTM coordinates
M : 05°40′42.08476"E	X:382 106.008 m
L: 25°58′19.50652"N	Y: 3025 602.040 m
Zs : 458.186m	ZT: 478.8m

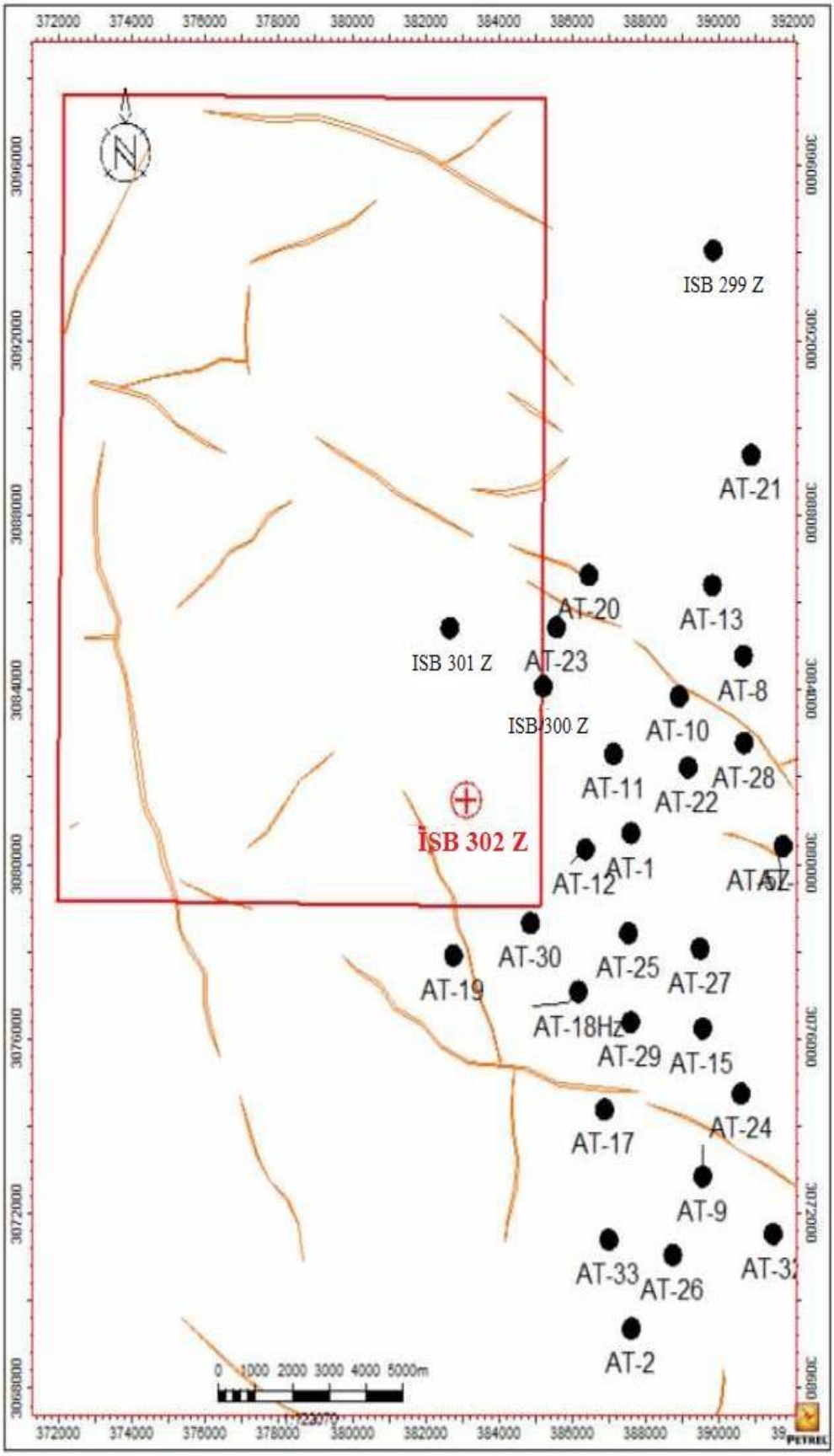


Figure III- 01: Well positioning map ISB 302 Z

III- Information of the Well :

- **Name of the well :** ISB 302 Z
- **The company that drill it :** ENTP130 (2019)
- **Total Depth :** 2250 m
- **Type of wellhead :** UH-1
- **Type of X mas tree :** 4 1/16" M120 WP = 5000 psi PSL 3 [1] [2]

Figure III -02 :RIG TP130

IV - Description of the problem :

A leak in the production valve can be described as a major problem that can lead to production losses, safety risks and high repair and maintenance costs , the Damage to the Production Wing Valve can result from a variety of factor, including:

- **Erosion and Corrosion:** Exposure to aggressive operating conditions, such as corrosive or erosive fluids, can lead to premature wear and corrosion of Production Wing Valve components, compromising its integrity and functionality.
- **Pressure and Temperature:** Excessive pressure or temperature fluctuations can place stress on the Production Wing Valve, leading to mechanical failure, leakage or rupture.
- **Poor Maintenance:** Inadequate maintenance, lack of regular inspection or inappropriate maintenance procedures can contribute to potential damage to the Production Wing Valve.
- **Material Failure:** The use of unsuitable or inferior materials in the manufacture of the Production Wing Valve can lead to premature failure and structural damage.

To find the cause of this issue, we must disassembled this gate valve , Before disassembling it, we must to put a plug (BPV) by Pressure Balanced Manually Operated (PBMO) Lubricators

IV -1- Pressure Balanced Manually Operated (PBMO) Lubricators :

Pressure Balanced Manually Operated (PBMO) Lubricators are specialized tools used in the oil and gas industry for installing and removing back pressure valves into tubing hangers. They provide a pressure-balanced and manually operated mechanism, ensuring smooth and efficient operations during the installation and removal of back pressure valves. PBMO Lubricators are designed to mount on a wellhead tree or a wellhead spool, and they can also be used for installing or retrieving VR plugs. The components of these lubricators are machined from homogenous materials, ensuring durability and reliability in the oil and gas industry [3]

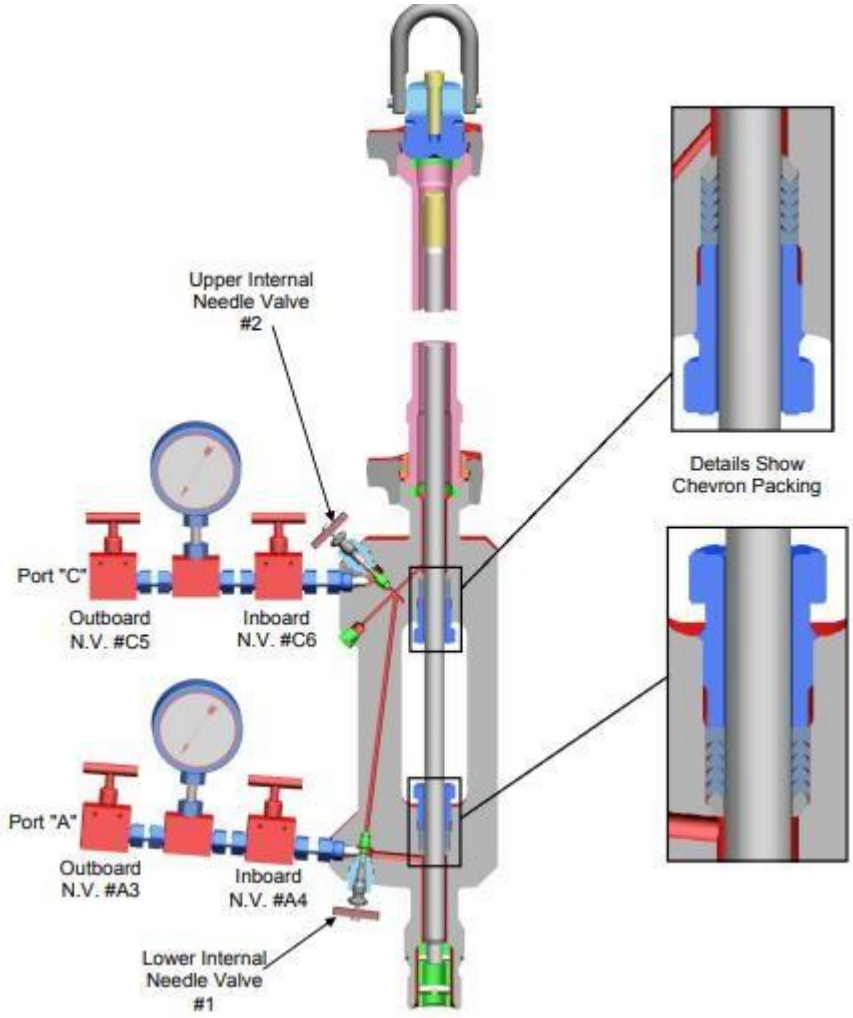


Figure III-03 : PBMO

Upper Internal Valve:

- **Open Position :**

– Allows Port C to monitor pressure from top side of lubricator.

- **Closed Position :**

– Isolates Port C only.

- **Lower Internal valve:**
- **Open Position :**

– allows wellbore pressure to flow into the top side of the lubricator.

- **Closed Position :**

– Isolates wellbore pressure from the top side of the lubricator. It does not isolate Port A from wellbore pressure This type of lubricator is designed to be attached to the top of a Surface Tree or other pressure containing device using 3 inch acme type threads and a crossover adapter.

The lubricator rod may be moved up and down with pressure in the wellbore and inside of the lubricator. This is accomplished by using the lubricator to extend the pressure envelope of the well and allowing pressure to equalize throughout the lubricator to wellbore pressure. When the pressure is equalized, the rod is considered pressure

balanced and can be manually stroked in or out.

The needle valves are designed to isolate pressure both in the wellbore and in the lubricator. The body of the lubricator is designed with an open yoke to provide access to the rod so that the rod may be raised, lowered, and rotated when running and retrieving a BPV. Standard chevron type packing and stuffing box nuts are provided to seal around the rod during the running and retrieving of the BPVs.

The upper adapter housings are designed with integral hammer union connections, which consist of a male union and a female union that join together to create and extend the pressure envelope of the lubricator. This design allows the lubricator to be adapted for different length polish rods due to the adapter housing's modular design. The PBMO lubricator can utilize wellbore pressure to retract the polish rod when the rod is extended. By closing the lower internal needle valve, wellbore pressure is isolated from the internal parts of the lubricator. When the lower internal needle valve is closed and under pressure, and the upper internal needle valve is open, it is possible to move the rod upwards by slowly bleeding pressure off of the top side of the lubricator through the manifold assembly attached to Port C. This creates a pressure differential and causes the lubricator rod to become underbalanced which will cause the rod to retract. [3]

IV -1-1- Back pressure valve BPV :

A Back Pressure Valve (BPV) is a unidirectional or bidirectional check valve that is installed through the Christmas tree into the tubing hanger. Its primary function is to prevent well fluids from flowing out of the well, ensuring control over the flow of fluids and gases in the wellbore. The BPV acts as a flow control valve to provide backflow control when running or pulling a string, contributing to the safety and efficiency of drilling operations . Additionally, a BPV, also known as a tubing plug, functions as a one-way check valve placed within a specially machined profile within the tubing hanger or plug bushing. It blocks the passage of fluids and gases through the hanger while allowing the injection of fluid into the tubing string. These valves are essential for various operations in the well, such as facilitating the removal of the production tree, supporting the installation of the tree during the nippling down of the BOP stack, and during heavy lifts over the wellhead

.In summary, a Back Pressure Valve (BPV) in the oil and gas industry is a critical component that serves as a check valve to control the flow of fluids and gases in the wellbore, ensuring operational safety and efficiency during drilling and completion activities. [3]

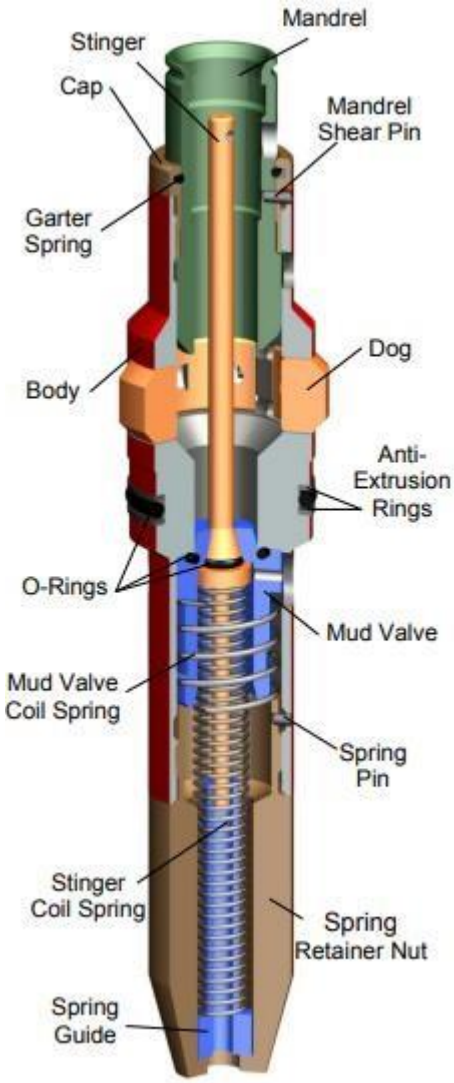


Figure III-04 :BPV

We brought it into the workshop and repaired it as follows :

1- Washing :

Deep clean of the equipment , remove all residual of grease debris to make the inspection easier for detection of any crack , deformation engraving etching , material deterioration [3]

2- Flushing :

Through flushing of valve , after exposure to corrosive well treatment fluids is recommended it is a good practice to flush the gate valve a neutralizing fluid immediately after acidizing or other well treatment service is conducted to ensure that potentially corrosive or damaging fluids are not left in the valve cavity and on critical sealing surfaces.

thorough flushing is also needed after FRAC treatment to remove proppant beads from the interior surfaces and crevices of the valve without employing additional cleaning or flushing operations the service life of the gate valve may be greatly reduced [3]

Figure III-05: Production Valve

Check pressure trap using stinger on bleeder , and close & open the GV then open the gate valve half way .

3- Dissembling GV :

Figure III -06 :Body GV

Figure III-07: Bonnet and gate

Figure III-08: Parts of GV (Seat and guide gate)

Figure III-09 : RH Seat gates

4- Inspection :

The inspection of a knife gate valve in the oil and gas industry is an essential process involving a series of checks and tests to ensure the valve's proper operation and safety. This process typically includes visual inspection, dimensional checks and functional testing. Visual inspection involves checking the valve for signs of wear, damage or corrosion. Dimensional checks involve measuring valve components to ensure they meet the manufacturer's specifications. Functional testing involves actuating the valve to ensure that it opens and closes correctly, and that there are no leaks

In addition, advanced testing methods such as pressure testing, temperature cycling and vibration analysis can be used to guarantee valve performance under extreme conditions.

In summary, the inspection of a knife gate valve in the oil and gas industry is a crucial process that includes visual checks, dimensional verifications, functional tests and advanced testing methods to ensure the valve's proper operation and safety.

*inspect the bonnet back seat profile, stem packing area , gasket profile and body gasket profile

*visually inspect each seat body to ensure there is no damage to the sealing surfaces

*inspect the rest parts which will be reused , e.g. packing nut , stem retainer , solid pin , bleeder plug , grease nipple , etc

Figure III-10 : Packing and packing nuts

Figure III-11 : Packing nuts

Figure III-12: Gate

5- Lapping :

Lapping Gate Valve refers to the process of refining and smoothing the sealing surfaces of seat gate using a lapping machine. This process involves the use of a slab that moves up and down to open and close the valve, with tungsten carbide coated seats within the body of the valve to maintain a seal that stops the fluid or gas from leaking. Lapping machines for gate valves are portable and designed for the repair of sealing surfaces in gate valves and check valves, as well as on gate wedges and flanges. These machines are lightweight for easy handling and installation, and they span working ranges for gate valves from 1.3 to 39.4 inches (32 to 1000 mm). During operation, grinding disks can be quickly changed, and the grind pressure can be adjusted. Solid construction, sealed lubrication, and pre-loaded bearings ensure long life and low maintenance [3]

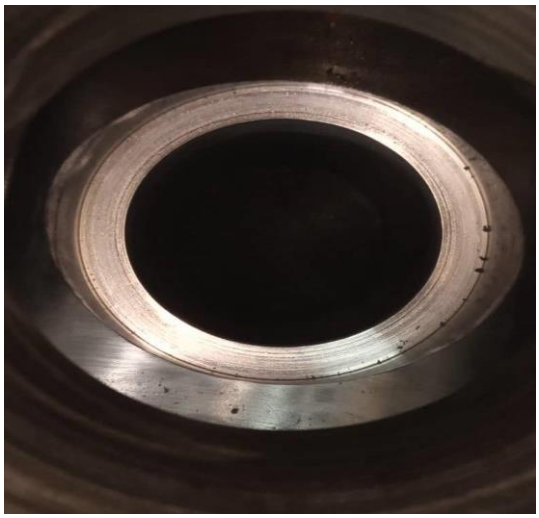


Figure III-13: Seat pocket before lapping Figure III-14: Seat pocket after lapping

6-Change spare parts :

We change stem , packing , packing nuts , bonnet gasket , gate , guide gate and seat gate

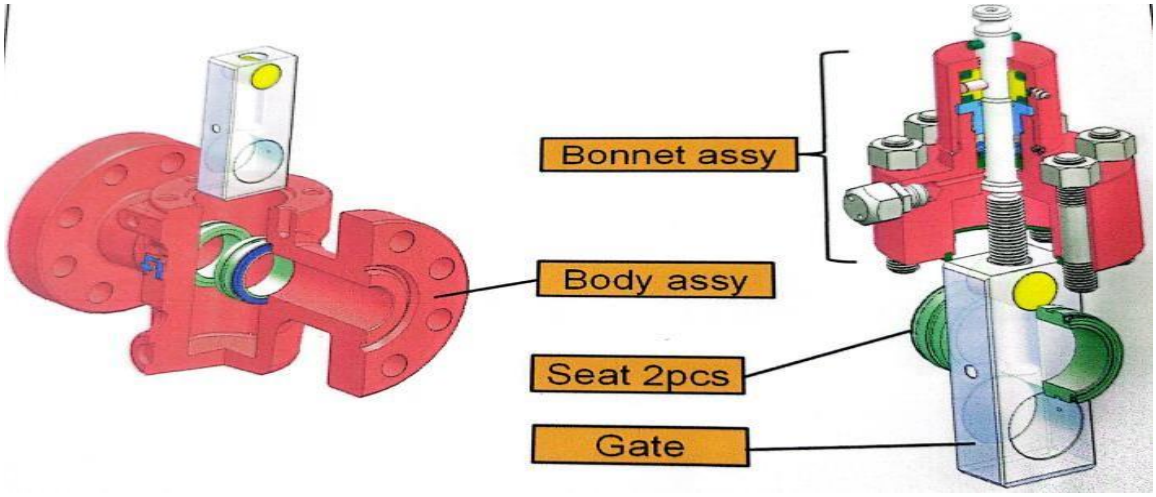


Figure III-15: Components of GV

7- Test body GV PSL 3 WP =5000 PSI :

- The body of the gate valve gets filled with testing fluid (hydrostatic test)
- Apply pressure with valve half open (1x 3min and 1x15 min) increments 2000 to 3000 psi at 5250psi
- Close the isolation and waiting for stability
- Start test at 5250 psi
- End test at 5245 psi (diminution 5 psi)
- No visible leakage

Test seat A :

-The seat of the gate valve gets filled with testing fluid (hydrostatic test)

-connect in seat A and watch for leaks in seat B

-Apply pressure with valve close (1 x 3min and 2x15 min) increments 2000 to 3000 psi at 5250 psi

-close the isolation and waiting for stability

-start test at 5250 psi

- end test at 5213 psi (diminution 37 psi)
- no visible leakage

Test seat B :

-The seat of the gate valve gets filled with testing fluid (hydrostatic test)

-connect in seat B watch for leaks in seat A

-Apply pressure with valve close (1 x 3min and 2x15 min) increments 2000 to 3000 psi at 5250 psi

-close the isolation and waiting for stability

-start test at 5250 psi

- end test at 5220 psi (diminution 30 psi)
- no visible leakage

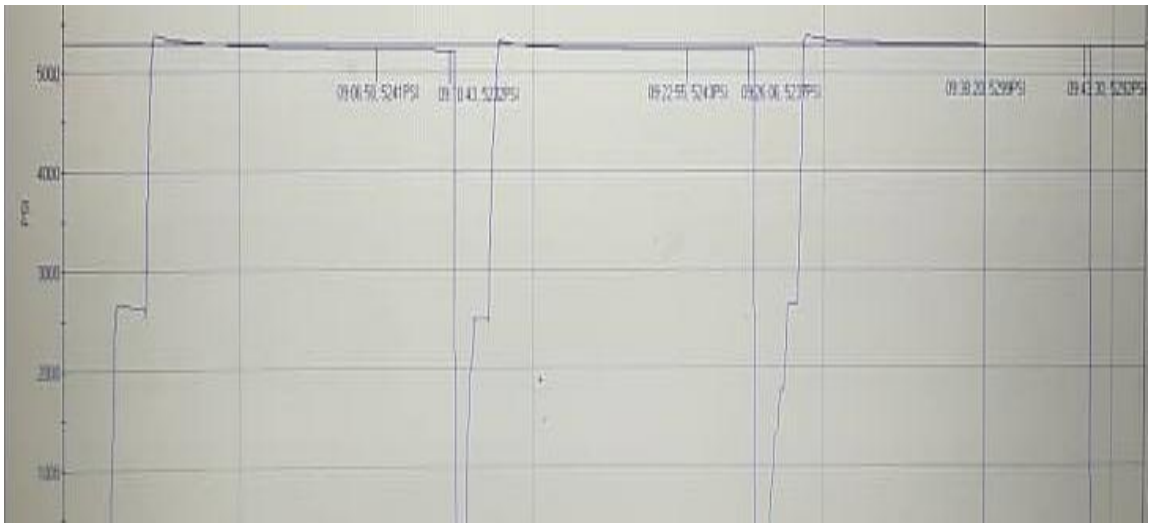


Figure III-16: A graph of pressure change with respect to time

8- Greasing :

It is vital for life of gate valve to have grease injected into the valve cavity . the purpose of the grease is to fill the valve cavity , to displace contaminants as much as possible and to prevent damage to the sealing surfaces as the sealing function of the gate valve depends on the condition of the gate & seat sealing surfaces . Additionally grease provides protective coat on the gate & seat seal surfaces , when they slide against each other under high contact pressure . An effective valve grease may also help to seal surfaces with minor damage (light scoring and galling) to provide temporary solution to perform corrective maintenance [3]

Table III-02: Cavity volume and grease quantity of valve

Valve type	Cavity volume (gallons)	Grease quantity required (lb)
2-1/16 5K M120	0.21	1.6
2-9/16 5K M120	0.30	2.3
3-1/8 5K M120	0.44	3.4
4-1-16 5K M120	0.75	5.7
5-1/8 5K M120	1.12	8.6
6-3/8 5K M120	2.25	17.2
6-5/8 5K M120	2.27	17.4
7-1/16 5K M120	2.29	17.5
1-13/16 10K M130	0.33	2.5
2-1/16 10K M130	0.43	3.3
2-9/16 10K M130	0.71	5.4
3-1/16 10K M130	1.09	8.3
4-1/16 10K M130	2.21	16.9
5-1/8 10K M130	2.35	18
1-13/16 15K M130	0.47	3.6
2-1/16 15K M130	0.64	4.9
2-9/16 15K M130	1.07	8.2
3-1/16 15K M130	1.73	13.2
4-1/16 15K M130	1.92	14.7

8-1 - Grease delivery calculation :

X= lb of grease required to fill valve

Y= Pump rate , lbs per minute

T= X/Y pumping time required to fill empty body , minutes

Jet-Lub Easy turn polar grease has density of 7.65 lb/gallon so grease required to fill valve cavity is

7.65*0.75=5.7375 lb

We shall use a pump rate of 2 lb per minute

T= 5.7375/2= 2.86 min

Figure III-17: Grease for groove

Figure III-18: Grease for body and bonnet

9- Drift :

To make sure the gate valve fully open and the gate good adjusted. [3]

Figure III-19 : Drift GV

10- Return it to the field and reinstall it :

We reinstalled it and to make sure it was good, we tested it test body (all valves are half open) .

Result :

-No pressure drop

- No visible leakage

11- BPV disassembly :

Retrieving BPV by PBMO

V-Conclusion :

Leakage in gate valves is a common problem in the oil and gas industry that can lead to significant downtime and costly repairs. Regular inspection and maintenance, including cleaning, tightening, and replacing worn or damaged parts, can prevent leakage and ensure the longevity of gate valves.

Regular maintenance of gate valves is essential to ensure their smooth operation and long service life in the oil and gas industry. These valves play a crucial role in controlling the flow of liquids and gases through the industry's complex systems.

Proper maintenance includes key steps such as visual inspection, greasing of moving parts, cleaning of sealing surfaces, tightening of bolts and pressure testing. Following the manufacturer's recommendations in terms of maintenance frequency and procedures is essential.

Adherence to relevant industry standards, such as API 600 and API 6D, is also essential to ensure that knife gate valves are designed, manufactured and maintained to guarantee the safety and reliability of oil and gas operations. By properly maintaining these valves, operators can prevent leaks, ensure smooth operation and extend equipment life. This contributes to the overall efficiency and profitability of oil and gas systems.

General Conclusion

General conclusion :

The installation and maintenance of wellhead and Xmas tree in the oil and gas industry are crucial for efficient and safe production. A wellhead provides a pressure seal or shut-in point between the casing/tubing and surface piping/facilities, ensuring the well integrity during drilling,completion, and production phases.

The Xmas tree, a series of valves, spools, gauges, and chokes, controls the flow of resources into and out of a well during the completion and production stages.

Wellhead maintenance involves regular inspections, lubrication, pressure testing, corrosion and erosion inspection, cleaning, preservation, and painting.

Preventive maintenance includes personnel and equipment on call for onshore and offshore locations, physical inspection of Wellhead and Christmas Tree components, lubrication of valves and actuators, injection of grease and sealant into Valve Body cavities, tubing head void test, pressure/function test of valves and actuators, casing head pressure void test, and updating data and wellhead stack-up configuration .

Periodic maintenance includes Critical Device Function Test (CDFT) using wellbore pressure on all Christmas tree valves, cycling and leak test on Surface Control Subsurface Valve (SCSSV), Tubing Retrievable Surface Control Subsurface Safety Valve (TRSCSSV), and Wireline Control Subsurface Safety Valve (WRSCSSV), function test on actuators, and flushing of valves to remove undesirable foreign materials from internal valve components.

Reliability and ease of maintenance are critical properties of any wellhead, as the various types of valves and actuators in the Xmas tree must be in the best operational state to ensure they are working properly and seamlessly for efficient productivity .

In summary, the installation and maintenance of wellhead and Xmas tree in the oil and gas industry are essential for safe, efficient, and productive well operations. Regular inspections, lubrication, pressure testing, corrosion and erosion inspection, cleaning, preservation, and painting, along with periodic maintenance, ensure the wellhead and Xmas tree integrity and reliability.

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