People's Democratic Republic of Algeria
Ministry of Higher Education and Scientific Research

Serial N°: ………/2024

Kasdi Merbah Ouargla University

Faculty of Hydrocarbons, Renewable Energies, Earth and Universe Sciences

Department of Hydrocarbon Production

MASTER'S THESIS

To obtain the Master's Degree
Option: Production

Presented By:

SEDDIKI Abdellah, BOUCHOURAB Anis

-THEME-

Collection Network Optimization of HAOUD BERKAOUI field
Case study: OKN62

Defended on: 05 /06/2024 before the examination committee

Jury:

President:	Mr. ALI ZERROUKI Ahmed	PR	Univ. Ouargla
Supervisor:	Mr. DOUAK Mohamed	MCB	Univ. Ouargla
Examiner:	Mrs. HAFSI Fadila	MAA	Univ. Ouargla

Academic Year 2023/2024

ACKNOWLEDGEMENT

By the grace and guidance of God, we were able to complete this humble work, and we thank God for His blessings upon us of health, wellness, and guidance.

We would like to express our sincere gratitude and appreciation to our esteemed supervisor, Mr. DOUAK Mohamed, for his support, guidance, and valuable comments that helped us complete this work in the required manner.

We would also like to acknowledge and thank the jury President Mr. ALI ZERROUKI Ahmed, and the examiner Mrs. HAFSI Fadila, for their time, effort, and insightful evaluations.

We also extend our sincere thanks and appreciation to our family and friends for their continuous support throughout our studies, which had a great impact on the completion of this work.

We would like to thank the University of Ouargla in particular for providing us with the necessary resources to complete this work, and we thank everyone who contributed to it directly or indirectly.

We hope that this work will be distinguished and useful to everyone, and that it will contribute to serving science and knowledge.

Dedication

To my beloved mother, Fatima:

I dedicate this humble work to my dear mother, the symbol of compassion and generosity, who never hesitated to support and encourage me. She stayed up nights for me, and prayed to God for my success. She is the source of wisdom and patience, and a light that has illuminated my path since childhood.

To my loving father, Mohamed Saleh:

I dedicate this work to my dear father, the symbol of strength and support, who instilled in me the love of knowledge and learning, and always pushed me to achieve my dreams. He is my role model in life, and a beacon that illuminates my path.

To my dear siblings:

I dedicate this work to my siblings, my true companions and friends, who never left my side and provided me with support and encouragement without expecting anything in return. They are my support and help in every moment, and a light that illuminates my life.

Finally, I dedicate this work to everyone who contributed to its completion directly or indirectly, and to everyone who believed in my abilities and supported me in achieving my goals.

With sincere thanks and appreciation.

SEDDIKI Abdellah

Dedication

To my family and friends, who have always believed in me, even when I doubted myself. Thank you for your love, support, and laughter.

To my professors and mentors, who have challenged me to think critically and helped me grow as a scholar. Thank you for your guidance and inspiration.

To everyone who has played a role in my journey to this point, thank you. I could not have done it without you

.

BOUCHOUAREB Anis

RESUME

Dans cette étude, nous simulons la situation actuelle du réseau existant du champ de Haoud Berkaoui (OKN62) et analysons différents scénarios pour évaluer leur impact sur la production. Les résultats indiquent que l'augmentation du diamètre de certains pipelines des puits au collecteur OKN62 (passant de 4 pouces à 6 pouces) peut optimiser la production. Nous avons utilisé le logiciel Pipesim pour analyser les performances du réseau de collecte et l'optimise.

Mot clé : Modélisation, Optimisation, Production, Débit, Pipesim, Collection Network Manifold.

ABSTRACT

In this study, we simulate the current situation of the existing network in the Haoud Berkaoui field (OKN62) and analyze different scenarios to assess their impact on production. The results indicate that increasing the diameter of certain pipelines from the wells to the OKN62 collector (from 4 inches to 6 inches) can optimize production. We used the Pipesim software to analyze and optimize the collection network performance.

Key words: Modeling, Optimization, Production, Flow, Pipesim, collection network, manifold.

ملخص

في هذه الدراسة، نقوم بمحاكاة الوضع الحالي للشبكة الموجودة في حقل حوض بركاوي (**OKN62**) وتحليل سيناريوهات مختلفة لتقييم تأثيرها على الإنتاج. تشير النتائج إلى أن زيادة قطر بعض الأنابيب من الآبار إلى المجمع **OKN62** (من 4 بوصات إلى 6 بوصات) يمكن أن تحسن الإنتاج. استخدمنا برنامج **Pipesim** لتحليل وتحسين أداء شبكة التجميع.

الكلمات الرئيسية: النمذجة ، التحسين ،الإنتاج ،شبكة التجميع ،التدفق ، **Pipesim، Manifold**

FIGURES LIST

Figure I.1: geographical location of the Haoud Berkaoui region. 2
Figure I.2: Geological situation of Haoud Berkaoui.. 3
Figure I.3: Fields in the Haoud-Berkaoui region. 6
Figure II.1: Schematic diagram of an individual line collection network. 10
Figure II.2: collector connection.. 11
Figure II.3: Pig Launcher & Receiver. 11
Figure II.4: Scrapers or Pig... 12
Figure II.5: Insulating joints. 13
Figure II.6: Check valves.. 13
Figure II.7 : Manifold. 13
Figure II.8 : Valves used on collection networks. 14
Figure II.9 : Pressure gauges mounted. 14
Figure II.10: Flow regimes of gas/ liquid horizontal flow... 15
Figure II.11: Liquid HOLD-UP.. 16
Figure II.12: Vertical Separator.. 18
Figure II.13: Horizontal Separator.. 19
Figure II.14: Spherical Separator.. 20
Figure III.1: Pipesim software 23
Figure III.2 : Collection network model of OKN62 manifold. 29
Figure III.3 : The Simulation Result by Pipesim... 29
Figure III.4 : Scenario 1.. 30
Figure III.5 : Result of Scenario 1. 31
Figure III.6 : Scenario 2.. 32
Figure III.7 : Result of Scenario 2. 32
Figure III.8: Scenario 3.. 33

TABLES LIST

Table I.1: History of the region. 4
Table I.2 : Initial reservoir characteristics. 6
Table I.3: Properties of gas and oil from Haoud Berkaoui field. 7
Table II.1: Percentage of each pressure loss term. 17
Table III.1: the pipes of the MFD OKJ 202. 25
Table III.2: the manifolds that consist OKJ20. 26
Table III.3: the pipes of the MFD OKN62 26
Table III.4: the number of wells of the MFD OKN62. 27
Table III.5 : Requirement input data to Pipesim. 28
Table III.6 : diameter of flowline before and after optimization. 33
Table III.7: Comparison between results obtained after optimization. 34

SYMBOLS - ABBREVIATION

Bg :	Gas Volume Formation Factor
BKH :	Benkahla field
Bo :	Oil Formation Factor
F.V.F :	Volumetric formation factor (m3/m3)
G.W.R:	Gas-Water-Ratio (stm^3/stm^3)
GLA :	Guellala field
GOR :	Gas Oil Ratio, *Gas Oil Ratio*
HBK :	Houd Berkaoui
MFD :	Manifold
PH :	potential of hydrogen
R :	Resistivity

TABLE OF CONTENTS

Abstract V
Figures List VI
Tables List VII
Symbols - Abbreviation VIII
General Introduction 1

Chapter I: Presentation Houd Berkaoui Field

Introduction: 2
I.1 Geographical Location 2
I.2 Geological Situation: 3
I.3 History Of The Region 4
I.4 The Fields Of The Region: 5
I.5 Properties Of Reservoir Fluids: 6
I.6 Overview Of The Three Reservoirs In The Field: 7
I.6.1 Lower Series: 8
I.6.2 Clay-Sandstone Trias T1: 8
I.6.3 Clay-Sandstone Trias T2: 8
Conclusion: 8

Chapter II: Overview of The Collection Network

Introduction: 9
II.1 Collection Network Plans 9
II.1.1 Individual Connection 9
II.1.2 Collector Connection 10
II.2 Collection Accessories 11
II.3 Horizontal Gas-Liquid Flow Regimes 14
II.3.1 Liquid Hold-Up 15
II.3.2 Gas-Oil Ratio (Gor) 17
II.3.3 Pipe Pressure Drop 17
II.4 Separation 17
II.4.1 Separator 17
II.4.2 The Different Types Of Separators 18
II.4.3 Separation Objectives 21

II.5 General Information On Pumps 21
II.5.1 Pumping Unit.. 21
Conclusion:.. 22
Chapter III: Collection Network Optimization In MFD OKN62
Introduction 23
III.1 Pipesim 23
III.1.1 Application Of Pipesim Software 24
III.1.2 Data Requirements For Pipesim Modeling 24
III.1.3 Pipesim Models 24
III.2 The Okj202 Manifold (Mfd) Collection Network Structure 25
III.3 The Okn62 Manifold (Mfd) Collection Network Structure 26
III.4 Okn62 Mfd Collection Network Modeling Using Pipsim: 27
III.4.1. Selection Of The Horizontal Flow Pressure Drop Correlation 27
III.4.2 Requirement Input Data To Pipesim 28
III.4.1 Collection Network Model Of Okn62 Manifold. 29
III.4.2 The Simulation Result By Pipesim: 29
III.5 Collection Network Optimization 30
III.5.1 Scenario 1 30
III.5.2 Scenario 2 31
III.5.3 Scenario 3 33
III.6 Comparison Between Results Obtained After Optimization 34
Conclusion:.. 34
Conclusion...35

INTRODUCTION

General Introduction

Since Algeria's economy depends heavily on oil and gas sales (over 98%), maximizing efficient and safe production is crucial. This means preventing shutdowns to keep costs down. Understanding and solving problems effectively is key to achieving this goal. The Haoud Berkaoui field, the largest in its region, is a prime example. This area has the potential to produce around 5,500 tons and utilizes various well operation methods. Production from all the wells is processed in three oil treatment centers, one gas treatment unit, and three water injection units**.**

All the wells are located on the ten perimeters of the Directorate, where the production is treated through three (3) oil treatment centers (HBK, BKH and GLA), one (1) gas treatment unit at GLA, in order to produce dry gas which will be used for gas lift and three (3) water injection units for pressure maintenance at HBK, BKH and GLA. The Haoud Berkaoui Regional Directorate has a very large and complex collection network. The latter links the oil producing wells to the oil production centers and water injection units for the water injection wells through mini manifolds and main manifolds. At the oil treatment centers (HBK, BKH and GLA), the oil is treated by separating crude oil in order to produce anhydrous oil, gas for possible treatment to produce dry gas which will be used for gas lift in the main fields and water for possible treatment in the desalting units of the main fields in order to produce clear water for natural laboring and to recycle the oil to the production centers. After years of operation, the Directorate has recorded a drop in reservoir pressure, with increasing gas production, which has led to many problems.

In this thesis, we will use this approach in order to optimize the production of collection network of Manifold OKN62. we investigated the impact of three scenarios on the productivity of the OKN62 manifold collection network. The results revealed that the third scenario, which involves increasing the diameter of certain flowline, is the most suitable option for enhancing production.

The objectives of our study are to:

- ❖ Model the collection network using PIPESIM® software.
- ❖ Studying the sensitivity of collection network to different scenarios
- ❖ Selecting the most effective scenario to enhance production rare

CHAPTER I: PRESENTATION HOUD BERKAOUI FIELD

Introduction:

The Haoud Berkaoui region is one of the main hydrocarbon-producing zones in the Algerian Sahara, comprising three reservoirs: the partially exploited Clay-sandstone Trias T1, Clay-sandstone Trias T2 and the lower series, which is the main reservoir in the region.

I.1 Geographical location

The Haoud-Berkaoui region represents one of the main hydrocarbon zones in the Algerian Sahara. It is part of Block 438, located north of the Oued-Mya depression. This region lies some 30 km south-west of the wilaya of Ouargla, between the two regions of Hassi- Messaoud and Hassi- R'mel, 700 km south-east of the capital, Algiers, and around 100 km west of Hassi-, at an altitude of 220 m (**Figure I.1**).

This region is important because of its share in the country's hydrocarbon production. It stretches from south-east of Ghardaïa to the extreme Boukhzana field near the Touggourt road. The Haoud- Berkaoui oil zone comprises three major fields: Berkaoui field (HBK);

Benkahla field (BKH);

Guellala field (GLA), as well as other small peripheral fields[2].

Figure I.1: geographical location of the Haoud Berkaoui region.[3]

I.2 Geological Situation:

The Haoud Berkaoui region is part of the Oued-Mya basin, which lies in the northern part of the Algerian Sahara, exactly in the central province. This basin has the configuration of an elongated northeast-southwest trough acquired during the Paleozoic. It is bounded to the north by the Djamâa-Touggourt high zone, made up of Cambrian-age terrain; to the northwest by the Talemzane mole (Hassi R'mel); to the east by the El-Agreb El-Gassi ridge, which extends as far north as Massaoud; and to the south by the Mouydir depression. The Haoud-Berkaoui region lies to the north of the Oued-Mya depression (Block 438) (**Figure I.2**).This structure lies in the most subsident part-oriented northeast/southwest,it is separated from the Erg Djouad bulge by a furrow whose amplitude varies from 200 to 400 Km, its width varies from 25 to 30 Km to the southwest and from 08 to 10 Km to the northeast.

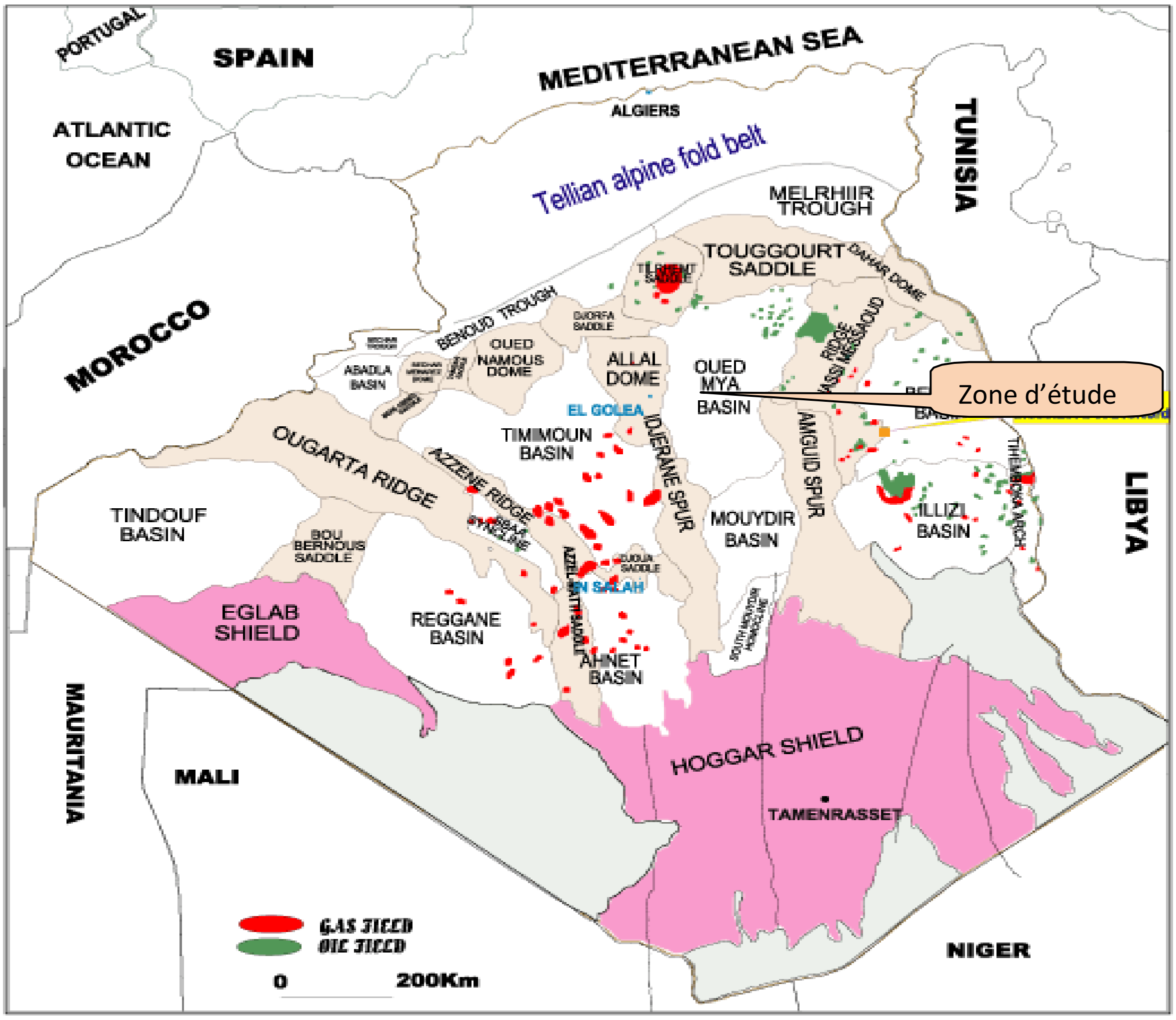


Figure I.2: Geological situation of Haoud Berkaoui.[4]

I.3 History of the region.

Up until its independence in 1977, the area was governed by the Hassi Massaoud district. Over the course of 39 years, the region has undergone tremendous transformations as it has developed, the most notable of which are:

Table I.1: History of the region. [3]

1963	**Discovery of the Ouargla field by drill hole OA#01.**
1965	**Discovery of the HBK field by drilling OK#101 at the top of the structure.**
1966	**Discovery of the BKH field by borehole OKP#24.**
1967	**Production start-up of an oil treatment center at Berkaoui, comprising two (02) separation batteries, three (03) storage bins and two (02) diesel pumps for shipping.**
1969	**Discovery of the Guellala field by borehole GLA#01.**
1970	**Extension of Berkaoui center to accommodate Benkahla production.**
1971	**Commissioning of the Benkahla center.**
1972	**Discovery of the Guellala northeast field by borehole GLA-NE#01.**
1976	**: Commissioning of the GLA production center.**
1978	**Commissioning of the GLA-NE production center and creation of the HaoudBerkaoui region.**
1979	**Commissioning of the DRT processing center.**
1981	**Start-up of water injection at HBK and BKH.**
1984	**Extension of the BKH center.**
1985	**Start-up of the associated gas treatment unit at Oued Noumer.**
1986	**Extension of the GLA-NE center.**
1989	**HBK and Hassi R'mel hand over instructions for Oued Noumer fields.**
1992	**Commissioning of new electric water injection units at GLA and BKH.**
1995	**Commissioning of the new electric water injection unit at HBK.**
1996	**Commissioning of a desalting unit at HBK.**
1999	**Discovery of the BKHE field by borehole BKHE#01.**
2000	**Start-up of 03 de-oiling plants at HBK, BKH, and GLA, with total oily water treatment capacity = 4,800 m3/d**
2001	**Commissioning of a domestic water treatment plant.**
2005	**Discover the NHN - EAAN - GLO - GLSW and BKRS fields**
2010	**Discovery of the BENKAHLA-Sud area.**

I.4 The fields of the region:

The Haoud-Berkaoui region is essentially composed of:

- **Haoud-Berkaoui Field:**

Discovered in March 1965 by the French company of Algeria petroleum (CFPA) by drilling the OK101 well at the top of the structure. It covers an area of 175 km2. Production began in January 1967, with an average depth of 3,550m. It produces by its own reservoir pressure, assisted by water injection for pressure maintenance (in certain zones) and gas-lift.

- **Benkahla Field:**

Discovered in November 1966 by the same company (CFPA) by drilling the OKP 24 well over an area of 72 km2. The Benkahla field went into production on May 2, 1967. The average depth is 3550m. It produces by its own reservoir pressure, aided by pressure maintenance and gas lift

- **Guellala Field:**

The field was discovered on October 28, 1969 by drilling GLA 01. It covers an area of 35 Km^2 Production began in February 1973.

The average depth is 3500m. Like Berkaoui and Benkahla, it is produced by naturaldepletion, pressure maintenance and gas lift

- **Several small "peripheral" fields:**
    - N'GOUSSA (N'GS).
    - DRAA TAMRA (DRT).
    - MOUKH EL KEBCH (MEK).
    - GARETE CHOUF (GEF).
    - MELLALA(MEL).
    - SAHANE (SAH).
    - BOUKHAZANA (BKZ).
    - EL HAICHA.
    - OUARSENIS (ORS).
    - BAB EL HATTABET (BHT).
    - TAKHOUKHET (TKT).
    - HANIET EL MOUKHTA (HKA).
    - ARIF.
    - HANJET EL BEIDA(HEB).
    - KEF EL AGROUB (KG).

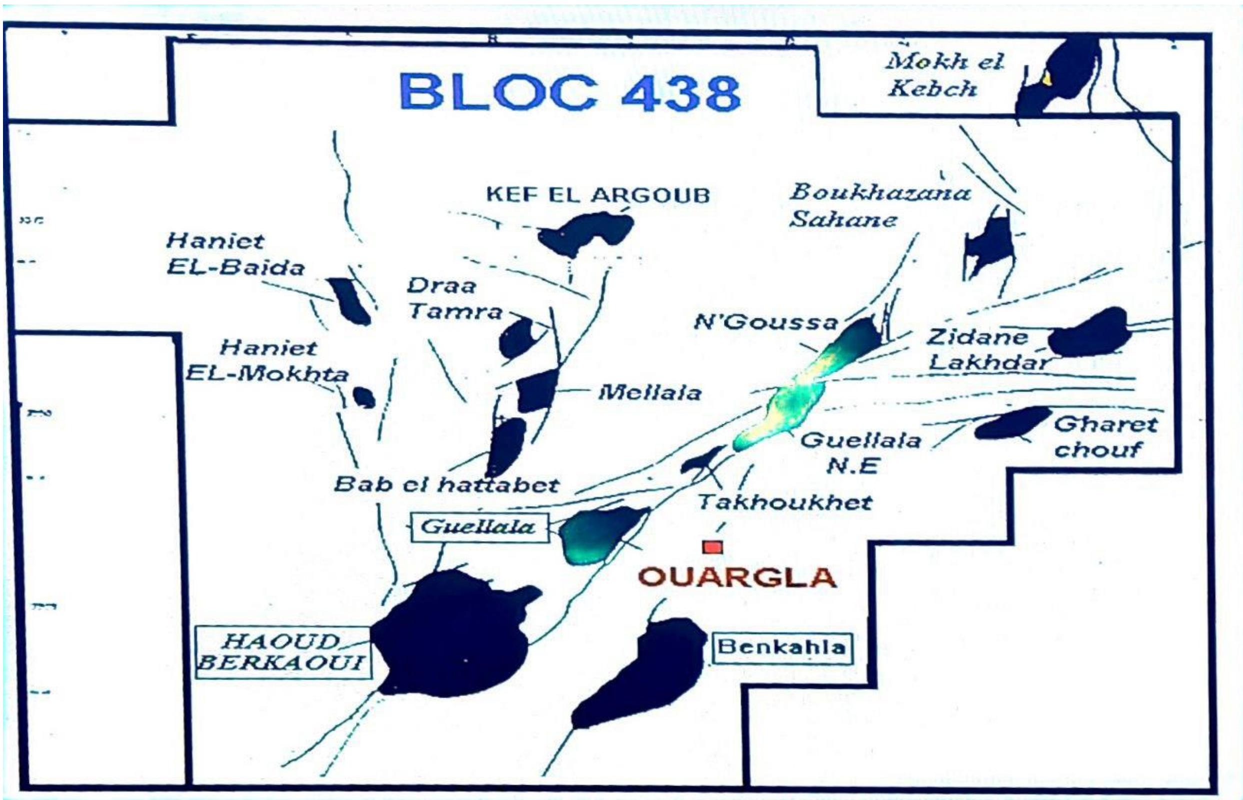


Figure I.3: Fields in the Haoud-Berkaoui region.[2]

The petro-physical characteristics of these three fields are summarized in the table below:

Table I.2 : Initial reservoir characteristics.[5]

	Haoud Berkaoui	Benkahla	Guellala
Average depth (m)	3550	3300	3500
Initial pressure (kgf/cm)^2	518	532	532.5
Bubble pressure (kgf/cm)^2	188	180	185
Initial oil/water contact (m)	3324	3324	3370
Average porosity ϕ (%)	8,8	9.3	9.3
Average permeability K (md)	56.2	70.4	232
Average saturation $_{Sw}$ (%)	32.7	32	22.3

I.5 Properties of reservoir fluids:

- GOR (gas-oil ratio) of initial dissolution Rsi=165 stm³/m³
- Density of (storage) oil at 15 °C =0.810

Table I.3: Properties of gas and oil from Haoud Berkaoui field.[5]

Gaz		
	At bubble pressure	**at the initial reservoir pressure**
Bg (m^3/stm^3)	0.00581	0.00347
viscosity (cp)	0.022	0.0419
density	0.2030	0.350
Oil		
	At bubble pressure	**at the initial reservoir pressure**
Bo (m^3/stm^3)	1.59	1.46
viscosity (cp)	0.245	0.337
water		
	At the initial reservoir pressure	**At atmospheric pressure**
density	1.22	1.264
viscosity (cp)	0.760	0.370
F.V.F (at15.6°C) (m^3/stm^3)	1.041	/
Compressibility ($1/Kg/cm^2$)	0.2494	/
Saturation pressure (Kg/cm^2)	148	/
G.W.R (stm^3/stm^3)	0.40	/
R (à 25o C) (ohms.m2/m)	/	0.061
PH (at 20°C)	/	3.2

I.6 Overview of the three reservoirs in the field:

The HBK field is characterized by the presence of three reservoirs:

I.6.1 Lower series:

This is the field's main reservoir. It is considered heterogeneous, with petrophysical characteristics varying in all directions. It consists of a stack of sandstone lenses, metric to decametric in thickness, hectometric to kilometric in length. The lower series consists of coarse sandstones, fine to medium sandstones and very fine sandstones, ending with intercalations of often dolomitic clays.

I.6.2 Clay-sandstone Trias T1:

This formation represents the region's secondary reservoir. It comprises a positive sequence of fine to medium-grained clay-carbonate sandstones at the base, tapering steadily upwards to dolomitic clays at the top. This reservoir appears as a relatively continuous sandstone nappe over the entire deposit.

I.6.3 Clay-sandstone Trias T2:

This reservoir, directly overlying T1, shows signs of oil, but is generally compact and is only exploited in a few wells. It consists of fine to very fine sandstones with a clayey part at the top, porosities vary from 2 to 4% with average permeabilities of 0.1 to 34 md. This series has very poor reservoir characteristics.

Conclusion:

In conclusion, Haoud Berkaoui stands as a crucial contributor to Algeria's hydrocarbon resources. Its geological characteristics, production activity, and regional significance solidify its position as a key area for continued exploration and development.

CHAPTER II: Overview of the Collection Network

Introduction:

All pipes and accessories used to transport raw effluent between the producing wells and the treatment center. Its role is to group the productions of the different wells of a field at a point where the treatment will take place, then the shipment to the refineries.

Collection lines almost always carry a multiphase effluent where the flow laws are complex and the pressure drops are significant, the latter are calculated by several methods that use different algorithms.

II.1 Collection Network Plans

When designing a collection network, it's crucial to select the shortest pipe route and most appropriate collection method. There are two forms of networks:

1. " individual pipes connecting each well to the treatment center.

2. "individual pipes connecting the wells to manifolds of valves allowing the production of several wells to be grouped to be transported by a collector of greater diameter to the treatment center. In the latter case, it is necessary to provide for the possibility of making individual tests on the wells; in general, the collector will be doubled by a test line.

II.1.1 Individual connection

In this case, each well is individually connected to the treatment center inlet, a system that offers significant technical advantages[6]:

Advantages:

- Immediate identification of wells in service at the treatment center, wells in operation and shutdown.
- Control of wells in service by simple examination of P and T° of arrival.
- Easy to isolate polluted production.
- Speed transition from well to test.

Disadvantages:

- Very expensive connection when the surface area of the field is large.
- the installation of several pipelines in the case of a large deposit and numerous wells.

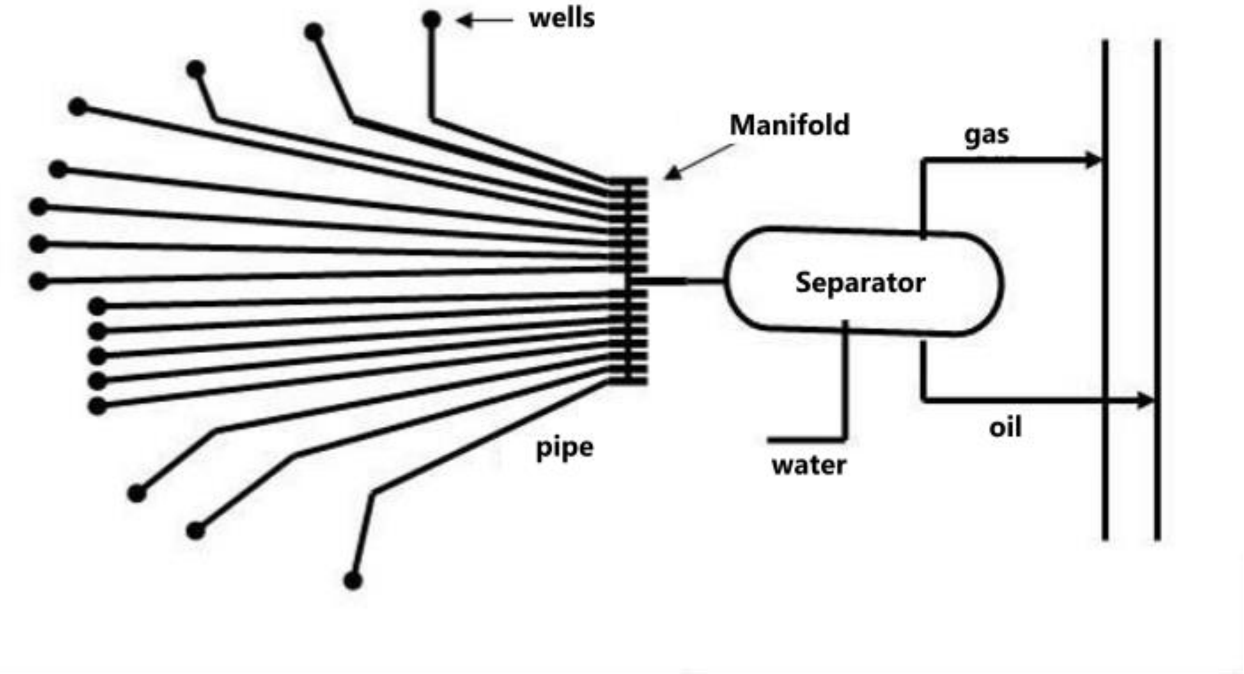


Figure II.1: Schematic diagram of an individual line collection network.[7]

II.1.2 Collector connection

The treatment center receives raw effluent from several wells through a high-capacity collector. The grouping point(s) for individual well lines are selected in the field to provide the shortest possible individual lines. Manifolds are grouping sites where valves isolate each well's production. In certain cases, a test line doubles the manifold[6].

Advantages:

- Savings on pipes.
- Easy expansion for new wells, reconfigurable for changing needs, handles various oil/gas types.

Disadvantages:

- Risks of undersizing the collection pipe during the estimate.
- Entire production can be polluted by that of a single well.
- Setting up the manifold system might be more expensive upfront.

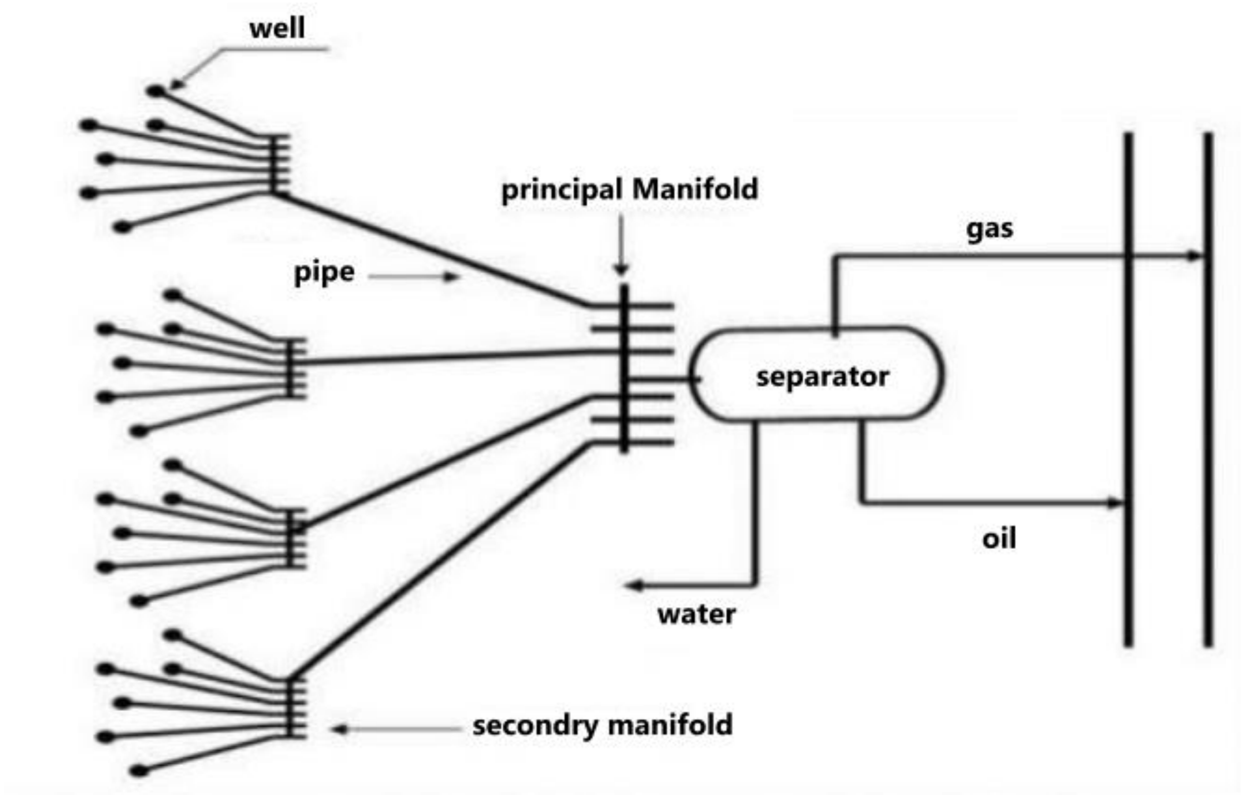


Figure II.2: collector connection.[7]

II.2 Collection Accessories

- **Pig Launcher & Receiver**:

where you'll find wiper stations for launching and others for wiper reception. These stations are used to introduce and receive pigs into a pipe in service, in order to clean it.


Figure II.3: Pig Launcher & Receiver.[1]

- **Scrapers or Pig**

which are pistons that are circulated in a pipe under the action of pressure from the effluent conveyed by the pipe. There are cleaning or maintenance tools fitted with metal brushes, to remove rust, salt and kerosene deposits. Scrapers are pistons that circulate in a pipe under the action of gas or liquid pressure. There are several types of scrapers, each designed to meet specific requirements:

- Scrapers with tungsten carbide blades, used to remove weld spatter,
- Scrapers for checking the internal condition of pipes.
- Articulated scrapers, to pass through bends.
- Scrapers with radioactive pellets, to locate a scraper blockage

Figure II.4: Scrapers or Pig.[8]

- **Insulating joints**

ensure the electrical isolation of collection lines from the Facilities to which they connect, as it is easier to ensure protection cathodic insulators, a distinction is made between flanged insulators and insulating sleeves.

- **Insulating flange gaskets:** Insulation is achieved by interposing an O-ring made of insulating material between the two flanges.
- **Insulating sleeves:** The part is factory-assembled and less fragile than the flanged fitting. Assembly on the pipe is either flanged or welded. This type of fitting is more expensive than the previous one.

Figure II.5: Insulating joints.[9]

❖ **Check valves (**in many forms):

Figure II.6: Check valves.[9]

❖ **Manifolds**

a set of grouped valves and pipes to direct production in all useful directions. Each element can accommodate from five to ten entries, depending on transport possibilities.

Figure II.7 : Manifold.[10]

❖ **Valves used on collection networks**

depending on their use and their position in the installation, it is possible to distinguish three kinds of valves:

- **In-line valves:** placed at the ends of pipes, they allow direct passage and cause minimal head loss.

- **Auxiliary valves:** these are filling or draining valves, control valves, etc. flow control, such as needle nozzles, flare valves.
- **Automatic control and safety** valves: (PSV) or (PRV)

Figure II.8 : Valves used on collection networks.[9]

❖ **Pressure gauges mounted on collection pipes**

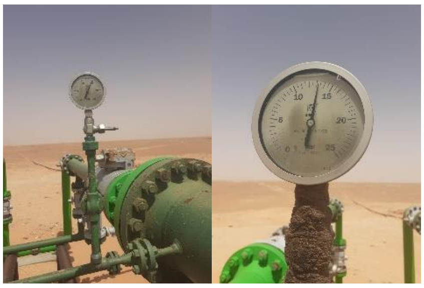


Figure II.9 : Pressure gauges mounted.

II.3 Horizontal gas-liquid flow regimes

Gas/Liquid flow regimes in horizontal pipes are summarized in (**Figure II.10)**, from top to bottom in order of increasing gas flow rate.

Bubble Flow: In bubble flow, small gas bubbles flow along the top of the pipe.

Elongated Bubble Flow: Collisions between the individual bubbles occur more frequently with increasing gas flow rate and they coalesce into elongated "plugs". This is often called plug flow.

Smooth Stratified Flow: The gas plugs coalesce to produce a continuous gas flow along the top of the pipe with a smooth gas-liquid interface typical of stratified flow at relatively low flow rates.

Wavy Stratified Flow: In most situations, the gas-liquid interface is rarely smooth with ripples appear on the liquid surface. The amplitude increases with increased gas flow rate.

Slug Flow: When the amplitude of the waves travelling along the liquid surface becomes sufficiently large enough for them to bridge the top of the pipe, the flow enters the slug flow regime. The gas flows as intermittent slugs and with smaller bubbles entrained in the liquid.

Annular Flow: Occurs when gas flow rate is large enough to support the liquid film around the pipe walls. Liquid is also transported as droplets distributed throughout the continuous gas stream flowing in the centre of the pipe. The liquid film is thicker along the bottom of the pipe because of the effect of gravity[11].

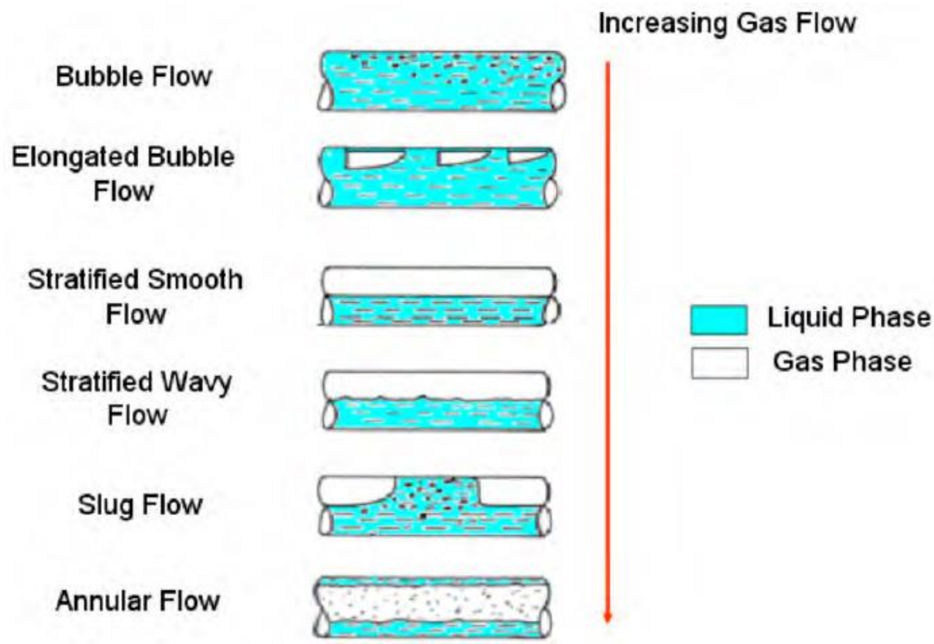


Figure II.10: Flow regimes of gas/ liquid horizontal flow [11].

II.3.1 Liquid HOLD-UP

In collection lines characterized by low points with significant gradients (slopes), a phenomenon called liquid holdup can occur. This arises because, at low fluid velocities, the denser component (often water) of the mixed fluid tends to accumulate at these low points. This accumulation has two main consequences[6].

- **Reduced Pipe Cross-Sectional Area:** As the liquid "holds up" in the low points, it effectively occupies a larger portion of the pipe's cross-sectional area. This leaves less space for the overall flow, hindering the passage of the fluid mixture.

- **Increased Pressure Losses:** Due to the reduced cross-sectional area and potential for turbulence at the low points, the resistance to flow increases. This translates to higher pressure losses within the pipe, making it more difficult to transport the fluid effectively.

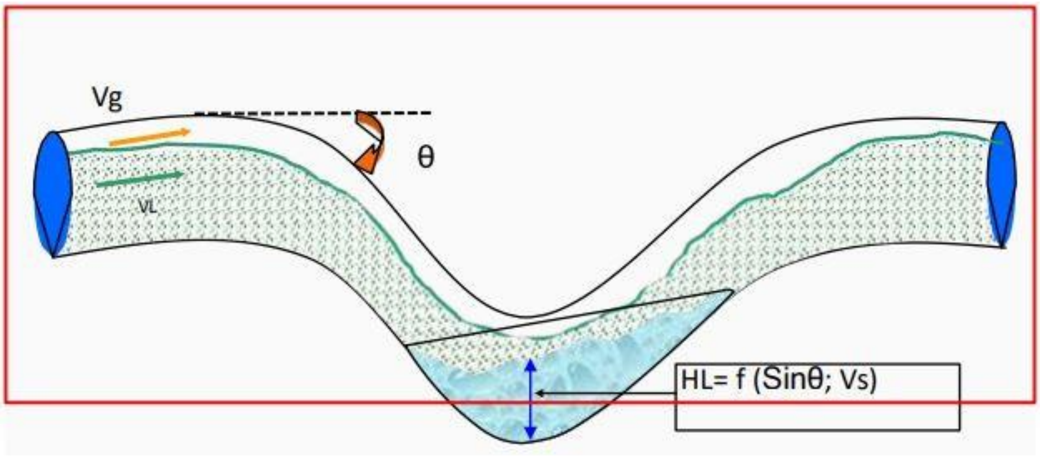


Figure II.11: Liquid HOLD-UP.[7]

Liquid holdup in collection lines can lead to several issues, including:

- **Reduced flow rates:** The accumulated liquid restricts flow, hindering the amount of fluid that can be transported through the pipe in a given timeframe.
- **Increased pumping costs:** Overcoming the higher-pressure losses requires more energy, leading to increased pumping costs.
- **Potential for pipe blockages:** In severe cases, complete blockages can occur if enough liquid accumulates and restricts the flow entirely.

II.3.2 Gas-Oil Ratio (GOR)

The GOR is a key parameter used in oil and gas production, representing the ratio of the volume of gas produced at standard conditions (temperature and pressure) to the volume of oil produced at the same standard conditions. This ratio remains constant for a fluid mixture flowing steadily along a pipeline[6].

II.3.3 Pipe Pressure DropΔP

When fluid flows through a pipe there will be a pressure drop that occurs as a result of resistance to flow. This pressure loss is caused by friction between the fluid and the pipe wall, as well as other factors like changes in pipe diameter, fittings, and elevation.

$$\frac{dP}{dP} = \left(\frac{dP}{dL}\right) ele + \left(\frac{dP}{dL}\right) f + \left(\frac{dP}{dL}\right) acc \quad \text{II.1)}$$

Table II.1: Percentage of each pressure loss term[7].

Component	Oil wells	Gas wells
Elevation	70% - 90%	20% - 50%
Friction	10% - 30%	30% - 50%
Acceleration	0% - 10%	0% - 10%

II.4 SEPARATION

Oil and gas production isn't simply about extracting hydrocarbons from the ground. It involves managing a complex mixture of components that emerge from the well as a two-phase or multiphase flow. This is where separation comes in, playing a vital role as the initial and critical step in the hydrocarbons (oil and gas) and non-hydrocarbons (water and other materials) processing chain.

II.4.1 Separator

The separators are placed at the head of the processing chain of which they constitute the essential elements. They receive the production brought by the collections directly from the input manifold. A separator is a pressurized capacity, incorporated into a circuit, on which it causes a slowdown in the flow speed of the effluent. A separator appears as a cylindrical tank arranged either vertically or horizontally. There are also spherical separators, but they are less commonly used. Connections equipped with valves and measuring devices allow operation to be checked

II.4.2 The Different Types of Separators

II.4.2.1 Vertical Separator:

The main advantage of this separator is that it can accept larger liquid plugs without excessive entrainment in the gas. Given the generally large distance between the liquid level and the gas outlet, there is less tendency for liquid drops to be entrained. It is, on the other hand, larger in diameter for a given gas capacity. The vertical separator will therefore be well suited for large quantities of liquid (low GOR) or on the contrary when there is only gas (the minimum liquid space of the horizontal tank is too large). They are also used for wells with solid deposits.

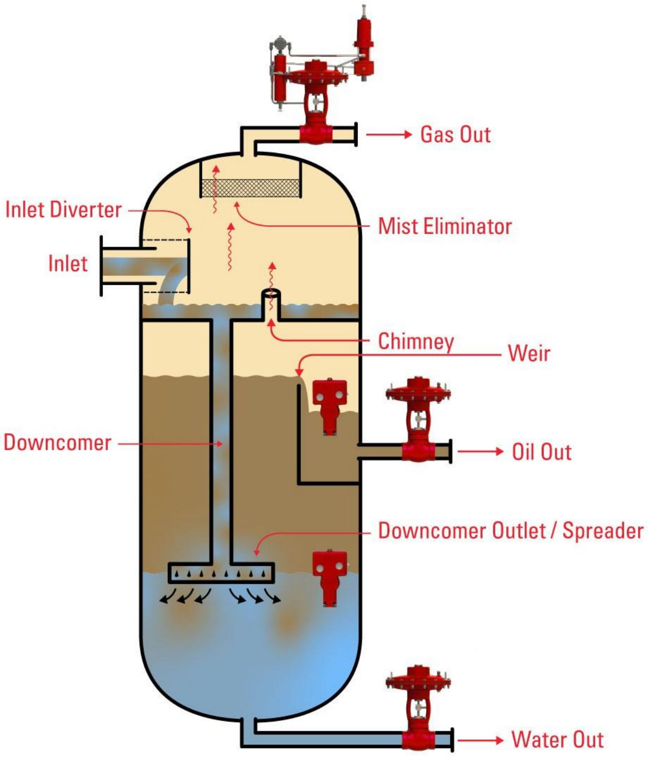


Figure II.12: Vertical Separator[12].

Advantages

- The potential for the liquid to re-vaporize into the gas phase is limited due to the significant vertical distance between the liquid level and the gas outlet.
- Have an adequate bottom-drain and clean-out system in place.
- There are fewer entrainment tendencies.
- Surge control is an added benefit

Disadvantages

- Without ladders or access platforms, several equipment and safety devices may be difficult to reach.
- In comparison to the horizontal separator, a larger diameter separator is required for a comparable gas capacity[13]..

II.4.2.2 Horizontal Separator:

They are widely used for high GOR wells because they have a very good exchange surface. These separators are generally of a smaller diameter than vertical separators for the same quantity of gas and have a wider interface between gas and liquid. They are easier to assemble on site.

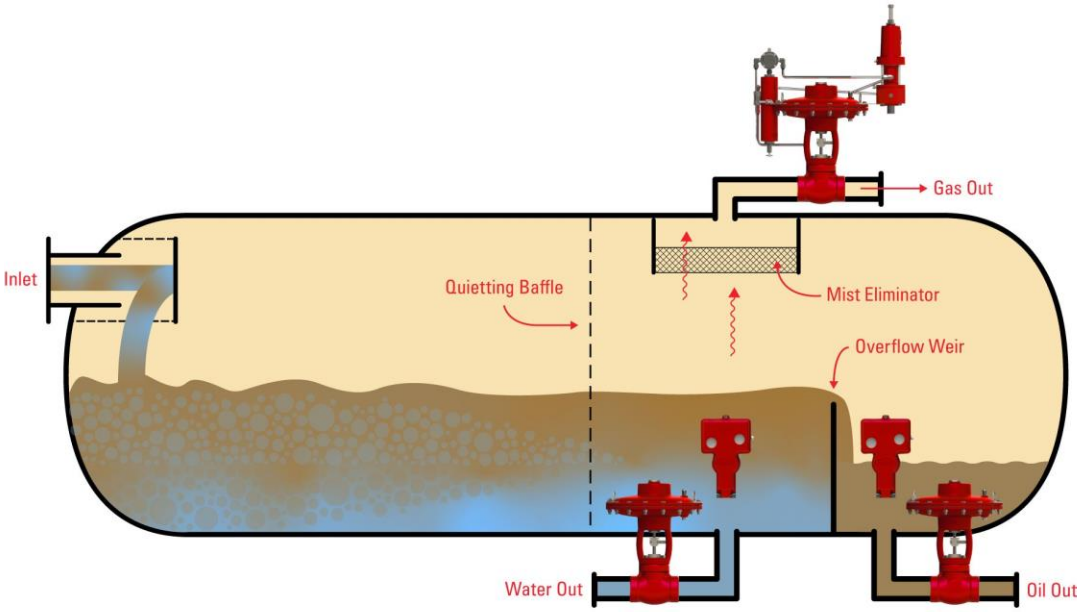


Figure II.13: Horizontal Separator[12].

Advantages

- Due to a large, lengthy and baffled gas-separation component, they have a substantially higher gas/liquid interface.
- The horizontal separator is less expensive than the vertical separator.

Disadvantages

- Level control is critical and must be maintained.
- More plan area is required to perform separation.
- Cleaning is difficult

II.4.2.3 Spherical Separator:

The spherical separator had the same working principle as vertical separator; the main difference is the existence of cylindrical shell between the inlet and outlet. This kind of separator is very efficient in term of working pressure but they have limited surge capability and it's difficult to fabricate[14].

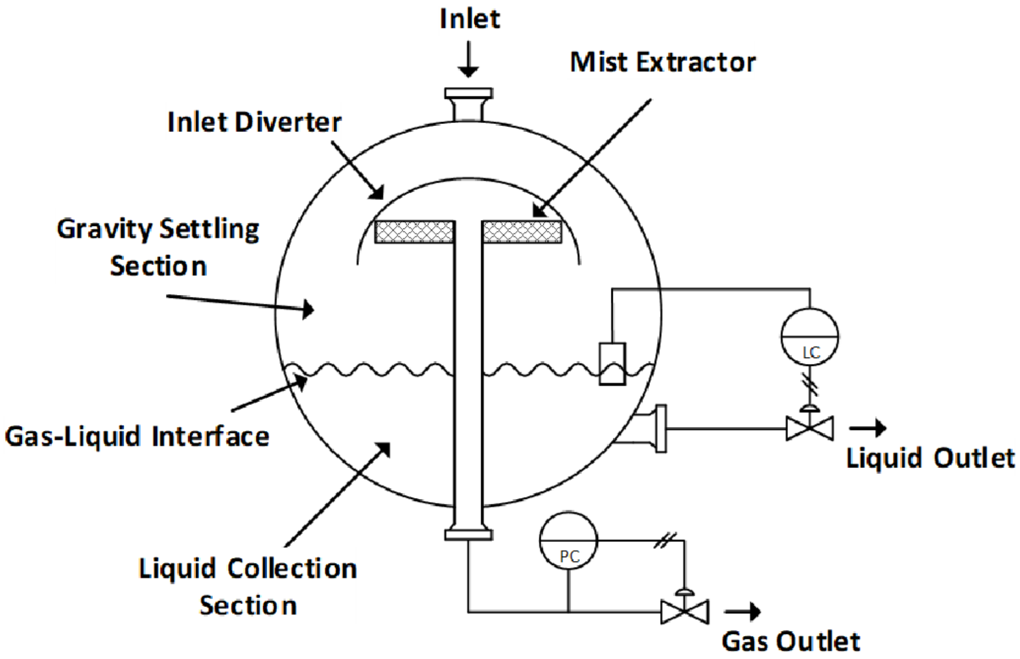


Figure II.14: Spherical Separator.[15]

Advantages

- It is cost effective.
- It is beneficial for gas-to-oil ratios that are moderate or low.

- It is small and simple to transport and setup.

Disadvantages

- The performance of the spherical separator is dependent on liquid level control.
- Surge capacity and liquid settling section are both severely limited.
- Because of the restricted internal space, it is difficult to utilize in three-phase (oil, water, and gas).

II.4.3 Separation Objectives

The purpose of the separation operation is to separate the oil from the gas and water so that the product can be delivered to the customer in compliance with well-defined standards such as:

- Density.
- Viscosity.
- B.S.W (Basic and sediment water).
- Salinity.
- Vapor pressure[7].

II.5 General information on pumps

A pump is a mechanical device that is used to give energy to a flowing liquid such that the liquid can overcome the resistance in the hydraulic system. Simply the pump converts mechanical energy into hydraulic energy given to the flow[16].

There are many different types of pumps, motors and principles, and any type of motor can be used on a pump:

- Electric motor
- Gas turbine
- Steam turbine
- Diesel engine

II.5.1 Pumping unit

■ Comprising two pumps, one in service and the other on stand-by.
■ Minimum inlet pressure: 5 bar
■ Maximum discharge pressure: 33 bar

■ Low NPSH

NPSH stands for Net Positive Suction Head. It's a crucial parameter in pump operation that refers to the available pressure a liquid has at the pump inlet compared to its vapor pressure. In simpler terms, it represents the minimum pressure required by the liquid to avoid cavitation when entering the pump.

Conclusion:

This chapter has served as an introduction to the collection network. We've explored its essential components, from individual well connections to collector systems and separation processes. We've gained a foundational understanding of horizontal gas-liquid flow regimes, recognizing their influence on efficient transportation within the network.

CHAPTER III: Collection Network Optimization in MFD OKN62

Introduction

The efficient transportation of produced oil and gas from wellheads to processing facilities is a critical challenge in the petroleum industry. Collection networks consisting of pipelines and flow lines are responsible for gathering the hydrocarbons from dispersed well locations. Proper design and optimization of these networks can significantly reduce operating costs and improve overall field productivity.

Optimizing the gathering network in an oil field involves a comprehensive set of steps, starting with designing an efficient pipeline network that considers both engineering and economic factors. It then moves on to improving resource flow to ensure the fastest possible transportation, and culminates in increasing productivity to maximize well potential.

Our objective in this chapter is to determine the optimal scheme for the wells of the manifold OKN62 that maximizes production. To do this, we will study several possible configurations and we will choose the optimal one.

III.1 PIPESIM

PIPESIM is a versatile software program designed for the comprehensive analysis and optimization of oil and gas production networks. This software empowers production and reservoir engineers to achieve accurate predictions of flow behavior and temperature distribution within wellbores and pipelines. PIPESIM's ability to model well performance under diverse scenarios fosters confident decision-making in production network management, solidifying its position as an invaluable asset for the industry[17].

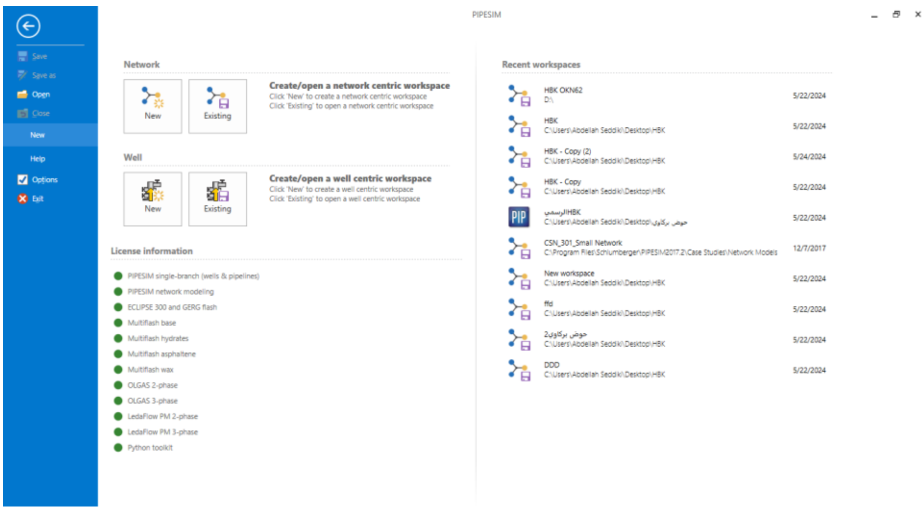


Figure III.1: Pipesim software

III.1.1 Application of PIPESIM Software

- Network Design and Optimization.
- Well Performance Analysis.
- Production optimization.
- Optimization of well equipment.

III.1.2 Data Requirements for PIPESIM Modeling

- **Well Completion Data**
- **Petrophysical Data**: (porosity, permeability….)
- **Geological Report:** A geological report provides valuable insights into the geological context of the reservoir, including details about the formation structure.
- **PVT (Pressure, Volume, Temperature) Data:** PVT data characterizes the physical properties of the reservoir fluids (oil, gas, and water) under varying pressure and temperature conditions. This typically includes bubble point pressure, oil and gas density at different pressures, and fluid viscosity data.
- **Well Test Data:** Data from well testing operations, such as Drill Stem Tests (DSTs), pressure buildup tests, and well gauging data, provides valuable information about reservoir pressure behavior, well productivity, and fluid flow characteristics.

III.1.3 Pipesim models

The software has two models:

III.1.3.1 Well Performance

The following basic steps are required to build a well model (single or multiple completion);

- Select the units set of your preference
- Determine the completion of the well
  - Single
  - Multiple
  - Horizontal
- Add the necessary components to the model (completion, tubing, etc) and defined the necessary data.
- Define the fluid specification
- Define the flow correlation to use.
- Save the model.

III.1.3.2 Network model

The following basic steps are required to build a network model;

- Select the units set of your preference
- Develop the network model (wells and surface facilities). Prebuilt models of wells/flowline can be used.
- Set the fluid properties
- Set the boundary conditions
- Save the model.

III.2 The OKJ202 manifold (MFD) collection network structure

The main manifold, MFD OKJ202, comprises a network of 43 production wells. These wells encompass various types, including eruptive wells, conventional gas lift wells, and gas lift wells with multiphase (MP) production from the Benkahla field. Three 12-inch diameter pipelines (A, B, and C) originate from this main manifold to supply the Haoud Berkaoui Production Center. Additionally, a 10-inch diameter pipeline delivers production from the BKP2 well (source of $BaSO_4$) within the Haoud Berkaoui field. Finally, a 6-inch diameter pipeline transports production from the Benkahla field utilizing multiphase technology.

Table III.1: the pipes of the MFD OKJ 202.

MFD OKJ202 CONNECT TO PRODUCTION CENTER HBK	**OKJ 202 MFD**	**6**	**1080**	**HBK CENTER**
		10	**1080**	**HBK CENTER**
		12A	**1080**	**HBK CENTER**
		12B	**1080**	**HBK CENTER**
		12C	**1080**	**HBK CENTER**

The OKJ202 main MFD is powered by 8 Mini manifolds as shown in the following table:

.

Table III.2: the manifolds that consist OKJ20.

	MFD	O PIPE	LENGTH	CONNECTION
OKJ202 MFD	OKJ02BIS	4X6	36X1350	MAIN MANIFOLD
		6	1386	MAIN MANIFOLD
	OKJ12	4	1977	MAIN MANIFOLD
		6	1977	MAIN MANIFOLD
	OKJ20	4	1682	MAIN MANIFOLD
		8X6	695X500	MAIN MANIFOLD
	OKNI4	8	5800	MAIN MANIFOLD
	OKN16	4	2935	MAIN MANIFOLD
		6	2935	MAIN MANIFOLD
		8	2935	MAIN MANIFOLD
	OKN36	8B	3535	MAIN MANIFOLD
	OKN54	8A	5293	MAIN MANIFOLD
		6	5293	MAIN MANIFOLD(MP)
	OKN62	8	8264	MAIN MANIFOLD
	Y EAAN+ NHN	8	2200	MAIN MANIFOLD

Our work focuses on study the gathering network of the OKN62 manifold and attempting to enhance its productivity under various scenarios. The aim is to select the most effective option considering productivity.

III.3 The OKN62 manifold (MFD) collection network structure

The MFD OKN62 consists of 18 producing wells of different types (conventional gas lift wells and gas lift wells and wells). From this manifold there are several pipes to supply the MFD OKJ202.

- (8" /6”) HP two pipes for the main manifold OKJ202
- 8” MP pipe for the same manifold.

Table III.3: the pipes of the MFD OKN62

MFD OKN62	8” HP	8350 (m)	connection MFD OKN62 to MFD PRINCIPL OKJ202
	6” HP	8760 (m)	
	8” MP	8550 (m)	

Table III.4: the number of wells of the MFD OKN62

	WELLS	STATE	TYBE
MFD OKN62	BKRE1	Active	gas lift
	BKRE2	Active	gas lift
	BKRE3	Active	gas lift
	BKRE4	Active	gas lift
	BKRE5	Active	gas lift
	BKRE6	Active	gas lift
	BKRE7	Active	gas lift
	BKRS1	Active	gas lift
	BKRS2	Active	gas lift
	OKN422	Active	gas lift
	OKN61	Active	gas lift
	OKN71	Active	gas lift
	OKN72	Active	gas lift
	OKNI62	Active	gas lift
	OKR20	Active	gas lift
	OKS44	Active	gas lift
	OKS45	Closed	/
	OKN721	Closed	/

III.4 OKN62 MFD collection Network Modeling using PIPSIM:

III.4.1 Selection of the Horizontal Flow Pressure Drop Correlation

selection of the horizontal flow correlation important when modeling a gathering network. Its significance lies in estimating pressure losses within the network with the utmost accuracy and developing a model that closely reflects reality. This selection will be based on field data. The correlation that yields the least relative error compared to these measurements will be chosen for our model. The PIPESIM software offers several horizontal flow correlations. We will select ours from the following:

Beggs and Brill Original

1- Beggs and Brill Revised

2- Dukler, AGA and Flanagan

3- Duns and Ros

4- Mukherjee and Brill

5- Xiao

After numerous attempts and applying this correlation to the PIPESIM software, we concluded that **Beggs and Brill Revised** the Correlation is the most suitable and closest to the actual values.

III.4.2 Requirement input data to Pipesim

Table III.5 : Requirement input data to Pipesim.

WELLS	P_{pipe}(bar)	GOR (sm3/sm3)	Temperature(degC)
BKRE1	12.5	252.0044	35
BKRE2	17	505.0063	35
BKRE3	14.5	288	35
BKRE4	16	349.6252	35
BKRE5	16.5	354.6835	35
BKRE6	16.5	329.2497	35
BKRE7	11.5	306.0067	35
BKRS1	13	460.9959	35
BKRS2	17.5	355.0041	35
OKN422	10.1	582.0022	35
OKN61	14.5	180.9929	35
OKN71	16.5	217.0063	35
OKN72	15	320.0059	35
OKNI62	9	299.007	35
OKR20	12	582.0022	35
OKS44	17.5	241.9948	35
OKS45	/	/	/
OKN721	/	/	/

sink	pressure(bar)
HP MFD PPL [12-C]	7.747254
MP MFD PPL [8]	4.707192

III.4.1 Collection network model of OKN62 manifold.

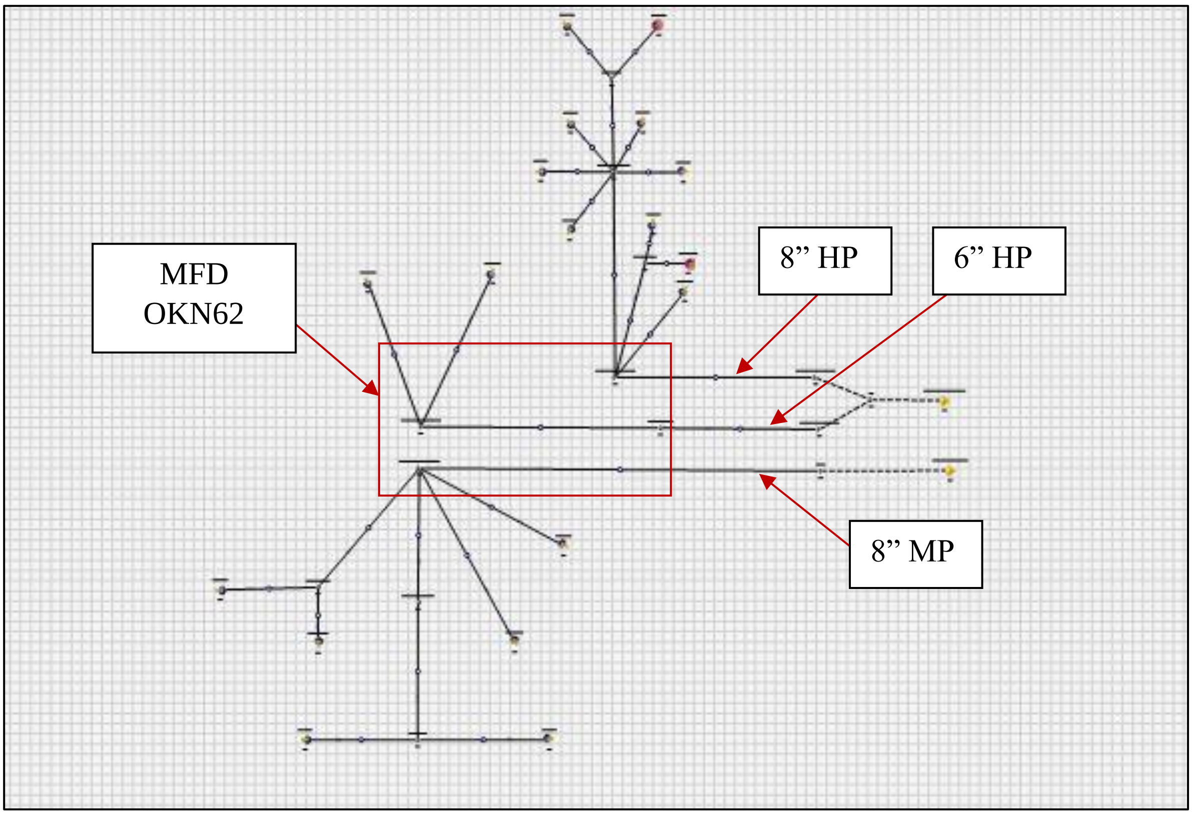


Figure III.2 : Collection network model of OKN62 manifold.

III.4.2 The Simulation Result by Pipesim:

	Name	Type	Pressure (out)	Temperatur...	ST liquid rate	ST Oil rate	ST Water rate	ST Gas rate	ST GOR	ST WCUT	FL Gas rate (...	FL WCUT
			bara	degC	SM3/h	sm3/d	sm3/d	mmsm3/d	sm3/sm3	%	m3/d	%
1	J	Junction	7.746951	21.89027	32.02917	675.202	93.49801	0.1999636	296.1536	12.16313	25731.77	11.99745
2	MFD BKRE -HP	Junction	15.48832	26.37341	17.36103	416.6648	0	0.1354038	324.9704	0	8507.091	0
3	MFD OKN62-HP 6	Junction	12.90016	32.2221	11.39959	180.0922	93.49801	0.0467653	259.674	34.17447	3635.072	33.50266
4	MFD OKN62-HP 8	Junction	14	23.55674	20.62957	495.1098	0	0.1531983	309.4227	0	10600.4	0
5	MFD OKN62-MP 8	Junction	7.385968	22.81275	9.199509	220.7882	0	0.07614417	344.874	0	10354.93	0
6	Y BKRE1	Junction	12.21722	23.10238	2.533067	60.79361	0	0.02068977	340.3278	0	1658.124	0
7	Y OKN 422	Junction	10.29395	15.55228	2.199505	52.78813	0	0.03072283	582.0022	0	2899.871	0
8	Y OKN721	Junction	14.28106	22.05407	1.400408	33.60979	0	0.009679626	288	0	649.3694	0
9	Y OKS45	Junction	15.67235	33.06104	6.093917	146.254	0	0.03539273	241.9948	0	2222.367	0
10	HP MFD PPL [12-C]	Sink	7.746949	21.89027	32.02917	675.202	93.49801	0.1999636	296.1536	12.16313	25731.78	11.99745
11	MP MFD PPL [8]	Sink	4.707189	17.67348	9.184743	220.4338	0	0.07602195	344.874	0	16152.44	0
12	BKRE 7	Source	11.49977	35	2.883394	69.20146	0	0.02117612	306.0067	0	1889.605	0
13	BKRE1	Source	12.50019	35	1.462549	35.10119	0	0.00884566	252.0044	0	716.8435	0
14	BKRE2	Source	16.99971	35	1.589743	38.15382	0	0.01926793	505.0063	0	1147.896	0
15	BKRE3	Source	14.49967	35	1.400408	33.60979	0	0.009679626	288	0	671.6886	0
16	BKRE4	Source	15.99997	35	2.930055	70.32133	0	0.02458612	349.6252	0	1545.716	0
17	BKRE5	Source	16.49984	35	2.447801	58.74723	0	0.02083668	354.6835	0	1268.871	0
18	BKRE6	Source	16.49984	35	2.122568	50.94163	0	0.01677253	329.2497	0	1018.145	0
19	BKRS1	Source	13.00006	35	1.070518	25.69243	0	0.01184411	460.9959	0	935.8445	0
20	BKRS2	Source	17.50027	35	2.176951	52.24682	0	0.01854784	355.0041	0	1060.158	0
21	OKN 422	Source	10.10013	15.55278	1.149654	27.59169	0	0.01605844	582.0022	0	1546.204	0
22	OKN61	Source	14.49967	35	1.868132	44.83516	0	0.008114853	180.9929	0	550.9317	0

Figure III.3 : The Simulation Result by Pipesim

According to the simulation results, we find that.

1. The flowrate of the HP Line (HP MFD OKN62 arrival OKJ202) is: 32.02917 sm3/h

2. The flowrate of the MP Line (MP OKN62 arrival OKJ202) is: 9.184743 sm3/h.

3. The production of the simulation is: 41.213913 sm3/h

32.02917+9.184743 = 41.213913 sm3/h

III.5 Collection network optimization

In our work we will suggest 3 scenarios to optimize the collection network of MFD OKN62 and increase the productivity.

III.5.1 Scenario 1

In this scenario we change path of two wells OKR20 and OKN422 and we see its effect on flowrate:

- Connect well OKR20 directly to manifold OKN62
- Connect well OKN422 directly to manifold OKN62

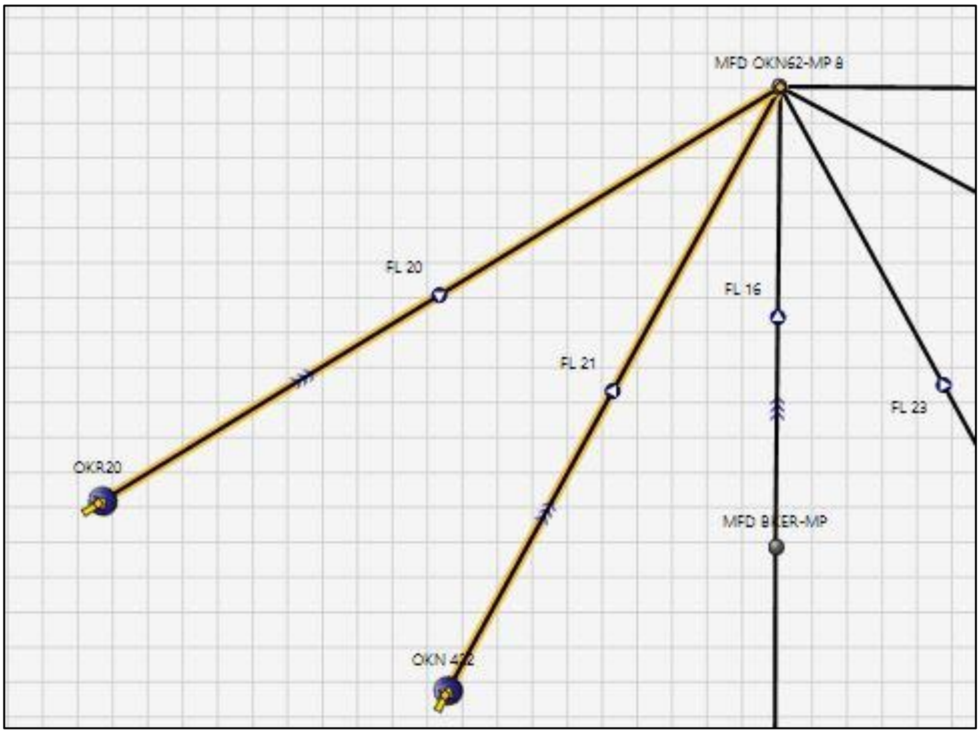


Figure III.4 : Scenario 1.

❖ The Simulation Result can be summarized as follows:

1. The flowrate of the HP Line (HP MFD OKN62 arrival OKJ202) is: 32.02917sm3/h

2. The flowrate of the MP Line (MP OKN62 arrival OKJ202) is: **10.26918** sm3/h.

3. The production of the simulation is: 42.29835 sm3/h

32.02917+10.26918 = 42.29835 sm3/h

	Name	Type	Pressure (out)	Temperatur...	ST liquid rate	ST Oil rate	ST Water rate	ST Gas rate	ST GOR	ST WCUT	FL Gas rate (...	FL WCUT
			bara	degC	SM3/h	SM3/h	sm3/d	mmsm3/d	sm3/sm3	%	m3/d	%
1	J	Junction	7.746951	21.89027	32.02917	28.13342	93.49801	0.1999636	296.1536	12.16313	25731.77	11.99745
2	MFD BKRE -HP	Junction	15.48832	26.37341	17.36103	17.36103	0	0.1354038	324.9704	0	8507.091	0
3	MFD OKN62-HP 6	Junction	12.90016	32.2221	11.39959	7.503843	93.49801	0.0467653	259.674	34.17447	3635.072	33.50266
4	MFD OKN62-HP 8	Junction	14	23.55674	20.62957	20.62957	0	0.1531983	309.4227	0	10600.4	0
5	MFD OKN62-MP 8	Junction	7.933149	20.90586	10.26918	10.26918	0	0.08598543	348.8813	0	10781.69	0
6	Y BKRE1	Junction	12.25427	22.68381	2.402457	2.402457	0	0.01979231	343.2649	0	1578.886	0
7	Y OKN721	Junction	14.28106	22.05407	1.400408	1.400408	0	0.009679626	288	0	649.3694	0
8	Y OKS45	Junction	15.67235	33.06104	6.093917	6.093917	0	0.03539273	241.9948	0	2222.367	0
9	HP MFD PPL [12-C]	Sink	7.746949	21.89027	32.02917	28.13342	93.49801	0.1999636	296.1536	12.16313	25731.78	11.99745
10	MP MFD PPL [8]	Sink	4.707189	17.26647	10.26918	10.26918	0	0.08598543	348.8813	0	18245.09	0
11	BKRE1	Source	12.50019	35	1.353374	1.353374	0	0.008185358	252.0044	0	663.3333	0
12	BKRE2	Source	16.99971	35	1.589743	1.589743	0	0.01926793	505.0063	0	1147.896	0
13	BKRE3	Source	14.49967	35	1.400408	1.400408	0	0.009679626	288	0	671.6886	0
14	BKRE4	Source	15.99997	35	2.930055	2.930055	0	0.02458612	349.6252	0	1545.716	0
15	BKRE5	Source	16.49984	35	2.447801	2.447801	0	0.02083668	354.6835	0	1268.871	0
16	BKRE6	Source	16.49984	35	2.122568	2.122568	0	0.01677253	329.2497	0	1018.145	0
17	BKRE7	Source	11.49977	35	2.715722	2.715722	0	0.01994471	306.0067	0	1779.723	0
18	BKRS1	Source	13.00006	35	1.049082	1.049082	0	0.01160695	460.9959	0	917.1057	0
19	BKRS2	Source	17.50027	35	2.176951	2.176951	0	0.01854784	355.0041	0	1060.158	0
20	OKN 422	Source	10.10013	35	1.546508	1.546508	0	0.01113503	300.0044	0	1137.585	0
21	OKN61	Source	14.49967	35	1.868132	1.868132	0	0.008114853	180.9929	0	550.9317	0
22	OKN71	Source	16.49984	35	4.395368	4.395368	0	0.02289175	217.0063	0	1362.074	0

Figure III.5 : Result of Scenario 1.

❖ Comment:

We observe an increase the flowrate (1.0844sm^3/h) of the MP Line (MP OKN62 arrival OKJ202) thus a slight increase in productivity.

III.5.2 Scenario 2

In this scenario we will add a separator after OKN62 manifold and observe how it affects the flowrate.

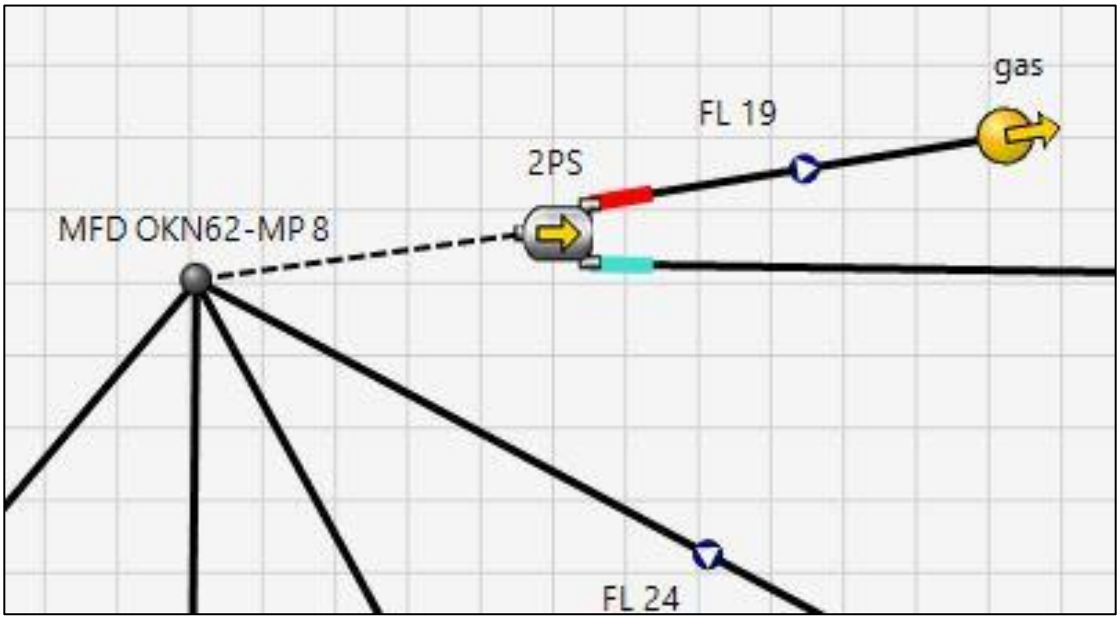


Figure III.6 : Scenario 2.

❖ The Simulation Result can be summarized as follows:

1. The flowrate of the HP Line (HP MFD OKN62 arrival OKJ202) is: 32.02917sm^3/h

2. The flowrate of the MP Line (MP OKN62 arrival OKJ202) is: **10.96091** sm^3/h.

3. The production of the simulation is: 42.29835 sm3/h

32.02917+10.96091 = 42.99008 sm^3/h

	Name	Type	Pressure (out)	Temperatur...	ST liquid rate	ST Oil rate	ST Water rate	ST Gas rate	ST GOR	ST WCUT	FL Gas rate (...	FL WCUT
			bara	degC	SM3/h	sm3/d	sm3/d	mmsm3/d	sm3/sm3	%	m3/d	%
1	J	Junction	7.746951	21.89027	32.02917	675.202	93.49801	0.1999636	296.1536	12.16313	25731.77	11.99745
2	MFD BKRE -HP	Junction	15.48832	26.37341	17.36103	416.6648	0	0.1354038	324.9704	0	8507.091	0
3	MFD OKN62-HP 6	Junction	12.90016	32.2221	11.39959	180.0922	93.49801	0.0467653	259.674	34.17447	3635.072	33.50266
4	MFD OKN62-HP 8	Junction	14	23.55674	20.62957	495.1098	0	0.1531983	309.4227	0	10600.4	0
5	MFD OKN62-MP 8	Junction	6.000025	23.75866	10.96202	263.0886	0	0.09022483	342.9445	0	15265.63	0
6	Y BKRE1	Junction	12.14362	23.85838	2.80981	67.43544	0	0.02267852	336.2995	0	1834.018	0
7	Y OKN 422	Junction	10.25047	15.55192	2.22439	53.38537	0	0.03107042	582.0022	0	2945.707	0
8	Y OKN721	Junction	14.28106	22.05407	1.400408	33.60979	0	0.009679626	288	0	649.3694	0
9	Y OKS45	Junction	15.67235	33.06104	6.093917	146.254	0	0.03539273	241.9948	0	2222.367	0
10	gas	Sink	5.000009	23.29925	0	0	0	0.08915676		0	18343.58	0
11	HP MFD PPL [12-C]	Sink	7.746949	21.89027	32.02917	675.202	93.49801	0.1999636	296.1536	12.16313	25731.78	11.99745
12	MP MFD PPL [8]	Sink	4.707189	17.46917	10.96091	263.0618	0	0.001091753	4.150174	0	57.99639	0
13	BKRE1	Source	12.50019	35	1.676495	40.23587	0	0.01013963	252.0044	0	821.7052	0
14	BKRE2	Source	16.99971	35	1.589743	38.15382	0	0.01926793	505.0063	0	1147.896	0
15	BKRE3	Source	14.49967	35	1.400408	33.60979	0	0.009679626	288	0	671.6886	0
16	BKRE4	Source	15.99997	35	2.930055	70.32133	0	0.02458612	349.6252	0	1545.716	0
17	BKRE5	Source	16.49984	35	2.447801	58.74723	0	0.02083668	354.6835	0	1268.871	0
18	BKRE6	Source	16.49984	35	2.122568	50.94163	0	0.01677253	329.2497	0	1018.145	0
19	BKRE7	Source	11.49977	35	3.257504	78.18009	0	0.02392364	306.0067	0	2134.774	0
20	BKRS1	Source	13.00006	35	1.133315	27.19956	0	0.0125389	460.9959	0	990.7418	0
21	BKRS2	Source	17.50027	35	2.176951	52.24682	0	0.01854784	355.0041	0	1060.158	0
22	OKN 422	Source	10.10013	15.55557	0.9732843	23.35882	0	0.0135949	582.0022	0	1309.014	0

Figure III.7 : Result of Scenario 2.

❖ Comment:

We observe an increase the flowrate (1.77617sm^3/h) of the MP Line (MP OKN62 arrival OKJ202) thus a slight increase in productivity.

III.5.3 Scenario 3

In this scenario we will change the diameter of flowline from MP wells to OKN62 MFD and observe the extent of its effect on the flowrate.

Table III.6 : diameter of flowline before and after optimization.

wells	Before optimization	After optimization
BKRE7	4"	6"
OKNI62	4"	6"
BKRE1	4"	6"
BKRS1	4"	6"
OKN 422	4"	6"
OKR20	4"	6"

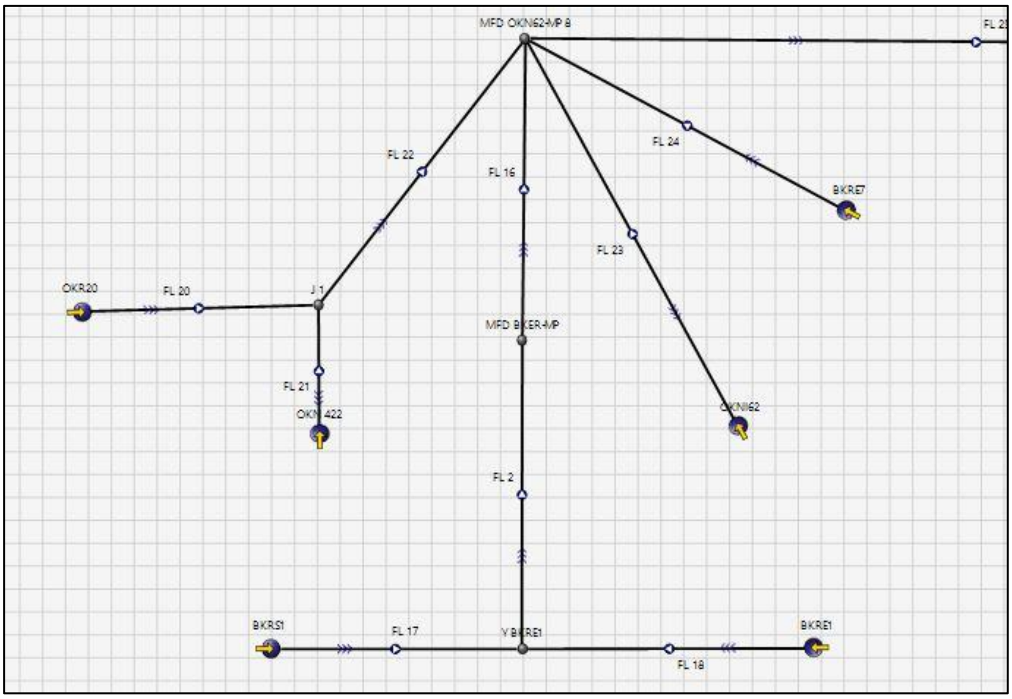


Figure III.8: Scenario 3

❖ The Simulation Result can be summarized as follows:

1. The flowrate of the HP Line (HP MFD OKN62 arrival OKJ202) is: 32.02917sm^3/h
2. The flowrate of the MP Line (MP OKN62 arrival OKJ202) is: **13.34949** sm^3/h.
3. The production of the simulation is: 45.37866 sm3/h

32.02917+ 13.34949= 45.37866 sm^3/h

❖ Comment:

We observe an increase the flowrate (4.16475sm^3/h) of the MP Line (MP OKN62 arrival OKJ202).

III.6 Comparison between results obtained after optimization

Table III.7: Comparison between results obtained after optimization.

OKN62 Flowrate (sm^3/h)	Before optimization	After optimization		
		Scenario 1	Scenario 2	Scenario 3
	41.21393	**42.29835**	**42.99008**	**45.37866**

After analyzing the results obtained, we note that the best scenario for improving production is scenario 3 where the production value increased by 4.16475sm3/h.

Conclusion:

In this chapter, we investigated the impact of three scenarios on the productivity of the OKN62 manifold collection network. The results revealed that the third scenario, which involves increasing the diameter of certain flowline, is the most suitable option for enhancing production.

CONCLUSION

Conclusion

The optimization study carried out on all the wells of manifold OKN62 allows us to conclude the following points:

- The redirection of the OKR20 and OKN422 wells to the OKN62 manifold resulted in a small production increase.
- The addition of a two-phase separator increased production slightly.
- The most effective way to enhance production in the OKN62 collection network is to increase the diameter of the pipes from 4 inches to 6 inches.

wells	Before optimization	After optimization
BKRE7	4"	6"
OKNI62	4"	6"
BKRE1	4"	6"
BKRS1	4"	6"
OKN 422	4"	6"
OKR20	4"	6"

- Beggs and Brill Revised correlation gives the most accurate horizontal pressure drop predictions.

Recommendations

Following the analysis of the results of our study and in order to predict optimal production from the Haoud Berkaoui field via the MFD OKN62, we recommend the following:

- Conduct regular measurements to update the gathering network database.
- Connect OKR20 and OKN422 wells directly to the OKN62 manifold.
- Increase pipeline diameters and select the optimal diameter
- Add a separator to separate gas from liquid

References

[1] aager. "Pig Launcher & Receiver." https://aager.de/ergil/pipeline-pigging-systems/pig-launcher-receiver/ (accessed 2024).

[2] M. R. Chebaiki and S. E. Moati, "Well Testing: Analyse des phénomènes des pseudo-skins dans le Flanc Est de Haoud Berkaoui (HBK)."

[3] H. Douachi, A. Tebbal, and Y. Nekhla, "Optimisation de réseau gaz Lift au niveau du champ Houd Berkaoui."

[4] F. TALBI and L. OUASSA, "Estimation de réserve de trias argilo-gréseux (série inferieure) Gisement Haoud Berkaoui."

[5] A. BOUTOUATOU and M. L. GHETTOUT, "OPTIMISATION DU GAZ-LIFT A HAOUD BERKAOUI."

[6] L. Mailhe, *Cours de production: Collecte, traitement, stockage. Tome 13*. Editions TECHNIP, 1974.

[7] K. Bouras and F. Mechalikh, "THÈMEOptimisation de production dans le champ Nord de Hassi Messaoud par la Mise en place d'un séparateur avec une unité de pomperie au niveau du manifold OMP153."

[8] NiGen. "How to Pig a Pipeline – Gas Pipeline Pigging Procedure." https://nigen.com/how-to-pig-a-pipeline-gas-pipeline-pigging-procedure/ (accessed 2024).

[9] Y. GHARBI and M. Y. ZERIZER, "L'Optimisation de réseau collecte OKJ202 de HAOUAD BERKAOUI."

[10] A.-K. E. Com. "Manifold services." https://site-alkarrareng.com/manifold/ (accessed 2024).

[11] S. Al-Lababidi, D. Mba, and A. Addali, "Upstream Multiphase Flow Assurance Monitoring Using Acoustic Emission," in *Acoustic Emission*, 2012, ch. Chapter 2.

[12] Kimray. "3-Phase Separators: An Overview." https://kimray.com/training/3-phase-separators-overview (accessed 26 May 2024.

[13] S. o. P. Engineers. "Separator types." Society of Petroleum Engineers (SPE). https://petrowiki.spe.org/Separator_types#Vertical_separator (accessed 22 MAY 2024.

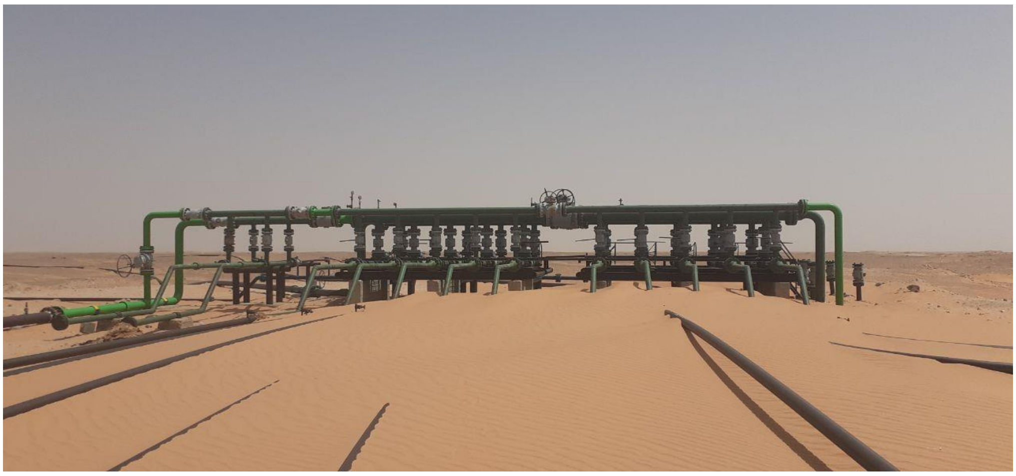
[14] K. Arnold and M. Stewart, *Surface production operations, Volume 2:: Design of gas-handling systems and facilities*. Elsevier, 1999.

[15] A. B. Daniel, "Gas evolution and gas-liquid separator modeling," Oklahoma State University, 2018.

[16] M. Volk, *Pump characteristics and applications*. CRC Press, 2013.

[17] shlumberger, *PIPESIM* production system analysis software*

Version 2010.1. 2010, p. 644.



Manifold OKN62

MANIFOLD BKRE