Journal of Chemical Reviews, 2021, Volume 3, Issue 1, pages 66-82.

Short-Review Article

An Overview of Gas Overflow in Gaseous Hydrates

Masoud Bagheri Sadr[1], Alireza Bozorgian[1*]

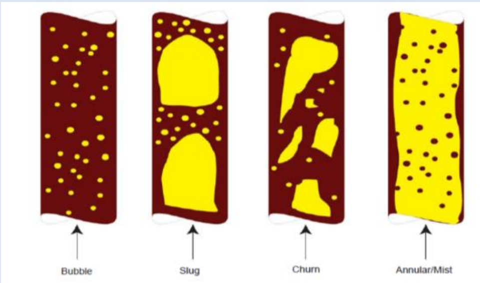
[1]*Department of Chemical Engineering, Mahshahr Branch, Islamic Azad University, Mahshahr, Iran*

Receive Date: 01 August 2020, **Revise Date:** 30 September 2020, **Accept Date:** 30 October 2020

Abstract: Basically, the design of the gas extraction supplementary string is specific to wells in which the pressure column of the fluid produced is close to or higher than the reservoir pressure. If the reservoir pressure cannot overcome the column of fluid produced or this pressure difference leads to production with low flow, the brain tube must be used. In this way, by pumping gas through this string and lightening the column and producing from the circular space, they solve the problem. In this way, after pumping, the gas comes out of the side of the suction valve and lightens the fluid column. It is obvious that the use of several lateral positions of the overflow valve in the field of overflow with gas has made it possible to inject gas from several points. In the continuous flow of ascent with base gas and the general rule, the energy resulting from the expansion of gas is from a high pressure to a low pressure that can be used to develop and increase the flow of fluid in the well. The use of this energy is generally continuous, which is in the form of continuous injection of gas into the fluid inside the well.

Keywords: **Gas Overflow; Tank Pressure; Pump; Fluid; Well**

Graphical Abstract:



Dr. Alireza Bozorgian was born in Kashan, (Iran). He completed his BSc, MSc and Ph.D. in Chemical Engineering. He currently works in Chemical Engineering at the Islamic Azad University of Mahshahr. His studies focused on Heat Transfer, Transport Phenomena, Nanotechnology and Gas Hydrate. He has published more than 30 papers.

Introduction

In 1797, a German mining engineer named Karl Emmanuel Luscher used air to raise mineral liquids in his first research. This research became the basis for introducing the gas descent system. Of course, he had performed several experiments prior the practical implementation of this plan. In 1914, Davis and Render [1] performed valuable work on a gas-scale ultrasonic system at the University of Riccaline in the United States on the effect of the coefficient of friction and the amount of gas injected. They used a vertical tube with a diameter of 1.25 inches and

*Corresponding author: Alireza Bozorgian, Email: a.bozorgian@mhriau.ac.ir

different lengths between 15-45 feet. In this experiment, increasing the amount of air injected (starting from zero) increased the water outflow to a certain extent. Any additional increase of air from a certain limit reduced the amount of water extraction [2-5].

Today, this issue has given a positive answer on the scale of oil wells. Obviously, for a certain amount of injection, a certain operation from the injection site must be used. In 1932-1939, Amarada Oil Company changed the diameter of the vertical pipe to increase production from oil wells instead of using a gas extraction system, so that increasing the percentage of saline water would not cause the liquid to fall back and become heavy, resulting in the death of the well.

They reduced the diameter from 5 inches to 2.5 inches, then to 2 inches and 1.5, and finally to 0.75 inches. They found that there is a diameter where all the oil and gas produced is enough to create the required minimum speed [6-9].

If the diameter is less than this certain diameter, the velocity increases and as a result, the friction quickly shows its effect and reduces the flow. So, there is an optimal diameter. The results of this experiment changed the amount of gas injected to optimize compared to optimizing the gas extraction system.

In 1940, Uren et al. [10] investigated the flow of a mixture of oil and air in a 42-foot vertical pipe. Oren is one of the people who worked hard to determine the viscosity of the oil-air mixture [11-15].

He ignored the velocity difference of the two phases and obtained the coefficient of friction from the pressure drop, and by determining the Reynolds number he was finally able to determine the viscosity according to the mixture. He also found that the viscosity of the mixture in the high gas-to-oil ratio did not change significantly. Therefore, excessive gas injection does not reduce the viscosity. In the 1960s, BROWN et al. [16]. obtained the best injection point by having the characteristics of the studied well and using the drawing coefficient by drawing method. Of course, this method has limitations, the most important limitation of which is that it does not respond to different modes. This method is limited to graphs that are prepared experimentally and used to optimize them. In 1982, Degg et al. [17] used external drawing method and experimental diagrams, which were prepared in this regard to predict the pressure drop in horizontal and vertical paths, prepared the performance diagram of the gas descent system and showed that economically Only one point of the oil production curve is cost-effective in terms of gas injection. In 1996, at the Boeirago Rodriguez Gas Industry Congress, one of the problems in optimizing the gas extraction system by drawing was the inefficiency of this method for wells that did not respond quickly to gas injections. Osman Salameh [18] optimized the gas extraction system in the Ramadan oil reservoir located in the Suez oil field in Saudi Arabia and succeeded in increasing the production of more than 2,000 barrels per day to 17,000 barrels per day [19].

Using the Gas Lift System is one of the ways to increase oil production from oil fields. In Iran, in the Aghajari oil field located in the oil-rich areas of the south, as well as in the production of offshore areas in some oil rigs, a gas-surge system is used to produce oil from the mentioned fields. For example, in 1970, MC CORD Oil Company first studied the long-term development plan of the Aghajari oil field, and its study showed that the most appropriate method of planned oil production from the Aghajari oil field is to stabilize the reservoir pressure. In 1971 and 1972, practical tests were performed on wells 84 and 93 in

Aghajari, which demonstrated an acceptable increase in production. The above example is a clear example of the positive effect of gas extraction system in increasing oil production from oil fields [20-22].

In this method, high-pressure gas is injected from the dalyse path in the well column and enters the brain tube from the place of the first ascending valves and lightens the fluid column. As soon as the hydrostatic pressure of the fluid column at the bottom of the well is less than the pressure of the reservoir, oil flows from the reservoir to the well and is mixed with the injected gas and reaches the surface.

Advantages of gas overflow method are as follows:

• Efficiency for a wide range of installation depths and production flow

• Simplicity of well completion

• Compatibility with sand production

• Ability to repair and replace or change the depth of gas overflows valves

• The most economical method of overflow in case of access to high pressure gas

• Longer life of equipment than other methods

• Lower flow costs than other methods

• Ability to access the well column during production

• Can be used in diversion wells

Limitations of gas extraction method are as follows

• The need for a suitable gas source

• Uneconomical for small number of wells due to high compressor cost

• Requires a lot of space for ground level equipment

• Possibility of hydrate formation

• The need for wells to be close to each other

• Restrictions on oil containing asphalting compounds

• Low energy efficiency

The need to develop a gas pipeline to the location of wells in the gas overflow system is very important. The types of flow regimes include bubble, floc, spherical and annular flow. According to the types of flow regimes, considering the amount of pressure drop along the well path, the best flow regime is the bubble flow regime, which has the lowest amount of pressure drop compared to other flow regimes [23-26].

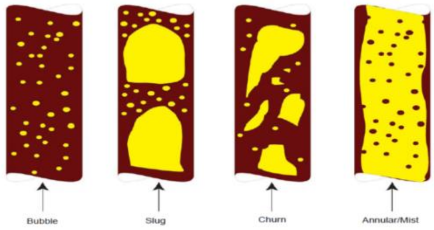


Figure 1. Types of flow regimes

In the bubble flow pattern, the tube is often completely filled with liquid and the gas phase is freely marked as small bubbles. The bubbles move at different velocities and this, except for their density, has little effect on the pressure rotators and the tube wall will always be in contact with the liquid phase. In the SLUG flow pattern, the gas phase is further specified, although the liquid phase is still continuous. The speed of the gas bubbles is faster than the speed of the liquid, and the thin layer of liquid around the bubbles may move downward at low speeds.

Both gas and liquid will have a significant effect on the pressure gradient. In annular flow, the gas phase is continuous and a volume of liquid drips inside. In this case, the tube wall is covered by a thin layer of liquid, but the gas phase is decisive in relation to the pressure gradient. In the continuous flow of ascent with base gas and the general rule, the energy resulting from the expansion of gas is from a high pressure to a low pressure that can be used to develop and increase the flow of fluid in the well [27-30]. The use of this energy is generally continuous, which is in the form of continuous injection of gas into the fluid inside the well. In this process, a useful work that can be said to be done is to increase the volume of fluid in the well. In Iranian wells, because the gas is sour (it contains a large amount of H2S), the gas is injected through the brain tube for extraction operations. The gas begins to bubble and rise in the form of a bubble in the fluid, which is caused by a difference in density between the two fluids [31-35].

Thermal conductivity of hydrates

Stoll and Bryan first measured the thermal conductivity of propane in 1979, which, when compared to the thermal conductivity of ice, is about 5 times lower than the thermal conductivity of ice. The thermal conductivity of ice at k263 is about 2.23 w/mk while the thermal conductivity of solid hydrates at the same temperature is about 0.5 w/mk.
If the thermal conductivity of solid hydrates at the same temperature is about 0.5 w/mk. The thermal conductivity of solid hydrates is more similar to the thermal conductivity of water (0.605 w/mk). Regarding the thermal conductivity of hydrates, a 1981 study by Ross et al. [35] revealed that the thermal conductivity of tetrahydrofuran depends on temperature but is not a function of pressure [36-39].

Thermal Expansion of Hydrates and Ice

Linear thermal expansion coefficients () dL/dT () are obtained for the structure of hydrate and ice. As seen in Table 3-1. These coefficients are 10% accurate. Values for hydrates vary from values close to $1/k$ ۱۰*۱۰$^{-۶}$ for tetrahydrofuran to $1/k$ ۵۰×۱۰ $^{-۶}$ for ethylene oxide, which is greater than ice values. The difference in properties is more noticeable at lower temperatures.

Reasons for difference in heat expansion between hydrate and ice

1- Structural difference between ice and hydrate
2- Interaction between guest molecule and water

Determinants of shape and ratio of gaseous hydrates

Most gaseous hydrates are very difficult to form, meaning they require a significant amount of cooling. When a crystal is formed, positive and negative temperature changes along the equilibrium curve cause the crystals to decompose or re-form. When the pressure is removed from the hydrate, the hydrates may decompose while the crystal does not change in appearance. This decomposition is accompanied by sound, which indicates that the crystals are breaking.
Hydrate crystals look like ice. The main hydrate framework is water molecules, and the inert and hydrocarbon molecules occupy the empty spaces of the network without establishing any strong chemical bonds with the water. Substances such as hydrochloric acid, which are highly soluble in water, do not form any hydrates [40].

Use of gas hydrates in gas and oil separation

Each operating plant has several sets and each set has several separators. The purpose of the separation operation is to separate gas or water from oil by reducing the pressure and to create facilities that can be produced by considering the transfer conditions and economic factors. The desired products increased. The separation set is divided into two categories in terms of the work they do: experimental separation set and exploitation separation set. In places where the flow pressure is relatively high, the separation of gas from oil in stages Multiple takes place. Today, the separation of gas and oil is usually done in four stages, the fourth stage of which is the test tank or the exploitation tank. Other devices are located next to the separators. Sometimes the first phase of separation is built near the well, in which case there will be three stages of separation at the separation site [41-45].

A disinfectant called a stripper is used as the third or fourth step to purify oil from hydrogen sulfide by reducing the amount of hydrogen sulfide in it to a certain level. In some factories, due to the lack of oil pressure in the wells (when the amount of dissolved gas in the oil is low), the separation operation is performed in less stages. Sometimes in a separation station, the third separation stage consists of two separators that each view is the same and is used in parallel. By placing these separators in such a way and by placing them in a high place, the inlet pressure of the pumps can be provided without using a tank [46].

These separators are called balance vessels. In some separation stations, a plan has been implemented according to which by opening and closing the first stage of separation, they have doubled the separation capacity [47-49].

They have done this in order. The two separators of the first stage are located in parallel and the inlet oil of each enters the first stage through a separate pipe which is the sequence of the common connection pipe. The output oil from both separators of the first stage after laying from the second and third stages, it enters the operation or test tank. In the input and output part of the separation stage separators, facilities are provided so that, if necessary, each of them can be taken out of service [50-52].

In a four-state separation station, the separation stages are connected in series, the oil enters the first separation stage, the pressure drop in this stage causes some oil-soluble gas to separate and the oil enters the stage through the outlet pipe. The gas obtained from this stage enters the gas connection pipe with high pressure after the separator. Part of this gas is used for operating turbines and other internal uses after passing through the oil trap [53].

The other part, if necessary, will enter the gas collection pipe, which delivers the gas to the gas and liquefied gas factories. Another part of the gas, if necessary, after delivery to the National Gas Company, will be used for domestic and industrial purposes. Gas is injected into oil tanks by gas injection wells (to maintain pressure or increase the pressure of the tank) or is burned in the fuel pit. Oil enters the second stage from the first stage, after separation, the gas is separated through the outlet pipe enters the gas connection pipe with medium pressure.

In some areas, part of this gas is delivered to the gas and liquefied gas plant and the surplus is burned in a place far from the plant. The oil is directed to the third stage through the outlet pipe. And then is routed through the oil outlet pipe to the fourth stage or reservoir. The gas from this stage enters the low-pressure connection pipe through the separator outlet pipe. Some of the gas in it and reaching a pressure slightly higher than atmospheric pressure is ready to be transferred and pumped. The gas obtained from this stage goes out of the unit through a pipe and burns [54].

In the exploitation units, which consist of experimental and exploitation separation sets, the connection pipes between the oil outlet pipes of the third stage of the separation set are used to transfer the oil of each of the separation sets mentioned to the test tank or each of the exploitation tanks is possible. Each experimental separation set in each separation stage, in addition to the oil and gas outlet pipe, has a sub-pipe to test, to measure the efficiency of each well. Each of the separators is a valve or safety valve to release the excess internal pressure. The extra pressure removed from all stages of the separator enters the communication pipe called the main pressure release pipe and from there to the pit. Fuel is sent. In the system design, in order to perform the separation operation, the amount of output of the well product from the tank, specific gravity and conditions inside the source such as pressure, heat and amount of water in the oil and pipe working pressure must be considered [55].

Factors affecting segregation

Factors that affect segregation include:

A) Separator capacity

B) The size of oil and gas inlet and outlet valves and pipes

C) The practical pressure of separation

D) The height of the liquid surface

E) Ambient temperature

F) Separator size

The geometric shape of the devices used inside the separator can also be effective in how the separation operation works and change its capacity to some extent. It should be noted that in the operation of separators that are made based on a specific capacity of oil with specific characteristics, how to separate and their utilization, factors such as practical pressure, liquid level and ambient temperature. They can be effective [56-59].

Two of the mentioned factors can be adjusted and controlled by considering the gas to oil ratio (GOR) and flow pressure, which are: maintaining the height of the liquid surface and adjusting and controlling the pressure [60]. If the outlet pipe of this container is closed by a valve and enter the liquid through the inlet pipe, the liquid level in the container will rise to the point that the container is full of liquid [61-63].

Now, if we open the outlet valve and close the inlet valve, the liquid level in the container will be low enough to empty the container. As the amount of inlet and outlet fluid is equal, the liquid level in the container will remain constant unless the amount of inlet or outlet fluid is changed. Therefore, the liquid level in the container can be changed and adjusted by increasing or decreasing the inlet and outlet oil. Another factor that is effective in controlling or changing the liquid level in the container is the force that if it enters the liquid surface will increase the speed and molecular motion in the liquid tube. In addition to maintaining the liquid level, pressure can affect the quality and the resulting gas is effective. Lighter gases are usually separated at higher pressures and heavier gases at lower pressures [64].

Changes in ambient temperature and its effect on separation action

If the temperature rises in a closed container containing gas, the speed of the molecules, the molecular distance and the molecular volume increase and cause more pressure. In liquids, the molecules are in contact with each other by intermolecular gravitational forces and at the same time. Now they are constantly moving and rolling on top of each other. This constant movement causes a number of liquid surface molecules that are free on one side to leave the environment and leave the container. Now if parts of a closed container fill with liquid [65-69].

If the temperature rises, the molecules move faster and more molecules leave the surface of the liquid. These molecules cause the gas phase. They create more pressure when they hit the wall of the container. Therefore, if the volume is constant, the liquid vapor pressure is higher at higher temperatures and lower at lower temperatures. The molecules in the gas phase always try to enter the liquid environment. The biggest factor that can be effective in doing this is a sudden drop in temperature. If this happens, the volume of gas will decrease and the volume of liquid will increase [70].

In a stage of separation of oil from gas where the volume of the separator is constant and its pressure and liquid level are set at a certain level, a sudden decrease in ambient temperature reduces the amount of gas and increases the volume of liquid, thus reducing the pressure of the device. To maintain the pressure, the amount of exhaust gas must be reduced, and as the volume of the liquid increases, the liquid level will rise. Therefore, to return the liquid level to its original state, we must increase the amount of liquid. In the case of increasing ambient temperature, the opposite the same is true. If a separator separating gas and oil is set to the maximum and the ambient temperature suddenly drops, some of the gas molecules in the tube that directs the oil from the well to the separating vessel.

Slowly, it turns into a liquid and as a result, the volume of liquid entering the separation device increases and due to the decrease of gas molecules, the pressure also decreases and the liquid level in the device increases. On the other hand, because the oil outlet pipe and valve cannot pass the liquid too much, the oil level rises to such an extent that in this case the separation operation is not done well and at the same time some oil droplets with gas come out of the gas outlet pipe. The amount of oil entering the distillation machine must be reduced [71].

Reason for separation device

For various reasons, the existence of a separation device at the wellhead (wellhead separator) or operation unit is necessary. These reasons are:

A) Most wells are very far from the place of loading or refining, which sometimes reaches hundreds of kilometers. Oil transfer at such a distance (due to reduced flow pressure along the route) causes either less oil to reach the destination or the product of the well does not flow at all [72].

B) If oil containing gas is stored in the tank with high pressure before loading, it will cause many dangers.

C) The yield of each well must be measured before joining the pipes of other wells.

D) It is necessary to sell oil and gas separately and in different places used by Dadia.

It is necessary to have an exploitation unit to collect oil from a number of wells and perform separation operations. The location of the separation plant is chosen so that the well oil travels the minimum possible distance to reach and enter it, thus resisting the flow is reduced, the pressure drop is minimized and the well is used as much as possible. Oil pressure should reach atmospheric pressures. Because the main purpose of exploiting this type of wells is crude oil, it is necessary to separate the impurities, ie gas and water along with oil, by means of a separator.

Usually in separation devices, the gas is easily separated from the oil, but the water will still flow with the oil. To separate the water from the oil, a special unit called desalination is used. In practice, the separators are almost the same. They are different, but they are different in terms of construction. In this type of separator, gas is separated from liquids and water from oil. The action of separating water from an oil-water emulsion is a function of time, so that after about 3 to 20 minutes, the maximum amount of water is separated from oil. In the figure on the next page, the operation of the three-phase vertical separators (oil, gas and water) can be seen. Since the water separated due to the difference in density is called free water, the three-phase separators are called Free Water. Also called Knock Outs. In the following figures, two types of vertical and horizontal separators can be seen. In these separators, like horizontal three-phase separators, the oil-water emulsion is placed under the oil phase for faster separation of water and oil. As the oil-water emulsion is placed under the oil phase to achieve faster separation of water and oil. Height adjustment is done by oil and measuring the contact surface of water and oil. This method of height adjustment is used when the well is associated with the production of sand and solids.

The height of the oil level and the water level are adjusted by the dossier (obstacle) and there is no need to adjust the height of the water-oil contact surface, although the advantage of the water-oil contact surface height regulator is that compared to the variable conditions created, It reacts quickly. In any case, for heavy oils and dealing with emulsions and paraffins, it is difficult to determine the level of contact between water and oil [73].

Note 1: When designing a three-phase separator, it is assumed that 50% of the volume of the fluid separation separator is occupied.

Note 2: Emulsions have a negative effect on the regulation of fluid levels and cause the standstill time for oil and water to be longer. Using brittle emulsion chemicals and placing hot tubes in the liquid phase is helpful in solving the problem.

Note 3: Paraffin deposits block the foaming sheets. Placing holes and valves in the separators for injecting solvent chemicals and injecting water vapor is essential for the problem.

In terms of performance, the separators can be divided as follows:

Conventional separators are generally used to completely separate the gas and oil mixture into two separate materials (pure gas and pure oil).

2- Smoke extractor or purifier: It is a separating container that is used to separate oil from gas in cases where the ratio of separated gas to oil (GOR) is high.

3- Liquid container Containers of these containers, which are considered separators, are divided into two categories:

A) Water-gas separators: separates water from a mixture of gas and liquid hydrocarbons. Gas and liquid hydrocarbons come out of the container on one side and water on the other side. It can be used more or less and it is also used to separate water from crude oil.
B) Separators of all liquids from gas: are placed in the path of high-pressure gas and as much as possible separate all the liquid with it.

Expansion vessel: The gas expands inside this vessel and separates in a space with low temperature. This container is usually placed in the next stage after the separator and is used to separate the liquid hydrocarbons that come out of the separator with gas and is used in a separator in which no heat is used. River and the second stage separator in which no heat is used, and in the second stage is the separation of liquid from gas. Expansion vessel works under low pressure and is usually designed for use at pressures less than 125 pounds per square inch. And not much different from low pressure separators [74].

Filter: In conventional separators, the liquids formed in the gas flow due to temperature change, while settling, deposit some solids in the gas with them at the bottom of the separating vessel and take them out of the separator with them. However, some of these solids in the gas have filters that need to be replaced for some time. These filters may be dry or floating in the oil, and each is used in proportion to its performance. Given the above, here is a typical example of separators, which is the Separator [75].

Separator in terms of building

Regardless of the mode of operation, there are also differences in the dividers in terms of construction, which can be generally classified in terms of the shape of the building as follows:

1- **Horizontal separators**

Horizontal separators are two examples:

A) Single or one floor

B) Two tanks or two floors

2) Vertical separators

3) Spherical separators

This model is the most common type of technician and is used when a large amount of gas is dissolved in the liquid. In this type of separator, there is a higher contact surface between the gas and the liquid inside the separator, which means Gas and oil are separable on a larger scale. Therefore, they are easier to separate. In addition to the above, it is also more suitable for large capacities than other types. It is also used in the separation of three-phase fluids. The oil that produces foam is more easily separated from the gas inside this model. Of course, a liquid such as silicon can be pumped into the separator to calm the foam and work more easily.

Horizontal single tank separator: In this separator, the dissociation factor is the slowing down of the motion as well as the force of gravity. The unrefined liquid and gas lose their velocity when they move from a place with a smaller diameter to a place with a larger diameter and capacity. The force of gravity flows downwards and the gas moves upwards due to being lighter and exits the gas outlet pipe.

Horizontal separator of two tanks: This separator consists of two containers that are stacked on top of each other. The separation operation is performed in the upper container and according to the mentioned principles for separating a tank, and the liquid enters the lower container through the two bottoms, which is a reserve. The separated gas moves to the top of the upper container and exits the gas outlet pipe. Due to the rapid deposition of the liquid phase in the horizontal separator of the two tanks (due to a sudden change in the size of the movement), liquid droplets from above (pipe Gas outlet) does not come out with the exhaust gas. This is one of the advantages of this separator over conventional separators. One of its disadvantages is the high cost of producing this type of separator compared to the conventional separators. These days, this type of horizontal separator is rarely utilized in oil industry exploitation units [76].

Advantages of horizontal separators

A) It is more economical to use.

B) It is easier to transport.

C) For a similar size, the horizontal sample has more space than other models for liquid phase sedimentation and gas separation deposits.

D) If it is necessary to heat the oil inside the separator by electric wire, this model is superior to other models.

E) The oil that produces foam is easier to separate from the gas.

F) In cases where we face emulsion problems, it is better to use this model [77-79].

Disadvantages of horizontal separators

A) Its capacity varies in terms of fluid level fluctuation compared to other models and is not very suitable.

B) Compared to other models, it is very difficult to control the contact surface of gas and oil.

Vertical separators

In these separators, the separation operation is influenced by two factors:

A) Gravity

B) Centrifugal force

Rotational motion is created by the angle between the inlet pipe and the tank wall at the inlet. The centrifugal force throws the undivided liquid towards the inner wall of the separator. The gas that separates, due to its lightness, towards the liquid moves upwards and after contact with the inner wall of the separator, it flows downwards due to the force of gravity. These separators are used especially when the ratio of gas to oil is low. Compared with the horizontal sample, the contact surface of the gas and oil in them is low [80].

Advantages of Vertical Separators

A) It is easier to design and use in case of liquid level fluctuation.

B) Liquid level control (liquid height) is easy.

C) It is easier to clean when depositing solids of horizontal type.

D) In terms of production of drilling sand or mud with oil, it is better than the horizontal type.

E) It takes up less space than the horizontal type.

Disadvantages of Vertical Separators

A) It is difficult to transport.

B) It is very expensive.

C) Compared with the horizontal model, for a constant amount of gas, its diameter must be very large [81-83].

Spherical Separators

The principles of fluid separation in this type of separators are the same as horizontal and vertical separators. Currently, this type is less used. Especially when oil produces foam, its use is minimized. In the past, it was used more because it was cheaper. This type of separator has disadvantages that have almost stopped its use [84].

Advantages of spherical separator

A) In this model, more gas is released.

B) It is easy to clean.

C) Easily used as a mobile separator.

D) Occupies little space.

E) Its resistance to pressure is high.

F) This model is used for high gas to oil ratio (GOR).

G) Separates two micrometers of liquid hiccups completely.

Disadvantages of spherical separators

A) Its production cost is high.

B) It has a very low efficiency in the case of oil that produces foam.

C) Liquid level control is limited.

D) Not suitable for a large amount of capacity.

According to the type and specifications of Iranian oil, horizontal separators are used in the exploitation units.

Containers for separation of operating units

The most important factors involved in the separator are including, the gender and all the characteristics related to the oil and its flow, pressure and operating temperature, as well as the time given for separation. To perform the separation operation in the existing exploitation units In Iran, two types of separators with different sizes and specifications are used called AIOC and NATCO, designed by the Anglo Iranian Co and National [85].

AIOC separators are of the old type and are installed diagonally (at an angle of less than 90° to the horizon). These types of separators are known as oblique separators. With diameters of 3 to 8 feet and lengths of 60 to 180 feet are designed and built. Another type, which is horizontal and is commonly known as its manufacturer (NATCO), is designed and built with a diameter of 6 to 10 and a length of 25 to 40 feet [86].

Characteristics of Separators

Each separator must have the following characteristics:

1. Can withstand experimental pressure.

2. The mechanical devices inside it should be installed in such a way that heavy liquids can settle by creating the necessary pressure in the lower part of the separator.

3. The separator should have a place for the accumulation of heavier compounds and its size should be such that there is the necessary time to stop the liquids and separate the gases containing them.

4- Have precision tools to control pressure and flow and places to install them.

5- Have places to install safety valves in order to remove excess pressure.

6- Have places for connecting gas and oil inlet and outlet pipes as well as bottoms.

7- It has a place in the form of a valve for cleaning.

8- Have places for installing pressure gauges, thermometers and liquid level sighting devices.

Conclusion

Each cell unit of the structure of 1 gas hydrate contains 46 molecules of water, which consists of two small empty spaces and 6 large spaces. Structures of the gas hydrates can only accommodate small gas molecules, such as methane and ethane, with a molecular diameter of less than 2.5 angstroms. The cellular structure of the structure of 2 gas hydrates consists of 16 small smokers and 8 large double-hexadecimal hexachord voids formed by 136 water molecules. Structure 2 Gas hydrates may contain gases with molecular dimensions in the range of 5.9 to 6.9 angstroms such as propane and iso-butane. Under the standard temperature and pressure (STP) conditions, a volume of methane saturated hydrate has More than 164 volumes of methane gas. Due to this huge gas storage capacity, these hydrates are important sources of natural gas. At the macroscopic level, many of the mechanical properties of gas hydrates are liked to ice, as hydrates contain at least 85% water on a molecular basis. Most interesting is the properties of the gas hydrate equilibrium phase, which is predominantly controlled by the proportion of the guest gas molecules inside the water hydrate cages.

References

[1]. Bozorgian, S. Zarinabadi, A. Samimi, Optimization of Well Production by Designing a Core pipe in one of the Southwest oil Wells of Iran, *Journal of Chemical Reviews*, 2(2) (2020), 122-129

[2]. Bozorgian, S. Zarinabadi, A. Samimi, Preparation of Xanthan Magnetic Biocompatible Nano-Composite for Removal of Ni^2+ from Aqueous Solution, *Chemical Methodologies*, 4 (4) (2020), 477-493

[3]. A. Krishna Mitra, Antioxidants: A Masterpiece of Mother Nature to Prevent Illness, Journal of Chemical Review, 2(4) (2020), 243-256

[4]. A. Bozorgian, Z. Arab Aboosadi, A. Mohammadi, B. Honarvar, A. Azimi, Evaluation of the effect of nonionic surfactants and TBAC on surface tension of CO2 gas hydrate, *Journal of Chemical and Petroleum Engineering, 54(1)* (2020), 73-81.

[5]. A. Mohsen Abass; J. Malallah Rzaij, A Review on: Molecularly Imprinting Polymers by Ion Selective Electrodes for Determination Drugs, Journal of Chemical Review, 2(3) (2020), 148-156

[6]. A. Bozorgian, P. KHadiv, MA. Mousavian, Simultaneous Effects of Ionic Surfactant and Salt on Drop-Interface Coalescence, (2009): 73-86.

[7]. A. Moslehipour, Recent Advances in Fluorescence Detection of Catecholamines, Journal of Chemical Review, 2(4) (2020), 130-147

[8]. S.V. Mousavi, A. Bozorgian, N. Mokhtari, M.A. Gabris, H.R. Nodeh, WA. Ibrahim, A novel cyanopropylsilane-functionalized titanium oxide magnetic nanoparticle for the adsorption of nickel and lead ions from industrial wastewater: Equilibrium, kinetic and thermodynamic studies, *Microchemical Journal*, 145 (2019), 914-920.

[9]. A. Ozaki, Y. Yamaguchi, T. Fujita, K. Kuroda, G. Endo, Chemical analysis and 625 genotoxicological safety assessment of paper and paperboard used for food packaging. *Food 626 Chem. Toxicol*. 42 (2004), 1323–37. 627

[10]. B. Raei, A. Ghadi, AR. Bozorgian, Heat integration of heat exchangers network using pinch technology.(2010) 19th International Congress of Chemical and Process Engineering, *In CHISA 2010 and 7th European Congress of Chemical Engineering, ECCE-7*.

[11]. A. Rosenmai, M. Dybdahl, G. Pedersen, M. Pedersen, B. van Vugt-Lussenburg, C. Taxvig, A. Vinggard, Are structural analogues to bisphenol A a safe alternative? *Toxicol*. *645 Lett.* (2013), 221. 646

[12]. A. Samimi, S. Zarinabadi, A. Bozorgian, A. Amosoltani, M.S. Tarkesh Esfahani, K. Kavousi, Advances of Membrane Technology in Acid Gas Removal in Industries, *Progress in Chemical and Biochemical Research* , (2020), 46-54.

[13]. A. Samimi, “Risk Management in Information Technology”, *Progress in Chemical and Biochemical Research*, 3 (2) (2020), 130-134

[14]. A. Bozorgian, Analysis and simulating recuperator impact on the thermodynamic performance of the combined water-ammonia cycle, *Progress in Chemical and Biochemical Research* 3(2) (2020), 169-179.

[15]. A. Samimi, "Risk Management in Oil and Gas Refineries", *Progress in Chemical and Biochemical Research*, 3(2) (2020), 140-146

[16]. A. Bozorgian, Z. Arab Aboosadi, A. Mohammadi, B. Honarvar, A. Azimi, Optimization of determination of CO2 gas hydrates surface tension in the presence of non-ionic surfactants and TBAC, *Eurasian Chemical Communications*, 2(3) (2020), 420-426.

[17]. A. Samimi, P. Rajeev, A. Bagheri, A. Nazari, J. Sanjayan, A. Amosoltani, M.S. Tarkesh, S. Zarinabadi, Use of data mining in the corrosion classification of pipelines in Naphtha Hydro-Threating Unit (NHT), *Pipeline science and technology*, 3(1) (2019), 344-342

[18]. A. Bozorgian, Z. Arab Aboosadi, A. Mohammadi, B. Honarvar, A. Azimi, Prediction of Gas Hydrate Formation in Industries, *Progress in Chemical and Biochemical Research* , (2019), 31-38.

[19]. A. Sturaro, R. Rella, G. Parvoli, D. Ferrara, F. Tisato, Contamination of dry foods with 661 trimethyldiphenylmethanes by migration from recycled paper and board packaging. *Food 662 Addit. Contam.* 23 (2006), 431–436

[20]. N. Farhami, A. Bozorgian, Factors affecting selection of tubes of heat exchanger, *In Int. Conf. on Chem. and Chem. Process IPCBEE*, vol. 10,(2011), 223-228.

[21]. A. Villanueva, H. Wenzel, Paper waste - recycling, incineration or landfilling? A review of 672 existing life cycle assessments. *Waste Manag. wasman.* 2 (2007), 673-689

[22]. A. Bozorgian, NM. Nasab, H. Mirzazadeh, Overall effect of nano clay on the physical mechanical properties of epoxy resin, *World Academy of Science, Engineering and Technology International Journal of Materials and Metallurgical Engineering* 5, no. 1 (2011), 21-24.

[23]. A. Vinggaard, W. Körner, K.H. Lund, U. Bolz, J. Petersen, Identification and 674 Quantification of Estrogenic Compounds in Recycled and Virgin Paper for Household Use As 675 Determined by an in Vitro Yeast Estrogen Screen and Chemical Analysis. *Chem. Res. Toxicol.* 676 (13) (2000), 1214–1222.

[24]. B. Raei, A. Ghadi, A.R. Bozorgian, Heat Integration of heat exchangers network using pinch technology, *In19th International Congress of Chemical and Process Engineering CHISA* (2010).

[25]. A.Samimi, S. Zarinabadi, A.H. Shahbazi Kootenaei, A. Azimi, M. Mirzaei, Corrosion Classification of Pipelines in hydrocracking units (ISOMAX) by Data Mining, *South African Journal of Chemical Engineering,* 31 (2020), 44-50

[26]. A. Bozorgian, Z. Arab Aboosadi, A. Mohammadi, B. Honarvar, A. Azimi, Statistical Analysis of the Effects of Aluminum Oxide (Al2O3) Nanoparticle, TBAC and APG on Storage Capacity of CO2 Hydrate Formation, *Iranian Journal of Chemistry and Chemical Engineering*,(2020).

[27]. B. Nasrollahzadeh, M.J. Choobineh, M. Abdollahbeigi, Investigation of Hydrate Formation Kinetics and Mechanism of Inhibitors Effect, *DAV International Journal of Science,* 4 (2015), 49-56

[28]. A. Bozorgian, Methods of Predicting Hydrates Formation, *Advanced Journal of Science and Engineering* 1(2) (2020), 34-39.

[29]. C. Liao, K. Kannan, Widespread occurrence of bisphenol in paper and paper products: 598 implications for human exposure. *Environ. Sci. Technol.* 45 (2011), 9372–9.

[30]. N. Kayedi, A. Samimi, M. Asgari Bajgirani, A. Bozorgian, Enhanced oxidative desulfurization of model fuel: A comprehensive experimental study, *South African Journal of Chemical Engineering* (2020).

[31]. C. Riber, C. Petersen, T. Christensen, Chemical composition of material fractions in 640 Danish household waste. *Waste Manag*. 29 (2009), 1251–7.

[32]. J. Mashhadizadeh, A. Bozorgian,A. Azimi, Investigation of the kinetics of formation of Clatrit-like dual hydrates TBAC in the presence of CTAB, *Eurasian Chemical Communications*, 2(4) (2020), 536-547.

[33]. C.K. Lee, I. Darah, C.O. Ibrahim, Enzymatic deinking of laser printed office waste papers: some governing parameters on deinking efficiency, *Bio-resource technology*, 98 (2007), 1684-1689

[34]. A. Bozorgian, M. Ghazinezhad, A Case Study on Causes of Scale Formation-Induced Damage in Boiler Tubes, *J. Biochem. Tech* 2 (2018), 149-153.

[35]. D. Mohammadnazar, A. Samimi, Nessacities of Studying HSE Management Position and Role in Iranian Oil Industry, *Journal of Chemical Reviews*, 1(4) (2019), 252-259

[36]. A. Bozorgian, The Production of Clay Nano-Composite Epoxy and Comparison of Its Properties with Epoxy Resins, *Polymer* 2 (2012), 3.

[37]. E. Opoku, Progress on Homogeneous Ruthenium Complexes for Water Oxidation Catalysis: Experimental and Computational Insights, *Journal of Chemical Review*, 2(4) (2020), 211-227

[38]. A. Bozorgian, S. Zarinabadi, A. Samimi, Optimization of Well Production by Designing a Core pipe in one of the Southwest oil Wells of Iran, *Journal of Chemical Reviews*, 2(2) (2020), 122-129.

[39]. E. Opoku, Progress on Homogeneous Ruthenium Complexes for Water Oxidation Catalysis: Experimental and Computational Insights, *Journal of Chemical Review*, 2(4) (2020), 211-227

[40]. A. Bozorgian, Investigation and comparison of experimental data of ethylene dichloride adsorption by Bagasse with adsorption isotherm models, *Chemical Review and Letters* 3(2) (2020), 79-85.

[41]. E. Storr-Hansen, S. Rastogi, Polychlorinated biphenyls and heavy metal levels in recycled 659 paper for household use. Bull. Environ. *Contam. Toxicol.* 40 (1988), 451–456.

[42]. A. Pourabadeh, B. Nasrollahzadeh, R. Razavi, A. Bozorgian, M. Najafi, Oxidation of FO and N 2 Molecules on the Surfaces of Metal-Adopted Boron Nitride Nanostructures as Efficient Catalysts, *Journal of Structural Chemistry*, 59(6) (2018), 1484-1491.

[43]. G.L. LeBel, D. Williams, F. Benoit, Determination of chlorinated dibenzodioxins and 596 dibenzofurans in selected paper products. *Chemosphere* 23 (1991), 737–746

[44]. A. Bozorgian, Exergy Analysis for Evaluation of Energy Consumptions in Hydrocarbon Plants, *International Journal of New Chemistry* (2020).

[45]. H. Santl, A. Bichlmaier, L. Gruber, E. Stöhrer, Mass balance of polychlorinated 649 dibenzofurans (PCDFs) and polychlorinated dibenzodioxins (PCDDs) in a recycling paper 650 mill. *Chemosphere* 28 (1994), 1633–1639.

[46]. A.H. Tarighaleslami, A. Bozorgian, B. Raei., Application of the exergy analysis in the petroleum refining processes optimization, *In The 1st Territorial Chemistry and Industry Symposium, Lecture number: E-1097, Damghan, Iran (in Persian)*.(2009).

[47]. J. Laurijssen, M. Marsidi, A. Westenbroek, E. Worrell, A. Faaij, Paper and biomass for 594 energy? Resour. *Conserv. Recycl.* 54 (2010), 1208–1218

[48]. A. Bozorgian, Investigation of Predictive Methods of Gas Hydrate Formation in Natural Gas Transmission Pipelines, *Advanced Journal of Chemistry-Section B*, 2(3) (2020), 91-101.

[49]. L. Castle, C. Offen, M. Baxter, J. Gilbert, Migration studies from paper and board 520 food packaging materials. 1. Compositional analysis. *Food Addit. Contam.* 14 (1997), 35–44.

[50]. K. Kavousi, S. Zarinabadi, A. Bozorgian, Optimization of the Gasoline Production Plant in order to Increase Feed, *Progress in Chemical and Biochemical Research* (2020), 7-19.

[51]. M. Abdollahbeigi, An Overview of the Paper Recycling Process in Iran, Journal of Chemical Reviews 3 (1) (2020), 284-302.

[52]. A. Bozorgian, Study of the Effect Operational Parameters on the Super critical Extraction Efficient Related to Sunflower Oil Seeds, *Chemical Review and Letters* 3(3) (2020), 94-97.

[53]. M. Abdollahbeigi, M. Asgari, Investigation of Nitrogen Removal in Municipal Wastewater Treatment Plants, Journal of Chemical Reviews 2 (4) (2020), 257-272

[54]. A. Bozorgian, N. Majdi Nasab, A. Memari, Buckling Analysis of a Five-walled CNT with Nonlocal Theory, *interaction* 1 (2011), 4.

[55]. M. Abdollahbeigi, M.J. Choobineh, B. Nasrollahzadeh, Investigation of Molecular Structure in Gas Hydrate, *Science road Journal*, 3(12) (2015), 74-79

[56]. A. Samimi, S. Zarinabadi, A. Bozorgian, Optimization of Corrosion Information in Oil and Gas Wells Using Electrochemical Experiments, *International Journal of New Chemistry* (2020).

[57]. M. Abdollahbeigi, M.J. Choobineh, B. Nasrollahzadeh, Nano Catalyst, Operation Mechanism and Their Application in Industry, *Australian Journal of International Social Research*, 1(5) (2015), 1-6

[58]. A. Bozorgian, A. Samimi, A review of Kinetics of Hydrate Formation and the Mechanism of the Effect of the inhibitors on it, *International Journal of New Chemistry* (2020).

[59]. M. Abdollahbeigi, Non-Climatic Factors Causing Climate Change, Journal of Chemical Reviews 2 (4) (2020), 303-319

[60]. S.E. Mousavi, A. Bozorgian, Investigation the Kinetics of CO2 Hydrate Formation in the

Water System+ CTAB+ TBAF+ ZnO, *International Journal of New Chemistry*,7(3) (2020), 195-219.

[61]. M. Abdollahbeigi, Optimizing the Process of Di-Isobutyl Phthalate Production Using Vapor Permeation, *DAV International Journal of Science*, 4(2) (2015), 47-52

[62]. A. Bozorgian, Effect of Additives on Hydrate Formation, *International Journal of Advanced Studies in Humanities and Social Science*, 9(3) (2020), 229-240.

[63]. M. Biedermann, J. Ingenhoff, M. Zurfluh, L. Richter, T. Simat, A. Harling, W. Altkofer, R. Helling, K. Grob, Migration of mineral oil, photoinitiators and plasticisers from 494 recycled paperboard into dry foods: a study under controlled conditions. Food Addit. Contam. 495 Part A. Chem. Anal. Control. *Expo. Risk Assess.* 30 (2013), 885–98. 496

[64]. A. Bozorgian, Investigation of Well Equipment in the Oil Industry, *International Journal of Advanced Studies in Humanities and Social Science*, 9(3) (2020), 205-218.

[65]. M. Biedermann, Y. Uematsu, K. Grob,Mineral oil contents in paper and board recycled to 497 paperboard for food packaging. *Packag. Technol. Sci.* 24 (2011), 61–73.

[66]. M. Binderup, G. Pedersen, A. Vinggaard, E. Rasmussen, H. Rosenquist, T. Cederberg, T., Toxicity testing and chemical analyses of recycled fibre-based paper for food contact. *502 Food Addit. Contam. 19* (2002), 13–28.

[67]. M. Karami, A. Samimi, M. Ja'fari, "The Necessity of Risk Management Evaluations in Petrochemical Industries", *Advanced Journal of Chemistry-Section B, Natural Products and Medical Chemistry*, 2 (3) (2020), 151-158

[68]. M. Karami, A. Samimi, M. Ja'fari, Necessity to Study of Risk Management in Oil and Gas Industries, (Case Study: Oil Projects), *Progress in Chemical and Biochemical Research*, 3 (2) (2020), 239-243

[69]. M. Karami, A. Samimi, M. Ja'fari, the Impact of Effective Risk Management on Corporate Financial Performance, *Progress in Chemical and Biochemical Research*, 2 (3) (2020), 144-150

[70]. M. Munawar, I. Munawar, D. Sergeant, C. Wenghofer, A preliminary bioassessment of 622 Lake Baikal sediment toxicity in the vicinity of a pulp and paper mill. Aquat. Ecosyst. *Health 623 Manag.* 3 (2000), 249–257.

[71]. M. Poças, J. Oliveira, J. Pereira, T. Hogg, Consumer exposure to phthalates from 637 paper packaging: an integrated approach. Food Addit. Contam. Part A. Chem. Anal. Control. *638 Expo. Risk Assess*. 27 (2010), 1451–9.

[72]. M. Zheng, Z. Bao, B. Zhang, X. Xu, Polychlorinated dibenzo-p-dioxins and 683 dibenzofurans in paper making from a pulp mill in China. *Chemosphere* 44 (2001), 1335–1337

[73]. M.J. Choobineh, B. Nasrollahzadeh, M. Abdollahbeigi, Investigation of Contact Resistance Effect on Finned Pipes under Natural and Forced Convection, *DAV International Journal of Science*, 4(2) (2015), 58-76

[74]. M.J. Choobineh, M. Abdollahbeigi, B. Nasrollahzadeh, the formation of gas hydrate

and the effect of inhibitors on their formation process, *Journal of Fundamental Applied Science* 8(2S) (2016), 1150-1159

[75]. M.J. Kadhim; M. Ibraheem Gamaj, Estimation of the Diffusion Coefficient and Hydrodynamic Radius (Stokes Radius) for Inorganic Ions in Solution Depending on Molar Conductivity as Electro-Analytical Technique-A Review, Journal of Chemical Review, 2(3) (2020), 182-188

[76]. Mohsen Abass; J. Malallah Rzaij, A Review on: Molecularly Imprinting Polymers by Ion Selective Electrodes for Determination Drugs, *Journal of Chemical Review*, 2(3) (2020), 148-156

[77]. N.P. Thacker, V. Nitnaware, S. Das, S. Devotta, Dioxin formation in pulp and paper 664 mills of India. Environ. Sci. Pollut. *Res. - Int.* 14 (2007), 225–226

[78]. O. Soleimani, Properties and Applications of Ionic Liquids, Journal of Chemical Review, 2(3) (2020), 169-181

[79]. P. Korde; S. Ghotekar; T. Pagar; S. Pansambal; R. Oza; D. Mane, Plant Extract Assisted Eco-benevolent Synthesis of Selenium Nanoparticles- A Review on Plant Parts Involved, Characterization and Their Recent Applications, Journal of Chemical Review, 2(3) (2020), 157-168

[80]. R. Parmar; R. Sapra; P. Pradhan; D. Meshram, A comprehensive Review of Analytical Methods for the Determination of Aceclofenac in Biological Fluids and Pharmaceutical Dosage Forms, Journal of Chemical Review, 2(3) (2020), 189-200

[81]. S. Alizadeh; Z. Nazari, A Review on Gold Nanoparticles Aggregation and Its Applications, *Journal of Chemical Review*, 2(4) (2020), 228-242

[82]. S. Biedermann, P. Tschudin, K. Grob, Transfer of bisphenol A from thermal printer paper 499 to the skin. Anal. *Bioanal. Chem.* 398 (2010), 571–6. 500

[83]. S. Parry, Neutron activation analysis of recycled paper and board in contact with food. J. 628 Radioanal. Nucl. *Chem.* 248 (2001), 143–147.

[84]. T. Fierens, K. Servaes, M. Van Holderbeke, L. Geerts, S. De Henauw, I. Sioen, G. Vanermen, G., Analysis of phthalates in food products and packaging materials sold on the Belgian 559 market. *Food Chem. Toxicol.* 50 (2012), 2575–2583.

[85]. T. Pagar; S. Ghotekar; S. Pansambal; R. Oza; B. Prasad Marasini, Facile Plant Extract Mediated Eco-Benevolent Synthesis and Recent Applications of CaO-NPs: A State-of-the-art Review, Journal of Chemical Review, 2(3) (2020), 201-210

[86]. T. Sipiläinen-Malm, K. Latva-Kala, L. Tikkanen, M. Suihko, E. Skyttä, and Purity of 652 recycled fibre-based materials. *Food Addit. Contam.* 14 (1997), 695–703

How to cite this manuscript: Alireza Bozorgian, Investigation of Hydrate Formation Kinetics and Mechanism of Effect of Inhibitors on it, a Review, *Journal of Chemical Reviews* (*J. Chem. Rev.*), 2020, 3(1), 374-390. DOI: